Simple Payback

To help managers choose between projects, they can use an unsophisticated measurement called ***simple payback***. If the purpose of the project is to improve cash flow—make it more positive or less negative—the improved positive cash flow each year is applied to the original cost (negative cash flow) of the project to determine how many years it would take to pay back the original cost. It is assumed that after that date, the improved cash flow could be used for other purposes or paid out to owners. For example, if the company borrows $100,000 to fund the project and the project increases cash flow by $20,000 a year, the simple payback would be five years, as shown in Figure 7.2.

Figure 7.2 Simple Payback

Year	0	1	2	3	4	5	6
Expense	$(100,000)						
Income/Savings		$ 20,000	$ 20,000	$ 20,000	$ 20,000	$20,000	$20,000
Annual Cash Flow	$(100,000)	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$20,000	$20,000
Cumulative Cash Flow	$(100,000)	$(80,000)	$(60,000)	$(40,000)	$(20,000)	$ –	$20,000

The cash flow from each year is summed up in the cumulative cash flow row. When the cumulative cash flow becomes zero or positive, it means that the original cost has been paid back by the increased income or savings created by the investment.

Companies can use simple payback to establish a cutoff for project consideration. For example, management could declare that no projects will be considered that have a payback of more than three years. For projects that meet this criterion, projects with shorter simple payback periods would have an advantage in the selection process. Not-for-profit or government organizations are likely to approve projects with longer simple payback periods because they are not compared to other not-for-profit or government agencies based on their profitability.

Internal Rate of Return

Companies whose mission is to make a profit are usually trying to make more profit than their competitors. Simply paying back the loan is not sufficient. If the project involves buying and installing equipment to make a profit, executives can use another method called ***internal rate of return (IRR)***. The IRR is like an internal interest rate that can be used to compare the profitability of competing projects. To calculate an IRR, the company considers the cash flow each year for the expected life of the product of the project. It assumes that some of the annual cash flows will be negative and that they can vary from year to year due to other factors, such as lost production during changeover, periodic maintenance, and sale of used equipment. For example, a company decides to upgrade a manufacturing line with new equipment based on new technology. They know that the initial cash flow—shown in year zero—will be negative due to the expense of the conversion. They know that the new equipment has an expected life of six years before newer technologies make it out of date, at which time they can sell it for a certain salvage value. The inputs to the IRR calculation are the net cash flow for each year where at least one of them is negative and at least one of them is positive. The result is a percentage that indicates how well this project performs as an investment. (See Figure 7.3.)

Figure 7.3 The internal rate of return measures the profitability of an investment.

Year	0	1	2	3	4	5	6
Equipment Cost, Maintenance, Salvage	$(100,000)						$10,000
Income/Savings		$ 20,000	$ 20,000	$ 20,000	$ 20,000	$20,000	$20,000
Annual Cash Flow	$(100,000)	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$20,000	$30,000
Cumulative Cash Flow	$(100,000)	$(80,000)	$(60,000)	$(40,000)	$(20,000)	$ –	$30,000
Internal Rate of Return (IRR)	8%						

The life of the equipment is part of the IRR calculation. If a project manager knows that senior management intends to sell the equipment in six years, team members can be made aware of that decision if it affects their choices.

Other Selection Criteria

Besides making money, there are many other reasons for a project to be selected, including the following:

- Keeping up with competitors
- Meeting legal requirements, such as safety or environmental protection
- Improving the organization's public image

The timing of the project can be very important. A project might be selected at a particular time of year for some of the following reasons:

- Accumulating a year-end budget surplus
- Increasing executive bonus for the year or quarter
- Funding or certification review deadline

If the project manager must make changes to the schedule at some point in the project that could affect its completion date, it is valuable to know if the project was selected because of timing.

Project Champions and Opponents

In addition to knowing why a project was selected, it is valuable to know which senior executives supported or opposed the selection of the project and if the project manager's supervisor was in favor of it or not. Because most project teams consist of people who do not report to the project manager but who report to other unit managers, they might not be available when you need them if their boss thinks other projects are more important. If a particular executive proposed the project and actively advocated for its approval, that person could be a source of support if the project runs into trouble and needs additional resources. A project champion, sometimes called an executive sponsor, is an influential person who is willing to use his or her influence to help the project succeed.

To identify the advocates and opponents of the project, you can read public documents (if available), such as the minutes of the meeting at which the project was approved. Next, the project manager can use his or her unofficial network of trusted colleagues to get their opinions. Those discussions should be informal and off the record. Those opinions might be inaccurate, but it is valuable to know what misunderstandings exist about a project. If executives in an organization are assigned as project sponsors, the project champion might be a different person.

Project Champions Support Employee Performance Training

A large organization hired an instructional design team to improve employee performance. The project took over a year to complete and faced some setbacks due to resistance from middle management. During the course of the project, some department managers were frustrated with the time needed for the project team's assessments, interviews, and

test implementations, which interrupted the normal course of business. Some of the project team's findings also indicated a need for specialized training, which put a greater burden on individual departments and the department managers balked at taking on this additional workload.

However, due to the organization director's priority of performance improvement, the project team had the support and authority to continue. If upper management did not reinforce the efforts of the project team, the department managers would have greatly inhibited the progress of the project. Ultimately, the project was a success and the department managers realized that the temporary upset to the status quo yielded exponential benefits to the organization as a whole.

KEY TAKEAWAYS

- A mission statement declares the purpose of the organization and identifies the primary stakeholders, the products or services offered, and the responsibility toward the stakeholders. Goals are statements of direction for the organization, and objectives are activities that achieve those goals with measurable outcomes.
- Profit-making organizations exist to make profits for their owners while in competition with other companies. Not-for-profit organizations are directed at providing a service to a particular group. A government agency is similar to a not-for-profit organization, but its sources of funding are usually taxes, fees, and funding from a higher level of government, and it has a responsibility to the citizens it represents.
- Two economic tools for evaluating and comparing projects are simple payback and internal rate of return. Simple payback is a calculation of the year when the cumulative income or savings due to spending money on a project will meet or exceed the original cost of the project. Internal rate of return is a calculation of the average percentage of increased cash flow over the life of the project's product.
- Project selection depends on the availability of funds, which depends on the way each type of organization receives money for projects. Funds might be available at certain times and projects are selected that can take advantage of that opportunity. Projects might be initiated for reasons that are not stated, and investigating the source of funding and likely motivation of project champions can provide better understanding of the project's chances for success.
- A project champion is an influential person who is willing to use his or her influence to help the project succeed. It is useful to know why the project champion wants the project to succeed and to be sure to accomplish that goal even if it is not stated.

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[1] https://edtechbooks.org/-VEhH

7.2

Project Scope

Objectives | Project Scope | Project Complexity

LEARNING OBJECTIVES

1. Describe how the project scope is affected by project complexity.
2. Identify the uses of a scope document.
3. Describe how a scope document is developed and changed.

Definition of Scope and the Effects of Complexity

Recall from Chapter 1 that the scope document (also called the scope of work document) defines the ***project scope***—what tasks the project team is expected to accomplish and, just as importantly, what is not part of the project. Depending on the complexity level of the project, the scope document can be as short as one page or as long as several hundred pages. On more technical projects (like the submarine project described in Dr. Gibbons' video), the scope would include a significant amount of technical specifications (such as focusing on the equipment used to find the submarines). The size and character of the project scope document is related to the project complexity. Higher scores on the Darnall-Preston Complexity Index indicate the need for more detailed scope documents.

Image by World Economic Forum

Uses of a Scope Document

A well-developed project scope statement provides the project team with information the team needs to design and implement the project execution plan. The well-developed project scope also provides the team with an understanding of the purpose of the project and the basis for defining project success.

Scope Document for Training Auto Workers

An automotive company is building a new plant to produce electric passenger cars in the southeast United States. As the plant nears completion, the plant's manager issues a contract to an instructional design firm to train the new plant workers. The training of workers who will be maintaining the production equipment will be done by the equipment suppliers and will not be in the scope of the training contract.

The scope of work for the training project will include the identification of the knowledge, skills, and abilities needed by each classification of worker and the development of the delivery methods (online, classroom, hands-on) that will effectively and efficiently teach the identified knowledge, skills, and abilities. The scope will also include delivery of the training, evaluation of the workers after training, and the development of training records. Items not included in the project scope are items that will be the responsibility of the automotive company, such as the selection and hiring of the workers and the provision of the automotive tools and equipment needed for training. These exclusions are specifically stated in the scope document.

During the design of the plant, the Human Resources Division of the company explored different workforce models. Experience in other plants indicated that a team-based approach combined with a lean manufacturing philosophy produced the highest productivity. This information was included in the documents provided to the team developing the training project's scope. The plant manager, the human resources manager, and the plant engineer reviewed and occasionally made changes to the draft training scope.

The scope of work for the training project was developed from a combination of information from experts with previous experience, documents that reflected the plant operation philosophy, and selected managers from operations and human resources. All the knowledge needed to develop the scope was within the automotive project team. Sometimes outside consultants are needed to develop a complete project scope. For example, if the team in our automotive training example did not have experience in the start-up of another automotive plant, then the hiring of a consultant with

that experience might have been required to understand the entire scope of activities needed for training the automotive workforce.
The automotive project described above is a typical example of the types of information and the people involved in developing a project scope. From the information in the project description, the project team could develop a project scope document.

Development and Management of a Scope Document

The project manager will often develop the first draft of the project scope and then solicit feedback and suggestions from the project team, client, and sometimes key vendors. The project manager will attempt to develop consensus around the project scope, but the final approval belongs to the project client or sponsor. Depending on the complexity profile of the project, the development of the project scope document can be a short discussion between the project manager and the client, or on a large, complex project, the process can take weeks.

The project scope is not a stagnant document, and changes are to be expected. Changes to the project scope are necessary to reflect new information. Changes to the project scope also create the opportunity for new purposes to emerge that will change the end results of the project. In some cases, these new results represent a positive outcome for the chartering organization.

Deviation versus Change

If a minor change is made to the schedule that does not affect the completion date of the project, it is a deviation from the schedule. As long as the end date of the project or major objectives are not delayed, a formal change request to the client is not needed. Recording and communicating these schedule deviations is still important for coordinating resources and maintaining the client's awareness of the project's progress.

Deviation of Educational Materials Cost

In our example above, the cost of educational materials for employee training was estimated at fifteen dollars per training packet. The winning bid for the printing contract actually quoted a cost of sixteen dollars per packet. The cost deviated from the estimate and a change was made to the budget. This was a cost deviation, not a change in scope. The additional cost for the materials was covered from the project contingency reserves, and the budget was revised to reflect the changes.

New Boss Causes a Change to the Schedule

The client hired a new boss who wants something completely different from what was decided upon under the old management. This is an actual change of scope that requires a change request because it changes the budget, the timeline, and the materials needed.

Documenting Changes

It is important to have a written record of changes to the scope of a project. On the least complex projects, an e-mail message can be sufficient, but on larger projects a standard form is normally used. The following steps are paraphrased from Tom Mochal,[1] and they have the necessary components of a change documentation process:

- Inform project stakeholders of the change request process.
- Require that the change request is made in writing, including the business value of the change to the project.
- Enter the request into a ***scope change log***, a record that should be kept to track changes (remember – "Document, document, document!").
- Estimate the time needed to evaluate the change. If the evaluation process is time consuming and would affect activity completion dates by diverting management resources, get approval from the project sponsor to evaluate the change request. If the evaluation is not approved, record the decision in the scope change log.
- Evaluate the change and its impact on the schedule and budget if the evaluation is approved.
- Present the change request to the project sponsor for approval. Record the decision in the scope change log with the recommended course of action.
- Distribute the scope change log periodically to team members so they know what changes are being considered and what happened to those that were not approved or evaluated.
- If the change is approved, update the project charter or other initiation documents.
- Update the work plan.
- Distribute the revised work plan to stakeholders and team members.

KEY TAKEAWAYS

- Scope is a description of the major tasks that are included in the project and some of the tasks that are specifically not included. More complex projects require more detailed and specific scope documents.
- A scope document is used to provide the project team with the information it needs to design and implement the project plan. It provides understanding of the purpose of the project and what project success would be.
- The scope document begins as a draft that is circulated for comments by the team, client, and in some cases, key vendors. The final draft is approved by the client or sponsor. Changes to the scope must be approved by the project sponsor or client and are documented carefully using standard forms and processes.

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[1] Tom Mochal and Jeff Mochal, Lessons in Project Management (Berkeley, CA: Apress, 2003).

7.3

Project Start-Up

Project | Project Manager | Project Infrastructure

LEARNING OBJECTIVES

1. Identify the major activities included in project start-up.
2. Explain how the project start-up activities may differ on a highly complex project.

The parent organization's decision-making process influences when start-up activities of the project will take place. The transition from planning to project initiation is typically marked by the decision to fund the project and the selection of the project manager. However, be aware that the selection of the project manager is not always the defining event. Some organizations will have the project manager involved in project evaluation activities, and some select the project manager after the decision to fund the project has been made. Including the project manager in the evaluation process enables the project manager to have an understanding of the selection criteria that he or she can use when making decisions about the project during later phases. Selecting the project manager prior to a complete evaluation also includes some risks. The evaluation of the project may indicate a need for project manager skills and experiences that are different from the project manager who is involved in the evaluation.

Selecting the best project manager depends on how that person's abilities match those needed on the project. Those skills can be determined using the Darnall-Preston Complexity Index (DPCI). If the project profile indicates a high complexity for external factors and a medium complexity for the project's technology, the profile would indicate the preference for a project manager with good negotiation skills and an understanding of external factors that affect the project. Because of the technological rating, the project manager should also be comfortable in working with the technical people assigned to the project. The project manager involved in the project selection process may not be the best match for the project execution.

During the start-up of a project, the project manager focuses on developing the project infrastructure needed to execute the project and developing clarity around the project charter and scope. Developing the project infrastructure can be a simple task on a project with a low complexity level. For example, the project manager of a worker training project in South Carolina who works for a training college has existing accounting, procurement, and information technology (IT) systems in the college that he or she can use. On large complex projects, a dedicated project office, IT system, and support staff might be needed that would be more challenging to set up. For example, on a large project in South America, the design and operations offices were set up in Canada, Chile, and Argentina. Developing compatible IT, accounting, and procurement systems involved a high degree of coordination. Acquiring office space, hiring

administrative support, and even acquiring telephone service for the offices in Argentina required project management attention in the early phases of the project.

Image by Novartis AG

The project manager will conduct one or more kickoff meetings to develop plans for the following activities:

- Establish the project office
- Develop project policies and procedures
- Begin refining the scope of work, the schedule, the budget, and the project execution plan

Depending on the complexity level of the project, these meetings can be lengthy and intense. Tools such as work flow diagrams and responsibility matrices, as defined in Chapter 8, can be helpful in defining the activities and adding clarity to project infrastructure during the project start-up.

Typically, the project start-up involves working lots of hours developing the initial plan, staffing the project, and building both internal and external relationships. The project start-up is the first opportunity for the project manager to set the tone of the project and set expectations for each of the project team members. The project start-up phase on complex projects can be chaotic, and the project manager must be both comfortable in this environment and able to create comfort with the client and team members. To achieve this level of personal comfort, the project manager needs appropriate tools, one of which is an effective alignment process. This is one of the reasons there are a large number of meetings during the start-up of projects with a high-complexity profile.

KEY TAKEAWAYS

- The major activities included in project start-up are selecting the project manager; establishing funding; developing project infrastructure such as accounting, procurement, and IT; holding a kickoff meeting, determining staffing; and building relationships.
- The start-up activities for small projects can utilize existing infrastructure for support functions and can have a single start-up meeting, while larger projects require more dedicated infrastructure and full-time staff, and the start-up meetings can take longer and involve more people.

7.4

Alignment Process

Goals | Trust | Alignment | Purpose

LEARNING OBJECTIVES

1. Identify the purpose of the alignment process.
2. Identify the components of the alignment process.
3. Identify the effects of a lack of trust on a project.

Developing a common understanding among the key stakeholders of the purpose and goals of the project and the means and methods of accomplishing those goals is called the ***alignment process***. It is important to accomplish this alignment during the initiation phase. Project managers usually conduct a start-up meeting that is sometimes called a kickoff meeting. The agenda and duration of the start-up meeting depends on the complexity level of the project. Projects with a limited scope and short duration may engage in a session start-up meeting over lunch. A medium-complexity project will require a four-hour meeting or more while a high-complexity project cannot achieve alignment in a single meeting. Alignment can require several days of activities.

Enhance Alignment Meetings

On one large, complex project, the project alignment required a five-day process. Over twenty members of the project team and client participated in this alignment. To create a relaxed atmosphere and facilitate an open discussion, the alignment meetings and activities were held on a horse ranch in Montana.
A number of companies specialize in designing and facilitating alignment sessions for large, complex projects. Although designed to meet the needs of each project, alignment sessions have some common agenda items:

- Developing a common understanding of the project purpose
- Agreeing on the means and methods for accomplishing the purpose
- Establishing trust among team members

Common Understanding

A common understanding does not mean building a consensus. People may disagree with the direction being developed, but they have the same basic understanding as to the purpose of the project. For a project plan to be effective, there must be a critical mass or sufficient commitment among the critical stakeholders. Therefore, disagreement is not fatal to the project execution, but a unified team with a common understanding is much more

powerful and increases the likelihood of success. If disagreement does exist, an open and forthright discussion will enable the project leadership to address the disagreement in developing the project plan. If the disagreement stays hidden and is not openly discussed, problems will emerge later in the project.

Developing a common understanding can be as easy as an informal discussion that lasts a few hours, or it can be a lengthy, complex process. The methods and processes employed to develop a common understanding are directly related to the complexity of the project. The more complex projects will require more intense discussions around those issues that score high on the complexity profile.

Developing a common understanding among the key project stakeholders requires the following:

- Defining project success
- Determining potential barriers to success
- Establishing key milestones
- Identifying decision makers and the decision-making process

It is difficult to execute a successful project without first defining what makes a successful project. The first part of this discussion is easy: the project must be completed on time, within budget, and to all specifications. The next level of the discussion requires more reflection. During this discussion, reflection on the organization's mission, goals, and related issues such as safety and public perception of the project emerge.

After the team develops a common understanding of project success, a discussion of barriers to achieving that success enables team members to express skepticism. On more complex projects, the goals of a project often seem difficult to achieve. A discussion by the team of the potential barriers to project success places these concerns out in the open where team members can discuss and develop plans to address the barriers. Without this discussion, the perception of these barriers becomes powerful and can have an effect on project performance.

Project Purpose

The project purpose is sometimes reflected in a written charter, vision, or mission statement. These statements are developed as part of the team development process that occurs during the project initiation phase and results in a common understanding of the purpose of the project. A purpose statement derived from a common understanding among key stakeholders can be highly motivating and connects people's personal investment to a project purpose that has value.

A ***purpose statement***—also called a charter, vision, or mission—provides a project with an anchor or organizational focus. Sometimes called an anchoring statement, these statements can become a basis for testing key decisions. A purpose statement can be a powerful tool for focusing the project on actions and decisions that can have a positive impact on project success. For example, a purpose statement that says that the project will design and build a free educational website for high-school students will influence meeting educational goals, designs appropriate for cognitive development levels, the cost, etc. When designers are deciding between different types of materials or instructional methods, the purpose statement provides the criteria for making these decisions.

Image by thekenyeung

Developing a common understanding of the project's purpose involves engaging stakeholders in dialogue that can be complex and in-depth. Mission and vision statements reflect some core values of people and their organization. These types of conversations can be very difficult and will need an environment where people feel safe to express their views without fear of recrimination.

Goals

Goals add clarity to the anchor statement. Goals break down the emotional concepts needed in the development of a purpose statement and translate them into actions or behaviors, something we can measure. Where purpose statements reflect who we are, goals focus on what we can do. Goals bring focus to conversations and begin prioritizing resources. Goals are developed to achieve the project purpose.

Developing goals means making choices. Project goals established during the alignment process are broad in nature and cross the entire project. Ideally, everyone on the project should be able to contribute to the achievement of each goal.

Goals can have significantly different characteristics. The types of goals and the processes used to develop the project goals will vary depending on the complexity level of the project, the knowledge and skills of the project leadership team, and the boldness of the project plan. Boldness is the degree of stretch for the team. The greater the degree of challenge and the greater the distance from where you are to where you want to be, the bolder the plan and the higher the internal complexity score.

Clarity of Objectives Saves Money

A critical online instructional resource was being developed for a project in Michigan. Designers determined that a software upgrade would enable the resource to be developed one month earlier, but at a cost higher than was allocated in the budget. Earlier in the project it was determined that any delays would cost the project over $100,000 per month.

Because the objectives of the project were well understood, the decision to obtain the more expensive software was made quickly and easily.

Roles

Role clarity is critical to the planning and execution of the project. Because projects by definition are unique, the roles of each of the key stakeholders and project leaders are defined at the beginning of the project. Sometimes the roles are delineated in contracts or other documents. Yet even with written explanations of the roles defined in documents, how these translate into the decision-making processes of the project is often open to interpretation.

A discussion of the roles of each entity and each project leader can be as simple as each person describing their role and others on the project team asking questions for clarification and resolving differences in understanding. On less complex projects, this is typically a short process with very little conflict in understanding and easy resolution. On more complex projects, this process is more difficult with more opportunities for conflict in understanding.

One process for developing role clarification on projects with a more complex profile requires project team members, client representatives, and the project's leadership to use a flip chart to record the project roles. Each team divides the flip chart in two parts and writes the major roles of the client on one half and the roles of the leadership team on the other half. Each team also prioritizes each role and the two flips charts are compared.

This and similar role clarification processes help each project team member develop a more complete understanding of how the project will function, how each team member understands their role, and what aspects of the role are most important. This understanding aids in the development or refinement of work processes and approval processes. The role clarification process also enables the team to develop role boundary spanning processes. This is where two or more members share similar roles or responsibilities. Role clarification facilitates the development of the following:

- Communication planning
- Work flow organization
- Approval processes
- Role boundary spanning processes

Means and Methods

Defining how the work of the project will be accomplished is another area of common understanding that is developed during the alignment session. An understanding of the project management methods that will be used on the project and the output that stakeholders can expect is developed. On smaller and less complex projects, the understanding is developed through a review of the tools and work processes associated with the following:

- Tracking progress
- Tracking costs
- Managing change

On more complex projects, the team may discuss the use of project management software tools, such as Microsoft Project, to develop a common understanding of how these tools will be used. The team discusses key work processes, often using flowcharts, to diagram the work process as a team. Another topic of discussion is the determination of what policies are needed for smooth execution of the project. Often one of the companies associated with the project will have policies that can be used on the project. Travel policies, human resources policies, and authorization procedures for spending money are examples of policies that provide continuity for the project.

Trust

Trust on a project has a very specific meaning. Trust is the filter that project team members use for evaluating information. The trust level determines the amount of information that is shared and the quality of that information. When a person's trust in another person on the project is low, he or she will doubt information received from that person

and might not act on it without checking it with another source, thereby delaying the action. Similarly, a team member might not share information that is necessary to the other person's function if they do not trust the person to use it appropriately and respect the sensitivity of that information. The level of communication on a project is directly related to the level of trust.

Trust is also an important ingredient of commitment. Team member's trust in the project leadership and the creation of a positive project environment fosters commitment to the goals of the project and increases team performance. When trust is not present, time and energy is invested in checking information or finding information. This energy could be better focused on goals with a higher level of trust.[1]

Establishing trust starts during the initiation phase of the project. The kickoff meeting is one opportunity to begin establishing trust among the project team members. Many projects have team-building exercises during the kickoff meeting. The project team on some complex projects will go on a team-building outing. One project that built a new pharmaceutical plant in Puerto Rico invited team members to spend the weekend spelunking in the lime caves of Puerto Rico. Another project chartered a boat for an evening cruise off the coast of Charleston, South Carolina. These informal social events allow team members to build a relationship that will carry over to the project work.

KEY TAKEAWAYS

- The purpose of the alignment process is to develop a common understanding of the purpose, agree on the means and methods, and establish trust.
- The components of the alignment process are discussions of the purpose, goals, participant roles, methods of tracking progress and costs, methods of managing change, and building trust.
- The effects of a lack of trust are delays caused by fact checking or missing information that was not shared because the person's discretion was not trusted to handle sensitive information.

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[1] Marsha Willard, "Building Trust: The Relationship Between Trust and High Performance," Axis Advisory 1999, http://www.paclink.com/~axis/M7trust.html.

7.5

Communications Planning

Communication | Organization | Information Flow | Communication Matrix

LEARNING OBJECTIVES

1. Describe the differences between communications in an existing organization compared with a new project.
2. Describe how the detail of the communications plan is related to the complexity of the project.
3. Describe a communication matrix and its function.
4. Describe conventions for naming files to indicate their content and the version.

When a person joins an existing organization, one of the early tasks is to learn the work processes of the organization, including where to find information, the meeting schedule, and what reports are required. In existing organizations, new members discover the gatekeepers of information: those persons in the organization who know how to generate or find information. Typically, the generation, flow, and storage of information reflects the organizational culture, and to effectively communicate in an organization, a person must be able to develop communication styles and processes consistent with that organization.

Image by Anthony Albright

Projects do not have the advantage—or sometimes the disadvantage—of an existing organizational culture or communication structure. The project leadership team develops an understanding of the information needs of the various members and stakeholders of the projects and develops a communications plan that provides the right information, at the right time, to the right people.

The detail of the communications plan is related to the complexity level of the project. Highly complex projects require a detailed communications plan to assure that the information needed by the project team and stakeholders is both generated and distributed to support the project schedule and project decisions. Crucial information can be lost or delayed in a complex project if the communications plan is not functioning properly.

Communicating Priorities

During a project in Tennessee, the project management team was exploring ways to complete the project earlier to meet the changing requirements of the client. The team identified a number of actions that could create an earlier completion date. The plan required an early delivery of testing materials by, and the team visited the supplier's senior management and agreed to pay a bonus for early delivery of the equipment.

Two weeks later, during a review of the project procurement team progress, the project manager discovered that the organization's procurement department had delayed approvals needed by the supplier because the engineering design was not submitted in the required format. This action effectively delayed the project two weeks and reduced the possibility of the project team meeting milestone requirements for earning a bonus.

The organization's procurement team did not understand the critical nature of this supplier's contribution to an early completion of the project. All the information needed by the organization's procurement team was in the meeting minutes distributed to the entire team. The procurement team did not understand the implications of their work processes, and the result was a delay to the project schedule and a reduction in client satisfaction and project profitability.

Effective communication on a project is critical to project success. The Tennessee project is a typical example of errors that can be created by the breakdown in communication flow. Highly complex projects require the communication of large amounts of data and technical information that often changes on a frequent basis. Even when the information is

at the right place and at the right time, the project procurement leader must assist the procurement team in understanding the priorities of the project. On large, complex projects, that procurement lead would not be in the daily communication to subcontractors or vendors. In the Tennessee project example, the procurement leader's unique understanding that came from participation in the project leadership meeting required a more direct involvement with those subcontractors and vendors that impacted the project goals.

An effective project communications plan also does not overload team members and project systems with information that is not useful. Some project managers will attempt to communicate everything to the entire project team. Although this assures that each team member will receive critical information, the large influx of information can make the distillation of the information to the critical and relevant people more difficult for each team member.

Communication Matrix

A Guide to the Project Management Body of Knowledge (PMBOK) describes tools and techniques for identifying project stakeholders, defining their information requirements, and determining the appropriate communication technology. The project includes developing a list of all the people impacted by the outcome of the project and people who can influence the execution of the project, including project team members. The project leadership then generates a list of information needed or requested by each stakeholder.

The project leadership team develops a list of communication methods for gathering and communicating project information. These include a list of reports, meetings, and document flowcharts. The leadership team then typically develops a ***communication matrix*** that details who is included in each project meeting and the distribution of major documents in a table format.

Figure 7.4 Simple Communication Matrix

Title	Scope Statement	Work Breakdown Structure	Budget	Quality	Change Management Procedures	Change Approvals
Project Chartering Committee	✓					
Client Representative	✓	✓	✓	✓	✓	✓
Project Manager	✓	✓	✓		✓	✓
Technology Team		✓		✓		
Finance Team			✓		✓	
Schedule Coordination Team		✓		✓	✓	

Document Control

On large, complex projects, organizing the creation, distribution, and storage of documents is a major and important activity. Organizations that execute a large number of complex projects will often have project document control systems that the project leadership team will adapt for their project. Document control systems distribute, store, and retrieve information that is needed by the project team. Documents originate from the various team members during the planning and execution of the work and then are transmitted to the document team for cataloging, distributing, and storing.

Document control systems have a systematic numbering system that allows a team member to derive information about the document through the document number.

Document Naming Provides Information about the Content

It is useful to have a unified system for naming documents which immediately provides content identification. For example, document names might indicate the category, purpose, author, and date via standardized codes that the project team adheres to. For example, a file named RFQ3.Monitors-Darnall-10.08.2012,rev3 lets team members instantly know this is a procurement document, which item was procured, who it was prepared by, when it was prepared, and what revision number it is.

When a document is expected to be revised over the course of the project, version control becomes important. ***Version control*** means labeling each revision which enables the team to understand the latest activity and status of the document (or the activity behind the document). For example, each drawing might be given a unique identification that reflects the type of drawing, the artist, and the version number. Because the design process includes several iterations of the drawings as more information is developed, document control uses an identification that indicates the version of the document. One procedure might be to use letters to indicate the version of the document until the document is approved and then use a number after approval. Therefore, a document with revision D will be the fourth version of the document. The same document with revision 3 means that this is third revision after the project was approved for construction.

To assure that everyone who should either review or approve the document received a copy, document control develops a distribution list for each type of document. Each person reviews and signs the distribution list and then sends the document to the next person on the list. The design documents, distribution lists, and other project documents are archived by document control for future reference. In the example above, the document was the third revision after the design was approved.

Naming conventions for files and the versions of files should be consistent with the practices of the parent organization or with the client organization so that the files may be archived with files from other projects.

KEY TAKEAWAYS

- In an existing organization, there are gatekeepers who know how to find information, when it is needed, and what reports are required. In a new project, the project manager can create a new flow of information and reporting requirements.
- More complex projects require more sophisticated communications plans.
- A communication matrix is a table that shows the names of people as column or row headings and the types of documents as row or column headings. In the cells where the name and document type intersect, a symbol indicates the person's responsibility or access with regard to that type of document.
- File names can be used as codes to describe the contents of the file. Parts of the name can be used to identify the category, location, subject, author, and date. File name conventions should be used that match those used by the parent organization or by the client.

8

Project Time Management

Overview

This chapter aligns with Chapter 6 of the PMBOK and 11% of the CAPM questions come from this knowledge area. Th content connects to the Planning and Monitoring & Controlling category of the PMP questions.

> *"In preparing for battle, I have always found that plans are useless, but planning is indispensable." –Dwight D. Eisenhower*

Although stated for a context quite distinct from instructional design, the above quote encapsulates several key truths about planning when it comes to project management: A well-structured plan and schedule fulfills an essential role in the completion of successful projects, although it may often be the case that events unfold quite differently from wha was originally projected.

The nature of the planning process varies by project. For larger and more complex projects, there may be an extensive planning process with multiple layers of complexity, documentation, and specialized staff; while for smaller projects, t planning process may consist of little more than a regularly updated Excel spreadsheet by a single project manager.

The purpose of this chapter is to provide you with a framework by which to approach planning as a project manager. Project planning and scheduling is both an art and a science. No two project managers or planning professionals develop identical plans or project schedules. The planning process is creative and reflects each planner's approach ar style. Even though the project plan is unique to the approach and style of the planner, methods for developing the schedule and documenting the resulting plan typically follow certain patterns. These include:

- Identification of project resources and scope
- Development of a project timeline
- Deciding on project milestones
- Determining the schedule of activities

By following these steps the project manager is in better position to successfully guide the project to completion.

Designers Share Their Experiences

Dr. Andy Gibbons – Instructional Psychology and Technology – BYU

Watch on YouTube

On this particular project, we were training two different positions: A helicopter pilot and a sensor operator who operated sensitive electronic equipment. We had about 500 different pieces that were being created of media, different kinds of media. Each one had to go through its own little development process. So managing the schedule was figuring out how many of each piece we had to create, how many steps it had to go through, how long each step would take on average, and then doing the multiplication deal. This was, by the way, before the day of spreadsheets, and so we didn't have, this is all done by hand on big sheets of graph paper. But we would build a schedule–actually there are two ways to do a schedule. On this project we were able to manage the schedule that way. We could do a very systematic approach, number of people, amount of time for each step, that kind of thing, and it worked out very well. On another project that I worked on, I did the same thing on a big piece of graph paper that was, here is this many things that need to be created, and here is this many steps, and I actually plotted each piece of thing that had to be created on a certain number of squares on this graph paper. And as the list grew, I still have this chart at home as a reminder that the systems approach doesn't always work. Because I got about half way down the list of things to be produced and I was already at the end of the project and there were still the rest of the things on this plan, the rest of the things had to be produced and it was going to double the time of the project. And so we finally just said, throw it away. We're just going to get it done. We don't know how we're going to get it done, but we're going to get it done. And we just started putting it through, and it worked, we were done on time, satisfied customer.

Heather Bryce – Independent Studies – BYU

Watch on YouTube

At the very beginning, I think the key to Art 45 or any project that you work in is to do as much planning work up front, in making predictions on how long you think something will take a team. A lot of a project is one part of the team will work on their portion of it, and then they'll pass it off to another team. So they're kind of dependent. And so we really try to get together and figure out. Okay, this project started last year in January, so you know, editing would take from January to March, from March to June we would be working on the Flash or the video. I think that's really key, is to plan ahead of time. To make sure that you kind of have a basis schedule and then what I do is, we actually have a program here that is a task management program. So, one person checks off their task. The next person who is supposed to receive the task will have it show up in their dashboard. And then that kind of helps control the flow of processes. And then I check in and remind people, because we have several people on several different teams. So you could be working on several different projects at the same time. So, one of my functions is to check in on people. Have regular meetings and see that we're staying on schedule. Our general guideline for a course is about a year. From beginning, when we're planning the idea to when we finish and it is actually available to students. We try to get it finished within a year, and this course finished within a year.

Dr. Larry Seawright – Center for Teaching and Learning – BYU

Watch on YouTube

You know, the BYU Learning Suite because it's such a large project, very complex, lots of different components, scheduling is our biggest difficulty. So, you know, we've got resources we have to schedule, the developers, instructional designers, graphic designers. So the complexity of that was my biggest challenge as a project manager. We always kept running into bottlenecks, the critical path, you know, seemed like one person, you know, they'd bounce around. Okay, as soon as we get this problem resolved and this person off the critical path, now we've got another one. So initially it was the instructional designers, they've got to get the initial look and feel, and their working that out with the consultants, we're gathering all the requirements, we're building the initial design. Now we have to throw it over to our graphic designer, and he's got to develop the high fidelity look and feel for the programmers to develop. And they take that look and feel, combine it with the requirements and they know what to program. So, you know, you're going through all those different things and it's like, how hard do you push this person, you know. And one of the constraints that we're working with is we're not a business. I can't say we've got a deadline, I don't care if you have to work 60, 70 , 80 , 90 hours a week, you got to get it done. This is a University where we kind of don't do that. It's not like we're working 40 hour weeks, but we're not working 60 hour weeks, at least not all of us are. Some of us are. So that's the biggest issue is how do you get the schedule in a constrained environment where your resources really are only working this many hours a week, as many as we're paid to work. And so that's the biggest difficulty, but that's true with any project. You have schedules and the resources that you have. And you have to know how hard you can push without pushing so hard that they leave, try to find a better job, they become disgruntled, they become less effective, because you can only work so many hours of peak efficiency work and then it starts dropping off. So you have to balance all those issues whether you are in a University environment or not, but in any instructional project you have almost always limited resources because folks who build instructional products are trainers, product specialists, folks who generally don't have unlimited budgets. So you have a limited amount of budget, a limited amount of time to get things done. So the schedule is often the thing that drives those other things. So you know, we've only got this much money to spend, and we've got this much time, so we're going to get this much done.

8.1

Types of Schedules

Master Schedule | Detail | Schedule | Project

LEARNING OBJECTIVES

1. Define the types of project schedules.

The schedule develops as the project moves from its early conceptual phase into the execution phase.

Image by Cairn

SCHEDULES

When the scope of the project is being determined, a conceptual simple schedule that shows the major tasks and approximate start and end dates is developed to allow senior management to make decisions about the scope of the project. Detail is not required at this stage because entire tasks might be dropped from the scope, or the whole project might not be approved.

Master

If the project is chosen, a master schedule is created. It has major events and dates such as the starting date and the completion date. The master schedule is often part of a contract. Changes to the master schedule must be approved using a documented change process with approval by the project sponsor and client.

Detail

To execute the master schedule, the major activities are broken down into smaller activities and resources are assigned to those activities. The most detailed versions or portions of the schedule may be developed a few weeks prior to the execution of those activities and are called two-week plans. Portions of the master schedule that affect particular vendors might be sent to them so they can provide detailed activities that they would perform.

KEY TAKEAWAYS

- Types of schedules vary in detail. A broad, general conceptual schedule is used in the earliest phases of the project design.
- A master schedule with start date, milestones, and completion date becomes part of the contract and is changed by mutual agreement using a formal change process.
- Details are added to the master schedule as needed to perform the work of the project activities.

8.2

Elements of Time Management

Project Management | Time management | Graphic representations | Work breakdown

Learning Objectives

1. Describe a work breakdown structure and how it relates to activities.
2. Describe the use of graphic representations for time management.

Project Time Management

According to the Project Management Institute (PMI), project time management includes the following elements:[1]

- Define activities
- Sequence activities
- Estimate activity resources
- Estimate activity durations
- Develop schedule
- Control schedule

The list of activities, their relationship to each other, and estimates of durations and required resources comprise the ***work breakdown structure (WBS)***. The project WBS is a hierarchical—classified according to criteria into successive levels—listing and grouping of the project activities required to produce the deliverables of the project. The WBS represents a breakdown of the project into components that encompass the entire scope of the project. Each level of the WBS hierarchy represents a more detailed description of the project work so that the highest level represents broad categories, and the lower levels represent increasing amounts of detail.

Image by Klaus Schoenwandt

Larger and more complex projects often require a larger WBS. The size of the WBS is directly related to the amount of work on the project and how that work is divided into work packages. The WBS can be developed around the project phases or the project units or functions that will be performing the work. A WBS organized around the project phases facilitates the understanding of the amount of work required for each phase of the project. A WBS developed around the project units or functions of the project facilitates the understanding of the amount of work required for each function.

The following example, “John’s move”, will often be used throughout the rest of the book. It has a low level of complexity compared to a larger project and would probably not receive the amount of detailed planning described in the following examples; however, we felt this basic scenario, which is familiar to most people, will demonstrate the concepts that can be applied to any project.

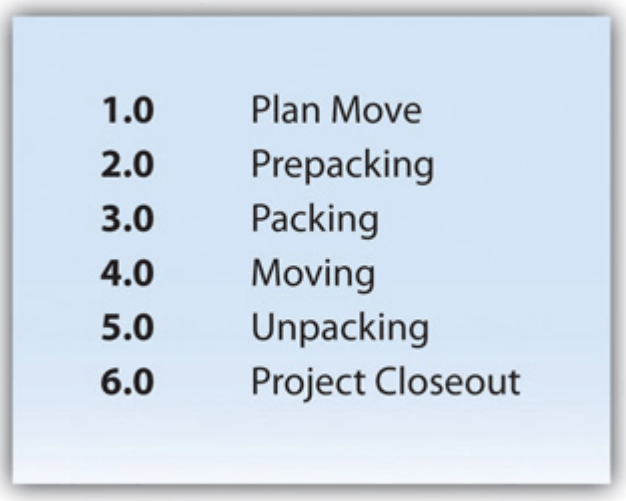
John’s Move

John has a small but important project. He has accepted an instructional design position in Atlanta and now has to move from Chicago to Atlanta and be there, ready to work, right after the Christmas holidays. If the furniture arrives in good condition at least two days before John starts work, and for less than five thousand dollars, the project will be a success. The move to Chicago five years ago cost five thousand dollars, but John is smarter now and will use his friends to help, so he is confident he can stay within budget.

Developing a WBS begins by defining and developing lists of all activities—work performed on the project that consumes project resources, including cost and time—needed to accomplish the work of the project. The first draft of the WBS includes activities at the highest level of the hierarchy or the management level and typically includes the major activities or summary activities required to accomplish the deliverables identified in the project scope of work. On John’s move project, these top-level activities are numbered 1.0, 2.0, 3.0, and so on, as shown in figure 8.1.

Figure 8.1

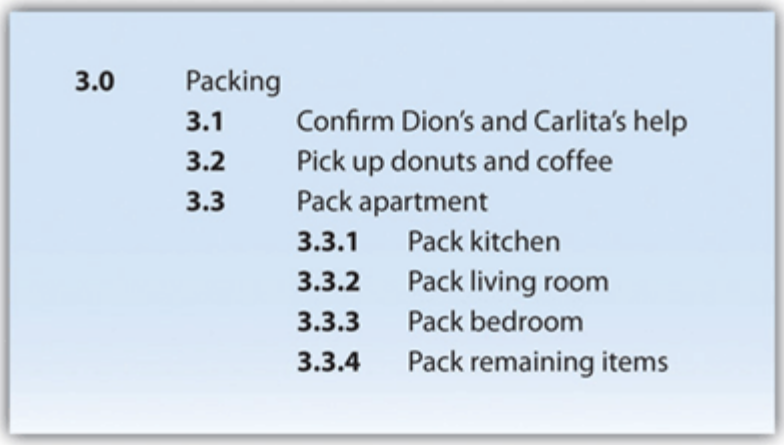
Summary Level Activities



One of John's Summary Level Activities is Packing (3.0). The activity is then decomposed—broken down into smaller units—to the next level by listing the tasks needed to accomplish that step, as shown in figure 8.2. The first subdivision of activities is listed as 3.1, 3.2, and 3.3. The WBS shows a greater level of detail by listing the tasks needed for each subdivision activity, such as 3.3.3 Pack bedroom (which could be decomposed further, such as 3.3.3.1 Pack closet, 3.3.3.2 Pack drawers, etc.). This type of numbering of the activities is called ***intelligent numbering***. In intelligent numbering, the numbering system has meaning so that a member of the project team knows something about the activity by the number of the activity. For example, any activity associated with packing begins with a 3; even picking up donuts is an activity under packing because the donuts are a form of payment for the packing labor of Dion and Carlita.

Figure 8.2

Major Activity Decomposed into Smaller Activities



The WBS is developed or decomposed to the level that the manager needs to control or manage the project. On our John's move example, the project schedule may have been just as effective without detailing the packing of the individual rooms in the old apartment. If we deleted these items, would John know when he needed to pack each one of these rooms? If the answer is yes, then we may not need that level of detail.

Estimation of Duration

After the project team has created the WBS, each activity is reviewed and evaluated to determine the ***duration*** (how long it will take to accomplish from beginning to end) and what ***resources*** (time, materials, facilities, and equipment) are needed. An ***estimate*** is an educated guess based on knowledge, experience, and ***inference***—the process of deriving

conclusions based on assumptions. The accuracy of the estimate is related to the quality of the knowledge and how that knowledge is applied. The person with the most knowledge may not be the most objective person to provide duration estimates. The person responsible for the work may also want to build in extra time. Multiple inputs into the duration estimate and a more detailed WBS help reduce ***bias***—the making of decisions based on a prejudged perspective.

Duration Estimate for Training

A language training facility recently decided to start teaching Arabic. The language training manager will need to know when the new language materials can be acquired, when the new instructors will start their training on the curriculum and when they can start teaching. The facility's human resources manager will need to know what skills the workers need to teach Arabic and how much time each training class will take. In addition, the HR manager will need to include activities to locate facilities, schedule training, write contracts for trainers, and manage the initiation of training classes. As can be seen, a duration estimate can become very complicated and require an even greater level of detail, which could be measured in days, hours or even minutes.

The unit of time used to develop the activity duration is a function of the level of detail needed by the user of the schedule. Typically, larger and more complex projects require a more detailed WBS—which usually translates into shorter time for the actual activities. The unit of duration is typically working days but could include other units of time such as hours, weeks, or months. The unit chosen should be used consistently throughout the schedule.

Resource Allocation and Calendars

A common resource constraint is availability. To consider the availability of team members, consultants, and vendors, you can create a ***resource calendar*** that indicates which days they are available and which are days off. A calendar for team members from the same company could be the company calendar that shows working days, weekends, and holidays. Individual team members can have individual calendars that show their vacation days or other days off, such as parental leave days. If major pieces of equipment are only available for certain periods of time, they can be given a resource calendar.

Resource calendars become important tools when changes must be made to the schedule. When a resource calendar is applied to a duration estimate, the duration in days is distributed across the available calendar days. For example, if the duration is three days and the start date of the activity is Thursday, the activity would begin on Thursday and end on Monday of the following week, assuming the resource calendar shows that the person has the weekend off. If the weekend included an extra day off for a holiday like Labor Day, the completion day of the same three-day activity would be pushed to Tuesday.

Activity Sequencing

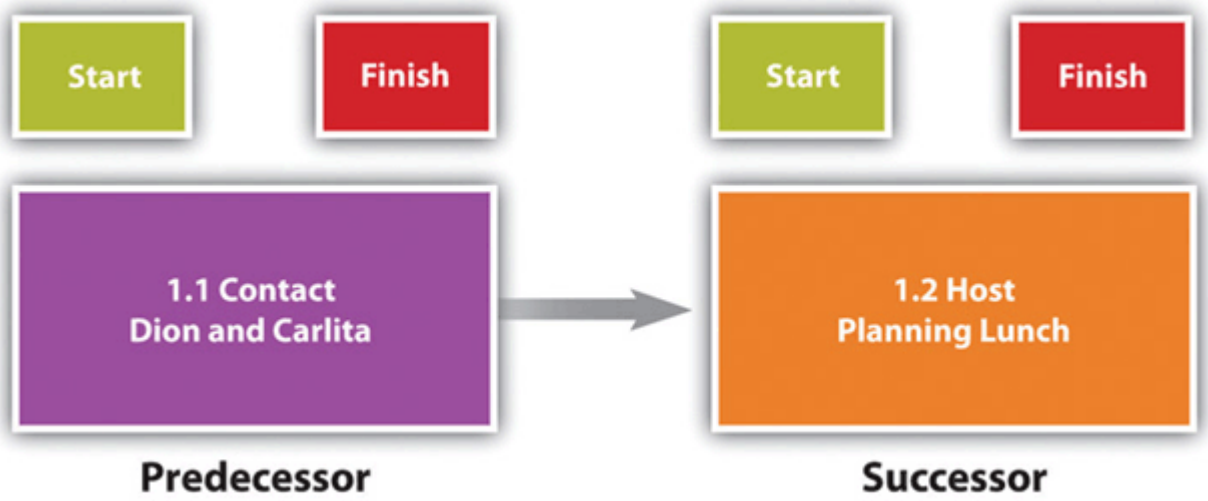
Determining the schedule of a project begins by examining each activity in the WBS to determine its relationship to the other activities. The ***project logic*** is the development of the activity sequence or determining the order in which the activities will be completed. The process for developing the project logic involves identifying the predecessors—activities that come before—and successors—the activities that come after.

Project Logic for John's Move

In our example of John's move, contacting Dion and Carlita—activity 1.1—comes before the lunch meeting is scheduled. You must logically contact Dion and Carlita before you schedule your Host Planning Lunch—activity 1.2. Your conversation with Dion and Carlita will provide you with dates they are available and establish their commitment to help you move. Therefore, the conversation with Dion and Carlita is a predecessor to the Host Planning Lunch Activity. This relationship is diagramed below.

Figure 8.3

Relationship between Two Activities



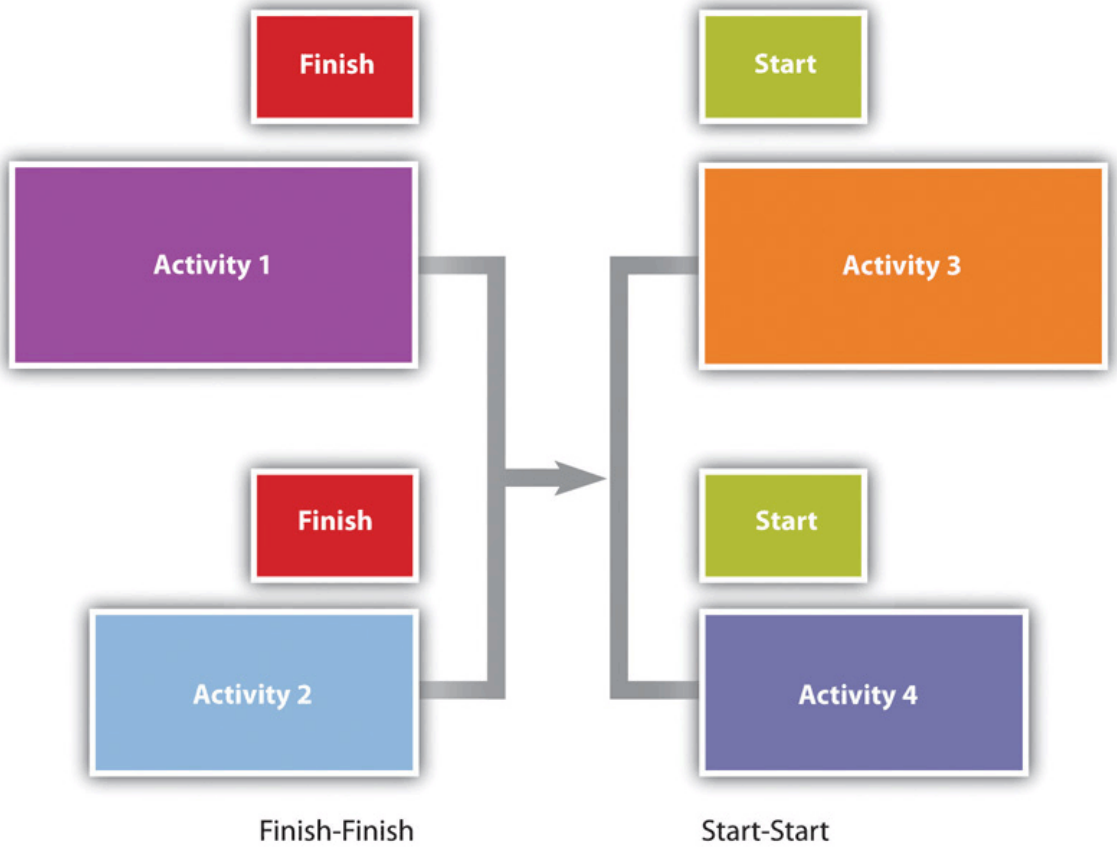
These terms define a relationship that is similar to a family relationship like father and son. The father exists in time before the son. Similarly, each element of the diagram can have predecessor-successor relationships with other elements, just like a father can be the son of someone else. Additionally, just as the son has a mother as well as a father, activities can have more than one predecessor.

The relationship between a predecessor activity and a successor activity is called a ***dependency***. The successor activity starts after and is dependent on the predecessor activity. Because the conversation with Dion and Carlita must take place before a planning meeting can be scheduled, this is called a ***natural dependency*** because the relationship can be inferred logically. Activities that have predecessor-successor relationships occur sequentially—one after the other. Another term for this type of relationship is ***finish-start***, which means the first activity must finish before the next one can start. (Refer to the figure 8.3.) Because the finish-start relationship is by far the most common, the type of relationship is assumed to be finish-start unless otherwise mentioned.

Some activities take place concurrently—at the same time. If they must begin at the same time, they have a ***start-start*** relationship. If the activities can start at different times but they must finish at the same time, they have a ***finish-finish*** relationship. (Refer to Figure 8.4.)

Figure 8.4

Start and Finish Relationships



Concurrent activities can be constrained to finish at the same time or start at the same time. Figure 8.5 shows the activities in John's move with the predecessors identified for the Plan Move and Prepacking groups of activities.

Figure 8.5

Outline of Activities with Predecessors Identified

1.0	Plan Move (Project Start)	**Predecessors**
1.1	Contact Dion and Carlita	
1.2	Host planning lunch	**1.1**
1.3	Develop and distribute schedule	**1.2**
1.4	Make hotel arrangement in Atlanta	**1.1**
2.0	Prepacking	
2.1	Gather packing material	
2.2	Select moving van company and sign contract	
2.2.1	Contact 3 moving van companies and get bids	**1.3**
2.2.2	Select company and negotiate a final price	**2.2.1**
2.2.3	Sign moving contract	**2.2.2**
2.3	Pack small delicate items	**1.3,2.1**

Lag and Lead Times

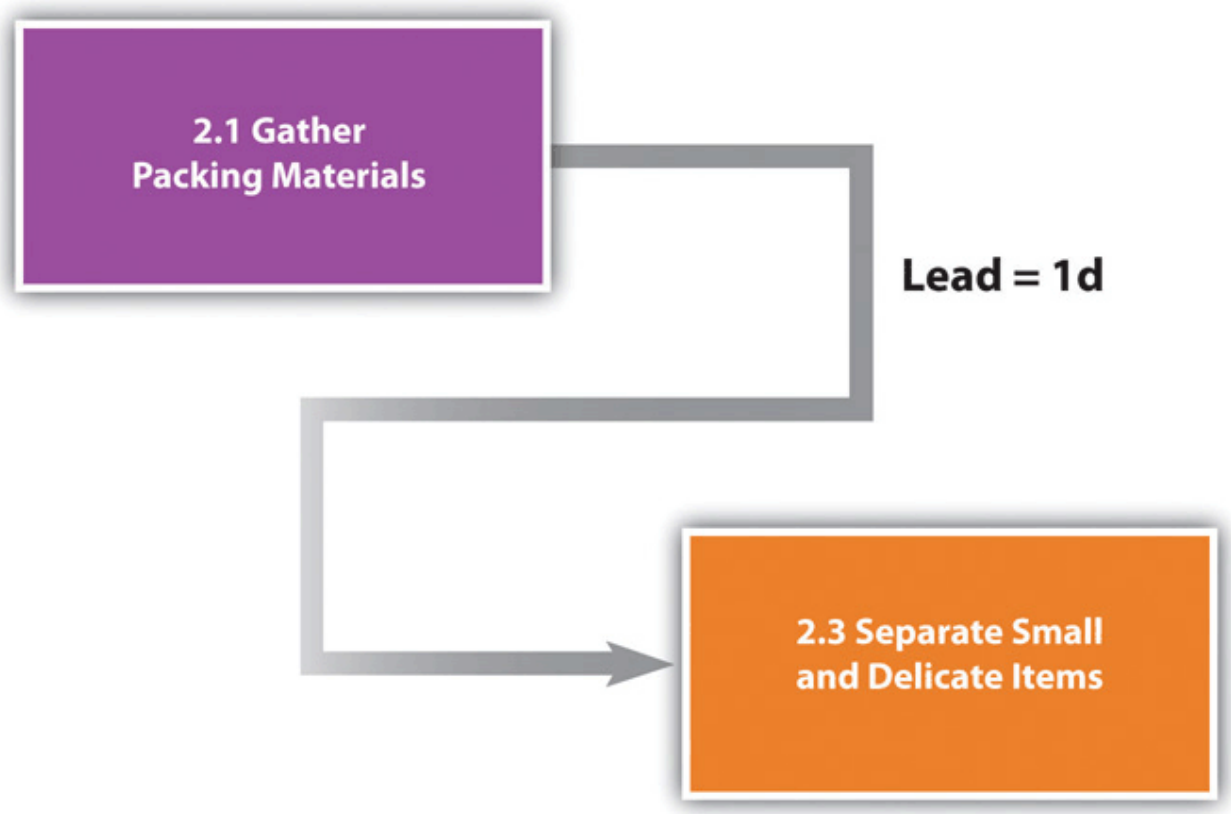
As stated before, most activities in a network diagram have a finish-start relationship. If a certain amount of time must go by before a successor activity can begin, the required delay is called ***lag time***. In some cases, the successor activity can overlap the end of its predecessor activity and begin before the predecessor is finished. This is called ***lead time***.

Lead Time in John's Move

In John's move, you might begin separating the small and delicate items that will be packed in step 2.3 before you get the packing materials in step 2.1 so that when the materials are available, step 2.3 is already partially completed. If preparing the small items for packing can overlap its predecessor and shortens the time it takes to accomplish both tasks by a day, it has a lead time of one day.

Figure 8.6

Lead Time



The characteristics and identifiers of an activity are its ***attributes***. At this point in the process of analyzing John's move, each activity has an identifying code, a short description, predecessors, and lead or lag times, as shown in a partial table of activities in Figure 8.7.

Figure 8.7

Table of Attributes

Code	Description	Predecessors	Relationships	Lead/Lag
1.1	Contact Dion and Carlita	None		0
1.2	Host planning lunch	1.1	FS (Finish/Start)	0
1.3	Develop and distribute schedule	1.2	FS	0
1.4	Make hotel arrangement in Atlanta	1.1	FS	0
2.1	Gather packing material	None		0
2.2.1	Contact moving van companies and get three bids	1.3	FS	0
2.2.2	Select company and get final price	2.2.1	FS	0
2.2.3	Sign moving contract	2.2.2	FS	0
2.3	Pack small and delicate items	1.3 2.1	FS FS	1

Milestones

Milestones are significant events in your project which consume no resources and have no duration. Milestones are usually indicated on the project schedule with a diamond and often have a vertical line on a time-scaled graph to show the relationship of various schedule paths to the milestone. An effective milestone schedule will capture the major constraints to the project schedule and provide a summary level overview of the project.

In our John's move project, we might create a milestone called "all packing complete" to represent the date when everything is packed and ready for the moving van. Any delay in this date will mean a delay in the arrival of the moving van in Chicago, a delay in the arrival of the moving van in Atlanta, and a delay of all the unpacking and other downstream activities (see Figure 8.8, "Gantt Chart").

Graphic Representations

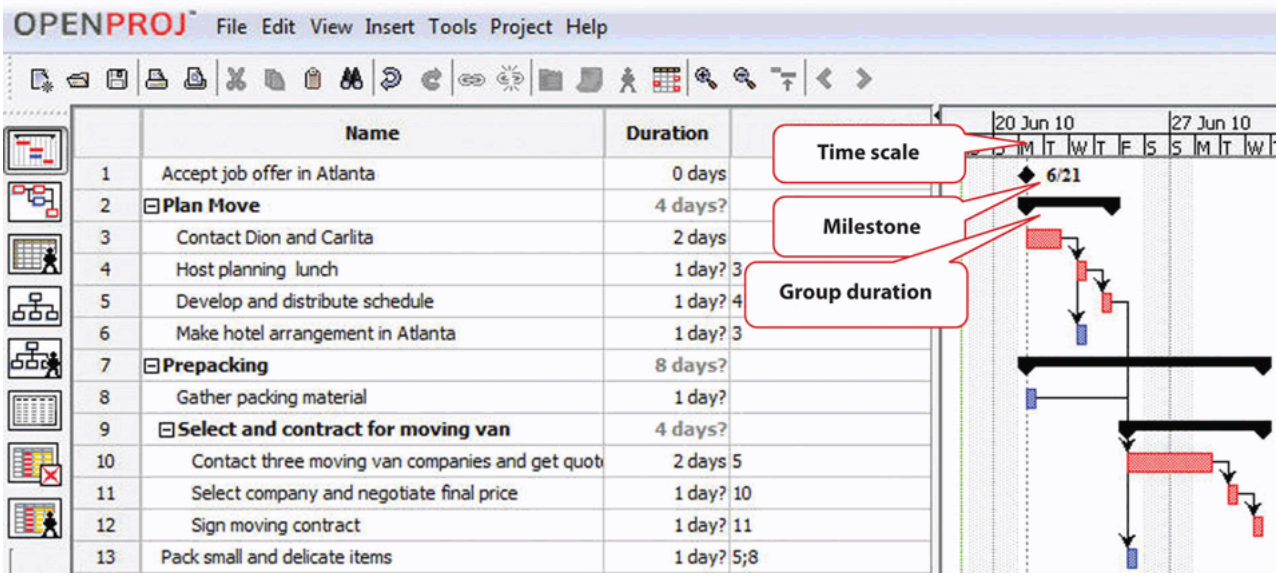
Relationships between activities are easier to recognize if they are presented using graphics such as bar charts or a network of connected boxes.

Gantt Chart

The type of bar chart used to illustrate activity relationships in a project is the ***Gantt chart***. The Gantt chart was developed by Henry Gantt and used on major projects, including building the Hoover Dam and the U.S. interstate highway system.[2] The Gantt chart is a time-scaled graphic that represents each activity with a bar that reflects the duration, start, and finish time, as shown in Figure 8.8.

Figure 8.8

Gantt Chart



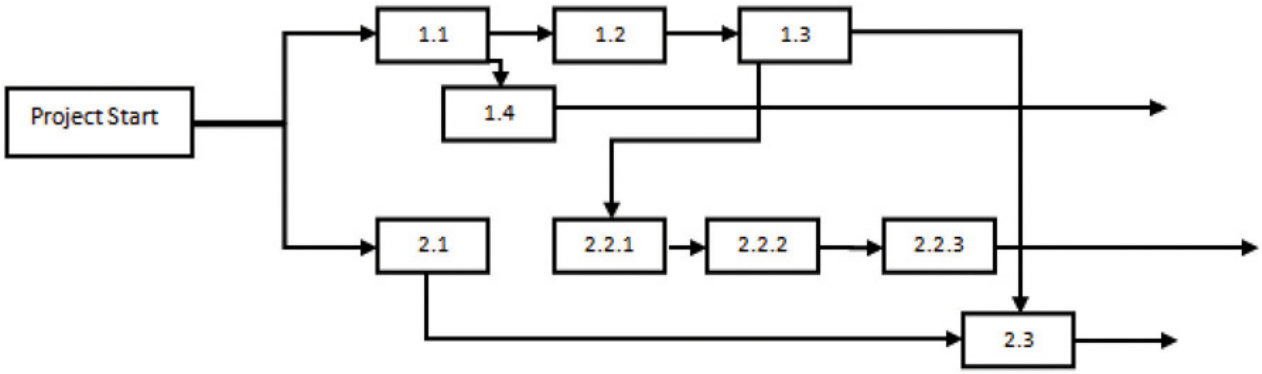
A Gantt chart is easy to read and provides sufficient information for project team members to plan activities within a short time frame. For many larger projects, a two-week bar chart, extracted from the larger master schedule, provides the information needed for team members and contractors to coordinate activity details. The Gantt chart provides information for simple planning but is limited because a Gantt chart does not illustrate complex relationships well.

Network Diagrams

People recognize relationships and patterns more effectively when they look at diagrams like the one in Figure 8.9, “Project Network Diagram”. The ***precedence diagram method (PDM)*** is a technique for graphically displaying the logic of the schedule by placing the activities in boxes with arrows between them to show the precedence-successor relationships. The boxes in this type of diagram are called ***nodes*** and the arrows indicate finish-start relationships. Compare the diagram in Figure 8.9 to the outline in Figure 8.5, “Outline of Activities with Predecessors Identified” to see how much easier it is to trace a sequential path from one activity to the next in the precedence diagram. This type of diagram is also called a ***project network diagram***.

Figure 8.9

Project Network Diagram



Key Takeaways

- The work breakdown structure is a list of activities, including estimates of their durations, their relationships with others, and the resources assigned to them.
- Bar charts are used to indicate durations and sequencing where the relationships are simple. Network diagrams are used to show complex relationships between activities.

References

Project Management Institute, Inc., A Guide to the Project Management Body of Knowledge (PMBOK Guide), 4th ed. (Newtown Square, PA: Project Management Institute, Inc., 2008), 129.

Reference.com, "Henry Gantt," http://www.reference.com/browse/wiki/Henry_Gantt (accessed July 27, 2009).

8.3

Critical Path and Float

Start Dates | Project Float | Critical Path

Learning Objective

1. Calculate critical path, project float, early start dates, and late start dates.

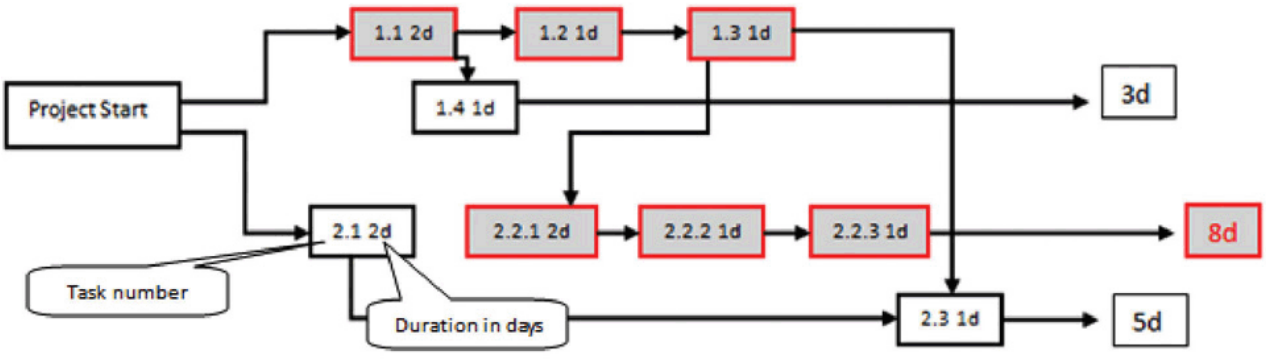
The ***critical path*** is the path through the network that results in the latest completion date of the project.

Image by Be the Change, Inc.

If any activity on the critical path is delayed, the completion of the project will be delayed by an equal amount. To determine the critical path, add the amount of time estimated for the duration of each activity to the previous activity, as shown in Figure 8.10. Durations are indicated in days and activities on the critical path are shaded. The critical path through these tasks takes at least eight days.

Figure 8.10

Critical Path



Early Start Dates

Starting dates can be assigned to each activity by doing a ***forward pass*** proceeding from left to right in the network diagram beginning with the project start date. The dates derived by this method are the ***early start (ES) dates***. The early start date for an activity is the earliest date the activity can begin. The estimate considers durations and resource

availability calendars. To calculate early start dates, begin with the project start date and assign that date as the start date of activities that have no predecessor activities. Follow these steps to calculate the early start dates of subsequent activities, assuming finish-start relationships:

- Add the predecessor activity's duration to its start date.
- Add the lag time or subtract the lead time.
- Refer to the resource calendar(s) that applies to the people and equipment necessary for the activity, and add the number of off-days that the activity would span on those calendars.
- Assign the calculated date as the early start date of the successor activity.

Forward Pass for John's Move

John begins planning his move to Atlanta the same day he accepts the job. The start date in this example is Monday, November 29, 2010. Tasks 1.1 and 2.1 can both start on that day, so the early start dates for tasks 1.1 and 2.1 are November 29. John calculates the early start date for the activities. A partial list is provided below. Compare the figure below and the figure in the next sidebar. Observe that John is willing to work on weekends, but activity 2.2.3 is delayed by two days because one of the moving companies did not provide bids on the weekend. Observe that activity 2.3 has a lead time of one day, but that relationship is between activity 2.1 and 2.3. The network path from activity 1.3 is longer, so the lead time with activity 2.1 is not considered in calculating the early start date of 2.3.

Figure 8.11

Early Start Dates Determined by a Forward Pass

Code	Description	Predecessors	Relationships	Lead/Lag	Resources	Duration	Early Start Date
1.1	Contact Dion and Carlita	None		0	J,D,C .25 hr each	2 d	11/29
1.2	Host planning lunch	1.1	FS (Finish/Start)	0	J,D,C 2 hr each	1 d	12/1
1.3	Develop and distribute schedule	1.2	FS	0	J 2 hr	1 d	12/2
1.4	Make hotel arrangement in Atlanta	1.1	FS	0	J .5 hr	1 d	11/30
2.1	Gather packing material	None		0	D 2 hr	1 d	11/29
2.2.1	Contact van companies and get 3 bids	1.3	FS			2 d	12/3
2.2.2	Select company and get final price	2.2.1	FS	0	J .5 hr	1 d	12/7
2.2.3	Sign moving contract	2.2.2	FS			1 d	12/8
2.3	Pack small and delicate items	1.3 2.1	FS FS	-1	C 6 hr	1 d	12/3

Start date delayed by nonworking weekend

Lead time does not apply to path from task 1.3, which is longer

Doing this process manually is error prone and time consuming. Fortunately, there are computer programs to assist in the process, but the project manager must understand the process well enough to recognize computer errors. Computer software must be combined with common sense or good judgment.

Float

Float, sometimes called slack, is the amount of time an activity, network path, or project can be delayed from the early start without changing the completion date of the project.

Total float is the difference between the finish date of the last activity on the critical path and the project completion date. Any delay in an activity on the critical path would reduce the amount of total float available on the project. A

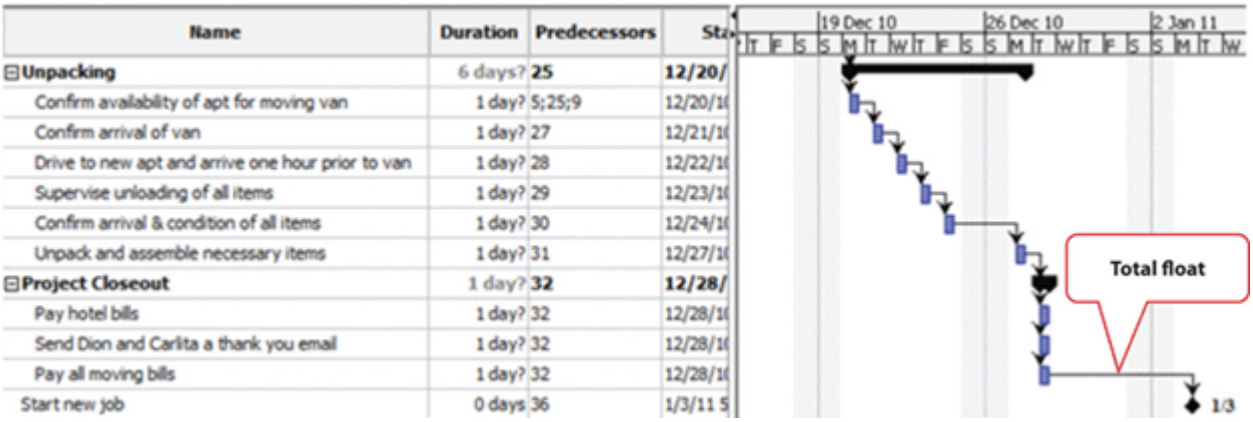
project can also have ***negative float***, which means the calculated completion date of the last activity is later than the targeted completion date established at the beginning of the project.

If activities that are not on the critical path have a difference between their early start date and their late start date, those activities can be delayed without affecting the project completion date. The float on those activities is called ***free float***.

Float in John's Move

The last activity in John's move has an early start date of December 28 and a duration of one day. John could start work on Wednesday, December 29. John's first day at work is Monday, January 3, so the project has a total float of five days. **Figure 8.12**

Total Project Float



Late Start Dates

The next step is to work through the network diagram from right to left beginning with the mandated completion date, which is a milestone that is set in the project plan. Subtract the duration of each activity in each path to determine the latest date the activity could begin and still meet the project completion date. Resource calendars must be considered in the backward pass as well as the forward pass.

To calculate late start dates, begin with the project completion milestone and assign that date as the finish date of its predecessor activities. Follow these steps to calculate the late start dates of predecessor activities, assuming finish-start relationships:

- Subtract the predecessor activity's duration from its late finish date.
- Subtract the lag time or add the lead time to the late finish date.
- Refer to the resource calendar(s) that applies to the people and equipment necessary for the activity, and subtract the number of off days that the activity would span on those calendars.
- Assign the calculated date as the late start date of the predecessor activity.

The difference between the early start date and the late start date for activities on the critical path is usually the same as the total float, unless the activities are affected by the resource calendars differently in the forward and backward pass. For example, if a piece of key equipment is only available for a few days, activities that depend on it have the same start and finish dates in the forward and backward passes.

Key Takeaways

- To calculate total project float, begin at the start date and add the duration of each activity in each possible path through the network diagram, including nonworking days from the resource calendars, to determine the early project end date.
- The longest path through the network is the critical path.
- The difference between the early end date and the required completion date of the project is the total project float, and the start date of each activity is the early start date.
- To calculate the late start dates, begin with the required project completion date and work backward, subtracting the duration of each activity though each possible pathway.

8.4

Managing the Schedule

tracking | Progress | Reporting | Resource Leveling | Accelerating Schedule

Learning Objectives

1. Describe methods of tracking and reporting progress.
2. Define resource leveling.
3. Describe methods of accelerating the schedule.

To manage a schedule, the project manager must know how the work is progressing compared to the master schedule and, if necessary, make changes to keep the project on time.

Tracking and Reporting Progress

Tracking the schedule performance involves measuring the work performed against the work expected to be performed with a given expenditure of resources. Periodic reporting on the progress of the project provides the project management team with information on how the project is performing against expectations and to make decisions and corrections. Accurate measurement of schedule performance requires planning during the early stages of the project to determine the unit of measure and process for tracking progress.

Reporting Percentage Completed

To determine the percentage of a project that has been completed, the project manager must determine what to measure. Some percentages are misleading. For example, a project that has completed 25% of the scheduled activities does not mean that the project is 25% complete. In our John's move example, four rooms were to be packed. After the bedroom was packed, packing was not 25% complete. The kitchen contained five times as many items and required more delicate, time-consuming packing. John estimated that 40% of the items to be packed were in the kitchen, 20% in the living room, 20% in the bedroom, and the remaining 20% in miscellaneous locations. If the unit of measure for these activities is items packed, the packing is only 20% complete instead of 25% if rooms are the unit of measure.

The unit of measure for tracking schedule progress is related to the estimate. If hours of labor are used as the unit of measure, the percentage of packing is even less because more time is estimated to pack each item in the kitchen. As the project management team estimates the duration for each activity, the amount of work to accomplish the tasks is captured in both resources expended and a unit of measure for tracking progress. The unit of measure is related to the

type of project. On a software development project, the unit of measure may be lines of code written. The unit of measure that is chosen can affect the quality of the work.

Units of Measure on a Programming Project

Steve Ballmer of Microsoft related early clashes with IBM over the unit of measure used to determine how much Microsoft would get paid for its work for IBM. IBM's standard was to pay per K-LOC, which is a thousand lines of code; Microsoft thought that they should not be paid less if they were able to produce good work in fewer lines of code.[1]

In this case, IBM's insistence on using thousands of lines of code as the unit of measure did not reward Microsoft for writing smaller code that would run faster. Microsoft and IBM cancelled their joint project for writing an operating system named OS/2. Microsoft wrote Windows, and IBM's OS/2 operating system was not able to compete with it successfully.

On a construction project, a unit of measure may be yards of concrete poured, and on a training project, the unit of measure may be the class curriculums developed or the number of students taught.

Managing Schedules Using Milestones

Milestones provide the opportunity for project management to focus on completing activities that will have the greatest impact on the schedule. On complex projects, focusing on the milestones is useful for communicating important dates to the entire project team. Project team members can then adjust their efforts to complete the activities connected to the milestone events.

Many project leaders believe that time lost on early activities can be made up toward the end of the project. Hard decisions about paying overtime and working weekends are often delayed until the end of the project when the pressure to complete the project on time becomes much stronger. Project managers who focus on milestone events create a sense of urgency to meet the milestone deadlines and spread the urgency to complete the project over the life of the project. Projects that meet milestone dates are more likely to meet project completion dates.

Current Schedule

A schedule update is distributed regularly to provide project stakeholders with an assessment of the progress of the project against the master schedule. This updated schedule is called the current schedule. The ***current schedule*** provides new start and end dates for all activities and the project. Calculations based on the current schedule may result in a new critical path and subsequent changes in the project execution plan.

The project team develops an understanding of the project productivity by comparing the current schedule to the original schedule. If the schedule is behind original estimates, the project team conducts an assessment of the causes of the schedule slippage and develops a plan to address the changes to the project. The project management team typically has several alternatives for addressing changes to the project situation. Selecting the right alternative requires good information.

Resource Leveling

The schedule of activities is constrained by the availability of resources. If you apply the resource calendar to each activity to be sure the people and equipment are available on those dates, you can still miss an important constraint. If there are several activities that use a particular person's time on the same days, that person could end up with too many activities scheduled for the same days and very little on other days. If key people are overloaded, the activities to which they are assigned might not be completed on time. Managing the schedule of activities to ensure that enough resources are available to complete each task by distributing the work load is called ***resource leveling***. Activities to which that person is assigned and that have free float can be delayed to reduce work overload of key people.

Image by Tulane Public Relations

Accelerating the Schedule

The project manager must know how to accelerate a schedule to compensate for unanticipated events that delay critical activities or to accommodate changes in the project completion date. Compressing or crashing the schedule are terms used to describe the various techniques used to shorten the project schedule. Project managers utilize several techniques to keep projects on schedule.

One method of accelerating the schedule is to add activities to the critical path that are empty or that are optional. If the project is behind schedule, the time can be made up by dropping these activities. This extra time that is built into the schedule is called ***contingency time***, buffer, or reserve time.

Activities that are not on the critical path that have free float can be delayed without delaying the end date of the project if they start by the late start date. Project managers can divert some resources from activities with free float to activities on the critical path without delaying the completion of the project.

Changing Scope

The unit cost of work to be performed on a project is calculated at the beginning of the project based on the execution strategy of the project to meet the project completion date. If the project completion date is moved up, then the unit cost of work will likely increase. Conversely, a project team may be able to save money by extending the project end date. With more time, the project team may be able to schedule activities in such a way to reduce their costs. For example, an activity requiring overtime to be paid can now pay the labor at normal rates, saving the overtime premium. Changing elements of the master schedule means a change in scope. Scope changes often affect costs and require agreement by the parties who signed the original scope documents.

Additional Resources

Another option is to allocate funds that can be used to add resources if necessary. Available resources can be increased by adding overtime to existing resource calendars or by hiring additional contract workers or renting additional equipment.

Adding Resources to the Dreamliner Project

When Boeing sales of the new 878 Dreamliner Airplane exceeded expectations, contractors who were building the plane were asked to increase production while maintaining all quality and safety requirements. All contractors involved in the plane production were affected by this change.

One project team was responsible for developing and delivering training to the new employees who would be building the fuselage of the Dreamliner. Training for new employees had to be complete three months early and the project team developed an execution strategy to meet the new deadlines. The project had a month of float, so the project accelerated the schedule by two months. The team authorized overtime from forty to fifty hours a week for team members working activities on the critical path. The project team leased additional space and hired contractors to perform selected work packages on the critical path and delayed the production of library quality documents until after the critical dates on the project. Authorizing overtime and hiring contractors added a 15% cost to the project. Overtime and the procurement of additional contract help was authorized only for work packages on the critical path because work not on the critical path would not accelerate the schedule.

Changing Quality

Another option for accelerating the schedule is the changing of the quality specifications of the product. This is usually done as a scope change.

Making Up Time by Reducing Quality

A western university contracted an online learning company to make an online independent study course for their Calculus 112 class. As the project went on it fell behind schedule. To speed up the project, it was decided to produce fewer animated videos, which meant that some of the lessons would not have these learning aids. The contract did not specify the amount or quality of these videos so this change did not require a change of scope. As a result, some of the more difficult calculus principles had only text as instruction. The university did not realize this change had been made until after the project was completed and being used by the students.

Key Takeaways

- Progress can be measured by determining the percentage of resources expended, completion of activities by scheduled dates, milestones achieved, or fraction of activities accomplished. Standards used to measure progress, particularly when partial payment to contractors is concerned, should be specified in contract documents.
- Resource leveling is reallocating people and equipment to remove periods of overuse or underuse.
- Unplanned delays and costs can be anticipated by including contingency time and budget amounts where needed to keep the schedule on time. Resource allocation and resource calendars should be examined to determine if a resource is overcommitted. Free float can be used to delay noncritical activities that use the same resource to allocate its time more evenly. If it is necessary to accelerate the schedule, activities that are not on the critical path can be delayed using their free float and their resources can be moved to activities on the critical path to complete them sooner. Contingency resources can be committed to speeding up the activities. If necessary, the scope can be changed to bring in additional resources or lower the quality.

References

[1] Robert X. Cringely, Triumph of the Nerds, June 1996, http://www.pbs.org/nerds/part2.html (accessed July 27, 2009).

8.5

Project Scheduling Software

Collaboration | Complexity | Software | Project

Learning Objectives

1. Describe the relationship between the choice of software and project complexity.
2. Identify the features that should be considered when selecting software for project management.

Low-complexity projects can be managed with lists of activities on paper or by using an outline in word processing or spreadsheet software. This software is inadequate for tracking complex projects. Fortunately, there are several dedicated software programs that keep track of the complex relationships between activities and resources.

Appropriate to Project Complexity

Simple projects can be tracked using general purpose word processing and spreadsheet software like those available in Microsoft Office or OpenOffice. Medium-complexity projects benefit from dedicated project management software such as Microsoft Project and OpenProject. Complex projects require software that can track the interactions of thousands of tasks and produce sophisticated reports such as Oracle's P6.

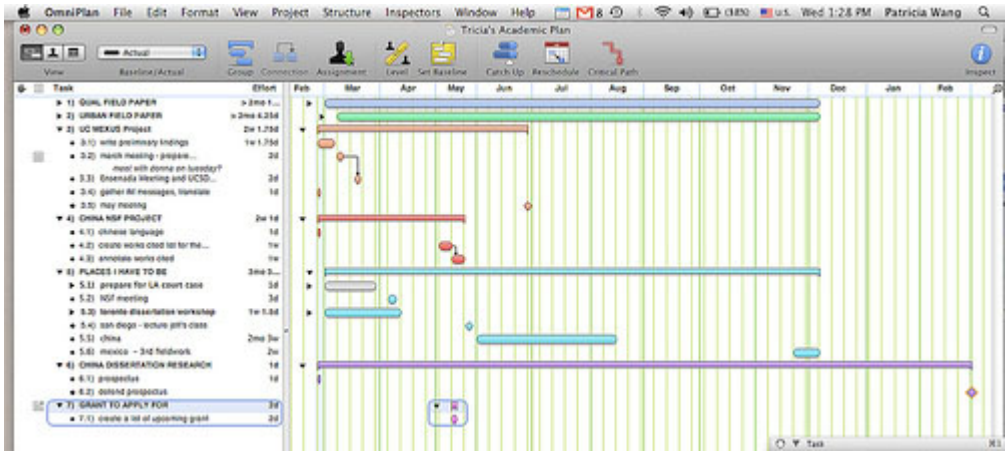


Image by Tricia Wang 王圣捷

Features

There are many features to consider when selecting the appropriate software. One consideration is cost. There are dozens of computer software programs available with a wide range of prices; some open source software programs are free, but others cost up to a thousand dollars. However, cost is not the most important feature.

Another factor to consider is familiarity. Use software that is already in use and with which most team members are already familiar. If software that is used by most team members is appropriate to the complexity of your project, it is the default choice. It is also valuable to know what software is used by key vendors or project partners so files can be exchanged electronically in the same format.

Team members should be able to view the project schedule. Some software products require the use of expensive proprietary software that runs on the company's server and that will allow several different team members to use the same schedule and restricts the use of the software to team members who have access to the company's computer system. Other software products use a server on the Internet that is open to team members and vendors who have valid passwords.

Any project management software that is selected must have the ability to track and display basic features such as the following:

- Durations
- Relationships
- Milestones
- Start and end dates
- Resource calendars
- Graphic displays using Gantt and network charts

For more complex projects, look for advanced features, such as the following:

- Issue tracking that tracks problems, actions, and resolutions
- Project portfolio management that tracks and compares groups of related projects
- Automatic resource leveling and alerts when a resource is overscheduled
- Document management feature that tracks contracts, bids, scope changes, and incidents

Key Takeaways

- Medium- to high-complexity projects usually require the use of software that is designed specifically for managing projects.
- Features to look for when choosing project management software include (1) compatibility with existing software at the company or its vendors, (2) basic features for managing medium-complexity projects, (3) a method for collaboration between team members, and (4) if needed, advanced features for managing multiple projects.

9

Costs and Procurement

Overview

The cost portion of the chapter aligns with chapter 7 of the PMBOK and 9% of the CAPM questions come from this knowledge area. The content connects to the Planning and Monitoring & Controlling category of the PMP questions. The procurement portion of the chapter deals with Chapter 12 of the PMBOK and 9% of the CAPM questions come from this knowledge area. The content connects to the Planning, Executing, Monitoring & Controlling and closure category of the PMP questions.

An important part of a project manager's job is managing money. All types of organizations must manage their money well in order to fulfill their mission, including not-for-profit and government organizations. The tools and methods used to manage money on a project vary depending on the phase and complexity of the project. This chapter first describes the methods used to estimate the cost of a project, create a budget, and manage the cost of activities while the project is being executed. It then covers a major component of cost management—the procurement process.

To achieve the objectives of the project, the management team often needs to look outside the internal organization for additional help. The process of obtaining goods and services from providers who are outside of the organization is called ***procurement***. We will discuss ways of selecting the work that will be procured and the different methods and processes for procuring the equipment, materials, and services for the project.

The procurement effort on projects varies widely and depends on the type of project. Often the client organization will provide procurement services on less complex projects. In this case, the project team identifies the materials, equipment, and supplies needed by the project and provides product specifications and a detailed delivery schedule. When the procurement department of the parent organization provides procurement services, a liaison from the project can help the procurement team better understand the unique requirements of the project and the time-sensitive or critical items of the project schedule.

On larger, more complex projects, personnel are dedicated to procuring and managing the equipment, supplies, and materials needed by the project. Because of the temporary nature of projects, equipment, supplies, and materials are procured as part of the product of the project or for the execution of the project. For example, workbook materials might be procured for the product of the project, and the computers and software might be equipment procured for the execution of the project work. At the end of the project, equipment bought or rented for the execution of the work of the project are sold, returned to rental organizations, or disposed of some other way.

More complex projects will typically procure through different procurement and management methods. ***Commodities*** are common products that are purchased based on the lowest bid. Commodities include items like concrete for building projects, office supplies, or even lab equipment for a research project. The second type of procurement includes products that are specified for the project. ***Vendors*** who can produce these products bid for a contract. The awarding of a contract can include price, ability to meet the project schedule, the fit for purpose of the product, and other considerations important to the project. Equipment especially designed and built for a research project is an example of

what might be provided by a project vendor. These vendors' performances become important parts of the project, and the project manager assigns resources to coordinate the work and schedule of the vendor.

The third procurement approach is the development of one or more partners. A public relations firm that is awarded the advertising contract for a major project and a research firm that is conducting critical subparts of the research are examples of potential project partners. A partner contributes to and is integrated into the execution plan. Partners perform best when they share the project vision of success and are emotionally invested in the project. The project management team builds and implements a project procurement plan that recognizes the most efficient and effective procurement approach to support the project.

Designers Share Their Experiences

Dr. Andy Gibbons – Instructional Psychology and Technology – BYU

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Well project budgets are scary. Because when you are out of money, you are out of money. Your goal is to come in under budget if you possibly can. You know it's funny, there is a concept, I was working on this project, training submarine finding helicopter pilots and sensor operators so we had two little mini-projects going on. Well they weren't mini-projects they were pretty good-sized projects. We had a staff of about 25 people. We had to pay them all. We had to bring them on at the right time, and we had to put them off of the project at the right time. Because if we didn't then, they would bill against the project and we would use up funds that we didn't have. So we had to know when a certain set of jobs was going to be done. One of our artists was a cartoonist. We had to know when he came on the project and when he left the project. We had to make sure he was busy the whole time. So sometimes that comes into conflict with the production schedule, and you end up having people being paid longer than you expected. Boy, budget. There is a concept called designed costs. I think it's an important concept for instructional designers to understand. It means you only have a certain amount of time, and a certain amount of money to pay people, and so you make your design to fit those resources. There is no project that you get on where you couldn't design something that is like the Taj Mahal, ornate and guilded and beautiful and pure marble and all that kind of stuff. But you know, every project can't be the Taj Mahal. You can't afford it, it takes too long, too many people. And so you have to make your design fit what you have. And people say that's giving up your principles, isn't there something wrong about that, isn't there something unethical about that. And the answer is no. When your client contracts with you for a certain amount of money, that's what they want to pay you. And you can go back to your client with a change order, and that's kind of an official thing, a change order, saying, now if you want this extra feature this is how much it's going to cost you. Because one of the things that happens as you design for a client, all of a sudden they start getting the picture, you create these wonderful clouds of vision in their mind and they say, "That's so cool! We could do this. And we could do this…" You excite them. And they start imagining, "Wow we could create this, such a cool thing". Well

your budget said Volkswagen, it didn't say Cadillac. It said Volkswagen. So if you want a Cadillac we're going to have to re-write some of the contract to say Cadillac in it. So budgets are scary.

Heather Bryce – Independent Studies – BYU

Watch on YouTube

Well, we didn't manage our budget very well for this course. Because of the meetings, the excessive meetings, it, the cost jumped up dramatically. And a lot of the things that we made decisions on, the instructional designer. You know, Flash takes a long time, video takes a long time, the recording, the post process, the pre-process. Those are costly things. So you have to kind of weigh those things out when you create a course. But, with an art course it would not be a very good course, instructionally, if you didn't have any of those things in it, if it was just straight reading. In the end, we spent a lot more money than we planned, but it made for such a rich course. It's a fantastic drawing course. In the triangle of project management, when you manage your time and your cost and your quality, the quality of this course is incredible. The time, we kept our time on time. What we gave up was, we gave up cost for quality in this example. And the award that we received, we all feel like it was worth it, but of course we wouldn't be in business if we did that with every course. So you have to weigh it out. What we have to manage the course budget, is we do have a program. Our same program that we use to manage our tasks, and everyone records their hours that they spend on each task. And so it tabulates how much money we're spending on the budget so you can look at the course at any time. I just, what I do is, and the instructional designers we check on that throughout. So each phase of the project it will tell you how much money. And so, how it's supposed to work is when you see that you are close, it will kind of go red, and it will show you that you're using up your budget money for that processor, so you better hurry it out. So, how ideally it works is you cut things out if you have to stay within your budget, but like I said, that was probably a project failure as far as budget went for this course.

Dr. Larry Seawright – Center for Teaching and Learning – BYU

Watch on YouTube

So in building the BYU Learning Suite, we're at the Center for Teaching and Learning. So, our budget is pretty constrained. And we have lots of stuff that we're doing. So we were kind of given this much money to do things, and we said we can only do this much of the project and you want this much done. So they said okay, we'll give you this much. And we just had to keep going back, this much, this much, this much. So, you know, budget management is one of the critical things that any project manager has to do. Where you're a smaller entity within a larger organization, and the larger organization is the one asking you to do something at least you're in a good position. You can go back and ask for more money. Is this really important to you? Then give us some more money. Is this really important to you? Than give us some more money. And that's kind of how we've been having to do this. They shortened the time frame that we needed to do the project in by quite a bit. So that compressed the development cycle. The budget went from this to this. Simply because we had to hire a lot more people to get it done that fast. So you know, it's a difficult project management triangle. You know, it's time, scope and money. If they reduce the time, you've got to spend more money, or reduce the scope. And we actually had to do both. We couldn't get as much done in that amount of time. But we tried to get more done by hiring more people. So you know, it's the old trade off.

9.1

Estimating Costs

Schedule | Project | Estimating | Budget | Cost

Learning Objectives

1. Describe methods of estimating costs.
2. Identify the effects of project phase and complexity on the choice of estimating method.
3. Describe the method of combining cost estimates with a schedule to create a budget.

ESTIMATING COSTS TO COMPARE AND SELECT PROJECTS

During the conceptual phase when project selection occurs, economic factors are an important consideration when choosing between competing projects. To compare the simple paybacks or internal rates of return between projects, an estimate of the cost of each project is made. The estimates must be accurate enough so that the comparisons are meaningful, but the amount of time and resources used to make the estimates should be appropriate to the size and complexity of the project. The methods used to estimate the cost of the project during the selection phase are generally faster and consume fewer resources than those used to create detailed estimates in later phases. They rely more on the expert judgment of experienced managers who can make accurate estimates with less detailed information. Estimates in the earliest stages of project selection are usually based from previous projects that can be adjusted—***scaled***—to match the size and complexity of the current project or by applying standardized formulas.

Image by Andrew Magill

Analogous Estimate

An estimate that is based on other project estimates is an ***analogous estimate***. If a similar project cost a certain amount, then it is reasonable to assume that the current project will cost about the same. Few projects are exactly the same size and complexity, so the estimate must be adjusted upward or downward to account for the difference. The selection of projects that are similar and the amount of adjustment needed is up to the judgment of the person who makes the estimate. Normally, this judgment is based on many years of experience estimating projects, including incorrect estimates that were learning experiences for the expert.

Analogous Estimate for John's Move

In the John's move example, John asked a friend for advice about the cost of his move. His friend replied, "I moved from an apartment a little smaller than yours last year and the distance was about the same. I did it with a fourteen-foot truck. It cost about $575 for the truck rental, pads, hand truck, rope, boxes, and gas." Because of the similarity of the projects, John's initial estimate of the cost of the move was less than $700 and he decided that the cost would be affordable and the project could go forward.

Less experienced managers who are required to make analogous estimates can look through the documentation that is available from previous projects. As explained in Chapter 2, if those projects were evaluated using the Darnall-Preston Complexity Index (DPCI), the manager can quickly identify projects that have similar profiles to the project under consideration even if those projects were managed by other people. Comparing the original estimates with the final project costs on several previous projects with the same DPCI ratings gives a less-experienced manager the perspective that it would take many years to acquire by trial and error. It also provides references which the manager can use to justify the estimate.

Parametric Estimate

If the project consists of activities that are common to many other projects, average costs are available per unit. For example, if you ask a construction company how much it would cost to build a standard office building, they will ask for the size of the building in square feet and the city in which the building will be built. From these two factors—size and location—the company's estimator can predict the cost of the building. Factors like size and location are ***parameters***—measurable factors that can be used in an equation to calculate a result. The estimator knows the average cost per square foot of a typical office building and adjustments for local labor costs. Other parameters such as quality of

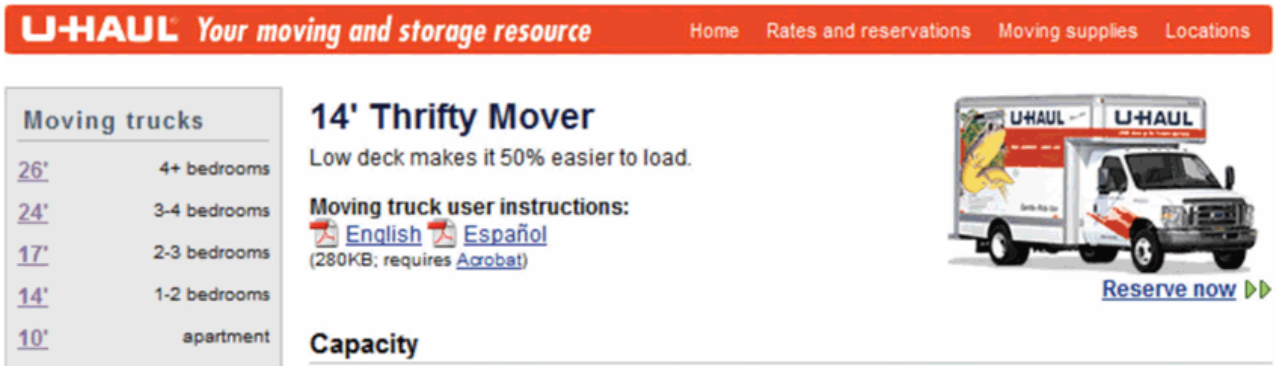
finishes are used to further refine the estimate. Estimates that are calculated by multiplying measured parameters by cost-per-unit values are ***parametric estimates***.

Parametric Estimate for John's Move

To estimate the size of the truck needed for John's move, the parameter used by a truck rental company is the number of bedrooms, as shown in Figure 9.1.

Figure 9.1

Number of Bedrooms Used for Parametric Cost Estimate



The moving company assumes that the number of bedrooms is the important parameter in determining how big a truck is needed for a move. For John's move, he has a one-bedroom apartment, so he chooses the fourteen-foot truck. Once the size is determined, other parameters, such as distance and days, are used to estimate the cost of the truck rental.

ESTIMATING COSTS TO INITIATE PROJECTS

Once the project is selected, more accurate estimates are often needed to raise funds and agree on contracts with vendors in the initiation phase.

Estimate During the Initiation Phase of John's Move

John recalled that his friend also told him how tiring it was to do all the packing, loading, and driving himself, and some items were damaged when the load shifted inside the truck during the trip. John decides to call in favors from two friends, Dion and Carlita, to help him pack in Chicago and to hire some of the skilled labor like that needed to load the truck properly.

Vendor Bid Analysis

If services or products will be provided by vendors, the cost of those services can be determined by issuing a ***request for proposal (RFP)***. The RFP describes the work, service, or product to be provided by the vendor and the quality level required. The RFP is sent to a list of vendors who are ***qualified***—meet standards of reliability and capability—to perform this type of work. They respond with a proposal for completing the work described in the RFP, including an estimate of the cost. Some government organizations are required to use the qualified vendor with the lowest bid. Other organizations are not bound to take the lowest bid but are usually required to justify their reasons for not doing so.

Using RFPs to Make Estimates on John's Move

John wants to find out how much it would cost to hire a skilled crew to load and secure the furniture in the truck and then have another crew from the same company meet him in Atlanta to unload the truck and help him unpack. He is not sure if any companies offer this option, so he decides to ask three moving companies for bids. He also decides to ask for bids on a standard move that includes all phases of packing, loading, transportation, and unloading as a comparison to see if his cost-saving plan is worth the extra effort.

The project management team can review the responses by several vendors to the RFP to determine if their estimate of the cost of that aspect of the project is close to the estimate made during the project selection stage. If the estimates by the vendors are much higher than expected, and if the project cannot be completed for the cost that was used to select the project, the selection decision might have to be reconsidered. Reconsidering the selection of the project should take into consideration the economic ratings of the competing projects that were not chosen and who the project champions are for the projects that would be affected.

Some vendors may suggest an alternative way to meet the objective of the RFP in a more cost-effective manner that does not match the specifics of the RFP. Such alternatives can reduce costs if they are acceptable.

Bottom-Up Estimating

The most accurate and time-consuming estimating method is to identify the cost of each item in each activity of the schedule, including labor and materials. If you view the project schedule as a hierarchy where the general descriptions of tasks are at the top and the lower levels become more detailed, finding the price of each item at the lowest level and then summing them to determine the cost of higher levels is called ***bottom-up estimating***.

Bottom-Up Estimate for John's Move

After evaluating the bids by the moving companies, John decides the savings are worth his time if he can get the packing done with the help of his friends. He decides to prepare a detailed estimate of costs for packing materials and use of a rental truck. He looks up the prices for packing materials and truck rental costs on company Web sites and prepares a detailed list of items, quantities, and costs, as shown in Figure 9.2.

Figure 9.2

Detailed Cost Estimate

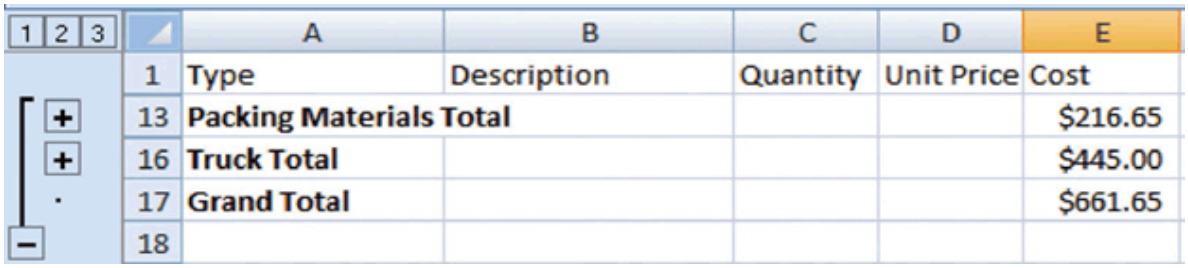
Category	Description	Quantity	Unit Price	Cost
Packing Materials	Small Boxes	10	$1.70	$17.00
Packing Materials	Medium Boxes	15	$2.35	$35.25
Packing Materials	Large Boxes	7	$3.00	$21.00
Packing Materials	Extra Large Boxes	7	$3.75	$26.25
Packing Materials	Short Hanger Boxes	3	$7.95	$23.85
Packing Materials	Box Tape	2	$3.85	$7.70
Packing Materials	Markers	2	$1.50	$3.00
Packing Materials	Mattress/Spring Bags	2	$2.95	$5.90
Packing Materials	Lift Straps per Pair	1	$24.95	$24.95
Packing Materials	Bubble Wrap	1	$19.95	$19.95
Packing Materials	Furniture Pads	4	$7.95	$31.80
Truck	Rental			$400.00
Truck	Gas at 10mpg	200	$2.25	$45.00

This type of estimate is typically more accurate than an analogous or parametric estimate. In this example, the sum of packing materials and truck expenses is estimated to be $661.25.

The detail can be ***rolled up***—subtotaled—to display less detail. This process is made easier using computer software. On projects with low complexity, the cost estimates can be done on spreadsheet software. On larger projects, software that manages schedules can also manage costs and display costs by activity and by category. For example, the subtotal feature could be used in Excel and collapsed to show the subtotals for the two categories of costs, as shown in Figure 9.3.

Figure 9.3

Sum of Detailed Costs by Type



	A	B	C	D	E
1	Type	Description	Quantity	Unit Price	Cost
13	**Packing Materials Total**				$216.65
16	**Truck Total**				$445.00
17	**Grand Total**				$661.65
18					

Activity-Based Estimates

An activity can have costs from multiple vendors in addition to internal costs for labor and materials. Detailed estimates from all sources can be reorganized so those costs that are associated with a particular activity can be grouped by adding the activity code to the detailed estimate, as shown in Figure 9.4.

Figure 9.4

Detailed Costs Associated with Activities

Category	Description	Activity	Quantity	Unit Price	Cost
Packing Materials	Small Boxes	2.1	10	$1.70	$17.00
Packing Materials	Medium Boxes	2.1	15	$2.35	$35.25
Packing Materials	Large Boxes	2.1	7	$3.00	$21.00
Packing Materials	Extra Large Boxes	2.1	7	$3.75	$26.25
Packing Materials	Short Hanger Boxes	2.1	3	$7.95	$23.85
Packing Materials	Box Tape	2.1	2	$3.85	$7.70
Packing Materials	Markers	2.1	2	$1.50	$3.00
Packing Materials	Mattress/Spring Bags	2.1	2	$2.95	$5.90
Packing Materials	Lift Straps per Pair	2.1	1	$24.95	$24.95
Packing Materials	Bubble Wrap	2.1	1	$19.95	$19.95
Packing Materials	Furniture Pads	2.1	4	$7.95	$31.80
Truck	Rental	2.2			$400.00
Truck	Gas at 10mpg	2.2	200	$2.25	$45.00

Cost estimate table

The detailed cost estimates can be sorted by activity and then subtotaled by activity to determine the cost for each activity.

Establishing a Budget

Once you have broken your project down into activities, you will be able to calculate your overall project costs by estimating and totaling the individual activity costs.

This process of subtotaling costs by category or activity is called ***cost aggregation***.

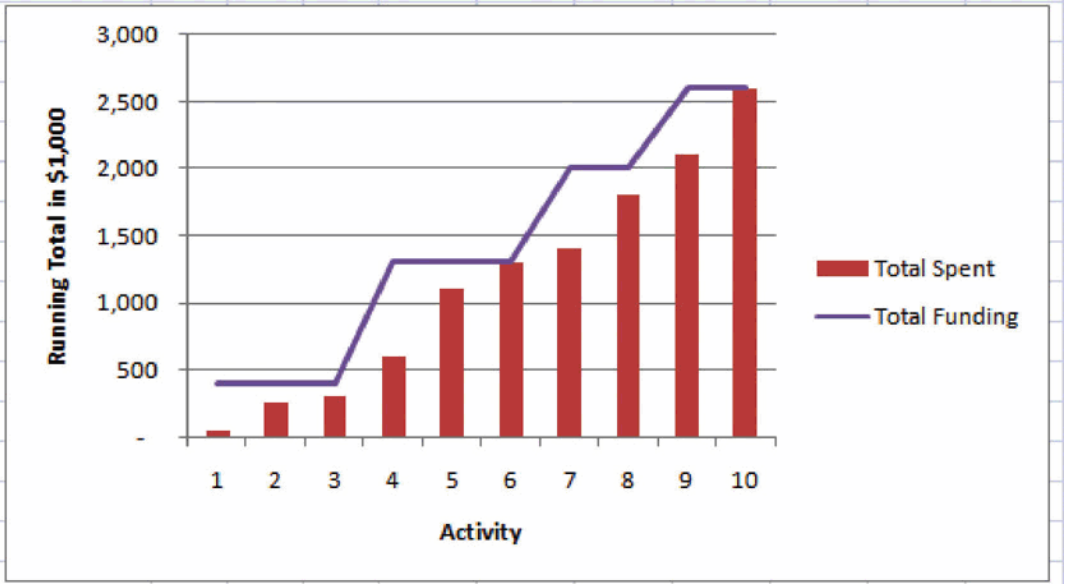
Budget Timeline

Costs are associated with activities and since each activity has a start date and a duration period, it is possible to calculate how much money will be spent by any particular date during the project. The money needed to pay for a project is usually transferred to the project account shortly before it is needed. These transfers must be timed so that the money is there to pay for each activity without causing a delay in the start of the activity. If the money is transferred too far in advance, the organization will lose the opportunity to use the money somewhere else, or they will have to pay unnecessary interest charges if the money is borrowed. A schedule of money transfers is created that should match the need to pay for the activities. The process of matching the schedule of transfers with the schedule of activity payments is called ***reconciliation***. Refer to Figure 9.5 which shows the costs of ten major activities in a project. Funds are transferred into the project account four times. Notice that during most of the project, there were more funds available than were spent except at activity 6 when all the available funds were spent.

Figure 9.5

Fund Transfers and Expenditures

Activity	1	2	3	4	5	6	7	8	9	10
Cost	50	200	50	300	500	200	100	400	300	500
Total Spent	50	250	300	600	1,100	1,300	1,400	1,800	2,100	2,600
Transfers	400			900			700		600	
Total Funding	400	400	400	1,300	1,300	1,300	2,000	2,000	2,600	2,600
Cash in Account	350	150	100	700	200	-	600	200	500	-



In the project budget profile shown in Figure 9.5 there is no margin for error if the total of the first six activities exceeds the amount of funding at that point in the project.

Contractual agreements with vendors often require partial payment of their costs during the project. Those contracts can be managed more conveniently if the unit of measure for partial completion is the same as that used for cost budgeting. For example, if a graphic designer is putting together several pieces of artwork for a textbook, their contract may call for partial payment after 25% of their total number of drawings is complete.

Key Takeaways

- Analogous estimating scales an estimate from a similar project to match the current project. Parametric estimating multiplies a standard cost-per-unit value by the number of units in the project. Bids from contractors can be compared to estimate costs. Bottom-up estimating determines the cost of each detail and aggregates them to determine activity cost estimates.
- During the project selection and approval stage, rough estimates are used that are usually obtained using analogous and parametric methods. Vendor bid analysis and detailed bottom-up estimates are used in the initiation phase to estimate project costs.
- Detailed estimates are associated with activities and aggregated during the planning phase to create an activity-based budget. Funding transfers are arranged to reconcile money spent to money from funding sources in a timely manner.

9.2

Managing the Budget

Cash Flow | Budget | Earned Value Analysis | Schedule Performance Index | Cost Performance Index

Learning Objectives

1. Describe methods to manage cash flow.
2. Describe the terms and relationships of budget factors used in earned value analysis.
3. Calculate and interpret budget and schedule variances.
4. Calculate and interpret the schedule performance index and the cost performance index.
5. Calculate and interpret estimates to complete the project.
6. Calculate the revised final budget.

Projects seldom go according to plan in every detail. It is necessary for the project manager to be able to identify when costs are varying from the budget and to manage those variations.

Managing Cash Flow

If the total amount spent on a project is equal to or less than the amount budgeted, the project can still be in trouble if the funding for the project is not available when it is needed. There is a natural tension between the financial people in an organization, who do not want to pay for the use of money that is just sitting in a checking account, and the project manager, who wants to be sure that there is enough money available to pay for project expenses. The financial people prefer to keep the company's money working in other investments until the last moment before transferring it to the project account. The contractors and vendors have similar concerns, and they want to get paid as soon as possible so they can put the money to work in their own organizations. The project manager would like to have as much cash available as possible to use if activities exceed budget expectations.

Image by kenteegardin

Contingency Reserves

Most projects have something unexpected occur that increases costs above the original estimates. If estimates are rarely exceeded, the estimating method should be reviewed because the estimates are too high. It is impossible to predict which activities will cost more than expected, but it is reasonable to assume that some of them will. Estimating the likelihood of such events is part of risk analysis, which is discussed in more detail in a later chapter.

Instead of overestimating each cost, money is budgeted for dealing with unplanned but statistically predictable cost increases. Funds allocated for this purpose are called ***contingency reserves***.[1] Because it is likely that this money will be spent, it is part of the total budget for the project. If this fund is adequate to meet the unplanned expenses, then the project will complete within the budget.

Management Reserves

If something occurs during the project that requires a change in the project scope, money may be needed to deal with the situation before a change in scope can be negotiated with the project sponsor or client. It could be an opportunity as well as a challenge. For example, if a new technology were invented that would greatly enhance your completed project, there would be additional cost and a change to the scope, but it would be worth it. Money can be made available at the manager's discretion to meet needs that would change the scope of the project. These funds are called ***management reserves***. Unlike contingency reserves, they are not likely to be spent and are not part of the project's budget baseline, but they can be included in the total project budget.[2]

Evaluating the Budget During the Project

A project manager must regularly compare the amount of money spent with the budgeted amount and report this information to managers and stakeholders. It is necessary to establish an understanding of how this progress will be measured and reported.

Reporting Budget Progress on John's Move

In the John's move example, he estimated that the move would cost about $1,500 and take about sixteen days. Eight days into the project, John has spent $300. John tells his friends that the project is going well because he is halfway through the project but has only spent a fifth of his budget. John's friend Carlita points out that his report is not

sufficient because he did not compare the amount spent to the budgeted amount for the activities that should be done by the eighth day.
As John's friend points out, a budget report must compare the amount spent with the amount that is expected to be spent by that point in the project. Basic measures such as percentage of activities completed, percentage of measurement units completed, and percentage of budget spent are adequate for less complex projects, but more sophisticated techniques are used for projects with higher complexity.

Earned Value Analysis

A method that is widely used for medium- and high-complexity projects is the ***earned value management (EVM)*** method. EVM is a method of periodically comparing the budgeted costs with the actual costs during the project. It combines the scheduled activities with detailed cost estimates of each activity. It allows for partial completion of an activity if some of the detailed costs associated with the activity have been paid but others have not.

The ***budgeted cost of work scheduled (BCWS)*** comprises the detailed cost estimates for each activity in the project. The amount of work that should have been done by a particular date is the ***planned value (PV)***. These terms are used interchangeably by some sources, but the planned value term is used in formulas to refer to the sum of the budgeted cost of work up to a particular point in the project, so we will make that distinction in the definitions in this text for clarity.

Planned Value on Day Six of John's Move

On day six of the project, John should have taken his friends to lunch and purchased the packing materials. The portion of the BCWS that should have been done by that date (the planned value) is listed in Figure 9.6. This is the planned value for day six of the project.
Figure 9.6

Planned Value for Lunch and Packing Materials

Description	Quantity	Cost
Lunch	3	$45.00
Small Boxes	10	$17.00
Medium Boxes	15	$35.25
Large Boxes	7	$21.00
Extra Large Boxes	7	$26.25
Short Hanger Boxes	3	$23.85
Box Tape	2	$7.70
Markers	2	$3.00
Mattress/Spring Bags	2	$5.90
Lift Straps per Pair	1	$24.95
Bubble Wrap	1	$19.95
Furniture Pads	4	$31.80
	Total	$261.65

The ***budgeted cost of work performed (BCWP)*** is the budgeted cost of work scheduled that has been done. If you sum the BCWP values up to that point in the project schedule, you have the ***earned value (EV)***. The amount spent on an item is often more or less than the estimated amount that was budgeted for that item. The ***actual cost (AC)*** is the sum of the amounts actually spent on the items.

Comparing PV, EV, and AC in John's Move on Day Six

Dion and Carlita were both trying to lose weight and just wanted a nice salad. Consequently, the lunch cost less than expected. John makes a stop at a store that sells moving supplies at discount rates. They do not have all the items he needs, but the prices are lower than those quoted by the moving company. They have a very good price on lifting straps so he decides to buy an extra pair. He returns with some of the items on his list, but this phase of the job is not complete by the end of day six. John bought half of the small boxes, all of five other items, twice as many lifting straps, and none of four other items. John is only six days into his project, and his costs and performance are starting to vary from the plan. Earned value analysis gives us a method for reporting that progress (refer to Figure 9.7).

Figure 9.7

Planned Value, Earned Value, and Actual Cost

Project Earned Value Analysis—Day 6						
	Budgeted Cost of Work Scheduled (BCWS)		Budgeted Cost of Work Performed (BCWP)		Actual Cost (AC)	
Description	Quantity	Cost	Quantity	Cost	Quantity	Cost
Lunch	3	$45.00	3	$45.00	3	$35.00
Small Boxes	10	$7.00	5	$8.50	5	$9.50
Medium Boxes	15	$35.25	15	$35.25	15	$28.00
Large Boxes	7	$21.00				
Extra Large Boxes	7	$26.25				
Short Hanger Boxes	3	$23.85				
Box Tape	2	$7.70	2	$7.70	2	$5.50
Markers	2	$3.00	2	$3.00	2	$2.00
Mattress/Spring Bags	2	$5.90	2	$5.90	2	$7.50
Lift Straps per Pair	1	$24.95	1	$24.95	2	$38.50
Bubble Wrap	1	$19.95				
Furniture Pads	4	$31.80	4	$31.80	4	$28.50
	PV	$261.65	EV	$162.10	AC	$154.50

The original schedule called for spending $261.65 (PV) by day six. The amount of work done was worth $162.10 (EV) according to the estimates, but the actual cost was only $154.50 (AC).

Schedule Variance

The project manager must know if the project is on schedule and within the budget. The difference between planned and actual progress is the ***variance***. The ***schedule variance (SV)*** is the difference between the earned value (EV) and the planned value (PV). Expressed as a formula, SV = EV − PV. If less value has been earned than was planned, the schedule variance is negative, which means the project is behind schedule.

Schedule Variance on John's Move

Planning for John's move calls for spending $261.65 by day six, which is the planned value (PV). The difference between the planned value and the earned value is the scheduled variance (SV). The formula is SV = EV − PV. In this example, SV = $162.10 − $261.65 = $(99.55) A negative SV indicates the project is behind schedule.
The difference between the earned value (EV) and the actual cost (AC) is the ***cost variance (CV)***. Expressed as a formula, CV = EV – AC. A positive CV indicates the project is under budget.

Cost Variance on John's Move

The difference between the earned value of $162.10 and the actual cost of $154.50 is the cost variance (CV). The formula is CV = EV − AC. In this example, CV = $162.10 − $154.50 = $7.60.

Variance Indexes for Schedule and Cost

The schedule variance and the cost variance provide the amount by which the spending is behind (or ahead of) schedule and the amount by which a project is exceeding (or less than) its budget. They do not give an idea of how these amounts compare with the total budget.

The ratio of earned value to planned value gives an indication of how much of the project is completed. This ratio is the ***schedule performance index (SPI)***. The formula is SPI = EV/PV. In the John's move example, the SPI equals 0.62 (SPI = $162.10/$261.65 = 0.62) A SPI value less than one indicates the project is behind schedule.

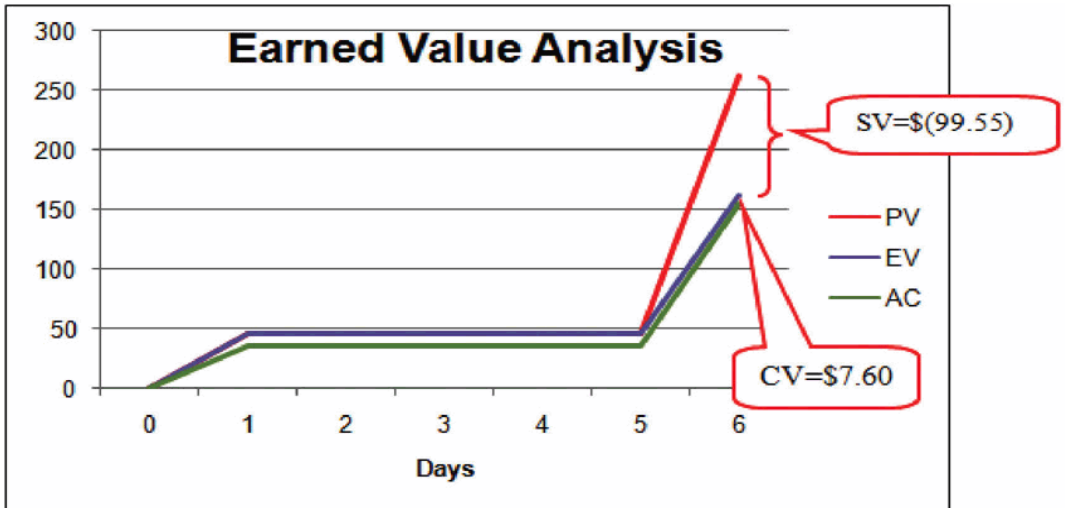
The ratio of the earned value to the actual cost is the ***cost performance index (CPI)***. The formula is CPI = EV/AC.

Cost Performance Index of John's Move

In the John's move example, CPI = $162.10/$154.50 = 1.05 A value greater than 1 indicates the project is under budget.

Figure 9.8

Schedule Variance and Cost Variance on Day Six of the John's Move Project



The cost variance of positive $7.60 and the CPI value of 1.05 tell John that he is getting more value for his money than planned for the tasks scheduled by day six. The schedule variance (SV) of negative $99.55 and the schedule performance index (SPI) of 0.62 tell him that he is behind schedule in adding value to the project.

During the project, the manager can evaluate the schedule using the schedule variance (SV) and the schedule performance index (SPI) and the budget using the cost variance (CV) and the cost performance index (CPI).

Estimated Cost To Complete the Project

Partway through the project, the manager evaluates the accuracy of the cost estimates for the activities that have taken place and uses that experience to predict how much money it will take to complete the unfinished activities of the project—***the estimate to complete (ETC)***.

To calculate the ETC, the manager must decide if the cost variance observed in the estimates to that point are representative of the future. For example, if unusually bad weather causes increased cost during the first part of the project, it is not likely to have the same effect on the rest of the project. If the manager decides that the cost variance up to this point in the project is atypical—not typical—then the estimate to complete is the difference between the original budget for the entire project—the ***budget at completion (BAC)***—and the earned value (EV) up to that point. Expressed as a formula, ETC = BAC − EV

Estimate to Complete John's Move

In John's move, John was able to buy most of the items at a discount house that did not have a complete inventory and, he chose to buy an extra pair of lift straps. He knows that the planned values for packing materials were obtained from the price list at the moving company where he will have to buy the rest of the items, so those two factors are not likely

to be typical of the remaining purchases. The reduced cost of lunch is unrelated to the future costs of packing materials, truck rentals, and hotel fees. John decides that the factors that caused the variances are atypical. He calculates that the estimate to complete (ETC) is the budget at completion ($1,534) minus the earned value at that point ($162.10), which equals $1,371.90. Expressed as a formula, ETC = $1,534 − $162.10 = $1,371.90.
If the manager decides that the cost variance is caused by factors that will affect the remaining activities, such as higher labor and material costs, then the estimate to complete (ETC) needs to be adjusted by dividing it by the cost performance index (CPI). For example, if labor costs on the first part of a project are estimated at $80,000 (EV) and they actually cost $85,000 (AC), the cost variance will be 0.94. (Recall that the cost variance = EV/AC).

To calculate the estimate to complete (ETC) assuming the cost variance on known activities is typical of future cost, the formula is ETC = (BAC – EV)/CPI. If the budget at completion (BAC) of the project is $800,000, the estimate to complete is ($800,000 – $80,000)/0.94 = $766,000.

Estimate Final Project Cost

If the costs of the activities up to the present vary from the original estimates, it will affect the total estimate for the project cost. The new estimate of the project cost is the estimate at completion (EAC). To calculate the EAC, the ***estimate to complete (ETC)*** is added to the actual cost (AC) of the activities already performed. Expressed as a formula, EAC = AC + ETC.

Estimate at Completion for John’s Move

The revised estimate at completion (EAC) for John’s move at this point in the process is EAC = $154.50 + $1,371.90 = $1,526.40.
Refer to Figure 9.9 for a summary of terms and formulas.

Figure 9.9

Summary of Terms and Formulas for Earned Value Analysis

Term	Acronym	Description	Formula	John's Move
Actual Cost	AC	The money actually spent on projects up to the present		$154.50
Budget at Completion	BAC	Original budget for the project (same as BCWS)		$1,534.00
Cost Performance Index	CPI	Ratio of earned value to actual cost	CPI = EV / AC	1.05
Cost Variance	CV	Difference between earned value and actual cost	CV = EV – AC	$ 7.60
Earned Value	EV	Sum of estimates for work actually done up to the present		$162.10
Estimate at Completion	EAC	Revised estimate of total project cost	EAC = AC + ETC	$1,526.40
Estimate to Complete	ETC	Money to complete the project if early cost variance is atypical	ETC = BAC – EV	$1,371.90
Estimate to Complete	ETC	Money to complete the project if early cost variance is typical	ETC = (BAC – EV) / CPI	N/A
Planned Value	PV	Sum of the estimates for work done up to the present		$261.65
Schedule Performance Index	SPI	Ratio of earned value to planned value	SPI = EV / PV	.62
Schedule Variance	SV	Difference between earned value and planned value	SV = EV – PV	$(99.55)

KEY TAKEAWAYS

- Extra money is allocated in a contingency fund to deal with activities where costs exceed estimates. Funds are allocated in a management reserves in case a significant opportunity or challenge occurs that requires change of scope but funds are needed immediately before a scope change can typically be negotiated.
- Schedule variance is the difference between the part of the budget that has been done so far (EV) versus the part that was planned to be completed by now (PV). Similarly, the cost variance is the difference between the EV and the actual cost (AC).
- The schedule performance index (SPI) is the ratio of the earned value and the planned value. The cost performance index (CPI) is the ratio of the earned value (EV) to the actual cost (AC).
- The formula used to calculate the amount of money needed to complete the project (ETC) depends on whether or not the cost variance to this point is expected to continue (typical) or not (atypical). If the cost variance is atypical, the ETC is simply the original total budget (BAC) minus the earned value (EV). If they are typical of future cost variances, the ETC is adjusted by dividing the difference between BAC and EV by the CPI.
- The final budget is the actual cost (AC) to this point plus the estimate to complete (ETC).

[1] Project Management Institute, Inc., A Guide to the Project Management Body of Knowledge (PMBOK Guide), 4th ed. (Newtown Square, PA: Project Management Institute, Inc., 2008), 173.

[2] Project Management Institute, Inc., A Guide to the Project Management Body of Knowledge (PMBOK Guide), 4th ed. (Newtown Square, PA: Project Management Institute, Inc., 2008), 177.

9.3

Identifying the Need for Procuring Services

Procurement | Outsourcing Work | Self-performed Work

LEARNING OBJECTIVES

1. Identify what factors are considered when deciding to outsource or perform the work within the organization.

The decision to procure work from outside companies (***outsourcing***) or whether to have the project team members perform the work (***self-performed***) is decided by the project team. Luu, Ng, and Chen[1] studied project procurement selection priorities and identified budget and schedule as the most important considerations in the decision to outsource activities. Other factors that must be considered are risk, quality, and flexibility. Self-performing and outsourcing the work have both benefits and risks. The project procurement strategy begins with these self-perform or outsourcing evaluations.

Outsourcing Decision

A design company has a contract to build a large training curriculum for a company in downtown New York. Most, if not all, of the editing and graphic-art work will be contracted with companies that specialize in these areas. Existing companies that have expertise can provide these project needs faster and at a much lower cost than if the project manager's organization attempted to build the capacity itself.Some outsourcing decisions—sometimes called make or buy decisions—are difficult. In the same training project example above, new learning devices and methods are required that will make the instruction more efficient. The project manager can decide to outsource this portion of the project to companies that have technological expertise or develop this expertise on the project and self-perform the work. The costs of developing this expertise within the project will be more expensive and may take more time than outsourcing this work.

Image by comedy_nose

Self-performing this work also has benefits. The project team would develop this expertise and the additional expertise would add value to their parent company and save money on future projects. The project management team would have greater control over the work because the work would be performed by members of the project team instead of outsiders.

Outsourcing Versus Self-Performing

On the New York project, the project manager decided to outsource the portion of the work that required new methods and materials. The project team designers evaluated the work during the project and assessed the appropriate methods and costs for the parent company to develop this capacity within the company. The additional costs of developing the capacity and the additional risks of implementing a new method with existing resources outweighed the benefits of developing the capacity within the organization. The basic instructional design activities are the core expertise of the parent company and the project team had access to the qualified resources to perform the work. The decision to self-perform this portion of the work was easy because the company had a cost and schedule advantage by using the existing resources.

KEY TAKEAWAYS

- The factors that influence procurement are primarily cost and schedule but also include risk, quality, and flexibility.
- To determine whether to outsource or do the work within the organization, consider which option is less costly and which option can deliver the work on time.

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[1] Duc Thanh Luu, S. Thomas Ng, and Swee Eng Chen, "Parameters Governing the Selection of Procurement System," Journal of Engineering, Construction, and Architectural Management10, no. 3.

9.4

Procurement of Goods

Procurement | Suppliers | Vendors | Partners

LEARNING OBJECTIVES

1. Describe the role of suppliers.
2. Describe the role of vendors.
3. Describe the role of partners.

After the outsourcing versus self-performing decisions are made, the procurement team develops the purchasing plan.

The method of purchasing products or services depends on the uniqueness and importance of the product or service. One way to organize the procurement plan is by the type of relationship with the providers of the outsourced goods or services.

Suppliers

Some of the goods or services are commonly available with little variation in quality or availability. Such goods and services are called ***commodities***. The providers of commodities are ***suppliers*** and there are usually several from which to choose. Purchasing commodities from suppliers focuses on achieving the lowest cost. Additional cost savings are often available if large quantities of a commodity are purchased from the same supplier.

On larger, more complex projects, a list of materials and supplies is developed from the project cost estimate. This list is provided to suppliers as a ***request for quote (RFQ)***, and the suppliers respond with their lowest price. To avoid choosing a ***bid***— a quote that lists the specific materials to be provided, the price for each, and a schedule for delivery– from a company that will make a promise it cannot keep, many organizations will maintain a list of suppliers that meet the organization's requirements. These requirements usually include the proven ability to meet the quality and schedule specifications.

The project management team develops a procedure for requesting a quote. On smaller projects, the parent purchasing organization may process all RFQs. On larger projects, a procurement organization is established with expertise in purchasing. The purchasing team will develop a list of all procurement requirements for the project and develop a procurement schedule that assures the materials will be available to the project when needed.

The project team develops an RFQ based on the quantity and schedule needs of the project and sends the RFQ to the identified qualified suppliers. The project team evaluates each quote from suppliers and determines that the supplier bid meets all the requirements, and in most cases, the supplier with the lowest price will be awarded the bid.

RFQ for Publishing Contractor

A publishing contractor who is drafting a series of ten math textbooks develops a materials list that includes all the supplies needed to publish all ten books. The contractor develops an RFQ for all these materials, including the writing schedule, and submits the RFQ to the four largest writing guild companies in the region. Each of the guild companies decides to bid on the project and provides a bid for the materials in the RFQ. One of the bidders has the lowest price but is unable to deliver the materials to the client site. The project team calculates the cost of transporting the materials to the client site. After the cost of transportation is added to the bid, it is no longer the lowest total cost. The bidder with the total lowest total cost is awarded the contract.

Some organizations that do a large number of projects will develop a relationship with one or two suppliers based on developing cost savings for both organizations. This relationship is commonly called a ***key supplier*** relationship.

Key Supplier for Publishing Supplies

The publishing contractor develops a key supplier relationship with one or two of the material supply companies. The material supply company would guarantee a 10% discount on all materials and the contractor would promise to purchase exclusively from the key supplier. Both organizations save the cost and time associated with preparing the bid. The publishing supply company plans on a consistent volume of business from the contractor and the contractor can expect priority treatment when supplies are scarce.

Vendors

Vendors often provide a unique product or service that cannot be readily purchased in the marketplace. The vendor typically provides a product or service that is designed for the project. The following are examples of products or services provided by vendors:

- Artwork
- Software developers and programs
- Publishers

Products and services from vendors need input and insight from the vendor. Instead of issuing a request for quote (RFQ) for a list of commodities, the project team issues a ***request for proposal (RFP)***. Companies responding to an RFP are invited to provide creative approaches to adding value to the project. Bidders are encouraged to offer design alternatives, alternative uses of materials, and scheduling alternatives that meet all the project requirements and also reduce the total project cost. The bids are evaluated on the total value to the project, including the contribution to the project goals.

Because vendor performance is critical to the success of the project, the management of the vendor relationship is a project management priority. Project management will often implement processes that encourage the vendors to submit suggestions that will reduce total project cost, shorten the schedule, or improve the performance. The project management team will often assign someone from the team to monitor the relationship and provide support from project resources to help assure vendor success.

Partners

If the parent organization lacks key skills or relationships, it might work with other organizations as partners—especially on international projects.

A ***partnership*** is a formal arrangement to execute the project with each party contributing resources. In most partnerships, both parties benefit from the success of the project and share the costs associated with a less successful project. Critical to the success of a partnership is the clear definition of roles and responsibilities on the project, a common understanding of the project goals, and a scope of work for each partner.

Building the relationship between major partners on the project is similar to building relationships with clients. On a large, complex project, a partnership alignment session is often required to build the trust required for open communication channels. Maintaining the relationship permits more effective problem solving and coordinated action on the project. A well-managed partnering relationship can contribute to the achievement of project goals, reduce overall costs, and shorten the project schedule. In most cases, the parent organization is aware of weaknesses in the project resources or skills and searches for a potential partner that has the needed resources or skills.

PR Partnership

On a project in Puerto Rico, an instructional design company wanted a Puerto Rican public relations firm to market their product because of their expertise with the locale. Both companies researched the capability of the other company to assure that the partnership was appropriate for each of them. This was a situation where a partnering relationship would benefit the project—both companies would mutually support each other to achieve project goals and both would benefit from project success.

In this situation, the project procurement plan specified the development of a subcontract for the PR services, and a contract was developed with a clear scope of work and a cost based on completing the work in the contract on time and according to specification. Because the project schedule required the PR firm to begin work before all the needed information was available, change orders were required when new information became available. The contract allowed several days to evaluate the impact of the change on cost and schedule, and the time evaluation process began to cause delays in the project.

Eventually, a new contract was developed to make the Puerto Rican company a partner. These new partnering arrangements allowed PR to get early information and contribute ideas that would shorten the schedule. This case is an example of the need to evaluate the project goals and environment and develop a procurement strategy that matches the conditions of the project.

KEY TAKEAWAYS

- Commodities are purchased through suppliers using a request for quote (RFQ) and selected on the basis of price. An exception is the key supplier relationship where the supplier-organization relationship is long term and the supplier passes along some of the savings of avoiding the bidding process.
- Vendors provide products and services that are designed for the project based on a request for proposal (RFP) that invites the vendors to meet the goals of the request using their products and skills.
- If the organization lacks key skills or relationships, it might form a partnership arrangement with another company to share the benefits and risks of the project.

9.5

Selecting the Type of Contract

Cost | Fixed Cost Contracts | Cost Reimbursable Contracts | Scope of Work

LEARNING OBJECTIVES

1. Identify factors that determine which type of contract to select.
2. Describe the types of fixed cost contracts.
3. Describe the types of cost reimbursable contracts.
4. Understand progress payments and how to reduce problems in changing the contractors' scope of work.

An agreement between the organization and an outside provider of a service or materials is a ***contract***. To limit misunderstandings and make them more legally binding, contracts are usually written documents that describe the obligations of both parties and are signed by those with authority to represent the interests of the parties.

Because legal agreements often create risk for the parent organization, procurement activities are often guided by the policies and procedures of the parent organization. After the project management team develops an understanding of what portions of the project work will be outsourced and defines the type of relationships that are needed to support the project execution plan, the procurement team begins to develop the ***contracting plan***. On smaller, less complex projects, the contract development and execution is typically managed through the parent company or by a part-time person assigned to the project. On larger, more complex projects, the procurement team can consist of work teams within the procurement function with special expertise in contracting. The contract plan defines the relationship between the project and the subcontractors (supplier, vendor, or partner) and also defines a process for making changes in the agreement to accommodate changes that will occur on the project. This change management process is similar to the change management process used with the project agreement with the project client.

Image by gibsonsgolfer

The contracting plan of the project supports the procurement approach of the project. The following are some factors to consider when selecting the type of contract:

- The uncertainty of the scope of work needed
- The party assuming the risk of unexpected cost increases
- The importance of meeting the scheduled milestone dates
- The need for predictable project costs

There are several types of contracting approaches and each supports different project environments and project approaches. The legal contracts that support the procurement plan consist of two general types of contract: the fixed-price and the cost-reimbursable contracts, with variations on each main type.

Fixed-Price Contracts

The ***fixed-price contract*** is a legal agreement between the project organization and an entity (person or company) to provide goods or services to the project at an agreed-on price. The contract usually details the quality of the goods or services, the timing needed to support the project, and the price for delivering goods or services. There are several variations of the fixed price contract. For commodities and goods and services where the scope of work is very clear and not likely to change, the fixed price contract offers a predictable cost. The responsibility for managing the work to meet the needs of the project is focused on the contractor. The project team tracks the quality and schedule progress to assure the contractors will meet the project needs. The risks associated with fixed price contracts are the costs associated with project change. If a change occurs on the project that requires a change order from the contractor, the price of the change is typically very high. Even when the price for changes is included in the original contract, changes on a fixed-price contract will create higher total project costs than other forms of contracts because the majority of the cost risk is transferred to the contractor, and most contractors will add a contingency to the contract to cover their additional risk.

Fixed-price contracts require the availability of at least two or more suppliers that have the qualifications and performance histories that assure the needs of the project can be met. The other requirement is a scope of work that is most likely not going to change. Developing a clear scope of work based on good information, creating a list of highly qualified bidders, and developing a clear contract that reflects that scope of work are critical aspects of a good fixed-priced contract.

If the service provider is responsible for incorporating all costs, including profit, into the agreed-on price, it is a ***fixed-total-cost contract***. The contractor assumes the risks for unexpected increases in labor and materials that are needed to provide the service or materials and in the materials and timeliness needed.

The ***fixed-price contract with price adjustmen***t is used for unusually long projects that span years. The most common use of this type of contract is the inflation-adjusted price. In some countries, the value of its local currency can vary greatly in a few months, which affects the cost of local materials and labor. In periods of high inflation, the client assumes risk of higher costs due to inflation, and the contract price is adjusted based on an inflation index. The volatility of certain commodities can also be accounted for in a price adjustment contract. For example, if the price of oil significantly affects the costs of the project, the client can accept the oil price volatility risk and include a provision in the contract that would allow the contract price adjustment based on a change in the price of oil.

The ***fixed-price with incentive fee*** is a contract type that provides an incentive for performing on the project above the established baseline in the contract. The contract might include an incentive for completing the work on an important milestone for the project. Often contracts have a penalty clause if the work is not performed according to the contract. For example, if the new software is not completed in time to support the implementation of the training, the contract might penalize the software company a daily amount of money for every day the software is late. This type of penalty is often used when the software is critical to the project and the delay will cost the project significant money.

If the service or materials can be measured in standard units, but the amount needed is not known accurately, the price per unit can be fixed—a ***fixed unit price contract***. The project team assumes the responsibility of estimating the number of units used. If the estimate is not accurate, the contract does not need to be changed, but the project will exceed the budgeted cost.

Figure 9.10 Table of Fixed Price Contracts and Characteristics

Type	Known Scope	Share of Risk	Incentive for Meeting Milestones	Predictability of Cost
Fixed Total Cost	Very High	All Contractor	Low	Very High
Fixed Unit Price	High	Mostly Project	Low	High
Fixed price with Incentive Fee	High	Mostly Project	High	Medium-high
Fixed Fee with Price Adjustment	High	Mostly Project	Low	Medium

Cost-Reimbursable Contracts

In a ***cost-reimbursable contract***, the organization agrees to pay the contractor for the cost of performing the service or providing the goods. Cost-reimbursable contracts are also known as ***cost-plus contracts***. Cost-reimbursable contracts are most often used when the scope of work or the costs for performing the work are not well known. The project uses a -reimbursable contract to pay the contractor for allowable expenses related to performing the work. Since the cost of the project is reimbursable, the contractor has much less risk associated with cost increases. When the costs of the work are not well known, a cost-reimbursable contract reduces the amount of money the bidders place in the bid to account for the risk associated with potential increases in costs. The contractor is also less motivated to find ways to reduce the cost of the project unless there are incentives for supporting the accomplishment of project goals.

Cost-reimbursable contracts require good documentation of the costs that occurred on the project to assure that the contractor gets paid for all the work performed and to assure that the organization is not paying for something that was not completed. The contractor is also paid an additional amount above the costs. There are several ways to compensate the contractor.

- A ***cost-reimbursable contract with a fixed fee*** provides the contractor with a fee, or profit amount, that is determined at the beginning of the contract and does not change.
- A ***cost-reimbursable contract with a percentage fee*** pays the contractor for costs plus a percentage of the costs, such as 5% of total allowable costs. The contractor is reimbursed for allowable costs and is paid a fee.
- A ***cost-reimbursable contract with an incentive fee*** is used to encourage performance in areas critical to the project. Often the contract attempts to motivate contractors to save or reduce project costs. The use of the cost reimbursable contract with an incentive fee is one way to motivate cost reduction behaviors.
- A ***cost-reimbursable contract with award fee*** reimburses the contractor for all allowable costs plus a fee that is based on performance criteria. The fee is typically based on goals or objectives that are more subjective. An amount of money is set aside for the contractor to earn through excellent performance, and the decision on how much to pay the contractor is left to the judgment of the project team. The amount is sufficient to motivate excellent performance.

On small activities that have a high uncertainty, the contractor might charge an hourly rate for labor, plus the cost of materials, plus a percentage of the total costs. This type of contract is called ***time and materials (T&M)***. Time is usually contracted on an hourly rate basis and the contractor usually submits time sheets and receipts for items purchased on the project. The project reimburses the contractor for the time spent based on an agreed-on rate and the actual cost of the materials. The fee is typically a percentage of the total cost.

Time and materials contracts are used on projects for work that is smaller in scope and has uncertainty or risk and the project, rather than the contractor, assumes the risk. Since the contractor will most likely include contingency in the price of other types of contracts to cover the high risk, T&M contracts provide lower total cost to the project.

Figure 9.11 Table of Contract Types and Characteristics

Cost Reimbursable (CR)	Known Scope	Share of Risk	Incentive for Meeting Milestones	Predictability of Cost
CR with Fixed Fee	Medium	Mostly Project	Low	Medium-high
CR with Percentage Fee	Medium	Mostly Project	Low	Medium-high
CR with Incentive Fee	Medium	Mostly Project	High	Medium
CR with Award Fee	Medium	Mostly Project	High	Medium
Time and Materials	Low	All Project	Low	Low

To minimize the risk to the project, the contract typically includes a not-to-exceed amount, which means the contract can only charge up to the agreed amount. The T&M contract allows the project to make adjustments as more information is available. The final cost of the work is not known until sufficient information is available to complete a more accurate estimate.

PROGRESS PAYMENTS AND CHANGE MANAGEMENT

Vendors and suppliers usually require payments during the life of the contract. On contracts that last several months, the contractor will incur significant cost and will want the project to pay for these costs as early as possible. Rather than wait until the end of the contract, a schedule of payments is typically developed as part of the contract and is connected to the completion of a defined amount of work or project milestones. These payments made before the end of the project and based on the progress of the work are called ***progress payments***. For example, the contract might develop a payment schedule that pays for the development of the curriculum, and payment is made when the curriculum is completed and accepted. There is a defined amount of work to be accomplished, a time frame for accomplishing that work, and a quality standard the work must achieve before the contractor is paid for the work.

Just as the project has a scope of work that defines what is included in the project and what work is outside the project, vendors and suppliers have a scope of work that defines what they will produce or supply to the company. (Partners typically share the project scope of work and may not have a separate scope of work.) Often changes occur on the project that require changes in the contractor's scope of work. How these changes will be managed during the life of the project is typically documented in the contract. Capturing these changes early, documenting what changed and how the change impacted the contract, and developing a change order (a change to the contract) are important to maintaining the progress of the project. Conflict among team members will often arise when changes are not documented or when the team cannot agree on the change. Developing and implementing an effective change management process for contractors and key suppliers will minimize this conflict and the potential negative effect on the project.

KEY TAKEAWAYS

- Contract selection is based on uncertainty of scope, assignment of risk, need for predictable costs, and the importance of meeting milestone dates.
- Total fixed cost is a single price where the scope is well defined. A fixed price with incentive contract offers a reward for finishing early or under budget or a penalty for being late. A fixed price with adjustment allows for increases in cost of materials or changes in currency values. A fixed unit price contract sets a price per unit, but the exact number of units is not known.
- In a cost reimbursable contract, the project pays for costs. A cost plus fixed fee contract assures the contractor of a known fee. A cost plus percentage fee calculates the fee as a percentage of the costs. A cost plus incentive fee sets goals for the contractor to achieve that would result in a bonus. A cost plus award fee is similar, but the goals are more subjective. Time and materials contracts pay for costs plus an hourly rate for the contractor's time.
- Payments to vendors and suppliers are required during the course of the project. A change management system needs to be in place when dealing with vendors and suppliers.

9.6

Procurement Process

Procurement | Contracts | Bids

LEARNING OBJECTIVES

1. Describe the components of the procurement plan.
2. Identify the decisions made when selecting the type of contract.
3. Describe how bidders are qualified, solicited, and chosen.
4. Identify the methods used to manage the contracts.

The project procurement cycle reflects the procurement activities from the decision to purchase the material or service through to the payment of bills and closing of procurement contracts.

Image by Jeremy Lim

Procurement Plan

After the decision has been made to purchase goods or outsource services, the procurement team develops a plan that includes the following:

- Selecting the appropriate relationships and contract approaches for each type of purchased goods or outsourced service
- Preparing RFQs and RFPs and evaluating partnership opportunities
- Evaluating RFQs, RFPs, and partnerships
- Awarding and signing contracts
- Managing quality, timely performance
- Managing contract changes
- Closing contracts

Depending on the complexity level of the project, each of these steps can take either hours or sometimes weeks of work to complete. Each of these steps is also included in the project master schedule. The time involved in the procurement cycle can influence the scheduling of critical activities, including the decision to self-perform the work or contract the work to others. The equipment and materials delivery dates and completion of contracted work dates are placed on the project schedule and any procurement activities that create a project delay or fall on the project critical path may require special attention.

Selecting the Contract Approach

The technical teams typically develop a description of the work that will be outsourced. From this information, the project management team answers the following questions:

- Is the required work or materials a commodity, customized product or service, or unique skill or relationship?
- What type of relationship is needed: supplier, vendor, or partnership?
- How should the supplier, vendor, or potential partner be approached: RFQ, RFP, or personal contact?
- How well known is the scope of work?
- What are the risks and which party should assume which types of risk?
- Does the procurement of the service or goods affect activities on the project schedule's critical path and how much float is there on those activities?
- How important is it to be sure of the cost in advance?

The procurement team uses the answers to the first three questions listed above to determine the approach to obtaining the goods or services and the remaining questions to determine what type of contract is most appropriate.

A key factor in selecting the contract approach is determining which party will take the most risk. The team determines the level of risk that will be managed by the project and what risks will be transferred to the contractor. Typically, the project management team wants to manage the project risk, but in some cases, contractors have more expertise or control that enable them to better manage the risk associated with the contracted work.

Soliciting Bids

A ***solicitation*** is the process of requesting a price and supporting information from bidders. The solicitation usually takes the form of either an RFQ or an RFP. Partnerships are pursued and established on a case-by-case basis by senior management.

Qualifying Bidders

Potential bidders are people or organizations capable of providing the materials or performing the work required for the project. On smaller, less complex projects, the parent company typically has a list of suppliers and vendors that have successfully provided goods and services in the past, and the project has access to the performance record of

companies on that list. On unique projects, where no supplier lists exist, the project team develops a list of potential suppliers and then qualifies them to become eligible to bid on project work. Eligible bidders are placed on the bidders list and provided with a schedule of when work on the project will be bid.

The eligibility of a supplier is determined by the ability to perform the work in a way that meets project requirements and demonstrates financial stability. Ability to perform the work includes the ability to meet quality specifications and meet the project schedule. During times when economic activity is high in a region, many suppliers become busy and stretch their resources. The project team investigates the potential suppliers to assure they have the capacity and the track record of meeting deadlines before they are included on the bidder's list.

The potential supplier must also be financially stable to be included on the bidders list. A credit check or a financial report from ***Dun and Bradstreet (D&B)***—a well-known provider of financial information about individual companies—will provide the project with information about the potential bidder's financial status. D&B services include the following:

- D&B proprietary rankings and predictive creditworthiness scores
- Public filings, including suits, liens, judgments, and ***UCC filings***—standardized financial disclosure documents that conform to the uniform commercial code
- Comprehensive payment history, including D&B's Paydex Scores
- Company financial statements and history

Request for Quote

An RFQ focuses on price. The type of materials or service is well defined and can be obtained from several sources. The bidder that can meet the project quality and schedule requirements usually wins the contract by quoting the lowest price.

Request for Proposal

An RFP accounts for price but focuses on meeting the project quality or schedule requirements. The process of developing a proposal in response to an RFP can be very expensive for the bidder, and the project team should not issue an RFP to a company that is not eligible to win the bid.

Evaluating Bids

Evaluation of bids in response to RFQs for commodity items and services is heavily graded for price. In most cases, the lowest total price will win the contract. The total price will include the costs of the goods or services, any shipping or delivery costs, the value of any warranties, and any additional service that adds value to the project.

The evaluation of bids based on RFPs is more complex. The evaluation of proposals includes the price and also an evaluation of the technical approach chosen by the bidder. The project team evaluating the proposal must include people with the expertise to understand the technical aspects of the various proposal options and the value of each proposal to the project. On more complex projects, the administrative part of the proposal is evaluated and scored by one team, and the technical aspect of the proposal is evaluated by another team. The project team combines the two scores to determine the best proposal for the project.

Awarding the Contract

After the project team has selected the bidder that provides the best value to the project, a project representative validates all conditions of the bid and the contract with the potential contractor. Less complex awards, like contracts for printed materials, require a reading and signing of the contract to assure the printed materials supplier understands the contract terms and requirements of the project schedule. More complex projects require a detailed discussion of the goals, the potential barriers to accomplishing those goals, the project schedule and critical dates, and the processes for resolving conflicts and improving work processes.

Planning Session Follows Contract Award

On a design project to create a major training for a world-wide company, the project manager invited two critical partners to a three-day planning session after the project contracts were awarded.

The project manager began the session by stating that the project leadership intended to create an environment that enabled each of the partners to exceed profit expectations on the project and that the only way to accomplish this goal was through a mutually supportive team where everyone contributed to improve project performance and everyone benefited from better performance. The session then focused on developing ways to resolve problems and increase performance. Although this may appear to be a simple process of focusing contractors on project success, the process took several days of lengthy discussion and conflict resolution. The effort invested in developing alignment between the project team and contractors can significantly improve project performance.

Managing the Contracts

The contract type determines the level of effort and the skills needed to manage the contract. The manager of supplier contracts develops detailed specifications and assures compliance to these specifications. The manager of vendor contracts assures the contractors that bid the work have the skills and capacity to accomplish the work according to the project schedule and tracks the vendor's performance against the project needs, supplying support and direction when needed. The manager of partnering arrangements develops alignment around common goals and work processes. Each of these approaches requires different skills and various degrees of effort.

Items that take a long time to acquire—***long lead items***—receive early attention by the project leadership. Examples of long lead items are equipment that is designed and built specifically for the project, curriculum that is created for training a new workforce, and a customized bioreactor for a biotech project. These items might require weeks, months, and sometimes years to develop and complete. The project team identifies long lead items early to begin the procurement activities as soon as possible because those procured through the normal procurement cycle may cause delays in the project.

After the contract is awarded, the project team tracks the performance of the contractor against performance criteria in the contract and his or her contribution to the performance of the project. Typically, the contractors deliver the product or service that meets the quality expectations and supports the project schedule. Typically, there are also one or two contractors that do not perform to project expectations. Some project managers will then pull out the contract and attempt to persuade the contractor to improve performance or be penalized. Other project managers will explore with the contractor creative ways to improve performance and meet project requirements. The contract management allows for both approaches to deal with nonperforming contractors and the project team must assess what method is most likely to work in each situation.

Managing contractor performance on a project is as important to the overall project outcomes as the work performed by the project team.

Logistics and Expediting

Equipment and materials that are purchased for use on the project must be transported, inventoried, warehoused, and often secured. This area of expertise is called logistics. The logistics for the project can be managed by the project team or can be included in the RFP or RFQ. On international projects, materials may be imported, and the procurement team manages the customs process. On smaller projects, the logistical function is often provided by the parent company. On larger projects, these activities are typically contracted to companies that specialize in logistical services. On larger, more complex projects, that procurement team will include logistical expertise.

The project work often depends on materials procured for the project. The delivery of these materials influences the scheduling of the project, and often some materials are needed earlier than normal procurement practices would

deliver. On long lead items, the project schedule is included in the contracting plans and contractors must explain how they will support the project schedule.

On large, complex projects, critical items might be scheduled for delivery after they are needed on the project. The procurement team then explores ideas with the contractor to expedite the manufacturing or transportation of the equipment or materials. The contract can often place a priority on the fabrication of the equipment and delivery of the equipment to meet the project schedule. The project logistics team can also explore ways of shortening the transportation time. For example, a project in Argentina flew some critical equipment from Sweden rather than transport the equipment by ship to save several weeks in transit. The logistics costs were higher, but the overall value to the project was greater.

KEY TAKEAWAYS

- The procurement plan includes determining the category of materials or services, choosing the type of contractual relationship, soliciting bids, selecting bidders, managing the work, and closing the contracts.
- The decisions made when selecting the type of contract are based on whether the materials can be provided by suppliers, vendors, or partners; how well defined the work is; how the risk will be shared; the importance of the task to the schedule; and the need for certainty of the cost.
- Companies that bid on contracts are evaluated on past performance and current financial status. RFQs and RFPs are sent to those companies. RFQs are evaluated on price and RFPs are evaluated on price and method.
- Long lead time items are identified and monitored. Items that are critical to the schedule or delayed are assigned to an expediter. The logistics of handling delivery, storage, and transportation are determined. Work and materials are inspected for quality.

10

Managing Project Quality

Overview

This chapter aligns with chapter 8 of the PMBOK and 7% of the CAPM questions come from this knowledge area. The content connects to the Planning, Executing and Monitoring & Controlling categories of the PMP questions.

Project quality has a very different definition under instructional design than it has in a traditional manufacturing setting. Nevertheless, no aspect of the final deliverable is more important than the actual quality and effectiveness of the educational materials.

Managing project quality within instructional design takes some ingenuity, since any assessment of a project's "quality" can differ depending on an individual's subjective criteria. The most important judges of the project's quality are your client and the people who will be using your training.

Designers Share Their Experiences

Dr. Andy Gibbons – Instructional Psychology and Technology – BYU

Watch on YouTube

Well the first thing that you do, is that you hire really capable people. You hire people who are really good at what they do. And you wait until you find the really good person that you want. We looked really hard for a cartoonist on this project. We were training submarine finding helicopter pilots, and sensor operators, military people, and we're going to have some cartooning in our art, we decided. We looked and we looked, and we waited and we waited until we found a really good cartoonist. Sometimes when you get the quality worker, you get all the quality workers quirks with him, and so, we had to manage this cartoonist. That was quite a revealing experience. So number one, you get the best people you can, people who are competent, people who are good because those people are also usually fast. The second thing you do is, you're innovative in your designs. You design your materials, how do you describe it? You design your materials so they can be created by, according to some kind of a pattern that people can get used to. You use those patterns as efficiency tools. You control costs by not having, in the early days of computer based instruction, people were so inventive, every piece of computer based instruction was different in some way. Uniquely, sometimes gothically so. Well, students had to learn a whole new system of navigating a lesson. Because in one lesson the controls would be up here, and in one lesson the controls would be down here. And so it became confusing. Designers eventually learned how to use screen designs that were consistent in the placement of controls. The worldwide web works that way today. The controls all work the same regardless of what web page you go to, more or less. One of the things you can do for designers is to find these patterns that designers use, I don't want to use the word templates, but templates is kind of what it is. Lesson patterns that they use, so that the lessons have the same internal

structure. And so you've got one class of lessons, maybe you've got fifteen lessons of this type, that have this kind of a strategy that require this much writing, this much art. And so you know how much that packet costs. And then there is this kind over here. It's going to require this kind of graphics, this kind of writing and this amount. And so you use that as a projection tool. You have to know what the characteristics are of the thing that you're creating. The advent types become very important to you.

Heather Bryce – Independent Studies – BYU

Watch on YouTube

How I balance quality and time and cost is really a factor of my boss. They make the decision on whether to do a course. Now if we know a course is going to be a high enroller, you have more money to play with on a course. If a course is a low enroller there might be different reasons for doing that. We have to be stricter about our budget. So when we meet at the very beginning with the designer, we talk about it and say, okay basically this is the budget that you've been given. And we've gotten more strict with budget, so then you can fudge with time or quality. Every project is different. Some projects, you have an absolute deadline that you have to have a course available. So then, at that point you say, okay, then do we fudge on the quality, or do we fudge on the cost? So it really depends on each project. For the project that I did, Art 45, we went with quality. That was the one that we weren't going to sacrifice, and so we sacrificed cost on that one. But there have been other projects that we've had, where time was a factor and we had to get it out. On those we said, okay, we'll have to not do those videos, because that's a cost. So we cut our cost and maybe possibly the quality. Every project is different.

Dr. Larry Seawright – Center for Teaching and Learning – BYU

Watch on YouTube

So that's always a project manager's trade-off. How do you balance quality with time and money? If you had as much money, regardless of what the project is. Whether it's an instructional design project or building a bridge. If you have a lot of money and a lot of time you could make a great bridge. If you don't have as much money and you don't have as much time then your beautiful four lane bridge becomes a two lane bridge and hopefully it's still earthquake proof and all those kinds of things. So you manage those quality things, but you have to shrink things down. In our project, the BYU Learning Suite, we have a kind of, pretty fixed quality target, in that there is an existing learning management system. And so let's say the satisfaction level is here with the existing management system. So we have to at least hit that target. Now what we've had to do is define what that target is. Basically that means no outages, we can't look at the history of that learning management system and say, well when they first started there were lots of outages, and you know, things like that. We can't do that because when it first started they had one hundred faculty on it. We have eighty percent of the faculty now using the learning management system, and it affects virtually every student at Brigham Young University. We have to hit that level of reliability. What we could do is kind of take a look at the quality of the offering in terms of the number of features that are offered by the current learning management system and what we're going to initially offer in our new BYU Learning Suite learning management system. And what we did is we took a look at what are the features that are used by most of the faculty and students most of the time? And deliver those in a way that's easier to use than the existing system, just as reliable as the existing system. So those are kind of two quality elements that we looked at. It has to be just as reliable. And it has to be easier to use. And that's kind of difficult because we think, in our design, we think it's easier to use, but it's different, and so the users may not think it's easier to use initially. And so there's a training curve and a learning curve. After they use it a little bit they say, "Oh this is easier to use." But it's like going from one kind of vehicle to another. They're both automatic

transitions, but the shift mechanism is on the column in one and on the middle panel on the other one. And some people just never get used to that. Same thing with the learning management system. You click here in one, and you click here in another. And people, they'll just never get used to it and they'll think it's not as good. Quality is so subjective in applications like this. You just have to do what you can. And then you provide instructional help to help address some of those kinds of issues. And that's kind of one of the roles of the project manager is you go through and you start evaluating as it comes close to completion, and you start testing it within users. You find out what are the issues that they have? And you build just in time help so that they can click that little help icon or the help with this page and it brings up appropriate help that says, "Oh, this is what that is, now I know what to do." You can address some quality issues with help, but you don't want to rely on that. But the old saying of, "it should be so easy, no help is needed." You can almost never rely on that. As much as you'd like too.

10.1

Standards of Quality and Statistics

Statistics | Quality | Grade | Standard Deviation

Learning Objectives

1. Define quality and grade.
2. Define and explain how statistics are used in quality control.
3. Estimate the likelihood of samples falling within one, two, or three standard deviations of the mean given a normal distribution caused by random factors.

Quality and Grade

According to the International Organization for Standardization (ISO), ***quality*** is "the degree to which a set of inherent characteristics fulfill requirements."[1] The requirements of a product or process can be categorized or given a grade to give a basis for comparison. The quality is determined by how well something meets the requirements of its grade.

Quality of Gasoline Grades

Petroleum refiners provide gasoline in several different grades based on the octane rating because higher octane ratings are suitable for higher compression engines. Gasoline must not be contaminated with dirt or water, and the actual performance of the fuel must be close to its octane rating. A shipment of low-grade gasoline graded as 87 octane that is free of water or other contaminants would be of high quality, while a shipment of high grade 93 octane gas that is contaminated with dirt would be of low quality.
For most people, the term quality also implies good value—getting your money's worth. For example, even low-grade products should still work as expected, be safe to use, and last a reasonable amount of time. Consider the following examples.

Quality of Furniture Packing in John's Move

John has antique furniture that is in excellent condition that was left to him by his grandmother. The pieces are important to John for sentimental reasons and they are also valuable. John decides to hire movers (high-grade professionals) to load his furniture into the truck using appropriate padding and restraints to prevent dents and scratches during the long trip to Atlanta and then to unload the truck in Atlanta. John's standard for high quality is that no observable damage occurs to his large pieces of furniture, especially the antiques. If the furniture arrives in his new apartment without a single dent, scratch, or other damage, the activity will be of high quality.John's standard for packing his kitchen is lower. His dishes are old and cheap, so he decides to trust his inexperienced friends (low-grade amateurs)

to help him pack his kitchen. If a few of the dishes or glassware are chipped or broken in the process, the savings in labor cost will more than make up for the loss and were still a good value.

Statistics

Determining how well products meet grade requirements is done by taking measurements and then interpreting those measurements. ***Statistics***—the mathematical interpretation of numerical data—is useful when interpreting large numbers of measurements and is used to determine how well the product meets a specification when the same product is made repeatedly. Measurements made on samples of the product must be between ***control limits***—the upper and lower extremes of allowable variation—and it is up to management to design a process that will consistently produce products between those limits.

Instructional Designers often use statistics to determine the quality of their designs. Student assessments are one way in which instructional designers are able to tell whether learning occurs within the control limits.

Setting Control Limits in Gasoline Production

A petroleum refinery produces large quantities of fuel in several grades. Samples of the fuels are extracted and measured at regular intervals. If a fuel is supposed to have an 87 octane performance, samples of the fuel should produce test results that are close to that value. Many of the samples will have scores that are different from 87. The differences are due to random factors that are difficult or expensive to control. Most of the samples should be close to the 87 rating and none of them should be too far off. The manufacturer has grades of 85 and 89, so they decide that none of the samples of the 87 octane fuel should be less than 86 or higher than 88.
If a process is designed to produce a product of a certain size or other measured characteristic, it is impossible to control all the small factors that can cause the product to differ slightly from the desired measurement. Some of these factors will produce products that have measurements that are larger than desired and some will have the opposite effect. If several random factors are affecting the process, they tend to offset each other, and the most common results are near the middle of the range – this phenomenon is called the ***central limit theorem***.

If the range of possible measurement values is divided equally into subdivisions called ***bins***, the measurements can be sorted, and the number of measurements that fall into each bin can be counted. The result is a ***frequency distribution*** that shows how many measurements fall into each bin. If the effects that are causing the differences are random and tend to offset each other, the frequency distribution is called a ***normal distribution***, which resembles the shape of a bell with edges that flare out. The edges of a theoretical normal distribution curve get very close to zero but do not reach zero.

Normal Distribution of Gasoline Samples

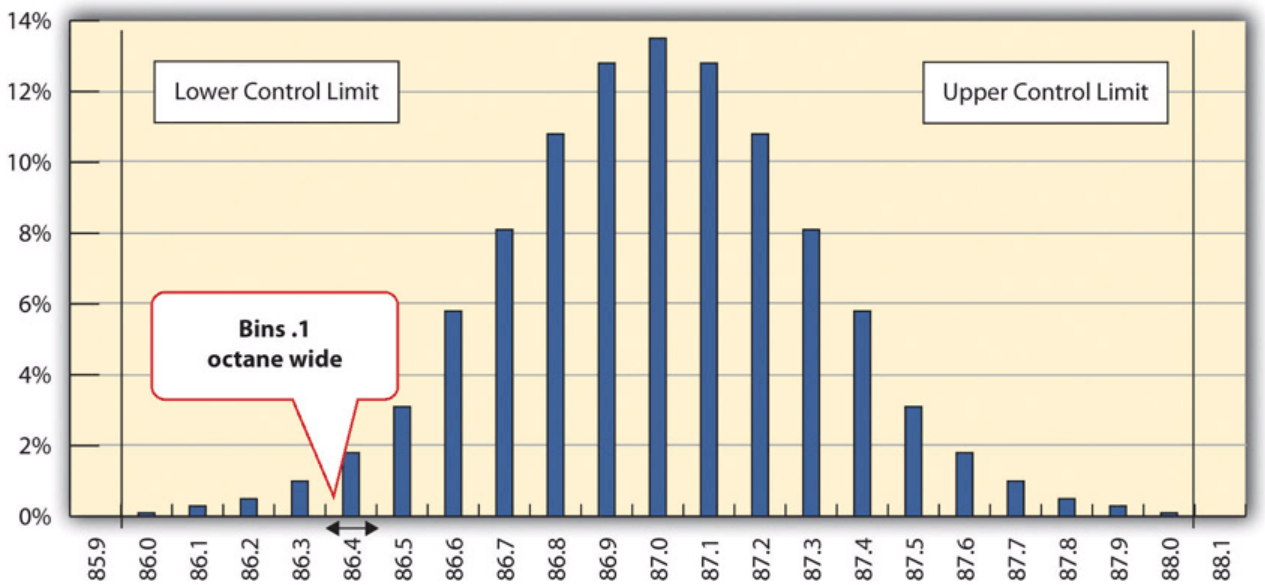
A refinery's quality control manager measures many samples of 87 octane gasoline, sorts the measurements by their octane rating into bins that are 0.1 octane wide, and then counts the number of measurements in each bin. Then she creates a frequency distribution chart of the data, as shown in Figure 10.1, "Normal Distribution of Measurements of Gasoline Samples".
It is common to take ***samples*** — randomly selected subsets from the total population—and measure and compare their qualities, since measuring the entire population would be cumbersome, if not impossible. If the sample measurements are distributed equally above and below the center of the distribution as they are in Figure 10.1, the average of those measurements is also the center value that is called the mean, and is represented in formulas by the lowercase Greek letter μ (pronounced mu). The amount of difference of the measurements from the central value is called the "sample standard deviation" or just the "standard deviation".

The first step in calculating the standard deviation is subtracting each measurement from the central value (mean) and then squaring that difference. (Recall from your mathematics courses that squaring a number is multiplying it by itself and that the result is always positive.) The next step is to sum these squared values and divide by the number of values

minus one. The last step is to take the square root. The result can be thought of as an average difference. (If you had used the usual method of taking an average, the positive and negative numbers would have summed to zero.) Mathematicians represent the standard deviation with the lowercase Greek letter σ (pronounced sigma). If all the elements of a group are measured, instead of just a sample, it is called the standard deviation of the population and in the second step, the sum of the squared values is divided by the total number of values.

Figure 10.1

Normal Distribution of Measurements of Gasoline Samples



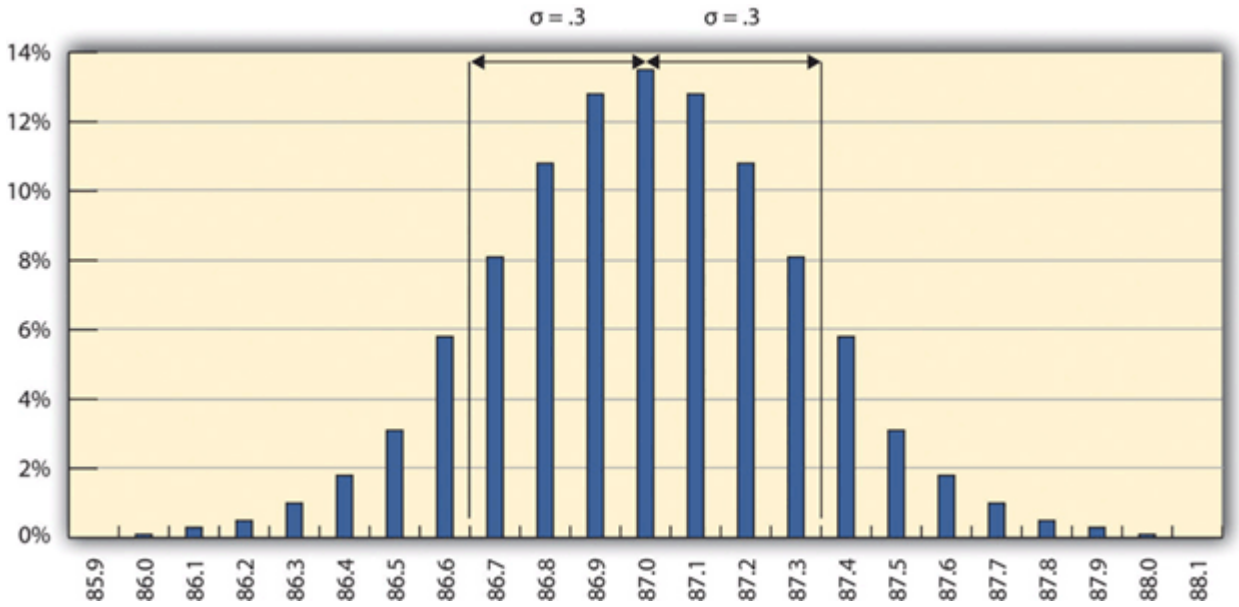
The chart shows that the most common measurements of octane rating are close to 87 and that the other measurements are distributed equally above and below 87. The shape of the distribution chart supports the central limit theorem's assumption that the factors that are affecting the octane rating are random and tend to offset each other, which is indicated by the symmetric shape. This distribution is a classic example of a normal distribution. The quality control manager notices that none of the measurements are above 88 or below 86 so they are within control limits and concludes that the process is working satisfactorily.

Standard Deviation of Gasoline Samples

The refinery's quality control manager uses the standard deviation function in her spreadsheet program to find the standard deviation of the sample measurements and finds that for her data, the standard deviation is 0.3 octane. She marks the range on the frequency distribution chart to show the values that fall within one sigma (standard deviation) on either side of the mean (see figure 10.2).

Figure 10.2

One Sigma Range



Most of the measurements are within 0.3 octane of 87.

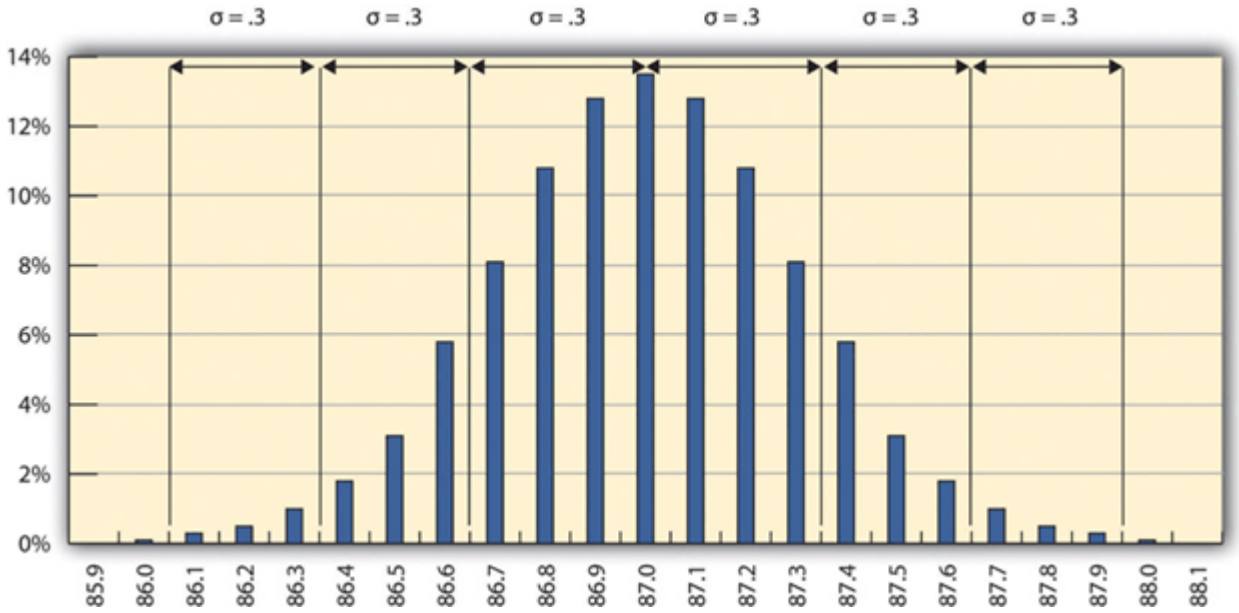
For normal distributions, about 68.3% of the measurements fall within one standard deviation on either side of the mean. This is a useful rule of thumb for analyzing some types of data. If the variation between measurements is caused by random factors that result in a normal distribution and someone tells you the mean and the standard deviation, you know that a little over two-thirds of the measurements are within a standard deviation on either side of the mean. Because of the shape of the curve, the number of measurements within two standard deviations is 95.4%, and the number of measurements within three standard deviations is 99.7%. For example, if someone said the average (mean) height for adult men in the United States is 5 feet 10 inches (70 inches) and the standard deviation is about 3 inches, you would know that 68% of the men in the United States are between five feet seven inches (67 inches) and six feet one inch (73 inches) in height. You would also know that about 95% of the adult men in the United States were between five feet four inches and six feet four inches tall, and that almost all of them (99.7%) are between five feet one inches and six feet seven inches tall. These figures are referred to as the ***68-95-99.7*** rule.

Almost All Samples of Gasoline are Within Three STD

The refinery's quality control manager marks the ranges included within two and three standard deviations, as shown below.

Figure 10.3

The 68-95-99.7 Rule



Some products must have less variability than others to meet their purpose. For example, if training designed to operate highly specialized and potentially dangerous machinery was assessed for quality, most participants would be expected to exceed the acceptable pass rate. Three standard deviations from the control limits might be fine for some products but not for others. In general, if the mean is six standard deviations from both control limits, the likelihood of a part exceeding the control limits from random variation is practically zero (2 in 1,000,000,000). (Refer to Figure 10.4)

Figure 10.4

Meaning of Sigma Levels

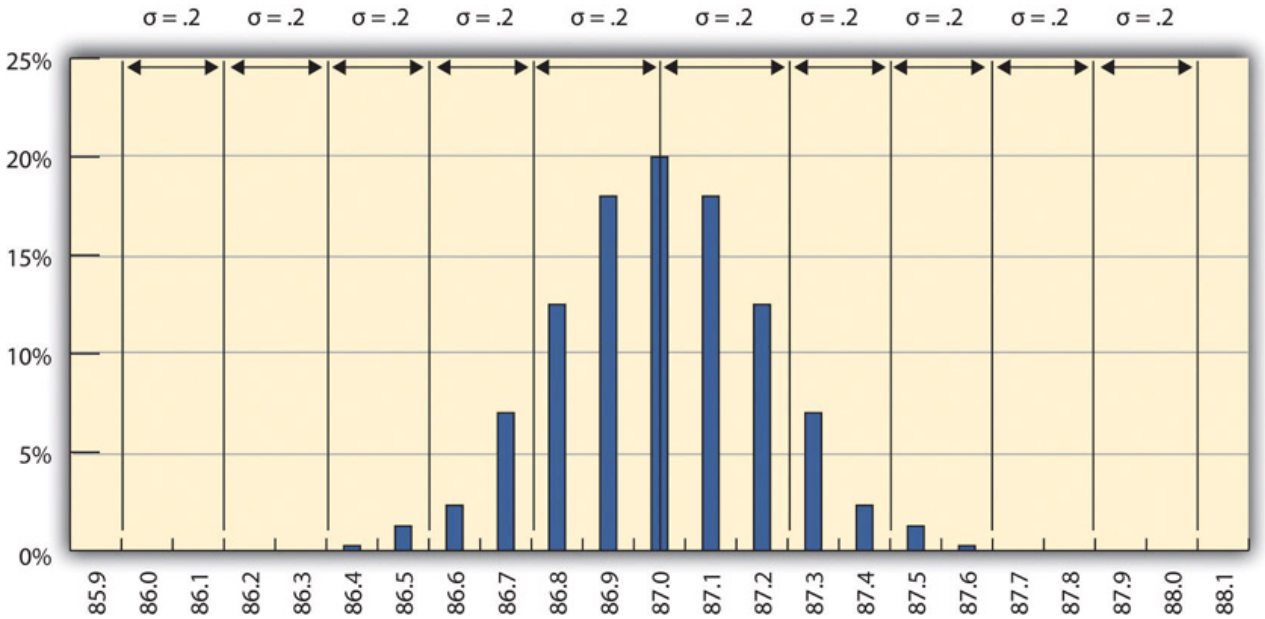
Standard Deviations between Mean and Either Control Limit	Sigma Level	Percentage Inside Control Limits	Percentage Outside Control Limits	Parts Outside Control Limits (approximate)
1	1	68.3%	31.7%	32 per 100
2	2	95.4%	4.6%	5 per 100
3	3	99.7%	.3%	3 per 1,000
4	4	99.993 7%	.006 3%	4 per 100,000
5	5	99.999 94%	.000 06%	6 per 10 million
6	6	99.999 999 8%	.000 000 2%	2 per billion

A Step Project Improves Quality of Gasoline

A new refinery process is installed that produces fuels with less variability. The refinery's quality control manager takes a new set of samples and charts a new frequency distribution diagram, as shown below.

Figure 10.5

Smaller Standard Deviation



The refinery's quality control manager calculates that the new standard deviation is 0.2 octane. From this, he can use the 68-95-99.7 rule to estimate that 68.3% of the fuel produced will be between 86.8 and 87.2 and that 99.7% will be between 86.4 and 87.6 octane. A shorthand way of describing this amount of control is to say that it is a five-sigma production system, which refers to the five standard deviations between the mean and the control limit on each side.

Key Takeaways

- Quality is the degree to which a product or service fulfills requirements and provides value for its price.
- Statistics is the mathematical interpretation of numerical data, and several statistical terms are used in quality control. Control limits are the boundaries of acceptable variation.
- If random factors cause variation, they will tend to cancel each other out—the central limit theorem. The central point in the distribution is the mean, which is represented by the Greek letter mu, μ. If you choose intervals called bins and count the number of samples that fall into each interval, the result is a frequency distribution. If you chart the distribution and the factors that cause variation are random, the frequency distribution is a normal distribution, which looks bell shaped.
- The center of the normal distribution is called the mean, and the average variation is calculated in a special way that finds the average of the squares of the differences between samples and the mean and then takes the square root. This average difference is called the standard deviation, which is represented by the Greek letter sigma, σ.
- About 68% of the samples are within one standard deviation, 95.4% are within two, and 99.7% are within three.

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10.2

Development of Quality as a Competitive Advantage

Quality | Competitive Advantage | History

Learning Objectives

1. Describe the historical events and forces that led up to today's emphasis on quality as a competitive requirement.
2. Describe quality awards in Japan and the United States.
3. Describe quality programs and standards such as TQM, Six Sigma, and ISO 9000.
4. Describe and calculate the cost of quality.

Quality management is an approach to work that has become increasingly important in every field, including instructional design, as global cooperation and competition have increased. A review of the history of quality management explains why it is so important for you to understand and why clients often require documentation to show that your processes satisfy their quality standards.

History

Prior to the late 1700s, products such as firearms and clocks were made as unique, individual works. If a part broke, a new one had to be made by hand to fit. In 1790 in France, Honoré Blanc demonstrated that he could make musket parts so nearly identical that a musket could be assembled from bins of parts chosen at random.[1] The practice of making parts to a high level of accuracy in their dimensions and finishes made the parts interchangeable. The use of interchangeable parts became the founding principle of assembly-line manufacturing to produce all manner of goods from sewing machines to automobiles to computer chips. The manufacturers of firearms and weapons were often the leaders in improving quality because reliable and safe operation of weapons and their rapid repair is a matter of life and death.

Statistical Control in the United States During World War II

During World War II, factories were converted from manufacturing consumer goods to weapons. War plants had to make large numbers of parts as fast as possible while doing it safely for the workers and for the service members who used them. Important improvements in ***quality control*** (QC)—the management of production standards through statistical interpretation of random product measurements, which emphasizes consistency and accuracy—were made during this period.

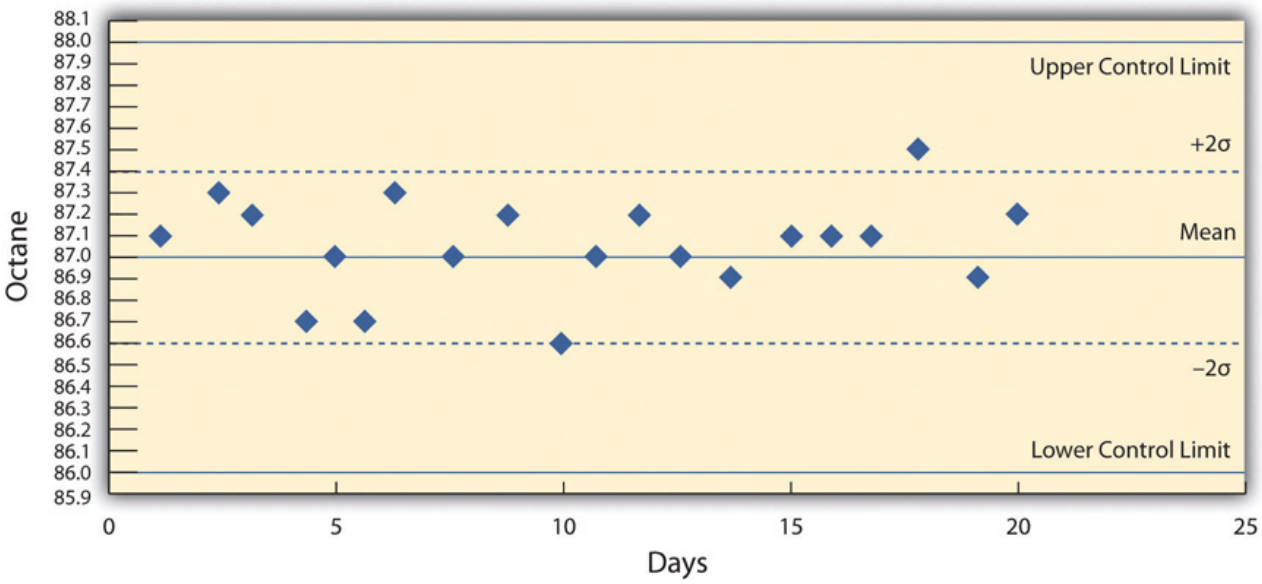
A key figure in the history of quality management who was an important person in the war effort was Walter Shewhart at Bell Telephone Laboratories. Shewhart recognized that real processes seldom behaved like theoretical random distributions and tended to change with time. He separated causes of variation into two categories: ***chance cause*** and ***assignable cause***. Chance causes could be ignored if they did not cause too much variation, and trying to eliminate them often made the problem worse, but assignable causes could be fixed. To help distinguish between variations caused by random events and trends that indicated assignable causes, Shewhart introduced the ***control chart***, which is also known as a type of ***run chart*** because data are collected while the process is running. A control chart has time on the bottom axis and a plot of sample measurements. The mean, upper control limit, lower control limit, and warning lines that are two sigma from the mean are indicated by horizontal lines.

Control Chart Shows Production Variation of Gasoline

The refinery quality control manager takes samples each day of the 87 octane gasoline for twenty days and charts the data on a control chart, as shown below.

Figure 10.6

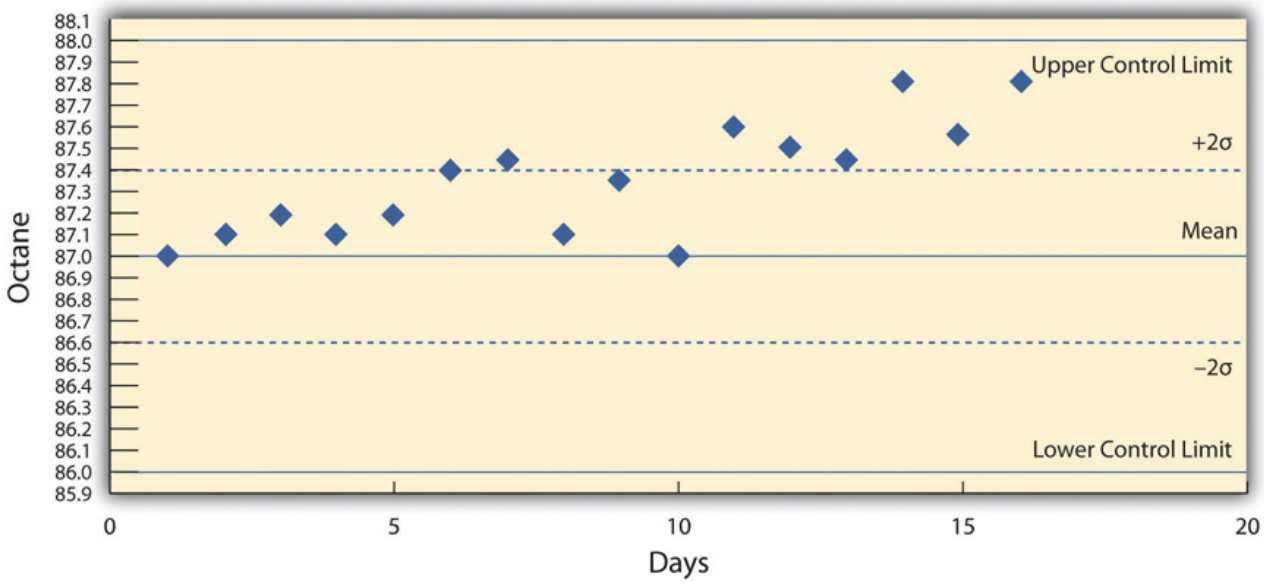
Control Chart Displaying Variations Due to Chance Causes



She recognizes that the highest and lowest measurements are not part of a trend and are probably due to chance causes. However, the control chart from the next twenty days, as shown below, indicates an upward trend that might be due to an assignable cause. She alerts the process manager to let him know that there is a problem that needs to be fixed before the product exceeds the upper control limit. This might indicate the need to initiate a project to fix the problem.

Figure 10.7

Control Chart Displaying Variations That Might Be Due to an Assignable Cause



Deming and Postwar Japan

The most influential person in modern quality control was an American who was a hero in Japan but virtually unknown in the United States. W. Edwards Deming worked with Shewhart at Bell Labs and helped apply Shewhart's ideas to American manufacturing processes during World War II. Following the war, American factories returned to the production of consumer goods. Many of the other major manufacturing centers in the world had been damaged by bombing during the war and took time to recover. Without the safety needs of wartime and with little competition, quality control was not a high priority for American companies.[2] Management in the United States focused on increasing production to meet demand and lowering costs to increase profits.

After the war, while the United States occupied Japan, Deming was asked by the U.S. Department of the Army to assist with the statistics of the 1950 census in Japan. Kenichi Koyanagi, the managing director of the Union of Japanese Scientists and Engineers and a very influential industrialist, asked Deming to speak to twenty-one top industrial leaders on the topic of global strategy for Japanese industry. Deming went beyond Shewhart's work and talked about his philosophy of quality manufacturing and how the responsibility for quality begins with management. He explained that a corporate culture devoted to producing high-quality products would result in less waste, lower costs, greater client loyalty, and greater market share. With Koyanagi's support, Deming's ideas were widely adopted by these influential leaders.

Deming described his philosophy as a system of profound knowledge, which has four parts:

1. Appreciation of a system. Understanding how suppliers, producers, and clients interact.
2. Knowledge of variation. Understanding statistical variation.
3. Theory of knowledge. Understanding what can be known and what cannot.
4. Knowledge of psychology. Understanding human nature.

In 1950, the Japanese created the ***Deming prize*** in Deming's honor, which is awarded to an individual and a company for major advances in quality improvements. In 1960, Deming was awarded the Order of the Sacred Treasure, Second Class by the Prime Minister on behalf of Emperor Hirohito.

Image by Shane Global Language Centres

Quality Management in America

By the 1970s, Japanese companies had a reputation for high quality and were taking market share from American companies, but Deming's teachings were virtually unknown in his own country. It was not until 1980 that America became aware of Deming when his work was described in an NBC documentary titled *If Japan Can, Why Can't We?*[3] By then, Deming was eighty years old and the producer of the show originally assumed he was dead.[4]

In 1982, Deming's book was published and later retitled *Out of Crisis*, in 1986.[5] It was aimed at explaining his system to American manufacturers and the American public. In the book, Deming described fourteen principles of management to guide the implementation of his philosophy. Some of them were challenges to Western managers and very different from the thinking that was prevalent at the time. In brief, they are as follows:

1. Create constancy of purpose toward improvement of product and service.
2. Adopt a new philosophy. We are in a new economic age. Western management must awaken to the challenge, learn their responsibilities, and take on leadership for a change.
3. Cease dependence on inspection to achieve quality. Eliminate the need for inspection on a mass basis by building quality into the product in the first place.
4. End the practice of awarding business on the basis of price tag. Instead, minimize cost. Move toward a single supplier for any one item, on a long-term relationship of loyalty and trust.
5. Improve constantly and forever the system of production and service to improve quality and productivity and thus constantly decrease costs.
6. Institute training on the job.
7. Institute leadership. The aim of supervision should be to help people and machines and gadgets to do a better job. Supervision of management is in need of overhaul, as well as supervision of production workers.
8. Drive out fear, so that everyone may work effectively for the company.
9. Break down barriers between departments.
10. Eliminate slogans, exhortations, and targets for the workforce asking for zero defects and new levels of productivity.
11. Eliminate work standards (quotas) on the factory floor. Substitute leadership.
12. Remove barriers that rob the hourly worker of his right to pride of workmanship.
13. Institute a vigorous program of education and self-improvement.
14. Put everybody in the company to work to accomplish the transformation. The transformation is everybody's job.

Between 1979 and 1982, Ford Motor Company lost $3 billion, and they were looking for solutions to their problems. They chose to apply Deming's approach to develop the new Taurus-Sable model and by 1986 had become the most profitable American auto company.[6]

Ford adopted a Japanese approach to quality known in America as ***total quality management*** (TQM). TQM in Japan has four major components:

1. ***Kaizen.*** Improvement must involve all members of a company.[7]
2. ***Atarimae hinshitsu***. Make things work the way they are supposed to work.[8]
3. ***Kansei.*** Learn from the way a user applies the product to make improvements.[9]
4. ***Miryokuteki hinshitsu.*** Things should have an aesthetic quality and be pleasing to use.[10]

According to Peter B. Petersen,[11] TQM differs from the Deming approach in four fundamental ways:

1. The Deming approach represents one philosophy that is used in its entirety or not at all. In contrast, TQM can be tailored to a particular environment.
2. Both agree that a long-term commitment is required by top management. However, Deming would drop clients if they started to wane, while TQM consultants were less demanding.
3. Deming insists on constancy of purpose, while TQM adapts to the situation, which results in lack of constancy.
4. Deming requires adoption of his principles of profound knowledge, while TQM lacks this unified philosophy.

Many poorly qualified consulting firms provided training in TQM to American companies. The approach worked in some cases but not in others where it was applied superficially, and the movement's credibility was diminished.

Another approach to quality management in the United States was formulated at Motorola in 1986 and was named ***Six Sigma*** (6σ). The Six Sigma practices were based on Deming's work, TQM, and others and had similarities regarding continuous efforts at improvement involving everyone at the company. It emphasized a clear focus on achieving quantifiable financial returns from any Six Sigma project. To determine the financial return on a quality initiative, the ***cost of quality*** (COQ) must be determined. The cost of quality has two parts: the cost of prevention and the cost of failure (or nonconformance). The cost of quality is the difference between the additional money spent on prevention and the corresponding reduction in the cost of failure.

Cost of prevention

1. Cost of conformance. Cost to improve quality
2. Cost of appraisal. Cost to measure and evaluate quality

Cost of failure

1. Internal costs. Repairing bad parts before shipment or retooling a manufacturing line to reduce failures
2. External costs. Managing returns, lawsuits, product recalls

The name Six Sigma refers to a process that has six standard deviations from the mean to either control limit that would ensure virtually zero defects. This approach was adopted by Jack Welch at General Electric with great success. By the late 1990s, about two-thirds of the top five hundred companies in the United States had begun Six Sigma projects, including Ford, which had allowed its quality programs to slip. To provide encouragement and a consistent standard, the U.S. government created the ***Malcolm Baldrige National Quality Award*** in 1987 to encourage companies to improve quality; the award was named for Malcolm Baldrige who was the U.S. secretary of commerce from 1981 to 1987.[12] The criteria used to determine award winners are as follows:

1. Leadership of senior executives
2. Strategic planning
3. Customer and market focus
4. Measurement, analysis, and knowledge management
5. Workforce focus
6. Process management
7. Results

Often, instructional designers will be working with others who focus on quality within their organizations. Quality is usually associated with the evaluation portion of instructional design. It is important to understand the current quality management models that are employed so that evaluation of a design can be in line with organizational expectations.

Trade and International Standards

Trade between countries increased as countries recovered from WWII and began producing consumer goods. In 1948, the General Agreement on Tariffs and Trade (GATT) established the rules for international trade in the postwar world. Through years of negotiations based on GATT, the ***World Trade Organization*** (WTO) was created in 1995. The WTO is a negotiating forum where governments can discuss ways to help trade flow as freely as possible.[13]

Increases in trade forced companies to improve the quality of their products to compete for clients and to exchange parts reliably between companies that used parts suppliers. To assist in developing standards for quality that would be the same between countries, an organization of 158 national standards groups formed the ***International Organization for Standardization*** (ISO), which is headquartered in Switzerland. There are thousands of ISO standards, and they are grouped by their numbers. The ISO 9000 group of standards relate to quality.

Recommended steps for implementing a quality management system (QMS) are as follows:

1. Fully engage top management.
2. Identify key processes and the interactions needed to meet quality objectives.
3. Implement and manage the QMS and its processes.
4. Build your ISO 9001-based QMS.
5. Implement the system, train company staff, and verify effective operation of your processes.
6. Manage your QMS—focus on client satisfaction, strive for continual improvement.
7. If necessary, seek third-party certification and registration of the QMS, or alternatively, issue a self-declaration of conformity.[14]

Key Takeaways

- The need for production of safe, reliable weapons that could be mass produced led to use of methods to assure that parts were manufactured within controlled limits. An early example is the interchangeable musket parts produced in France in 1790 and, later, the quality control methods introduced by Shewhart in the United States during World War II.
- Following World War II, Japanese companies followed advice from Deming and others to make quality a top priority for management. Higher-quality products gave Japan a competitive advantage with U.S. consumers that forced U.S. firms to respond with similar quality programs.
- The Deming award is given by Japan to companies doing business in Japan for high-quality standards. Similarly, the Baldrige National Quality Award is given to U.S. companies and individuals for their contribution to quality.
- Total quality management is a flexible program that is adapted from Japanese practices that emphasize kaizen, participation by all; atarimaie hinshitsu, making things work the way they should; kansei, learning from the way the client uses the product to make improvements; and miryokuteki hinshitsu, giving products an aesthetic quality to make them pleasing to use. Six Sigma identifies specialists within the organization and assigns titles like Master Black Belt. Each quality project must evaluate the cost of quality to gain approval.
- The International Standards Institute devises guidelines for establishing practices. The ISO 9000 group are guidelines for establishing practices that are likely to create quality products.
- The cost of quality has two parts: the cost of prevention and the cost of failure. The cost of prevention includes costs to establish quality practices and the costs to verify them. The cost of failure includes internal costs before the product is sold, such as waste and fixing products, while external costs include those that occur after the product is sold, such as returns and lawsuits.

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10.3

Relevance of Quality Programs to Project Quality

Quality | Project | Process | Management

Learning Objectives

1. Identify the similarities between process quality management and project quality management.
2. Identify the differences between process quality management and project quality management.

Process vs. Project Quality Management

Project quality refers to two distinct aspects of the project. The first aspect is the quality of the product or service delivered by the project. Does the end product meet client specifications? For example, does a software development project develop a program that performs to the client's requirements? A software program that performs the basic work functions but does not integrate with existing software would not be considered a quality product, as long as the client specified that the software must interface with existing software.

The second aspect of project quality is managing the project efficiently and effectively. Almost any client specification can be met if the project manager has unlimited time and resources. Recall that high quality means meeting the requirements for a particular grade while providing value. Meeting project deliverables within the time and resource constraints is also a measure of project quality. Developing a project execution plan that matches the complexity level of the project is the most critical aspect in developing a project plan that meets project specifications within the time frame and at the lowest costs. These two aspects of project quality have similarities and differences to quality as applied to parent organizations.

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Similarities

All successful quality programs have (1) a requirement for commitment to quality by all the employees and their partners and (2) an emphasis on error prevention and client satisfaction. To comply with TQM, Six Sigma, ISO, or other quality standards required by the client or by the project management firm, the project manager must engage in quality programs and provide documents that specifically comply with the quality standards in use. For example, a project is typically required to follow the parent organization's work processes related to procurement and document management. Any project's processes that interface with the organization's quality processes will be required to meet the quality standards of the organization.

If a large project involves repetitive processes such as repeated modules in an online training course, statistical processes control methods can be used to maintain the quality of the product. These process control methods are similar to those used by process managers in the manufacturing environment. The intent is for the work of the project to meet design specifications. The modules, for example, if repeated could be assessed to determine whether they consistently meet the quality standards of the project. The programmers design the modules to meet certain criteria that will support a structure. The criteria, detailed in the design specifications, provide the parameters that the instructional designers must meet when designing the course. On large projects the use of quality control tools and methods are critical to meeting design specifications.

Differences

Because projects are temporary, spotting trends in samples produced by repetitive processes is not as important as considering quality in the planning of the project. Instead, the project manager must be able to provide documentation that demonstrates that the correct processes are in place to prevent quality failures.

The cost of quality (COQ) must be considered in the scope document and the project budget. If the group or company that is providing the project management is separate from the client, the project budget will bear the cost of prevention while the client will reap the rewards of avoiding the costs of failure. If senior management does not recognize the

benefit to the organization of reducing cost of failure by spending more on prevention during the project, the project manager can be placed in the position of producing a product or service that he or she knows could be of higher quality.

If the cost of quality is not specifically considered and approved by senior management in the scope of the project, quality might be sacrificed during the project to meet budget goals.

Cost of Quality in a Learning Management System

At a Midwestern university, a new learning management system was being implemented. To reduce the cost of the system and avoid a late penalty, the project manager purchased and installed inferior server capacity. The less expensive system could only handle the current size of the university's processing load. Five years after the learning management system went online, the university had grown to far exceed the capabilities of their server architecture. The university did not take the time to specify the quality of the learning management system in the scope statement and was not aware of the implication of the inferior system at the time it was made. As a result, the cost of quality was lower in the prevention category but much higher in the cost of failure category. Because each party acted in their own interests instead of the interest of the university, and quality was not a priority, waste occurred and total cost increased.

Some separation of responsibility for quality is necessary. For example, if a project is undertaken to build a facility that makes something, it is important to distinguish between the quality of the work done by the project team and the quality of the items produced after the project is over. The client provides specifications for the facility that should result in production of quality products. It is the client's responsibility to provide appropriate project requirements that will result in a facility that can produce quality products. It is the project manager's responsibility to meet the project requirements. The project manager must focus on meeting requirements for project activities, but as part of the quality team, opportunities to improve the quality of the final product should be discussed with the client. If the final products fail to meet quality standards, someone will be blamed for the failure. It could be the project manager, even if he or she met all the requirements of the project specified by the client.

Cost of Prevention in Safety Training

An electronic parts manufacturer chooses to expand operations and needs to hire and train fifty employees. It uses its own human resources department to handle the selection and hiring of the employees, but it contracts with a nearby technical college to provide some of the training. The technical college is responsible for designing and delivering training on the topic of plant safety practices. The objective of the training project is to reduce the number of workplace accidents, but that is not the characteristic by which the quality of the training program is determined because the rate of accidents for employees who go through the training will not be known until after they have been employed for months or years. The criteria for determining the quality of the training must be something that can be controlled and measured by the project manager during the project.

Because projects are time sensitive, meeting activity finish dates is a common characteristic of quality work on a project that is not typical of a requirement of a process manager.

Timely Delivery Part of Quality

While developing training for a national event, certain deadlines were already set. If the event is scheduled for 6 months out, then those volunteering will need appropriate training before the event. If the training is designed and developed to specifications, but is delivered without enough time before the event, then the quality of the product is poor regardless of the effectiveness of the training.

Key Takeaways

- Both project and process quality management require commitment from all employees, including top management. They are both client oriented and prevention oriented.
- Projects are temporary and allow fewer opportunities to improve repetitive processes. Cost of prevention is often part of the project budget, but the cost of failure usually happens after the project is completed. This separation of costs and benefits can lead to taking short-term savings on the project at the expense of higher cost of failure after the project is complete.

10.4

Planning and Controlling Project Quality

Measurement | Quality | Project | Planning

Learning Objectives

1. Define statistical measurement terminology.
2. Identify sources of information for the planning process.
3. Identify and describe the techniques for controlling project quality.
4. Describe the results of planning and controlling quality.

High quality is achieved by planning for it rather than by reacting to problems after they are identified. Standards are chosen and processes are put in place to achieve those standards.

Measurement Terminology

During the execution phase of the project, services and products are sampled and measured to determine if the quality is within control limits for the requirements and to analyze causes for variations. This evaluation is often done by a separate quality control group, and knowledge of a few process measurement terms is necessary to understand their reports. Several of these terms are similar, and it is valuable to know the distinction between them.

The quality plan specifies the control limits of the product or process; the size of the range between those limits is the tolerance. ***Tolerances*** are often written as the mean value, plus or minus the tolerance. The plus and minus signs are written together, ±.

Tolerance in Gasoline Production

The petroleum refinery chose to set its control limits for 87 octane gasoline at 86 and 88 octane. The tolerance is 87 ± 1.
Tools are selected that can measure the samples closely enough to determine if the measurements are within control limits and if they are showing a trend. Each measurement tool has its own tolerances.

The choice of tolerance directly affects the cost of quality (COQ). In general, it costs more to produce and measure products that have small tolerances. The costs associated with making products with small tolerances for variation can be very high and not proportional to the gains. For example, if the cost of evaluating each screen as it is created in an

online tutorial is greater than delivering the product and fixing any issues after the fact, then the COQ may be too high and the instructional designer will tolerate more defects in the design.

Defining and Meeting Client Expectations

Clients provide specifications for the project that must be met for the project to be successful. Recall that meeting project specifications is one definition of project success. Clients often have expectations that are more difficult to capture in a written specification. For example, one client will want to be invited to every meeting of the project and will then select the ones that seem most relevant. Another client will want to only be invited to project meetings that need client input. Inviting this client to every meeting will cause unnecessary frustration. Listening to the client and developing an understanding of the expectations that are not easily captured in specifications is important to meeting the client's expectations.

Project surveys can capture how the client perceives the project performance and provide the project team with data that is useful in meeting client expectations. If the results of the surveys indicate that the client is not pleased with some aspect of the project, the project team has the opportunity to explore the reasons for this perception with the client and develop recovery plans. The survey can also help define what is going well and what needs improved.

Sources of Planning Information

Planning for quality is part of the initial planning process. The early scope, budget, and schedule estimates are used to identify processes, services, or products where the expected grade and quality should be specified. Risk analysis is used to determine which of the risks the project faces could affect quality.

Techniques

Several different tools and techniques are available for planning and controlling the quality of a project. The extent to which these tools are used is determined by the project complexity and the quality management program in use by the client.

Quality Management Methodology

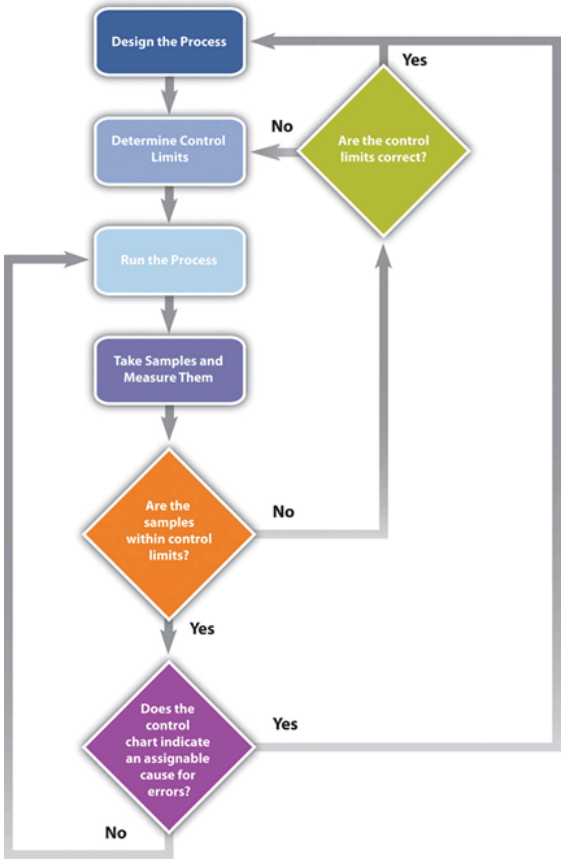
The quality management methodology required by the client is used. The project manager must provide the documentation the client needs to prove compliance with their methodology. There are several different quality management methodologies, but they usually have characteristics that are similar to the ones described previously in the text.

Flowcharting

Many processes are more complicated than a simple sequence of related events that include several different paths. A ***flowchart*** uses standard symbols to diagram a process that has branches or loops. Diamonds indicate decisions, and arrows indicate the direction of the flow of the process, as shown in Figure 10.8.

Figure 10.8

Flowchart of a Quality Control Process



The process used to plan and assess quality can be described using flowcharts. They are useful for communicating processes that have logical branches that can be determined by simple yes or no questions. Flowcharting is also useful for discovering misunderstanding in project roles and responsibilities and communicating responsibility for work processes.

Benchmarking

When products like shoes were made by hand, artisans would seek some degree of standardization by marking standard lengths for different parts of the product on their workbench. In modern management practice, if a particular method or product is a standard of quality, comparing your organization's quality plan to it is called ***benchmarking***. If a product or service is similar to something that is done in another industry or by a competitor, the project planners can look at the best practices that are used by others and use them as a comparison.

Cost-to-Benefit Analysis

Because the cost of prevention is more often part of the project budget, the case must be made for increasing the project budget to raise quality. Some quality management programs, like Six Sigma, require that expenditures for quality are justified using a cost-to-benefit analysis that is similar to calculating the cost of quality, except that it is a ratio of cost of increasing quality to the resulting benefit. A cost-benefit analysis in some quality programs can take into account nonfinancial factors such as client loyalty and improvements to corporate image and the cost-to-benefit analysis takes the form of a written analysis rather than a simple numeric ratio. It is similar to determining the cost of quality (COQ).

Design of Experiments

Measuring for quality of manufactured products or use of repetitive processes requires taking samples. Specialists in quality control design a test regimen that complies with statistical requirements to be sure that enough samples are taken to be reasonably confident that the analysis is reliable. In project management, the testing experiments are designed as part of the planning phase and then used to collect data during the execution phase.

Control Charts

If some of the functions of a project are repetitive, statistical process controls can be used to identify trends and keep the processes within control limits. Part of the planning for controlling the quality of repetitive processes is to determine what the control limits are and how the process will be sampled.

Cause and Effect Diagrams

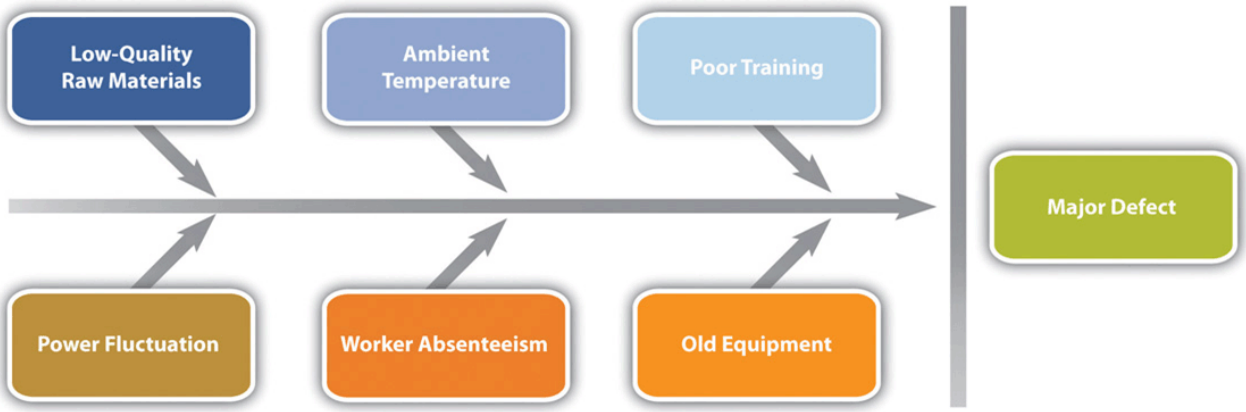
When control charts indicate an assignable cause for a variation, it is not always easy to identify the cause of a problem. Discussions that are intended to discover the cause can be facilitated using a cause-and-effect or ***fishbone diagram*** where participants are encouraged to identify possible causes of a defect.

Diagramming Quality Problems

For example, a small manufacturing firm tries to identify the assignable causes to variations in its manufacturing line. They assemble a team that identifies six possibilities, as shown in the fishbone diagram below.

Figure 10.9

Cause and Effect Diagram

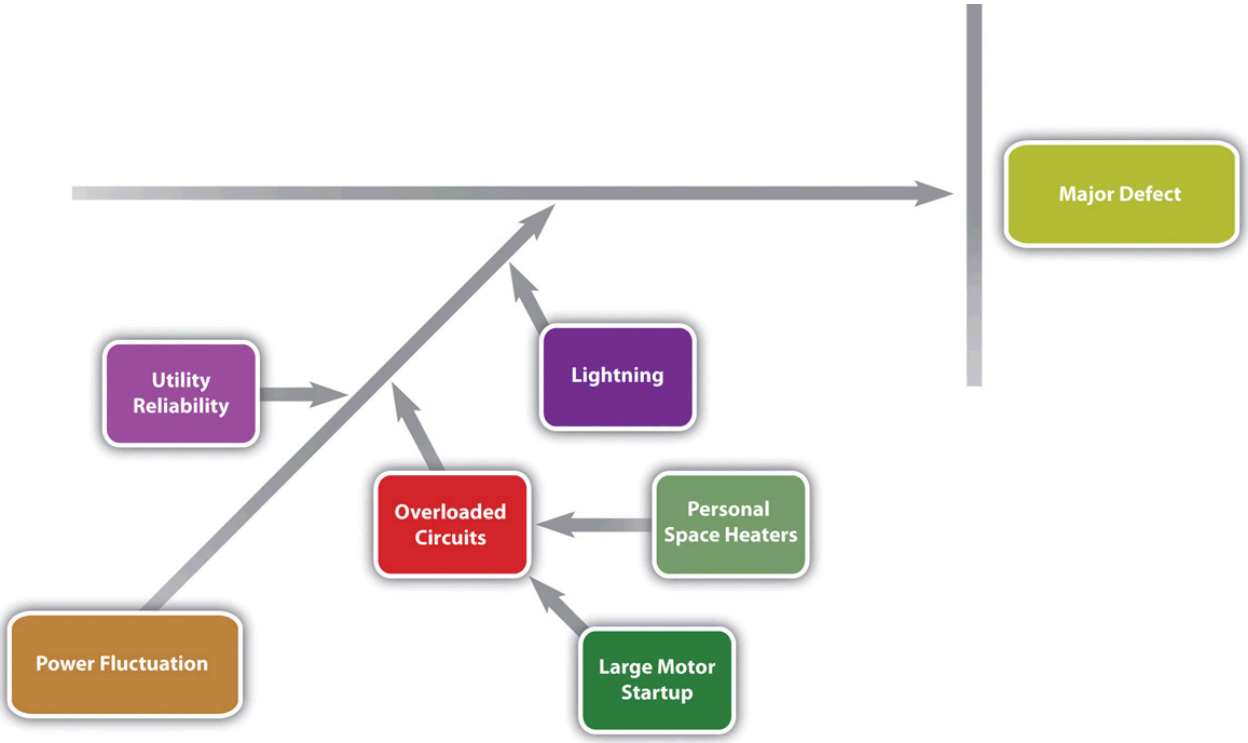


Each branch of the diagram can be expanded to break down a category into more specific items.

An engineer and the electrician work on one of the branches to consider possible causes of power fluctuation and add detail to their part of the fishbone diagram, as shown below.

Figure 10.10

Possible Causes of Power Fluctuation



Check Sheets, Histograms, and Pareto Charts

When several quality problems need to be solved, a project manager must choose which ones to address first. One way to prioritize quality problems is to determine which ones occur most frequently. This data can be collected using a ***check sheet***, which is a basic form on which the user can make a check in the appropriate box each time a problem occurs or by automating the data collection process using the appropriate technology. Once the data are collected, they can be analyzed by creating a type of frequency distribution chart called a ***histogram***. A true histogram is a column chart where the width of the columns fill the available space on the horizontal axis and are proportional to the category values displayed on the x axis, while the height of the columns is proportional to the frequency of occurrences. Most histograms use one width of column to represent a category, while the vertical axis represents the frequency of occurrence.

A variation on the histogram is a frequency distribution chart invented by economist Vilfredo Pareto known as a ***Pareto chart***, in which the columns are arranged in decreasing order with the most common on the left and a line added that shows the cumulative total. The combination of columns and a line allows the user to tell at a glance which problems are most frequent and what fraction of the total they represent.

Planning and Control Results

The quality plan is produced during the initiation phase. The methods, procedures, and logic are described to demonstrate a commitment to a project of high quality. The plan identifies the products or services that will be measured and how they will be measured and compared to benchmarks. A flowchart demonstrates the logic and pathways to improve the plan.

During the execution phase, data are collected by measuring samples according to the design specified in the plan. The data are charted and analyzed. If variations are due to assignable causes, change requests are created.

Key Takeaways

- Statistical control terms that are commonly used are tolerance (the range between control limits), flowchart (a diagram showing decision branches and loops), benchmarking (comparison to best practices), fishbone diagram (shows possible causes of quality problems), check sheet (form used to record frequency of problem occurrences), histogram (column chart that shows frequency of problems), and Pareto chart (histogram sorted by frequency from highest to smallest with a line that shows total cumulative problems).
- The quality planning process uses initial scope, budget, and schedule estimates to identify areas that need quality management.
- Control of quality in repetitive processes use statistical control methods that involve designing testing while considering the cost of quality, taking measurements, and then analyzing the data using run charts that show control limits and trends. Methodologies are compared to the best practices by competitors, which is called benchmarking. Errors are documented using check sheets and analyzed using fishbone diagrams, histograms, or Pareto charts.
- The products of planning and controlling quality are a quality management plan, data, analysis documents, and proposals for improvement.

10.5

Assuring Quality

Quality Assurance

Learning Objectives

1. Describe the purpose and methods of quality assurance.

The purpose of quality assurance is to create confidence that the quality plan and controls are working properly. To assure quality, time must be allocated to review the original quality plan and compare that plan to how quality is being ensured during the execution of the project.

Process Analysis

The flowcharts of quality processes are compared to the processes followed during actual operations. If the plan was not followed, the process is analyzed and corrective action taken. The corrective action could be to educate the people involved on how to follow the quality plan or to revise the plan.

The experiments that sample products and processes and collect data are examined to see if they are following statistically valid sampling techniques and that the measurement methods have small enough tolerances to detect variation within control limits.

Because projects are temporary, there are fewer opportunities to learn and improve within one project if it has a short duration, but even in short projects, the quality manager should have a way to learn from experience and change the process for the next project of a similar complexity profile.

Analyzing Quality Processes in Safety Training

The technical college responsible for training employees in safe plant practices evaluates its instructor selection process at the end of the training to see if it had the best criteria for selection. For example, it required the instructors to have Masters degrees in manufacturing to qualify as college instructors. The college used an exit survey of the students to ask what they thought would improve the instruction of future classes on this topic. Some students felt that it would be more important to require that the instructors have more years of training experience, while others recommended that the college seek certification as a training center by the Occupational Safety and Health Administration (OSHA).[1] The college considered these suggestions and decided to retain its requirement of a Master's degree but add a requirement that the instructor be certified by OSHA in plant safety.

Key Takeaways

- The purpose of quality assurance is to build confidence in the client that quality standards and procedures are being followed. This is done by an internal review of the plan, testing, and revisions policies or by an audit of the same items performed by an external group or agency.

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11

Managing Project Risk

Overview

This chapter aligns with chapter 11 of the PMBOK and 11% of the CAPM questions come from this knowledge area. The content connects to the Planning and Monitoring & Controlling category of the PMP questions.

All projects, including those within instructional design, rarely, if ever, go completely according to plan. Thus, competent project managers are prepared to deal with unexpected adversity during the course of the project. In order to mitigate the impact of disruptions, project managers must identify the potential risks and make appropriate plans. Failure to do so can easily lead to a decrease in project quality or unnecessary increases in budget.

Designers Share Their Experiences

Dr. Andy Gibbons – Instructional Psychology and Technology – BYU

Watch on YouTube

At the beginning of this project we were training helicopter pilots, we were training sensor operators who sit at the back and operate electronic equipment. What was the biggest threat? It was probably me and my naivety. I was the project director of a project that eventually accumulated twenty-five staff members, and we were working with Navy teams of subject matter experts. We probably had eight or nine subject matter experts assigned to our project. That was a rich, rich resource. And I had no idea, I'd not been trained how to manage a project that size. My previous project experience had been a staff of four people at most: a secretary, an artist and a writer, and myself. Well this project was a different kind of challenge. The biggest risk was me not understanding, and as a result, there were some big mistakes made. I would say that as far as designer's secrets, that I should have known that I didn't know, it would be how subject matter experts, excuse me, how bodies of subject matter are organized. And how, as a designer, you have to be able to get to the heart of the subject matter quickly and efficiently, sometimes even before the subject matter expert is there. I'll tell you about another project. I was working on a project with DC-10 pilots, for a major airline. And we were doing a task analysis. Tried to identify all the tasks that these pilots had to be able to perform. We got to the part where we were talking about emergencies that they had to be able to perform. And we were listing emergencies that happened in the pilot's handbook. And I was all the time going through trying to make sure, are we leaving anything out? Is there anything that could go wrong with this aircraft that a pilot would have to be able to respond to, that needs to go into this task analysis? And they said, well no. I said, well okay, hydraulic systems, your aircraft' s got two hydraulic systems. And they said, yeah. And I said, well what if both hydraulic systems,

we've got a single hydraulic system failure here, and you got a procedure that the pilot has to learn for that. What about if you have a dual hydraulic system failure? What if both of them go out at the same time? Oh it never happens. If one of them goes out, the second one kicks in, it automatically turns itself on, you don't have to do anything. I said, hasn't there been any instance or isn't there some possibility of that happening. No, no, no. So we left it out of the task analysis. Not nine months later there was a DC-10 flying over Saint Louis somewhere in the region, mid U.S, and a private plane clipped off its tail. And both hydraulic systems failed. And there were three hundred people on board. Now, a quick thinking pilot figured out a way, I mean what happens when a hydraulic system fails on a major airliner, you can't control the aircraft, you can't turn it, you can't bank it you can't do anything. So how did they land that aircraft, they finally did land the aircraft, it was a crash landing, but it was a landing, and half of the people on board survived, so 150 people survived that crash landing in a cornfield. How did the pilot figure out how to handle that emergency? Well, they used the jet throttles. They would adjust it this way if they wanted to turn this way, they would adjust it this way if they wanted to turn this way. And so they were able to land the aircraft where they wanted to. And of course, they did altitude control just by denying gas to the engines. So they brought it down and a hundred and fifty people were saved, that otherwise would have died. But I always remembered that one time when I had the instinct to say I think I know your subject matter better than you do, and I think this is something that could happen. This is a task that you ought to include in your training. I'll just bet you it's in the training now. And so, you have to, as an instructional designer, you can't just be naive. You can't just accept what they tell you. You've got to question everything. You've got to become a big critic.

Heather Bryce – Independent Studies – BYU

Watch on YouTube

I didn't know how expensive Art 45 was going to be. And I hate bringing that up over and over again, because honestly it was the only drawback of this project. Everything else went so well. That was probably a risk. Fortunately, you know, we had the funds to be able to pay for that. But some places, you know, you don't have the funds. If you run out of money, you are not able to finish your project. So that was probably a huge risk to this project. But other than that, there weren't really any risks. I mean I suppose there could have been conflict between the artist's opinions of what you should do when you have several artists working on different projects. But we just really didn't have that.

Dr. Larry Seawright – Center for Teaching and Learning – BYU

Watch on YouTube

Probably in building the learning management system, that we call the BYU Learning Suite, the biggest risk that we had was the short beta test period that we're going to have. Had we known that up front I think we would have compressed some of our development cycle sooner so that we have a little bit more of a beta test period.

11.1

Defining Risk

Project Risk | Risk Management

Learning Objectives

1. Define project risk.
2. Define the difference between known and unknown risks.
3. Describe the difference between the business risk of the organization and project risk.

Risk is the possibility of loss or injury.[1] ***Project risk*** is an uncertain event or condition that, if it occurs, has an effect on at least one project objective.[2] ***Risk management*** focuses on identifying and assessing the risks to the project and managing those risks to minimize the impact on the project. There are no risk-free projects because there are an infinite number of events that can have a negative effect on the project. Risk management is not about eliminating risk but about identifying, assessing, and managing risk.

Tzvi Raz, Aaron Shenhar, and Dov Dvir[3] studied risk management practices on one hundred projects in a variety of industries. The results of this study suggested the following about risk management practices:

- Risk management is not widely used.
- The projects that were most likely to have a risk management plan were those that were perceived to be high risk.
- When risk management practices were applied to projects, they appeared to be positively related to the success of the project.
- The risk management approach influenced project schedules and cost goals but exerted less influence on project product quality.
- Good risk management increases the likelihood of a successful project.

Risk deals with the uncertainty of events that could affect the project. Some potential negative project events have a high likelihood of occurring on specific projects. Examples are as follows:

- Safety risks are common on construction projects.
- Changes in the value of local currency during a project affect purchasing power and budgets on projects with large international components.
- Projects that depend on good weather, such as road construction or coastal projects, face risk of delays due to exceptionally wet or windy weather.

These are examples of known risks. ***Known risks*** are events that have been identified and analyzed for which advanced planning is possible. Other risks are unknown or unforeseen.

Weather

Project team members were flying to a project review meeting in South Carolina when a severe storm caused all flights to be cancelled. Members of the leadership team could not make the meeting and weren't even able to return to their home base for a couple of days.

Sudden Family Death

Just before a project meeting in Texas, the instructional design lead received word that his father had died in the middle of the night. The team delayed making decisions on some critical events without the knowledge and judgment of the instructional designer.
These events were unforeseen by the project team, and in both cases the projects experienced schedule delays and additional costs.

Project risks are separate from the ***organizational risks*** that are associated with the business purpose of the project.

A project was chartered to design training for a new customer management system at a cost not to exceed $250,000. If a project is completed on time, within budget, and meets all quality specifications, the project is successful. If the customer management system does not meet the needs of the organization, the organizational goals of the project may not be achieved. The customer management system is an organizational or business risk. The company authorized the project based on assumptions about the system meeting their needs. The system's capability is not a project risk on this project.

Key Takeaways

- Project risk is the possibility that project events will not occur as planned or that unplanned events will occur that will have a negative impact on the project.
- Known risks can be identified before they occur, while unknown risks are unforeseen.
- Organizational risks are associated with the business purpose of the project and assumed by the client when deciding to do the project.

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11.2

Risk Management Process

Project Risk | Risk | Risk Evaluation | Risk Mitigation

Learning Objectives

1. Identify the major elements in managing project risk.
2. Describe the processes for identifying project risk.
3. Describe the processes for evaluating risk.
4. Describe the processes for mitigating risk.

Managing risks on projects is a process that includes risk assessment and a mitigation strategy for those risks. *Risk assessment* includes both the identification of potential risk and the evaluation of the potential impact of the risk. A ***risk mitigation plan*** is designed to eliminate or minimize the impact of the ***risk events***—occurrences that have a negative impact on the project. Identifying risk is both a creative and a disciplined process. The creative process includes brainstorming sessions where the team is asked to create a list of everything that could go wrong. All ideas are welcome at this stage with the evaluation of the ideas coming later.

Risk Identification

A more disciplined process involves using checklists of potential risks and evaluating the likelihood that those events might happen on the project. Some companies and industries develop risk checklists based on experience from past projects. These checklists can be helpful to the project manager and project team in identifying both specific risks on the checklist and expanding the thinking of the team. The past experience of the project team, project experience within the company, and experts in the industry can be valuable resources for identifying potential risk on a project.

Identifying the sources of risk by category is another method for exploring potential risk on a project. Some examples of categories for potential risks include the following:

- Technical
- Cost
- Schedule
- Client
- Contractual
- Weather
- Financial
- Political
- Environmental
- People

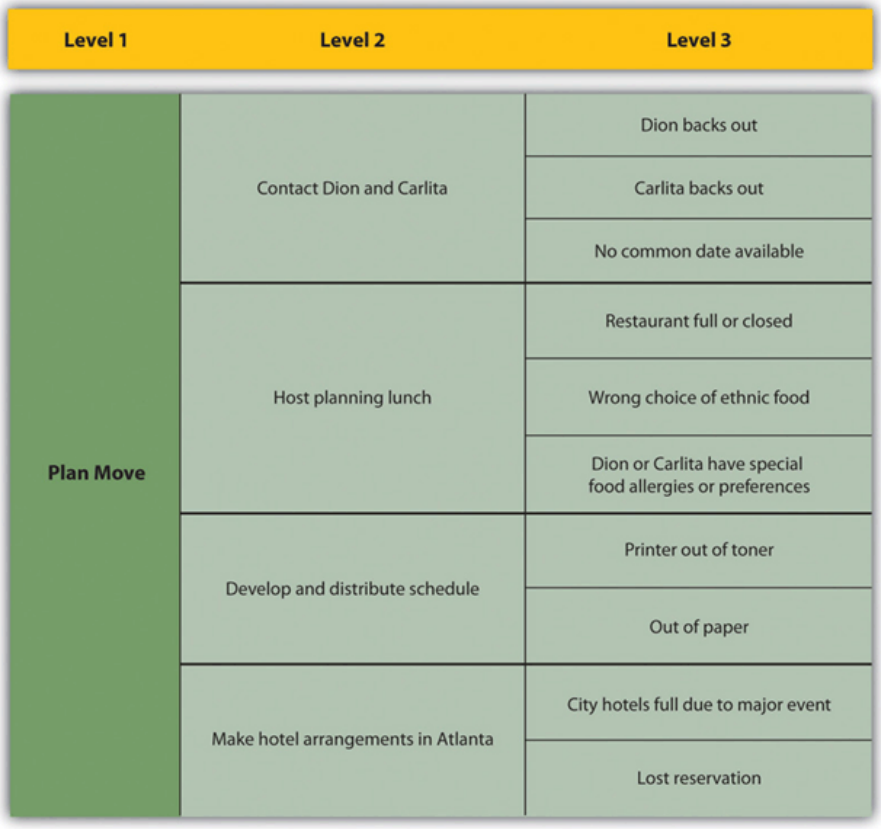
The people category can be subdivided into risks associated with the people. Examples of people risks include the risk of not finding the skills needed to execute the project or the sudden unavailability of key people on the project. David Hillson[1] uses the same framework as the work breakdown structure (WBS) for developing a ***risk breakdown structure (RBS)***. A risk breakdown structure organizes the risks that have been identified into categories using a table with increasing levels of detail to the right.

Risks in John's Move

In John's move, John makes a list of things that might go wrong with his project and uses his work breakdown structure as a guide. A partial list for the planning portion of the RBS is shown in Figure 11.1.

Figure 11.1

Risk Breakdown Structure (RBS)



The result is a clearer understanding of where risks are most concentrated. Hillson's approach helps the project team identify known risks, but can be restrictive and less creative in identifying unknown risks and risks not easily found inside the work breakdown structure.

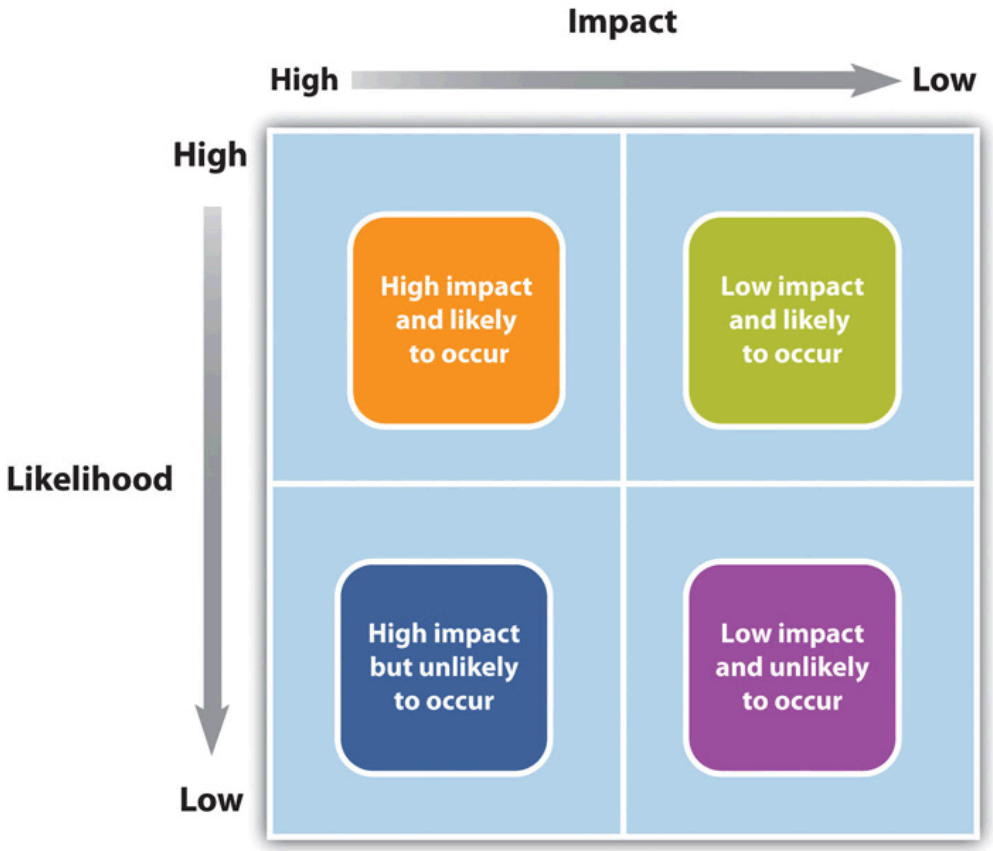
Risk Evaluation

After the potential risks have been identified, the project team then evaluates the risk based on the probability that the risk event will occur and the potential loss associated with the event. Not all risks are equal. Some risk events are more likely to happen than others, and the cost of a risk event can vary greatly. Evaluating the risk for probability of occurrence and the severity or the potential loss to the project is the next step in the risk management process.

Having criteria to determine high impact risks can help narrow the focus on a few critical risks that require mitigation. For example, suppose high-impact risks are those that could increase the project costs by 5% of the conceptual budget or 2% of the detailed budget. Only a few potential risk events met these criteria. These are the critical few potential risk events that the project management team should focus on when developing a project risk mitigation or management plan. Risk evaluation is about developing an understanding of which potential risks have the greatest possibility of occurring and can have the greatest negative impact on the project. These become the critical few.

Figure 11.2

Risk and Impact



There is a ***positive correlation***—both increase or decrease together—between project risk and project complexity. A project with new and emerging technology will have a high-complexity rating and a correspondingly high risk. The project management team will assign the appropriate resources to the technology managers to assure the accomplishment of project goals. The more complex the technology, the more resources the technology manager typically needs to meet project goals, and each of those resources could face unexpected problems.

Risk evaluation often occurs in a workshop setting. Building on the identification of the risks, each risk event is analyzed to determine the likelihood of occurring and the potential cost if it did occur. The likelihood and impact are both rated as high, medium, or low. A risk mitigation plan addresses the items that have high ratings on both factors—likelihood and impact.

Risk Analysis of Equipment Delivery

A project team analyzed the risk of some important equipment not arriving to the project on time. The team identified three pieces of equipment that were critical to the project and would significantly increase the costs of the project if they were late in arriving. One of the vendors, who was selected to deliver an important piece of equipment, had a history of being late on other projects. The vendor was good and often took on more work than it could deliver on time. This risk event (the identified equipment arriving late) was rated as high likelihood with a high impact. The other two pieces of equipment were potentially a high impact on the project but with a low probability of occurring.
Not all project managers conduct a formal risk assessment on the project. One reason, as found by David Parker and Alison Mobey[2] in their phenomenological study of project managers, was a low understanding of the tools and benefits of a structured analysis of project risks. The lack of formal risk management tools was also seen as a barrier to implementing a risk management program. Additionally, the project manager's personality and management style play into risk preparation levels. Some project managers are more ***proactive*** and will develop elaborate risk management programs for their projects. Other managers are *reactive* and are more confident in their ability to handle unexpected events when they occur. Yet others are ***risk averse***, and prefer to be optimistic and not consider risks or avoid taking risks whenever possible.

On projects with a low complexity profile, the project manager may informally track items that may be considered risk items. On more complex projects, the project management team may develop a list of items perceived to be higher risk and track them during project reviews. On projects with greater complexity, the process for evaluating risk is more formal with a risk assessment meeting or series of meetings during the life of the project to assess risks at different phases of the project. On highly complex projects, an outside expert may be included in the risk assessment process, and the risk assessment plan may take a more prominent place in the project execution plan.

On complex projects, statistical models are sometimes used to evaluate risk because there are too many different possible combinations of risks to calculate them one at a time. One example of the statistical model used on projects is the Monte Carlo simulation, which simulates a possible range of outcomes by trying many different combinations of risks based on their likelihood. The output from a Monte Carlo simulation provides the project team with the probability of an event occurring within a range and for combinations of events. For example, the typical output from a Monte Carlo simulation may reflect that there is a 10% chance that one of the three important pieces of equipment will be late and that the weather will also be unusually bad after the equipment arrives.

Risk Mitigation

After the risk has been identified and evaluated, the project team develops a risk mitigation plan, which is a plan to reduce the impact of an unexpected event. The project team mitigates risks in the following ways:

- Risk avoidance
- Risk sharing
- Risk reduction
- Risk transfer

Each of these mitigation techniques can be an effective tool in reducing individual risks and the risk profile of the project. The risk mitigation plan captures the risk mitigation approach for each identified risk event and the actions the project management team will take to reduce or eliminate the risk.

Risk avoidance usually involves developing an alternative strategy that has a higher probability of success but usually at a higher cost associated with accomplishing a project task. A common risk avoidance technique is to use proven and existing technologies rather than adopt new techniques, even though the new techniques may show promise of better performance or lower costs. A project team may choose a vendor with a proven track record over a new vendor that is providing significant price incentives to avoid the risk of working with a new vendor. The project team that requires drug

testing for team members is practicing risk avoidance by avoiding damage done by someone under the influence of drugs.

Risk sharing involves partnering with others to share responsibility for the risk activities. Many organizations that work on international projects will reduce political, legal, labor, and others risk types associated with international projects by developing a joint venture with a company located in that country. Partnering with another company to share the risk associated with a portion of the project is advantageous when the other company has expertise and experience the project team does not have. If the risk event does occur, then the partnering company absorbs some or all of the negative impact of the event. The company will also derive some of the profit or benefit gained by a successful project.

Risk reduction is an investment of funds to reduce the risk on a project. On international projects, companies will often purchase the guarantee of a currency rate to reduce the risk associated with fluctuations in the currency exchange rate. A project manager may hire an expert to review the technical plans or the cost estimate on a project to increase the confidence in that plan and reduce the project risk. Assigning highly skilled project personnel to manage the high-risk activities is another risk reduction method. Experts managing a high-risk activity can often predict problems and find solutions that prevent the activities from having a negative impact on the project. Some companies reduce risk by forbidding key executives or technology experts to ride on the same airplane.

Risk transfer is a risk reduction method that shifts the risk from the project to another party. The purchase of insurance on certain items is a risk transfer method. The risk is transferred from the project to the insurance company. A construction project in the Caribbean may purchase hurricane insurance that would cover the cost of a hurricane damaging the construction site. The purchase of insurance is usually in areas outside the control of the project team. Weather, political unrest, and labor strikes are examples of events that can significantly impact the project and that are outside the control of the project team.

Contingency Plan

The project risk plan balances the investment of the mitigation against the benefit for the project. The project team often develops an alternative method for accomplishing a project goal when a risk event has been identified that may frustrate the accomplishment of that goal. These plans are called contingency plans. The risk of a truck drivers' strike may be mitigated with a contingency plan that uses a train to transport the needed equipment for the project. If a critical piece of equipment is late, the impact on the schedule can be mitigated by making changes to the schedule to accommodate a late equipment delivery.

Contingency funds are funds set aside by the project team to address unforeseen events that cause the project costs to increase. Projects with a high-risk profile will typically have a large contingency budget. Although the amount of contingency allocated in the project budget is a function of the risks identified in the risk analysis process, contingency is typically managed as one line item in the project budget.

Some project managers allocate the contingency budget to the items in the budget that have high risk rather than developing one line item in the budget for contingencies. This approach allows the project team to track the use of contingency against the risk plan. This approach also allocates the responsibility to manage the risk budget to the managers responsible for those line items. The availability of contingency funds in the line item budget may also increase the use of contingency funds to solve problems rather than finding alternative, less costly solutions. Most project managers, especially on more complex projects, will manage contingency funds at the project level, with approval of the project manager required before contingency funds can be used.

Key Takeaways

- Risk management is a creative process that involves identifying, evaluating, and mitigating the impact of the risk event.
- Risk management can be very formal, with defined work processes, or informal, with no defined processes or methods. Formal risk evaluation includes the use of checklists, brainstorming, and expert input. A risk breakdown structure (RBS) can follow the work breakdown structure (WBS) to identify risk by activity.
- Risk evaluation prioritizes the identified risks by the likelihood and the potential impact if the event happens.
- Risk mitigation is the development and deployment of a plan to avoid, transfer, share, and reduce project risk. Contingency planning is the development of alternative plans to respond to the occurrence of a risk event.

References

David Hillson, "Using a Risk Breakdown Structure in Project Management," Journal of Facilities Management 2, no. 1 (2003): 85–97.

David Parker and Alison Mobey, "Action Research to Explore Perceptions of Risk in Project Management," International Journal of Productivity and Performance Management 53, no. 1 (2004): 18–32.

11.3

Project Risk by Phases

Risk Management | Initiation | Planning | Execution | Closeout

Learning Objectives

1. Describe the elements of risk management during the initiation phase.
2. Describe the elements of risk management during the planning phase.
3. Describe the elements of risk management during the execution phase.
4. Describe the elements of risk management during the closeout phase.

Image by shawncalhoun

Project risk is dealt with in different ways depending on the phase of the project.

Initiation Phase

Risk is associated with things that are unknown. More things are unknown at the beginning of a project, but risk must be considered in the initiation phase and weighed against the potential benefit of the project's success in order to decide if the project should be chosen.

Risks by Phase in John's Move

In the initiation phase of John's move, John considers the risk of events that could affect the whole project. He identifies the following risks during the initiation phase that might have a high impact and rates the likelihood of their happening from low to high.

1. His new employer might change his mind and take back the job offer after he's given notice at his old job: Low.
2. The current tenants of his apartment might not move out in time for him to move in by the first day of work at the new job: Medium.
3. The movers might lose his furniture: Low.
4. The movers might be more than a week late delivering his furniture: Medium.
5. He might get in an accident driving from Chicago to Atlanta and miss starting his job: Low.

John considers how to mitigate each of the risks.

1. During his job hunt, John had more than one offer, and he is confident that he could get another job, but he might lose deposit money on the apartment and the mover. He would also lose wages during the time it took to find the other job. To mitigate the risk of his new employer changing his mind, John makes sure that he keeps his relationships with his alternate employers cordial and writes to each of them thanking for their consideration in his recent interviews.
2. John checks the market in Atlanta to determine the weekly cost and availability of extended-stay motels.
3. John checks the mover's contract to confirm that they carry insurance against lost items, but they require the owner to provide a detailed list with value estimates and they limit the maximum total value. John decides to go through his apartment with his digital camera and take pictures of all of his possessions that will be shipped by truck and to keep the camera with him during the move so he has a visual record and won't have to rely on his memory to make a list. He seals and numbers the boxes so he can tell if a box is missing.
4. If the movers are late, John can use his research on extended-stay motels to calculate how much it would cost. He checks the moving company's contract to see if they compensate the owner for late delivery, and he finds that they do not.
5. John checks the estimated driving time from Chicago to Atlanta using an Internet mapping service and gets an estimate of eleven hours of driving time. He decides that it would be too risky to attempt to make the drive by himself in one day, especially if he didn't leave until after the truck was packed. John plans to spend one night on the road in a motel to reduce the risk of an accident caused by driving while too tired.

John concludes that the high-impact risks can be mitigated and the costs from the mitigation would be acceptable in order to get a new job.

Planning Phase

Once the project is approved and it moves into the planning stage, risks are identified with each major group of activities. A risk breakdown structure (RBS) can be used to identify increasing levels of detailed risk analysis.

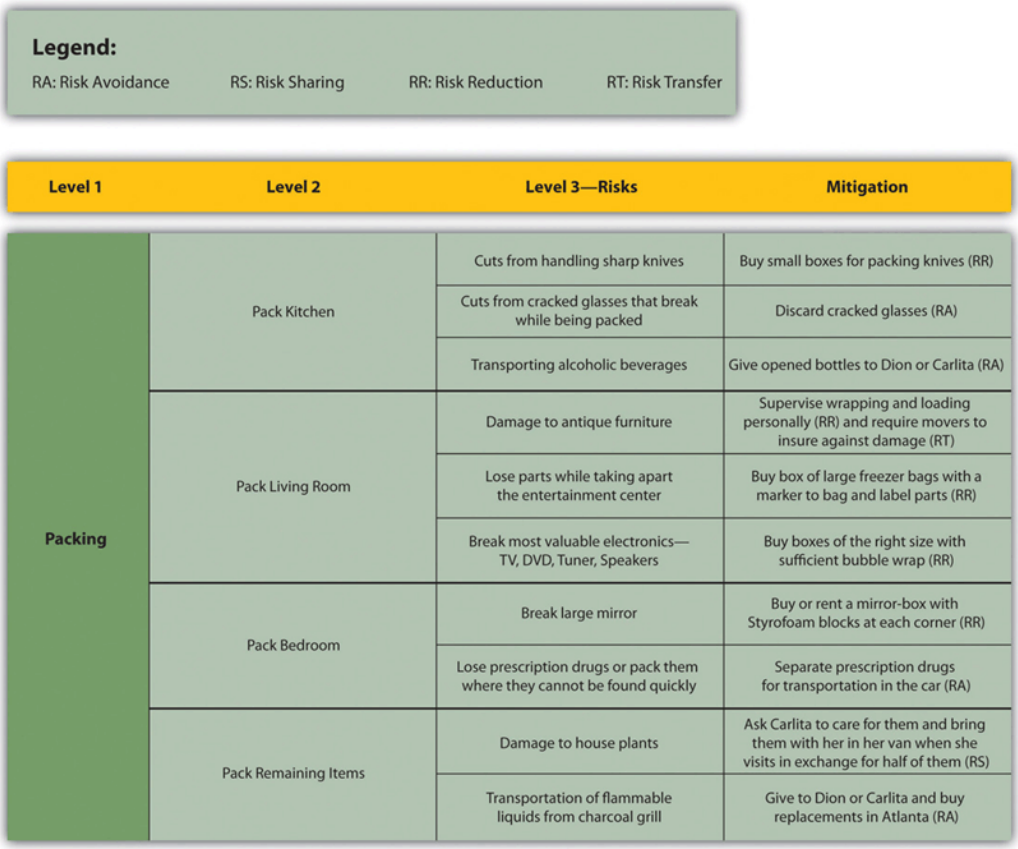
Risk Breakdown Structure for John's Move

John decides to ask Dion and Carlita for their help during their first planning meeting to identify risks, rate their impact and likelihood, and suggest mitigation plans. They concentrate on the packing phase of the move. They fill out a table of

risks, as shown in Figure 11.3.

Figure 11.3

Risk Breakdown Structure (RBS) for Packing John's Apartment



Level 1	Level 2	Level 3—Risks	Mitigation
Packing	Pack Kitchen	Cuts from handling sharp knives	Buy small boxes for packing knives (RR)
		Cuts from cracked glasses that break while being packed	Discard cracked glasses (RA)
		Transporting alcoholic beverages	Give opened bottles to Dion or Carlita (RA)
	Pack Living Room	Damage to antique furniture	Supervise wrapping and loading personally (RR) and require movers to insure against damage (RT)
		Lose parts while taking apart the entertainment center	Buy box of large freezer bags with a marker to bag and label parts (RR)
		Break most valuable electronics—TV, DVD, Tuner, Speakers	Buy boxes of the right size with sufficient bubble wrap (RR)
	Pack Bedroom	Break large mirror	Buy or rent a mirror-box with Styrofoam blocks at each corner (RR)
		Lose prescription drugs or pack them where they cannot be found quickly	Separate prescription drugs for transportation in the car (RA)
	Pack Remaining Items	Damage to house plants	Ask Carlita to care for them and bring them with her in her van when she visits in exchange for half of them (RS)
		Transportation of flammable liquids from charcoal grill	Give to Dion or Carlita and buy replacements in Atlanta (RA)

Execution Phase

As the project progresses and more information becomes available to the project team, the total risk on the project typically reduces, as activities are performed without loss. The risk plan needs to be updated with new information and risks checked off that are related to activities that have been performed.

Understanding where the risks occur on the project is important information for managing the contingency budget and managing cash reserves. Most organizations develop a plan for financing the project from existing organizational resources, including financing the project through a variety of financial instruments. In most cases, there is a cost to the organization to keep these funds available to the project, including the contingency budget. As the risks decrease over the length of the project, if the contingency is not used, then the funds set aside by the organization can be used for other purposes.

To determine the amount of contingency that can be released, the project team will conduct another risk evaluation and determine the amount of risk remaining on the project. If the risk profile is lower, the project team may release contingency funds back to the parent organization. If additional risks are uncovered, a new mitigation plan is developed including the possible addition of contingency funds.

Closeout Phase

During the closeout phase, agreements for risk sharing and risk transfer need to be concluded and the risk breakdown structure examined to be sure all the risk events have been avoided or mitigated. The final estimate of loss due to risk can be made and recorded as part of the project documentation. If a Monte Carlo simulation was done, the result can be compared to the predicted result.

Risk Closeout on John's Move

To close out the risk mitigation plan for John's move, John examines the risk breakdown structure and risk mitigation plan for items that need to be finalized. He makes a checklist to be sure all the risk mitigation plans are completed, as shown in Figure 11.4.

Figure 11.4

Closeout of Risk Mitigation Plan for John's Move

Risk	Mitigation	Closeout
Items lost by movers	Mover's insurance plus digital image inventory	Confirm all of the numbered boxes are present and still sealed
Antique furniture damaged	Mover's insurance plus personal supervision of wrapping and loading	Supervise unloading and unwrapping; visually inspect each piece
House plants	Ask Carlita to bring half of them in her van when she visits	Confirm that the plants are healthy and that Carlita brought about half of them

Risk is not allocated evenly over the life of the project. On projects with a high degree of new technology, the majority of the risks may be in the early phases of the project. On projects with a large equipment budget, the largest amount of risk may be during the procurement of the equipment. On global projects with a large amount of political risk, the highest portion of risk may be toward the end of the project.

Key Takeaways

- During the initiation phase, risks are identified that could threaten the viability of the project. Mitigation options are considered to see if they would be sufficient to protect the project.
- During the planning phase, risks are identified and analyzed for each activity group in a risk breakdown structure, and mitigation is planned for each risk
- During the execution phase, risks are checked off as activities are completed or mitigation is performed if loss does occur. New risks are identified and added to the plan.
- During the closeout phase, insurance contracts are cancelled and partnerships terminated. A summary of actual costs associated with risks are compared with initial estimates to refine estimating capabilities. The successes and failures of the risk management plan are summarized and saved with the project documentation to add to the company's corporate knowledge.

11.4

Project Risk and the Project Complexity Profile

Complexity | Technical | Internal | External | Project Risk | Environmental

Learning Objectives

1. Identify the relationship between project risk and external, internal, technical, and environmental complexity.

Risk seems to have a positive correlation to complexity. High-risk projects are in most cases highly complex. The process of conducting a risk analysis focuses on understanding what can go wrong and the likelihood that it will go wrong. The project team then develops a project mitigation plan that addresses the items that were identified as high risk. The complexity analysis explores the project from the perspective of what elements on the project add to project complexity. The result of this analysis is the information needed by the project leadership to develop an appropriate execution plan. This execution plan also contains the risk management plan.

Image by Michigan Municipal League (MML)

Although increased complexity on a project increases the project risk profile, risk is only one component of the complexity profile, and the manageability of the risk is also reflected in the complexity level of the project. For example, the organizational component of the project may be extremely complex with decision making shared among several independent clients. The project management team will develop an execution plan that includes developing and maintaining alignment among the various clients. Although the organizational risk of the project decreases with the development of the execution plan, the organizational approach of the client did not change the complexity level of the project. If the Darnall-Preston Complexity Index (DPCI) is used to rate the project, high ratings in each category carry their own types of increased risks.

External Complexity

Projects that have a high score in the external complexity category in the DPCI are larger and longer than usual for the project management group and the project manager and the available resources are lacking. Due to lack of experience on this size project, unknown risks are significant. The inadequacy of resources will cause risks that are more predictable.

Internal Complexity

Projects with high scores for internal complexity have risks to the budget, schedule, and quality due to organizational complexity and changes of scope due to lack of clarity in project and scope statements.

Technological Complexity

High scores in technological complexity are associated with high levels of risk due to unknown flaws in the technology and lack of familiarity with it. These problems result in risks to the schedule, budget, and quality.

Environmental Complexity

Environmental complexity includes legal, cultural, political, and ecological factors. High scores for complexity in this category imply high risks for delay and expensive resolution to lawsuits, public opposition, changes for political considerations, and unforeseen ecological impacts.

Key Takeaways

- There is a positive correlation between the complexity of a project and the risk. Increased levels of complexity imply more people, newer technologies, and increased internal and external unknown factors.
- High scores for external complexity imply high risks to the schedule, budget, and quality due to unknown factors and limited resources.
- High scores for internal complexity imply high risks to the budget, schedule, and quality due to organizational complexity and changes of scope due to lack of clarity in project and scope statements.
- High scores for technological complexity imply high risks to the budget, schedule, and quality due to unknown flaws in the technology and lack of familiarity with it.
- Environmental complexity includes legal, cultural, political, and ecological issues. High scores for complexity in this category imply high risks for delay and expensive resolution to lawsuits, public opposition, changes for political considerations, and unforeseen ecological impacts.

12

Project Closure

Overview

This chapter aligns with chapter 3 of the PMBOK. 11% of the CAPM questions come from this knowledge area. The content connects to the Closure category of the PMP questions.

This chapter describes several of the essential close-out activities to be performed at the end of a project.

Designers Share Their Experiences

Dr. Andy Gibbons – Instructional Psychology and Technology – BYU

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The most interesting part of scaling back a project toward the end is, actually it's the funnest part of the project because there are a lot of celebrations as people are dropping off the payroll you have a party for them, and you have a close-out, and there are gifts that are given to each other, and it's fun. And people who are on your staff use their talents to celebrate each other. We had one, oh just this amazing artist on this one helicopter pilot project I did. And he drew a big caricature of the whole team. And gave out caricatures of the team members to each one of them. It was a wonderful thing, and I still have a poster that is about this big, in colorful color, the nicest artwork you want to see. The caricature of everybody that is on the team and they all signed it. It's just a warm memory. And one of the things that you want to do at the end of the project is make sure that you've given the people on your project the best possible experience. As a manager, you're not just a dollar and cents person, you're not just a timetable person. You're a leader and you need to be an inspiring leader. And you need to, by the time they finish the project, they need to have seen you as a leader, they need to have learned something, the project needs to have enriched their experience, they need to have gained friendships, they need to be working as a team. If you can't get there, then the project gets done, but as a designer you haven't done your job.

Heather Bryce – Independent Studies – BYU

Watch on YouTube

I think the biggest challenge in finishing a project is keeping people engaged. When you've worked on a project for a long time, maybe at the beginning of a project you had a more important role than you might as your role kind of becomes less in one project as you move onto another, I think it's hard to stay engaged in that former project. As your roles, you might have to do a few edits, come back and fix a few things that you worked on, but you might have moved on. So I think that's the biggest challenge is, people who have moved on to a more important role in project B, it's harder to get them back to "Hey don't forget about the things you need to finish up to get project A. So I think the most important process that we have is the course completion process. It goes through a lot of different hands and it's those final touches that you have to put on to have a course go live. And while the tasks themselves are kind of small, they add up. So a course could be delayed up to two weeks, because people just sit on their tasks. You know, "oh it's just a five minute task". But if everybody sits on a five minute task for a couple of days the time adds up quickly. So I think as the project manager you need to make sure that people continue to be engaged even when their role lessens, and to make sure you finish up strong.

Dr. Larry Seawright – Center for Teaching and Learning – BYU

Watch on YouTube

With the BYU Learning Suite, which is an ongoing project, there is never a close-out or something like that. Until the University decides, okay we're going to shift from using our own internally developed learning management system, and we'll go back out on the market and once more buy a more commercially available one. At that point then we'll go through the close-out process, and take a look at things. But, that being said, you still have, no matter how you officially close out a project, there is a delivery. We're going to start delivery on December 1st this year. Faculty, it will be available to them to begin to build courses. So that's really the close out period at that point were going to have post-mortem meetings. We'll take a look at what went well, what didn't go well? What can we learn that we can apply to the ongoing enhancement process, because this is an ongoing project. Things that we can do better, places that we can involve the faculty more, so that there's more faculty buy-in. Places where we can involve students more, so students are more appreciative of it, and understand it better. Quite frankly, become demanding of faculty, you know, you must use the Learning Suite because it makes our lives so easy, kind of thing. That's how the Learning Suite will succeed. Ultimately, in any project, it's the end users and whether or not they like it that will determine its success. They like it and start buying it or accessing it or downloading it, you know, whatever the method of delivery is, or the method of purchase is, then it's a success. And you know, you can take a look those things and say, you know, this was good, these things were not quite so good, but there has to be some point where you just kind of stick a stake in the ground and say let's take some time and look at what worked, what didn't work and what lessons can we learn from that. And that's kind of difficult sometimes. It's actually the classic evaluation problem. A lot of evaluation never gets done because it takes time, it takes money, and it's never used. You know, once the evaluation is done, people don't make use of it, same with a project management post-mortem. If you don't take the time and the money to do it, you won't get useful data that is usable and actionable for making changes. So you don't want to just go through and have a post-mortem because it's part of the project management checklist. You want to do it if people are going to use it. Otherwise just skip it and, you know, go on with the project.

12.1

Project Closure

contract Post-Project Review

Learning Objectives

1. Describe the procedures for closing out contracts.
2. Describe the elements and purpose of the post-project review process.
3. Identify the types of documents that should be archived.
4. Identify the objectives of the project closeout celebration.

Team members who were excited by the project in its early stages may find it difficult to maintain their focus to complete the project. They might already be looking forward to the next project. Bringing a project to an end requires a different management style that focuses on details as well as an analysis of the decisions that were made.

Closing out Contracts

The last stage of the project procurement cycle includes the payment of the bills and closing of procurement contracts. Suppliers provide commodities that should meet standards of quality. The project team must check the records of deliveries made and determine that they were acceptable quality. If any items were rejected for poor quality or not delivered, the final payment is adjusted accordingly.

Punch Lists and Performance Tests

If a vendor is providing a service or building something for the project, there are usually items that must be fixed or mistakes that must be corrected before the contract is complete. On a software project, performance tests are run on the software, usually by the people who will be using the software, and any performance expectations not met are noted. Sometimes the expectations were not captured in the project scope of work and sometimes the performance did not meet the expectations established in the scope. If the items were not in the scope of work and the owner wants the work done, then the owner typically issues a change order. If the expectations were in the scope of work, the contractor is still responsible for completing the work.

Before the contract is closed, any minor items that need to be repaired or completed are placed on a ***punch list***, which is a list of all the items found by the client/or team/manager that still remain to be done. The project team will then work on all of the items on the list, building a small schedule to complete the remaining work. If the number of items on the punch list is too large or the amount of work is significant, the project team continues to work the project. Once the

punch list becomes smaller, the project manager begins closing down the project, maintaining only enough staff and equipment to support the team that is working the punch list.

Transfer to Customer or Sponsor

If the product of the project is a software system, or something that must be operated and maintained by someone else, it must be turned over to the people who will be responsible for it after the project is complete. They might perform their own inspection to determine if the project team has met its goals for quality and that all elements of the project are complete. These performance tests are typically identified in the original project contract.

Final Payments

The final payment is usually more than a simple percentage of the work that remains to be completed. Completing the project might involve fixing the most difficult problems that are disproportionately expensive to solve, so the final payment should be large enough to motivate the vendor to give the project a high priority so that the project can be completed on time.

If the supplier has met all the contractual obligations, including fixing problems and making repairs as noted on a punch list, the project team signs off on the contract and submits it to the accounting department for final payment. The supplier is notified that the last payment is final and completes the contractual agreement between the supplier and the project.

Post-project Evaluations

Before the team is dissolved and begins to focus on the next project, a review is conducted to capture the lessons that can be learned from this project, often called a ***lessons learned meeting*** or document. The team explores what went well and captures the processes to understand why they went well. The team asks if the process is transferable to other projects. The team also explores what did not go well and what people learned from the experience. The process is not to find blame, but to learn.

Quality management is a process of continual improvement that includes learning from past projects and making changes to improve the next project. This process is documented as evidence that quality management practices are in use. Some organizations have formal processes for changing work processes and integrating the lessons learned from the project so other projects can benefit. Some organizations are less formal in the approach and expect individuals to learn from the experience and take the experience to their next project and share what they learned with others in a very informal way. Whatever type of approach is used, the following elements should be evaluated and the results of the post-project evaluations are summarized in reports for external and internal use.

Project Profile

One of the first activities was to create a project profile to determine where the challenges were most likely to occur. If the Darnall-Preston Complexity Index (DPCI) was used, each of the complexity evaluations is reviewed and compared to actual events that occurred during the project. The team explores the changes in the complexity level during the life of the project and how the team managed the complexity during the life of the project. Learning from this exercise develops expertise that is useful in making the next project profile. The DPCI rating is adjusted, if necessary, for reference purposes on future projects.

Trust and Alignment Effectiveness

The project leadership reviews the effect of trust—or lack of trust—on the project and the effectiveness of alignment meetings at building trust. The team determines which problems might have been foreseen and mitigated and which ones could not have been reasonably predicted. What were the cues that were missed by the team that indicated a problem was emerging? What could the team have done to better predict and prevent trust issues?

Schedule and Budget Management

The original schedule of activities and the network diagram are compared to the actual schedule of events. Events that caused changes to the schedule are reviewed to see how the use of contingency reserves and float mitigated the disruption caused by those events. The original estimates of contingency time are reviewed to determine if they were adequate and if the estimates of duration and float were accurate. These activities are necessary for the project team to develop expertise in estimating schedule elements in future projects—they are not used to place blame.

A review of budget estimates for the cost of work scheduled is compared to the actual costs. If the estimates are frequently different from the actual costs, the choice of estimating method is reviewed.

Risk Mitigation

After the project is finished, the estimates of risk can be reviewed and compared to the events that actually took place. Did events occur that were unforeseen? What cues existed that may have allowed the team to predict these events? Was the project contingency sufficient to cover unforeseen risks? Even if nothing went wrong on this project, it is not proof that risk mitigation was a waste of money, but it is useful to compare the cost of avoiding risk versus the cost of unexpected events to understand how much it cost to avoid risk.

Procurement Contracts

The performance of suppliers and vendors is reviewed to determine if they should still be included in the list of qualified suppliers or vendors. The choice of contract for each is reviewed to determine if the decision to share risk was justified and if the choice of incentives worked.

Customer Satisfaction

Relationships with the client are reviewed and decisions about including the client in project decisions and alignment meetings are discussed. The client is given the opportunity to express satisfaction and identify areas in which to improve. Often a senior manager from the organization interviews the client to develop feedback on the project team performance.

A general report that provides an overview of the project is created to provide stakeholders with a summary of the project. The report includes the original goals and objectives and statements that show how the project met those goals and objectives. Performance on the schedule and budget are summarized and an assessment of client satisfaction is provided. A version of this report can be provided to the client as a stakeholder and as another means for deriving feedback.

Senior Management

The report to senior management contains all the information provided to the stakeholders in a short executive summary. The report identifies practices and processes that could be improved or lessons that were learned that could be useful on future projects.

Document Archival

The documents associated with the project must be stored in a safe location where they can be retrieved for future reference. Signed contracts or other documents that might be used in tax reviews or lawsuits must be stored. Organizations will have legal document storage and retrieval policies that apply to project documents and must be followed. Some project documents can be stored electronically.

Care should be taken to store documents in a form that can be recovered easily. If the documents are stored electronically, standard naming conventions should be used so documents can be sorted and grouped by name. If

documents are stored in paper form, the expiration date of the documents should be determined so they can be destroyed at some point in the future. The following are documents that are typically archived:

- Charter documents
- Scope statement
- Original budget
- Change documents
- DPCI ratings
- Manager's summary—lessons learned
- Final DPCI rating

Project Celebration

A final celebration is a symbolic ending of a project and perhaps the dissolution of the team. The end of a major project is often a time to reflect. Project team members and stakeholders have typically invested a great deal of time and emotional energy into the success of the project. Because of this investment and because of the close relationships that develop during a project, project closure is often sad. However, it is also an opportunity to improve client and team-member satisfaction.

Image by Jason Pratt

Reviewing the challenges and successes of the project creates a positive memory of the project and reinforces the learning that can be transferred to future projects. Awards or recognition plaques might be given out to individuals who made an outstanding contribution to the project. Groups or teams can be recognized for instances where trust between team members made a positive difference can be rewarded. Celebrating the successes of the project provides a sense of accomplishment and closure that brings satisfaction and pride in a job well done.

Key Takeaways

- To close contracts, systems are tested, materials are inspected, and punch lists of work to be completed are made.
- The purpose of the post-project review is to examine decisions that were made with partial knowledge with the way the project actually developed to learn from the experience and to improve future decisions. It is also used to identify processes that can be improved.
- Original project documents, such as the charter, scope statement, and budget, are stored. Documents developed during the project, such as change agreements, are stored. Post-project reviews, including a summary of lessons learned and a final project profile description—DPCI rating—are saved.
- At the project closeout celebration, positive behavior is awarded for individuals, and groups and the client or sponsor is invited to speak to enforce a sense of satisfaction.