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4.4 Project Management

CHAPTER OUTLINE

Project management is a lexicon and set of procedures meant to synchronize work on various projects. As you read, you will find that the project management vocabulary is quite intuitive and quite rational. For that reason, you can expect at least one or two boards questions on these chapters. Even if you are not familiar with all the terminology, there is a good chance that you will be able to answer the questions just by knowing some key terms. Most of these chapters are based on the project management body of knowledge (PMBOK), published by the Project Management Institute (A guide to the project management body of knowledge (PMBOK® guide). 5th ed. Sydney, NSW: SAI Global; 2013). A nice read if you have the time.

4.4.1 BASIC PRINCIPLES

According to the Project Management Institute, A **project** is a temporary endeavor undertaken to create a unique product, service or result. Since a project is temporary, it has a defined beginning and end in time, and therefore defined scope and resources. Further, a project is not a routine operation, so it often includes teams of people who do not ordinarily work together, sometimes from different organizations and different walks of life. **Project management** is the application of knowledge, skills, tools and techniques to meet project requirements.

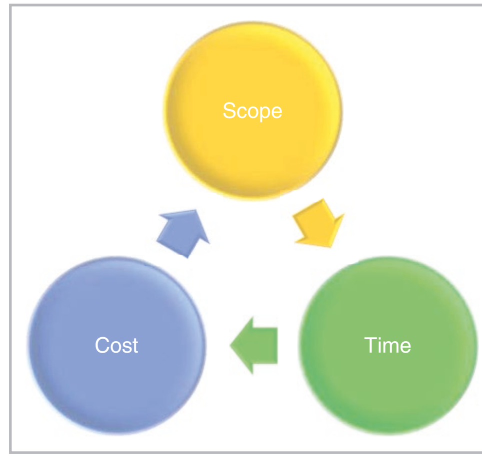
As opposed to normal operations, projects have a number of unique properties

1. A project has a specific purpose. For example, the IT department will replace all the desktop computers on the 4-West nursing unit.
2. A project is temporary. For example, the computers will be replaced between January 4 and January 15.
3. A project requires resources. For example, 15 new computers, licenses for all software programs, sufficient network, power supply and cooling.
4. A project has a primary customer or sponsor who provides direction and funding for the project. For example, the IT department will provide the funding, the sponsor is the IT director and the customer is the nursing unit.
5. A project may have to adapt as it progresses when new information or new hurdles appear. Many projects involve uncertainty.

The **triple constraint** refers to the fact that projects are limited in **scope** (i.e. the work expected for the project), **time** and **cost**. These three items are in continuous balance. If one constraint is loosened, the others are able to expand. For example, if the project is given more time, more work can be done. Similarly, if the budget of a project is halved, the amount of work has to shrink as well. More recent versions of the PMBOK list the constraints as scope, time, cost, quality, resources and risk (Fig. 14-1).

FIGURE 14-1

The triple constraint



Stakeholders are people who are involved or affected by the project and include the project team, the customer, users, suppliers, vendors and sometimes even opponents to the project.

A **program** is a group of related projects which are managed in a coordinated way which results in benefits which could not be obtained if the projects were managed separately. For example, an IT department may have a user support program which includes projects like building a better help-desk, creating more training classes and producing manuals.

Project Management Knowledge Areas

1. Integration management: coordinating all the following knowledge areas to complete a project.
2. Scope management: defining the work that needs to be done
3. Time management: ensuring timely completion of the work
4. Cost management: preparing and adhering to project budgets
5. Quality management: guaranteeing that the work will meet the needs of the project
6. Human resource management: making effective use of the people on the project
7. Communications management: generating, collecting, broadcasting project information
8. Risk Management: analyzing and controlling project risks
9. Procurement Management: acquiring goods and services for the project.
10. Stakeholder management: setting expectations and communicating with all stakeholders.

Systems are sets of interacting parts which work together to achieve some purpose. **Systems analysis** is an approach which involves defining the scope of the system, dividing it into components, and identifying its problems, constraints and needs. Whenever new solutions are investigated, they are seen in the context of the whole system. **Systems management** involves the work of creating, maintaining and upgrading a system. There are three spheres of system management: business; organization and technology (Fig. 14-2).[1]

For example, suppose you are installing a new software system. The business sphere involves the cost, anticipated revenue, risk reduction and business value. The Technology sphere would include technical details, such as hardware and software specifications, network traffic impact and so on. The organizational sphere is concerned with the impact on the organization, such as who will be using the system and who will require training and who will provide that training. The organizational sphere has four frames: the **structural frame** which represents the company's hierarchy (i.e. on the organizational chart, who reports to whom); the **human resources frame** which involves managing the people of the organization; the **political frame** which refers to organizational politics; and the **symbolic**

1 Schwalbe K. Information technology project management, 5th ed. Boston, Mass: Thomson Course Technology; 2007.

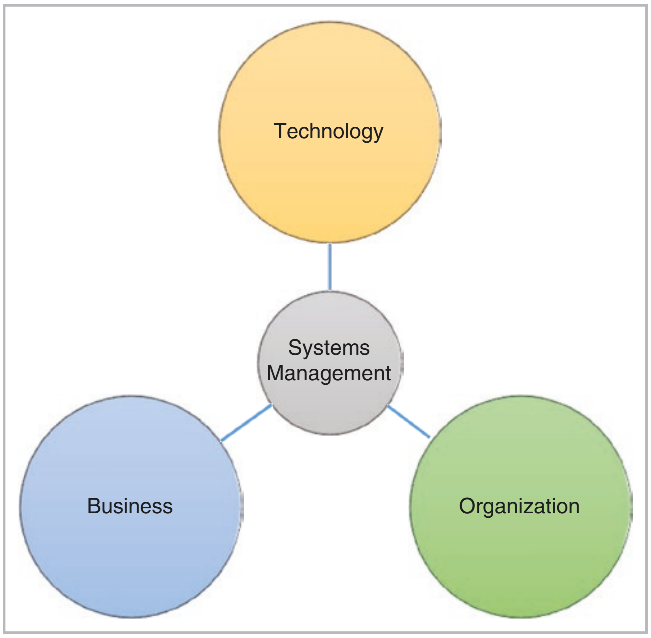


FIGURE 14-2

Systems management

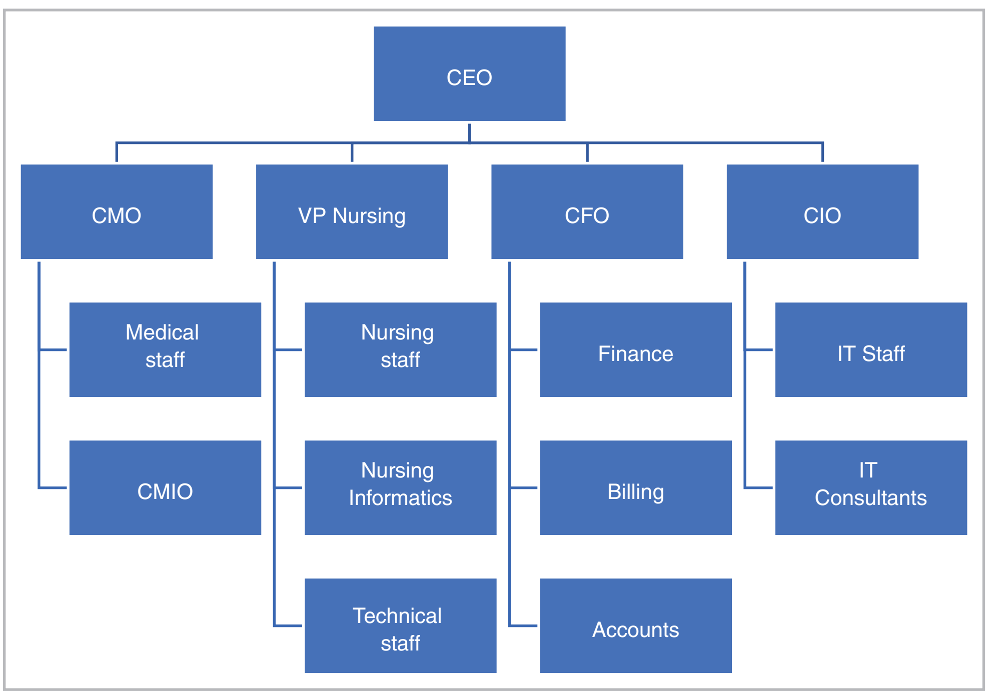


FIGURE 14-3

Functional organizational chart (most common)

frame which relates to symbols and meanings (e.g. if the CEO goes to the meeting, it must be important)

There are several common organizational structures. The most common is the **functional organizational structure** which is typically what we think of when we see an organizational chart. Each member's role is defined by their function and whom they report to in the organization. In a **project organizational structure**, project managers report directly to the CEO and staff report to them. A hybrid between the two is the **matrix organizational structure** in which each staff member reports to both a project manager as well as a functional manager. As you can imagine, the project manager's authority increases as we go from a functional structure to a project structure (Figs. 14-3, 14-4, and 14-5).

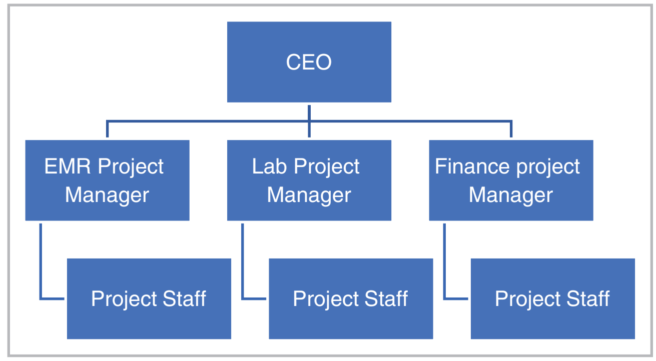


FIGURE 14-4

Project organizational structure; project staff report directly to project managers

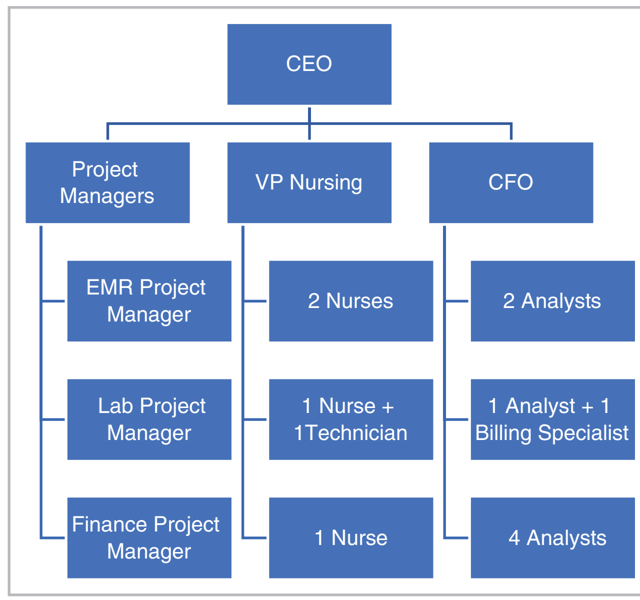


FIGURE 14-5

Matrix organizational chart; each staff member reports to a functional leader (e.g. VP Nursing) as well as a Project Manager

Probably the most important factor for the success of a project is support from top management because they have the ability to marshal organizational resources in support of a project.

1. Projects require adequate money, people and visibility to thrive.
2. Projects often require approval for unique needs.
3. Projects require cooperation from people in other parts of the organization.
4. Projects require a champion—a respected person within the organization who can promote the project.
5. IT Projects require an organizational commitment to IT at a high level
6. Projects run much more smoothly with organizational standards which allow project managers to communicate changes to all affected employees

Project Phases

A **project life cycle** is the set of phases through which a project passes on its way to completion. **Project feasibility** includes phases called *concept* and *development* which create initial cost and time estimates. **Project Acquisition** involves *implementation* (i.e. the actual work) and *close-out* (customer acceptance). During the course of the project, there are frequent management meetings called **phase exits** or **kill points**, where it is decided whether the project should be continued, modified or abandoned. Some projects have **predictive lifecycles** where great emphasis is placed on the planning phase (consider the Waterfall method in Sect. 3.1.1.3) while other projects involve more uncertainty and have **adaptive lifecycles** (consider the agile method in the same section).

Each of the knowledge areas can be broken down into five **process groups**, which include **initiating, planning, executing, monitoring and controlling** and **closing.** For the most part, these processes run sequentially, except for the monitoring and controlling process group which runs for the length of the project (Fig. 14-6).

Each of the 10 knowledge area has tasks which are related to each of the 5 process groups. Table 14-1 shows a grid demonstrating the **outputs** or **deliverables** for each combination. For example, the Integration knowledge area has an initiating phase which includes developing the project charter. In the planning phase, the management plan is developed, and so on. Some of the areas are blank because the work is minimal. For example, there is not much to do in the cost knowledge area during the initiating phase because cost estimation isn't begun until the planning phase.

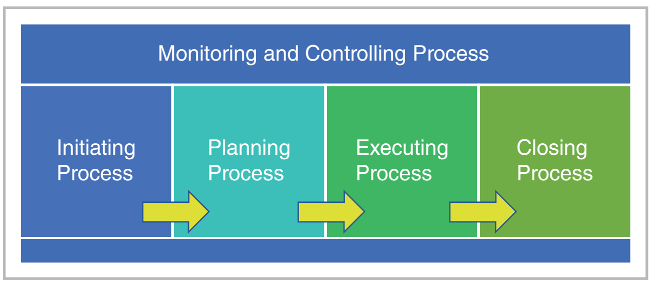


FIGURE 14-6

Process groups. Each of the knowledge areas has five processes: initiating, planning, executing, monitoring and controlling, and closing

TABLE 14-1

EACH OF THE 10 KNOWLEDGE AREAS HAS 5 ASSOCIATED PROCESS GROUPS AS SHOWN IN THE GRID

KNOWLEDGE AREA/ PROGRESS GROUP	INITIATING	PLANNING	EXECUTING	MONITORING AND CONTROLLING	CLOSING
Integration	Develop project charter	Develop project management plan	Direct and manage project work	Monitor and control work; Integrated change control	Close project
Scope		Scope Planning, definition, create WBS		Control and validate scope	
Time		Define activity and sequencing; resource and duration estimation; scheduling		Schedule control	
Cost		Cost estimation		Cost control	
Quality		Quality planning	Perform quality assurance	Control quality	
HR		HR planning	Create and develop team		
Communications		Communication planning	Manage communications	Control communications	
Risk		Identify risks; qualitative and quantitative risk analysis and response		Control risks	
Procurement		Plan purchases	Conduct procurements	Control procurements	Close Procurements
Stakeholder	Identify Stakeholders	Plan Stakeholder Management	Manage Stakeholder Engagement	Control Stakeholder Engagement	

4.4.2 IDENTIFYING RESOURCES

The primary output of the initiating phase of integration management is the **project charter**, which is a document that formally authorizes the project and gives project managers access to organizational assets. The **preliminary project scope statement** describes, in broad strokes, what work will be done. The **project management plan** describes what resources will be needed and how and when they will be used.

One of the most important things to be developed in the **scope management plan** is the **work breakdown structure (WBS).** The WBS is a deliverable-oriented grouping of the work involved in a project. A **work package** is the smallest level of task on the WBS. Each work package is assigned a start date, an expected duration and responsibility. The **WBS dictionary** gives detailed information about each work item and helps define the deliverables that are expected. Each work package is also associated with certain resources, such as people, equipment, office space, funding, etc. These resources must be made available in preparation for the work package. If the resources are unavailable, the work package may be delayed.

Human Resources

Assembling an appropriate team and making sure that the right people are in the right place at the right time can be a daunting task. A **responsibility assignment matrix (RAM)** is a 2-dimensional chart which shows the degree of responsibility each team has to each work package (Table 14-2).

Procurement (or **outsourcing**) refers to acquiring goods or services from an outside agency, such as suppliers, vendors, and contractors. There are many reasons a project manager may choose to outsource some elements of a project.

1. **Reduce costs.** Large suppliers can operate with greater economies of scale and provide products more cheaply than if they were made in house.
2. **Allow the organization to focus on its core business.** For example, by hiring an outside company to process laundry, a hospital can concentrate its executive efforts on caring for patients.
3. **Utilize limited or specialized resources.** For example, an organization may require an unusual piece of equipment for a short project.
4. **Staffing flexibility.** By outsourcing staffing, an organization can better adapt to peaks and troughs of activity.
5. **Accountability.** By adhering to a contract, organizations may be better able to solidify expectations of deliverables.

Taking these benefits into account, a project manager has to decide if outsourcing is right for this project. This is often called a **make-or-buy decision**. One of the most common make-or-buy decisions in IT is whether an application should be developed in house or purchased.

TABLE 14-2

EXAMPLE RESPONSIBILITY ACCOUNTABILITY MATRIX (RAM) FOR A MEDICATION BARCODING PROJECT. THIS PARTICULAR MATRIX USES THE RESPONSIBILITY, ACCOUNTABILITY, CONSULTATION, INFORMED (RACI) CONVENTION

	PHARMACY	NURSING	IT	RADIOLOGY	CMIO
Research symbology	I	I	R	I	A
Catalog NDC	R	C	I	I	I
Inventory drugs	R	I	A	C	I
Track implementation	C	A	C	I	R
Train staff	A	R	A	C	C

R responsibility, *A* accountability, *C* consultation, *I* informed

In order to compare an organization's internal capacity to that of a supplier, the organization will solicit information from various suppliers. These requests can take many forms. The most general request is called a **request for information (RFI)** which simply asks for the suppliers' capabilities and timelines. A **request for quote (RFQ)** is submitted when the particulars of the job are known and various suppliers compete for the contract. The most detailed request is a **request for proposal (RFP)** in which the buyer submits a statement of their need and the suppliers compete to find innovative solutions. When the responses are received by the organization, the proposals are evaluated and compared and a supplier is chosen. See Sect. 3.5.2.3 for more information.

4.4.3 RESOURCE ALLOCATION

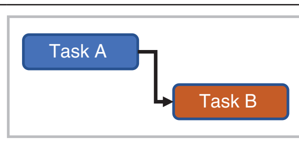
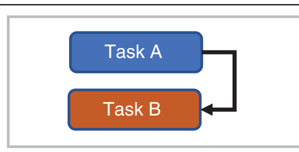
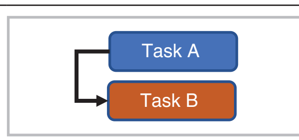
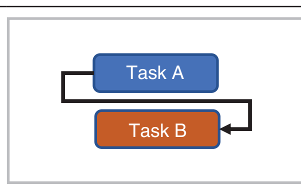
An **activity** is a defined portion of work that has an expected duration, cost and resource requirement. Defining these activities and then deciding which must be done in which order is called **activity sequencing.** It is important to remember that many activities depend on other activities to be complete before they start. For example, imagine a project involving building a data center. The new floor can not be laid until the old floor is taken up. This relationship is called a **dependency** because one activity depends on another. This particular dependency is called a finish-to-start (FS) dependency because the old floor must be completely removed before the new floor is started.

Another example: a project includes writing code and unit tests for a new module. In general, unit tests are written in conjunction with the code, so they are occurring simultaneously. However, the unit tests can not be completed until the code is complete. This represents a finish-to-finish dependency.

This can be depicted graphically as shown (Table 14-3)

TABLE 14-3

TASK DEPENDENCIES

NAME	DIAGRAM	WHAT IT MEANS
Finish to start (FS)		Task B can not begin until task A is completed
Finish to finish (FF)		Task B can not finish before A is finished
Start to start (SS)		Task B can't start until A is started
Start to finish (SF)		Task B can't finish until A is started

An arrow shows when one tasks depends on another. The left side of a box is the start and the right side is the finish. The arrowhead indicates the dependent task

Earned Value Management is a technique for estimating progress of a project. The **planned value (PV)** is the amount of money budgeted to a given activity at a certain time. For example, suppose the project involved hiring an expert for $50,000 for a 10-week contract. At 5 weeks, the PV should be $25,000. The **actual cost (AC)** is the total direct and indirect costs incurred. The **earned value (EV)** is an estimate of what the work so far is actually worth. Suppose the expert generated $30,000 in value during the first 5 weeks. The EV would be $30,000.

Occasionally, the project will progress faster or slower than expected. These differences are called **variances**. For example, suppose the project has an earned value of $7500 and a planned value of $5000. The project is now ahead of schedule, and is said to have a positive **schedule variance** of $2500. Variance can also be calculated from cost. For example, if a project has an earned value of $7500 and an actual cost of $6000, it has a positive **cost variance** of $1500.

4.4.4 PROJECT MANAGEMENT TOOLS (NON-SOFTWARE SPECIFIC)

After estimating the total number of resources and durations, a schedule can be developed. These schedules are sometimes called **network diagrams** or **process diagrams**.

Figure 14-7 represents ten tasks which are required to finish a project, however some tasks depend on others. For example, task D can not be started until task A is finished; task J can not start until tasks H, F and I are finished. The numbers adjacent to the tasks represent the amount of time required to complete the task. For example, task A takes 1 day; task B takes 2 days; task C takes 3 days, and so on.

The circles, called **nodes,** represent start and endpoints for the tasks. **Bursts** are nodes that have multiple activities dependent on them, such as nodes 1 and 3. **Merges** are nodes that depend on multiple activities, such as 5 and 6.

The **critical path** is the *minimum* time required to complete the project. Since all tasks must be completed in order to finish the project, the critical path is calculated by finding the *longest* path from beginning to end. In our example, there are four paths. The first path is $1 \rightarrow 2 \rightarrow 5 \rightarrow 6 \rightarrow 8$. In order to traverse this path, four tasks must be done, namely A, D, H and J. Each task has an assigned length. By adding all these task lengths, we get the total length of the path.

$$A = 1; D = 4; H = 6; J = 3$$
$$A + D + H + J = 1 + 4 + 6 + 3 = 14$$

So, the length of path ADHJ is 14. The complete list of paths is as follows:

$$ADHJ = 1 + 4 + 6 + 3 = 14$$
$$BEHJ = 2 + 5 + 6 + 3 = 16$$
$$BFJ = 2 + 4 + 3 = 9$$
$$CGIJ = 3 + 6 + 2 + 3 = 14$$

The longest path is BEHJ, which requires a total of 16 days. This is the critical path. If the project manager wants to deliver the project sooner, he should focus on accelerating the activities along the critical path. If he is able to shorten an activity along the critical path, a new critical path may emerge. For example, suppose the project manager shortens task E from 5 days to 1. Now ADHJ and CGIJ are the critical paths.

A more common method of diagramming a schedule is a **Gantt chart**. Tasks from the WBS are listed hierarchically with a calendar showing start and end times. Arrows on tasks indicate dependence. Task groups are depicted with heavy umbrella-shaped lines and extend from the beginning of the earliest task to the end of the latest task in the group. These are also called **summary tasks.** A **milestone** is a significant event on the schedule that has no

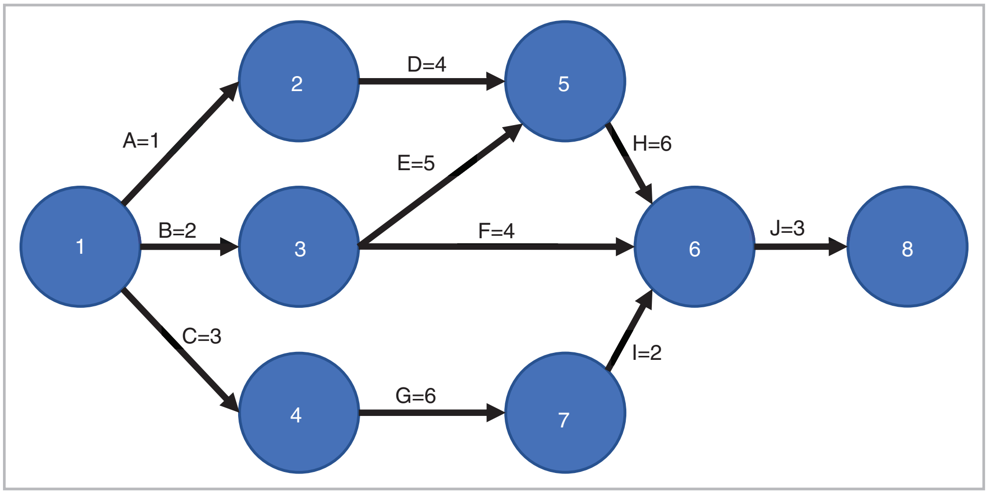


FIGURE 14-7

Node diagram showing tasks using the Activity Over Arrow (AOA) method. The duration of the activity is listed next to the name of the task

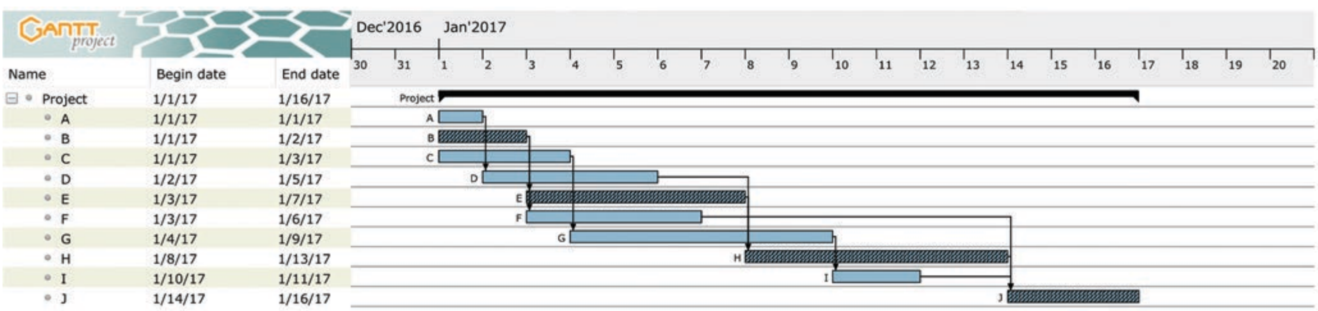


FIGURE 14-8

Gantt chart showing start and end time for several tasks. Arrows indicate dependencies. The critical path is shaded

duration of its own, but represents the completion of some important part of the project. In a Gantt chart, this is commonly drawn as a diamond shape (Fig. 14-8).

Activities that are not along the critical path often have built in leeway when they can start or finish. In our example, let's assume that the project starts on 1/1/17. If we assume that the schedule is as efficient as possible, there should be no delay between tasks B, E, H and J, and the project will finish 16 days later, on 1/17/17.

What about the other tasks? If task A is started 2 days later, task D will also be delayed by 2 days. It can not be delayed more than 2 days, because that would affect task H, which is part of the critical path. This variability in starting time is called **slack** or **float.** Using this knowledge can help with resource planning. For example, suppose that tasks A and B both require the use of an expensive consultant. If the plan is followed as written, the project manager would require two consultants to start the project. However, if task A is postponed and starts on 1/3 instead of 1/1, the same consultant can be used for both tasks A and B, potentially saving money in the project. This process is called **resource levelling**

A **Monte Carlo analysis** attempts to estimate total risk based on the risk of its components. For example, suppose a project has three tasks named A, B and C, which must run sequentially. Although we don't know exactly how long each task will take, we can make an estimate. Task A has a 30% chance of taking 5 days, 40% chance of taking 6 days, 20% chance of 7 days and 10% chance of 8 days as shown in Fig. 14-9.

Let us further assume that tasks B and C have the following distributions (Figs. 14-10 and 14-11)

By choosing numbers at random, we create a simulation of how long each task will take. For example, suppose task A takes 6 days; task B takes 13 days and task C takes 5 days. The total duration of the project is 24 days. By repeating this simulation many times, we can get a rough estimate of how long the project will take See Table 14-4.

After 1000 iterations, we get the following histogram (Fig. 14-12):

The bars indicate the distribution of project durations. The S-shaped line tells us the cumulative probability that the task will be completed by a certain day. For example, in 50% of iterations, the job is finished on day 20.

Good news. There is no way that the board will ask you to do a Monte Carlo simulation on the exam—it's way to computationally difficult. But you should be familiar with the concept and at least know *how* to do one.

A **sensitivity analysis** allows us to vary input parameters to determine the optimum result. For example, a person looking to equip a team with computers may investigate several options by varying the amount of memory, the size and type of hard drive and the number of peripherals. At some point, he will determine the best combination of characteristics for the best cost. This type of analysis only works where a discrete formula exists to predict utility.

FIGURE 14-9

Probability distribution for time to complete task A

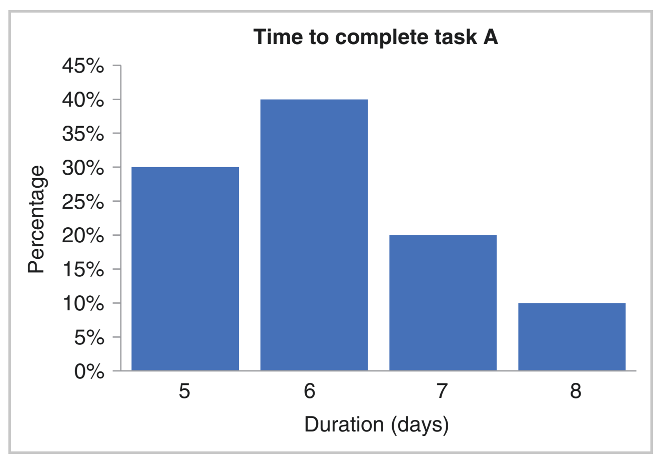
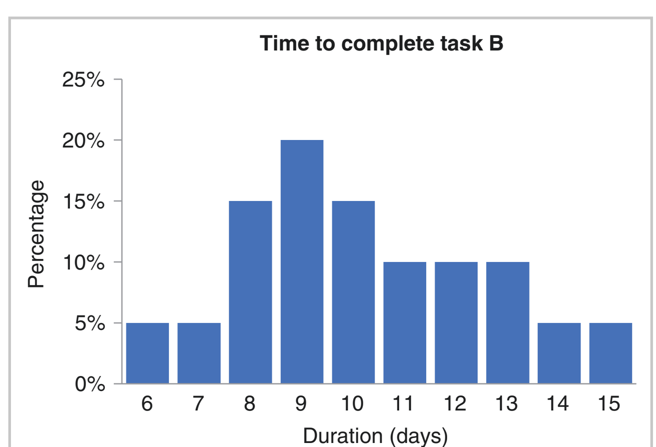


FIGURE 14-10

Probability distribution for time to complete task B



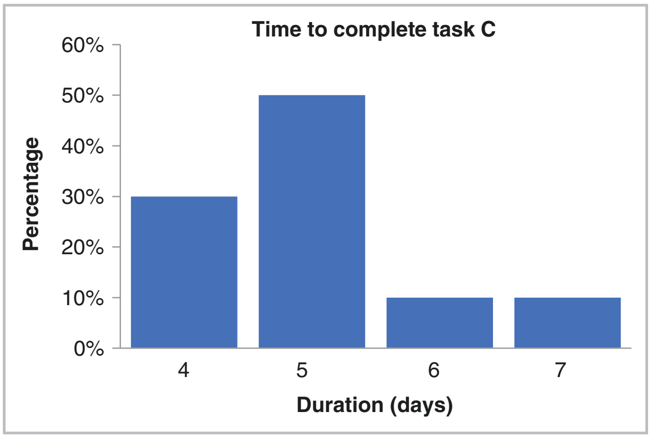


FIGURE 14-11

Probability distribution for time to complete task C

TABLE 14-4

MONTE CARLO SIMULATION SHOWING RANDOMLY SELECTED LENGTHS FOR THREE TASKS BASED ON THE PROBABILITY DISTRIBUTIONS ABOVE

ITERATION	A	B	C	TOTAL
1	6	13	5	24
2	6	10	5	21
3	5	6	4	15
4	5	9	4	18
5	6	13	4	23
6	5	8	5	18
7	8	6	4	18
8	7	11	5	23
9	5	9	7	21
10	7	9	5	21
…				…

Only the first 10 iterations are shown here

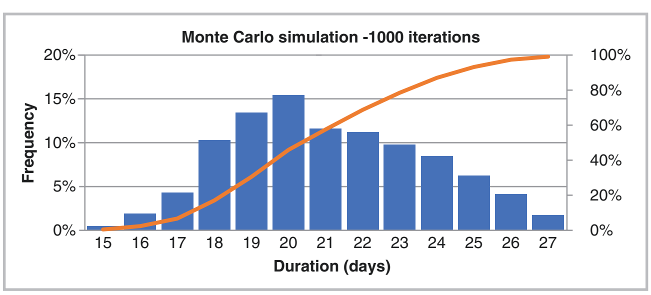


FIGURE 14-12

Cumulative Monte Carlo simulation based on 1000 iterations of the data in Table 14-4

4.4.5 INFORMATICS PROJECT CHALLENGES

4.4.5.1 Scope Creep

All projects, but especially technology projects which have no physical limitations are subject to the ever-expanding expectations called **scope creep**. As a project develops, stakeholders will identify new requests and expectations for the the project. It is vitally important to have a strong change process in place to prevent this.

Integrated change control involves accepting or rejecting any changes to the scope of the work as well as coordinating those changes among workers and stakeholders. Since this process has many ramifications, there is often a **change control system** in place, and sometimes even a predefined group of stakeholders called a **change control board** who oversee all changes in scope of the project.

4.4.5.2 Managing Expectations

Sometimes, tasks may not be completed on schedule. The difference between planned and actual performance is called **variance.** A positive variance usually means that the project is ahead of schedule, while a negative variance means it is behind. Adjusting the schedule to account for variances and other changes is called **schedule control.**

Part of scope management monitoring and controlling is ensuring that the work is done properly, such as meeting milestones, forecasting, reporting, implementing **corrective actions** (to fix problems) and **preventive actions** (to prevent problems). The resulting project management plan combined with approved changes is often called a **baseline.** In most cases, this is used in the context of one of the knowledge areas, such as the scope baseline or the schedule baseline. The process which ensures that descriptions of all products are up-to-date is called **configuration management.**

Cost estimating is the process of developing an approximate cost for the project, while **cost budgeting** is allocating the overall cost to individual work items. Keeping a project within its budget is called **cost control.**

Project Communication Management
Project team members require up-to-date information in order to coordinate their efforts. Investors and other stakeholders require status reports and progress reports to guarantee that a project is moving in the right directions. In order to make sure that the right communications reach the right people, the project manager should develop a communications management plan. The plan should include which stakeholders require which pieces of information; who will provide the information; the method of delivery; frequency of transmission; and technology to manage the security/confidentiality of messages.

Communication takes many forms, and some are much more appropriate for certain situations than others. For example, face-to-face meetings are important for sensitive issues and for conflict resolution, but their output is not durable. Similarly, policies and procedures are normally printed and stored in a binder for easy reference, but lack interactivity. In some cases, multiple communication channels will be used.

Some methods of communication are more personal than others. In decreasing order, these include: one-on-one meetings, phone calls, group meetings, video conferencing, conference calls, voice mail, email, paper mail, web site, blog. (See Sect. 4.3.4 Developing effective communications.)

4.4.5.3 Balancing Competing Priorities

Project **portfolio management** is the process of selecting projects and programs deemed beneficial for an organization's success and evaluating projects from a strategic standpoint (Fig. 14-13).

FIGURE 14-13

Project management and Portfolio management

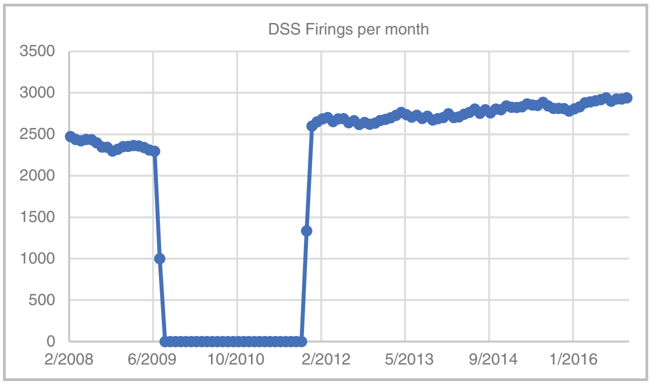


FIGURE 14-14

Run chart showing activations of a decision support system (DSS) per month. The run chart helps identify process anomalies

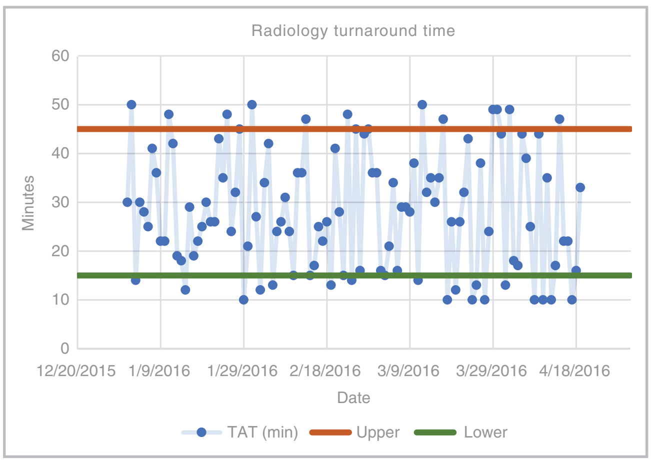


FIGURE 14-15

A control chart showing a radiology process. Many points fall outside the upper and lower control bars indicating a process that is out of control

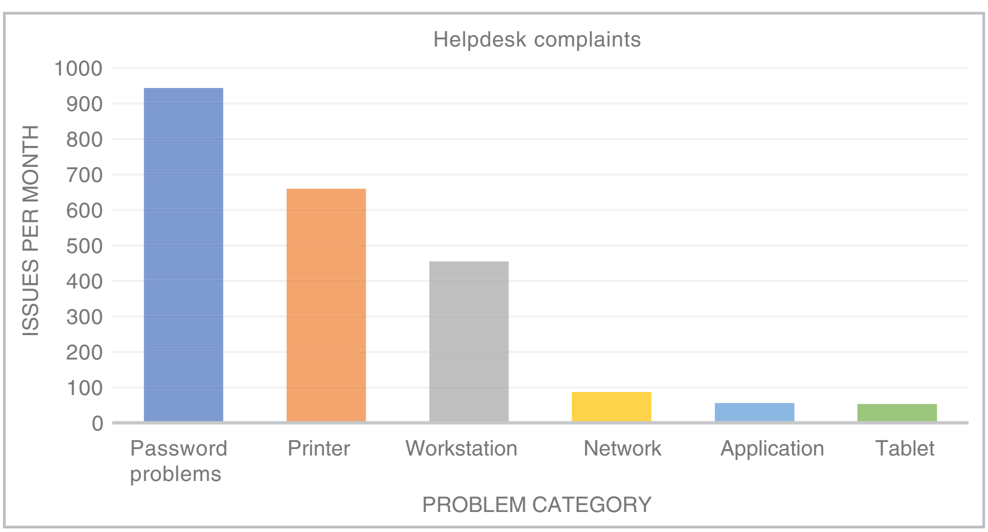


FIGURE 14-16

Pareto chart showing typical complaints received by a help-desk. Note that the problems are listed in decreasing order of incidence. This chart is used to help managers focus efforts on fixing the most frequent problems first

Maintaining quality is a key component of any project. One way to monitor quality is through **a run chart,** which graphs the variation of a process over time. For example, Fig. 14-14 shows the number of times that a decision support system (DSS) issued a warning during a particular period. This is an extreme example, but it can be seen that the DSS failed to fire from mid-2009 until early 2012. In this case it was due to a

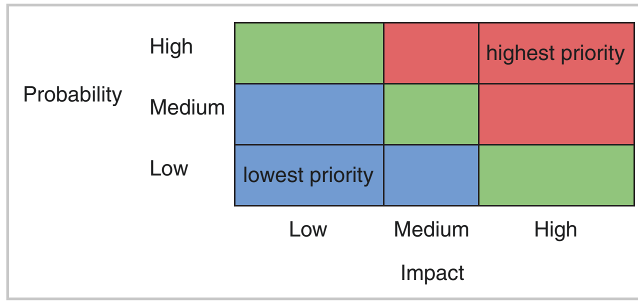


FIGURE 14-17

Probability/Impact matrix. By classifying risks along a gradient from high risk to low risk and high-impact to low impact, it is possible to prioritize risk responses

programming error. Careful monitoring of DSS firings could have detected this error much sooner.[2]

A **control chart**, similar to a run chart, depicts the results of a process over time. A control chart includes upper and lower acceptable bounds to determine if a process is in control or not. For example, the radiology department has determined that x-ray reading transcriptions should be available between 10 and 45 min after study is complete. (Fig. 14-15).

A Pareto chart is a particular type of histogram that shows problems in decreasing order of occurrence. It is useful to help prioritize efforts on finding solutions (Fig. 14-16).

Project Risk Management

A risk is an uncertainty which can lead to a positive or negative impact on a project. Risk management seeks to reduce the uncertainty by identifying and analyzing possible weaknesses and preparing for them. For example, developing solid downtime procedures guards against the risk of lost productivity should the information system fail. Purchasing insurance guards against catastrophic loss if a project harms someone.

Since all risk management requires investment, a probability/impact chart can help prioritize risk management functions. In Fig 14-17, the probability of a risk occurring is plotted against the potential impact of the risk. Low impact-low probability risks are given the lowest priority, while high-impact, high-probability risks are given the highest priority.

Risk can be classified as **positive risk** where the potential outcome is beneficial, or **negative risk** which the outcome is undesirable. There are four methods of responding to negative risk.

1. **Risk avoidance.** This is the most common method and it involves making systematic changes to a project to avoid aspects of risk. For example, patients with esophageal obstruction can be treated with orally administered meat tenderizer (papain or another digestive enzyme). However, there are safer methods of addressing this problem, such as endoscopy. To avoid this risk, a department could create a policy which prohibits the use of meat tenderizer for this indication. Creating a new policy may also create a new risk, such as a delay in care while waiting for the endoscopy suite to become available. This new risk is called a **secondary risk**.
2. **Risk acceptance.** This is the easiest approach, and is used when safer alternatives are unavailable or are too costly.
3. **Risk transference** involves shifting the risk to another entity. For example, gastric tubes commonly become dislocated and have to be replaced. This is commonly done as a blind procedure in the Emergency Department (ED), but can lead to injury if the tube is not placed appropriately. An ED that is concerned about this risk may opt to enact a policy forcing all gastric tube replacements to be done in the endoscopy suite, thereby transferring the risk to another department.
4. **Risk mitigation** is the reduction of risk by reducing the likelihood of occurrence. For example, the placement of central lines is a common risky procedure performed in the ED. The use of real time ultrasound has been shown to reduce the risk of complications.

2 see Wright A, Hickman TT, McEvoy D et al. Analysis of clinical decision support system malfunctions: a case series and survey. J Am Med Inform Assoc (2016) 23(6): 1068–1076.

Unfortunately, most risks can not be minimized into nothing, and **residual risks** may remain.

Similarly, there are four ways to respond to positive risk

1. **Risk exploitation** seeks to aggressively increase the likelihood of success by doing whatever measures it takes.
2. **Risk sharing** involves enlisting other entities to share in the risk and reward. For example, a hospital and a clinic seek to improve Medicaid enrollments so they partner on a combined financial aid office.
3. **Risk enhancement** differs from risk exploitation, but only in degree. While exploitation seeks to guarantee the positive result, enhancement only tries to increase the likelihood that the risk will occur. For example, a hospital wishes to meet a core measure threshold and employs extra personnel to make sure that they are successful.
4. **Risk acceptance** is identical to negative risk acceptance in that the project manager will accept the risk as it is without trying to modify it.