

*Project Management  
According to  
Project Management  
Body of Knowledge*





## **About this Study Guide . . . . .**

Welcome to this study guide.

This study guide is developed based on the PMBOK Guide 3<sup>rd</sup> Ed (2004), and is designed to provide the underpinning knowledge necessary for all the Knowledge Areas in Project Management.

The design of this learning materials is based on the understanding that project management is not an entry level qualification and that learners are likely to have existing knowledge, skills and competencies of the profession, in addition to adequate language literacy and numeracy skills.

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## **A. The Project Management Framework**

### **Introduction**

The Project Management Body of Knowledge is the sum of knowledge within the profession of project management. As with other professions such as law, medicine, and accounting, the body of knowledge rests with the practitioners and academics who apply and advance it.

The complete Project Management Body of Knowledge includes proven traditional practices that are widely applied, as well as innovative practices that are emerging in the profession, including published and unpublished material. As a result, the Project Management Body of Knowledge is constantly evolving.

### **1 Purpose of the PMBOK® GUIDE**

The primary purpose of the PMBOK® Guide is to identify that subset of the Project Management Body of Knowledge (PMBOK) that is generally recognised as good practice. "Identify" means to provide a general overview as opposed to an exhaustive description. "Generally recognised" means that the knowledge and practices described are applicable to most projects most of the time, and that there is widespread consensus about their value and usefulness.

"Good practice" means that there is general agreement that the correct application of these skills, tools, and techniques can enhance the chances of success over a wide range of different projects. Good practice does not mean that the knowledge described should always be applied uniformly on all projects; the project management team *is responsible for determining what is appropriate for any given project.*

The PMBOK® Guide also provides and promotes a common lexicon for *discussing, writing, and applying project management. Such a standard lexicon is an essential element of a profession.* The Project Management Institute uses this document as a foundational, but not the sole, *project management reference for its professional development programs including:*

- Project Management Professional (PMP®) certification
- Project management education and training offered by PMI Registered Education Providers (REPs)
- Accreditation of educational programs in project management.

*As a foundational reference, this standard is neither comprehensive nor all inclusive.* This standard addresses **only single projects** and the *project management processes that are generally recognised as good practice.*

*The lack of consensus means there are variations in the profession regarding how, when or where within the organisation, as well as who within the organisation, should perform that specific project management activity.* The organisation or the project management team must decide how those activities are going to be addressed in the context and the circumstances of the project for which the PMBOK® Guide is being used.

## **What is a Project?**

Projects are endeavours. Projects are temporary. A project creates a product, a service, or brings about a result. To define a project, one has to think of some work that has a deadline associated with it, involves resources, has a budget to satisfy the scope of the project work, and where one can state what the end result of the project should be. So, projects are temporary work assignments, with a budget, that require some amount of resources, and some amount of time to complete, and create a definite deliverable, service, or environment.

A project is a **temporary** endeavor undertaken to create a **unique** product, service, or result.

## **2.1 Project Characteristics**

### **2.1.1 Temporary**

Temporary means that every project has a definite beginning and a definite end. The end is reached when the project's objectives have been achieved, or it becomes clear that the project objectives will not or cannot be met, or the need for the project no longer exists and the project is terminated. Temporary does not necessarily mean short in duration; many projects last for several years. In every case, however, the duration of a project is finite. Projects are not ongoing efforts.

In addition, temporary does not generally apply to the product, service or result created by the project. Most projects are undertaken to create a lasting outcome. For example, a project to erect a national monument will create a result expected to last centuries. Projects also may often have intended and unintended social, economic and environmental impacts that far outlast the projects themselves.

### **2.1.2 Unique Products, Services, or Results**

A project creates *unique deliverables*, which are products, services, or results. Projects can create:

- A product or artifact that is produced, is quantifiable, and can be either an end item in itself or a component item
- A capability to perform a service, such as business functions supporting production or distribution
- A result, such as outcomes or documents. For example, a research project develops knowledge that can be used to determine whether or not a trend is present or a new process will benefit society.

*Uniqueness is an important characteristic of project deliverables. For example, many thousands of office buildings have been developed, but each individual facility is unique—different owner, different design, different location, different contractors, and so on. The presence of repetitive elements does not change the fundamental uniqueness of the project work.*

### **2.1.3 Progressive Elaboration**

Progressive elaboration is a characteristic of projects that accompanies the concepts of temporary and unique. Progressive elaboration means developing in steps, and continuing by increments. For example, *the project scope will be broadly described early in the project and made more explicit and detailed as the project team develops a better and more complete understanding of the objectives and deliverables.*

Progressive elaboration should not be confused with scope creep. *Progressive elaboration of a project's specifications needs to be carefully coordinated with proper project scope definition, particularly if the project is performed under contract. When properly defined, the scope of the project - the work to be done - should remain the same even as the project and product specifications are progressively elaborated.*

The following examples illustrate progressive elaboration in two different application areas:

- Development of a chemical processing plant begins with process engineering to define the characteristics of the process. These characteristics are used to design the major processing units. This information becomes the basis for engineering design, which defines both the detailed plant layout and the mechanical characteristics of the process units and ancillary facilities.

- All of this results in design drawings that are elaborated to produce fabrication and construction drawings. During construction, interpretations and adaptations are made as needed and are subject to proper approval. This further elaboration of the deliverables is captured in as-built drawings, and final operating adjustments are made during testing and turnover.
- The product of an economic development project may initially be defined as: "Improve the quality of life of the lowest income residents of community X." As the project proceeds, the products may be described more specifically as, for example: "Provide access to food and water to 500 low-income residents in community X."
- The next round of progressive elaboration might focus exclusively on increasing agriculture production and marketing, with provision of water deemed to be a secondary priority to be initiated once the agricultural component is well under way.

## **2.2 Projects vs. Operational Work**

Organisations perform work to achieve a set of objectives. Generally, *work can be categorised as either projects or operations, although the two sometimes overlap.* They share many of the following characteristics:

- Performed by people
- Constrained by limited resources
- Planned, executed, and controlled.

Projects and operations differ primarily in that operations are ongoing and repetitive, while projects are temporary and unique. The objectives of projects and operations are fundamentally different. The *purpose of a project is to attain its objective and then terminate.* Conversely, the *objective of an ongoing operation is to sustain the business.*

Examples of projects include, but are not limited to:

- Developing a new product or service
- Effecting a change in structure, staffing, or style of an organisation
- Designing a new transportation vehicle
- Developing or acquiring a new or modified information system
- Constructing a building or facility
- Building a water system for a community
- Running a campaign for political office
- Implementing a new business procedure or process
- Responding to a contract solicitation.

### **2.3 Projects and Strategic Planning**

Projects are a means of organising activities that cannot be addressed within the organisation's normal operational limits. *Projects are, therefore, often utilised as a means of achieving an organisation's strategic plan, whether the project team is employed by the organisation or is a contracted service provider.*

#### **What is Project Management?**

*Project management is the application of knowledge, skills, tools and techniques to project activities to meet project requirements. Project management is accomplished through the application and integration of the project management processes of initiating, planning, executing, monitoring and controlling, and closing. The project manager is the person responsible for accomplishing the project objectives.*

*Managing a project is best described as consistently producing key results expected by stakeholders. While all stakeholders are important, it is of prime importance to meet the customers needs and requirements.*

### **Managing a project includes:**

- Identifying requirements
- Establishing clear and achievable objectives
- Balancing the competing demands of scope, time, cost and quality
- Adapting the specifications, plans, and approach to the different concerns and expectations of the various stakeholders.

Project managers often talk of a "triple constraint"-project scope, time and cost-in managing competing project requirements. *Project quality is affected by balancing these three factors.* High quality projects deliver the required product, service or result within scope, on time, and within budget. *The relationship among these factors is such that if any one of the three factors changes, at least one other factor is likely to be affected.*

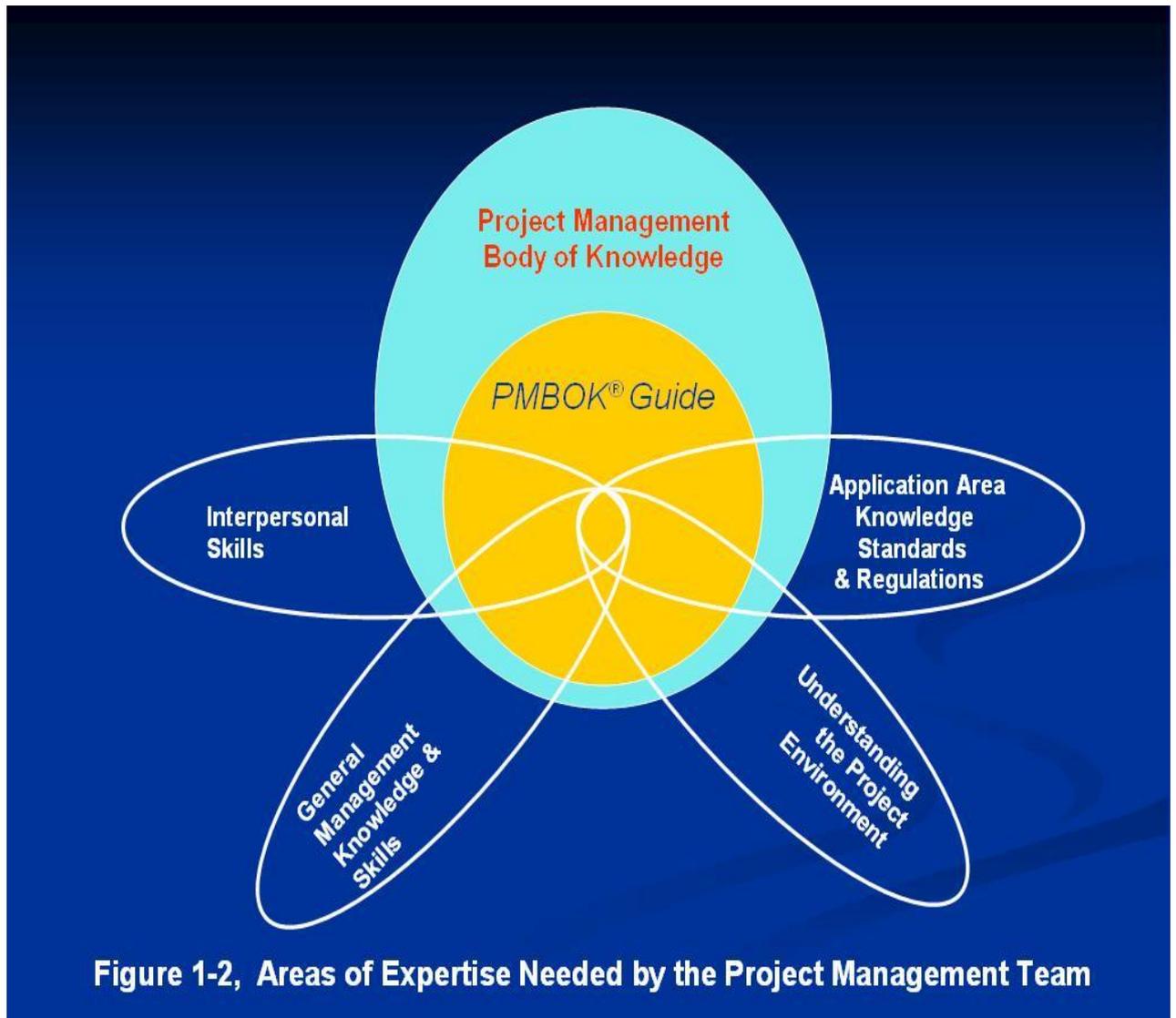
The term "project management" is sometimes used to describe an organisational approach to the management of ongoing operations. This approach, more properly called "management by projects," treats many aspects of ongoing operations as projects to ensure the application of proven project management techniques.

### **Areas of Expertise**

Much of the knowledge and many of the tools and techniques for managing projects are unique to project management, such as *work breakdown structures, critical path analysis, and earned value management.* However, understanding and applying the knowledge, skills, tools, and techniques, which are generally recognised as good practice, are not sufficient alone for effective project management. Effective project management requires that the project management team understand and use knowledge and skills from at least five (5) areas of expertise:

- *The Project Management Body of Knowledge*
- *Application area knowledge, standards, and regulations*
- *Understanding the project environment*

- *General management knowledge and skills*
- *Interpersonal skills.*



**Figure 1-2. Areas of Expertise needed by the Project Management Team**

Although they appear as discrete elements, they generally overlap; none can stand alone. Effective project teams integrate them into all aspects of their project. It is not necessary for every project team member to be an expert in all five areas. In fact, it is unlikely that any one person will have all the knowledge and skills needed for the project. However, it is important that the project management team has full knowledge of the PMBOK® Guide and is conversant in the knowledge of the Project

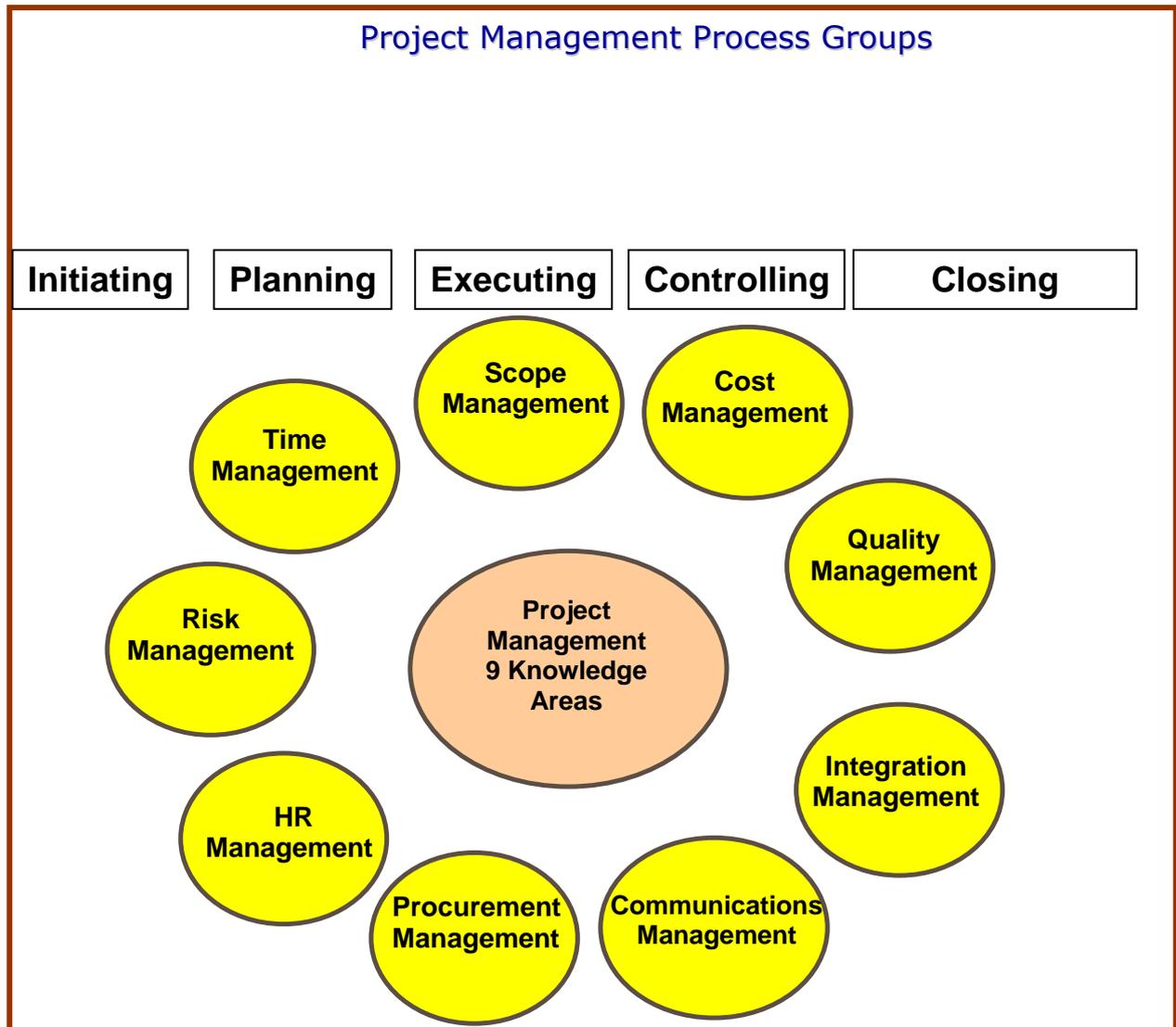
Management Body of Knowledge and the other four areas of management to effectively manage a project.

#### **4.1 Project Management Body of Knowledge**

The Project Management Body of Knowledge describes knowledge unique to the project management field and that overlaps other management disciplines. Figure 1-2 shows the common areas of expertise needed by the project team. *The PMBOK® Guide is, therefore, a subset of the larger Project Management Body of Knowledge.* The knowledge of project management described in the PMBOK® Guide consists of:

- Project life cycle definition (about when a project starts and when a project ends)
- Five Project Management Process Groups (Initiation, Planning, Execution, Controlling & Closing)
- Nine Knowledge Areas (Scope, Time, Cost, Quality, Communication, HR, Risk, Procurement, Integration)

The figure below shows the five project management process groups, and the nine knowledge areas:



#### **4.2. Application Area Knowledge, Standards and Regulations**

*Application areas are categories of projects that have common elements significant in such projects, but are not needed or present in all projects.*

**Application areas are usually defined in terms of:**

- Functional departments and supporting disciplines, such as legal, production and inventory management, marketing, logistics, and personnel
- Technical elements, such as software development or engineering, and sometimes a specific kind of engineering, such as water and sanitation engineering or construction engineering
- Management specialisations, such as government contracting, community development, and new product development
- Industry groups, such as automotive, chemical, agriculture, and financial services.

Each application area generally has a set of accepted standards and practices, often codified in regulations. The International Organisation for Standardisation (ISO) differentiates between **standards** and **regulations** as follows:

- A standard is a "document established by consensus and approved by a recognised body *that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.*" Some examples of standards are computer disk sizes and the thermal stability specifications of hydraulic fluids.
- A regulation *is a government-imposed requirement, which specifies product, process or service characteristics, including the applicable administrative provisions, with which compliance is mandatory. Building codes are an example of regulations.*

### **4.3. General Management Knowledge and Skills**

General management encompasses **planning, organising, staffing, executing, and controlling** the operations of an ongoing enterprise.

**It includes supporting disciplines such as:**

- *Financial management and accounting*
- *Purchasing and procurement*
- *Sales and marketing*
- *Contracts and commercial law*
- *Manufacturing and distribution*
- *Logistics and supply chain*
- *Strategic planning, tactical planning, and operational planning*
- *Organisational structures, organisational behavior, personnel administration, compensation, benefits, and career paths*
- *Health and safety practices*
- *Information technology.*

**4.4. Interpersonal Skills**

**The management of interpersonal relationships includes:**

1. **Effective communication:** The exchange of information. Typically the area where the PM devotes the most amount of time
2. **Influencing the organisation:** The ability to "get things done" through a thorough understanding of formal and informal organisational structures
- 3 **Leadership:** Developing a vision and strategy, and motivating people to achieve that vision and strategy
4. **Motivation:** Energising people to achieve high levels of performance and to overcome barriers to change
5. **Negotiation and conflict management:** Conferring with others to come to terms with them or to reach an agreement, e.g. arbitration

6. **Problem solving:** The combination of problem definition, alternatives identification and analysis, and decision-making.

**5.0 The 44 PMBOK Processes** The following table shows the 44 PMBOK Processes recommended for managing a project. Not all processes are required on all projects, the processes used will depend on the nature and size of the project.



Figure 1-1. Overview of Project Management Knowledge Areas and Project Management Processes

The following table provides description of each knowledge area and the associated processes. The list of suggested evidence is intended as a guide and is not meant to be exclusive or exhaustive.

Knowledge Area	Process
<p><b>Project Integration Management</b></p> <p>Project integration management includes the processes required to ensure that the various elements of the project are properly coordinated. It involves making tradeoffs among competing objectives and alternatives to meet or exceed stakeholder needs and expectations. It has seven processes: develop project charter, preliminary project scope statement, develop project management plan, direct and manage project execution, monitor and control project work, integrated change control, and close project.</p>	<p><b>Develop Project Charter</b> – including project requirements for satisfaction, project purpose, milestone schedule, stakeholder influences, statement of work (SOW), functional organisation, assumptions and constraints.</p> <p><b>Preliminary Project Scope Statement</b> – contains project objectives, deliverable characteristics, acceptance criteria, project boundaries, risks, milestones, WBS etc,</p> <p><b>Develop Project Management Plan</b> – project purpose, scope, schedule, cost, quality, resources, time, communications, risk, procurement and close.</p> <p><b>Direct and Manage Project Execution</b> – applying rules and regulations for project execution.</p> <p><b>Monitor and Control Project Work</b> – ensure project plan schedules, costs, milestones, deliverables are met, evaluated before proceeding to next phase.</p> <p><b>Integrated Change Control</b> – Implementing tools and techniques to manage integrated change, examining change requests. Where feasible, it is recommended this change system is controlled by a Change Control Board.</p> <p><b>Close Project</b> – preparing to close project, including contract documentation, work performance information, deliverables.</p>

Knowledge Area	Process
<p><b>Project Scope Management</b></p> <p>Project Scope Management includes the processes required to ensure that the project includes all the work required, and only the work required to complete the project successfully.</p> <p>It is a framework or scaffolding for the project and is primarily concerned about what the project is about and not about – setting a boundary around the project.</p> <p>Project Scope Management includes five processes; scope planning, scope definition, create work breakdown structure (WBS), scope verification, and scope control.</p>	<p><b>Scope Planning</b> – creating a project scope management plan that documents how the project scope will be defined, verified, controlled, and how the WBS will be created and defined.</p> <p><b>Scope Definition</b> – Listing of project deliverables (may be products, processes or events), identifying measurable outcomes for project evaluation.</p> <p><b>Creating WBS</b> – breaking down the project deliverables and project work into smaller, more manageable work parcels.</p> <p><b>Scope Verification</b> - Monitoring project scope for non compliance, reviewing progress against project plan to determine any scope changes.</p> <p><b>Scope Control</b> - Reporting scope changes, reviewing project outcomes and scope management techniques.</p>

Knowledge Area	Process
<p><b>Project Time Management</b></p> <p>Project time management includes the processes required to ensure timely completion of the project. It includes six major processes in developing the project time schedule: activity definition, activity sequencing, activity resource estimating, activity duration estimating, schedule development, and schedule control.</p>	<p><b>Activity Definition</b> – identifying the specific activities that must be performed to produce the various project deliverables.</p> <p><b>Activity Sequencing</b> – determining and documenting dependencies.</p> <p><b>Activity Resource Estimating</b> – determining activity resource requirements, attributes, capabilities, organisational process assets.</p> <p><b>Activity Duration Estimating</b> - estimating the chunks of time, days, months etc. that will be needed to complete each individual activity</p> <p><b>Schedule Development</b> - analysing the duration, sequences and resource requirements to create the project schedule</p> <p><b>Schedule Control</b> - controlling changes to the schedule</p>

Knowledge Area	Process
<p><b>Project Cost Management</b></p> <p>Project cost management includes the processes required to ensure that the project is completed within the approved budget. It consists of three major processes; cost estimating; cost budgeting; and cost control.</p>	<p><b>Cost Estimating</b> – developing an approximation or estimate of the costs of the resources needed to complete project activities.</p> <p><b>Cost Budgeting</b> – allocating the overall cost estimate to individual work activities.</p> <p><b>Cost Control</b> – controlling changes to the project budget.</p>

Knowledge Area	Process
<p><b>Project Quality Management</b></p> <p>Project quality management includes the processes required to ensure that the project is planned and completed to established standards. It consists of three major processes; quality planning; perform quality assurance; and perform quality control.</p>	<p><b>Quality Planning</b> - Identifying which quality standards (and regulations) are relevant to the project and determining how to satisfy them. Determining quality requirements and outcomes. Selecting quality tools for use in projects.</p> <p><b>Perform Quality Assurance</b> - Applying the planned, systematic quality activities to ensure that the project employs all processes needed to meet requirements. Identifying and addressing quality problems and issues during projects.</p> <p><b>Perform Quality Control</b> - Monitoring specific project results to determine whether they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory performance. Reviewing and evaluating project quality management. Implementing improvements to quality management.</p>

Knowledge Area	Process
<p><b>Project Human Resource Management</b></p> <p>Project human resources management includes the processes required to make the most effective use of the people involved with the project. It includes all the project stakeholders – sponsors, customers, partners, individual contributors. It consists of four processes: human resource planning, acquire project team, develop project team, and manage project team.</p>	<p><b>Human Resource Planning</b> - organisational planning; identifying, documenting and assigning project roles, responsibilities, and reporting relationships; identifying project interfaces such as, organisational, technical, interpersonal interfaces, logistical, and political interfaces which may impact the project and its deliverables.</p> <p><b>Acquire Project Team</b> - getting the human resources needed for the project, assigned to and working on the project.</p> <p><b>Develop Project Team</b> - developing individual and group competencies to enhance project performance. This includes, team building activities, performance monitoring, reporting, rewarding performance.</p> <p><b>Manage Project Team</b> - tracking individual and team performance, providing feedback to project team members about performance, solutions to conflicts and disputes with the team members.</p>

Knowledge Area	Process
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**Project Communications Management**

Project communications management is about ensuring the correct information is exchanged at the correct time. The effective management of project communications is critical to project success. Communication is a two way process and must include a feedback cycle, to enable processes to be improved and issues to be addressed. Project Communications Management includes four processes: communications planning, information distribution, performance reporting, and managing stakeholders.

**Communications Planning** - Planning communications processes in consultation with stakeholders and guidance from the higher project authority. Developing project communications plan considering environmental factors, communications requirements, and feedback loop.

**Information Distribution** - Maintaining project management information systems, structures and procedures to ensure the quality, validity, timeliness and integrity of project information and communication distribution.

**Performance Reporting** - Managing validation of information to optimise quality and accuracy of data. Managing and reporting on communication networks between project staff, client and stakeholders. Managing project reporting requirements

**Managing Stakeholders** - Managing and communicating with stakeholders. Managing the evaluation of information and communications processes and procedures.

Knowledge Area	Process
<p><b>Project Risk Management</b></p> <p>Risk management is the systematic process of identifying, analysing and responding to project risk. It includes maximising the probability and consequences of positive events and minimising the probability and consequences of adverse events to project objectives. It consists of six processes, risk management planning, risk identification, qualitative risk analysis, quantitative risk analysis, risk response planning, risk monitoring and control.</p>	<p><b>Risk Management Planning</b> – examining stakeholder tolerance, creating and examining risk management plan, measurement analysis, and monitoring and reporting risk.</p> <p><b>Risk Identification</b> - identifying and categorising risks, preparing for risks, creating a risk register.</p> <p><b>Qualitative Risk Analysis</b> – completing qualitative risk analysis, creating and applying probability and impact matrix, examining the results.</p> <p><b>Quantitative Risk Analysis</b> – inputs for quantitative risk analysis, applying sensitivity analysis, finding expected monetary value, using decision tree method, and project simulations.</p> <p><b>Risk Response Planning</b> – planning and preparing for risk response. One common response is mitigation, reducing the likelihood and impact of a negative event.</p> <p><b>Risk Monitoring and Control</b> – preparing, implementing and completing risk monitor and control strategies including, risk response audits, periodic risk reviews, measuring technical performance, and using earned value analysis.</p>

Knowledge Area	Process
<p><b>Project Procurement Management</b></p> <p>Procurement planning is the processes of identifying which part of the project should be procured from resources outside the organisation. Procurement Management includes six processes; plan purchase and acquisitions, plan contracting, request seller responses, select sellers, contract administration, and contract closure.</p>	<p><b>Plan Purchase and Acquisitions</b> – Procurement planning including determining what and when to procure, make or buy decisions, how much and when to buy.</p> <p><b>Plan Contracting</b> – types of contracts, contract requirements, preparing for contracting, examining results of contracting.</p> <p><b>Request Seller Responses</b> – obtaining quotes, bids, offers or proposals, tenders.</p> <p><b>Select Sellers</b> – evaluation criteria, weighting systems, independent estimates, screening systems, contract negotiating, statement of work (SOW), measurement analysis to choose potential sellers.</p> <p><b>Contract Administration</b> – planning and preparing contract administration including, performance reports, work results, change requests, payment systems, claims administration and records management.</p> <p><b>Contract Closure</b> – review contract documentation, auditing procurement process, completing contract closeout.</p>

## **Project Management Context**

### **6.1. Programs and Program Management**

A program is a group of related projects managed in a coordinated way to obtain benefits and control not available from managing them individually. Programs may include elements of related work outside of the scope of the discrete projects in the program.

In contrast with project management, program management is the centralised, coordinated management of a group of projects to achieve the program's strategic objectives and benefits.

### **6.2 Portfolios and Portfolio Management**

A portfolio is a collection of projects or programs and other work that are grouped together to facilitate effective management of that work to meet strategic business objectives. The projects or programs in the portfolio may not necessarily be interdependent or directly related. Funding and support can be assigned on the basis of risk/reward categories, specific lines of business, or general types of projects, such as infrastructure and internal process improvement. Portfolios are typically run by senior management.

### **6.3 Subprojects**

*Projects are frequently divided into more manageable components or subprojects, although the individual subprojects can be referred to as projects and managed as such.* Subprojects are often contracted to an external enterprise or to another functional unit in the performing organisation. Examples include:

- Subprojects based on the project process, such as a single phase in the project life cycle

- Subprojects according to human resource skill requirements, such as plumbers or electricians needed on a construction project
- Subprojects involving specialised technology, such as the automated testing of computer programs on a software development project.

*On very large projects, the subprojects can consist of a series of even smaller subprojects.*

#### **6.4 Project Management Office**

*A project management office (PMO) is an organisational unit to centralise and coordinate the management of projects under its domain. A PMO can also be referred to as a "program management office," "project office," or "program office." A PMO oversees the management of projects, programs, or a combination of both. The projects supported or administered by the PMO may not be related other than by being managed together. Some PMOs, however, do coordinate and manage related projects. In many organisations, those projects are indeed grouped or are related in some manner based on the way the PMO will coordinate and manage those projects.*

The PMO's primary purpose is to support the PM and focuses on the coordinated planning, prioritisation and execution of projects and subprojects that are tied to the parent organisation's or client's overall business objectives. *PMOs can operate on a continuum, from providing project management support functions in the form of training, software, standardised policies, and procedures, to actual direct management and responsibility for achieving the project objectives.*

*A specific PMO can receive delegated authority to act as an integral stakeholder and a key decision-maker during the initiation stage of each project, can have the authority to make recommendations, or can*

*terminate projects to keep the business objectives consistent.* In addition, the PMO can be involved in the selection, management, and redeployment, if necessary, of shared project personnel and, where possible, dedicated project personnel.

**Some of the key features of a PMO include, but are not limited to:**

- *Shared and coordinated resources across all projects administered by the PMO*
- *Identification and development of project management methodology, best practices, and standards*
- *Clearinghouse and management for project policies, procedures, templates, and other shared documentation*
- *Centralised configuration management for all projects administered by the PMO*
- *Centralised repository and management for both shared and unique risks for all projects*
- *Central office for operation and management of project tools, such as enterprise-wide project management software*
- *Central coordination of communication management across projects*
- *A mentoring platform for project managers*
- *Central monitoring of all PMO project timelines and budgets, usually at the enterprise level*
- *Coordination of overall project quality standards between the project manager and any internal or external quality personnel or standards organisation.*

*Differences between Project Management and a PMO may include the following:*

Project managers and PMOs *pursue different objectives* and, as such, are driven by different requirements. All of these efforts, however, are aligned with the strategic needs of the organisation.

- A project manager is responsible for *delivering specific project objectives within the constraints of the project*, while a PMO is an organisational structure *with specific mandates that can include an enterprise wide perspective*.
- The *project manager* focuses on the specified project objectives, while the *PMO manages major program scope changes* and can view them as potential opportunities to better achieve business objectives.
- The *project manager controls the assigned project resources to best meet project objectives*, while the *PMO optimises the use of shared organisational resources across all projects*.
- The *project manager manages the scope, schedule, cost, and quality of the products of the work packages*, while the *PMO manages overall risk, overall opportunity, and the interdependencies among projects*.
- The *project manager reports on project progress and other project specific information*, while the *PMO provides consolidated reporting and an enterprise view of projects under its purview*.

**The table below compares program management with project management.**

<b>Program management approach</b>	<b>Project management approach</b>
Summary: Managing delivery of predetermined outcomes defined in plans	Summary: Management of uncertainty using cross functional teams
Aim: Imbed controls to minimise variations	Aim: Imbed responsiveness and problem solving
Characteristics: <ul style="list-style-type: none"> <li>• Predictable</li> <li>• Maintaining normal operations to meet corporate objectives</li> <li>• Hierarchical structure of work teams</li> <li>• Departmentalisation of functions and personnel</li> <li>• Employment based on notion of ongoing and full-time</li> <li>• Structured, functional work arrangements</li> <li>• Formalised plans as the basis for development and delivery services and products</li> <li>• Bureaucratic structures with rules, procedures</li> <li>• Habits and working practices are generated by experience</li> </ul>	Characteristics: <ul style="list-style-type: none"> <li>• Dynamic and changing</li> <li>• Management of uncertainty</li> <li>• Open ended, iterative structures</li> <li>• Self directed work teams operating across functional boundaries</li> <li>• Loosely structured work arrangements</li> <li>• Flexible structures and processes designed to accommodate change and innovation</li> <li>• “One size does not fit all” approach</li> <li>• Bounded by agreed constraints</li> <li>• Utilising specialist skills</li> <li>• Temporary – exist only for life of the project and have a life cycle</li> </ul>

## Summary and Self-test

### **TWO-MINUTE DRILL**

#### **Exploring Project Attributes**

- ❑ Projects are temporary, unique, and create a product or service.
- ❑ Projects move from concept to completion through progressive elaboration.
- ❑ Not all projects get selected. The decisions to choose one project over another may vary from organisation to organisation. The process, however, may be called Project Portfolio Management.
- ❑ Project Management Offices standardise the project management approach within an organisation

#### **The Project Management Framework**

- ❑ Within the project management framework are nine knowledge areas, which span the project management life cycle.
- ❑ The focus of Project Integration Management is on managing all of the moving parts of a project.
- ❑ The focus of Project Scope Management is on protecting, fulfilling, and delivering the project scope.
- ❑ The focus of Project Time Management is on scheduling activities, monitoring the project schedule, and working with the project team and stakeholders to ensure the project completes on time.
- ❑ The focus of Project Cost Management is on estimating and maintaining project costs.
- ❑ The focus of Project Quality Management is on setting the quality expectations and then delivering the project product with the expected level of quality.
- ❑ The focus of Project Human Resources Management is on developing the project team to work together to deliver the project as expected.
- ❑ The focus of Project Communications Management is on delivering needed information to the correct parties at the correct time.
- ❑ The focus of Project Risk Management is on identifying, mitigating, and managing project risks.
- ❑ The focus of Project Procurement Management is soliciting, selecting, and managing vendors to complete project work or supply project materials.

#### **Identifying Project Manager Characteristics**

- ❑ A project manager must have multiple skills to be successful,

including the ability to communicate, manage a budget, be organised, negotiate, and provide leadership for the project.

- ❑ Project managers in different sectors of business and non-profit entities will encounter situations unique only to their area of expertise. For example, a project manager of a construction project will have different issues and concerns to a project manager of a manufacturing project.
- ❑ Project managers require organisation.

### **SELF TEST**

1. Which one of the following is not an attribute of a project?
  - A. Definite starting date
  - B. Has no definite end date
  - C. Creates a product, service, or results
  - D. Requires resources
  
2. You are a project manager for Johnson Keyboards Inc. Your organisation has adapted the PMBOK as a standard tool for how projects should operate and you are involved in shaping the standardisation for all future projects. In light of this information, what is the recommended course of action for the processes and procedures in the PMBOK?
  - A. Not all processes and procedures in the PMBOK are actually required on all projects.
  - B. All processes and procedures are to be followed as defined in the PMBOK.
  - C. Not all processes and procedures are needed unless the PMBOK states the process or procedure is a requirement for the project type.
  - D. All processes and procedures are to be followed as identified in the PMBOK, otherwise the PMP is in violation of the PMP Code of Professional Conduct.
  
3. You are explaining to a junior engineer the difference between a project and operations. Which one of the following is true only of operations?
  - A. They are performed by people.
  - B. They are constrained by limited resources.
  - C. They are ongoing.
  - D. They are planned, executed, and controlled.
  
4. Project managers are not responsible for which one of the following in most organisations?
  - A. Identifying the project requirements
  - B. Selecting the projects to be initiated
  - C. Balancing demands for time, cost, scope, and quality
  - D. Establishing clear and achievable project objectives

- 5.** You and William, a project stakeholder, are discussing risks within your project. Which one of the following best describes risk?
- A. Any event which can cause your project to fail
  - B. Any event which may have a positive or negative effect on your project's project team
  - C. An uncertain event which may have a positive or negative effect on your project
  - D. An event which will cause time and cost constraints to be broken
- 6.** Which knowledge area includes the creation of the project charter?
- A. Project Scope Management
  - B. Project Cost Management
  - C. Project Integration Management
  - D. Project Communications Management
- 7.** Which one of the following is not a general management skill?
- A. Motivating the project team
  - B. Purchasing and procurement
  - C. Sales and marketing
  - D. Contracts and commercial law
- 8.** You are the project manager for an architectural design company. Your company consistently completes projects for other companies. Within your organisation the project managers have the highest level of authority on a project. You are likely operating within what type of company?
- A. A company using a functional structure
  - B. A company using a matrix structure
  - C. A company using management by projects
  - D. A company using an ISO 9000 program
- 9.** Who is usually responsible for portfolio management within an organisation?
- A. Project managers
  - B. Project sponsors
  - C. Stakeholders
  - D. Senior management
- 10.** Where can a project manager expect software, templates, and standardised policies?
- A. A Project Management Office
  - B. With the stakeholders
  - C. Human Resources
  - D. The project budget
- 11.** Of the following, which one is not part of Project Integration Management?

- A. The creation of the project plan
  - B. The interaction between project teams
  - C. The execution of the project plan
  - D. The documentation of changes to the project plan Management
- 12.** Which document will guide the interaction between the project manager and a selected vendor on a project?
- A. The project plan
  - B. The STATEMENT OF WORK (SOW)
  - C. The procurement management plan
  - D. The contract
- 13.** What is the difference between a standard and a regulation?
- A. Standards and regulations are the same.
  - B. Standards are regulated by specific industries; regulations are laws.
  - C. Standards are optional; regulations are required.
  - D. Standards are required; regulations are laws.
- 14.** The project manager typically devotes the most amount of time to which of the following tasks?
- A. Communications
  - B. Budget management
  - C. Project organisation
  - D. Management of team negotiations
- 15.** Which one of the following is an interpersonal skill a project manager must have to be successful?
- A. Sales and marketing
  - B. Leadership
  - C. Health and safety practices
  - D. Information technology experience
- 16.** Of the following, which is the most important stakeholder involved with a project?
- A. The project manager
  - B. The project sponsor
  - C. The CEO
  - D. The customer

## 2 Project Life Cycle and Organisation

*Projects and project management are carried out in an environment broader than that of the project itself.* The topics included here are:

- 1. The Project Life Cycle**
- 2. Project Stakeholders**
- 3. Organisational Influences**

### The Project Life Cycle

Project managers or the organisation can divide projects into phases to provide better management control with appropriate links to the ongoing operations of the performing organisation. Collectively, these phases are known as the project life cycle. Many organisations identify a specific set of life cycles for use on all of their projects.

#### **1.1 Characteristics of the Project Life Cycle**

*The project life cycle defines the phases that connect the beginning of a project to its end.* For example, when an organisation identifies an opportunity to which it would like to respond, it will often authorise a feasibility study to decide whether it should undertake the project.

*The project life cycle definition can help the project manager clarify whether to treat the feasibility study as the first project phase or as a separate, stand-alone project. Where the outcome of such a preliminary effort is not clearly identifiable, it is best to treat such efforts as a separate project.* The phases of a project life cycle are not the same as the Project Management Process Groups.

The transition from one phase to another within a project's life cycle generally involves, and is usually defined by, some form of technical transfer or handoff. *Deliverables from one phase are usually reviewed for*

*completeness and accuracy and approved before work starts on the next phase. However, it is not uncommon for a phase to begin prior to the approval of the previous phase's deliverables, when the risks involved are deemed acceptable. This practice of overlapping phases, normally done in sequence, is an example of the application of the schedule compression technique called "fast tracking".*

- Phases are *generally sequential* and are usually defined by some form of technical information transfer or technical component handoff.
- *Cost and staffing levels are low at the start, peak during the intermediate phases, and drop rapidly as the project draws to a conclusion.*
- *The level of uncertainty is highest and, hence, risk of failing to achieve the objectives is greatest at the start of the project. The certainty of completion generally gets progressively better as the project continues.*
- *The ability of the stakeholders to influence the final characteristics of the project's product and the final cost of the project is highest at the start, and gets progressively lower as the project continues. A major contributor to this phenomenon is that the cost of changes and correcting errors generally increases as the project continues.*

## **1.2 Characteristics of Project Phases**

*The completion and approval of one or more deliverables characterises a project phase. A **deliverable** is a measurable, tangible work product such as a specification, feasibility study report, detailed design document, or working prototype. Some deliverables can correspond to the project management process, whereas others are the end products or components of the end products for which the project was conceived.*

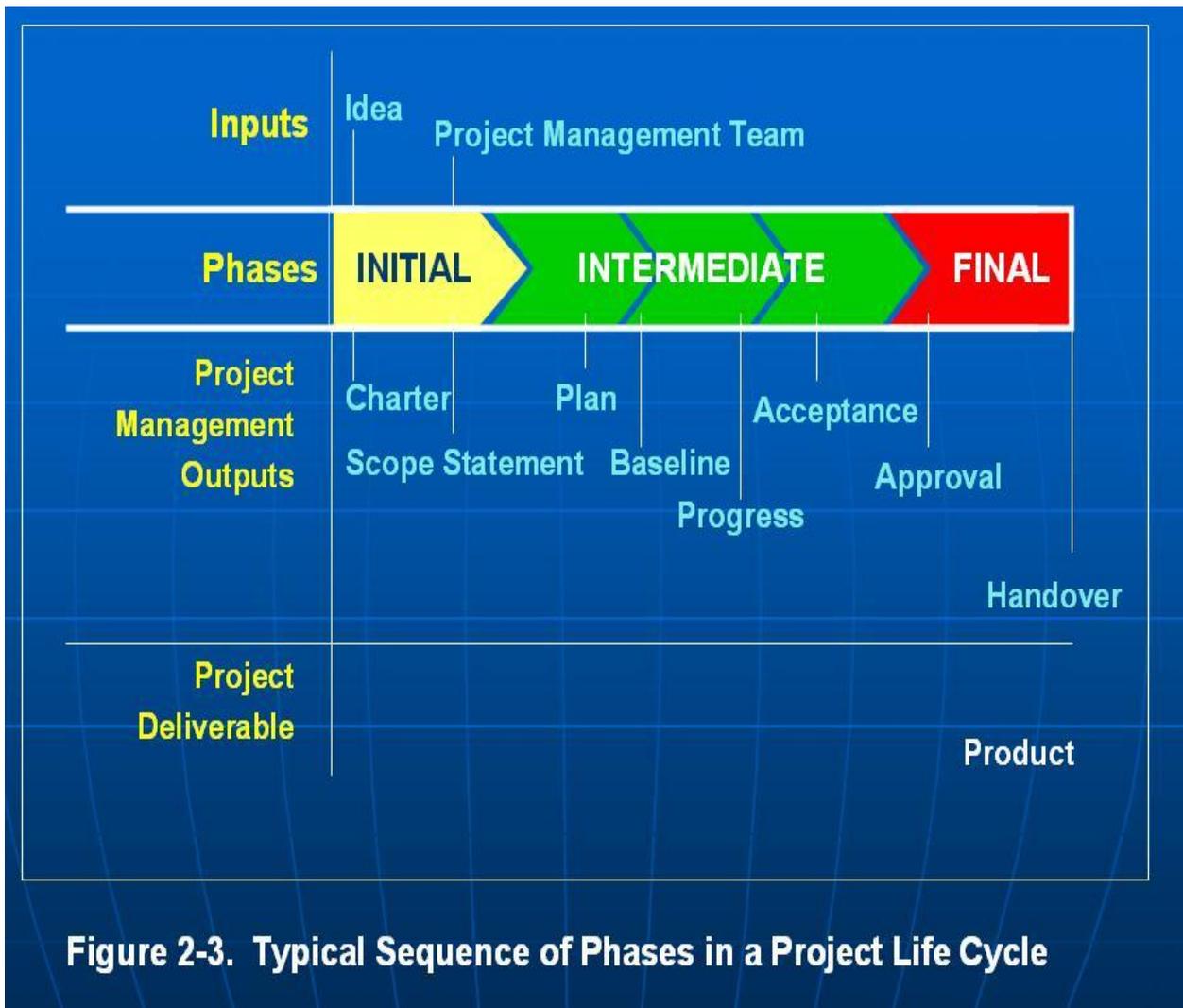
The deliverables, and hence the phases, are part of a generally

sequential process designed to ensure proper control of the project and to attain the desired product or service, which is the objective of the project.

The majority of these sub phase deliverables are related to the primary phase deliverable, and the phases typically take their names from these phase deliverables: requirements, design, build, test, startup, turnover, and others, as appropriate. A project phase is generally concluded with a review of the work accomplished and the deliverables to determine acceptance, whether extra work is still required, or whether the phase should be considered closed. A management review is often held to reach a decision to start the activities of the next phase without closing the current phase, for example, when the project manager chooses fast tracking as the course of action.

Another example is when an information technology company chooses an iterative life cycle where more than one phase of the project might progress simultaneously. Requirements for a module can be gathered and analysed before the module is designed and constructed. While analysis of a module is being done, the requirements gathering for another module could also start in parallel. Similarly, a phase can be closed without the decision to initiate any other phases. For example, the project is completed or the risk is deemed too great for the project to be allowed to continue.

*Formal phase completion does not include authorising the subsequent phase.* For effective control, each phase is formally initiated to produce a phase-dependent output of the Initiating Process Group, specifying what is allowed and expected for that phase, as shown in Figure 2-3. A *phase-end review can be held with the explicit goals of obtaining authorisation to close the current phase and to initiate the subsequent one.* Sometimes both authorisations can be gained at one review. *Phase-end reviews are also called **phase exits, phase gates, or kill points** and can be such things as customer sign-offs, quality metrics and regulatory inspections.*



Source: PMBOK Guide 3<sup>rd</sup> Ed

### 1.3 Project Life Cycle and Product Life Cycle Relationships

Many projects are linked to the ongoing work of the performing organisation. Some organisations formally approve projects only after completion of a feasibility study, a preliminary plan, or some other equivalent form of analysis; in these cases, the preliminary planning or analysis takes the form of a separate project. For example, additional phases could come from developing and testing a prototype prior to initiating the project for the development of the final product.

Some types of projects, especially internal service or new product development projects, can be initiated informally for a limited amount of time to secure formal approval for additional phases or activities. The

driving forces that create the stimuli for a project are typically referred to as problems, opportunities, or business requirements. The effect of these pressures is that management generally must prioritise this request with respect to the needs and resource demands of other potential projects.

*The project life cycle definition will also identify which transitional actions at the end of the project are included or not included, in order to link the project to the ongoing operations of the performing organisation. Examples would be when a new product is released to manufacturing, or a new software program is turned over to marketing. Care should be taken to distinguish the project life cycle from the product life cycle. For example, a project undertaken to bring a new desktop computer to market is only one aspect of the product life cycle.*

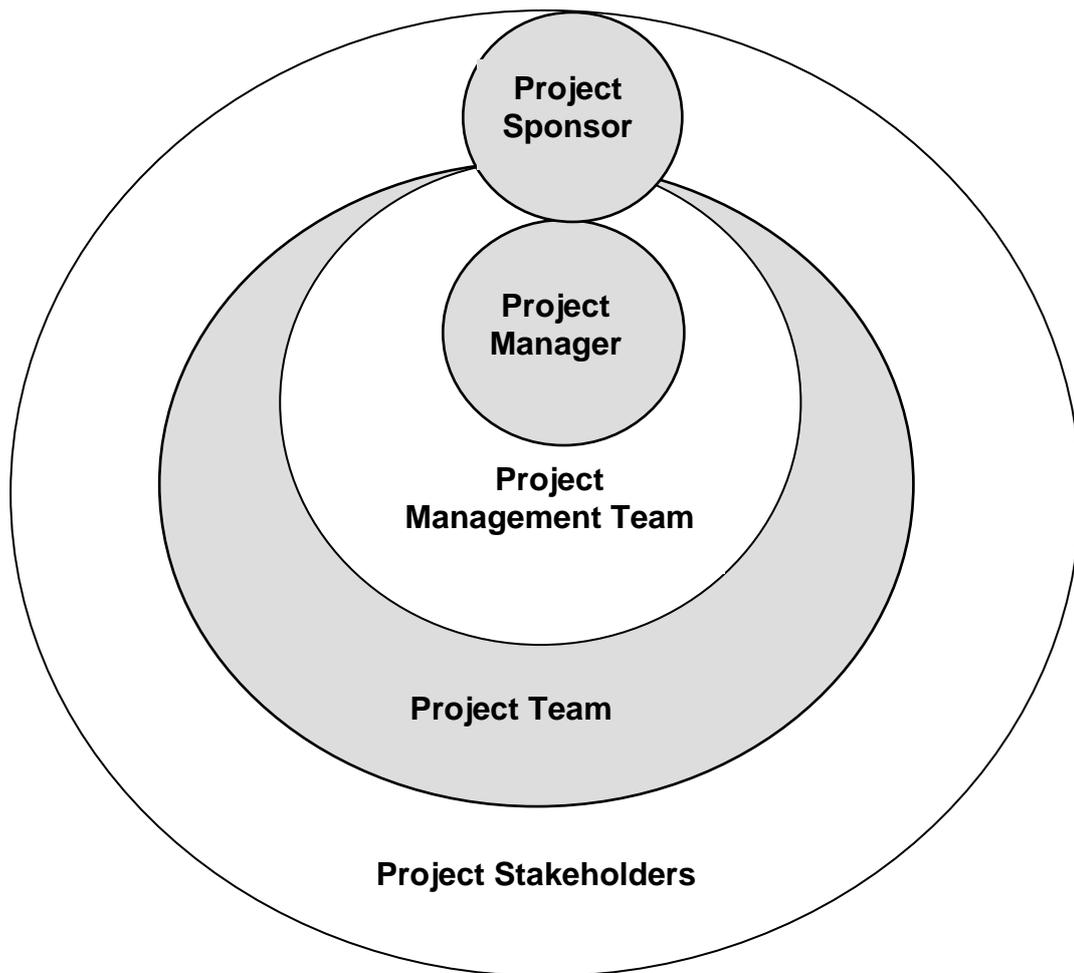
## **Project Stakeholders**

*Project stakeholders are individuals and organisations that are actively involved in the project, or whose interests may be affected as a result of project execution or project completion. They may also exert influence over the project's objectives and outcomes. The project management team must identify the stakeholders, determine their requirements and expectations, and, to the extent possible, manage their influence in relation to the requirements to ensure a successful project. Figure 2-4 illustrates the relationship between stakeholders and the project team.*

*Stakeholders have varying levels of responsibility and authority when participating on a project and these can change over the course of the project's life cycle. Their responsibility and authority range from occasional contributions in surveys and focus groups to full project sponsorship, which includes providing financial and political support.*

Stakeholders who ignore this responsibility can have a damaging impact on the project objectives. Likewise, project managers who ignore stakeholders can expect a damaging impact on project outcomes.

Sometimes, *stakeholder identification can be difficult*. For example, some would argue that an assembly-line worker whose future employment depends on the outcome of a new product-design project is a stakeholder.



**Figure 2.4 – The Relationship Between Stakeholders and the Project**

Source: PMBOK 3<sup>rd</sup> Ed

*Failure to identify a key stakeholder can cause major problems for a project.* For example, late recognition that the legal department was a significant stakeholder in a year 2000 rollover (Y2K) software upgrade project caused many additional documentation tasks to be added to the project's requirements.

*Stakeholders may have a positive or negative influence on a project.* Positive stakeholders are those who would normally benefit from a successful outcome from the project, while negative stakeholders are those who see negative outcomes from the project's success. For example, business leaders from a community that will benefit from an industrial expansion project may be positive stakeholders because they see economic benefit to the community from the project's success. Conversely, environmental groups could be negative stakeholders if they view the

project as doing harm to the environment.

In the case of positive stakeholders, their interests are best served by helping the project succeed, for example, helping the project obtain the needed permits to proceed. The negative stakeholders' interest would be better served by impeding the project's progress by demanding more extensive environmental reviews. *Negative stakeholders are often overlooked by the project team at the risk of failing to bring their projects to a successful end.* Key stakeholders on every project include:

- *Project manager.* The person responsible for managing the project.
- *Customer/user.* The person or organisation that will use the project's product. There may be multiple layers of customers. For example, the customers for a new pharmaceutical product can include the doctors who prescribe it, the patients who take it and the insurers who pay for it. In some application areas, customer and user are synonymous, while in others, customer refers to the entity acquiring the project's product and users are those who will directly utilise the project's product.
- *Performing organisation.* The enterprise whose employees are most directly involved in doing the work of the project.
- *Project team members.* The group that is performing the work of the project.
- *Project management team.* The members of the project team who are directly involved in project management activities.
- *Sponsor.* The person or group that provides the financial resources, in cash or in kind, for the project.
- *Influencers.* People or groups that are not directly related to the acquisition or use of the project's product, but due to an individual's position in the customer organisation or performing organisation, can influence, positively or negatively, the course of the project.
- *PMO.* If it exists in the performing organisation, the PMO can be a stakeholder if it has direct or indirect responsibility for the outcome

of the project. In addition to these key stakeholders, there are many different names and categories of project stakeholders, including internal and external, owners and investors, sellers and contractors, team members and their families, government agencies and media outlets, individual citizens, temporary or permanent lobbying organisations, and society-at-large. The naming or grouping of stakeholders is primarily an aid to identifying which individuals and organisations view themselves as stakeholders. Stakeholder roles and responsibilities can overlap, such as when an engineering firm provides financing for a plant that it is designing. *Project managers must manage stakeholder expectations, which can be difficult because stakeholders often have very different or conflicting objectives.*

## **Organisational Influences**

Projects are typically part of an organisation that is larger than the project. Examples of organisations include corporations, government agencies, healthcare institutions, international bodies, professional associations, and others. Even when the project is external (joint ventures, partnering), the project will still be influenced by the organisation or organisations that initiated it. The maturity of the organisation with respect to its project management system, culture, style, organisational structure and project management office can also influence the project. The following sections describe key aspects of these larger organisational structures that are likely to influence the project.

### **3.1 Organisational Systems**

*Project-based organisations are those whose operations consist primarily of projects.* These organisations fall into two categories:

- *Organisations that derive their revenue primarily from performing projects for others under contract - architectural firms, engineering firms, consultants, construction contractors, and government contractors.*
- *Organisations that have adopted management by projects. These organisations tend to have management systems in place to facilitate project management. For example, their financial systems are often specifically designed for accounting, tracking, and reporting on multiple, simultaneous projects.*

### **3.2 Organisational Cultures and Styles**

Most organisations have developed unique and describable cultures. These cultures are reflected in numerous factors, including, but not limited to:

- Shared values, norms, beliefs, and expectations
- Policies and procedures
- View of authority relationships
- Work ethic and work hours.

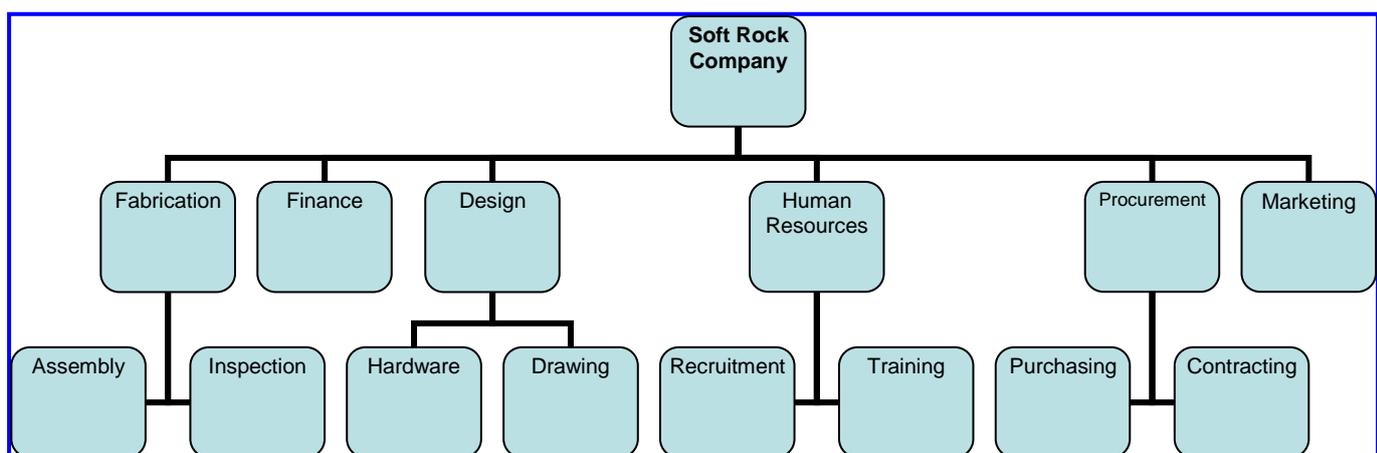
*Organisational cultures often have a direct influence on the project.* For example:

- A team proposing an unusual or high-risk approach is more likely to secure approval in an aggressive or entrepreneurial organisation
- A project manager with a *highly participative style* is apt to encounter problems in a *rigidly hierarchical organisation*, while a project manager with an authoritarian style will be equally challenged in a participative organisation.

### 3.3 Organisational Structures

Concepts of organisational structure apply to all kinds of organisations – companies, institutions, agencies, as well as to their sub units – divisions, departments, projects, teams and so on. There is no ‘best’ kind of organisation. The most appropriate structure depends on the organisation’s goals, type of work, and environment. Organisations create specialised roles and units, each with suitable expertise and resources needed to deal with certain classes of situations and problems efficiently. How an organisation is subdivided is referred to as the basis for differentiation. The six bases for differentiation are functional, geographical, product, customer, process, and project. The classic functional organisation, is a hierarchy where each employee has one clear superior. Staff members are grouped by specialty, such as production, marketing, engineering, and accounting at the top level. *Functional organisations still have projects, but the scope of the project is usually limited to the boundaries of the function.*

The figure 2.5 below is an example of a an organisational sturcture showing functional breakdown.



#### Drawbacks of Traditional Forms of Organisation

By their very design, traditional forms of organisation can address only certain anticipated, classifiable kinds of problems. As the

environment changes and new kinds of problems arise, they react by further differentiating subunits and adding more rules, procedures, and levels of management. Most traditional organisations work on the assumption that problems or tasks can be neatly classified and resolved within specialised areas. Thus, subunits in traditional forms tend to work independently and toward their own goals. One way to address unanticipated, unclassifiable problems is to redesign the organisation structure, which is very expensive and slow process.

The structure of the performing organisation can constrain the availability of resources in a spectrum from *functional* to *projectised*, with a variety of *matrix structures in between*. The table 2.1 below shows key project-related characteristics of the *major types of organisational structures*.

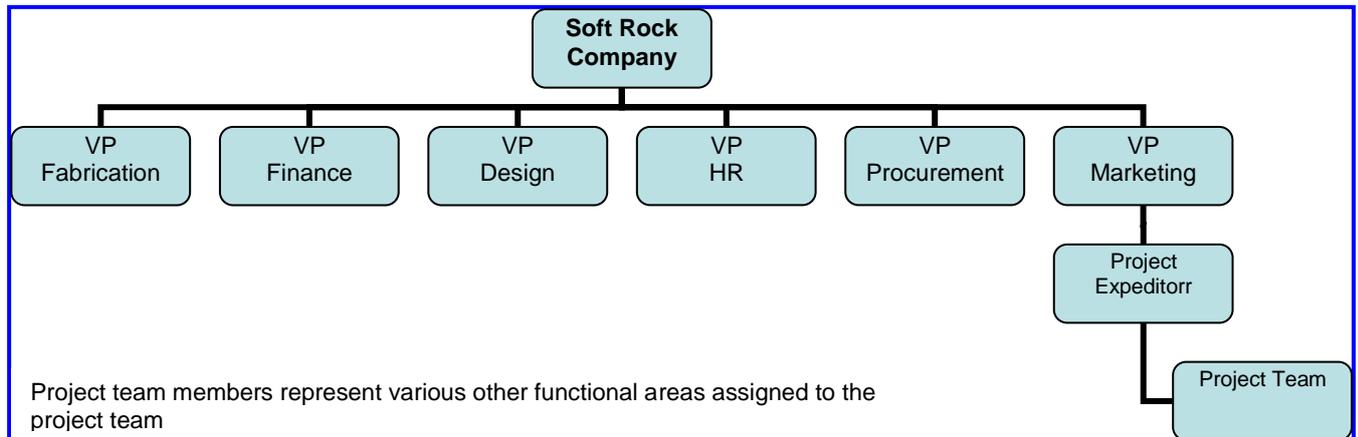
**Table 2.1 - Role of Organisational Structure Influences on Projects**

Org. Type Project Management	Functional	Matrix Organisations			Projectised
		Weak	Balanced	Strong	
Project Managers Authority	Little or None	Limited	Low to Moderate	Moderate to High	High to almost Total
Resource Availability	Little or None	Limited	Low to Moderate	Moderate to High	High to Almost Total
Who controls the project budget	Functional Manager	Functional Manager	Mixed	Project Manager	Project Manager
Project Managers Role	Part-time	Part-time	Full-time	Full-time	Full-time
Project Management Administrative Staff	Part-time	Part-time	Part-time	Full-time	Full-time
Project Staff	Part-time	Part-time	Part-time	Full-time	Full-time

**Projects within a functional area**

It makes sense that a project that affects or is the responsibility of only one functional area should be located in that area. For example, a project to survey customer attitudes about a new product would ordinarily be placed within the marketing department because the necessary resources and expertise are located there. The team does all the tasks itself – it prepares the survey questionnaire, obtains mailing lists, distributes the survey, and processes the results. With few exceptions, these can be done by members inside the marketing department. Project teams such as this are managed by a *project expeditor* – a staff member selected by the manager of the area wherein the project lies. *The figure*

2.6 below illustrates the single team, project expeditor type organisation:



### Pure Project Organisations

At the opposite end of the spectrum of a functional organisation is the project organisation. In a project organisation, team members are often co-located. A significant amount of the organisation's resources are involved in project work, and project managers have a great deal of independence and authority. Project organisations often have organisational units called departments, but these groups either report directly to the project manager or provide support services to the various projects. Projects that entail high-level complexity, major resource commitments, and heavy stakes in the outcome require a *pure project* form of organisation. A pure project is a separate organisation, similar to another company, especially created for and singularly devoted to achievement of the project goal. Whatever the project must have to afford it the highest priority – all necessary human and physical resources – is incorporated into the pure project organisation. These organisations are able to react quickly to changing demands of the environment, the user, and the parent organisation. They rely heavily on the use of liaisons, task forces, and teams. **The figure 2.7 below describes a pure project organisation:**

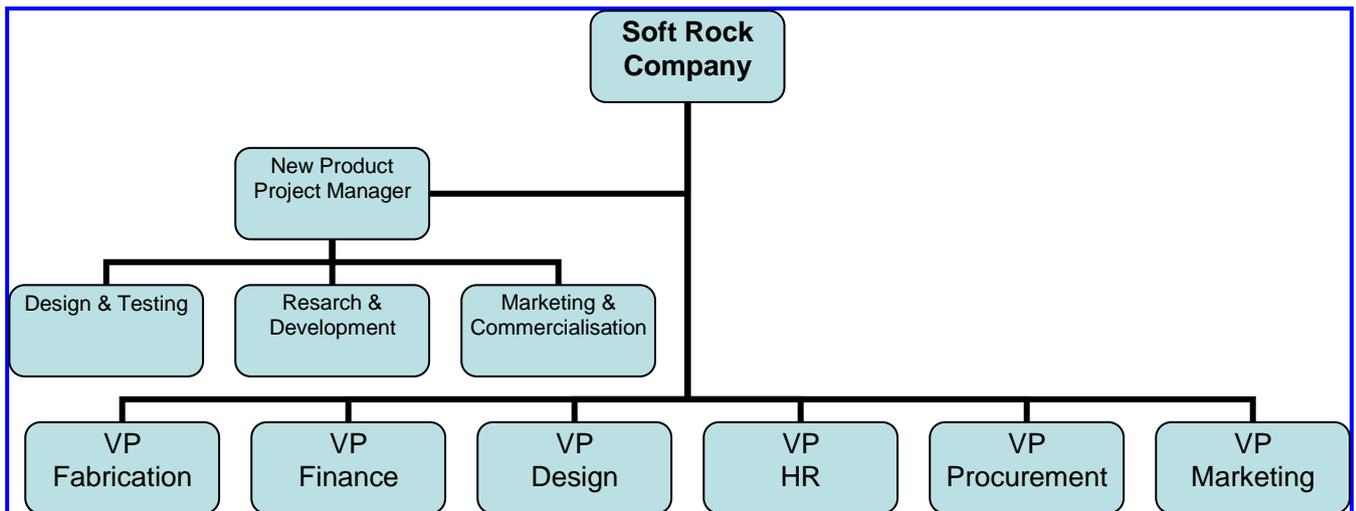


Figure 2.7 Pure project as an 'arm' to the functional organisation

### 3.4 The Role of the PMO in Organisational Structures

The term project office has dual meaning: it refers first to a support staff group which reports to, and supports, the project manager, and second to a physical place where the project team meets. Many organisations realise the benefit of developing and implementing a PMO. This is often true of those organisations employing a matrix organisational structure, and almost always true of those employing a projectised organisational structure, especially when the parent organisation is involved with the simultaneous management of multiple and/or sequential projects.

A PMO can exist in any of the organisational structures, including those with a functional organisation, with increasing likelihood of occurrence toward the rightmost columns in Table 2-1. A PMO's function in an organisation may range from an advisory influence, limited to the recommendation of specific policies and procedures on individual projects, to a formal grant of authority from executive management. In such cases, the PMO may, in turn, delegate its authority to the individual project manager.

The project manager will have administrative support from the PMO either through dedicated staff or through a shared staff member. The project team members will either be dedicated to the project or might include staff members who are shared with other projects and, in turn, are managed by the PMO. Project team members will report either directly to the project manager or, if shared, to the PMO. The project manager reports directly to the PMO. Additionally, the flexibility of the PMO's centralised management can offer the project manager a greater opportunity for advancement within the organisation.

### **3.5 Project Management System**

The project management system is the set of tools, techniques, methodologies, resources, and procedures used to manage a project. It can be formal or informal and aids a project manager in effectively guiding a project to completion. The system is a set of processes and the related control functions that are consolidated and combined into a functioning, unified whole.

The project management plan describes how the project management system will be used. The project management system content will vary depending upon the application area, organisational influence, complexity of the project, and availability of existing systems. The organisational influences shape the system for executing projects within that organisation. The system will adjust or adapt to accommodate any influence imposed by the organisation.

If a PMO exists in the performing organisation, one of the functions of the PMO would typically be to manage the project management system, in order to ensure consistency in application and continuity on the various projects being performed.

## Summary and Self Test

### TWO-MINUTE DRILL

#### Project Management Life Cycle and Organisations

- ❑ Projects within each organisation will follow the culture and expected practices of the organisation hosting the project. Projects, in any organisation, operate to support the organisation and its purpose.
- ❑ Projects move through phases to reach completion. Project life cycles complement the product life cycle.

#### Project Phases Create Projects

- ❑ Projects follow a logical sequence of phases to completion. Phases are typically different from project to project since the project work will differ from one to the next. The point of segmenting projects into phases is to allow for smaller, manageable sections, and to provide deliverables in support of the ongoing operations.
- ❑ The collection of the project phases, as a whole, is known as the project life cycle.
- ❑ Project life cycles define the beginning, middle, and end of a project. Projects have a greater risk and uncertainty in the early phases of the project life cycle than near their end. The project is also most susceptible to change, failure, and stakeholder influences at the beginning of the life cycle than near its end.
- ❑ In tandem, project costs and demand for resources are generally low at the beginning of the project, have a tendency to peak near the end of the project work, and then diminish.

#### Identifying Project Stakeholders

- ❑ Project stakeholders are individuals, businesses, or communities that have a vested interest in the project's outcome. Typically, project stakeholders are involved in the project process and their expectations drive the project requirements.
- ❑ It is essential to scan for hidden stakeholders early in the project life cycle to eliminate the need for change when addressing stakeholder needs later in the project.
- ❑ There are several key stakeholders that have direct influence over the project. They are
  - ❑ **Project manager** Manages the project
  - ❑ **Customer** Pays for the project; uses the project deliverable
  - ❑ **Performing organisation** The organisation hosting the project
  - ❑ **Project team** The collection of individuals completing the project work
  - ❑ **Project management team** The collection of individuals that

- contribute to the management of a project
- ❑ **Project Sponsor** Authorises the project work and budget
- ❑ **Influencers** People that can influence the project for better or worse
- ❑ **PMO** May have direct responsibility for the project's success

## Organisational Structures

- ❑ Organisational structures have direct influence over the project. Organisational structures determine the procedures that the project manager must follow and the amount of authority the project manager possesses. A project office may oversee project management activities and provide additional support in any of the organisational structures. The organisational types and the level of authority a project manager can expect are shown in the following table:

<b>Organisational Structure</b>	<b>Level of Power</b>
Functional	Low to none
Weak matrix	Low
Balanced matrix	Low to moderate
Strong matrix	Moderate to high
Projectised	High to complete
Composite	Varies

## **SELF TEST**

1. The project life cycle is comprised of which of the following?
  - A. Phases
  - B. Milestones
  - C. Estimates
  - D. Activities
  
2. Of the following management skills, which will a project manager use most?
  - A. Leading
  - B. Communication
  - C. Influencing the organisation
  - D. Negotiations
  
3. Managing a project is best described as which one of the following?
  - A. Establishing direction
  - B. Functional controls over the project team and stakeholders
  - C. Consistently producing key results expected by stakeholders
  - D. Motivating and inspiring the project team to produce results that are expected by project stakeholders

- 4.** Which of the following is an example of negotiation?
- A. Arbitration
  - B. Formal communications
  - C. Conferring
  - D. Scope creep
- 5.** You are the project manager for your organisation. Influencing your organisation requires which of the following?
- A. An understanding of the organisational budget
  - B. Research and documentation of proven business cases
  - C. An understanding of formal and informal organisational structures
  - D. Positional power
- 7.** All of the following are examples of stakeholders that have a positive influence on a project except for which one?
- A. Business leaders in a community affected by a commercial development project
  - B. Team members that will receive a bonus if the project is successful
  - C. Employees that prefer the older version of the software that a project is replacing
  - D. Functional managers that want your project to complete so their employees can move onto other projects
- 8.** Which of the following is an example of a deliverable at the end of the design phase in a software design project?
- A. Responsibility matrix creation
  - B. Detail design document
  - C. Business needs
  - D. Project team assembled
- 9.** You are the project manager for the ERP Project. Your organisation uses a PMO. The primary purpose of a project office is to:
- A. Support the project managers
  - B. Support the project sponsor
  - C. Support the project team
  - D. Identify the stakeholders
- 10.** Which of the following best describes a project deliverable?
- A. The resources used by the project to complete the necessary work
  - B. The resources exported from the project as a result of the project work
  - C. The end result of a project planning session
  - D. The tangible good or service created by the project team
- 11.** Of the following, which is not an exit criterion?
- A. Customer sign-offs

- B. Quality metrics
  - C. Stakeholder analysis
  - D. Regulatory inspections
- 12.** The compilation of all the phases within a project equates to:
- A. The project life cycle
  - B. The product life cycle
  - C. Project completion
  - D. Project processes
- 13.** Management has asked Nancy to determine if a project concept is valid and can be completed using a reasonable amount of time and finances. Management is asking for which of the following?
- A. Kill points
  - B. Cost and time estimates
  - C. A project case study
  - D. A feasibility study
- 14.** Henry, the project manager of the MHB Project, has allowed a subsequent project phase to begin before the predecessor phase is complete. This is an example of which of the following?
- A. Crashing
  - B. Fast tracking
  - C. Risk management
  - D. Tandem scheduling
- 15.** Which of the following describes the early stages of a project?
- A. High costs and high demand for resources
  - B. A high demand for change
  - C. A high demand for project team time
  - D. Low costs and low demand for resources
- 16.** At which point is the risk of failure the least, but the consequence of failure the highest?
- A. During the early stages
  - B. During the middle stages
  - C. During the final stages
  - D. Risk of failure is even across all project phases
- 17.** Tracey is the project manager of the KHG Project. Her organisation is a classic functional environment. Her level of authority as a project manager can be best described as which of the following?
- A. Low
  - B. Moderate
  - C. Balanced
  - D. High

- 18.** Project team members are most likely to work full-time on a project in which of the following organisational structures?
- A. Functional
  - B. Weak matrix
  - C. Strong matrix
  - D. Projectised

## **B. The Standard for Project Management of a Project**

### **3 Project Management Processes**

Project management is the application of knowledge, skills, tools, and techniques to project activities to meet project requirements. Project management is accomplished through processes, using project management knowledge, skills, tools, and techniques that receive inputs and generate outputs. In order for a project to be successful, the project team must:

- Select appropriate processes within the Project Management Process Groups that are required to meet the project objectives
- Use a defined approach to adapt the product specifications and plans to meet project and product requirements
- Involve stakeholder to improve the probability of satisfying customer requirements and in order to manage stakeholder expectations, which is one of the biggest challenges for any project
- Balance the competing demands of scope, time, cost, quality, resources, and risk to produce a quality product.

This standard documents information is needed to initiate, plan, execute, monitor and control, and close a single project, and identifies those project management processes that have been recognised as good practice on most projects most of the time.

This does not mean that the knowledge, skills and processes described should always be applied uniformly on all projects. The project manager, in collaboration with the project team, is always responsible for determining what processes are appropriate, and the appropriate degree of rigour for each process, for any given project.

In fact, project managers and their teams are advised to carefully

consider addressing each process and its constituent inputs and outputs. Project managers and their teams should use this chapter as a high-level guide for those processes that they must consider in managing their project. This effort is known as tailoring.

A process is a set of interrelated actions and activities that are performed to achieve a pre-specified set of products, results, or services. The project management processes are performed by the project team, and generally fall into one of two major categories:

- The project management processes common to most projects most of the time are associated with each other by their performance for an integrated purpose. The purpose is to initiate, plan, execute, monitor and control, and close a project. These processes interact with each other in complex ways that cannot be completely explained in a document or with graphics.
- Product-oriented processes specify and create the project's product. Product oriented processes are typically defined by the project life cycle and are unique to the project. Project management processes and product-oriented processes overlap and interact throughout the project. For example, the scope of the project cannot be defined in the absence of some basic understanding of how to create the specified product.

Project management is an integrative undertaking. Project management integration requires each project and product process to be appropriately aligned and connected with the other processes to facilitate their coordination. These process interactions often require tradeoffs among project requirements and objectives. Failure to take action during one process will usually affect that process and other related processes. For example, a scope change will almost always affect project cost, but the scope change may or may not affect team morale or product quality. The specific performance tradeoffs will vary from project to project and

organisation to organisation. Successful project management includes actively managing these interactions to successfully meet sponsor, customer and other stakeholder requirements.

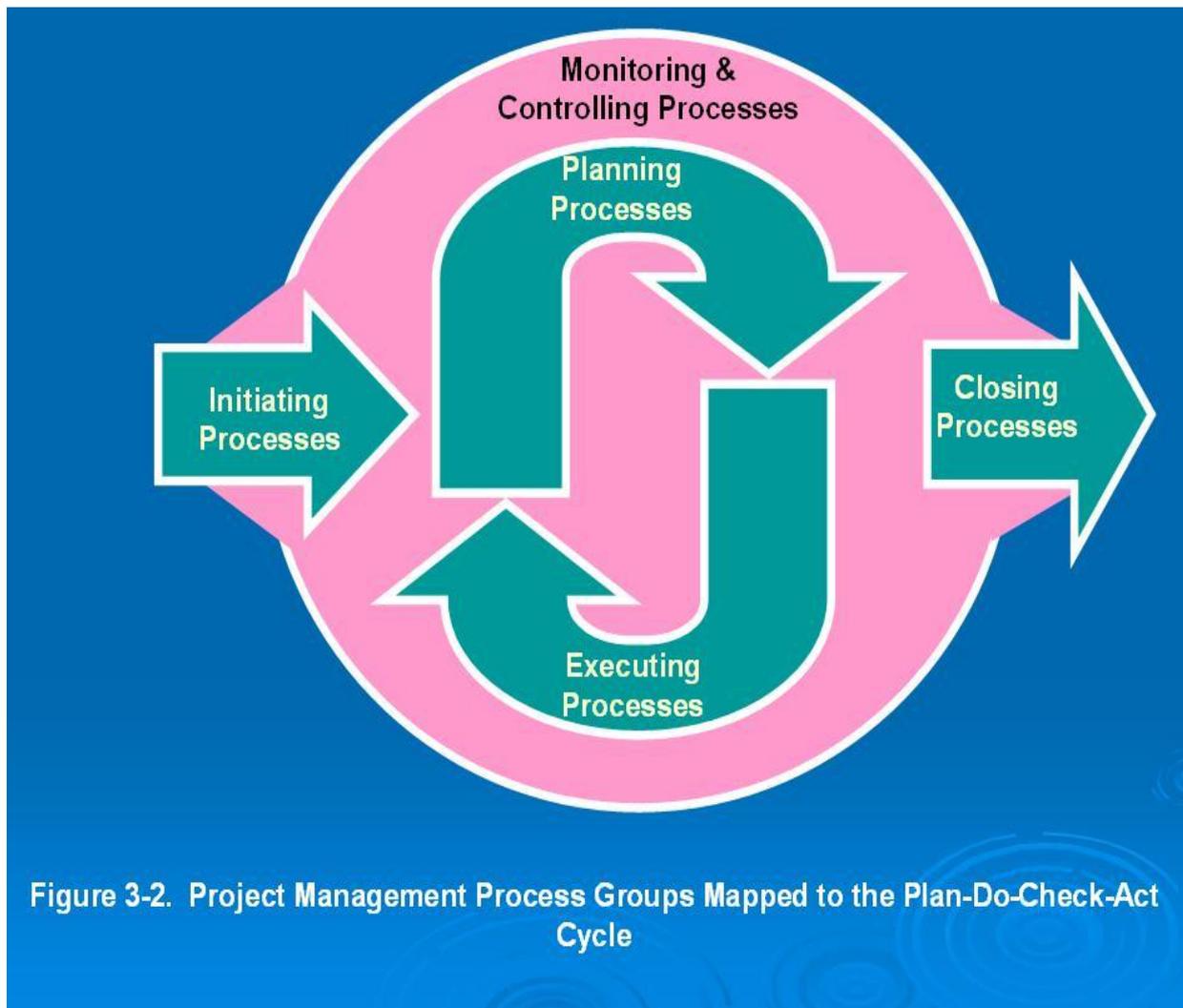
### **Project Management Processes**

The project management processes are presented as discrete elements with well-defined interfaces. However, in practice they overlap and interact in ways that are not completely detailed here. Most experienced project management practitioners recognise there is more than one way to manage a project.

In addition, the application of the project management processes to a project is iterative and many processes are repeated and revised during the project. The project manager and the project team are responsible for determining what processes from the Process Groups will be employed, by whom, and the degree of rigour that will be applied to the execution of those processes to achieve the desired project objective.

The integrative nature of the Process Groups is more complex than the basic plan-do-check-act cycle (see Figure 3-2). However, the enhanced cycle can be applied to the interrelationships within and among the Process Groups. The Planning Process Group corresponds to the "plan" component of the plan-do-check-act cycle. The Executing Process Group corresponds to the "do" component and the Monitoring and Controlling Process Group corresponds to the "check and act" components.

In addition, since management of a project is a finite effort, the Initiating Process Group starts these cycles and the Closing Process Group ends them. The integrative nature of project management requires the Monitoring and Controlling Process Group interaction with every aspect of the other Process Groups.



Source: PMBOK Guide 3<sup>d</sup> Ed.

### Project management Process Groups

A Process Group includes the constituent project management processes that are linked by the respective inputs and outputs, that is, the result or outcome of one process becomes the input to another. The Monitoring and Controlling Process Group, for example, not only monitors and controls the work being done during a Process Group, but also monitors and controls the entire project effort.

*The Monitoring and Controlling Process Group must also provide feedback to implement corrective or preventive actions to bring the project into compliance with the project management plan or to appropriately modify the project management plan. The Process Groups are not project*

*phases*. Where large or complex projects may be separated into distinct phases or sub-projects such as feasibility study, concept development, design, prototype, build, test, etc. all of the Process Group processes would normally be repeated for each phase or subproject.

**The five Process Groups are:**

- **Initiating Process Group.** Defines and authorises the project or a project phase.
- **Planning Process Group.** Defines and refines objectives, and plans the course of action required to attain the objectives and scope that the project was undertaken to address.
- **Executing Process Group.** Integrates people and other resources to carry out the project management plan for the project.
- **Monitoring and Controlling Process Group.** Regularly measures and monitors progress to identify variances from the project management plan so that corrective action can be taken when necessary to meet project objectives.
- **Closing Process Group.** Formalises acceptance of the product, service or result and brings the project or a project phase to an orderly end.

***Initiating Process Group***

The Initiating Process Group consists of the processes that facilitate the formal authorisation to start a new project or a project phase. Initiating processes are often done external to the project's scope of control by the organisation or by the program or portfolio process, which may blur the project boundaries for the initial project inputs. For example, before beginning the Initiation Process group activities, the organisations business needs or requirements are documented. The feasibility of the new undertaking may be established through a process of evaluating alternatives to pick the best one. Clear descriptions of the project objectives are developed, including the reasons why a specific project is

the best alternative solution to satisfy the requirements. The initial scope description and the resources that the organisation is willing to invest are further refined during the initiation process. *The Initiating Process Group includes the following project Management processes:*

1. Develop Project Charter
2. Develop Preliminary Project Scope Statement

The initiation process group is important as projects typically fail at the beginning, not the end, due to poor planning in the initial stages.

### ***Planning Process Group***

The project management team uses the Planning Process Group and its constituent processes and interactions to plan and manage a successful project for the organisation. It's recommended to include the stakeholders in planning to increase the commitment to the project through shared ownership. The Planning Process Group helps gather information from many sources with each having varying levels of completeness and confidence. The planning processes develop the project plan. These processes also identify, define and mature the project scope, project cost, and schedule the project activities that occur within the project. As new project information is discovered, additional dependencies, requirements, risks, opportunities, assumptions, and constraints will be identified and resolved. The Planning Process Group facilitates project planning across multiple processes. The following list identifies the processes the project team should address during the planning process to decide if they need to be done, and if so, by whom. Planning represents an ongoing effort throughout the project, which is called progressive elaboration. Rolling wave planning is an ongoing process of planning where the work to be accomplished in the near term is planned in detail, while the work far in the future is planned at a high level.

*The Planning Process Group includes the following project management processes:*

1. Develop Project Management Plan

2. Scope Planning
3. Scope Definition
4. Create WBS
5. Activity Definition
6. Activity Sequencing
7. Activity Resource Estimating
8. Activity Duration Estimating
9. Schedule Development
10. Cost Estimating
11. Cost Budgeting
12. Quality Planning
13. Human Resource Planning
14. Communications Planning
15. Risk Management Planning
16. Risk Identification
17. Qualitative Risk Analysis
18. Quantitative Risk Analysis
19. Risk Response Planning
20. Plan Purchases and Acquisitions
21. Plan Contracting

### ***Executing Process Group***

The Executing Process Group consists of the *processes used to complete the work defined in the project management plan to accomplish the project's requirements. The project team should determine which of the processes are required for the team's specific project.* This Process Group involves coordinating people and resources, as well as integrating and performing the activities of the project in *accordance with the project management plan.*

*Normal execution variances will cause some replanning. These variances can include activity durations, resource productivity and*

*availability and unanticipated risks. Such variances may or may not affect the project management plan, but can require an analysis. The results of the analysis can trigger a change request that, if approved, would modify the project management plan and possibly require establishing a new baseline. The vast majority of the project's budget will be expended in performing the Executing Process Group processes. The Executing Process Group includes the following project management processes:*

1. Direct and Manage Project Execution
2. Perform Quality Assurance
3. Acquire Project Team
4. Develop Project Team
5. Information Distribution
6. Request Seller Responses
7. Select Sellers

### ***Monitoring and Controlling Process Group***

*The Monitoring and Controlling Process Group consists of those processes performed to observe project execution so that potential problems can be identified in a timely manner and corrective action can be taken, when necessary, to control the execution of the project. The project team should determine which of the processes are required for the team's specific project. The key benefit of this Process Group is that project performance is observed and measured regularly to identify variances from the project management plan. The Monitoring and Controlling Process Group also includes controlling changes and recommending preventive action in anticipation of possible problems. The Monitoring and Controlling Processes Group includes, for example:*

1. Monitoring the ongoing project activities *against the project management plan* and the project performance baseline
2. Influencing the factors that could circumvent integrated change control so only approved changes are implemented.

This continuous monitoring provides the project team insight into the health of the project and highlights any areas that require additional attention. *The Monitoring and Controlling Process Group includes the following project management processes:*

1. Monitor and Control Project Work
2. Integrated Change Control
3. Scope Verification
4. Scope Control
5. Schedule Control
6. Cost Control
7. Perform Quality Control
8. Manage Project Team
9. Performance Reporting
10. Manage Stakeholders
11. Risk Monitoring and Control
12. Contract Administration

### **Closing Process Group**

*The Closing Process Group includes the processes used to formally terminate all activities of a project or a project phase, hand off the completed product to others or close a cancelled project. This Process Group, when completed, verifies that the defined processes are completed within all the Process Groups to close the project or a project phase, as appropriate, and formally establishes that the project or project phase is finished. The Closing Process Group includes the following project management processes:*

1. Close Project
2. Contract Closure

### **Process Interactions**

*Project Management Process Groups are linked by the objectives they*

produce. The output of one process generally becomes an input to another process or is a deliverable of the project. The Planning Process Group provides the Executing Process Group a documented *project management plan* and *project scope statement*, and often updates the *project management plan* as the project progresses. Figure 3-11 illustrates how the Process Groups interact and the level of overlap at varying times within a project. *If the project is divided into phases, the Process Groups interact within a project phase and also may cross the project phases.*

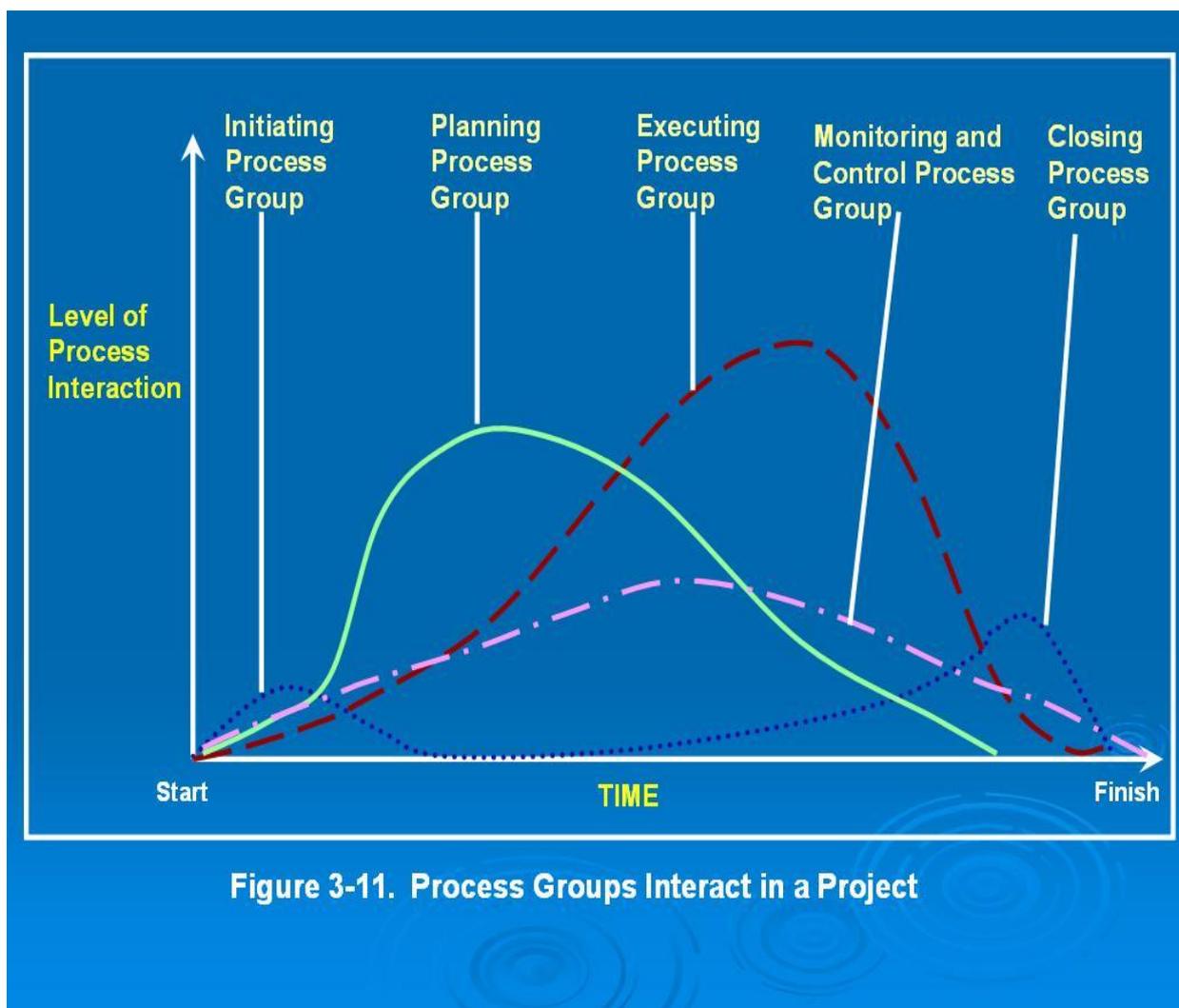


Figure 3-11 How Process Groups Interact in a Project Source: *PMBOK Guide 3<sup>rd</sup> Ed*

Among the Process Groups and their processes, the process outputs are related and have an impact on the other Process Groups. For example, closing a design phase requires customer acceptance of the design

document. Then, the design document defines the product description for the ensuing Executing Process Group. When a project is divided into phases, the Process Groups are normally repeated within each phase throughout the project's life to effectively drive the project to completion. The Process Groups and their relationships are illustrated in Figure 3-12.

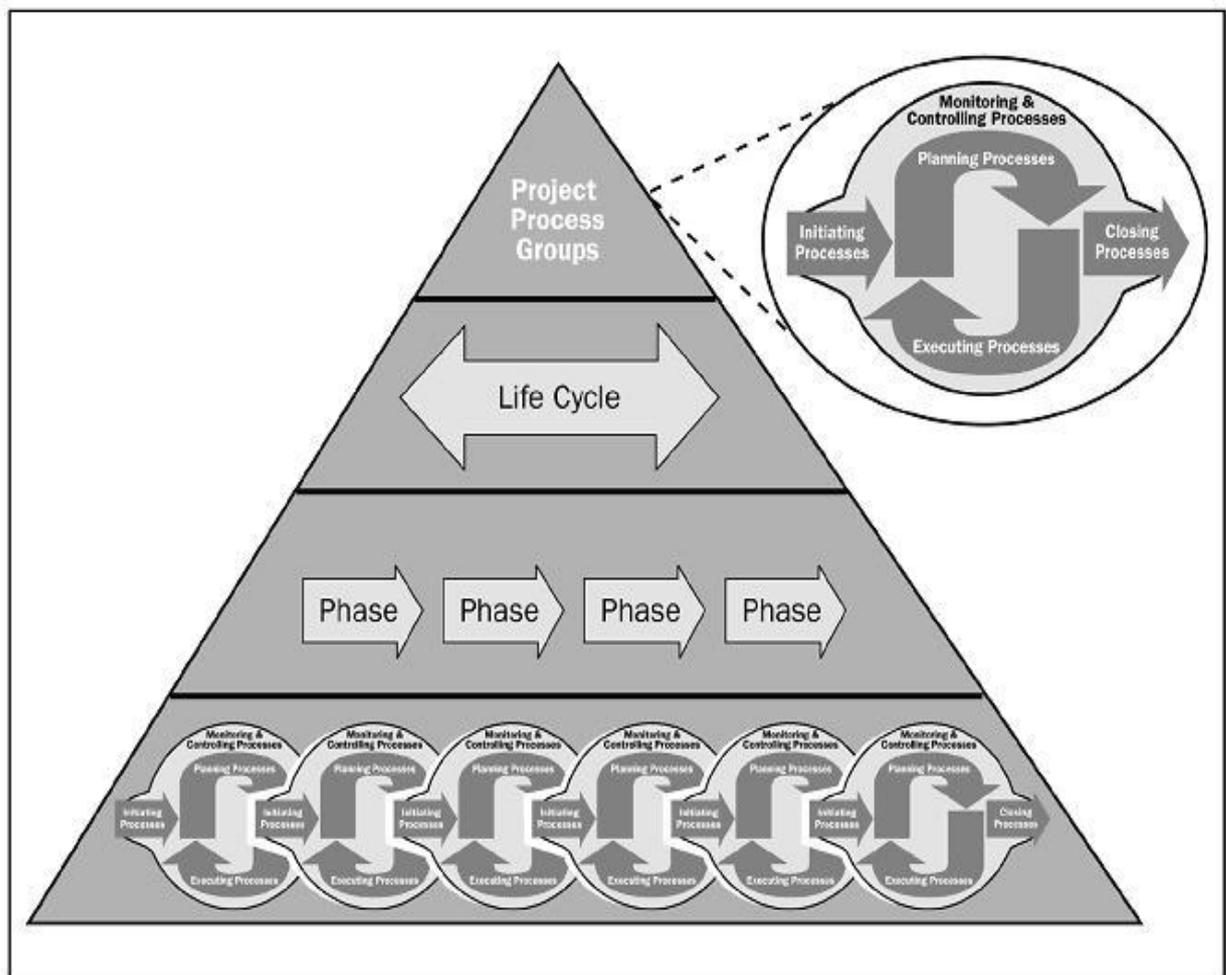


Figure 3-12. Project Management Process Group Triangle

Source: PMBOK Guide 3<sup>d</sup> Ed

However, just as not all of the processes will be needed on all projects, not all of the interactions will apply to all projects or project phases

### Project Management Process Mapping

Table 3-45 reflects the mapping of the 44 project management processes into the 5 PM Process Groups and the 9 PM Knowledge Areas.

Each of the required project management processes is shown in the Process Group in which most of the activity takes place. For instance, when a process that normally takes place during planning is revisited or updated during execution, it is still the same process that was performed in the planning process, not an additional, new process.

Knowledge Areas	Process Groups				
	Initiation	Planning	Execution	Monitoring & Controlling	Closing
<b>Integration</b>	Develop Project Charter Develop Preliminary Project Scope Statement	Develop Project Management Plan	Direct and Manage Project Execution	Monitor and Control Project Work Integrated Change Control	Close Project
<b>Scope</b>		Scope Planning Scope Definition Create WBS		Scope Verification Scope Control	
<b>Time</b>		Activity Definition Activity Sequencing Activity Resource Estimating Activity Duration Estimating Schedule Development		Schedule Control	
<b>Cost</b>		Cost Estimating Cost Budgeting		Cost Control	
<b>Quality</b>		Quality Planning	Perform Quality Assurance	Perform Quality Control	
<b>Human Resource</b>		Human Resource Planning	Acquire Project Team Develop Project Team	Manage Project Team	
<b>Communications</b>		Communications Planning	Information Distribution	Performance Reporting Manage Stakeholders	
<b>Risk</b>		Risk Management Planning Risk Identification Qualitative Risk Analysis Quantitative Risk Analysis Risk Response Planning		Risk Monitoring and Control	
<b>Procurement</b>		Plan Purchase and Acquisitions Plan Contracting	Request Seller Responses Select Sellers	Contract Administration	Contract Closure

**Table 3-45. Mapping of the Project Management Processes to the Project Management Process Groups and the Knowledge Areas – Source: *PMBOK Guide 3<sup>rd</sup> Ed.***

## Summary and Self Test

### TWO-MINUTE DRILL

#### Project Management Processes

- ❑ Projects are comprised of processes. People, not things, complete processes; processes move the project or phase to completion.
- ❑ The five process groups
  - ❑ initiating
  - ❑ planning
  - ❑ executing
  - ❑ monitoring and controlling
  - ❑ closing
 comprise projects and project phases. These five process groups have sets of actions that move the project forward towards completion.
- ❑ Just because a process was not completed does not mean it was not needed. A project manager, however, doesn't always have to complete every process within each process group—just those processes that are needed for the project to be successful.

#### Determining the Need for Projects

- ❑ Projects are created to provide a solution for a problem or to take advantage of an opportunity. They can be created to reduce costs, reduce waste, increase revenue, increase productivity and efficiency, or produce other results. The project manager should know why the project is created in order to aim towards the project purpose.
- ❑ Some projects require a feasibility study to prove that the problem exists or to conduct root cause analysis to find the root of a given problem. Feasibility studies also determine the possibility of the project to solve the identified problem for a reasonable cost and within a reasonable amount of time.
- ❑ The product description describes the expected outcome of the project. The product description should define what the project is creating. If the project is solving a problem, the product description should describe how the organisation will perform without the problem in existence. If the project is seizing a market opportunity, it should describe the organisation once the opportunity is seized. Basically, product descriptions describe life after a successful project.

#### The Project Management Framework

- ❑ The three components of processes—inputs, tools and techniques, and outputs—spawn decisions, conditions, plans, and reactions to conditions

and progress. The output of one process serves as the input to another. Within each process, the tools and techniques—such as expert judgment—guide and influence the output of a process. A faulty output will likely influence downstream processes negatively.

- ❑ Project processes can be customised to meet the needs and demands of the project. Some processes may be moved to better meet the conditions and requirements of a given project. In some instances, a process may be removed from a project. Use caution, however: a process that is not completed does not necessarily mean it wasn't needed.
- ❑ The nine knowledge areas are comprised of the project management processes we've discussed in detail in this section. The process groups discussed in this chapter map to the following nine knowledge areas:
  1. Project integration management
  2. Project scope management
  3. Project time management
  4. Project cost management
  5. Project quality management
  6. Project human resource management
  7. Project communications management
  8. Project risk management
  9. Project procurement management

## **SELF TEST**

1. What is a project process?
  - A. The creation of a product or service
  - B. The progressive elaboration resulting in a product
  - C. A series of actions that bring about a result
  - D. A series of actions that allow the project to move from concept to deliverable
  
2. Within a project, there are two distinct types of processes. Which of the following processes is unique to the project?
  - A. Earned Value Management (EVM) processes
  - B. Project management planning
  - C. IPECC
  - D. A product-oriented process
  
3. There are five project management processes that allow projects to move from start to completion. Which one of the following is not one of the project management process groups?
  - A. Initiating
  - B. Planning
  - C. Communicating
  - D. Closing

- 4.** Of the following, which is the logical order of the project management processes?
- A. Initiating, planning, monitoring and controlling, executing
  - B. Planning, initiating, monitoring and controlling, executing, closing
  - C. Initiating, planning, executing, monitoring and controlling, closing
  - D. Planning, initiating, executing, closing
- 5.** Which of the project management processes is progressively elaborated?
- A. Planning
  - B. Communicating
  - C. Contract administration
  - D. Closing
- 6.** The ongoing process of project planning is also known as:
- A. Constant integration planning
  - B. Rolling wave planning
  - C. Continuous planning
  - D. Phase gates
- 7.** You are the project manager for the AQA Project. You would like to include several of the customers in the project planning sessions, but your project leader would like to know why the stakeholders should be involved since your project team will be determining the best method to reach the project objectives. You explain to the project leader that the stakeholders should be included because:
- A. It generates goodwill between the project team and the stakeholders
  - B. It allows the stakeholders to see the project manager as the authority of the project
  - C. It allows the project team to meet the stakeholders and express their concerns regarding project constraints
  - D. It allows the stakeholders to realise the shared ownership of the project
- 8.** You have requested that several of the stakeholders participate in the different phases of the project. Why is this important?
- A. It prevents scope creep
  - B. It allows for scope constraints
  - C. It improves the probability of satisfying the stakeholder requirements
  - D. It allows for effective communications

- 9.** The information from the planning phase is input into which of the following processes?
- A. Initiating
  - B. Monitoring and controlling
  - C. Executing
  - D. Closing
- 10.** The information from the initiating phase is input into which of the following processes?
- A. Planning
  - B. Executing
  - C. Controlling
  - D. All of the project phases
- 11.** Which Process Group represents an ongoing effort throughout the project?
- A. Lessons learned
  - B. Planning
  - C. Closing
  - D. Earned Value Management (EVM)
- 12.** Which of the following planning processes happen in the correct order?
- A. Activity definition, scope planning, activity duration estimating, cost budgeting
  - B. Scope planning, resource planning, activity duration estimating, activity sequencing
  - C. Scope definition, scope planning, activity definition, activity sequencing
  - D. Scope planning, scope definition, activity definition, activity sequencing
- 13.** Which of the following processes happens in the closing process?
- A. Activity definition
  - B. Cost budgeting
  - C. Quality planning
  - D. Contract closeout
- 14.** Which of the following planning processes is concerned with reporting relationships?
- A. Organisational planning
  - B. Human resource planning
  - C. Scope planning
  - D. Activity definition

- 15.** Of the following, which process is most concerned with mitigation (reducing the likelihood and impact of a negative event)??
- A. Quality planning
  - B. Risk response planning
  - C. Procurement planning
  - D. Risk identification
- 16.** You are the project manager for the FTG Project. This project will affect several lines of business, and controversy on the project deliverables already abounds. You have 45 key stakeholders on this project representing internal customers from all areas of your organisation. With this many stakeholders, what challenge will be the most difficult for the project's success?
- A. Communication
  - B. Managing stakeholder expectations
  - C. Managing scope creep
  - D. Coordinating communications between the project manager, project team, and the project stakeholders
- 17.** Which of the following is representative of a project constraint?
- A. A project that must be finished by year's end
  - B. That 45 stakeholders exist on a long-term project
  - C. The requirement to complete Earned Value Management (EVM)
  - D. The requirement to produce a new product
- 18.** You are a project manager of a large construction project. There are many different stakeholders involved in the project and each has their own opinion as to what the project should create. To maintain communication, set objectives, and document all decisions, you can say that larger projects generally require:
- A. A larger budget
  - B. More detail
  - C. Phase gate estimating
  - D. A large project team
- 19.** In order to create a network diagram, the project manager needs which of the following?
- A. Activity sequencing
  - B. Project sponsor approval of the WBS
  - C. The WBS dictionary
  - D. A cost baseline
- 20.** Which of the following is considered an output of the cost budgeting process?
- A. Cost estimating
  - B. Resource requirements
  - C. The risk management plan
  - D. The cost baseline

- 21.** Which of the following is considered an output of risk management planning?
- A. Activity lists
  - B. WBS
  - C. The risk management plan
  - D. The scope management plan
- 22.** Which of the following is not an input to schedule development?
- A. The cost baseline
  - B. Resource requirements
  - C. The risk management plan
  - D. The network diagram
- 23.** Frances is the project manager of the JHG Project. This project is very similar to a recent project she completed for another customer. Which planning process will Frances need to finish first to ensure the project is completed successfully?
- A. Contract planning
  - B. Scope definition
  - C. Activity sequencing
  - D. Quality planning
- 24.** You are the project manager for the BKL Project. This type of project has never been attempted before by your organisation. The stakeholders already have high requirements for the project deliverables and you need to create a change control system. This system should be controlled by which of the following?
- A. A formal change control form
  - B. It should be completed by the team
  - C. The Change Control Board
  - D. It is specific to the organisational structure
- 25.** Complete this statement: Projects fail \_\_\_\_\_.
- A. At the beginning, not at the end
  - B. During initiating, not closing
  - C. Because of inadequate project managers
  - D. Because of the project manager

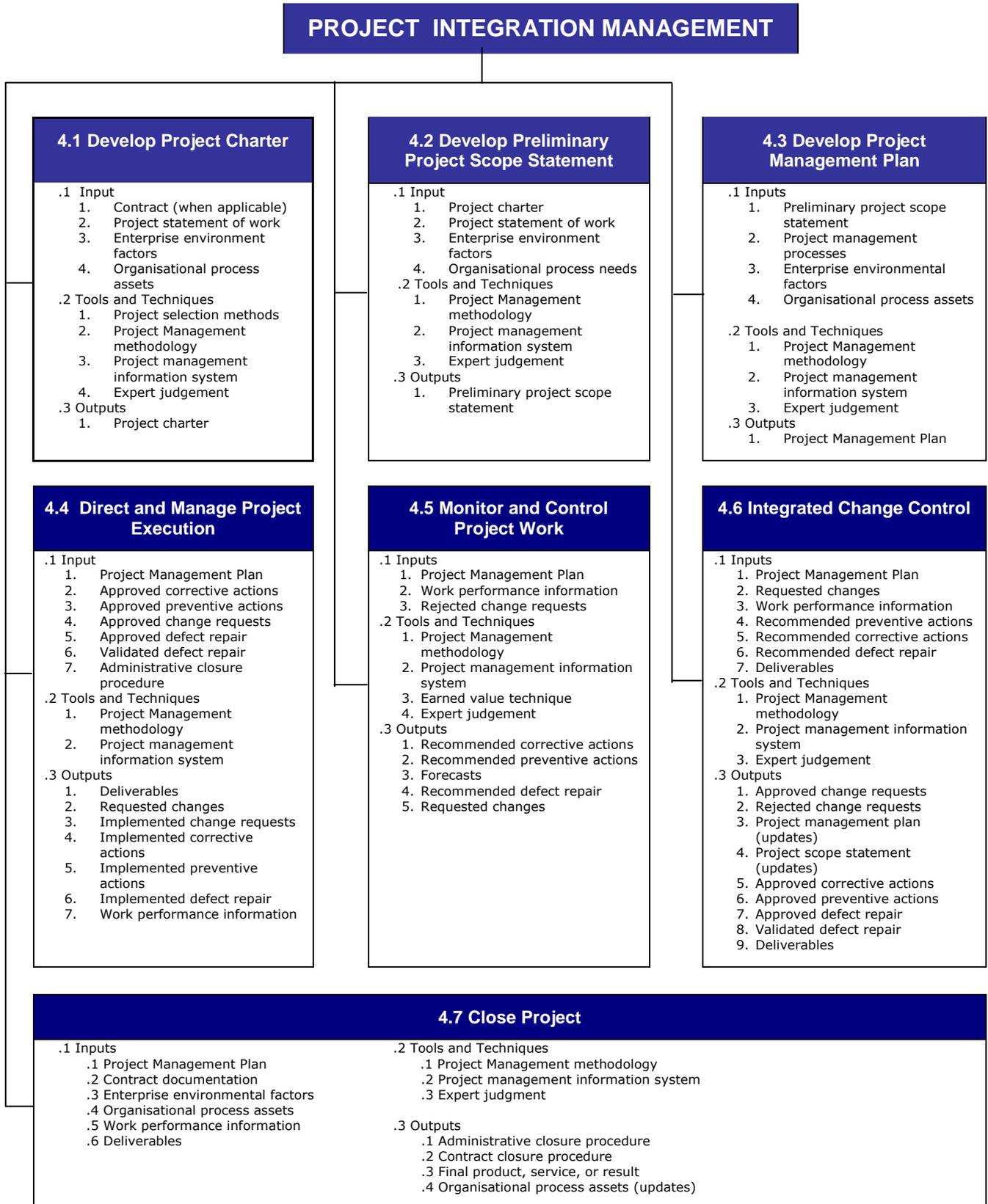
## **C. Project Management Knowledge Areas**

### **4 Project Integration Management**

#### **Introduction**

Project Integration Management knowledge area is concerned with coordinating all aspects of the project plan and is highly interactive. This knowledge area involves identifying and defining the work of the project and combining, unifying, and integrating the appropriate processes. This knowledge area also takes into account satisfactorily meeting the requirements of the customer and stakeholders and managing their experiences.

Integration is primarily concerned with effectively integrating the processes among the Project Management Process groups. Project planning, project execution, monitoring project work, and change control occur throughout the project and are repeated continuously while working on the project. The integrative project management processes, include the following as described in figure 4-1:

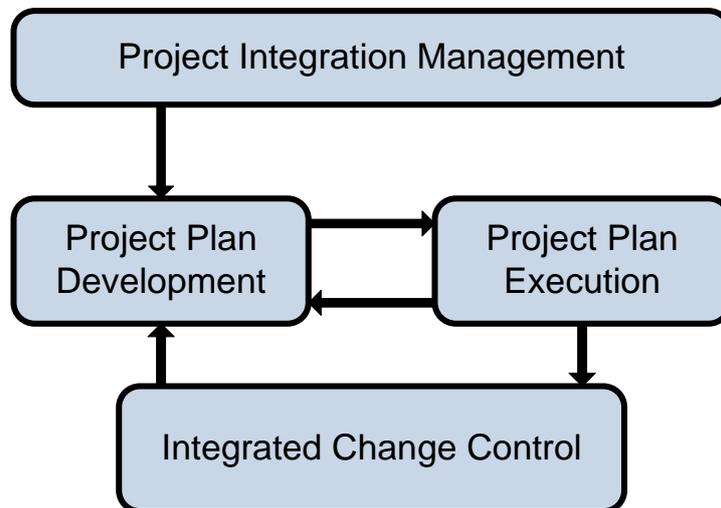


**Figure 4-1. Project Integration Management Process Overview**

- Developing the Project Charter – developing the project charter that formally authorises a project or a project phase.

- Developing the preliminary project scope statement - developing the preliminary project scope statement that provides a high-level scope narrative.
- Developing the project plan – documenting the actions necessary to define, prepare, integrate, and coordinated all subsidiary plans into a project management plan.
- Directing and managing the project execution – executing the work defined in the project management plan to achieve the project’s requirements defined in the project scope statement.
- Monitoring and controlling the project – monitoring and controlling the processes used to initiate, plan, execute, and close a project to meet the performance objectives defined in the project management plan.
- Managing integrated change control – reviewing all change requests, approving changes, and controlling changes to the deliverables and organisational process assets.
- Closing the project – finalising all activities across all of the project management process groups to formally close the project or a project phase.

Project integration uses plan development, plan execution, and integrated change control as described in figure 4-2.



**Figure 4-2. Project integration model**

## 4.1 Develop Project Charter

The project charter is the document that formally authorises a project. The project charter provides the project manager with the authority to apply organisational resources to project activities. A project manager is identified and assigned as early in the project as is feasible. The project manager should always be assigned prior to the start of planning, and preferably while the project charter is being developed.

A project initiator or sponsor external to the project organisation, at a level that is appropriate to funding the project, issues the project charter. Projects are usually chartered and authorised external to the project organisation by an enterprise, a government agency, a company, a program organisation, or a portfolio organisation, as a result of one or more of the following:

- A market demand (e.g., a car company authorising a project to build more fuel-efficient cars in response to gasoline shortages)
- A business need (e.g., a training company authorising a project to create a new course to increase its revenues)
- A customer request (e.g., an electric utility authorising a project to build a new substation to serve a new industrial park)
- A technological advance (e.g., an electronics firm authorising a new project to develop a faster, cheaper, and smaller laptop after advances in computer memory and electronics technology)
- A legal requirement (e.g., a paint manufacturer authorising a project to establish guidelines for handling toxic materials)
- A social need (e.g., a nongovernmental organisation in a developing country authorising a project to provide potable water systems, eco fuel, and sanitation education to communities suffering from high rates of cholera).

Chartering a project links the project to the ongoing work of the organisation. In some organisations, a project is not formally chartered and initiated until completion of a needs assessment, feasibility study,

preliminary plan, or some other equivalent form of analysis that was separately initiated. Developing the project charter is primarily concerned with documenting the business needs, project justification, current understanding of the customer's requirements, and the new product, service, or result that is intended to satisfy those requirements. The project charter, either directly, or by reference to other documents, should address the following information:

- Requirements that satisfy customer, sponsor, and other stakeholder needs, wants and expectations
- Business needs, high-level project description, or product requirements that the project is undertaken to address
- Project purpose or justification
- Assigned Project Manager and authority level
- Summary milestone schedule
- Stakeholder influences
- Functional organisations and their participation
- Organisational, environmental and external assumptions
- Organisational, environmental and external constraints
- Business case justifying the project, including return on investment
- Summary budget.

During subsequent phases of multi-phase projects, the Develop Project Charter process validates the decisions made during the original chartering of the project. If required, it also authorises the next project phase, and updates the charter.

## **Develop Project Charter: Inputs**

### **.1 Contract (When Applicable)**

A contract from the customer's acquiring organisation is an input if the project is being done for an external customer.

## .2 Project Statement of Work

The Statement of Work (SOW) is a summary of what the project will provide. For organisations completing an internal project, the SOW provides the business needs of the project, the product the project must create, or the service the project will create. For organisations that complete projects for external customers, the SOW is typically provided by the customer to the vendor. The vendor then responds with a proposal, quote, or bid—depending on what the customer asked for. In either case, the SOW includes the following:

**Business need** - an organisation's business need can be based on needed training, market demand, technological advance, legal requirement, or governmental standard.

**Product scope description** - documents the product requirements and characteristics of the product or service that the project will be undertaken to create. The product requirements will generally have less detail during the initiation process and more detail during later processes, as the product characteristics are progressively elaborated. These requirements should also document the relationship among the products or services being created and the business need or other stimulus that causes the need. While the form and substance of the product requirements document will vary, it should always be detailed enough to support later project planning.

**Strategic plan** - all projects should support the organisation's strategic goals. The strategic plan of the performing organisation should be considered as a factor when making project selection decisions.

## .3 Enterprise Environmental Factors

Project managers know there are many things that influence a project's success; it's not all planning, execution, and good luck. Projects take place within organisations and there are many components of any organisation that can, and will, affect a project's success. These are

enterprise environmental factors that have to be considered throughout the project and should be identified in the project charter. Enterprise environmental factors include the following:

- Organisational or company culture and structure
- Governmental or industry standards (e.g., regulatory agency regulations, product standards, quality standards, and workmanship standards)
- Infrastructure (e.g., existing facilities and capital equipment)
- Existing human resources (e.g., skills, disciplines, and knowledge, such as design, development, legal, contracting, and purchasing)
- Personnel administration (e.g., hiring and firing guidelines, employee performance reviews, and training records)
- Company work authorisation system
- Marketplace conditions
- Stakeholder risk tolerances
- Commercial databases (e.g., standardised cost estimating data, industry risk study information, and risk databases)
- Project management information systems (e.g., an automated tool suite, such as a scheduling software tool, a configuration management system, an information collection and distribution system, or web interfaces to other online automated systems).

#### **.4 Organisational Process Assets**

When developing the project charter and subsequent project documentation, any and all of the assets that are used to influence the project's success can be drawn from organisational process assets. Any and all of the organisations involved in the project can have formal and informal policies, procedures, plans, and guidelines whose effects must be considered.

Organisational process assets also represent the organisation's learning and knowledge from previous projects; for example, completed schedules, risk data, and earned value data. Organisational process assets

can be organised differently, depending on the type of industry, organisation, and application area. For example, the organisational process assets could be grouped into two categories:

**Organisation's processes and procedures for conducting work:**

1. Organisational standard processes, such as standards, policies (e.g., safety and health policy, and project management policy), standard product and project life cycles, and quality policies and procedures (e.g., process audits, improvement targets, checklists, and standardised process definitions for use in the organisation)
2. Standardised guidelines, work instructions, proposal evaluation criteria, and performance measurement criteria
3. Templates (e.g., risk templates, work breakdown structure templates, and project schedule network diagram templates)
4. Guidelines and criteria for tailoring the organisation's set of standard processes to satisfy the specific needs of the project
5. Organisation communication requirements (e.g., specific communication technology available, allowed communication media, record retention, and security requirements)
6. Project closure guidelines or requirements (e.g., final project audits, project evaluations, product validations, and acceptance criteria)
7. Financial controls procedures (e.g., time reporting, required expenditure and disbursement reviews, accounting codes, and standard contract provisions)
8. Issue and defect management procedures defining issue and defect controls, issue and defect identification and resolution, and action item tracking
9. Change control procedures, including the steps by which official company standards, policies, plans, and procedures-or any project documents-will be modified, and how any changes will be approved and validated
10. Risk control procedures, including risk categories, probability definition and impact, and probability and impact matrix

11. Procedures for approving and issuing work authorisations.

**Organisational corporate knowledge base for storing and retrieving information:**

1. Process measurement database used to collect and make available measurement data on processes and products
2. Project files (e.g., scope, cost, schedule, and quality baselines, performance measurement baselines, project calendars, project schedule network diagrams, risk registers, planned response actions, and defined risk impact)
3. Historical information and lessons learned knowledge base (e.g., project records and documents, all project closure information and documentation, information about both the results of previous project selection decisions and previous project performance information, and information from the risk management effort – created by the project team)
4. Issue and defect management database containing issue and defect status, control information, issue and defect resolution, and action item results
5. Configuration management knowledge base containing the versions and baselines of all official company standards, policies, procedures, and any project documents
6. Financial database containing information such as labor hours, incurred costs, budgets, and any project cost overruns

**Develop Project Charter: Tools and Techniques**

**.1 Project Selection Methods**

Project selection methods are used to determine which project the organisation will select. These methods generally fall into one of two broad categories:

**Benefit measurement methods that** are comparative approaches,

scoring models, benefit contribution, or economic models. There are several different benefit measurement methods. These methods are all about comparing values of one project against the values of another. Usually, the projects with higher, positive values typically get selected over projects with low values. The following are some common benefit measurement methods:

**Murder Boards** Murder boards are committees that ask every conceivable negative question about the proposed project. Their goal is to expose strengths and weakness of the project—and kill the project if it's deemed worthless for the organisation to commit to.

**Scoring Models** Scoring models (sometimes called weighted scoring models) are models that use a common set of values for all of the projects up for selection. For example, values can be profitability, complexity, customer demand, and so on. Each of these values has a weight assigned to them—values of high importance have a high weight, while values of lesser importance have a lesser weight. The projects are measured against these values and assigned scores by how well they match to the predefined values. The projects with high scores take priority over projects with lesser scores.

**Benefit/Cost Ratios** benefit/cost ratio (BCR) models examine the cost-to-benefit ratio. For example, a typical measurement is the cost to complete the project, and the cost of ongoing operations of the project product compared against the expected benefits of the project. For example, consider a project that will use \$575,000 to create a new product, market the product, and provide ongoing support for the product for one year. The expected gross return on the product, however, is \$980,000 in year one. The benefit of completing the project is greater than the cost to create the product.

**The Payback Period** How long does it take the project to “pay back” the costs of the project? For example, the AXZ Project will cost the

organisation \$500,000 to create over five years. The expected cash inflow (income) on the project deliverable, however, is \$40,000 per quarter. From here it's simple math: 500,000 divided by \$40,000 is 12.5 quarters, or a little over three years to recoup the expenses. This selection method, while one of the simplest, is also the weakest. Why? The cash inflows are not discounted against the time it takes to begin creating the cash. This is the time value of money. The \$40,000-per-quarter five years from now is worth less than \$40,000 today.

**Considering the Discounted Cash Flow** Discounted cash flow accounts for the time value of money. If you were to borrow \$100,000 for five years you'd be paying interest on the money. If the \$100,000 were invested for five years and managed to earn six-percent interest per year, compounded annually it'd be worth \$133,822.60 at the end of five years. This is the future value of the money in today's terms. The magic formula for future value is

**$FV = PV (1 + I)^n$ , where:**

FV is future value

PV is present value

I is the interest rate per time period

n is the number of time periods (years, quarters, and so on)

Here's the formula with the \$100,000 in action:

1.  $FV = 100,000(1 + .06)^5$
2.  $FV = 100,000(1.338226)$
3.  $FV = 133,822.60$

The future value of the \$100,000 five years from now is worth \$133,822.60 today. So how does that help? Now we've got to calculate the discounted cash flow across all of the projects up for selection. The discounted cash flow is really just the inverse of the preceding formula. We're looking for the present value of future cash flows:

$$PV = FV \div (1 + I)^n.$$

In other words, if a project says it'll be earning the organisation \$160,000 per year in five years, that's great. But what's \$160,000 five years from

now really worth today? This puts the amount of the cash flow in perspective with what the projections are in today's money. Let's plug it into the formula and find out (assuming the interest rate is still six percent):

$$1. PV = FV \div (1 + I)^n$$

$$2. PV = 160,000 \div (1.338226)$$

$$3. PV = \$119,561$$

So \$160,000 in five years is really only worth \$119,561 today. If we had four different projects with various times to completion, costs, and expected project cash inflows at completion, we'd calculate the present value, and choose the project with the best PV since it'll likely be the best investment for the organisation.

### **Calculating the Net Present Value**

The net present value (NPV) is a somewhat complicated formula, but allows a more precise prediction of project value than the lump sum approach found with the PV formula. NPV evaluates the monies returned on a project for each time period the project lasts. In other words, a project may last five years, but there may be a return of investment in each of the five years the project is in existence, not just at the end of the project.

For example, a retail company may be upgrading the facilities at each of their stores to make shopping and purchasing easier for their customers. The company has 1000 stores. As each store makes the conversion to the new facility design, the project deliverables will begin, hopefully, generating cash flow as a result of the project deliverables. The project can begin earning money when the first store is completed with the conversion to the new facilities. The faster the project can be completed, the sooner the organisation will see a complete return on their investment.

The following outlines how the NPV formula works:

1. Calculate the project's cash flow for time unit (typically quarters or years).

2. Calculate each time unit total into the present value.
3. Sum the present value of each time unit.
4. Subtract the investment for the project.
5. Examine the NPV value. An NPV greater than one is good and the project should be approved. An NPV less than one is bad and the project should be rejected.

When comparing two projects, the project with the greater NPV is typically better, though projects with high returns (PV) early in the project are better than those with low returns early in the project. The following at table 4-1 is an example of an NPV calculation:

Time Period	Cash Flow	Present Value
1	\$15,000	\$14,150.94
2	\$25,000	\$22,249.91
3	\$17,000	\$14,273.53
4	\$25,000	\$19,802.34
5	\$18,000	\$13,450.65
Totals	\$100,000	\$83,927.37
Investment	-\$78,000	-\$78,000
Net Present Value (NPV)		\$5,927.37

**Table 4-1. Example of NPV calculation**

### Considering the Internal Rate of Return

The last benefit measurement method is the internal rate of return (IRR). The IRR is a complex formula to calculate when the present value of the cash inflow equals the original investment. Don't get too lost in this formula—it's a tricky business and you won't need to know how to calculate the IRR for the exam. You will need to know, however, that when comparing multiple projects' IRRs, projects with high IRRs are better choices than projects with low IRRs.

Mathematical models that use linear, nonlinear, dynamic, integer, or multi-objective programming algorithms also called constrained optimisation methods. Constrained optimisation methods are complex mathematical formulas and algorithms that are used to predict the success of projects, the variables within projects, and tendencies to move forward with selected project investments. The following are the major constrained optimisation methods:

- Linear programming
- Nonlinear programming
- Integer algorithms
- Dynamic programming
- Multiobjective programming

Benefit measurement methods are the most common approaches to project selection. Benefit measurement methods are tools that allow management and key stakeholders to examine the benefits of a project and how the project completion will contribute to the organisation. Constrained optimisation methods are also tools for selecting projects, but their approach is much more scientific and math-driven.

## **.2 Project Management Methodology**

A project plan methodology is a structured approach to developing the project plan. Methodologies can be simple or complex and based on the project type, the requirements of the performing organisation, or multiple inputs. Organisations can use hard or soft tools to lead the project plan methodology. In its choice of hard tools, one organisation may require that the project team create a project plan based on a checklist of plan requirements, while another organisation may require that project teams complete a computer-based project template.

Soft tools include project meetings, business analysts to investigate and research all facets of the problem or opportunity, and subject matter experts' interviews of stakeholders and project team members. A methodology used in creating the project plan can include the following:

- Project templates
- Paper and electronic forms
- Monte Carlo simulations for risk management
- Project simulations for expected results
- The design of experiments
- Project startup meetings
- Interviews

### **.3 Project Management Information System (PMIS)**

The PMIS is a tool that can help the project team to plan, schedule, monitor and report on a project. A PMIS is typically a computer-driven system (though it can be paper-based) to aid a project manager in the development of the project. A PMIS is a tool for, not a replacement of, the project manager. A PMIS can calculate schedules, costs, expectations, and likely results. The PMIS cannot, however, replace the expert judgment of the project manager and the project team. The goal of a PMIS is to automate, organise, and provide control of the project management processes. A typical PMIS software system has:

- WBS creation tools
- Calendaring features
- Scheduling abilities
- Work authorisation tools
- Earned Value Management (EVM) controls
- Quality control charts, PERT charts, Gantt charts, and other charting features
- Calculations for the critical path, Earned Value Management (EVM), target dates based on the project schedule, and more
- Resource tracking and leveling
- Reporting functionality.

The PMIS is used by the project management team to support generation of a project charter, facilitate feedback as the document is refined, control changes to the project charter, and release the approved document.

#### .4 Expert Judgment

Expert judgment is often used to assess the inputs needed to develop the project charter. Such judgment and expertise is applied to any technical and management details during this process. Such expertise is provided by any group or individual with specialised knowledge or training, and is available from many sources, including:

- Other units within the organisation
- Consultants
- Stakeholders, including customers or sponsors
- Professional and technical associations
- Industry groups.

### Develop Project Charter: Outputs

#### .1 Project Charter

The project charter is the document that formally authorises a project. The project charter provides the project manager with the authority to apply organisational resources to project activities. A project manager is identified and assigned as early in the project as is feasible. The project manager should always be assigned prior to the start of planning, and preferably while the project charter is being developed.

The point of the charter, other than authorising the project and the project manager, is to officially launch the project and allow the project manager to go about the business of getting the project work planned and then finished. The project charter needs to clearly communicate all of the following directly or through references to other documents:

- **Project requirements for satisfaction.** The charter must identify what it'll take to complete the project—in other words, it should

identify the metrics for success.

- **The big picture.** The charter should identify the high-level purpose of the project, the business need the project aims to accomplish, and/or the product requirements the project will create.
- **Project purpose.** The charter needs to answer why the project is being launched and why it's important to the organisation.
- **Milestone schedule.** Milestones are timeless events that show the progress within a project.
- **Stakeholder influences.** The charter needs to identify the stakeholders that will influence the project.
- **Functional organisations.** Functional organisations, such as departments, communities, agencies, and other stakeholders, should be identified and their expected level of participation should be addressed.
- **Assumptions.** An assumption is anything held to be true, but not proven to be true; assumptions about the organisation, the stakeholders, and the project work should be documented in the project charter.
- **Constraints.** A constraint is anything that limits the project manager's options. Common constraints include deadlines and preset budgets. These need to be documented in the project charter. Or else.
- **Summary budget.** The charter should have a summary budget.
- **Contract.** If the project is being completed for another entity that is an external customer, then a contract is also needed.

## 4.2 Develop Preliminary Project Scope Statement

Once the project charter has been created along with the project statement of work, the project management team must then create and develop the project scope statement. The project scope statement defines what the project will accomplish, create, and deliver. It defines the purpose of the project, in detail, so that all stakeholders may share a common understanding of the project. The Develop Preliminary Project Scope Statement process addresses and documents the characteristics and boundaries of the project and its associated products and services, as well as the methods of acceptance and scope control. A project scope statement includes:

- Project and product objectives
- Product or service requirements and characteristics
- Product acceptance criteria
- Project boundaries
- Project requirements and deliverables
- Project constraints
- Project assumptions
- Initial project organisation
- Initial defined risks
- Schedule milestones
- Initial WBS
- Order of magnitude cost estimate
- Project configuration management requirements
- Approval requirements.

The preliminary scope statement is created by the project manager along with the project team. The purpose of creating the preliminary scope statement is to capture the information as provided by the project initiator or project sponsor and to reflect the goals and expectations of the project stakeholders. The project management team can use expert judgment, historical information, and organisational assets

such as templates to create the preliminary scope statement. As the project moves through planning, the preliminary scope statement is refined and then approved by the project sponsor. In today's IT-driven world, a project management information system is likely to be used to help the project management team create the scope statement and track revisions that may be made to the project scope.

## **Develop Preliminary Project Scope Statement: Inputs**

### **.1 Project Charter**

The project charter is the document that formally authorises a project. The project charter provides the project manager with the authority to apply organisational resources to project activities. *(Please refer to previous section for more details on a Project Charter).*

### **.2 Project Statement of Work**

The Statement of Work (SOW) is a summary of what the project will provide. For organisations completing an internal project, the SOW provides the business needs of the project, the product the project must create, or the service the project will create. For organisations that complete projects for external customers, the SOW is typically provided by the customer to the vendor. *(Please refer to previous section for more details on Project Statement of Work).*

### **.3 Enterprise Environmental Factors**

When developing the project charter, any and all of the organisation's enterprise environmental factors and systems that surround and influence the projects success must be considered. There are numerous factors that must be considered. *(Please refer to previous section for more details on Enterprise Environmental Factors).*

#### **.4 Organisational Process Assets**

When developing the project charter and subsequent project documentation, any and all of the assets that are used to influence the project's success can be drawn from organisational process assets. Any and all of the organisations involved in the project can have formal and informal policies, procedures, plans, and guidelines whose effects must be considered.

Organisational process assets also represent the organisations' learning and knowledge from previous projects; for example, completed schedules, risk data, and earned value data. Organisational process assets can be organised differently, depending on the type of industry, organisation, and application area. *(Please refer to previous section on Organisational Process Assets for more details).*

### **Develop Preliminary Project Scope Statement: Tools and Techniques**

#### **.1 Project Management Methodology**

The project management methodology defines a process that aids a project management team in developing and controlling changes to the preliminary project scope statement.

#### **.2 Project Management Information System**

The project management information system, an automated system, is used by the project management team to support generation of a preliminary project scope statement, facilitate feedback as the document is refined, control changes to the project scope statement, and release the approved document.

#### **.3 Expert Judgment**

Expert judgment is applied to any technical and management

details to be included in the preliminary project scope statement.

## **Develop Preliminary Project Scope Statement: Outputs**

### **.1 Preliminary Project Scope Statement**

The project scope statement defines what the project will accomplish, create, and deliver. It defines the purpose of the project, in detail, so that all stakeholders may share a common understanding of the project. The Develop Preliminary Project Scope Statement process addresses and documents the characteristics and boundaries of the project and its associated products and services, as well as the methods of acceptance and scope control. *(Please refer to previous section for more details on Preliminary Project Scope Statement).*

### 4.3 Develop Project Management Plan

#### Introduction

Project Management Plan development requires an iterative process of progressive elaboration. The project manager will revise and update the plan as research and planning reveal more information and as the project develops. For example, an initial Project Management Plan may describe a broad overview of what the project entails, what the desired future state should be, and the general methods used to achieve the goals of the plan. Then, after research, careful planning, and discovery, the Project Management Plan will develop into a concise document that details the work involved in, and the expectations of, the project; how the project will be controlled, measured, and managed; and how the project should move. In addition, the Project Management Plan will contain all of the supporting details, specify the project organisation, and allow for growth in the plan.

The Develop Project Management Plan process includes the actions necessary to define, integrate, and coordinate all subsidiary management plans (which describe the PM approach and methodology) into a project management plan. The project management plan content will vary depending upon the application area and complexity of the project. This process results in a project management plan that is updated and revised through the Integrated Change Control process.

The primary purpose of the project management plan is to define how the project is executed, monitored and controlled, and closed. The project management plan documents the collection of outputs of the planning processes of the Planning Process Group and includes:

- The project management processes selected by the project management team
- The level of implementation of each selected process

- The descriptions of the tools and techniques to be used for accomplishing those processes
- How the selected processes will be used to manage the specific project, including the dependencies and interactions among those processes, and the essential inputs and outputs.
- How work will be executed to accomplish the project objectives
- How changes will be monitored and controlled
- How configuration management will be performed
- How integrity of the performance measurement baselines will be maintained and used
- The need and techniques for communication among stakeholders
- The selected project life cycle and, for multi-phase projects, the associated project phases
- Key management reviews for content, extent, and timing to facilitate addressing open issues and pending decisions.

The project management plan can be either summary level or detailed, and can be composed of one or more subsidiary plans and other components. Each of the subsidiary plans and components is detailed to the extent required by the specific project. These subsidiary plans include, but are not limited to:

- Project scope management plan
- Schedule management plan
- Cost management plan
- Quality management plan
- Process improvement plan
- Staffing management plan
- Communication management plan
- Risk management plan
- Procurement management plan.

These other components include, but are not limited to:

- Milestone list.

- Resource calendar.
- Scope baseline.
- Schedule baseline.
- Cost baseline.
- Quality baseline.
- Risk register.

### **Understanding the Project Management Plan's Purpose**

The Project Management Plan is more than a playbook to determine what work needs to be accomplished. The Project Management Plan is a fluid document that will control several elements:

- **Provide structure** The Project Management Plan is developed to provide a structure that advances the project toward completion. It is a thorough but concise collection of documents that will serve as a point of reference through the project execution.
- **Provide documentation** A documented Project Management Plan is needed for truly successful projects—they provide a historical reference and the reasoning for why decisions were made. A Project Management Plan must provide documentation of the assumptions and constraints influencing the Project Management Plan development.
- **Provide communication** Project Management Plans are documents that provide the information, explanations, and reasoning underlying the decisions made for the project. The Project Management Plan serves as a source of communication among stakeholders, the project team, and management on how the Project Management Plan will be controlled.
- **Provide baselines** A Project Management Plan contains several baselines. As the project moves toward completion, management, stakeholders, and the project manager can use the Project Management Plan to see what was predicted for costs, scheduling,

quality, and scope—and then see how these predictions compare with what is being experienced.

## **Develop Project Management Plan: Inputs**

### **.1 Preliminary Project Scope Statement**

*Please refer to previous section for details about the Preliminary Project Scope Statement*

### **.2 Project Management Processes**

The Project Management Knowledge Areas organises the 44 project management processes within the 5 Process Groups (Initiating, Planning, Executing, Monitoring & Controlling, and Closing Process Group) across the nine knowledge areas. Each process and knowledge area is described in the introductory section – Project Management Framework.

### **.3 Enterprise Environmental Factors**

*Please refer to previous section for details about Enterprise Environmental Factors*

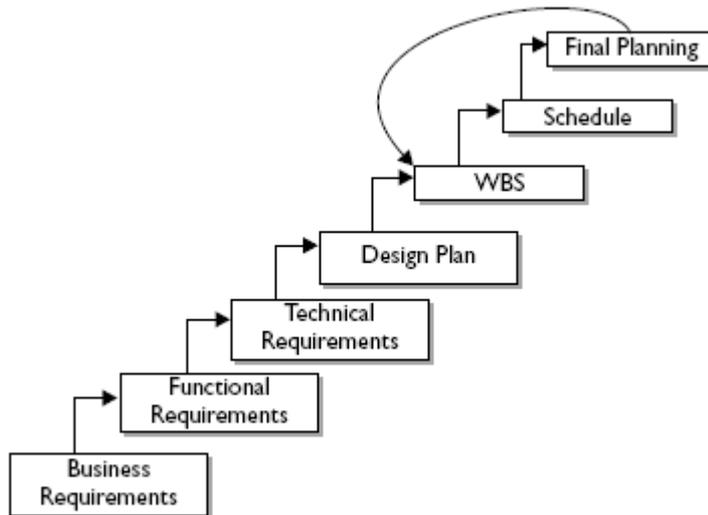
### **.4 Organisational Process Assets**

*Please refer to previous section for details about Organisational Process Assets*

## **Develop Project Management Plan: Tools and Techniques**

The planning processes are iterative and allow the project manager and the project team to revisit them as needed. But at what point do we push back from the planning buffet and move on with a working, feasible plan? Every project is different when it comes to planning, but a project team will continue in the planning stage until it is knowledgeable about

the project work and has a clear vision of what needs to be done.



**Figure 4-3. The planning processes require documentation and a logical, systematic approach.** (Source: PMP Study Guide, Phillips 2006)

Figure 4-3 depicts the evolution of the planning to action process for a typical technology project. Once the business and the functional requirements have been established, the planning processes move into the specifics. Recall that the business requirements establish the project vision and that the functional requirements establish the goals for the project. The technical requirements and the design plan shift the focus onto the specifics the project will accomplish. All of the inputs to the Project Management Plan should be readily available for the project manager, because he or she may need to rely on this information for additional planning. With all of the “stuff” the project manager has to work with, it should be a snap to create the actual Project Management Plan, right? Well, not exactly. The project manager, the project team, stakeholders, and management will work together to finalise the Project Management Plan. The contributions from each include the following:

- **Project manager** Leadership, facilitation, organisation, direction, and expert judgment
- **Project team members** Knowledge of the project work and time estimates; also influence the schedule, provide advice and opinions on risk, as well as expert judgment

- **Customer** Objectives, quality requirements, expert judgment, and have some influence over budget and schedule
- **Management** Influence budget, resources, project management methodology, quality requirements, and Project Management Plan approval

At a minimum the project manager must consider the following tools and techniques when developing a project management plan:

### .1 Project Management Methodology

The project management methodology defines a process, which aids a project management team in developing and controlling changes to the project management plan. *(Please refer to previous section for more details on Project Management Methodology).*

### .2 Project Management Information System

The project management information system, an automated system, is used by the project management team to support generation of the project management plan, facilitate feedback as the document is developed, control changes to the project management plan, and release the approved document.

- **Configuration Management System**

The configuration management system is a subsystem of the overall project management information system. The system includes the process for submitting proposed changes, tracking systems for reviewing and approving proposed changes, defining approval levels for authorising changes, and providing a method to validate approved changes. In most application areas, the configuration management system includes the change control system.

The configuration management system is also a collection of formal documented procedures used to apply technical and

administrative direction and surveillance to:

1. Identify and document the functional and physical characteristics of a product or component
2. Control any changes to such characteristics
3. Record and report each change and its implementation status
4. Support the audit of the products or components to verify conformance to requirements.

- **Change Control System**

The change control system is a collection of formal documented procedures that define how project deliverables and documentation are controlled, changed, and approved. The change control system is a subsystem of the configuration management system. For example, for information technology systems, a change control system can include the specifications (scripts, source code, data definition language, etc.) for each software component.

### **.3 Expert Judgment**

Expert judgment is applied to develop technical and management details to be included in the project management plan.

## **Develop Project Management Plan: Outputs**

### **.1 Project Management Plan**

Please refer to Introduction section in Develop Project Management Plan for more details.

#### 4.4 Direct and Manage Project Execution

The product of the project is created during these execution processes. The largest percentage of the project budget will be spent during the project execution processes. The project manager and the project team must work together to orchestrate the timings and integration of all the project's moving parts. The Project Sponsor is responsible for helping the Project team resolve issues during execution. A flaw in one area of the execution can have ramifications in cost and additional risk and can cause additional flaws in other areas of the project.

The Direct and Manage Project Execution process requires the project manager and the project team to perform multiple actions to execute the project management plan to accomplish the work defined in the project scope statement. Some of those actions are:

- Perform activities to accomplish project objectives
- Expend effort and spend funds to accomplish the project objectives
- Staff, train, and manage the project team members assigned to the project
- Obtain quotations, bids, offers, or proposals as appropriate
- Select sellers by choosing from among potential sellers
- Obtain, manage, and use resources including materials, tools, equipment, and facilities
- Implement the planned methods and standards
- Create, control, verify, and validate project deliverables
- Manage risks and implement risk response activities
- Manage sellers
- Adapt approved changes into the project's scope, plans, and environment
- Establish and manage project communication channels, both external and internal to the project team
- Collect project data and report cost, schedule, technical and quality progress, and status information to facilitate forecasting

- Collect and document lessons learned, and implement approved process improvement activities.

The project manager, along with the project management team, directs the performance of the planned project activities, and manages the various technical and organisational interfaces that exist within the project. The Direct and Manage Project Execution process is most directly affected by the project application area. Deliverables are produced as outputs from the processes performed to accomplish the project work planned and scheduled in the project management plan.

Work performance information about the completion status of the deliverables, and what has been accomplished, is collected as part of project execution and is fed into the performance reporting process. Although the products, services, or results of the project are frequently in the form of tangible deliverables such as buildings, roads, etc., intangible deliverables, such as training, can also be provided.

Direct and Manage Project Execution also requires implementation of:

- Approved corrective actions that will bring anticipated project performance into compliance with the project management plan
- Approved preventive actions to reduce the probability of potential negative consequences
- Approved defect repair requests to correct product defects found by the quality process.

## **Direct and Manage Project Execution: Inputs**

### **.1 Project Management Plan**

Please refer to previous section on Project Management Plan.

### **.2 Approved Corrective Actions**

Corrective actions are methods the project manager and the project team can take to bring the project back into alignment with the Project

Management Plan—for example, a delay in the project work has now shifted the project schedule by a month. The project manager, the project team, and even the stakeholders can examine the project schedule to see what possible alternatives can be taken in the project schedule to complete the project on time. Solutions may include additional resources, fast-tracking, changing the order of work packages, and so on. Corrective actions bring the project performance back in line with the Project Management Plan. In addition to communicating, project managers spend a great deal of their time applying corrective actions. Approved corrective actions are documented, authorised directions required to bring expected future project performance into conformance with the project management plan.

### **.3 Approved Preventive Actions**

In project management, preventive actions are steps the project manager and the project team can take to prevent the negative outcome of possible risk events. Preventive actions are documented methods to avoid risks from influencing the project success in a negative way. Preventive actions are actions to take risk events out of play. Approved preventive actions are documented, authorised directions that reduce the probability of negative consequences associated with project risks.

### **.4 Approved Change Requests**

Approved change requests are the documented, authorised changes to expand or contract project scope. The approved change requests can also modify policies, project management plans, procedures, costs or budgets, or revise schedules. Approved change requests are scheduled for implementation by the project team.

### **.5 Approved Defect Repair**

The approved defect repair is the documented, authorised request for product correction of a defect found during the quality inspection or the audit process.

## **.6 Validated Defect Repair**

Notification that reinspected repaired items have either been accepted or rejected.

## **.7 Administrative Closure Procedure**

The administrative closure procedure documents all the activities, interactions, and related roles and responsibilities needed in executing the administrative closure procedure for the project.

## **Direct and Manage Project Execution: Tools and Techniques**

### **.1 Project Management Methodology**

The project management methodology defines a process that aids a project team in executing the project management plan.

### **.2 Project Management Information System**

The project management information system is an automated system used by the project management team to aid execution of the activities planned in the project management plan.

## **Direct and Manage Project Execution: Outputs**

### **.1 Deliverables**

A deliverable is any unique and verifiable product, result or capability to perform a service that is identified in the project management planning documentation, and must be produced and provided to complete the project.

### **.2 Requested Changes**

Changes requested to expand or reduce project scope, to modify policies or procedures, to modify project cost or budget, or to revise the project schedule are often identified while project work is being

performed. Requests for a change can be direct or indirect, externally or internally initiated, and can be optional or legally/contractually mandated.

### **.3 Implemented Change Requests**

Approved change requests that have been implemented by the project management team during project execution.

### **.4 Implemented Corrective Actions**

The approved corrective actions that have been implemented by the project management team to bring expected future project performance into conformance with the project management plan.

### **.5 Implemented Preventive Actions**

The approved preventive actions that have been implemented by the project management team to reduce the consequences of project risks.

### **.6 Implemented Defect Repair**

During project execution, the project management team has implemented approved product defect corrections.

### **.7 Work Performance Information**

Information on the status of the project activities being performed to accomplish the project work is routinely collected as part of the project management plan execution. This information includes, but is not limited to:

- Schedule progress showing status information
- Deliverables that have been completed and those not completed
- Schedule activities that have started and those that have been finished
- Extent to which quality standards are being met

- Costs authorised and incurred
- Estimates to complete the schedule activities that have started
- Percent physically complete of the in-progress schedule activities
- Documented lessons learned posted to the lessons learned knowledge base
- Resource utilisation detail.

## 4.5 Monitor and Control Project Work

The Monitor and Control Project Work process is performed to monitor project processes associated with initiating, planning, executing, and closing. Corrective or preventive actions are taken to control the project performance. Monitoring is an aspect of project management performed throughout the project.

Monitoring includes collecting, measuring, and disseminating performance information, and assessing measurements and trends to effect process improvements. Continuous monitoring gives the project management team insight into the health of the project, and identifies any areas that can require special attention. The Monitor and Control Project Work process is concerned with:

- Comparing actual project performance against the approved project management plan (baseline)
- Assessing performance to determine whether any corrective or preventive actions are indicated, and then recommending those actions as necessary
- Analysing, tracking, and monitoring project risks to make sure the risks are identified, their status is reported, and that appropriate risk response plans are being executed
- Maintaining an accurate, timely information base concerning the project's product(s) and their associated documentation through project completion
- Providing information to support status reporting, progress measurement, and forecasting
- Providing forecasts to update current cost and current schedule information
- Monitoring implementation of approved changes when and as they occur.

## **Monitor and Control Project Work: Inputs**

### **.1 Project Management Plan**

Please refer to previous section for more details on Project Management Plan

### **.2 Work Performance Information**

Please refer to previous section for more details on Work Performance Information.

### **.3 Rejected Change Requests**

Rejected change requests include the change requests, their supporting documentation, and their change review status showing a disposition of rejected change requests.

## **Monitor and Control Project Work: Tools and Techniques**

### **.1 Project Management Methodology**

The project management methodology defines a process that aids a project management team in monitoring and controlling the project work being performed in accordance with the project management plan.

### **.2 Project Management Information System**

The project management information system (PMIS), an automated system, is used by the project management team to monitor and control the execution of activities that are planned and scheduled in the project management plan. The PMIS is also used to create new forecasts as needed. Baselines (approved versions of scope, budget and schedule) are common control tools.

### **.3 Earned Value Technique**

The earned value technique measures performance of the project as it moves from project initiation through project closure. The earned value management methodology also provides a means to forecast future performance based upon past performance.

### **.4 Expert Judgment**

Expert judgment is used by the project management team to monitor and control project work.

## **Monitor and Control Project Work: Outputs**

### **.1 Recommended Corrective Actions**

Corrective actions are documented recommendations required to bring expected future project performance into conformance with the project management plan.

### **.2 Recommended Preventive Actions**

Preventive actions are documented recommendations that reduce the probability of negative consequences associated with project risks.

### **.3 Forecasts**

Forecasts include estimates or predictions of conditions and events in the project's future, based on information and knowledge available at the time of the forecast. Forecasts are updated and reissued based on work performance information provided as the project is executed. This information is about the project's past performance that could impact the project in the future; for example, estimate at completion and estimate to complete.

### **.4 Recommended Defect Repair**

Some defects, which are found during the quality inspection and

audit process, are recommended for correction.

#### **.5 Requested Changes**

Please refer to previous section for more details on Requested Changes.

## 4.6 Integrated Change Control

The Integrated Change Control process is performed from project inception through completion. Change control is necessary because projects seldom run exactly according to the project management plan.

The project management plan, the project scope statement, and other deliverables must be maintained by carefully and continuously managing changes, either by rejecting changes or by approving changes so those approved changes are incorporated into a revised baseline. Change requests happen while the project work is being done, should be written but may be verbal and can be requested by any stakeholder. They do not always require additional funding.

The Integrated Change Control process includes the following change management activities in differing levels of detail, based upon the completion of project execution:

- Identifying that a change needs to occur or has occurred.
- Influencing the factors that circumvent integrated change control so that only approved changes are implemented.
- Ensuring supporting documentation for the change exists.
- Reviewing and approving requested changes.
- Managing the approved changes when and as they occur, by regulating the flow of requested changes.
- Maintaining the integrity of baselines by releasing only approved changes for incorporation into project products or services, and maintaining their related configuration and planning documentation.
- Reviewing and approving all recommended corrective and preventive actions.
- Controlling and updating the scope, cost, budget, schedule and quality requirements based upon approved changes, by coordinating changes across the entire project. For example, a proposed schedule change will often affect cost, risk, quality, and staffing.
- Documenting the complete impact of requested changes.

- Validating defect repair.
- Controlling project quality to standards based on quality reports.

Proposed changes can require new or revised cost estimates, schedule activity sequences, schedule dates, resource requirements, and analysis of risk response alternatives. These changes can require adjustments to the project management plan, project scope statement, or other project deliverables. The configuration management system with change control provides a standardised, effective, and efficient process to centrally manage changes within a project.

Configuration management with change control includes identifying, documenting, and controlling changes to the baseline. The applied level of change control is dependent upon the application area, complexity of the specific project, contract requirements, and the context and environment in which the project is performed. Project-wide application of the configuration management system, including change control processes, accomplishes three main objectives:

- Establishes an evolutionary method to consistently identify and request changes to established baselines, and to assess the value and effectiveness of those changes.
- Provides opportunities to continuously validate and improve the project by considering the impact of each change.
- Provides the mechanism for the project management team to consistently communicate all changes to the stakeholders. Some of the configuration management activities included in the integrated change control process are:
  - **Configuration Identification.** Providing the basis from which the configuration of products is defined and verified, products and documents are labeled, changes are managed, and accountability is maintained.
  - **Configuration Status Accounting.** Capturing, storing, and accessing configuration information needed to manage products and product information effectively.

- **Configuration Verification and Auditing.** Establishing that the performance and functional requirements defined in the configuration documentation have been met.

Every documented requested change must be either accepted or rejected by some authority within the project management team or an external organisation representing the initiator, sponsor, or customer. Many times, the integrated change control process includes a change control board responsible for approving and rejecting the requested changes.

The roles and responsibilities of these boards are clearly defined within the configuration control and change control procedures, and are agreed to by the sponsor, customer, and other stakeholders. Many large organisations provide for a multi-tiered board structure, separating responsibilities among the boards. If the project is being provided under a contract, then some proposed changes would need to be approved by the customer.

## **Integrated Change Control: Inputs**

### **.1 Project Management Plan**

Please see previous section for more details

### **.2 Requested Changes**

Please see previous section for more details

### **.3 Work Performance Information**

Please see previous section for more details

### **.4 Recommended Preventive Actions**

Please see previous section for more details

### **.5 Recommended Corrective Actions**

Please see previous section for more details

## **.6 Recommended Defect Repair**

Please see previous section for more details

## **.7 Deliverables**

Please see previous section for more details

## **Integrated Change Control: Tools and Techniques**

### **.1 Project Management Methodology**

The project management methodology defines a process that aids a project management team in implementing Integrated Change Control for the project.

### **.2 Project Management Information System**

The project management information system, an automated system, is used by the project management team as an aid for the implementing an Integrated Change Control process for the project, facilitate feedback for the project and control changes across the project.

### **.3 Expert Judgment**

The project management team uses stakeholders with expert judgment on the change control board to control and approve all requested changes to any aspect of the project.

## **Integrated Change Control: Outputs**

### **.1 Approved Change Requests**

Please see previous section for more details

### **.2 Rejected Change Requests**

Please see previous section for more details

**.3 Project Management Plan (Updates)**

Please see previous section for more details

**.4 Project Scope Statement (Updates)**

Please see previous section for more details

**.5 Approved Corrective Actions**

Please see previous section for more details

**.6 Approved Preventive Actions**

Please see previous section for more details

**.7 Approved Defect Repair**

Please see previous section for more details

**.8 Validated Defect Repair**

Please see previous section for more details

**.9 Deliverables**

Please see previous section for more details

## 4.7 Close Project

The Close Project process involves performing the project closure portion of the project management plan. In multi-phase projects, the Close Project process closes out the portion of the project scope and associated activities applicable to a given phase. This process includes finalising all activities completed across all Project Management Process Groups to formally close the project or a project phase, and transfer the completed or cancelled project as appropriate.

The Close Project process also establishes the procedures to coordinate activities needed to verify and document the project deliverables, to coordinate and interact to formalise acceptance of those deliverables by the customer or sponsor, and to investigate and document the reasons for actions taken if a project is terminated before completion. Two procedures are developed to establish the interactions necessary to perform the closure activities across the entire project or for a project phase:

- Administrative closure procedure. This procedure details all the activities, interactions, and related roles and responsibilities of the project team members and other stakeholders involved in executing the administrative closure procedure for the project. Performing the administrative closure process also includes integrated activities needed to collect project records, analyse project success or failure, gather lessons learned, and archive project information for future use by the organisation.
- Contract closure procedure. Includes all activities and interactions needed to settle and close any contract agreement established for the project, as well as define those related activities supporting the formal administrative closure of the project. This procedure involves both product verification (all work completed correctly and satisfactorily) and administrative closure (updating of contract

records to reflect final results and archiving that information for future use).

The contract terms and conditions can also prescribe specifications for contract closure that must be part of this procedure. Early termination of a contract is a special case of contract closure that could involve, for example, the inability to deliver the product, a budget overrun, or lack of required resources. This procedure is an input to the Close Contract process.

## **Close Project: Inputs**

### **.1 Project Management Plan**

Please see previous section for more details

### **.2 Contract Documentation**

Contract documentation is an input used to perform the contract closure process, and includes the contract itself, as well as changes to the contract and other documentation (such as the technical approach, product description, or deliverable acceptance criteria and procedures).

### **.3 Enterprise Environmental Factors**

Please see previous section for more details

### **.4 Organisational Process Assets**

Please see previous section for more details

### **.5 Work Performance Information**

Please see previous section for more details

### **.6 Deliverables**

Please see previous section for more details

## **Close Project: Tools and Techniques**

### **.1 Project Management Methodology**

The project management methodology defines a process that aids a project management team in performing both administrative and contract closure procedures for the project.

### **.2 Project Management Information System**

The project management team uses the project management information system to perform both administrative and contract closure procedures across the project.

### **.3 Expert Judgment**

Expert judgment is applied in developing and performing both the administrative and contract closure procedures.

## **Close Project: Outputs**

### **.1 Administrative Closure Procedure**

This procedure contains all the activities and the related roles and responsibilities of the project team members involved in executing the administrative closure procedure. The procedures to transfer the project products or services to production and/or operations are developed and established. This procedure provides a step by step methodology for administrative closure that addresses:

- Actions and activities to define the stakeholder approval requirements for changes and all levels of deliverables
- Actions and activities that are necessary to confirm that the project has met all sponsor, customer, and other stakeholders' requirements, verify that all deliverables have been provided and accepted, and validate that completion and exit criteria have been met

- Actions and activities necessary to satisfy completion or exit criteria for the project.

## **.2 Contract Closure Procedure**

This procedure is developed to provide a step-by-step methodology that addresses the terms and conditions of the contracts and any required completion or exit criteria for contract closure. It contains all activities and related responsibilities of the project team members, customers, and other stakeholders involved in the contract closure process. The actions performed formally close all contacts associated with the completed project.

## **.3 Final Product, Service, or Result**

Formal acceptance and handover of the final product, service, or result that the project was authorised to produce. The acceptance includes receipt of a formal statement that the terms of the contract have been met.

## **.4 Organisational Process Assets (Updates)**

Closure will include the development of the index and location of project documentation using the configuration management system.

- Formal Acceptance Documentation. Formal confirmation has been received from the customer or sponsor that customer requirements and specifications for the project's product, service, or result have been met. This document formally indicates that the customer or sponsor has officially accepted the deliverables.
- Project Files. Documentation resulting from the project's activities; for example, project management plan, scope, cost, schedule and quality baselines, project calendars, risk registers, planned risk response actions, and risk impact.

- **Project Closure Documents.** Project closure documents consist of formal documentation indicating completion of the project and the transfer of the completed project deliverables to others, such as an operations group. If the project was terminated prior to completion, the formal documentation indicates why the project was terminated, and formalises the procedures for the transfer of the finished and unfinished deliverables of the cancelled project to others.
- **Historical Information.** Historical information and lessons learned information are transferred to the lessons learned knowledge base for use by future projects.

## **Summary and Self Test**

Project integration management is an ongoing process the project manager completes to ensure the project moves from start to completion. It is the gears, guts, and grind of project management—the day-in, day-out business of completing the project work. Project integration management takes your project plans, coordinates the activities, project resources, constraints, and assumptions and massages them into a working model.

Of course project integration management isn't an automatic process; it requires you, the project manager, to negotiate, finesse, and adapt to the project's circumstances. Project integration management relies on general business skills such as leadership, organisational skills, and communication to get all the parts of the project working together.

The process of project management can be broken down into three chunks:

- **Developing the Project Management Plan** Project Management Plan development is an iterative process that requires input from the project manager, the project team, the project customers, and other stakeholders. It details how the project work will accomplish the project goals. The Project Management Plan provides communication.

- **Executing the Project Management Plan** Now that the plan has been created, it's time to execute it. The project execution processes authorise the work to begin, manage procurement and quality assurance, host project team meetings, and manage conflict between stakeholders. On top of all these moving parts, the project manager must actively work to develop the individuals on the project to work as a team for the good of the project.

- **Managing changes to the project** Changes can kill a project. Change requests must be documented and sent through a formal change control system to determine their worthiness for implementation. Integrated Change Control manages changes across the entire project. Change requests are evaluated, considered for impacts on risk, costs, schedule, and scope. Not all change requests are approved—but all change requests should be documented for future reference. As the project moves from start to completion the project manager and the project team must update the lessons learned documentation. The lessons learned serves as future historical information to the current project and to other future projects within the organisation. The project manager and project team should update the lessons learned at the end of project phases, when major deliverables are created, and at the project's completion.

### **Project Integration Management**

Project integration management relies on Project Management Plan development, Project Management Plan execution, and Integrated Change Control. Integrated Change Control manages all the moving parts of a project.

- Project integration management is a fancy way of saying that the project components need to work together—and the project manager sees to it that they do. Project integration management requires negotiation between competing objectives.
- Project integration management calls for general management skills, effective communications, organisation, familiarity with the product, and more. It is the day-to-day operations of the project execution.

### **Planning the Project**

Planning is an iterative process and the results of planning are inputs to the Project Management Plan. The Project Management Plan is a fluid document, authorised by management, and guides all future decisions on the project.

- The Project Management Plan is a fluid work in progress. Updates to the plan reflect changes to the project, discoveries made during the Project Management Plan execution, and conditions of the project. The Project Management Plan serves as a point of reference for all future project decisions, and it becomes future historical information to guide other project managers. When changes occur, the cost, schedule, and scope baselines in the Project Management Plan must be updated.

### **Project Constraints**

Projects have at least one or more constraints: time, cost, and scope. This is known as the triple constraint of project management. Constraints are factors that can hinder project performance.

- Time constraints include project deadlines, availability of key personnel, and target milestone dates. Remember that all projects are temporary: they have a beginning and an end.
- Cost constraints are typically predetermined budgets for project completion. It's usually easier to get more time than more money.
- Scope constraints are requirements for the project deliverables regardless of the cost or time to implement the requirements (safety regulations or industry mandates are examples).

### **Managing Change Control**

Integrated Change Control is the process of documenting and controlling the features of a product, measuring and reacting to project conditions, and revisiting planning when needed.

- Projects need a Change Control System to determine how changes will be considered, reviewed, and approved or declined. A Change Control System is a documented approach to how a stakeholder may request a change and then what factors are considered when approving or declining the requested change.
- Configuration management is part of change control. It is the process of controlling how the characteristics of the product or service the project is creating are allowed to be changed.

**SELF TEST**

- 1.** You are a project manager for your organisation. Management has asked you to help them determine which projects should be selected for implementation. In a project selection model, which of the following is the most important factor?
  - A. Business needs
  - B. The type of constraints
  - C. The budget
  - D. The schedule
  
- 2.** On any project, the lessons learned document is created by which of the following?
  - A. The customers
  - B. The project sponsor
  - C. The project team
  - D. The stakeholders
  
- 3.** Your project is moving ahead of schedule. Management elects to incorporate additional quality testing into the project to improve the quality and acceptability of the project deliverable. This is an example of which one of the following?
  - A. Scope creep
  - B. Change control
  - C. Quality assurance (QA)
  - D. Integrated Change Control
  
- 4.** All of the following are true about change requests except:
  - A. They happen while the project work is being done
  - B. They always require additional funding
  - C. They can be written or verbal
  - D. They can be requested by a stakeholder
  
- 5.** You are the project manager for a pharmaceutical company. You are currently working on a project for a new drug your company is creating. A recent change in a law governing drug testing will change your project scope. Since the project must be completed within two years, what's the first thing you should do as project manager?
  - A. Create a documented change request
  - B. Proceed as planned since the project will be grandfathered beyond the new change in the law
  - C. Consult with the project sponsor and the stakeholders
  - D. Stop all project work until the issue is resolved
  
- 6.** During project execution activities, a project sponsor's role in a functional organisation can best be described as doing which one of the following?
  - A. Acting as a sounding board for the project stakeholders

- B. Helping the project manager and stakeholders resolve any issues ASAP
- C. Deflecting change requests for the project manager
- D. Showing management the project progress and status reports

**7.** You are the project manager for the HALO Project. You and your project team are preparing the project plan. Of the following, which one is a project plan development constraint you and your team must consider?

- A. The budget as assigned by management
- B. Project plans from similar projects
- C. Project plans from similar projects that have failed
- D. Interviews with subject matter experts (SMEs) who have experience with the project work in your project plan

**8.** Which of the following is the primary purpose of the project management plan?

- A. To define the work to be completed to reach the project end date
- B. To define the work needed in each phase of the project life cycle
- C. To prevent any changes to the scope
- D. To define how the project is executed, monitored, controlled, and then closed

**9.** Of the following, which one is an input to project plan development?

- A. The project scope statement
- B. Project planning methodology
- C. Earned Value Management (EVM)
- D. Business needs

**10.** What is the difference between a project baseline and a project plan?

- A. Project plans change as needed, while baselines change only at milestones
- B. Project plans and baselines do not change—they are amended
- C. Project plans change as needed, while baselines are snapshots of the project plan
- D. Baselines are control tools, while project plans are execution tools

**11.** Which one of the following is not beneficial to the project manager during the project plan development process?

- A. Gantt charts
- B. PMIS
- C. The project management methodology
- D. Stakeholder knowledge

**12.** Which one of the following represents the vast majority of a project's budget?

- A. Project planning
- B. Project plan execution
- C. Labor
- D. Cost of goods and services

- 13.** The project plan provides a baseline for several things. Which one of the following does the project plan not provide a baseline for?
- A. Scope
  - B. Cost
  - C. Schedule
  - D. Control
- 14.** Which of the following can best help a project manager during project execution?
- A. Stakeholder analysis
  - B. Change Control Boards
  - C. PMIS
  - D. Scope verification
- 15.** You are the project manager for your organisation. When it comes to integrated change control, you must ensure which one of the following is present?
- A. Supporting detail for the change exists
  - B. Approval of the change from the project team
  - C. Approval of the change from an SME
  - D. Risk assessment for each proposed change
- 16.** The project plan provides what in regard to project changes?
- A. A methodology to approve or decline CCB changes
  - B. A guide to all future project decisions
  - C. A vision of the project deliverables
  - D. A fluid document that may be updated as needed based on the CCB
- 17.** You are the project manager for the DGF Project. This project is to design and implement a new application that will connect to a database server. Management of your company has requested that you create a method to document technical direction on the project and to document any changes or enhancements to the technical attributes of the project deliverable. Which one of the following would satisfy management's request?
- A. Configuration management
  - B. Integrated change control
  - C. Scope control
  - D. The change management plan
- 18.** Baseline variances, a documented plan to management variances, and a proven methodology to offer corrective actions to the project plan are all part of which process?
- A. Change management
  - B. The Change Control System
  - C. The scope change control
  - D. Integrated change control

**19.** One of the requirements of project management in your organisation is to describe your project management approach and methodology in the project plan. You can best accomplish this requirement through which one of the following actions?

- A. Establishing a project office
- B. Establishing a program office
- C. Compiling the management plans from each of the knowledge areas
- D. Creating a PMIS and documenting its inputs, tools and techniques, and outputs

**20.** You have just informed your project team that each team member will be contributing to the lessons learned documentation. Your team does not understand this approach and wants to know what the documentation will be used for. Which one of the following best describes the purpose of the lessons learned documentation?

- A. Offers proof of concept for management
- B. Offers historical information for future projects
- C. Offers evidence of project progression as reported by the project team
- D. Offers input to team member evaluations at the project conclusion

**21.** Which one of the following is a formal document to manage and control project execution?

- A. WBS
- B. The project management plan
- C. The organisational management plan
- D. The work authorisation system

**22.** Configuration management is a process for applying technical and administrative direction and surveillance of the project implementation. Which activity is not included in configuration management?

- A. Controlling changes to the project deliverables
- B. Scope verification
- C. Automatic change request approvals
- D. Identification of the functional and physical attributes of the project deliverables

**23.** Which set of the following are parts of the project plan execution?

- A. PMIS, WBS, and Earned Value Management (EVM)
- B. General management skills, status review meetings, and Earned Value Management (EVM)
- C. Project management methodology and the PMIS
- D. General management skills, status review meetings, and Earned Value Management (EVM)

**24.** Earned Value Management (EVM) is used during the:

- A. Controlling processes
- B. Executing processes

- C. Closing processes
- D. Entire project

**25.** You are the project manager for your organisation. Management would like you to use a tool that can help you plan, schedule, monitor, and report your findings on your project. This tool is which one of the following?

- A. PMIS
- B. Earned Value Management (EVM)
- C. Status Review Meetings
- D. Project team knowledge and skill set

## 5 Project Scope Management

Project scope management, according to the PMBOK, constitutes “the processes to ensure that the project includes all of the work required, and only the work required, to complete the project successfully.” Project scope management has several purposes:

- It defines what work is needed to complete the project objectives.
- It determines what is included in the project.
- It serves as a guide to determine what work is not needed to complete the project objectives.
- It serves as a point of reference for what is not included in the project.

Project scope statement is a description of the work required to deliver the product of a project. The project scope statement defines what work will be included in the project and what will not be included in the project work. A project scope guides the project manager on decisions to add, change, or remove the work of the project.

### Project Scope vs. Product Scope

Project scope and product scope are different entities. A project scope deals with the required work to create the project deliverables. For instance, a project to create a new house would focus only on the required work to complete the house with the specific attributes, features, and characteristics called for by the project plan. The scope of the project is specific to the work required to complete the project objectives.

Product scope, on the other hand, is the attributes and characteristics of the deliverables the project is creating. As in the preceding house project, the product scope would define the features and attributes of the house. In this instance, the project to build a house would not include creating a flower garden, a wading pool, and the installation of a fence.

There would be very specific requirements regarding the features and characteristics of the house: the materials to be used, the dimensions of the different rooms and walls, electrical requirements, and more.

The project scope and the product scope are bound to each other. The product scope constitutes the characteristics and features of the product that the project creates. The end result of the project is measured against the requirements for that product. The project scope is the required work to deliver the product. Throughout the project execution, the work is measured against the project plan to verify that the project is on track to fulfill the product scope. The product scope is measured against requirements, while the project scope is measured against the project plan.

## **Project Scope Management Processes**

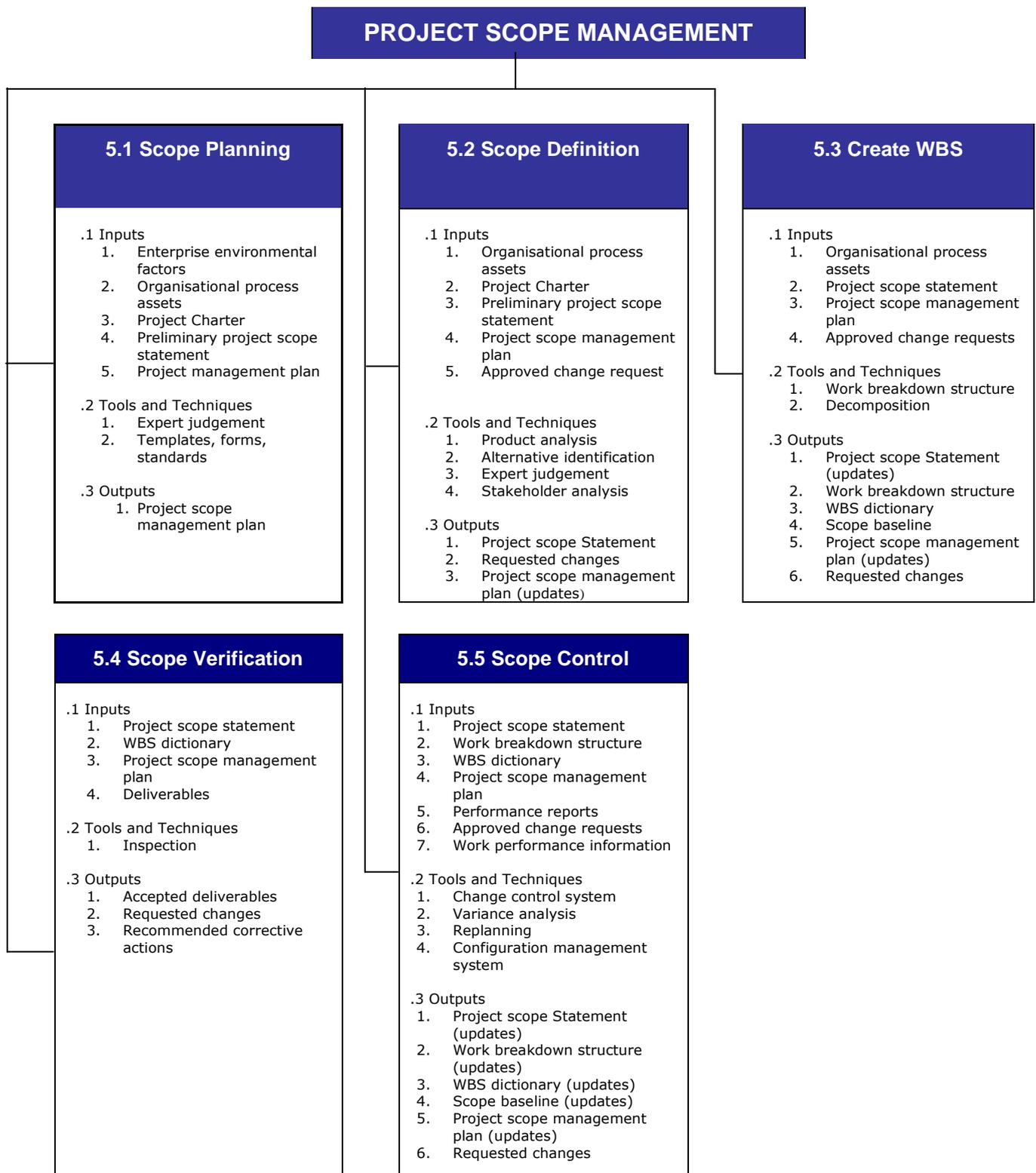
Project Scope Management as described in figure 5.1, includes the processes required to ensure that the project includes all the work required, and only the work required, to complete the project successfully. Project scope management is primarily concerned with defining and controlling what is and is not included in the project. The processes involved are

- 1. Scope Planning** - Scope planning is creating a project scope management plan that documents how the project scope will be defined, verified, controlled, and how the Work Breakdown Structure (WBS) will be created and defined.
- 2. Scope Definition** - Scope definition is developing a detailed project scope statement as the basis for future project decisions.
- 3. Create WBS** - Subdividing (i.e. decompose or breakdown to) the major project deliverables and project work into smaller, more manageable components.

**4. Scope Verification** - Scope verification is formalising acceptance of the completed project deliverables.

**5. Scope Control** - Controlling changes to the project scope.

These processes interact with each other and with processes in the other Knowledge Areas as well. Each process can involve effort from one or more persons or groups of persons, based on the needs of the project. Each process occurs at least once in every project and occurs in one or more project phases (provided the project is divided into phases).



**Figure 5.1. Overview of Project Scope Management Processes**

## 5.1. Scope Planning

Planning the project scope involves progressive elaboration. The project scope begins broad and through refinement becomes focused on the required work to create the product of the project. The project manager and the project team must examine the product scope—what the customer expects the project to create—in order to plan on how to achieve that goal.

To define how the project scope is created and then managed, the scope planning process will rely on the:

- Enterprise environmental factors

the organisation's culture, defined tools, human resources, and the policies of the organisation.

- Organisational process assets

the formal and informal policies and procedures that influence the way a project manager manages a project. *Defining and managing the project scope influences the project's overall success.* Each project requires to ensure that the effort expended on scoping activities is commensurate with the project's size, complexity, and importance.

*The project scope management plan is a planning tool describing how the team will define the project scope, develop the detailed project scope statement, define and develop the work breakdown structure, verify the project scope, and control the project scope.*

The development of the *project scope management plan* and the detailing of the project scope begin with the analysis of information contained in:

- the project charter,
- the preliminary project scope statement,
- the latest approved version of the *project management plan*,
- historical information contained in the *organisational process assets*, and any relevant enterprise environmental factors.

## **Scope Planning: Inputs**

### **1. Enterprise Environmental Factors**

Enterprise environmental factors include items such as the organisation's culture, infrastructure, tools, human resources, personnel policies, and marketplace conditions that could affect how project scope is managed.

### **2. Organisational Process Assets**

Organisational process assets are the formal and informal policies, procedures, and guidelines that could impact how the project's scope is managed. Those of particular interest to project scope planning include:

- Organisational policies as they pertain to project scope planning and management
- Organisational procedures related to project scope planning and management
- Historical information about previous projects that may be located in the lessons learned knowledge base.

### **3. Project Charter**

The document that formally authorises a project or a project phase. (Please see section on project integration for more details).

### **4. Preliminary Project Scope Statement**

The document that provides a high-level scope narrative.

## **5. Project Management Plan**

Contains the actions necessary to define, prepare, integrate, and coordinate all subsidiary plans into a project management plan.

### **Scope Planning: Tools and Techniques**

The goal of scope planning is to create a project scope statement and the project scope management plan, two of the outputs of the scope planning process. The project manager and the project team must have a full understanding of the project requirements, the business need of the project, and stakeholder expectations to be successful in creating the scope statement and the scope management plan. Recall that there are two types of scope:

- **Product scope** Features and functions of the product of the project
- **Project scope** The work needed to create the product of the project

There are two tools that the project manager and the project team can rely on to plan the project scope.

#### **1. Expert Judgment**

Expert judgment related to how equivalent projects have managed scope is used in developing the project scope management plan.

Expert judgment can come from experts within the organisation or third-party experts, such as consultants or even key stakeholders.

#### **2. Templates, Forms, Standards**

The second set of tools the project manager can rely on during scope planning is the templates, forms, and standards an organisation may

provide. Common templates and forms for projects include work breakdown structure templates, scope management plan templates, and project scope change control forms. Standards are guidelines that an organisation has created to direct project teams in their scope-planning endeavors.

## **Scope Planning: Outputs**

### **1. Project Scope Management Plan**

The scope management plan explains how the project scope will be managed and how scope changes will be factored into the project plan, in effect it is a plan that guards the scope from unauthorised changes. Based on the conditions of the project, the project work, and the confidence of the project scope, the scope management plan should also define the likelihood of changes to the scope, how often the scope may change, and how much the scope can change. The scope management plan also details the process of how changes to the project scope will be documented and classified throughout the project life cycle.

Every scope management plan should define four things:

- The process to create a detailed project scope statement
- The process to create the WBS based on the project scope statement—and the methods for maintaining the WBS integrity and the process for WBS approval
- The process for formal acceptance of the project deliverables by the project customer
- The process for evaluating, and approving or declining, project change requests

*A project scope management plan is contained in, or is a subsidiary of, the project management plan.* The project scope management plan can be informal and broadly framed, or formal and highly detailed, based on the needs of the project.

## 5.2. Scope Definition

The process of scope definition is all about breaking down the work into manageable chunks. The preparation of a detailed project scope statement is critical to project success and builds upon the major deliverables, assumptions, and constraints that are documented during project initiation in the preliminary project scope statement. Stakeholder needs, wants, and expectations are analysed and converted into requirements.

The project assumptions and constraints are analysed for completeness, with additional assumptions and constraints added as necessary. The project team and other stakeholders, who have additional insight into the preliminary project scope statement, can perform and prepare the analyses.

### Scope Definition: Inputs

The following are the inputs to defining the scope of a project with a brief explanation on each of them:

#### **1. Organisational Process Assets**

The formal and informal guidelines, policies, and procedures that influence how a project scope is managed.

#### **2. Project Charter**

The project charter authorises the project and the project manager. If a project charter is not used in a performing organisation, then comparable information needs to be acquired or developed, and used to develop the detailed project scope statement.

### **3. Preliminary Project Scope Statement**

This is the project scope statement that was created during project initiation. If a preliminary project scope statement is not used in a performing organisation, then comparable information, including the product scope description, needs to be acquired or developed and used to develop the detailed project scope statement.

### **4. Project Scope Management Plan**

Defines how the project scope will be managed. Every scope management plan should define four things:

- The process to create a detailed project scope statement
- The process to create the WBS based on the project scope statement—and the methods for maintaining the WBS integrity and the process for WBS approval
- The process for formal acceptance of the project deliverables by the project customer
- The process for evaluating, and approving or declining, project change requests

*A project scope management plan is contained in, or is a subsidiary of, the project management plan.* The project scope management plan can be informal and broadly framed, or formal and highly detailed, based on the needs of the project.

### **5. Approved Change Requests**

Approved change requests can cause a change to project scope, project quality, estimated costs, or project schedule. Changes are often identified and approved while the work of the project is ongoing.

## Scope Definition: Tools and Techniques

### 1. Product Analysis

Product analysis is, as the name implies, analysing the product the project will create. Product analysis is a method for converting the product description into project deliverables and requirements. Specifically, it involves understanding all facets of the product, its purpose, how it works, and its characteristics. Product analysis includes techniques such as product breakdown, systems analysis, systems engineering, value engineering, value analysis, and functional analysis. Product analysis can be accomplished through one or more of the following:

- **Product breakdown:** This method breaks down the product into components, examining each component individually and how it may work with other parts of the product. This approach can be used in chemical engineering to see how a product, such as a pharmaceutical, is created and how effective it is.
- **Systems engineering:** This process focuses on satisfying the customers' needs, cost requirements, and quality demands through the design and creation of the product. There is an entire science devoted to systems engineering in various industries.
- **Value engineering:** Deals with reducing costs and increasing profits, all while improving quality. Its focus is on solving problems, realising opportunities, and maintaining quality improvement.
- **Value analysis:** Similar to value engineering, this focuses on the cost/quality ratio of the product. For example, your expected level of quality of a \$100,000 car versus a \$6,700 used car is likely relevant to the cost of each. Value analysis focuses on the expected quality against the acceptable cost—also known as the cost of quality.
- **Function analysis:** Related to value engineering, this allows team input to the problem, institutes a search for a logical solution, and tests the functions of the product so the results can be graphed.

- **Quality function:** This deployment is a philosophy and a practice to fully understand customer needs—both spoken and implied—without incorporating unnecessarily costly features or refinements into the project deliverables.

## 2. Alternatives Identification

Identifying alternatives is a technique used for discovering different methods or ways of accomplishing the project. A variety of general management techniques is often used here, the most common of which are brainstorming and lateral thinking.

## 3. Expert Judgment

Each application area has experts who can be used to develop portions of the detailed project scope statement.

## 4. Stakeholder Analysis

For a project to be successful, the project manager and the project team must know what the stakeholders of the project expect. This means communication between the project manager and the stakeholders. Business analysts may be involved or even facilitate this process of scope definition, but the end result is the same: the expectations of the project stakeholders must be identified, documented, and then prioritised.

This is also the time to define exactly what the stakeholders' expectations are of the project outcomes. Unquantifiable metrics, such as customer satisfaction, "good," and "fast" is inappropriate. The project manager and the stakeholders must agree on metrics that indicate a project's success or failure.

Stakeholder analysis identifies the influence and interests of the various stakeholders and documents their needs, wants, and expectations. The analysis then selects, prioritises, and quantifies the needs, wants, and expectations to create requirements. Unquantifiable expectations, such as

customer satisfaction, are subjective and entail a high risk of being successfully accomplished. Stakeholders' interests may be positively or negatively affected by execution or completion of the project and they may also exert influence over the project and its deliverables.

It is important for the project manager to understand each stakeholder's role in the project and their role in the organisation. Effective communication with stakeholders is essential.

## **Scope Definition: Outputs**

### **1. Project Scope Statement**

The scope statement, an output of scope planning, is the guide for all future project decisions when it comes to change management (serving as a reference to determine if the change is in or out of scope). The scope statement allows the project team to manage all of the work, and only the work, of the project to create the project's deliverables. It is the key document to providing understanding of the project purpose. The scope statement provides justification for the project existence, lists the high-level deliverables, and quantifies the project objectives. The scope statement is a powerful document that the project manager and the project team will use as a point of reference for potential changes, added work, and any project decisions.

The degree and level of detail to which the project scope statement defines *what work will be performed and what work is excluded can determine how well the project management team can control the overall project scope*. Managing the project scope, in turn, can determine how well the project management team can plan, manage, and control the execution of the project. The *detailed project scope statement* includes, either directly or by reference to other documents:

- **Project objectives:** Objectives are quantifiable criteria used to measure project success. Project objectives are specific conditions

that determine the success of a project. Conditions are typically cost, schedule, and quality metrics. Vague metrics, such as customer satisfaction, increase risk for the project since the metric “customer satisfaction” is subjective and not quantified.

Objectives should follow the SMART rule:

**S** – Specific. Objectives should be specific and written in clear, concise, and understandable terms.

**M** – Measurable. Objectives should be measurable.

**A** – Accurate. Objectives should be accurate and should describe precisely what’s required.

**R** – Realistic and tangible. Objectives that are impossible to accomplish are not realistic and not attainable.

**T** – Time bound. Objectives should have a time frame with an end date assigned to them.

- **Product scope description:** The product scope description defines the characteristics and features of the product or service the project is aiming to create. In most projects, the product scope will be vague early in the scope planning process and then more details will become available as the product scope is progressively elaborated.
- **Project requirements:** The scope statement must define the requirements that the project must adhere to in order for the project to be deemed successful. This includes the prioritisation of the stakeholders’ needs, wants, and expectations.
- **Project boundaries:** Every project has boundaries. The scope statement defines the boundaries of the project by defining what’s included in the project scope—and what’s excluded. For example, a project to create a piece of software may include the created compilation of a master software image, but excludes the packaging and delivery of the software to each workstation within an organisation.

- **Project deliverables:** The high-level deliverables of the project should be identified. These deliverables, when predefined metrics are met, signal that the project scope has been completed. When appropriate, the scope statement should also list what deliverables are excluded from the project deliverables. For example, a project to create a new food product may state that it is not including the packaging of the food product as part of the project. Items and features not listed as part of the project deliverables should be assumed to be excluded.
- **Project acceptance criteria:** The scope statement defines the requirements for acceptance. This establishes what exactly qualifies a project's success or failure.
- **Project constraints:** A constraint is anything that restricts the project manager's options. Common constraints include predefined budgets and schedules. Constraints may also include resource limitations, material availability, and contractual restrictions.
- **Project assumptions:** An assumption is anything held to be true, but not proven to be true. For example, weather, travel delays, the availability of key resources, and access to facilities can all be assumptions.
- **Initial project organisation:** The project team members, the project manager, and the key stakeholders are identified and documented. The chain of command within the project is also documented.
- **Initial defined risks:** The scope statement should document the known risks and what their expected probability and impact on the project may be.
- **Scheduled milestones:** The project customer may have identified milestones within the project and assigned deadlines using these milestones. The scope should thus identify these milestones which are essentially schedule constraints.

- **Fund limits:** Most projects have a limitation on available funding. This limit should be identified in the project scope statement.
- **Cost estimate:** Just as organisations have a limited amount of funds to invest in a project, they have expectations for an estimate of what the project should cost to complete. This estimate usually includes some modifier, such as +/- a percentage or dollar amount.
- **Project configuration management requirements:** Configuration management describes the characteristics of the product of the project and ensures that the description is accurate and complete.
- **Project specifications:** Most technical projects have specifications which the project must adhere to. The project scope statement should identify the specifications and the expectations on the project team to meet them.
- **Project approval requirements:** The approval requirements for project documentation, processes, work, and project acceptance must be identified within the project scope statement.

Project scope statement is a significant document that aims to create the confines of the project and the expectations of the project manager, the project team, and the project customers. It defines what's in and what's out of the project scope.

During the scope statement creation, the project manager may also face change requests from the project stakeholders. Change requests are managed through the integrated change control process, which basically means that any proposed change is reviewed and its impact on all areas of the project are considered. If a change is approved, then the scope statement should be updated to reflect the approved change.

## 2. Requested Changes

Requested changes to the project management plan and its subsidiary plans may be developed during the Scope Definition process.

Requested changes are processed for review and disposition through the Integrated Change Control process.

### **3. Project Scope Management Plan (Updates)**

The project scope management plan component of the project management plan may need to be updated to include approved change requests resulting from the project's Scope Definition process.

### **5.3. Create Work Breakdown Structure (WBS)**

*The WBS is a deliverable-oriented hierarchical decomposition of the work to be executed by the project team, to accomplish the project objectives and create the required deliverables.*

*The WBS maps out the deliverables of the projects with subdeliverables and other components stemming from each major deliverable in a chart or tree format.*

The WBS organises and defines the total scope of the project. As you can see in Figure 5.1, each level of the WBS becomes more detailed. The WBS subdivides the project work into smaller, more manageable pieces of work, with each descending level of the WBS representing an increasingly detailed definition of the project work.

The planned work contained within the lowest-level WBS components, which are called work packages, can be scheduled, cost estimated, monitored, and controlled. The WBS represents the work specified in the current approved project scope statement. Components comprising the WBS assist the stakeholders in viewing the deliverables of the project.

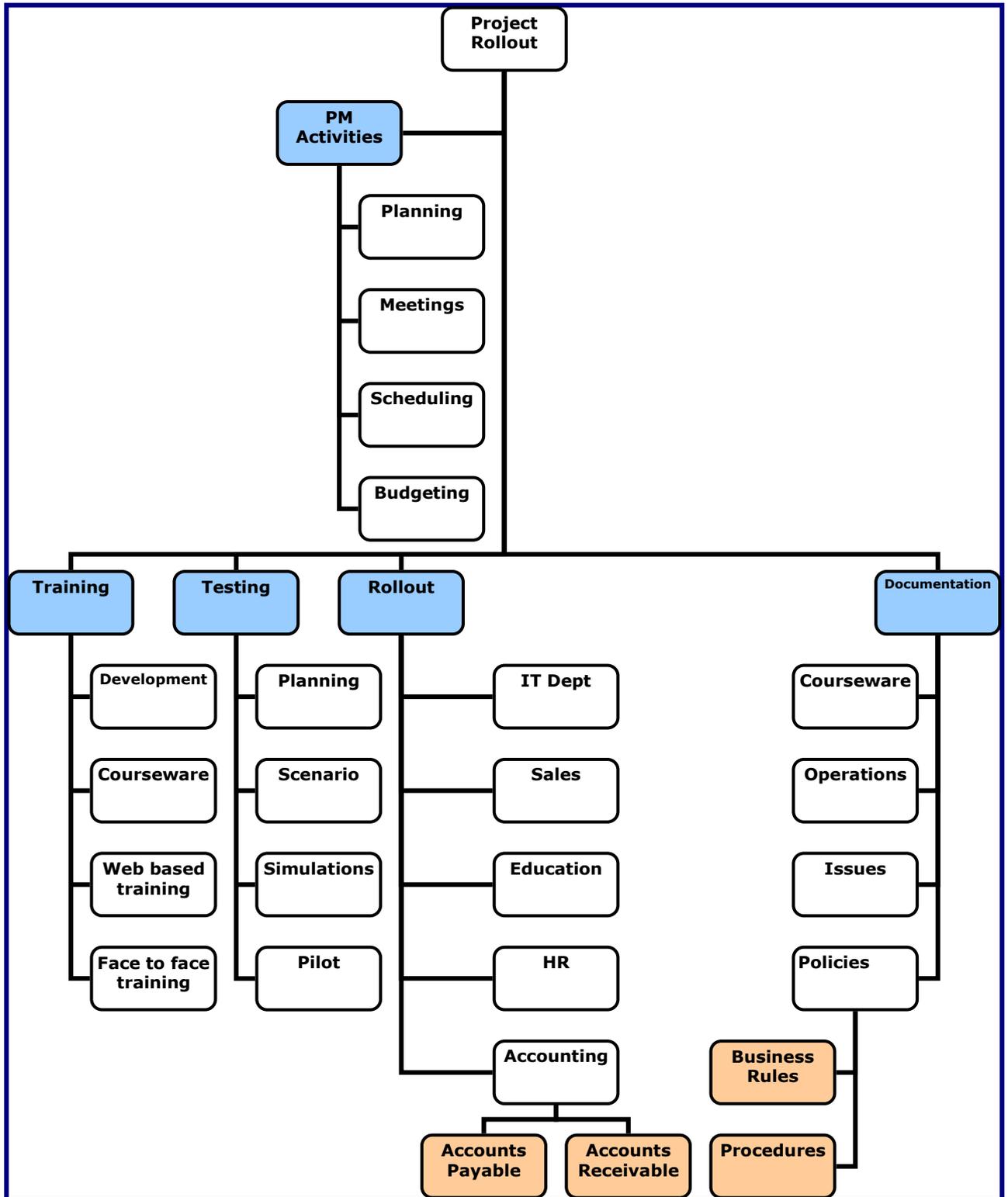


Figure 5-1. Sample Work Breakdown Structure

## Create WBS: Inputs

The components in the WBS should be included in a WBS dictionary. A WBS dictionary is a reference tool to explain the WBS components, the nature of the work package, the assigned resources, and the time and billing estimates for each element. The WBS also identifies the relationship between work packages. Finally, the WBS should be updated to reflect changes to the project scope. Following are essential elements about the WBS:

- It serves as a major component of the project scope baseline.
- It's one of the most important project management tools.
- It serves as the foundation for planning, estimating, and project control.
- It visualises the entire project.
- Work not included in the WBS is not part of the project.
- It builds team consensus and buy-in to the project.
- It serves as a control mechanism to keep the project on track.
- It allows for accurate cost and time estimates.
- It serves as a deterrent to scope change.

In addition to the above, the WBS is an input to the following five core processes:

- Cost estimating
- Cost budgeting
- Resource planning
- Risk management planning
- Activity definition

The following are a minimum set of inputs necessary to develop a WBS:

### **1. Organisational Process Assets**

This comprises all policies, procedures and assets of the organisation which may assist in developing the project charter and subsequent project documentation. *(Please see Organisation Process Assets under Project Integration Management Knowledge Area for more details)*

### **2. Project Scope Statement**

The scope statement, an output of scope planning, is the guide for all future project decisions when it comes to change management. It is the key document to providing understanding of the project purpose. The scope statement provides justification for the project existence, lists the high-level deliverables, and quantifies the project objectives.

The degree and level of detail to which the project scope statement defines *what work will be performed and what work is excluded can determine how well the project management team can control the overall project scope*. Managing the project scope, in turn, can determine how well the project management team can plan, manage, and control the execution of the project. The *detailed project scope statement* includes, either directly or by reference to various other documents. *(Please see previous section on Project Scope Statement for full details)*.

### **3. Project Scope Management Plan**

The scope management plan explains how the project scope will be managed and how scope changes will be factored into the project plan. Based on the conditions of the project, the project work, and the confidence of the project scope, the scope management plan should also define the likelihood of changes to the scope, how often the scope may change, and how much the scope can change. The scope management plan also details the process of how changes to the project scope will be

documented and classified throughout the project life cycle. Every scope management plan should define four things:

- The process to create a detailed project scope statement
- The process to create the WBS based on the project scope statement—and the methods for maintaining the WBS integrity and the process for WBS approval
- The process for formal acceptance of the project deliverables by the project customer
- The process for evaluating, and approving or declining, project change requests

*A project scope management plan is contained in, or is a subsidiary of, the project management plan.* The project scope management plan can be informal and broadly framed, or formal and highly detailed, based on the needs of the project.

#### **4. Approved Change Requests**

Approved change requests are the documented, authorised changes to expand or contract project scope. The approved change requests can also modify policies, project management plans, procedures, costs or budgets, or revise schedules.

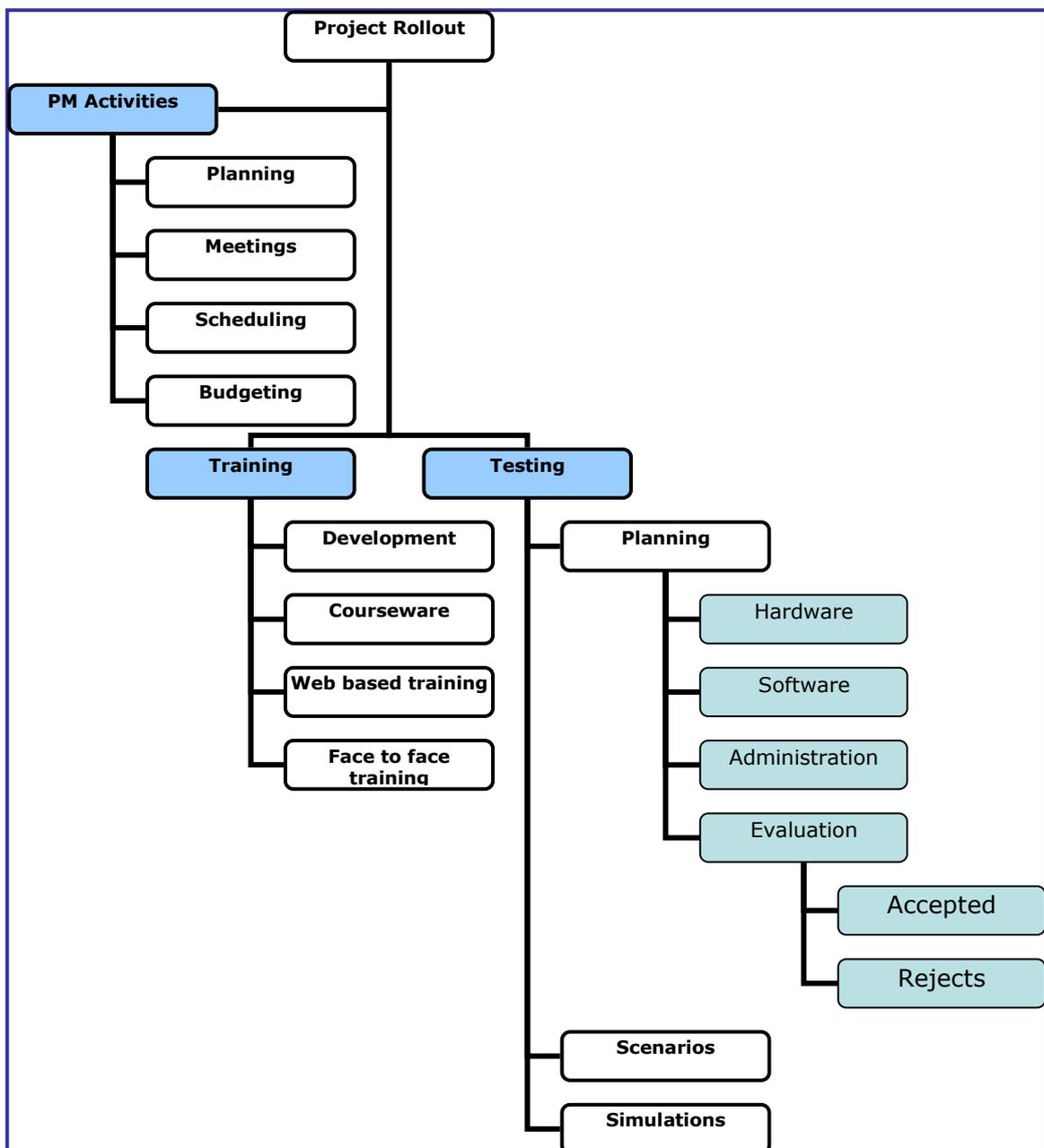
### **Create WBS: Tools and Techniques**

#### **1. Work Breakdown Structure Templates**

A WBS breaks down work into a deliverables-orientated collection of manageable pieces (see Figure 5-2). It is not a list of activities necessary to complete the project. A WBS template uses a similar project's WBS as a guide for the current work. This approach is recommended since most projects in an organisation are similar in their project life cycles—and the approach can be adapted to fit a given project.

Many application areas of performing organisations have standard

WBS templates. Depending on the organisation and its structure, an entity may have a common WBS template that all projects follow. The WBS template may have common activities included in the form, a common lexicon for the project in the organisation, and a standard approach to the level of detail required for the project type. *Although each project is unique, a WBS from a previous project can often be used as a template for a new project, since some projects will resemble another prior project to some extent.*



**Figure 5-2.** This section of the WBS has been expanded to provide more detail.

## 2. Decomposition

Decomposition is the process of breaking down the major project deliverables into smaller, manageable components. *Decomposition is the subdivision of project deliverables into smaller, more manageable components until the work and deliverables are defined to the work package level. The work package level is the lowest level in the WBS, and is the point at which the cost and schedule for the work can be reliably estimated. The level of detail for work packages will vary with the size and complexity of the project.*

*Decomposition may not be possible for a deliverable or subproject that will be accomplished far into the future. The project management team usually waits until the deliverable or subproject is clarified so the details of the WBS can be developed. This technique is sometimes referred to as "rolling wave planning".*

*Different deliverables can have different levels of decomposition. To arrive at a manageable work effort (i.e., a work package), the work for some deliverables needs to be decomposed only to the next level, while others need more levels of decomposition. As the work is decomposed to lower levels of detail, the ability to plan, manage, and control the work is enhanced. However, excessive decomposition can lead to non-productive management effort, inefficient use of resources, and decreased efficiency in performing the work. The project team needs to seek a balance between too little and too much in the level of WBS planning detail.*

Decomposition of the total project work generally involves the following activities:

1. The major deliverables of the project are identified. This includes the project management activities. A logical approach includes identifying the phases of the project life cycle or the major deliverables of the project.

2. Determine if adequate cost and time estimates can be applied to the lowest level of the decomposed work. Adequate is subjective to the demands of the project work. Deliverables that won't be realised until later portions of the project may be difficult to decompose since there are many variables between now and when the deliverable is created. The smallest component of the WBS is the work package.

3. Identify the deliverable's constituent components. Meaning, can the project deliverable be measured at this particular point of decomposition. For example, the decomposition of a user manual may have the constituent components of assembling the book, confirming that the book is complete, shrink-wrapping the book, and shipping it to the customer. Each component of the work can be measured, and may take varying amounts of time to complete, but it all must be done to complete the requirement.

4. Verify the decomposition. The lower-level items must be evaluated to ensure they are complete and accurate. Each item within the decomposition must be clearly defined and deliverable-orientated. Finally, each item should be decomposed to the point that it can be scheduled, budgeted, and assigned to a resource.

5. Other approaches include breaking it out by geography or functional area, or even breaking the work down by in-house and contracted work.

Identifying the major deliverables of the project and the work needed to produce those deliverables requires analysing the detailed project scope statement. This analysis requires a degree of expert judgment to identify all the work including project management deliverables and those deliverables required by contract.

Structuring and organising the deliverables and associated project work into a WBS that can meet the control and management requirements of the project management team is an analytical technique that may be done with the use of a WBS template.

Decomposition of the upper level WBS components requires subdividing the work for each of the deliverables or subprojects into its fundamental components, where the WBS components represent verifiable products, services, or results. Each component should be clearly and completely defined and assigned to a specific performing organisational unit that accepts responsibility for the WBS component's completion. The components are defined in terms of how the work of the project will actually be executed and controlled. For example, the status reporting component of project management could include weekly status reports, while a product to be manufactured might include several individual physical components plus the final assembly.

## **Create WBS: Outputs**

### **.1 Project Scope Statement (Updates)**

If approved change requests result from the Create WBS process, then the project scope statement is updated to include those approved changes.

### **.2 Work Breakdown Structure**

*The key document generated by the Create WBS process is the actual WBS. Each WBS component, including work package and control accounts within a WBS, is generally assigned a unique identifier from a code of accounts. These identifiers provide a structure for hierarchical summation of costs, schedule, and resource information. For example:*

20 Requirements Definition

20-1 Game Requirements

20-1-1 Define Characters

20-1-2 Define Instruments

## 20-2 Software Requirements

### 20-2-1 Determine Language

### 20-2-2 Define Systems

The WBS *should not be confused with other kinds of breakdown structures* used to present project information. Other structures used in some application areas or other Knowledge Areas include:

- Organisational Breakdown Structure (OBS). Provides a hierarchically organised depiction of the project organisation arranged so that the work packages can be related to the performing organisational units.
- Bill of Materials (BOM). Presents a hierarchical tabulation of the physical assemblies, subassemblies, and components needed to fabricate a manufactured product.
- Risk Breakdown Structure (RBS). A hierarchically organised depiction of the identified project risks arranged by risk category.
- Resource Breakdown Structure (RBS). A hierarchically organised depiction of the resources by type to be used on the project.

### **.3 WBS Dictionary**

*The document generated by the Create WBS process that supports the WBS is called the WBS dictionary and is a companion document to the WBS. The detailed content of the components contained in a WBS, including work packages and control accounts, can be described in the WBS dictionary. For each WBS component, the WBS dictionary includes:*

- *Code of account identifier*
- *Statement of work*
- *Responsible organisation,*

- *List of schedule milestones*

Other information for a WBS component can include:

- Contract information
- Quality requirements
- Resource requirements
- Technical references to facilitate performance of the work

#### **.4 Scope Baseline**

The scope baseline for the project is the approved project scope statement, the WBS, and the WBS dictionary. The *approved detailed project scope statement* and its associated WBS and *WBS dictionary* are the scope baseline for the project from which the project manager will document schedules, assign resources, and monitor and control the work of the project.

#### **.5 Project Scope Management Plan (Updates)**

If approved change requests result from the Create WBS process, then the project scope management plan may need to be updated to include approved changes.

#### **.6 Requested Changes**

Requested changes to the project scope statement and its components may be generated from the Create WBS process, and are processed for review and approval through the integrated change control process.

## 5.4. Scope Verification

Scope verification is the process of the project customer accepting the project deliverables. Once the project scope has been completed to plan, scope verification should be conducted. Scope verification is ensuring that the deliverables the project creates are in alignment with the project scope. Scope verification is concerned with the acceptance of the work. A related activity, quality control, is concerned with the correctness of the work. Scope verification and quality control happen in tandem as the quality of the work contributes to scope verification. Poor quality will typically result in scope verification failure.

Should a project get cancelled before it has completed the scope, scope verification is measured against the deliverables up to the point of the project's cancellation. In other words, scope verification measures the completeness of the work up to cancellation, not the work that was to be completed after project termination. *Scope verification is the process of obtaining the stakeholders' formal acceptance of the completed project scope and associated deliverables.* Verifying the project scope includes reviewing deliverables to ensure that each is completed satisfactorily. If the project is terminated early, the project scope verification process should establish and document the level and extent of completion.

Scope verification *differs from quality control* in that *scope verification is primarily concerned with acceptance of the deliverables, while quality control is primarily concerned with meeting the quality requirements specified for the deliverables. Quality control is generally performed **before** scope verification, but these two processes can be performed in parallel.*

## Scope Verification: Inputs

To verify the project scope, which is accomplished through inspection, there must be something to inspect—namely work results. The work results are compared against the project plan to check for their completeness and against the quality control measure to check their correctness of the work. One of the biggest inputs of scope verification is the product documentation. This information describes the requirements and expectations of the product, its features, and attributes. The product documentation varies by many different names depending on the industry. A few project documentation names include the following:

- Plans
- Specifications
- Technical documentation
- Drawings
- Blueprints

The WBS which is a collection of deliverables-orientated components can be used to ensure that the defined project work has been completed to obtain all of the components of the product. The WBS allows the project manager, the project team, and the customer to verify that the necessary work was completed to create the deliverable. Some of the inputs which must be considered when verifying scope include:

- 1. *Project Scope Statement***
- 2. *WBS Dictionary***
- 3. *Project Scope Management Plan***
- 4. *Deliverables***

## Scope Verification: Tools and Techniques

To complete scope verification, the work must be inspected. This may require measuring, examining, and testing the product to prove it meets customer requirements. Inspection usually involves the project manager and customer inspecting the project work for verification, which in turn results in acceptance. Depending on the industry, inspections may also be known as:

- Reviews
- Product reviews
- Audits
- Walkthroughs

### **1 Inspection**

Inspection includes activities such as measuring, examining, and verifying to determine whether work and deliverables meet requirements and product acceptance criteria. *Inspections are variously called reviews, product reviews, audits, and walkthroughs.* In some application areas, these different terms have narrow and specific meanings.

## Scope Verification: Outputs

Assuming the scope has been verified, the customer accepts the deliverable. This is a formal process that requires signed documentation of the acceptance by the sponsor or customer. Scope verification can also happen at the end of each project phase or at major deliverables within the project. In these instances, scope verification may be conditional, based on the work results. When the scope is not verified, the project may undergo one of several actions. It may be cancelled and deemed a failure, sent through corrective actions, or put on hold while a decision is made based on the project or phase results.

### **.1 Accepted Deliverables**

The Scope Verification process documents those *completed deliverables that have been accepted*. Those completed deliverables that have not been accepted are documented, along with the reasons for non-acceptance. *Scope verification includes supporting documentation received from the customer or sponsor and acknowledging stakeholder acceptance of the project's deliverables.*

### **.2 Requested Changes**

Requested changes may be generated from the Scope Verification process, and are processed for review and disposition through the Integrated Change Control process.

### **.3 Recommended Corrective Actions**

Some defects which are found during the quality inspection and audit process are recommended for correction.

## 5.5. Scope Control

When it comes to project management, the one constant thing is change. Changes happen, or try to happen, all the time in projects. The project manager must have a reliable system to track, monitor, manage, and review changes to the project scope. Change control focuses on three things:

- It facilitates scope changes to determine that changes are agreed upon.
- It determines if a scope change has happened.
- It manages the scope changes when, and if, they happen.

Project scope control is concerned with influencing the factors that create project scope changes and controlling the impact of those changes. *Scope control assures all requested changes and recommended corrective actions are processed through the Project Integrated Change Control process.* Project scope control is also used to manage the actual changes when they occur and is integrated with the other control processes. *Uncontrolled changes are often referred to as project scope creep.*

### Scope Control: Inputs

Throughout a project's life, the need and desire for change will come from project team members, the sponsor, management, customers, and other stakeholders. All of these change requests must be coupled with supporting evidence to determine the need of the change, the change's impact on the project scope (and usually on other processes as well), and the required planning, schedule, and budget to account for the changes.

### Using the WBS

The WBS serves as an input to the scope change control. It represents the sum of the components, and ultimately the project work, that make up the project scope. It is part of the project scope baseline. The change requests may be for additional components in the project

deliverables, changes to product attributes, or changes to different procedures to create the product. The WBS is referenced to determine which work packages would be affected by the change, and which may be added or removed as a result of the change.

### ***Evaluating Performance Reports***

Performance reports provide information on project work performance, such as interim deliverables that have been completed. Performance reports indicate how the project is going—good or bad. Performance reports can lead to change requests. How? When a project is going astray operating beyond its budget, or off schedule, changes may be made to reduce the project scope, add corrective actions, or add quality activities to ensure the product is correct.

### ***Considering Change Requests***

Some project managers despise change requests. Change requests can mean additional work, adjustments to the project, or a reduction in scope. They mean additional planning for the project manager, time for consideration, and can be seen as a distraction from the project execution and control. Change requests, however, are a very real and expected part of project management. They can come in several modalities:

- Oral or written
- Direct or indirect
- Internal or external
- Legally mandated or optional

Why do change requests happen? And which ones are most likely to be approved? Most change requests are a result of:

- **Value-added** The change will reduce costs (this is often due to technological advances since the time when the project scope was created)

- **External events** These could be such things as new laws or industry requirements.
- **Errors or omissions** Errors and omissions can happen to both the project scope (the work to complete the project) and the product scope, and typically constitute an overlooked feature or requirement.
- **Risk response** A risk has been identified and changes to the scope are needed to mitigate the risk.

### ***Relying on the Scope Management Plan***

It's an output of scope planning and controls how the project scope can be changed. The scope management plan also defines the likelihood of the scope to change, how often the scope may change, and how much it may change. The scope management plan also details the process of how changes to the project scope will be documented and classified throughout the project life cycle.

### ***Project Scope Statement***

The project scope statement, along with its associated WBS and WBS dictionary, defines the project's scope baseline and product scope.

An approved change request impacting project scope is any modification to the agreed-upon project scope baseline, as defined by the approved project scope statement, WBS, and WBS dictionary.

### ***Work Performance Information***

Information on the status of the project activities being performed to accomplish the project work is routinely collected as part of the project management plan execution. This information includes, but is not limited to:

- Schedule progress showing status information
- Deliverables that have been completed and those not completed

- Schedule activities that have started and those that have been finished
- Extent to which quality standards are being met
- Resource utilisation detail.

## **Scope Control: Tools and Techniques**

The most prominent tool applied with scope change control is the Change Control System. Because changes are likely to happen within any project, there must be order to process, document, and manage the changes. The Change Control System includes the following:

- Cataloguing the documented requests and paperwork
- Tracking the requests through the system
- Determining the required approval levels for varying changes
- Supporting the integrated change control policies of the project
- In instances when the project is performed through a contractual relationship, the scope change control system must map to the requirements of the contract.

### **.1 Change Control System**

*A project scope change control system, documented in the project scope management plan, defines the procedures by which the project scope and product scope can be changed.* The system includes the documentation, tracking systems, and approval levels necessary for authorising changes. The scope change control system is integrated with any overall project management information system to control project scope. When the project is managed under a contract, the change control system also complies with all relevant contractual provisions.

## **.2 Variance Analysis**

Project performance measurements are used to assess the magnitude of variation. Important aspects of project scope control include determining the *causes of variance relative to the scope baseline* and deciding whether corrective action is required.

## **.3 Replanning**

Approved change requests affecting the project scope can require modifications to the WBS and WBS dictionary, the project scope statement, and the project scope management plan. These approved change requests can cause updates to components of the project management plan.

## **.4 Configuration Management System**

A formal configuration management system provides procedures for the status of the deliverables, and assures that requested changes to the project scope and product scope are thoroughly considered and documented before being processed through the Integrated Change Control process.

### **Scope Control: Outputs**

#### **.1 Project Scope Statement (Updates)**

When changes to the project scope have been approved, the documented project scope must be updated to reflect these new changes. The stakeholders affected by the scope changes must be notified. The WBS must also be updated to reflect the components added, or removed, from the project. Scope changes can include cost updates, schedule updates, quality updates, or changes to the project deliverables.

When the project scope is to be changed, the new requirements must pass through the planning processes. The changes must be evaluated for cost and time estimates, risk, work considerations, product specification, and technical specification.

### ***.2 Work Breakdown Structure (Updates)***

If the approved change requests have an effect upon the project scope, then the WBS is revised and reissued to reflect the approved changes.

### ***.3 WBS Dictionary (Updates)***

If the approved change requests have an effect upon the project scope, then the WBS dictionary is revised and reissued to reflect the approved changes.

### ***.4 Scope Baseline (Updates)***

When changes are made, the project baselines will need to be adjusted to reflect these changes. Such changes can affect time, cost, schedule, and scope. The changes that affect the appropriate baseline should be updated to reflect the new project scope. The new baselines serve as a point of reference for the remainder of the project (assuming there are no additional changes). Should other changes occur, the baseline should be updated—enabling the project to continue.

### ***.5 Requested Changes***

The results of project scope control can generate requested changes, which are processed for review and disposition according to the project Integrated Change Control process.

### ***.6 Recommended Corrective Action***

A recommended corrective action is any step recommended to bring expected future project performance in line with the project management plan and project scope statement. Often the reason for change is due to faulty deliverables, quality problems, or poor performance of the project deliverables. Corrective actions are activities that will make an effort to bring the project back in line with the project plan. Errors and omissions in the product specifications are scope changes, not corrective action changes.

### ***.7 Organisational Process Assets (Updates)***

The causes of variances, the reasoning behind the corrective action chosen, and other types of lessons learned from project scope change control are documented and updated in the historical database of the organisational process assets. The lessons learned documentation should be updated as an output of scope change control. The project manager should document reasons why changes were approved, corrective actions were taken, components were added or removed from the scope — and the reasoning behind these decisions. Lessons learned will serve as future historical information to help guide other project managers.

### ***.8 Project Management Plan (Updates)***

If the approved change requests have an effect on the project scope, then the corresponding component documents and cost baseline, and schedule baselines of the project management plan, are revised and reissued to reflect the approved changes.

## Summary and Self Test

### TWO-MINUTE DRILL

#### Defining the Project Scope Statement

- ❑ Project scope planning aims to define what work is needed to complete the project objectives. The project scope statement defines what's in—and out—of scope and then serves as a guide to determine what work may be contributing to elements outside of the project scope.
- ❑ The project scope builds the product scope. If the project scope contains work that's not needed, then the product scope has changed from what the project customer is expecting. The product scope and the project scope support each other.
- ❑ Projects move through product-orientated processes to create the project's product. These processes are typically marked by phases unique to the project work. For example, foundation, framing, roofing, finishing, and so on. Project management processes are the activities universal to all projects.
- ❑ There are two scopes: the project scope and the product scope. The project scope is the work to be completed to create the product. The product scope describes the features of the product and its characteristics.

#### Working with Project Stakeholders

- ❑ The project manager and the project team must share the vision of the project's product. This vision, however, originates not with the project manager, but with the project customer. If the project manager and the project team do not understand the requirements of the project customer, then it'll be impossible to create the deliverable the customer is expecting.
- ❑ The project scope statement defines what the expectations of the project are. The project scope statement helps the project manager

determine if a change request is valid and should be incorporated into the project, or if the change request should be declined.

### **Creating the WBS**

- ❑ The WBS is a deliverables-oriented decomposition of the project scope. It is not the activity list, but the predecessor to creating the activity list. The WBS reflects, in detail, the elements and components that contribute to the project scope.
- ❑ The smallest item in the WBS is called the work package. The work package should follow the 8/80 rule which means it should not take less than 8 hours of labor to create the work package item and no more than 80 hours. Don't worry, this is just a heuristic. There may be small items that you want to account for in your WBS that don't follow this guideline.
- ❑ A WBS dictionary is a reference tool to explain the WBS components, the nature of the work package, the assigned resources, and the time and billing estimates for each element. The WBS also identifies the relationship between work packages.

### **Project Scopes**

- ❑ Scope management is the process that follows the scope management plan. It ensures that the scope includes all of the required work—and only the required work—to complete the project. It documents how changes may enter into the scope, and how frequently the scope is expected to change.
- ❑ At the end of the project or project phase—or even at major deliverables within the project—scope verification happens. Scope verification is the process of formally accepting the project work as defined in the product documentation, the project scope, or in the contractual agreement, if relevant. Formal acceptance requires signoff for acceptance of the product.

*Source: PMP Study Guide, Phillips 2006*

**SELF TEST**

- 1.** Of the following, which is not part of project scope management?
  - A. Scope planning
  - B. Scope verification
  - C. Quality assurance
  - D. Create WBS
  
- 2.** You are the project manager for the HGD Project and will need as many inputs to the scope planning as possible. Of the following, which one is not an organisational process asset?
  - A. Organisational procedures
  - B. Organisational policies
  - C. WBS
  - D. Historical information
  
- 3.** You are a project manager for your organisation. Sarah, a project manager in training, wants to know which project documents can stem from templates? Your answer should be...
  - A. Risk policies
  - B. Organisational policies
  - C. Scope management plans
  - D. Historical information
  
- 4.** You are the project manager for a technical project. The project product is the complete installation of a new operating system on 4500 workstations. You have, in your project cost and time estimates, told the customer that the estimates provided will be accurate if the workstations meet the hardware requirements of the new operating system. This is an example of which of the following?
  - A. Risk
  - B. Assumption
  - C. Constraint

D. Order of magnitude

**5.** You are the project manager for the NBG Project. This project must be completed within six months. This is an example of which of the following?

- A. Schedule
- B. Assumption
- C. Constraint
- D. Planning process

**6.** Which of the following best describes the project scope statement?

- A. The description of the project deliverables
- B. The authorising document that allows the project manager to move forward with the project and to assign resources to the tasks
- C. The document that allows the team to manage all of the required work—and only the required work—to create the project's deliverables
- D. The process of planning and executing all of the required work in order to deliver the project to the customer

**7.** During the planning phase of your project, your project team has discovered another method to complete a portion of the project scope. This method is safer for the project team, but may cost more for the customer. This is an example of:

- A. Risk assessment
- B. Alternative identification
- C. Alternative selection
- D. Product analysis

**8.** Of the following, which does the scope statement not provide?

- A. Project boundaries
- B. Project product
- C. Project manager authority
- D. Project objective

**9.** You are the project manager for the JHN Project. Mike, a project manager you are mentoring, does not know which plan he should reference for guarding the project scope. Which of the following plans does Mike need?

- A. The scope management plan
- B. The scope change control system
- C. The scope verification
- D. The scope charter

**10.** You are the project manager for the JKL Project. This project has over 45 key stakeholders and will span the globe when implemented. Management has deemed that the project's completion should not cost more than \$34 million. Because of the global concerns, the final budget must be in U.S. dollars. This is an example of which of the following?

- A. Internationalisation
- B. Budget constraint
- C. Management constraint
- D. Hard logic

**11.** You are the project manager for your organisation. You need to ensure the customer formally accepts the deliverables of each project phase. This process is known as \_\_\_\_\_?

- A. Earned value management
- B. Scope verification
- C. Quality control
- D. Quality assurance

**12.** Which of the following is an output of scope verification?

- A. WBS template
- B. Rework
- C. Formal acceptance
- D. SOW acceptance

**13.** Where can the project manager find work package information such as the code of an account identifier, a statement of work, information on the responsible organisation, quality requirements and information on the required resources?

- A. Project plan
- B. WBS
- C. WBS dictionary
- D. Project management plan

**14.** You are a project manager for a large manufacturer. Your current project is to create a new manufacturing assembly line that will allow your organisation to create its products with less downtime and faster turnaround time for its clients. A stakeholder has presented a change request for your project which will likely increase the cost and time needed to complete the project. All of the following components are not part of the Change Control System except for which one?

- A. Adding more team members to the project to get the project work done faster
- B. Outsourcing portions of the project execution to transfer risk
- C. Tracking systems for the proposed change
- D. Documenting the project and how the manufacturing assembly should work

**15.** A project team member has, on his own initiative, added extra vents to an attic to increase air circulation in the attic. The project plan did not call for these extra vents, but the team member decided they were needed based on the geographical location of the house. The project team's experts concur with this decision. This is an example of:

- A. Cost control
- B. Ineffective change control
- C. Self-led teams
- D. Value added change

**16.** Which of the following is an output of scope change control?

- A. Workarounds
- B. Recommended corrective action
- C. Transference
- D. Risk assessment

**17.** You are the project manager for the JHG Project. Your project is to create a new product for your industry. You have recently learned your competitor is also working on a similar project but their offering will include a computer-aided program and web-based tools, which your project does not offer. You have implemented a change request to update your project. This is an example of which of the following?

- A. A change due to an error or omission in the initiation phase
- B. A change due to an external event
- C. A change due to an error or omission in the planning phase
- D. A change due to a legal issue

**18.** You are the project manager for a pharmaceuticals company. A new government regulation will change your project scope. For the project to move forward and be in accordance with the new regulation, your next action should be?

- A. Prepare a new baseline to reflect the government changes
- B. Notify management
- C. Present the change to the Change Control Board (CCB)
- D. Create a feasibility study

**19.** You have finished the project scope according to plan. For the customer to accept the project, what must happen next?

- A. Nothing. The plan is complete so the project is complete.
- B. Scope verification should be conducted.
- C. Lessons learned should be finalised.
- D. Proof-of-concept should be implemented.

**20.** You are the project manager for an airplane manufacturer. Your project concerns the development of lighter, stronger material for commercial jets. As the project moves towards completion, different material composition is considered for the deliverable. This is an example of which of the following?

- A. Program management
- B. Alternatives identification
- C. Quality assurance
- D. Regulatory guidelines

**21.** You are the project manager of a large project. Your project sponsor and management have approved you to outsource portions of the project plan. The \_\_\_\_\_ must document project scope management decisions.

- A. Project sponsor
- B. Organisation's management
- C. Vendor(s)
- D. Project management team

**22.** A project team member has asked you what project scope management is. Which of the following is a characteristic of project scope management?

- A. It defines the baseline for project acceptance.
- B. It defines the requirements for each project within the organisation.
- C. It defines the processes to ensure that the project includes all the work required—and only the work required—to complete the project successfully.
- D. It defines the functional managers assigned to the project.

**23.** One of the stakeholders of the project you are managing asks why you consider the scope statement so important in your project management methodology. You answer her question with which of the following?

- A. It is mandatory to consult the plan before authorising any change.
- B. Project managers must document any changes before approving or declining them.
- C. The project scope statement serves as a reference for all change requests to determine if the change is in or out of scope.
- D. The project plan and Earned Value Management (EVM) work together to assess the risk involved with proposed changes.

**24.** A WBS serves as an input to many of the project management processes. Of the following, which is not true?

- A. WBS serves as an input to activity sequencing.
- B. WBS serves as an input to activity definition.
- C. WBS serves as an input to resource planning.
- D. WBS serves as an input to cost budgeting.

**25.** You are the project manager of the WIFI Project. You would like to meet with a stakeholder for scope verification. Which of the following is typical of scope verification?

- A. Reviewing changes to the project scope with the stakeholders
- B. Reviewing the performance of the project deliverables
- C. Reviewing the performance of the project team to date
- D. Reviewing the Earned Value Management (EVM) results of the project to date

*Source: PMP Study Guide, Phillips 2006*

## 6 Project Time Management

### Introduction

Effective project management requires adequate time for planning—and based on the results of that planning, adequate time for the implementation of those plans. In this book, we'll discuss how project activities are decomposed and then how the work packages are sequenced, calculated, and accounted for. Project Time Management includes the processes required to *accomplish timely completion* of the project. The Project Time Management processes include the following:

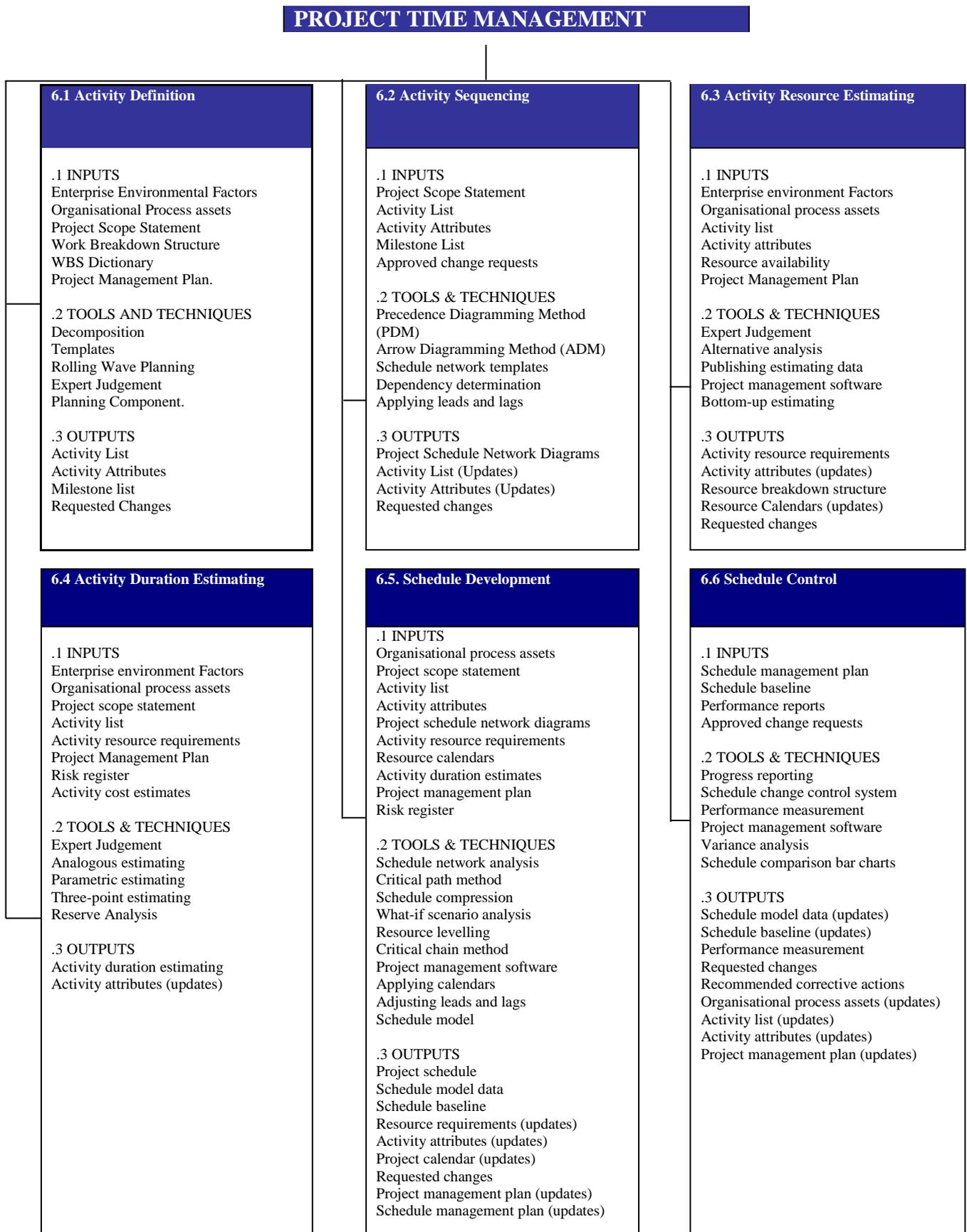
1. **Activity Definition** - Identifying the specific schedule **activities** *that need to be performed* to produce the various project deliverables.
2. **Activity Sequencing** - Identifying and documenting *dependencies* among schedule activities (*so as to arrive at a **project schedule network diagram***)
3. **Activity Resource Estimating** - Estimating the *type and quantities of resources* required to perform each schedule activity.
4. **Activity Duration Estimating** - **Estimating** the *number of work periods* that will be needed to complete individual schedule activities.
5. **Schedule Development** - Analysing activity sequences, durations, resource requirements, and schedule **constraints** to create the **project schedule**.
6. **Schedule Control** - Controlling changes to the project schedule.

These processes *interact with each other and with processes in the other Knowledge Areas as well*. Each process can involve effort from one or more persons or groups of persons, based on the needs of the project. Each process occurs at least once in every project and occurs in one or

more **project phases**, if the project is divided into phases. Although the processes are presented here as discrete **components** with well-defined interfaces, in practice they can overlap and interact in ways not detailed here.

*On some projects, especially ones of smaller scope, activity sequencing, activity resource estimating, activity duration estimating, and schedule development are so tightly linked that they are viewed as a single process that can be performed by a person over a relatively short period of time.*

Figure 6-1. Overview of Project Time Management Processes



## 6.1 Activity Definition

Projects are temporary undertakings to create a unique product or service. The idea of time is inherent to the very definition of a project in that all projects are temporary. Even though they may seem to last forever, sooner or later they must end. Adequate planning of the temporary project can predict when a project will end. Within this short, limited time, the project manager must create something: a product or a service.

Defining the schedule activities involves identifying and documenting the work that is planned to be performed. The **Activity Definition** process *will identify the deliverables at the lowest level in the work breakdown structure (WBS), which is called the work package. Project work packages are planned (decomposed) into smaller components called schedule activities to provide a basis for estimating, scheduling, executing, and monitoring and controlling the project work.*

### **Activity Definition: Inputs**

#### **.1 Enterprise Environmental Factors**

Enterprise environmental factors that can be considered include availability of project management information systems and scheduling software tools. This is all the inputs an organisation can offer the project manager to assist with the activity definition. In particular, it's the project management information system and scheduling software.

#### **.2 Organisational Process Assets**

Organisations have a way of getting things done. The process assets are the methods and procedures an organisation must follow to create the activity list. This also includes historical information from past projects that can help the project team define activities on the current project.

Organisational process assets contain the existing formal and informal activity planning-related policies, procedures, and guidelines that are considered in developing the activity definitions. The lessons-learned knowledge base contains historical information regarding activities lists used by previous similar projects that can be considered when defining project schedule activities.

### ***.3 Project Scope Statement***

This is a description of the required work, and only the required work, to complete the project. The project deliverables, constraints, and assumptions documented in the **project scope** statement are considered explicitly during activity definition. Constraints are factors that will limit the project management team's options, such as schedule **milestones** with imposed **completion dates** that are required either by management or contract. Assumptions are factors that are considered to be true for project schedule planning, such as work hours per week or the time of the year that construction work will be performed.

### ***.4 Work Breakdown Structure***

The work breakdown structure which is a deliverables-oriented collection of project components is a primary input to schedule activity definition.

### ***.5 WBS Dictionary***

The WBS serves as a major input in the creation of the activity list. The WBS dictionary defines the attributes of each work package in the WBS.

### ***.6 Project Management Plan***

This plan includes the introductory schedule management plan, and procedures for how activities are defined, scheduled, and developed. This plan also includes the scope management plan which ensures that planned activities support the project scope.

## **Activity Definition: Tools and Techniques**

### **.1 Decomposing the Project Work Packages**

The WBS, the collection of deliverable-orientated components, must now be broken into activities. Specifically, the work packages within the WBS must be decomposed into manageable work elements. What's the difference between decomposing the project deliverables and the project work? The elements in the WBS are deliverables; this process is concerned with the actions needed to create the deliverables.

It's quite possible to create the WBS and the activity list in tandem. Simply put, the WBS describes the components of the deliverables; the activity list defines the actions to create the deliverables. The technique of decomposition, as it is applied to activity definition, *involves subdividing the project work packages into smaller, more manageable components called schedule activities*. The Activity Definition process defines the final outputs as schedule activities rather than as deliverables, as is done in the Create WBS process.

The activity list, WBS, and WBS dictionary can be developed either sequentially or concurrently, with the WBS and WBS dictionary being the basis for development of the final activity list. Each work package within the WBS is decomposed into the schedule activities required to produce the work package deliverables. *This activity definition is often performed by the **Project team members** responsible for the work package.*

### **.2 Relying on Templates**

A standard activity list or a portion of an activity list from a previous project is often usable as a template for a new project. The related activity attributes information in the templates can also contain a list of resource skills and their required hours of effort, identification of risks, expected deliverables, and other descriptive information. Templates

can also be used to identify typical schedule milestones.

### **.3 Using Rolling Wave Planning**

The WBS and WBS dictionary reflect the project scope evolution as it becomes more detailed until the work package level is reached. **Rolling wave planning is a form of progressive elaboration planning** where the work to be accomplished in the near term is planned in detail at a low level of the WBS, while **work far in the future is planned for WBS components** that are at a relatively high level of the WBS.

The work to be performed within another one or two reporting periods in the near future is planned in detail as work is being completed during the current period. *Therefore, schedule activities can exist at various levels of detail in the project's life cycle.* During early strategic planning, when information is less defined, activities might be kept at the milestone level.

### **.4 Expert Judgment**

Project team members or other experts who are experienced and skilled in developing detailed project scope statements, WBS, and project schedules can provide expertise in defining activities.

### **.5 Using Planning Component**

*When insufficient definition of the project scope is available to decompose a branch of the WBS down to the work package level, the last component in that branch of the WBS can be used to develop a high-level project schedule for that component.* These planning components are selected and used by the project team to plan and schedule future work at various higher levels within the WBS.

*The schedule activities used for these planning components may be summary activities that are not enough to support detailed estimating, scheduling, executing, monitoring, or controlling of the project work.* Two planning components are:

**Control Account.** A management control point can be placed at selected management points (specific components at selected levels) of the work breakdown structure above the work package level. These control points are used as a basis for planning when associated work packages have not yet been planned. All work and effort performed within a control account is documented in a control account plan.

**Planning Package.** A planning package is a WBS component *below the control account, but above the work package*. This component is used for planning known work content that does not have detailed schedule activities.

### **Activity Definition: Outputs**

#### **.1 Compiling the Activity List**

The primary output of decomposing the work is the activity list, which is a collection of all the work elements required to complete the project. The activity list is actually an extension of the WBS, and will serve as a fundamental tool in creating the project schedule. The activity list is needed to ensure that all the deliverables of the WBS are accounted for and that the necessary work is mapped to each. *The activity list is a comprehensive list including all schedule activities that are planned to be performed on the project.* The activity list does not include any schedule activities that are not required as part of the project scope. The activity list includes the activity identifier and a scope of work description for each schedule activity in sufficient detail to ensure that project team members understand what work is required to be completed.

The schedule activity's scope of work can be in physical terms, such as linear feet of pipe to be installed, designated placement of concrete, number of drawings, lines of computer program code, or chapters in a book. *The activity list is used in the schedule model and is a component of the project management plan. The schedule activities are discrete components of the project schedule, but are not components of the WBS.*

## **.2 Activity Attributes**

These activity attributes are an extension of the activity attributes in the activity list and identify the multiple attributes associated with each schedule activity. *Activity attributes for each schedule activity include the activity identifier, activity codes, **activity description**, **predecessor activities**, **successor activities**, logical relationships, leads and lags, resource requirements, imposed dates, constraints, and assumptions.*

Activity attributes can also include the person responsible for executing the work, geographic area or place where the work has to be performed, and schedule activity type such as **level of effort**, discrete effort, and apportioned effort. These attributes are used for project schedule development and for selecting, ordering, and sorting the planned schedule activities in various ways within reports. The number of attributes varies by **application area**. The activity attributes are used in the schedule model.

## **.3 Milestone List**

The list of schedule milestones identifies all milestones and indicates whether the milestone is mandatory (required by the contract) or optional (based upon project requirements or historical information). The milestone list is a component of the project management plan and the milestones are used in the schedule model.

## **.4 Requested Changes**

The Activity Definition process can generate requested changes that can affect the project scope statement and WBS. Requested changes are processed for review and disposition through the Integrated Change Control process.

## 6.2 Activity Sequencing

Once the activity list has been created, the activities must be arranged in a logical sequence. This process calls on the project manager and the project team to identify the logical relationships between activities—and the preferred relationship between those activities. This can be accomplished a few different ways:

- **Computer-driven.** There are many different scheduling and project management software packages available. These programs can help the project manager and the project team determine which actions need to happen in what order—and with what level of discretion.
- **Manual process.** In smaller projects, and on larger projects in the early phases, manual sequencing may be preferred. An advantage of manual sequencing is that it's easier to move around dependencies and activities than in some programs.
- **Blended approach.** A combination of manual and computer-driven scheduling methods is fine. It's important to determine the finality of the activity sequence, however. Sometimes a blended approach can be more complex than relying on just one or another.

### Activity Sequencing: Inputs

#### ***.1 Project Scope Statement***

The project scope statement contains the product scope description, which includes product characteristics that often can affect activity sequencing, such as the physical layout of a plant to be constructed or subsystem interfaces on a software project. While these effects are often apparent in the activity list, the product scope description is generally reviewed to ensure accuracy.

#### ***.2 Activity List***

As just mentioned, this is the list of actions needed to complete the project deliverables.

### **.3 Activity Attributes**

Each scheduled activity has attributes that need to be documented. For example, the successor and predecessor of each activity, the lead and lag information, and the person responsible for completing the activity should all be documented. This information is important when it comes to schedule development and project control.

### **.4 Milestone List**

Milestones must be considered and evaluated when sequencing events to ensure all of the work needed to complete the milestones is included.

### **.5 Approved Change Requests**

Approved change requests are the documented, authorised changes to expand or contract project scope. The approved change requests can also modify policies, project management plans, procedures, costs or budgets, or revise schedules.

## **Activity Sequencing: Tools and Techniques**

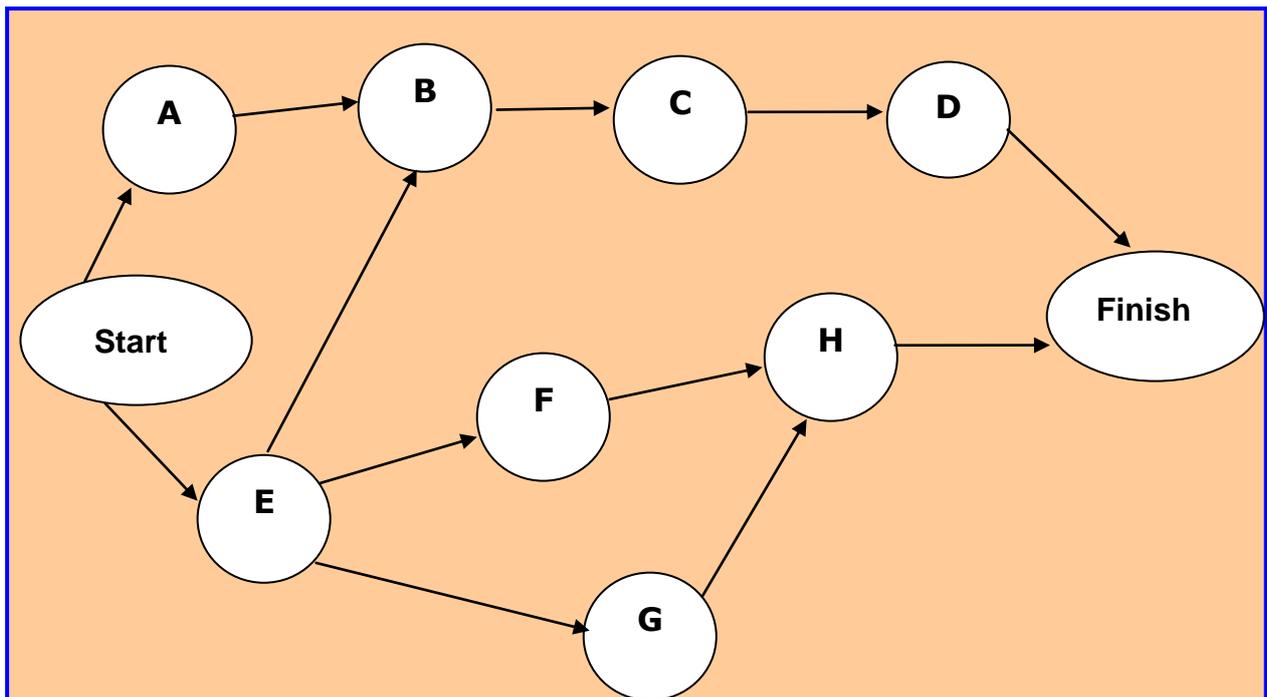
### **.1 Precedence Diagramming Method (PDM)**

The precedence diagramming method (PDM) is the most common method of arranging the project work visually. The PDM puts the activities in boxes, called nodes, and connects the boxes with arrows. The arrows represent the relationship and the dependencies of the work packages. The illustration at figure 6-1 shows a simple network diagram using PDM.

PDM includes *four types of dependencies or precedence relationships*:

- **Finish-to-Start (FS).** This relationship means Task A must complete before Task B can begin. This is the most common relationship. For example, the foundation must be set before the framing can begin. The initiation of the successor activity depends upon the completion of the **predecessor activity**.
- **Finish-to-Finish.** This relationship means Task A must complete before Task B does. Ideally, two tasks must finish at exactly the same time, but this is not always the case. The completion of the successor activity depends upon the completion of the predecessor activity.
- **Start-to-Start.** This relationship means Task A must start before Task B can start. This relationship allows both activities to happen in tandem. The initiation of the successor activity depends upon the initiation of the predecessor activity.
- **Start-to-Finish.** This relationship is unusual and is rarely used. It requires that Task A start so that Task B may finish. Such relationships may be encountered in construction and manufacturing. It is also known as just-in-time (JIT) scheduling. The completion of the successor activity depends upon the initiation of the predecessor activity.

In PDM, *finish-to-start is the most commonly used type of precedence relationship. Start-to-finish relationships are rarely used.*

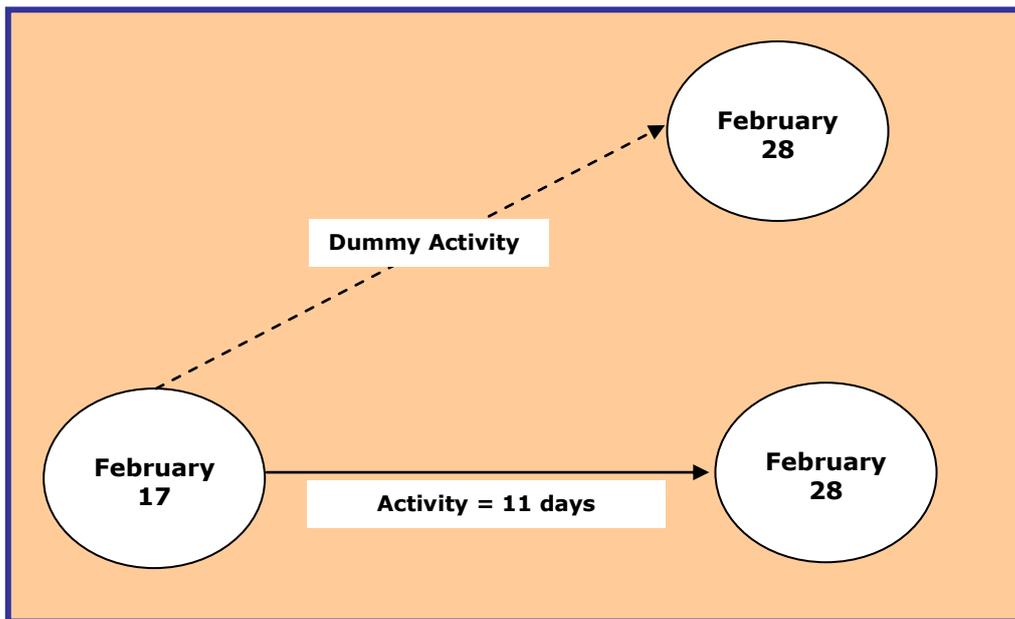


**Figure 6-1. Simple Precedence Diagram Method** (Source: PMBOK Guide 3<sup>rd</sup> Ed)

This technique is also called **Activity-On-Node (AON)** and is the *method used by most project management software packages*. It includes four types of dependencies or precedence relationships

## 2. Arrow Diagramming Method (ADM)

**Arrow Diagramming Method (ADM)** is a method of constructing a project schedule network diagram that *uses arrows to represent activities and connects them at nodes to show their dependencies*. The arrow diagramming method (ADM) approach to activity sequencing uses arrows to represent the activities. The arrows are “connected” on nodes. ADM only uses finish-to-start relationships. In some instances, dummy activities are required to express the logical relationship between two activities. A dummy activity is illustrated with a dashed arrow between the nodes. The following illustration is a simple example of an ADM network diagram.



**Figure 6-2 Simple Arrow Diagramming Method** (Source: PMBOK Guide 3<sup>rd</sup> Ed)

ADM is an example of “activity on arrow” (AOA) networks. This approach is not as popular as PDM, but may still be prevalent in some industries. ADM can be created manually or through a PMIS. Figure 6-2 shows a simple **network logic** diagram drawn using ADM. This technique is *also called activity-on-arrow (AOA)* and, although *less prevalent than PDM*, it is still used in teaching schedule network theory and in some application areas.

*ADM uses only finish-to-start dependencies and can require the use of “dummy” relationships called dummy activities, which are shown as dashed lines, to define all logical relationships correctly. Since dummy activities are not actual schedule activities (they have no work content), they are given a zero value duration for schedule **network analysis** purposes.*

### **.3 Schedule Network Templates**

Just as a project manager can rely on WBS templates, there may be network templates available to streamline the planning process or to conform to a predetermined standard. Network

templates can represent an entire project if appropriate, though portions of a network template, such as the required project management activities, are common.

The portions of a network template are also known as subnets or fragnets. Subnets are often associated with repetitive actions within a network diagram. For example, each floor in a high-rise apartment building may undergo the same or similar actions during construction. Rather than complete the network diagram for each floor, a subnet can be implemented.

Sub network templates are especially useful when a project includes several identical or nearly identical deliverables, such as floors on a high-rise office building, clinical trials on a pharmaceutical research project, coding program modules on a software project, or the start-up phase of a development project.

#### ***.4 Dependency Determination***

The progression of the project is built on the sequence of activities. Activities are dependent on their predecessor activities completing before successor activities may begin. The following are the dependencies you should know for your PMP exam:

- **Mandatory dependencies** These dependencies are the natural order of activities. For example, you can't begin building your house until your foundation is in place. These relationships are called hard logic.
- **Discretionary dependencies** These dependencies are the preferred order of activities. Project managers should use these relationships at their "discretion" and document the logic behind the decision. Discretionary dependencies allow activities to happen in a preferred order because of best practices, conditions unique to the project work, or external

events. For example, a painting project typically allows the primer and the paint to be applied within hours of each other. Due to the expected high humidity during the project, however, all of the building will be completely primed before the paint can be applied. These relationships are also known as soft logic, preferred logic, or preferential logic.

- **External dependencies** As its name implies, these are dependencies outside of the project's control. Examples include the delivery of equipment from a vendor, the deliverable of another project, or the decision of a committee, lawsuit, or expected new law.

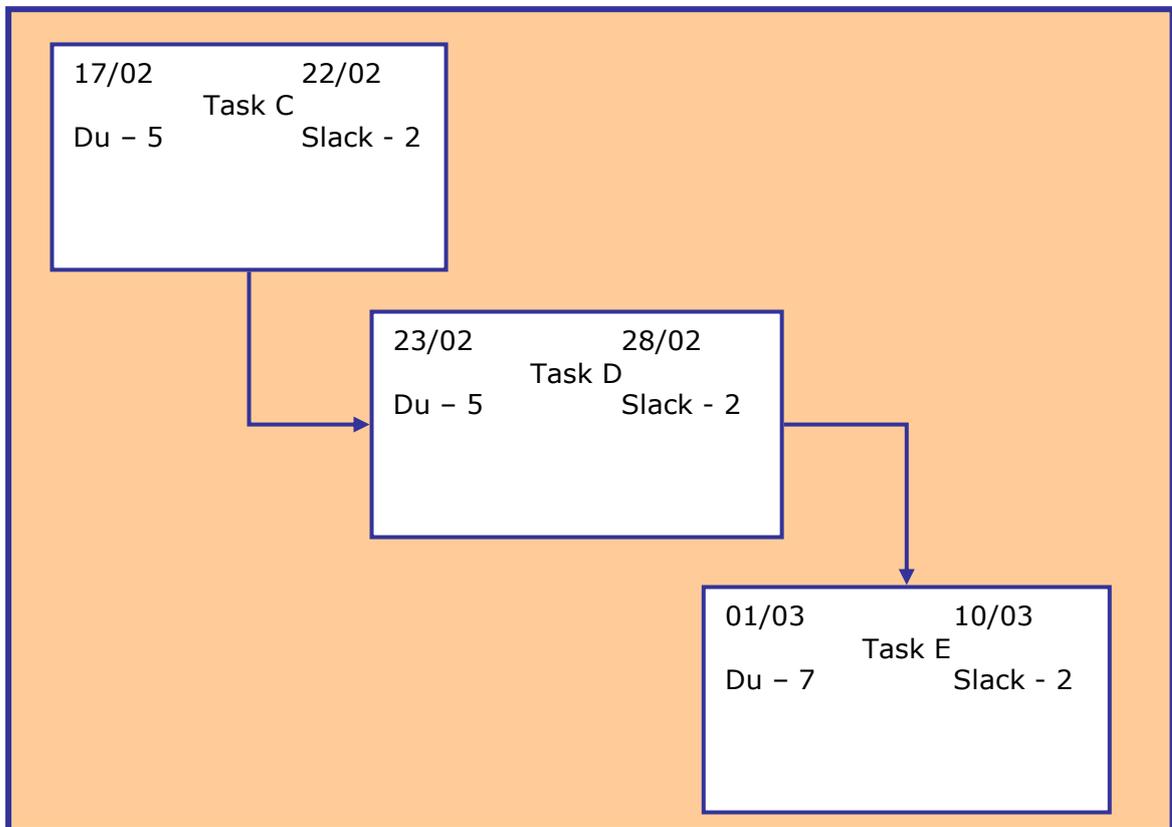
### ***.5 Applying Leads and Lags***

Leads and lags are values added to work packages to slightly alter the relationship between two or more work packages. The project management team determines the dependencies that may require a lead or a lag to accurately define the logical relationship. The use of leads and lags and their related assumptions are documented.

*A lead allows an acceleration of the successor activity.* For example, a technical writing team can begin writing the second draft of a large document (the successor activity) fifteen days before they finish writing the entire first draft (the predecessor activity). This could be accomplished by a finish-to-start relationship with a fifteen-day lead time.

Lag time is waiting time, adding time between activities. Imagine a project to install wood floors in an office building. *A lag directs a delay in the successor activity.* For example, to account for a ten-day curing period for concrete, a ten-day lag on a finish-to-start

relationship could be used, which means the successor activity cannot start until ten days after the predecessor is completed.



**Figure 6-3. Project Network Diagram** (Source: PMBOK Guide 3<sup>rd</sup> Ed)

## Activity Sequencing: Outputs

### .1 Project Schedule Network Diagrams

Once the activity list has been put into sequential order, the flow of the project work can be visualised. As illustrated in figure 6.3, a project network diagram (PND) shows the flow of the project work and the relationship between the work packages. PNDs are typically “activity on node” (AON) and most PMIS packages use the PDM method.

Project schedule network diagrams are schematic displays of the project's schedule activities and the logical relationships among them, also referred to as dependencies. Figures 6-1 and 6-2 illustrate two

different approaches to drawing a project schedule network diagram. A project schedule network diagram can be produced manually or by using project management software.

The project schedule network diagram can include full project details, or have one or more summary activities. A summary narrative accompanies the diagram and describes the basic approach used to sequence the activities. Any unusual activity sequences within the network are fully described within the narrative.

*A project network diagram is often referred to as a PERT chart. Historically PERT (Program Evaluation and Review Technique) was a specific type of network diagram*

### **.2 Activity List (Updates)**

If approved change requests result from the Activity Sequencing process, then the activity list is updated to include those approved changes.

### **.3 Activity Attributes (Updates)**

The activity attributes are updated to include the defined logical relationships and any associated leads and lags. If approved change requests resulting from the Activity Sequencing process affect the activity list, then the related items in the activity attributes are updated to include those approved changes.

### **.4 Requested Changes**

Preparation of project logical relationships, leads, and lags might reveal instances that can generate a requested change to the activity list or the activity attributes. Examples include where a schedule activity can be divided or otherwise redefined, where dependencies can be refined, or where a lead or lag is adjusted to

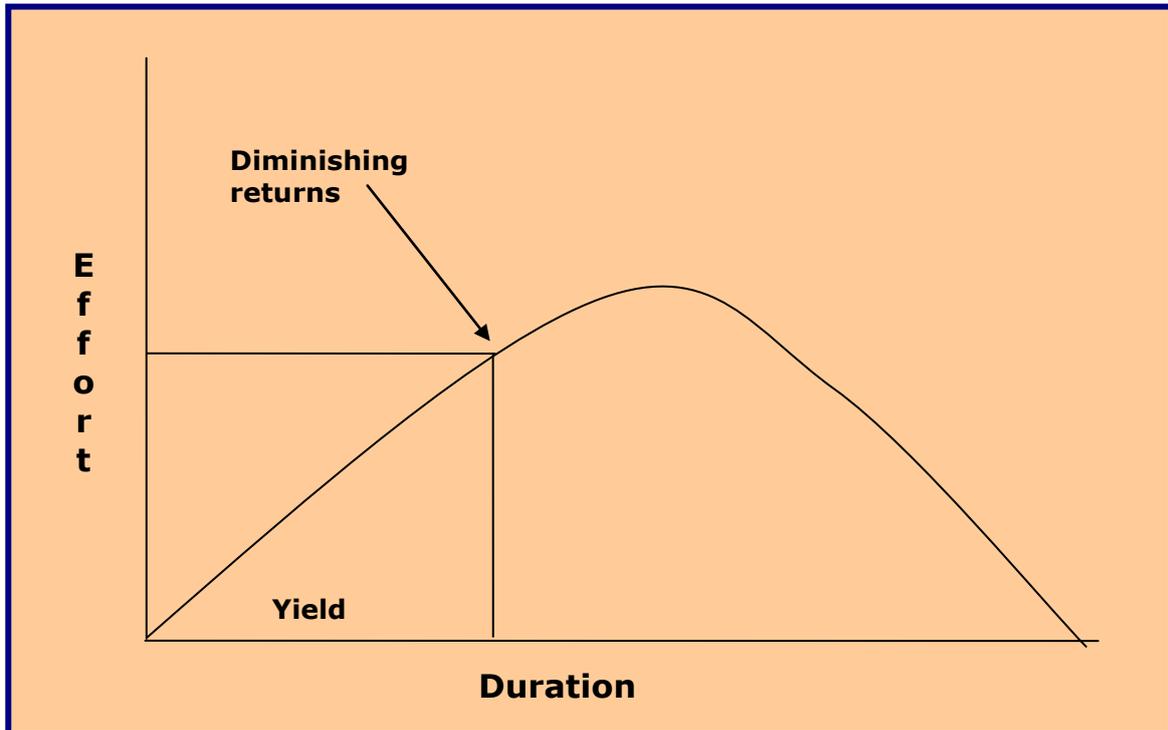
adequately diagram the correct logical relationships. Requested changes are processed for review and disposition through the Integrated Change Control process.

### 6.3 Activity Resource Estimating

The identified resource requirements will affect the project schedule. The difference between duration and effort will affect the schedule. Duration is how long the activity will take, while effort is the labor applied to the task.

*Estimating schedule activity resources involves determining what resources (persons, equipment, or materiel) and what quantities of each resource will be used, and when each resource will be available to perform project activities.* The Activity Resource Estimating process is closely coordinated with the Cost Estimating process. For example:

Landscaping a building may take 60 hours to complete with two workers assigned to the job. Add one more worker and now the work will take only 30 hours. The duration to complete the landscaping in the preceding example is 30 hours, but there will still be 90 hours of effort expended on the activity. At some point in the work, the “duration to effort ratio” becomes saturated, and adding additional laborers will actually become counterproductive. The example is illustrated in figure 6.4



**Figure 6.4 – Diminishing Returns** (Source: PMBOK Guide 3<sup>rd</sup> Ed)

## **Activity Resource Estimating: Inputs**

### **.1 Enterprise Environmental Factors**

The Activity Resource Estimating process uses the infrastructure resource availability information included in enterprise environmental factors.

### **.2 Organisational Process Assets**

Organisational process assets provide the policies of the performing organisation regarding staffing and the rental or purchase of supplies and equipment that are considered during activity resource estimating. If available, historical information regarding what types of resources were required for similar work on previous projects are reviewed.

### **.3 Activity List**

The activity list identifies the schedule activities for resources that are estimated.

#### ***.4 Activity Attributes***

The activity attributes developed during the activity definition process provide the primary data input for use in estimating those resources required for each schedule activity in the activity list.

#### ***.5 Resource Availability***

When resources (not limited to people resources only, but other physical, financial, technological etc) are needed but are not available, the project manager must negotiate to secure the resource. This may involve tradeoffs between projects or additional expenses as the activity is outsourced to a vendor to complete the work. The project manager does not want to delay the project because of having to wait on a resource. Information on which resources (such as people, equipment, and materiel) are potentially available is used for estimating the resource types. This knowledge includes consideration of various geographical locations from which the resources originate and when they may be available. One such tool to check resource availability is to refer to an up-to-date resource calendar.

#### ***.6 Project Management Plan***

The schedule management plan is a component part of the project management plan that is used in Activity Resource Estimating.

### **Activity Resource Estimating: Tools and Techniques**

#### ***.1 Expert Judgment***

Expert judgment is often required to assess the resource-related inputs to this process. Any group or person with specialised knowledge in resource planning and estimating can provide such expertise.

## **.2 Alternatives Analysis**

Many schedule activities have alternative methods of accomplishment. They include using various levels of resource capability or skills, different size or type of machines, different tools (hand versus automated), and make-or-buy decisions regarding the resource.

## **.3 Published Estimating Data**

Several companies routinely publish updated production rates and unit costs of resources for an extensive array of labor trades, materiel, and equipment for different countries and geographical locations within countries.

## **.4 Project Management Software**

Project management software has the capability to help plan, organise, and manage resource pools and develop resource estimates. Depending upon the sophistication of the software, resource breakdown structures, resource availabilities, and resource rates can be defined, as well as various resource calendars.

## **.5 Bottom-up Estimating**

*When a schedule activity cannot be estimated with a reasonable degree of confidence, the work within the schedule activity is decomposed into more detail. The resource needs of each lower, more detailed piece of work are estimated, and these estimates are then aggregated into a total quantity for each of the schedule activity's resources. Schedule activities may or may not have dependencies between them that can affect the application and use of resources. If there are dependencies, this pattern of resource usage is reflected in the estimated requirements of the schedule activity and is documented.*

## **Activity Resource Estimating: Outputs**

### ***.1 Activity Resource Requirements***

The output of the Activity Resource Estimating process is an identification and description of the types and quantities of resources required for each schedule activity in a work package. These requirements can then be aggregated to determine the estimated resources for each work package. The amount of detail and the level of specificity of the resource requirement descriptions can vary by application area.

The resource requirements documentation for each schedule activity can include the basis of estimate for each resource, as well as the assumptions that were made in determining which types of resources are applied, their availability, and what quantity are used. *The Schedule Development process determines when the resources are needed.*

### ***.2 Activity Attributes (Updates)***

The types and quantities of resources required for each schedule activity are incorporated into the activity attributes. If approved change requests result from the Activity Resource Estimating process, then the activity list and activity attributes are updated to include those approved changes.

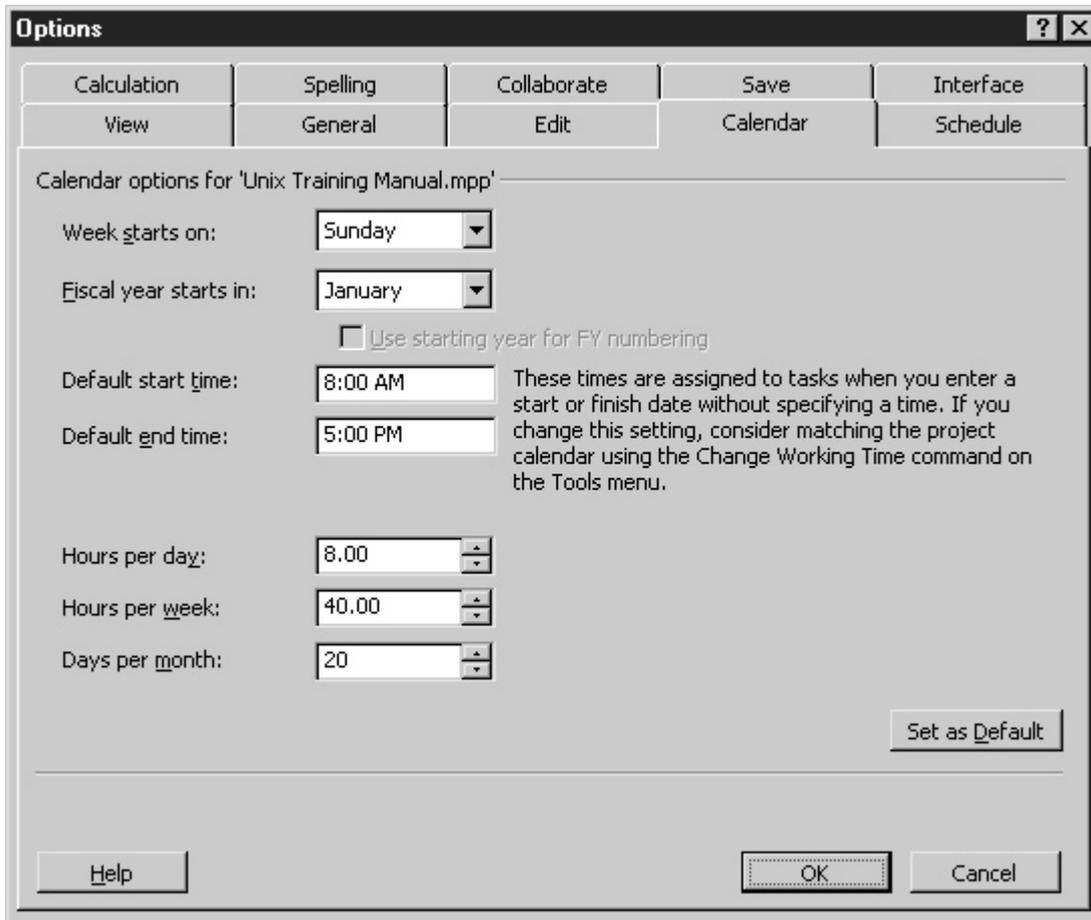
### ***.3 Resource Breakdown Structure***

The resource breakdown structure (RBS) is a hierarchical structure of the identified resources by resource category and resource type.

### ***.4 Resource Calendar (Updates)***

A composite resource calendar (figure 6.5) for the project documents working days and nonworking days that determine those dates on which a specific resource, whether a person or materiel, can be active or is idle.

The project resource calendar typically identifies resource-specific holidays and resource availability periods. The project resource calendar identifies the quantity of each resource available during each availability period.



**Figure 6.5 – Project Calendar** (Source: PMP Study Guide, Phillips 2006))

### **.5 Requested Changes**

The Activity Resource Estimating process can result in requested changes to add or delete planned schedule activities within the activity list. Requested changes are processed for review and disposition through the Integrated Change Control process.

## 6.4 Activity Duration Estimating

The answer to the question “How long will it take?” depends on the accuracy of the estimates, the consistency of the work, and other variables within the project. The best a project manager can do is create honest estimates based on the information he’s been provided. Until the schedule is finalised, no one will know the duration of the project.

The tasks are first identified, the sequencing of the activities takes place, resources are defined and then durations are estimated. These activities are required to complete the project schedule and the estimated project duration. These four activities are iterated as more information comes available. If the proposed schedule is acceptable, the project can move forward. If the proposed schedule takes too long, the scheduler can use a few strategies to compress the project. We’ll discuss the art of scheduling in a few moments. Activity duration estimates, like the activity list and the WBS, don’t come from the project manager—they come from the people completing the work. They may also undergo progressive elaboration.

The process of estimating schedule activity durations uses information on schedule activity scope of work, required resource types, estimated resource quantities, and resource calendars with resource availabilities. The inputs for the estimates of schedule activity duration originate from the person or group on the project team who is most familiar with the nature of the work content in the specific schedule activity. *The duration estimate is progressively elaborated, and the process considers the quality and availability of the input data.*

For example, as the project engineering and design work evolves, more detailed and precise data is available, and the accuracy of the duration estimates improves. Thus, *the duration estimate can be assumed*

*to be progressively more accurate and of better quality.* The Activity Duration Estimating process requires that the amount of work effort required to complete the schedule activity is estimated, the assumed amount of resources to be applied to complete the schedule activity is estimated, and the number of work periods needed to complete the schedule activity is determined.

*All data and assumptions that support duration estimating are documented for each activity duration estimate.* Estimating the number of work periods required to complete a schedule activity can require consideration of elapsed time as a requirement related to a specific type of work. Most project management software for scheduling will handle this situation by using a project calendar and alternative work-period resource calendars that are usually identified by the resources that require specific work periods. The schedule activities will be worked according to the project calendar, and the schedule activities to which the resources are assigned will also be worked according to the appropriate resource calendars. *Overall project duration is calculated as an output of the Schedule Development process.*

## **Activity Duration Estimating: Inputs**

### ***.1 Enterprise Environmental Factors***

One or more of the organisations involved in the project may maintain duration estimating databases and other historical reference data. This type of reference information is also available commercially. These databases tend to be especially useful when activity durations are not driven by the actual work content (e.g., how long it takes concrete to cure or how long a government agency usually takes to respond to certain types of requests).

### ***.2 Organisational Process Assets***

Historical information on the likely durations of many categories of activities is often available. One or more of the organisations involved in the project may maintain records of previous project results that are detailed enough to aid in developing duration estimates. Historical information can come from several sources, including project files from other projects, commercial duration estimating databases, project team members, and other such sources.

### ***.3 Project Scope Statement***

The constraints and assumptions from the project scope statement are considered when estimating the schedule activity durations. An example of an assumption would be the length of the reporting periods for the project that could dictate maximum schedule activity durations. An example of a constraint would be document submittals, reviews, and similar non-deliverable schedule activities that often have frequency and durations specified by contract or within the performing organisation's policies.

### ***.4 Activity List***

Activity lists are the work elements necessary to create the deliverables.

### ***.5 Activity Attributes***

Effort is the amount of labour applied to a task. Duration, on the other hand, is how long the task is expected to take with the given amount of labour. For example, a task to unload a freight truck may take eight hours with two people assigned to the task. If the effort is increased by adding more labour to the task (in this instance, more people), then the duration of the task is decreased. Some activities, however, have a fixed duration and are not affected by the amount of labour assigned to the task. For example, to install a piece of

software on a computer will take the same amount of time if one computer administrator is completing the work or if two computer administrators are doing it.

### ***.6 Activity Resource Requirements***

Activity resource requirements define the resources that are needed to complete a particular activity. For example, a project to build a home will require lots of different resources: plumbers, electricians, architects, framers, and landscapers. The project manager would not, however, assign all of the different resources to every task, but only to the tasks that the resource was qualified to complete.

However, as additional resources are added or lower skilled resources are applied to some schedule activities, projects can experience a reduction in efficiency. This inefficiency, in turn, could result in a work production increase of less than the equivalent percentage increase in resources applied.

### ***.7 Resource Calendar***

The composite resource calendar, developed as part of the Activity Resource Estimating process, includes the availability, capabilities, and skills of human resources. The type, quantity, availability, and capability, when applicable, of both equipment and materiel resources that could significantly influence the duration of schedule activities are also considered. For example, if a senior and junior staff member are assigned full time, a senior staff member can generally be expected to complete a given schedule activity in less time than a junior staff member.

### ***.8 Project Management Plan***

The project management plan contains the risk register and project cost estimates.

- *Risk Register.* The risk register has information on identified project risks that the project team considers when producing estimates of activity durations and adjusting those durations for risks. The project team considers the extent to which the effects of risks are included in the baseline duration estimate for each schedule activity, in particular those risks with ratings of high probability or high impact.
- *Activity Cost Estimates.* The project activity cost estimates, if already completed, can be developed in sufficient detail to provide estimated resource quantities for each schedule activity in the project activity list.

## **Activity Duration Estimating: Tools and Techniques**

### **.1 Expert Judgment**

Activity durations are often difficult to estimate because of the number of factors that can influence them, such as resource levels or resource productivity. Expert judgment, guided by historical information, can be used whenever possible. The individual project team members may also provide duration estimate information or recommended maximum activity durations from prior similar projects. If such expertise is not available, the duration estimates are more uncertain and risky.

### **.2 Analogous Estimating**

Analogous duration estimating means using the actual duration of a previous, similar schedule activity as the basis for estimating the duration of a future schedule activity. It is frequently used to estimate project duration when there is a limited amount of detailed

information about the project for example, in the early phases of a project.

Analogous estimating uses historical information and expert judgment. Analogous duration estimating is most reliable when the previous activities are similar in fact and not just in appearance, and the project team members preparing the estimates have the needed expertise.

### **.3 Parametric Estimating**

Estimating the basis for activity durations can be quantitatively determined by multiplying the quantity of work to be performed by the productivity rate. For example, productivity rates can be estimated on a design project by the number of drawings multiplied by labour hours per drawing, or a cable installation in meters of cable times labour hours per meter. The total resource quantities are multiplied by the labour hours per work period or the production capability per work period, and divided by the number of those resources being applied to determine activity duration in work periods.

### **.4 Three-Point Estimates**

The accuracy of the activity duration estimate can be improved by considering the amount of risk in the original estimate. Three-point estimates are based on determining three types of estimates:

- *Most likely.* The duration of the schedule activity, given the resources likely to be assigned, their productivity, realistic expectations of availability for the schedule activity, dependencies on other participants, and interruptions.
- *Optimistic.* The activity duration is based on a best-case scenario of what is described in the most likely estimate.

- *Pessimistic.* The activity duration is based on a worst-case scenario of what is described in the most likely estimate.

An activity duration estimate can be constructed by using an average of the three estimated durations. That average will often provide a more accurate activity duration estimate than the single point, most-likely estimate.

### **.5 Reserve Analysis**

Project teams can choose to incorporate additional time referred to as contingency reserves, time reserves or buffers, *into the overall project schedule as recognition of schedule risk*. The contingency reserve can be a percentage of the estimated activity duration, a fixed number of work periods, or developed by quantitative schedule risk analysis.

The contingency reserve can be used completely or partially, or can later be reduced or eliminated, as more precise information about the project becomes available. Such contingency reserve is documented along with other related data and assumptions.

There is a tendency to consume contingencies by default! Two academic theories that discuss this are:

**Parkinson's Law** - Work expands to fill the time available; and

**Student Syndrome** - People will start to fully apply themselves to a task at the last possible moment before a deadline.

## **Activity Duration Estimating: Outputs**

### **.1 Activity Duration Estimates**

Activity duration estimates are quantitative assessments of the likely number of work periods that will be required to complete a

schedule activity. Activity duration estimates include some indication of the range of possible results. For example:

- 2 weeks  $\pm$  2 days to indicate that the schedule activity will take at least eight days and no more than twelve (assuming a five-day workweek).
- 15 percent probability of exceeding three weeks to indicate a high probability-85 percent-that the schedule activity will take three weeks or less.

### ***.2 Activity Attributes (Updates)***

The activity attributes are updated to include the durations for each schedule activity, the assumptions made in developing the activity duration estimates, and any contingency reserves.

## 6.5 Schedule Development

Creating the project schedule is part of the planning process group. It is calendar-based and relies on both the project network diagram and the accuracy of time estimates. Project schedule development, *an iterative process, determines planned start and finish dates for project activities*. Schedule development can require that duration estimates and resource estimates are reviewed and revised to create an approved project schedule that can serve as a baseline against which progress can be tracked.

Schedule development continues throughout the project as work progresses, the project management plan changes, and anticipated risk events occur or disappear as new risks are identified.

### Schedule Development: Inputs

#### ***.1 Organisational Process Assets***

The organisational process assets of the performing organisation may have some asset items that can be used in Schedule Development, such as a project calendar (a calendar of working days or shifts that establishes dates on which schedule activities are worked, and nonworking days on which schedule activities are idle).

#### ***.2 Project Scope Statement***

The project scope statement contains assumptions and constraints that can impact the development of the project schedule. Assumptions are those documented schedule-related factors that, for schedule development purposes, are considered to be true, real, or certain. Constraints are factors that will limit the project management team's options when performing schedule network analysis.

There are three major categories of time constraints considered during schedule development:

- Imposed dates on activity starts or finishes can be used to restrict the start or finish to occur either no earlier than a specified date or no later than a specified date. While several constraints are typically available in project management software, the "Start No Earlier Than" and the "Finish No Later Than" constraints are the most commonly used.
- Date constraints include such situations as agreed-upon contract dates, a market window on a technology project, weather restrictions on outdoor activities, government-mandated compliance with environmental remediation, and delivery of materiel from parties not represented in the project schedule.
- The project sponsor, project customer, or other stakeholders often dictate key events or major milestones affecting the completion of certain deliverables by a specified date. Once scheduled, these dates become expected and can be moved only through approved changes.

- 

Milestones can also be used to indicate interfaces with work outside of the project. Such work is typically not in the project database and milestones with constraint dates can provide the appropriate schedule interface.

### ***.3 Activity List***

The activity list is a comprehensive list including all schedule activities that are planned to be performed on the project.

#### ***.4 Activity Attributes***

Activity attributes identify the multiple attributes associated with each schedule activity. (See section relating to Activity Definition: Outputs for a more detailed description).

#### ***.5 Project Schedule Network Diagrams***

Project schedule network diagrams are schematic displays of the project's schedule activities and the logical relationship among them. (See section relating to Activity Sequencing: Outputs for a more detailed description).

#### ***.6 Activity Resource Requirements***

This refers to the identification and description of the types and quantities of resources required for each schedule activity in a work package. (See section relating to Activity Resource Estimating: Outputs for a more detailed description).

#### ***.7 Resource Calendars***

This details the dates on which specific resources are available and whether they are active or idle. (See section relating to Activity Resource Estimating: Outputs for a more detailed description).

#### ***.8 Activity Duration Estimates***

These are quantitative assessments of the likely number of work periods that will be required to complete a schedule activity. (See section relating to Activity Duration Estimating: Outputs for a more detailed description).

#### ***.9 Project Management Plan***

The project management plan contains the schedule management plan, cost management plan, project scope

management plan, and risk management plan. These plans guide the schedule development, as well as components that directly support the Schedule Development process. One such component is the risk register.

- **Risk Register.** The risk register identifies the project risks and associated risk response plans that are needed to support the Schedule Development process.

## **Schedule Development: Tools and Techniques**

### **.1 Schedule Network Analysis**

Schedule network analysis is a technique that generates the project schedule. It employs a schedule model and various analytical techniques, such as **critical path method**, **critical chain method**, **what-if analysis**, and **resource levelling** to calculate the early and late start and finish dates, and scheduled start and finish dates for the uncompleted portions of project schedule activities.

If the schedule network diagram used in the model has any network loops or network open ends, then those loops and open ends are adjusted before one of the analytical techniques is applied. Some network path may have points of path convergence or path divergence that can be identified and used in schedule compression analysis or other analyses.

### **.2 Critical Path Method**

The **critical path** method is a schedule network analysis technique that calculates the earliest project completion date. The critical path is the path with the longest duration. The critical path method calculates the theoretical **early start and finish dates**, and **late start and finish dates**, for all schedule activities without regard

for any resource limitations, by performing a **forward pass** analysis and a **backward pass** analysis through the project schedule network paths.

The resulting early and late start and finish dates are not necessarily the project schedule; rather, they indicate the time periods within which the schedule activity should be scheduled, given activity durations, logical relationships, leads, lags, and other known constraints. Calculated early start and finish dates, and late start and finish dates, may or may not be the same on any network path since total float, which provides schedule flexibility, may be positive, negative, or zero.

On any network path, the schedule flexibility is measured by the positive difference between early and late dates, and is termed "total float." **Critical paths have either a zero or negative total float, and schedule activities on a critical path are called "critical activities"**. Adjustments to activity durations, logical relationships, leads and lags, or other schedule constraints may be necessary to produce network paths with a zero or positive total float.

*Once the total float for a network path is zero or positive, then the **free float** - the amount of time that a schedule activity can be delayed without delaying the early start date of any immediate successor activity within the network path - can also be determined.*

### **.3 Schedule Compression**

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

- **Crashing.**

Schedule compression technique in which *cost and schedule*

*tradeoffs* are analysed to determine how to obtain the greatest amount of compression for the least incremental cost. Crashing does not always produce a viable alternative and can result in increased cost. An example of crashing is adding more project team members to bring the project end date forward.

- **Fast tracking.**

*A schedule compression technique in which phases or activities that normally would be done in sequence are performed in parallel. An example would be to construct the foundation for a building before all the architectural drawings are complete. Fast tracking can result in rework and increased risk. This approach can require work to be performed without completed detailed information, such as engineering drawings. It results in trading cost for time, and increases the risk of achieving the shortened project schedule.*

#### **.4 What-If Scenario Analysis**

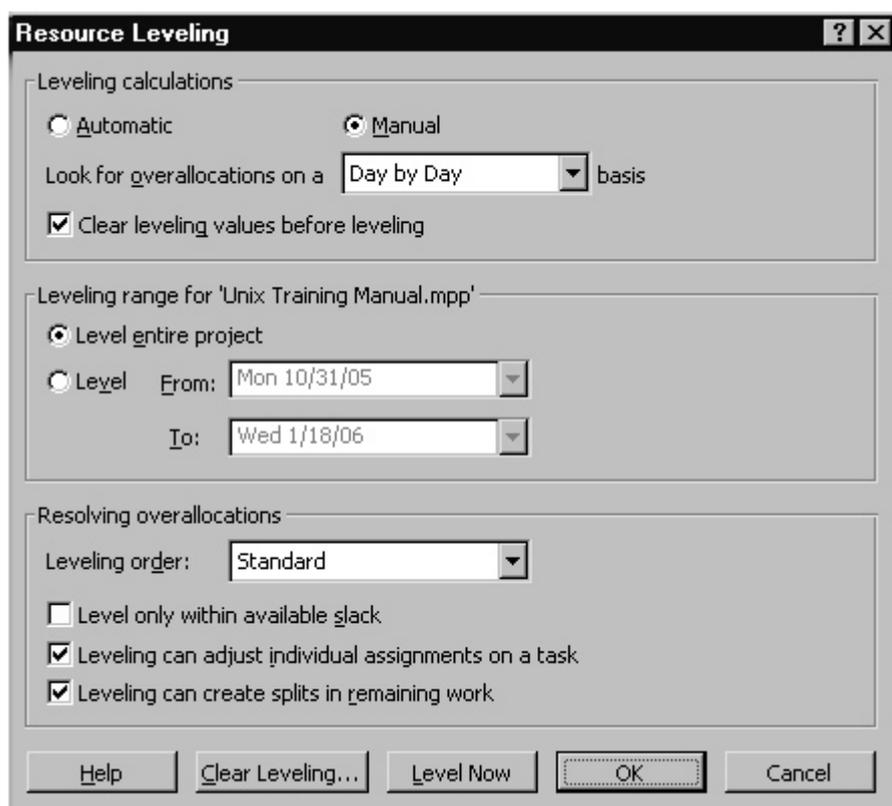
This is an analysis of the question "What if the situation represented by scenario 'X' happens?" A schedule network analysis is performed using the schedule model to compute the different scenarios, such as delaying a major component delivery, extending specific engineering durations, or introducing external factors, such as a strike or a change in the permitting process.

The outcome of the what-if scenario analysis can be used to assess the feasibility of the project schedule under adverse conditions, and in preparing contingency and response plans to overcome or mitigate the impact of unexpected situations. Simulation involves calculating multiple project durations with different sets of activity assumptions.

The most common technique is Monte Carlo Analysis, in which a distribution of possible activity durations is defined for each schedule activity and used to calculate a distribution of possible outcomes for the total project.

### .5 Resource Levelling

A heuristic is a fancy way of saying “rule of thumb.” A resource levelling heuristic is a method to flatten the schedule when resources are over-allocated. Resource levelling can be applied using different methods to accomplish different goals. One of the most common methods is to ensure that workers are not overextended on activities. Figure 6-8 is a screenshot from Microsoft Project where resource levelling has been applied.



**Figure 6-6. Screenshot of MS Project – resource levelling** (Source: PMP Study Guide, Phillips, 2006)

Allocating scarce resources to critical path activities first can be used to develop a project schedule that reflects such constraints. *Resource levelling often results in a projected duration for the project that is longer than the preliminary project schedule. This technique is sometimes called the resource based method, especially when implemented using schedule optimisation project management software. Resource reallocation from non-critical to critical activities is a common way to bring the project back on track, or as close as possible, to its originally intended overall duration.*

Some projects can have a finite and critical project resource. In this case, the resource is scheduled in reverse from the project ending date, which is known as reverse resource allocation scheduling, and may not result in an optimal project schedule. *The resource levelling technique produces a resource-limited schedule, sometimes called a resource-constrained schedule, with scheduled start dates and scheduled finish dates.*

### **.6 Critical Chain Method**

*Critical chain is another schedule network analysis technique that modifies the project schedule to account for limited resources. Critical chain combines deterministic and probabilistic approaches. Initially, the project schedule network diagram is built using non-conservative estimates for activity durations within the schedule model, with required dependencies and defined constraints as inputs.*

The critical path is then calculated. After the critical path is identified, resource availability is entered and the **resource-limited schedule** result is determined. *The resulting schedule often has an altered critical path. The critical chain method adds duration buffers that are non-work schedule activities to maintain focus on the planned activity durations.*

Once the buffer schedule activities are determined, the planned activities are scheduled to their latest possible planned start and finish dates. Consequently, in lieu of managing the total float of network paths, *the critical chain method focuses on managing the buffer activity durations and the resources applied to planned schedule activities.*

### **.7 Project Management Software**

Project management scheduling software is widely used to assist with schedule development. Other software might be capable of interacting directly or indirectly with project management software to carry out the requirements of other Knowledge Areas, such as cost estimating by time period and schedule simulation in quantitative risk analysis.

These products automate the calculation of the mathematical forward pass and backward pass critical path analysis and resource levelling, and, thus, allow for rapid consideration of many schedule alternatives. They are also widely used to print or display the outputs of developed schedules.

### **.8 Applying Calendars**

Project calendars and resource calendars identify periods when work is allowed. Project calendars affect all activities. For example, it may not be possible to work on the site during certain periods of the year because of weather.

Resource calendars affect a specific resource or category of resources. Resource calendars reflect how some resources work only during normal business hours, while others work three full shifts, or a project team member might be unavailable, such as on vacation or in

a training program, or a labour contract can limit certain workers to certain days of the week.

### **.9 Adjusting Leads and Lags**

Since the improper use of leads or lags can distort the project schedule, *the leads or lags are adjusted during schedule network analysis to develop a viable project schedule.*

### **.10 Schedule Model**

Schedule data and information are compiled into the schedule model for the project. The schedule model tool and the supporting schedule model data are used in conjunction with manual methods or project management software to perform schedule network analysis to generate the project schedule.

## **Schedule Development: Outputs**

### **.1 Project Schedule**

*The project schedule includes at least a planned start date and planned finish date for each schedule activity.* If resource planning is done at an early stage, then the project schedule would remain preliminary until resource assignments have been confirmed, and scheduled start dates and finish dates are established.

This process usually happens no later than completion of the project management plan. A project target schedule may also be developed with defined **target start dates** and **target finish dates** for each schedule activity. The project schedule can be presented in summary form, sometimes referred to as the **master schedule** or milestone schedule, or presented in detail. Although a project

schedule can be presented in tabular form, it is more often presented graphically, using one or more of the following formats:

- *Project schedule network diagrams.* These diagrams, with activity date information, usually show both the project network logic and the project's critical path schedule activities. These diagrams can be presented in the activity-on-node diagram format, as shown in Figure 6-3, or presented in a time-scaled schedule network diagram format that is sometimes called a logic **bar chart**, as shown for the detailed schedule in Figure 6-9. This example also shows how each work package is planned as a series of related schedule activities.
- *Bar charts/Gantt Charts.* These charts, with bars representing activities, show activity start and end dates, as well as expected durations. Bar charts are relatively easy to read, and are frequently used in management presentations. For control and management communication, the broader, more comprehensive summary activity, sometimes referred to as a **hammock** activity, is used between milestones or across multiple interdependent work packages, and is displayed in bar chart reports. An example is the summary schedule portion of Figure 6-8 that is presented in a WBS structured format. Typically Project Management bar charts depicts the work in a project against a calendar, and these are called **Gantt charts**.
- *Milestone charts.* These charts are similar to bar charts, but only identify the scheduled start or completion of major deliverables and key external interfaces. An example is the milestone schedule portion of Figure 6-7.

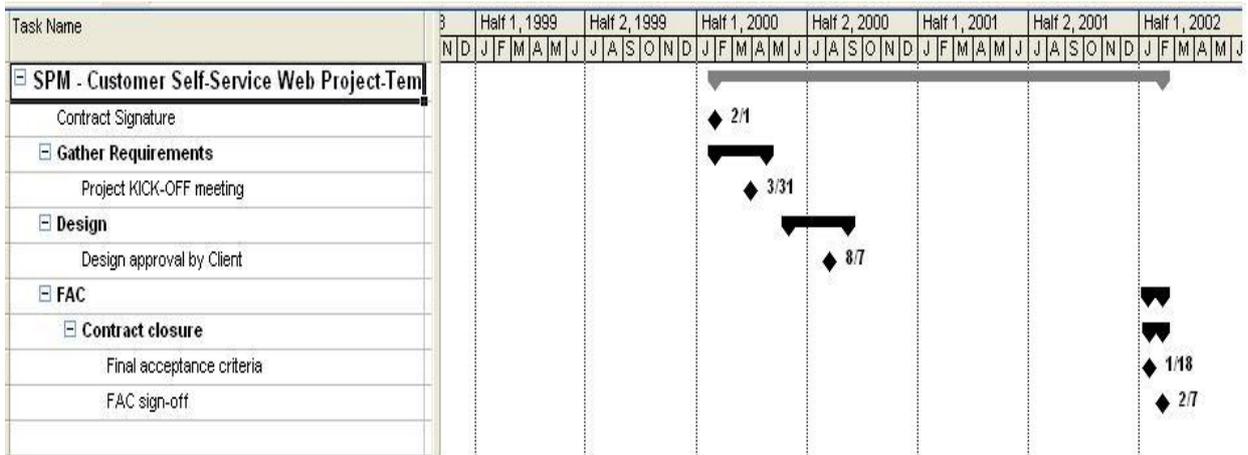


Figure 6-7. Milestone Schedule

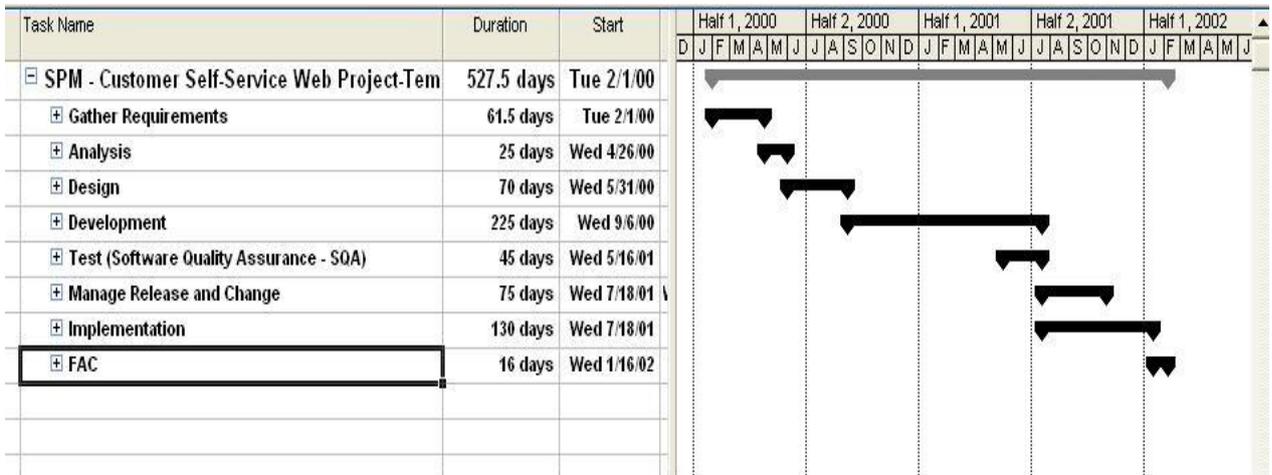


Figure 6-8. Summary Schedule

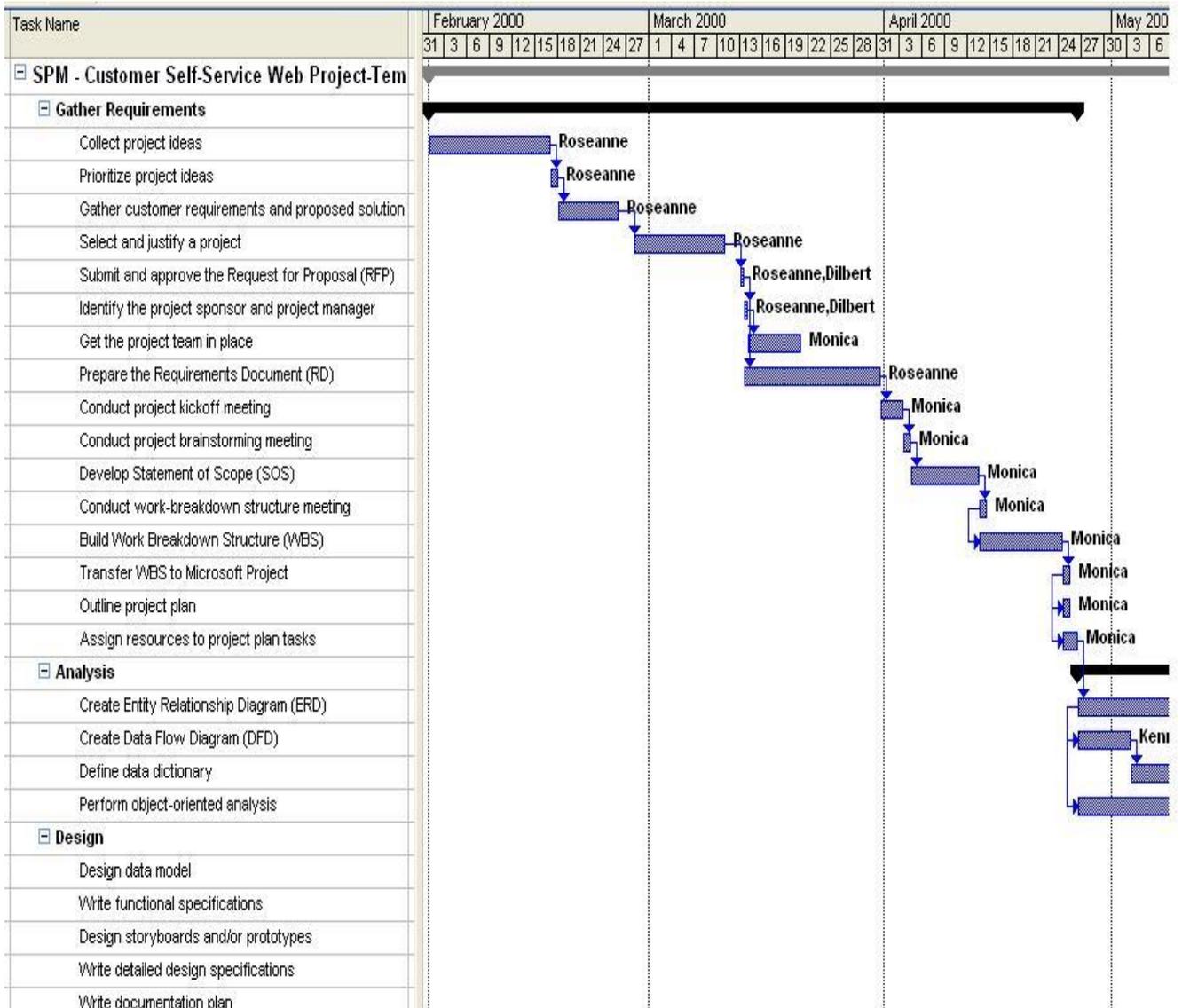


Figure 6-9. Project Schedule – Graphical Examples

Figure 6-9 shows the schedule for a sample project being executed, with the work in progress reported through the **data date**, which is sometimes also called the as-of date or time now date. Typically a project schedule will show the actual start date, actual duration, and **actual finish date** for completed schedule activities, the **actual start date**, **remaining duration**, and **current finish date** for schedule activities with work in progress, and the **current start date**, original duration, and current finish date for schedule activities where work has not yet started.

For a simple project schedule, Figure 6-9 gives a graphic display of a Milestone Schedule, a Summary Schedule, and a Detailed Schedule. Figure 6-9 also visually shows the relationships among the three different levels of schedule presentation.

### **.2 Schedule Model Data**

Supporting data for the project schedule includes at least the schedule milestones, schedule activities, activity attributes and documentation of all identified assumptions and constraints. The amount of additional data varies by application area. Information frequently supplied as supporting detail includes, but is not limited to:

- Resource requirements by time period, often in the form of a resource histogram
- Alternative schedules, such as best-case or worst-case, not resource leveled, resource leveled, with or without imposed dates
- Schedule contingency reserves.

For example, on an electronics design project, the schedule model data might include such items as human resource histograms, cash-flow projections, and order and delivery schedules.

### **.3 Schedule Baseline**

A schedule baseline is a specific version of the project schedule developed from the schedule network analysis of the schedule model. It is accepted and approved by the project management team as the schedule baseline with baseline start dates and baseline finish dates.

### **.4 Resource Requirements (Updates)**

Resource levelling can have a significant effect on preliminary estimates of the types and quantities of resources required. If the

resource-levelling analysis changes the project resource requirements, then the resource requirements are updated.

### **.5 Activity Attributes (Updates)**

The activity attributes are updated to include any revised resource requirements and any other related approved changes generated by the Schedule Development process.

### **.6 Project Calendar (Updates)**

*A project calendar is a calendar of working days or shifts that establishes those dates on which schedule activities are worked.* It also establishes nonworking days that determine dates on which schedule activities are idle, such as holidays, weekends, and non-shift hours. The calendar for each project may use different calendar units as the basis for scheduling the project.

### **.7 Requested Changes**

The Schedule Development process can create requested changes that are processed for review and disposition through the Integrated Change Control process.

### **.8 Project Management Plan (Updates)**

The project management plan is updated to reflect any approved changes in how the project schedule will be managed.

- **Schedule Management Plan (Updates).** If approved change requests result from the Project Time Management processes, then the schedule management plan (Chapter 6 introductory material) component of the project management plan may need to be updated to include those approved changes.

## 6.6 Schedule Control

Schedule control is part of integrated change management. Throughout a typical project, events will happen that may require updates to the project schedule. Schedule control is concerned with three processes:

- The project manager works with the factors that can cause schedule change in an effort to confirm that the changes are agreed upon. Factors can include project team members, stakeholders, management, customers, and project conditions.
- The project manager examines the work results and conditions to determine whether the schedule has changed.
- The project manager manages the actual change in the schedule.

### Schedule Control: Inputs

#### ***.1 Schedule Management Plan***

The project management plan contains the schedule management plan that establishes how the project schedule will be managed and controlled.

#### ***.2 Schedule Baseline***

The project schedule used for control is the *approved project schedule*, which is referred to as the schedule baseline. The schedule baseline is a component of the project management plan. *It provides the basis for measuring and reporting schedule performance as part of the performance measurement baseline.*

### **.3 Performance Reports**

Performance reports provide information on schedule performance, such as which planned dates have been met and which have not. Performance reports may also alert the project team to issues that may cause schedule performance problems in the future.

### **.4 Approved Change Requests**

Only approved change requests that have been previously processed through the Integrated Change Control process are used to update the project schedule baseline or other components of the project management plan.

## **Schedule Control: Tools and Techniques**

### **.1 Progress Reporting**

*The progress reporting and current schedule status includes information such as actual start and finish dates, and the remaining durations for unfinished schedule activities. If progress measurement such as earned value is also used, then the percent complete of in-progress schedule activities can also be included.* To facilitate the periodic reporting of project progress, a template created for consistent use across various project organisational components can be used throughout the project life cycle.

### **.2 Schedule Change Control System**

A schedule control system is a formal approach to managing changes to the project schedule. It considers the conditions, reasons, requests, costs, and risks of making changes. It includes methods of tracking changes, approval levels based on thresholds, and the documentation of approved or declined changes. The schedule control system process is part of integrated change management.

### **.3 Performance Measurement**

Poor performance may result in schedule changes. Performance measurement techniques produce the Schedule Variance (SV) and Schedule Performance Index (SPI), which are used to assess the magnitude of any project schedule variations that do occur. An important part of schedule control is to decide if the schedule variation requires corrective action.

### **.4 Project Management Software**

Project management software for scheduling provides the ability to track planned dates versus actual dates, and to forecast the effects of project schedule changes, real or potential, which makes it a useful tool for schedule control.

### **.5 Variance Analysis**

*Performing the schedule variance analysis during the schedule monitoring process is a key function of schedule control. Comparing target schedule dates with the actual/forecast start and finish dates provides useful information for the detection of deviations, and for the implementation of corrective actions in case of delays. The total float variance is also an essential planning component to evaluate project time performance.*

### **.6 Schedule Comparison Bar Charts**

To facilitate analysis of schedule progress, it is convenient to use a comparison bar chart, which displays two bars for each schedule activity. One bar shows the current actual status and the other shows the status of the approved project schedule baseline. This shows graphically where the schedule has progressed as planned or where slippage has occurred.

## **Schedule Control: Outputs**

### ***.1 Schedule Model Data (Updates)***

A project schedule update is any modification to the project schedule model information that is used to manage the project. Appropriate stakeholders are notified of significant modifications as they occur.

New project schedule network diagrams are developed to display approved remaining durations and modifications to the work plan. In some cases, project schedule delays can be so severe that development of a new target schedule with revised target start and finish dates is needed to provide realistic data for directing the work, and for measuring performance and progress.

### ***.2 Schedule Baseline (Updates)***

Schedule revisions are a special category of project schedule updates. Revisions are changes to the schedule's start and finish dates in the approved schedule baseline. These changes are generally incorporated in response to approved change requests related to project scope changes or changes to estimates. Development of a revised schedule baseline can only occur as a result of approved changes.

### ***.3 Performance Measurements***

The calculated schedule variance (SV) and schedule performance index (SPI) values for WBS components, in particular the work packages and control accounts, are documented and communicated to stakeholders.

#### ***.4 Requested Changes***

Schedule variance analysis, along with review of progress reports, results of performance measures, and modifications to the project schedule model can result in requested changes to the project schedule baseline. Project schedule changes might or might not require adjustments to other components of the project management plan.

#### ***.5 Recommended Corrective Actions***

A corrective action is anything done to bring expected future project schedule performance in line with the approved project schedule baseline. Corrective action in the area of time management often involves expediting, which includes special actions taken to ensure completion of a schedule activity on time or with the least possible delay.

Corrective action frequently requires root cause analysis to identify the cause of the variation. The analysis may address schedule activities other than the schedule activity actually causing the deviation; therefore, schedule recovery from the variance can be planned and executed using schedule activities delineated later in the project schedule.

#### ***.6 Organisational Process Assets (Updates)***

Lessons learned documentation of the causes of variance, the reasoning behind the corrective actions chosen, and other types of lessons learned from schedule control are documented in the organisational process assets, so that they become part of the historical database for both the project and other projects of the performing organisation.

**.7 Activity List (Updates)**

The activity list is updated with all schedule activities that are planned to be performed on the project.

**.8 Activity Attributes (Updates)**

The activity attributes are updated. (See section relating to Activity Definition: Outputs for a more detailed description).

**.9 Project Management Plan (Updates)**

The schedule management plan component of the project management plan is updated to reflect any approved changes resulting from the Schedule Control process, and how the project schedule will be managed.

## Summary and Self Test

### TWO-MINUTE DRILL

#### Sequencing Activities

- Projects are made up of sequential activities to create a product. The WBS and the activity list serve as key input to the sequencing of project activities. The science of arranging, calculating, and predicting how long the activities will take to complete allows the project manager to create a schedule and then predict when the project will end.
- Hard logic is the approach that requires activities to happen in a specific order due to the nature of the work—for example, configuring a computer workstation's operating systems before adding the software.
- Soft logic is a "preferred" method of arranging activities based on conditions, guidelines, or best practices—for example, the project manager preferring to have the photocopying of a user manual be completed before any bindery work on the manual begins.
- The sequence of activities is displayed in a network diagram. The network diagram illustrates the flow of activities and the relationship between activities. The precedent diagramming method is the most common approach to arranging activities visually.

#### Estimating Activity Durations

- Activity duration estimates are needed to calculate how long the project will take to complete. Estimates can come from project team members, commercial databases, expert judgment, and historical information.
- Analogous estimating relies on historical information to predict how long current project activities should last.
- Parametric estimates use a mathematical model to calculate how long activities should take based on units, duration, and effort.

## Evaluating Resources

- ❑ The resources to complete the project activities must be considered. The project manager must evaluate the skill set, the experience, and the ability to get the work done.
- ❑ The project manager must evaluate applying additional resources to effort-driven activities to reduce their duration. Adding resources does not reduce fixed-duration activities' durations.
- ❑ The calendar of the project is the time when the project work may take place. The project manager must consider access to the workplace, project schedule, organisation holidays, and events that affect the project calendar.
- ❑ The resource calendar reflects when the project resources (project team members, consultants, and so on) are available to complete the project work.

## Determining the Project Schedule

- ❑ The critical path is the longest path to completion in the network diagram. Activities on the critical path have no float or slack. Free float is the amount of time an activity can be delayed without affecting the next activity's scheduled start date. Total float is the amount of time an activity can be delayed without affecting the project end date.
- ❑ Duration compression is applied to reduce the length of the project or to account for project delays. Crashing adds resources to project activities and usually increases cost. Fast tracking allows activities to happen in tandem and usually increases risk.
- ❑ The schedule management plan must be consulted when project schedule changes occur, are proposed, or are needed. The schedule control system implements the schedule management plan and is part of integration change management.
- ❑ Critical chain method relies on the availability of resources to determine when the project is most likely to finish. Activities are scheduled based on their latest possible start and finish dates.

**SELF TEST**

**1.** You are the project manager of the JHG Project. This project has 32 stakeholders and will require implementation activities in North and South America. You have been requested to provide a duration estimate for the project. Of the following, which will offer the best level of detail in your estimate?

- A. The resource calendar
- B. An order of magnitude
- C. A requirements document
- D. A stakeholder analysis

**2.** Michael is the project manager of the 78GH Project. This project requires several members of the project team to complete a certification class for another project the week of November 2. This class causes some of the project activities on Michael's activities to be delayed from his target schedule. This is an example of which of the following?

- A. Hard logic
- B. External dependencies
- C. Soft logic
- D. Conflict of interest

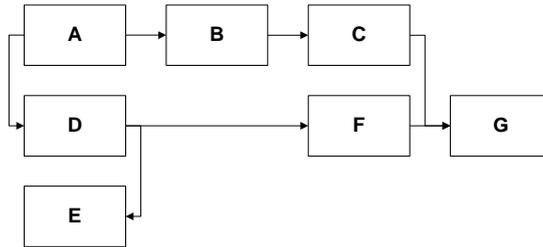
**3.** You are managing an interior decorating project. The walls are scheduled to be painted immediately after the primer. You have allowed 36 hours between the primer activity and the painting activity to ensure that the primer has cured. This is an example of which one of the following?

- A. Lead
- B. Lag
- C. Soft logic
- D. Finish-to-Start relationship

**4.** As the project manager for the DFK Project, you are reviewing your project's network diagram (as shown in the following illustration):

Given the diagram, what is the relationship between tasks F and G?

- A. FS
- B. SS
- C. FF
- D. SF



**5.** You are the project manager for the LLL Project. Steven, a project team member, is confused about network diagrams. Specifically, he wants to know what the critical path is in a network diagram. Your answer is which one of the following?

- A. The critical path is the network that hosts the activities most critical to the project's success.
- B. The critical path is the path with the longest duration.
- C. The critical path is always one path that cannot be delayed or the entire project will be delayed.
- D. The critical path is the path from start to completion with no deviation from the project plan.

**6.** What is the difference between PDM and ADM?

- A. ADM places activities on arrows, while PDM places activities on nodes.
- B. ADM is also known as AOA, while PDM is sometimes referred to as PERT.
- C. ADM hosts activities on nodes, while PDM hosts activities on arrows.
- D. PDM can have two types of relationships between tasks, while ADM can have only one type of relationship between tasks.

**7.** Which network diagram method type can use dummy activities?

- A. Project network diagrams

- B. Precedence diagram method
- C. Activity on the node method
- D. Arrow diagramming method

**8.** Where is a project manager most likely to experience a subnet?

- A. WBS
- B. Kill points
- C. PERT charts
- D. A network template

**9.** You are the project manager for the POL Project. This project will use a three-point estimate to calculate the estimates for activity duration. For activity D, you have the following information:  $P = 9$ ,  $O = 4$ ,  $M = 5$ . What is the result of this estimate?

- A. 18 weeks
- B. Six weeks
- C. 33.33 days
- D. Three weeks

**10.** You are the project manager for the YKL Project. This project will impact several lines of business at completion. You have elected to schedule each milestone in the project to end so the work does not impact current business cycles. This is an example of which one of the following?

- A. Constraint
- B. Expert judgment
- C. WBS scheduling
- D. Soft logic

**11.** You are the project manager for the MNB Project. You and your project team are about to enter into the activity duration estimating process. Which of the following will not be helpful in your meeting?

- A. Constraints
- B. Assumptions

- C. The project charter
- D. Identified risks

**12.** You are the project manager for a new training program at your customer's site. This program will require each of the customer's employees to attend the half-day class and complete an assessment exam. You will be completing the training at the customer's facility, and will need a trainer for the duration of the training, which is six months. This is an example of which of the following?

- A. Resource requirements
- B. Assumption
- C. Cost constraint
- D. A human resource issue

**13.** You are the project manager for a construction company. Your firm has been contracted to complete the drilling of a well for a new cabin in Arkansas. The specification of the well is documented, but your company has little experience in well drilling in Arkansas. The stakeholder is concerned your time estimates are not accurate since the soil and rock in Arkansas are much different than the soil in your home state. Which one of the following can you use to ensure your project estimates are accurate?

- A. An order of magnitude
- B. A commercial duration estimating database
- C. Local contractors
- D. Soil samplings from the Arkansas government

**14.** You are the project manager for your organisation. You and your project team are in conflict on the amount of time allotted to complete certain activities. Several of the team members want to bloat the time associated with activities to ensure they will have enough time to

complete their tasks should something go awry. The law of economics that these tasks may suffer from is which one of the following?

- A. Parkinson's Law
- B. The law of diminishing returns
- C. Hertzberg's theory of motivation
- D. Oligopoly

**15.** You are the project manager for your organisation. You and your project team are in conflict on the amount of time allotted to complete certain activities. Several of the team members want to bloat the time associated with activities to ensure they will have enough time to complete their tasks should something go awry. Instead of overestimating their project activities, the project team should use which of the following?

- A. Capital reserve
- B. Contingency plans
- C. Contingency reserve analysis
- D. Assumptions of plus or minus a percentage

**16.** Which of the following is not an output from the activity duration estimating process?

- A. WBS
- B. Activity list updates
- C. A basis of estimates
- D. Duration estimates

**17.** You are the project manager for the 987 Project. Should this project run over schedule, it will cost your organisation \$35,000 per day in lost sales. With four months to completion, you realise the project is running late. You decide, with management's approval, to add more project team members to the plan to complete the work on time. This is an example of which of the following?

- A. Crashing

- B. Fast tracking
- C. Expert judgment
- D. Cost benefit analysis

**18.** You are the project manager for the 987 Project. Should this project run over schedule, it will cost your organisation \$35,000 per day in lost sales. With four months to completion, you realise the project is running late. You decide, with management's approval, to change the relationship between several of the work packages so they begin in tandem rather than sequentially. This is an example of which one of the following?

- A. Crashing
- B. Fast tracking
- C. Expert judgment
- D. Cost benefit analysis

**19.** Chris, a project manager for his company, is explaining the difference between a Gantt chart and a milestone chart. Which of the following best describes a Gantt chart?

- A. A Gantt chart depicts what was planned against what actually occurred.
- B. A Gantt chart compares the work in the project against the work that has been completed.
- C. A Gantt chart depicts the work in the project against a calendar.
- D. A Gantt chart depicts the work in the project against each resource's calendar.

**20.** Which of the following is a correct attribute of the critical path?

- A. It determines the earliest completion date.
- B. It has the smallest amount of float.
- C. It has the most activities in the PND.
- D. It is the path with the most expensive project activities.

**21.** You are the project manager for a construction project. Your foreman informs you that, due to the humidity, the concrete will need to cure for an additional 24 hours before the framing can begin. To accommodate the requirement, you add \_\_\_\_\_ time to the framing activity.

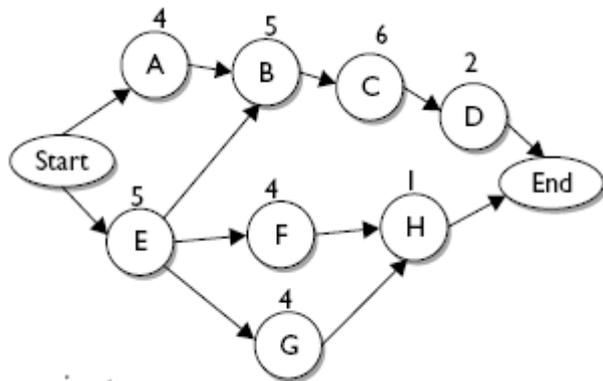
- A. Lead
- B. Lag
- C. Delay
- D. Slack

**22.** A heuristic is a \_\_\_\_\_?

- A. Guideline
- B. Regulation
- C. A regulation internal to an organisation
- D. A best method of implementing an activity

**23.** You are the project manager for a project with the following network diagram. Studying the diagram, which path is the critical path?

- A. ABCD
- B. EBCD
- C. EFH
- D. EGH



Source: PMP Study Guide, Phillips 2006

**24.** Bertha is the project manager for the HAR Project. The project is behind schedule and Bertha has elected, with management's approval, to crash the critical path. This process adds more what? (Choose the best answer.)

- A. Cost
- B. Time
- C. Risk
- D. Documentation

**25.** Bertha is the project manager for the HAR Project. It's currently behind schedule and Bertha has elected, with management's approval, to fast track the critical path. This process adds more what? (Choose the best answer.)

- A. Cost
- B. Time
- C. Risk
- D. Documentation

## 7 Project Cost Management

### Introduction

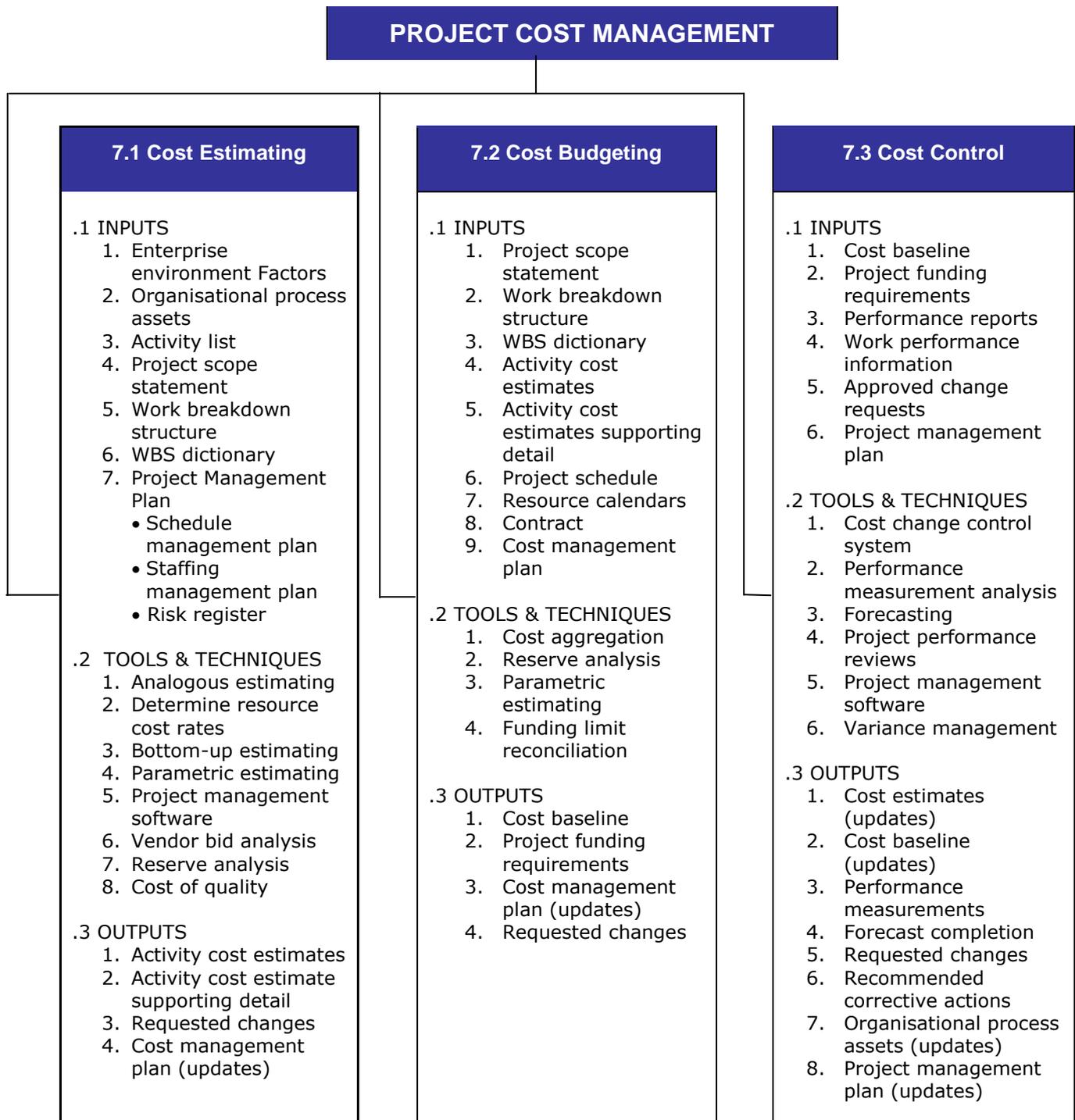
Project Cost Management includes the processes involved in planning, estimating, budgeting, and controlling costs so that the project can be completed within the approved budget. As the business need undergoes analysis, progressive elaboration and estimates are completed based on varying levels of detail, and eventually the cost of the project emerges. Often, however, predicted costs and actual costs vary. Poor planning, skewed assumptions, and overly optimistic estimates all contribute to this. A successful project manager must be able to plan, predict, budget, and control the costs of a project.

Costs associated with projects are not just the costs of goods procured to complete the project. The cost of the labor may be one of the biggest expenses of a project. The project manager must rely on time estimates to predict the cost of the labor to complete the project work. In addition, the cost of the equipment and materials needed to complete the project work must be factored into the project expenses, as should Life-cycle costs such as costs to support the product such as maintenance and service. This study guide examines the management of project costs, how to predict them, account for them, and then, with plan in hand, to control them. In addition, this section explores exactly how costs are planned for and taken into consideration by the performing organisation and how the size of the project affects the cost estimating process.

Project Cost Management is primarily concerned with the following 3 processes as outlined in figure 7-1:

- **Cost estimating** is developing an approximation of the *costs of the resources needed* to complete project activities.
- **Cost budgeting** is *aggregating the estimated costs* of individual activities or work packages to establish a cost baseline.

- **Cost Control** it's influencing the factors that create cost variances and *controlling changes to the project budget*.



**Figure 7-1.. Overview of Project Cost Management Processes**

*These processes interact with each other and with processes in the other Knowledge Areas as well. Each process can involve effort from one or more persons or groups of persons based upon the needs of the project.*

In many application areas, predicting and analysing the prospective financial performance of the project's product is done outside the project. In others, such as a capital facilities project, Project Cost Management can include this work. When such predictions and analyses are included, Project Cost Management will address additional processes and numerous general management techniques such as return on investment, discounted cash flow, and investment payback analysis.

Project Cost Management considers the information requirements of the project stakeholders. Different stakeholders will measure project costs in different ways and at different times. For example, the cost of an acquired item can be measured when the acquisition decision is made or committed, the order is placed, the item is delivered, and the actual cost is incurred or recorded for project accounting purposes.

On some projects, especially the ones with smaller scope, cost estimating and cost budgeting are so tightly linked that they are viewed as a single process that can be performed by a single person over a relatively short period of time. The ability to influence cost is greatest at the early stages of the project, and this is why early scope definition is critical.

The work involved in performing the three processes of Project Cost Management is preceded by a planning effort by the project management team. This planning effort is part of the *Develop Project Management Plan* process. (Please see *Project Integration management*, which produces a *cost management plan* that sets out the format and establishes the criteria for planning, structuring, estimating, budgeting, and controlling project costs). For example, the **cost management plan** can establish:

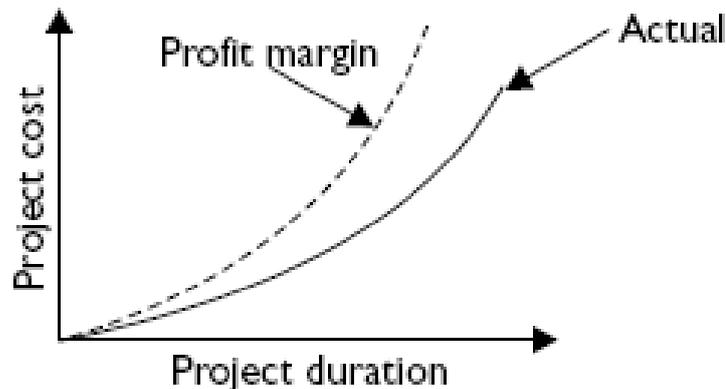
- **Precision level.** Schedule activity cost estimates will adhere to a rounding of the data to a prescribed precision (e.g., \$100, \$1,000), based on the scope of the activities and magnitude of the project, and may include an amount for contingencies.

- **Units of measure.** Each unit used in measurements is defined, such as staff hours, staff days, week, lump sum, etc., for each of the resources.
- **Organisational procedures links.** The WBS component used for the project cost accounting is called a *control account (CA)*. *Each control account is assigned a code or account number that is linked directly to the performing organisation's accounting system.* If cost estimates for planning packages are included in the control account, then the method for budgeting planning packages is included.
- **Control thresholds.** Variance thresholds for costs or other indicators (e.g., person-days, volume of product) at designated time points over the duration of the project can be defined to indicate the agreed amount of variation allowed.
- **Earned value rules.** Three examples of earned value rules that are generally defined or established or included in the *cost management plan* are :
  1. *Earned value management computation formulas for determining the Estimate To Complete (ETC).*
  2. *Earned value credit criteria (e.g., 0-100, 0-50-100, etc.)*
  3. *Define the WBS level at which earned value technique analysis will be performed.*
- **Reporting formats.** The formats for the various cost reports are defined.
- **Cost Control.** Descriptions of how cost variances will be managed.

## 7.1 Cost Estimating:

Cost estimating is the process of calculating the costs of the identified resources needed to complete the project work. The person or group doing the estimating must consider the possible fluctuations, conditions, and other causes of variances that could affect the total cost of the estimate.

There is a distinct difference between cost estimating and pricing. A cost estimate is the cost of the resources required to complete the project work. Pricing, however, includes a profit margin. In other words, a company performing projects for other organisations may do a cost estimate to see how much the project is going to cost to complete. Then, with this cost information, they'll factor a profit into the project work, as shown next: *Estimating schedule activity costs involves developing an approximation of the costs of the resources needed to complete each schedule activity as described in the figure below:*



**Figure 7-2. Estimating the cost and profit of a project** (Source: PMP Study Guide, Phillips 2006)

*Cost estimates are generally expressed in units of currency (dollars, euro, yen, etc.) to facilitate comparisons both within and across projects. In some cases, the estimator can use units of measure to estimate cost,*

such as staff hours or staff days, along with their cost estimates, to facilitate appropriate management control.

Cost estimates can benefit from refinement during the course of the project to reflect the additional detail available. *The accuracy of a project estimate will increase as the project progresses through the project life cycle.* For example, a project in the initiation phase could have a Rough Order of Magnitude (ROM) estimate in the range of -50 to +100%, which is the least accurate estimating tool. Later in the project, as more information is known, estimates could narrow to, a range of -10 to +15 %.( *Budgetary estimate*)

The costs for schedule activities are estimated for all resources that will be *charged to the project*. This includes, but is not limited to, labor, materials, equipment, services, and facilities, as well as special categories such as *an inflation allowance or a contingency cost*. A schedule activity cost estimate is a *quantitative assessment* of the likely costs of the resources required to complete the schedule activity.

*If the performing organisation does not have formally trained project cost estimators, then the project team will need to supply both the resources and the expertise to perform project cost estimating activities.*

## **Cost Estimating: Inputs**

Cost estimating relies on several project components from the initiation and planning process groups. This process also relies on enterprise environmental factors, the processes and procedures unique to your organisation, and the organisational process assets, such as historical information and forms and templates.

### **1. Enterprise Environmental Factors**

The Cost Estimating process considers:

- **Marketplace conditions.** What products, services, and results are available in the marketplace, from whom, and under what terms and conditions.
- **Commercial databases.** Resource cost rate information is often available from commercial databases that track skills and human resource costs, and provide standard costs for material and equipment. Published seller price lists are another source.

## 2. Organisational Process Assets

One of the preferred organisational process assets is historical information. After all, if the project's been done before, why reinvent the wheel? *Existing formal and informal cost estimating-related policies, procedures, and guidelines are considered in developing the cost management plan, selecting the cost estimating tools, and monitoring and reporting methods to be used.* Historical information is proven information and can come from several places including some of the following:

- **Cost estimating policies.** Some organisations have predefined approaches to cost estimating. Where these exist, the project operates within the boundaries defined by these policies.
- **Cost estimating templates.** Some organisations have developed templates (or a pro forma standard) for use by the project team. The organisation can continuously improve the template based on its application and usefulness in prior projects.
- **Project files** - Past projects within the performing organisation can be used as an accurate reference to predict costs and time. Caution should be taken that the records referenced are accurate, somewhat current, and reflective of what was actually experienced in the historical project.

- **Team members** Team members may have specific experience with the project costs or estimates. Recollections may be useful, but are highly unreliable when compared to documented results.
- **Lessons learned** Lessons learned documentation can help the project team estimate the current project if the lessons are from a similar project scope.

### 3. Project Scope Statement

*The project scope statement describes the business need, justification, requirements, and current boundaries for the project. It provides important information about project requirements that is considered during cost estimating. The project scope statement includes constraints, assumptions, and requirements.*

Constraints are specific factors that can limit cost estimating options. *One of the most common constraints for many projects is a limited project budget. Other constraints can involve required delivery dates, available skilled resources, and organisational policies. Assumptions are factors that will be considered to be true, real, or certain.*

*Requirements with contractual and legal implications can include health, safety, security, performance, environmental, insurance, intellectual property rights, equal employment opportunity, licenses, and permits - all of which are considered when developing the cost estimates.*

*The project scope statement also provides the list of deliverables, and acceptance criteria for the project and its products, services, and results. All factors are considered when developing the project cost estimate.*

### 4. Work Breakdown Structure

The project's work breakdown structure (WBS) is an input to five major planning processes: cost estimating, cost budgeting, resource

planning, risk management planning, and activity definition.

## 5. WBS Dictionary

The WBS dictionary and related detailed statements of work provide an identification of the deliverables and a description of the work in each WBS component required to produce each deliverable.

## 6. Project Management Plan

The project management plan provides the overall plan for executing, monitoring, and controlling the project, and includes subsidiary plans that provide guidance and direction for cost management planning and control.

- **Schedule management plan.** *The type and quantity of resources and the amount of time those resources are applied to complete the work of the project is a major part of determining the project cost. Schedule activity resources and their respective durations are used as key inputs to this process.*

*Activity Resource Estimating* involves determining the availability and quantities required of staff, equipment, and material needed to perform schedule activities. It is closely coordinated with cost estimating. *Activity Duration Estimating* will affect cost estimates on any project where the project budget includes an allowance for the cost of financing, including interest charges, and where resources are applied per unit of time for the duration of the schedule activity.

*Schedule activity duration estimates* can also affect cost estimates that have time-sensitive costs included in them, such as union labor with regularly expiring collective bargaining agreements, materials with seasonal cost variations, or cost estimates with time-related costs, such as time-related field overhead costs during construction of a project.

- **Staffing management plan.** Project staffing attributes and personnel rates are necessary components for developing the schedule cost estimates.
- **Risk register.** The cost estimator considers information on risk responses when producing cost estimates. *Risks, which can be either threats or opportunities, typically have an impact on both schedule activity and project costs. As a general rule, when the project experiences a negative risk event, the cost of the project will nearly always increase, and there will be a delay in the project schedule.*

## Cost Estimating: Tools and Techniques

### 1. Analogous Estimating

Analogous estimating relies on historical information to predict the cost of the current project. It is also known as top-down estimating. The process of analogous estimating takes the actual cost of a historical project as a basis for the current project. The cost of the historical project is applied to the cost of the current project, taking into account the scope and size of the current project as well as other known variables.

Analogous estimating is a form of expert judgment. This estimating approach takes less time to complete than other estimating models, but is also less accurate. This top-down approach is good for fast estimates to get a general idea of what the project may cost.

The following is an example of analogous estimating: The Langley Park Project was to grade and pave a sidewalk around a pond in the community park. The sidewalk of Langley Park was 1,048 feet by 6 feet, used a textured surface, had some curves around trees, and cost \$25,287 to complete. The current project, King's Park, will have a similar surface and will cover 4,500 feet by 6 feet. The analogous estimate for this

project, based on the work in Langley Park, is \$108,500. This is based on the price per foot of material at \$4.02.

## **2. Determine Resource Cost Rates**

As part of the planning process, the project manager must determine what resources are needed to complete the project. Resources include the people, equipment, and materials that will be utilised to complete the work. In addition, the project manager must identify the quantity of the needed resources and when the resources are needed for the project. The identification of the resources, the needed quantity, and the schedule of the resources are directly linked to the expected cost of the project work. *The project manager determining the rates or the group preparing the estimates must know the unit cost rates, such as staff cost per hour and bulk material cost per cubic yard, for each resource to estimate schedule activity costs.*

Obtaining data from commercial databases and seller published price lists is another source of cost rates. If the actual rates are not known, then the rates themselves will have to be estimated.

## **3. Bottom-up Estimating**

This technique involves estimating the cost of individual work packages or individual schedule activities with the lowest level of detail. This detailed cost is then summarised or "rolled up" to higher levels for reporting and tracking purposes. Bottom-up estimating starts from zero, accounts for each component of the WBS, and arrives at a sum for the project. It is completed with the project team and can be one of the most time-consuming methods used to predict project costs. While this method is more expensive, because of the time invested to create the estimate, it is also one of the most accurate. A fringe benefit of completing a bottom-up estimate is that the project team may buy into the project work since they see the cost and value of each cost within the project. The cost and

accuracy of bottom-up cost estimating is typically motivated by the size and complexity of the individual schedule activity or work package. Generally, activities with smaller associated effort increase the accuracy of the schedule activity cost estimates.

#### 4. Parametric Estimating

Parametric estimating is a quantitative based estimating method that multiplies the quantity of work by the rate, to calculate a cost estimate for a schedule activity resource.

This technique can produce higher levels of accuracy depending upon the sophistication, as well as the underlying resource quantity and cost data built into the model. A cost-related example involves multiplying the planned quantity of work to be performed by the historical cost per unit to obtain the estimated cost.

There are two types of parametric estimating:

- **Regression analysis** This is a statistical approach to predict what future values may be, based on historical values. Regression analysis creates quantitative predictions based on variables within one value to predict variables in another. This form of estimating relies solely on pure statistical math to reveal relationships between variables and predict future values.
- **Learning curve** This approach is simple: the cost per unit decreases the more units workers complete—this is because workers learn as they complete the required work, thus increasing their efficiency. The more an individual completes an activity, the easier it is to complete. The estimate is considered parametric since the formula is based on repetitive activities, such as wiring telephone jacks, painting hotel rooms, or other activities that are completed over and over within a project. The cost per unit decreases as the experience

increases because the time to complete the work is shortened.

## 5. Project Management Software

Project management software, such as cost estimating software applications, computerised spreadsheets, and simulation and statistical tools, are widely used to assist with cost estimating. Such tools can simplify the use of some cost estimating techniques and thereby facilitate rapid consideration of various cost estimate alternatives.

## 6. Vendor Bid Analysis

Sometimes it's just more cost effective to hire someone else to do the work. Other times, the project manager has no choice because the needed skill set doesn't exist within the organisation. In either condition, the vendors' bids need to be analysed to determine which vendor should be selected based on their ability to satisfy the project scope, the expected quality, and the cost of their services. Other cost estimating methods include vendor bid analysis and an analysis of "*what the project should cost*". In cases where projects are won under competitive bidding processes, additional cost estimating work can be required of the project team to examine the price of individual deliverables, and derive a cost that supports the final total project cost.

## 7. Reserve Analysis

Many cost estimators include reserves, also called contingency allowances, as costs in many schedule activity cost estimates. Contingency reserves are estimated costs *to be used at the discretion of the project manager to deal with anticipated, but not certain, events*. These events are "*known unknowns*" and are part of the project scope and cost baselines.

*One option to manage cost contingency reserves is to aggregate each schedule activity's cost contingency reserve for a group of related*

*activities into a single contingency reserve that is assigned to a schedule activity. This schedule activity may be a zero duration activity that is placed across the network path for that group of schedule activities, and is used to hold the cost contingency reserve.*

An example of this solution to managing cost contingency reserves is to assign them at the work package level to a zero duration activity, which spans from the start to the end of the work package sub network. As the schedule activities progress, the contingency reserve, as measured by resource consumption of the non-zero duration schedule activities, can be adjusted. As a result, the activity cost variances for the related group of schedule activities are more accurate because they are based on cost estimates that are not pessimistic.

*Alternatively, the schedule activity may be a buffer activity in the critical chain method, and is intentionally placed directly at the end of the network path for that group of schedule activities. As the schedule activities progress, the contingency reserve, as measured by resource consumption of the non-buffer schedule activities, can be adjusted. As a result, the activity cost variances for the related group of schedule activities are more accurate because they are based on cost estimates that are not pessimistic.*

## **8. Cost of Quality**

Cost of quality can also be used to prepare the schedule activity cost estimate.

### **Cost Estimating: Outputs**

The output of cost estimating is the actual cost estimates of the resources required to complete the project work. The estimate is typically quantitative and can be presented in detail against the WBS components, or summarised in terms of a grand total according to various phases of

the project, or its major deliverables. Each resource in the project must be accounted for and assigned to a cost category. Categories include the following:

- Labor costs
- Material costs
- Travel costs
- Supplies
- Hardware costs
- Software costs
- Special categories (inflation, cost reserve, and so on)

The cost of the project is expressed in monetary terms, such as dollars, euros, or yen, so management can compare projects based on costs. It may be acceptable, depending on the demands of the performing organisation, to provide estimates in staffing hours or days of work to complete the project along with the estimated costs.

As projects have risks, the cost of the risks should be identified along with the cost of the risk responses. The project manager should list the risks, their expected risk event value, and the response to the risk should it come into play.

The project manager also has to consider changes to the project scope. Chances are that if the project scope increases in size, then the project budget should reflect these changes. A failure to offset approved changes with an appropriate dollar amount will skew the project's cost baselines and show a false variance.

## **1. Activity Cost Estimates**

An activity cost estimate is a quantitative assessment of the likely costs of the resources required to complete schedule activities. This type of estimate can be presented in summary form or in detail.

## 2. Activity Cost Estimate Supporting Detail

The amount and type of additional details supporting the schedule activity cost estimate vary by application area. *Regardless of the level of detail, the supporting documentation should provide a clear, professional, and complete picture by which the cost estimate was derived.*

*Supporting detail for the activity cost estimates should include:*

- *Description of the schedule activity's project scope of work*
- *Documentation of the basis for the estimate (i.e., how it was developed)*
- *Documentation of any assumptions made*
- *Documentation of any constraints*
- *Indication of the range of possible estimates (e.g., \$10,000 (-10% / +15%) to indicate that the item is expected to cost between \$9,000 and \$11,500).*

## 3. Requested Changes

The Cost Estimating process may generate requested changes that may affect the cost management plan, activity resource requirements, and other components of the project management plan. Requested changes are processed for review and disposition through the Integrated Change Control process.

## 4. Cost Management Plan (Updates)

If approved change requests result from the Cost Estimating process, then the cost management plan component of the project management plan is updated if those approved changes impact the management of costs.

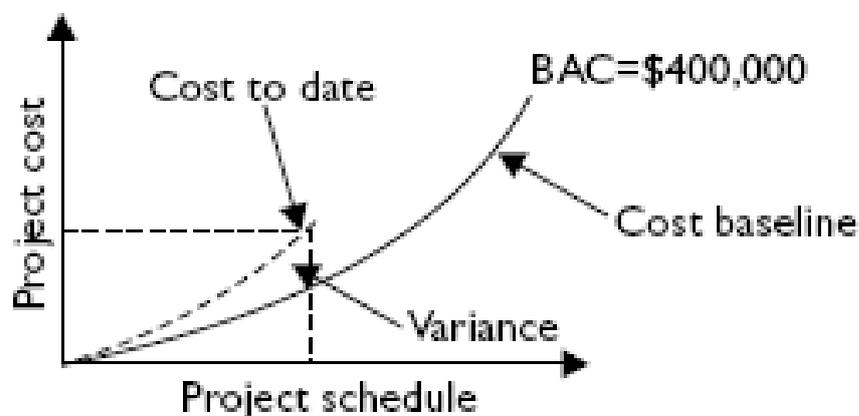
## 5. Refining the Cost Estimates

Cost estimates can also pass through progress elaboration. As more details are acquired as the project progresses, the estimates are refined. Industry guidelines and organisational policies may define how the estimates are refined, but there are three generally accepted categories of estimating accuracy:

- **Rough order of magnitude** This estimate is “rough” and is used during the initiating processes and in top-down estimates. The range of variance for the estimate can be from –25 percent to +75 percent.
- **Budget estimate** This estimate is also somewhat broad and is used early in the planning processes and also in top-down estimates. The range of variance for the estimate can be from –10 percent to +25 percent.
- **Definitive estimates** This estimate type is one of the most accurate. It’s used late in the planning processes and is associated with bottom-up estimating. The range of variance for the estimate can be from –5 percent to +10 percent.

## 7.2 Cost Budgeting

*Cost budgeting involves aggregating the estimated costs of individual schedule activities or work packages to establish a total cost baseline for measuring project performance.* Cost budgeting is the process of assigning a cost to an individual work package. The goal of this process is to assign costs to the work in the project so it can be measured for performance. This is the creation of the cost baseline, as shown in the following figure:



**Figure 7-3. Creating the cost baseline** (source: *PMP Study Guide*, Phillips, 2006)

Cost budgeting and cost estimates may go hand-in-hand, but estimating should be completed before a budget is requested—or assigned. Cost budgeting applies the cost estimates over time. This results in a time-phased estimate for cost, allowing an organisation to predict cash flow needs. The difference between cost estimates and cost budgeting is that cost estimates show costs by category, whereas a cost budget shows costs across time.

### Cost Budgeting: Inputs

#### 1. Project Scope Statement

Formal periodic limitations of the expenditure of project funds can be given in the project charter or contract. These funding constraints are

reflected in the project scope statement, and can be due to annual funding authorisations by the buyer's organisation or other entities like government agencies.

## **2. Work Breakdown Structure**

The project work breakdown structure (WBS) provides the relationship among all the components of the project and the project deliverables.

## **3. WBS Dictionary**

The WBS dictionary and related detailed statements of work provide an identification of the deliverables and a description of the work in each WBS component required to produce each deliverable.

## **4. Activity Cost Estimates**

The cost estimates for each schedule activity within a work package are aggregated to obtain a cost estimate for each work package.

## **5. Activity Cost Estimate Supporting Detail**

The amount and type of additional details supporting the schedule activity cost estimate vary by application area. *Regardless of the level of detail, the supporting documentation should provide a clear, professional, and complete picture by which the cost estimate was derived.*

*Supporting detail for the activity cost estimates should include:*

- *Description of the schedule activity's project scope of work*
- *Documentation of the basis for the estimate (i.e., how it was developed)*
- *Documentation of any assumptions made*
- *Documentation of any constraints*

- *Indication of the range of possible estimates (e.g., \$10,000 (-10% / +15%) to indicate that the item is expected to cost between \$9,000 and \$11,500).*

## **6. Project Schedule**

*The project schedule includes planned start and finish dates for the project's schedule activities, schedule milestones, work packages, planning packages, and control accounts. This information is used to aggregate costs to the calendar periods when the costs are planned to be incurred.*

## **7. Resource Calendars**

A composite resource calendar for the project documents working days and nonworking days that determine those dates in which a specific resource, whether a person or material, can be active or idle, including the quantity of that resource which is available.

## **8. Contract**

Contract information related to what products, services, or results have been purchased - and their costs - are used in developing the budget.

## **9. Cost Management Plan**

The cost management plan, a *component of the project management plan* and other subsidiary plans, are considered during cost budgeting.

## Cost Budgeting: Tools and Techniques

### 1. Cost Aggregation

Schedule activity cost estimates are aggregated by work packages in accordance with the WBS. The work package cost estimates are then aggregated for the higher component levels of the WBS, such as control accounts, and ultimately for the entire project.

### 2. Reserve Analysis

*Reserve analysis establishes contingency reserves, such as the management contingency reserve, that are allowances for unplanned, but potentially required, changes. Such changes may result from risks identified in the risk register.*

*Management contingency reserves are budgets reserved for unplanned, but potentially required, changes to project scope and cost. These are "unknown unknowns," and the project manager must obtain approval before obligating or spending this reserve.*

*Management contingency reserves are not a part of the project cost baseline, but are included in the budget for the project. They are not distributed as budget and, therefore, are not a part of the earned value calculations.*

### 3. Parametric Estimating

The parametric estimating technique involves *using project characteristics (parameters) in a mathematical model to predict total project costs*. Models can be simple (e.g., residential home construction will cost a certain amount per square foot of living space) or complex (e.g., one model of software development costs uses thirteen separate adjustment factors, each of which has five to seven points within it).

Both the cost and accuracy of parametric models vary widely. They are most likely to be reliable when:

- *The historical information used to develop the model is accurate*
- *The parameters used in the model are readily quantifiable*
- *The model is scalable, such that it works for a large project as well as a small one.*

#### **4. Funding Limit Reconciliation**

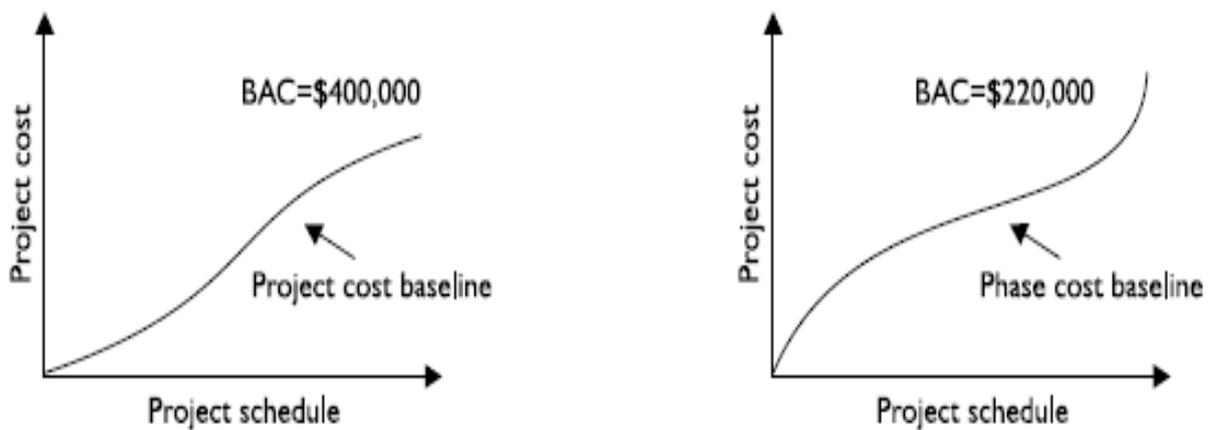
*Large variations in the periodic expenditure of funds are usually undesirable for organisational operations. Therefore, the expenditure of funds is reconciled with the funding limits set by the customer or performing organisation on the disbursement of funds for the project. Reconciliation will necessitate the scheduling of work to be adjusted to smooth or regulate those expenditures, which is accomplished by placing imposed date constraints for some work packages, schedule milestones, or WBS components into the project schedule.*

Rescheduling can impact the allocation of resources. If funds were used as a limiting resource in the Schedule Development process, then the process is repeated using the new imposed date constraints. The final product of these planning iterations is a cost baseline.

### **Cost Budgeting: Outputs**

#### **1. Cost Baseline**

*The cost baseline is a time-phased budget that is used as a basis against which to measure, monitor, and control overall cost performance on the project. It is developed by summing estimated costs by period and is usually displayed in the form of an S-curve, as illustrated in Figure 7-4. The cost baseline is a component of the project management plan.*



**Figure 7-4. Cost baselines show predicted project and phase performance.**  
 (Source: *PMP Study Guide, Phillips 2006*)

The purpose of a cost baseline is to measure performance, and a baseline will predict the expenses over the life of the project. Any discrepancies early on in the predicted baseline and the actual costs serve as a signal that the project is slipping.

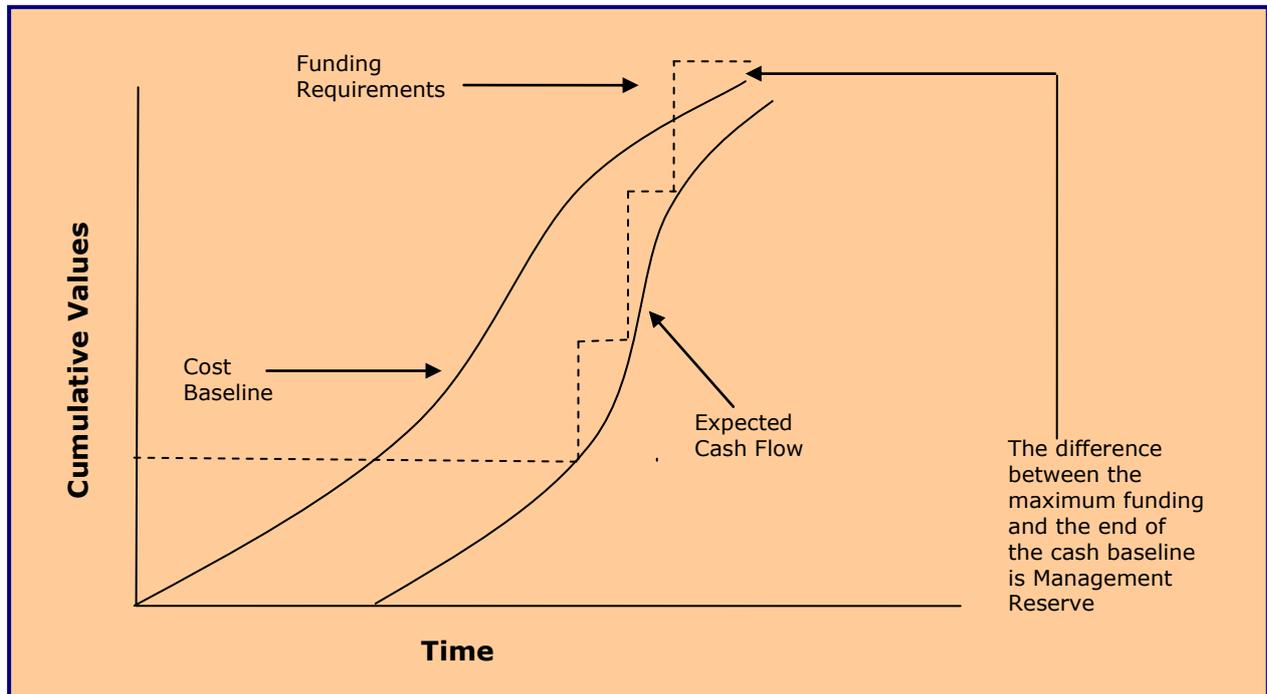
## 2. Project Funding Requirements

*Funding requirements, total and periodic (e.g., annual or quarterly), are derived from the cost baseline and can be established to exceed, usually by a margin, to allow for either early progress or cost overruns. Funding (or income generated by progress payments) usually occurs in incremental amounts that are not continuous, and, therefore, appears as a step function in figure 7-5.*

*The total funds required are those included in the cost baseline **plus** the management contingency reserve amount. Some portion of the management contingency reserve can be included incrementally in each funding step or funded when needed, depending on organisational policies.*

*Any gap at the end of a project between the funds allocated and the cost baseline and cash flow amounts shows the amount of the*

management reserve that was not used as illustrated in figure 7-5.



**Figure: 7-5. Cash Flow, Cost Baseline and Funding Display**  
(Source: PMBOK Guide 3<sup>rd</sup> Ed)

### 3. Cost Management Plan (Updates)

If approved change requests result from the Cost Budgeting process, then the cost management plan component of the project management plan is updated if those approved changes impact the management of costs.

### 4. Requested Changes

The Cost Budgeting process can generate requested changes that affect the cost management plan or other components of the project management plan. Requested changes are processed for review and disposition through the Integrated Change Control process.

### 7.3 Cost Control

Cost control focuses on the ability of costs to change and on the ways of allowing or preventing cost changes from happening. When a change does occur, the project manager must document the change and the reason why the change occurred, and, if necessary, create a variance report. Cost control is concerned with understanding why the cost variances, both good and bad, have occurred. The “why” behind the variances allows the project manager to make appropriate decisions on future project actions. Ignoring the project cost variances may cause the project to suffer from budget shortages, additional risks, or scheduling problems. When cost variances happen, they must be examined, recorded, and investigated. Cost control allows the project manager to confront the problem, find a solution, and then act accordingly. Specifically, cost control focuses on the following activities:

- Controlling causes of change to ensure the changes are actually needed
- Controlling and documenting changes to the cost baseline as they happen
- Controlling changes in the project and their influence on cost
- Performing cost monitoring to recognise and understand cost variances
- Recording appropriate cost changes in the cost baseline
- Preventing unauthorised changes to the cost baseline
- Communicating the cost changes to the proper stakeholders
- Working to bring and maintain costs within an acceptable range

Project **cost control** includes:

- *Influencing the factors that create changes to the cost baseline*
- *Ensuring requested changes are agreed upon*
- *Managing the actual changes when and as they occur*

- *Assuring that potential cost overruns do not exceed the authorised funding periodically and in total for the project*
- *Monitoring cost performance to detect and understand variances from the cost baseline*
- *Recording all appropriate changes accurately against the cost baseline*
- *Preventing incorrect, inappropriate, or unapproved changes from being included in the reported cost or resource usage*
- *Informing appropriate stakeholders of approved changes*
- *Acting to bring expected cost overruns within acceptable limits.*

Project cost control searches out for the causes of *both positive and negative variances* and is part of Integrated Change Control. For example, inappropriate responses to cost variances can cause quality or schedule problems or produce an unacceptable level of risk later in the project.

## **Cost Control: Inputs**

### **1. Cost Baseline**

The cost baseline is the expected cost the project will incur. This time-phased budget reflects the amount that will be spent throughout the project. Cost baseline is a tool used to measure project performance.

### **2. Project Funding Requirements**

The funds for a project are not allotted all at once, but stair-stepped in alignment with project deliverables. Thus, as the project moves towards completion, additional funding is allotted. This allows for cash-flow forecasting. In other words, an organisation doesn't have to have all of the project's budget allotted at the start of the project, but it can predict, based on expected income, that all of the project's budget will be available in incremental steps.

### **3. Performance Reports**

Performance reports provide information on cost and resource performance as a result of actual work progress. These reports focus on project cost performance, project scope, and planned performance versus actual performance.

### **4. Work Performance Information**

Work performance information pertaining to the status and cost of project activities being performed is collected. This information includes, but is not limited to:

- Deliverables that have been completed and those not yet completed
- Costs authorised and incurred
- Estimates to complete the schedule activities
- Percent physically complete of the schedule activities.

### **5. Approved Change Requests**

Approved change requests from the Integrated Change Control process can include modifications to the cost terms of the contract, project scope, cost baseline, or cost management plan. When changes to the project scope are requested, an analysis of the associated costs to complete the proposed change is required. In some instances, such as removing a portion of the project deliverable, a change request may reduce the project cost.

### **6. Project Management Plan**

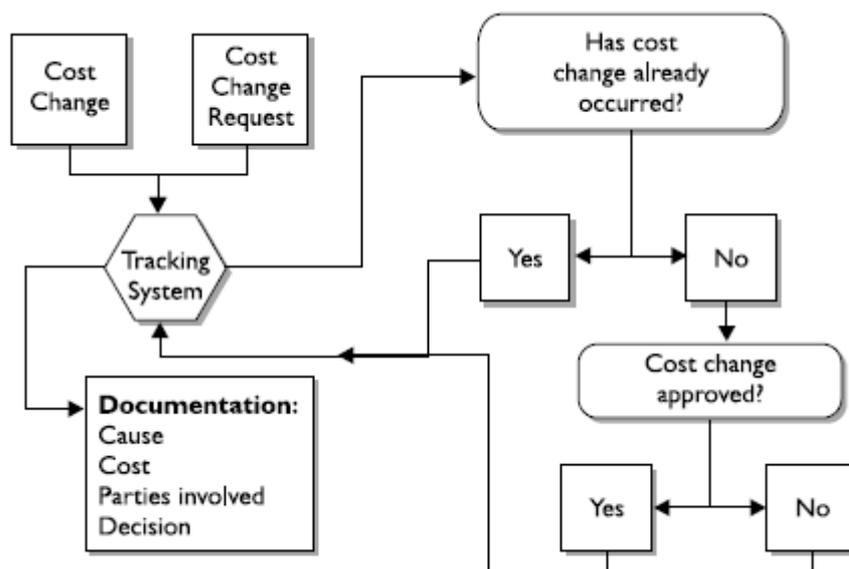
The project management plan and its cost management plan component and other subsidiary plans are considered when performing the Cost Control process. The cost management plan dictates how cost variances will be managed.

## Cost Control: Tools and Techniques

### 1. Cost Change Control System

Sometimes a project manager must add, or remove, costs from a project. The cost change control system is part of the integrated change control system and documents the procedures to request, approve, and incorporate changes to project costs.

When a cost change enters the system, there is appropriate paperwork, a tracking system, and procedures the project manager must follow to obtain approval on the proposed change. Hence, a cost change control system, *documented in the cost management plan*, defines the procedures by which the *cost baseline can be changed*. It includes the *forms, documentation, tracking systems, and approval levels necessary for authorising changes*. The cost change control system is integrated with the integrated change control process. Figure 7-6 demonstrates a typical workflow for cost change approval. If a change gets approved, the cost baseline is updated to reflect the approved changes. If a request gets denied, the denial must be documented for future potential reference.



**Figure 7-6.** A cost change control system tracks and documents cost changes. (Source: PMP Study Guide, Phillips 2006)

## 2. Performance Measurement Analysis

Performance measurement techniques help to assess the magnitude of any variances that will invariably occur. The Earned Value Technique (EVT) compares the cumulative value of the Budgeted Cost of Work Performed (Earned Value) at the original allocated budget amount to both the Budgeted Cost of Work Scheduled (Planned Value) and to the Actual Cost of Work Performed (Actual Cost). This technique is especially useful for cost control, resource management, and production.

*An important part of cost control is to determine the causes of a variance, the magnitude of the variance, and to decide if the variance requires corrective action. The earned value technique uses the cost baseline contained in the project management plan to assess project progress and the magnitude of any variations that occur.*

The earned value technique involves developing these key values for each schedule activity, work package, or control account:

- **Planned value (PV).** PV is the Budgeted Cost for the Work Scheduled (BCWS) *or planned to be completed* on an activity or WBS component up to a given point in time. For example, if a project has a budget of \$100,000 and month six represents 50 percent of the project work, the PV for month six is \$50,000.
- **Earned value (EV).** EV is the Budgeted amount for the work *actually completed or performed* (BCWP) on the schedule activity or WBS component during a given time period. For example, if a project has a budget of \$100,000 and the work completed to date represents 25 percent of the entire project work, its EV is \$25,000. *Formula: % complete \* budget*

- **Actual cost (AC).** AC is the *total cost incurred in accomplishing work* on the schedule activity or WBS component during a given time period. This AC must correspond in definition and coverage to whatever was budgeted for the PV and the EV (e.g., direct hours only, direct costs only, or all costs including indirect costs). For example, if a project has a budget of \$100,000 and \$35,000 has been spent on the project to date, the AC of the project would be \$35,000.

These three values are key information about the worth of the project to date (EV), the cost of the project work to date (AC), and the planned value of the work to date (PV).

- **Cost variance (CV).** CV equals earned value (EV) minus actual cost (AC).

**Formula:  $CV = EV - AC$**

The cost variance at the end of the project will be the difference between the budget at completion (BAC) and the total actual amount spent.

- **Schedule variance (SV).** SV equals earned value (EV) minus planned value (PV).

**Formula:  $SV = EV - PV$**

*Schedule variance will ultimately equal to zero when the project is completed because all of the planned values will have been earned. These two values, the CV and SV, can be converted to efficiency indicators to reflect the cost and schedule performance of any project.*

- **Cost Performance Index (CPI).** A Cost Performance Index CPI value less than 1.0 indicates a cost overrun of the

estimates. A CPI value greater than 1.0 indicates a cost under run of the estimates. CPI equals the ratio of the EV to the AC. The CPI is the most commonly used cost-efficiency indicator.

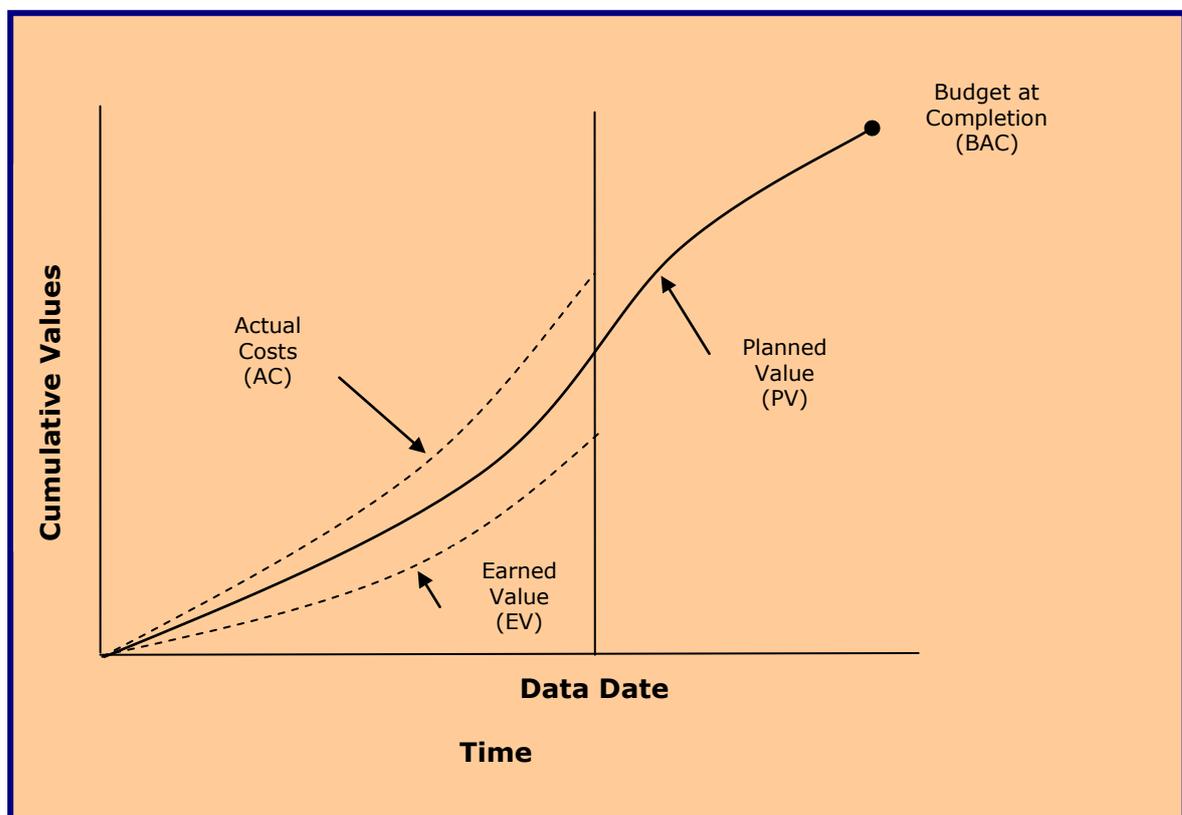
**Formula:  $CPI = EV / AC$**

- **Cumulative CPI ( $CPI^c$ )** The cumulative CPI is widely used to forecast project costs at completion.  $CPI^c$  equals the sum of the periodic earned values ( $EV^c$ ) divided by the sum of the individual actual costs ( $AC^c$ ).

**Formula:  $CPI^c = EV^c / AC^c$**

- **Schedule performance index (SPI).** The Schedule performance index (SPI) is used, in addition to the schedule status, to predict the completion date and is sometimes used in conjunction with the CPI to forecast the project completion estimates. SPI equals the ratio of the EV to the PV.

**Formula:  $SPI = EV / PV$**



**Figure 7-7. Illustrative Graphic Performance Report**  
 (Source: PMBOK Guide 3<sup>rd</sup> Ed)

The earned value technique in its various forms is a commonly used method of performance measurement. *It integrates project scope, cost (or resource) and schedule measures to help the project management team assess project performance.*

### 3. Forecasting

- **Estimate to complete (ETC) and estimate at completion (EAC).**

The PV, EV, and AC values are used in combination to provide performance measures of whether or not work is being accomplished as planned at any given point in time. The most commonly used measures are Cost Variance (CV) and schedule variance (SV). The amount of variance of the CV and SV values tend to decrease as the project reaches completion due to the compensating effect of more work being accomplished. Predetermined acceptable variance values that will decrease over time as the project progresses towards completion can be established in the cost management plan.

*Forecasting includes making estimates or predictions of conditions in the project's future based on information and knowledge available at the time of the forecast.* Forecasts are generated, updated, and reissued based on work performance information provided as the project is executed and progressed. The work performance information is about the project's past performance and any information that could impact the project in the future, for example, estimate at completion and estimate to complete.

The earned value technique parameters of BAC, actual cost (AC) to date, and the CPI efficiency indicator are used to calculate ETC and EAC, where the BAC is equal to the total PV at completion for a schedule activity, work package, control account, or other WBS component.

**Formula:**  $BAC = \text{total cumulative PV at completion}$  Forecasting

techniques help to assess the cost or the amount of work to complete schedule activities, which is called the EAC. Forecasting techniques also help to determine the ETC, which is the estimate for completing the remaining work for a schedule activity, work package, or control account. While the earned value technique of determining EAC and ETC is quick and automatic, it is not as valuable or accurate as a manual forecasting of the remaining work to be done by the project team. The ETC forecasting technique based upon the performing organisation providing the estimate to complete is:

- **ETC based on 'New Estimate'**. ETC equals the revised estimate for the work remaining, as determined by the performing organisation. This more accurate and comprehensive completion estimate is an independent, non-calculated estimate to complete for all the work remaining, and considers the performance or production of the resource (s) to date.

Alternatively, to calculate ETC using earned value data, one of two formulas is typically used:

- **ETC based on 'atypical variances'**. This approach is most often used when current variances are seen as atypical and the project management team expectations are that similar variances will not occur in the future. ETC equals the BAC minus the earned value to date.

**Formula:  $ETC = (BAC - EV)$**

- **ETC based on 'typical variances'**. This approach is most often used when current variances are seen as typical of future variances. ETC equals the BAC minus the EV (the remaining PV) divided by the cost performance index (CPI).

**Formula:  $ETC = (BAC - EV) / CPI$**

An EAC is a forecast of the most likely total value based on project performance and risk quantification. EAC is the projected or anticipated

total final value for a schedule activity, WBS component, or project when the defined work of the project is completed. One EAC forecasting technique is based upon the performing organisation providing an estimate at completion:

- **EAC using a new estimate.** EAC equals the actual costs to date (AC) plus a new ETC that is provided by the performing organisation. This approach is most often used when past performance shows that the original estimating assumptions were fundamentally flawed or that they are no longer relevant due to a change in conditions.

**Formula:  $EAC = AC + ETC$**

The two most common forecasting techniques for calculating EAC using earned value data are some variation of:

- **EAC using remaining budget.** EAC equals AC plus the budget required to complete the remaining work, which is the budget at completion (BAC) minus the earned value (EV). This approach is most often used when current variances are seen as atypical and the project management team expectations are that similar variances will not occur in the future.

**Formula:  $EAC = AC + BAC - EV$**

- EAC using CPI. EAC equals actual costs to date (AC) plus the budget required to complete the remaining project work, which is the BAC minus the EV, modified by a performance factor (often the CPI). This approach is most often used when current variances are seen as typical of future variances.

**Formula:  $EAC = AC + ((BAC - EV) / CPI)$**

Each of these approaches can be the correct approach for any given project and will provide the project management team with a signal if the EAC forecasts are not within acceptable tolerances.

#### 4. Project Performance Reviews

Performance reviews compare cost performance over time, schedule activities or work packages overrunning and under running budget (planned value), milestones due, and milestones met. Performance reviews are meetings held to assess schedule activity, work package, or cost account status and progress, and are typically used in conjunction with one or more of the following performance-reporting techniques:

- **Variance analysis.** Variance analysis involves comparing actual project performance to planned or expected performance. Cost and schedule variances are the most frequently analysed, but variances from plan in the areas of project scope, resource, quality, and risk are often of equal or greater importance.
- **Trend analysis.** Trend analysis involves examining project *performance over time* to determine if performance is *improving or deteriorating*.
- **Earned value technique.** The earned value technique *compares planned performance to actual performance*.

## 5. Project Management Software

Project management software, such as computerised spreadsheets, is often used to monitor PV versus AC, and to forecast the effects of changes or variances.

## 6. Variance Management

The cost management plan describes how cost variances will be managed, for example, having different responses to major or minor problems. The amount of variance tends to decrease as more work is accomplished. The larger variances allowed at the start of the project can

be decreased as the project nears completion.

## **Cost Control: Outputs**

### **1. Cost Estimates (Updates)**

Revised schedule activity cost estimates are modifications to the cost information used to manage the project. Appropriate stakeholders are notified as needed. Revised cost estimates may require adjustments to other aspects of the project management plan.

### **2. Cost Baseline (Updates)**

Budget updates are changes to an approved cost baseline. These values are generally revised only in response to approved changes in project scope. However, in some cases, cost variances can be so severe that a revised cost baseline is needed to provide a realistic basis for performance measurement.

### **3. Performance Measurements**

The calculated CV, SV, CPI, and SPI values for WBS components, in particular the work packages and control accounts, are documented and communicated to stakeholders.

### **4. Forecasted Completion**

Either a calculated EAC value or a performing organisation-reported EAC value is documented and the value communicated to stakeholders. Either a calculated ETC value or a reported ETC value provided by the performing organisation is documented and the value communicated to stakeholders.

### **5. Requested Changes**

Analysis of project performance can generate a request for a change to some aspect of the project. Identified changes can require increasing or

decreasing the budget. Requested changes are processed for review and disposition through the Integrated Change Control process.

## **6. Recommended Corrective Actions**

A corrective action is anything done to bring expected future performance of the project in line with the project management plan. Corrective action in the area of cost management often involves adjusting schedule activity budgets, such as special actions taken to balance cost variances.

## **7. Organisational Process Assets (Updates)**

Lessons learned are documented so they can become part of the historical databases for both the project and the performing organisation. Lessons learned documentation includes the root causes of variances, the reasoning behind the corrective action chosen, and other types of lessons learned from cost, resource, or resource production control.

## **8. Project Management Plan (Updates)**

Schedule activity, work package, or planning package cost estimates, as well as the cost baseline, cost management plan, and project budget documents are components of the project management plan. All approved change requests affecting those documents are incorporated as updates to those documents.

## Summary and Self Test

### TWO-MINUTE DRILL

#### **Resources and the Project Work**

- ❑ The project manager must know what resources are needed to complete the project work. How will the project ever be completed without the resources? The project manager must know the people, the equipment, materials, and other resources needed to make the vision of the project a reality.
- ❑ The resources also must be known so the project manager may predict, monitor, and control what the project costs are expected to be. The relation between the project vision and the needed resources can help the project manager work within the predicted costs.
- ❑ Resources to complete a project also include services, leases, real estate, and other components that contribute to the project work being completed.

#### **Creating Project Estimates**

- ❑ The identified resource requirements and the WBS are two key tools to identify what resources are needed for what component of the project. The cost of the resources help the project manager calculate the estimated costs based on the duration of the project activities or the amount of materials applied to the project.
- ❑ Analogous estimating uses a similar project to predict what the costs of the current project should be. It is less accurate, but easier and faster to complete than other methods.
- ❑ Bottom-up estimating starts with zero, and each component of the WBS is accounted for to reach a grand total of the project. It is the most accurate method, but takes longer to complete.
- ❑ Parametric estimating uses a parameter for units of goods and time to calculate what the project will cost. For example, cost per hour, cost per metric ton, or cost per cubic yard.

#### **Management Project Costs**

- ❑ The cost management plan documents how the project manager will react to cost variances within the project. The performing organisation will likely have policies and procedures on unacceptable variances.
- ❑ Variances that cross a given threshold may require the project manager to create a variance report to explain the variance, why it has happened, and what corrective action has been applied to prevent the variance from recurring.
- ❑ Cost control is the process of monitoring and documenting cost changes, whether they are allowed to occur or prevented from occurring. The project manager studies the cost changes to understand

why the change has happened and then makes corrective actions to the project if needed.

### Applying Earned Value Management

Earned value management is a method to measure project performance. The formulas we covered in this chapter include the following:

Name	Formula
Earned Value	$EV = \% \text{ complete} \times BAC$
Cost Variance	$CV = EV - AC$
Schedule Variance	$SV = EV - PV$
Cost Performance Index	$CPI = EV / AC$
Schedule Performance Index	$SPI = EV / PV$
Estimate to Complete: ETC based on new estimate ETC based on atypical variances ETC based on typical variances	Manual calculation by the Project Team $ETC = BAC - EV$ $ETC = BAC - EV / CPI$
Estimate at Completion: EAC using a new estimate EAC using remaining budget EAC using CPI	$EAC = AC + ETC$ $EAC = AC + BAC - EV$ $EAC = AC + ((BAC - EV) / CPI)$

BAC = Budget

**SELF TEST**

- 1.** Which of the following best describes analogous estimating?
  - A. Regression analysis
  - B. Bottom-up estimating
  - C. Less accurate
  - D. More accurate
  
- 2.** You are the project manager for the GHG Project. You are about to create the cost estimates for the project. Which input to this process will help you the most?
  - A. Parametric modeling
  - B. WBS
  - C. Project scope
  - D. Requirements document
  
- 3.** You are the project manager for the JKH Project. You have elected to use parametric estimating in your cost estimating for the project. Which of the following is an example of parametric estimating?
  - A. \$750 per ton
  - B. Historical information from a similar project
  - C. Estimates built bottom up based on the WBS
  - D. Estimates based on top-down budgeting
  
- 4.** You are the project manager for a new technology implementation project. Management has requested that your estimates be as exact as possible. Which one of the following methods of estimating will provide the most accurate estimate?
  - A. Top-down estimating
  - B. Top-down budgeting
  - C. Bottom-up estimating
  - D. Parametric estimating

**5.** Your company has been hired to install the tile in 1,000 hotel rooms. All rooms will be identical in nature and will require the same amount of materials. You calculate the time to install the tile in each hotel room at six hours. The cost for labor for each room is calculated at \$700. Your project sponsor disagrees with your labor estimate. Why?

- A. You haven't completed one hotel room yet so you don't know how long the work will actually take
- B. You have not factored in all of the effort applied to the work
- C. You have not considered the law of diminishing returns
- D. You have not considered the learning curve

**6.** You are the project manager for a construction project to build 17 cabins. All of the cabins will be identical in nature. The contract for the project is set at a fixed cost, the incentive being that the faster the project work is completed, the more profitable the job. Management has requested that you study the work method to determine a faster, less costly, and better method of completing the project. This is an example of which one of the following?

- A. Time constraint
- B. Schedule constraint
- C. Value engineering
- D. Learning curve

**7.** You are the project manager for a technical implementation project. The customer has requested that you factor in the after-the-project costs, such as maintenance and service. This is an example of which one of the following?

- A. Life-cycle costs
- B. Scope creep
- C. Project spin off
- D. Operations

- 8.** Which one of the following provides the least accuracy in estimating?
- A. Rough order of magnitude
  - B. Budget estimate
  - C. Definitive estimate
  - D. WBS estimate
- 9.** Which one of the following is true?
- A. The cost management plan controls how change management affects the BAC
  - B. The cost management plan controls how cost variances will be managed
  - C. The cost management plan controls how the project manager may update the cost estimates
  - D. The cost management plan controls how the BAC may be adjusted
- 10.** You have just started a project for a manufacturer. Project team members report they are 30-percent complete with the project. You have spent \$25,000 out of the project's \$250,000 budget. What is the earned value for this project?
- A. 10 percent
  - B. \$75,000
  - C. \$25,000
  - D. Not enough information to know
- 11.** You and your project team are about to enter a meeting to determine project costs. You have elected to use bottom-up estimating and will base your estimates on the WBS. Which one of the following is not an attribute of bottom-up estimating?
- A. People doing the work create the estimates
  - B. It creates a more accurate estimate
  - C. It's more expensive to do than other methods
  - D. It's less expensive to do than other methods

**12.** What is the present value if the organisation expects to make \$100,000 four years from now and the annual interest rate is six percent?

- A. \$100,000
- B. \$58,000
- C. \$25,000
- D. Zero

**13.** You are the project manager for the construction of a new hotel. Before you begin the cost budgeting process, what is needed?

- A. Costs estimates and project schedule
- B. Cost estimates and supporting detail
- C. EAC and BAC
- D. A parametric model used to arrive at the costs submitted

**14.** You are the project manager of the MNJ Project. Your project is falling behind schedule and you have already spent \$130,000 of your \$150,000 budget. What do you call the \$130,000?

- A. Planned value
- B. Present value
- C. Actual costs
- D. Capital expenditure

**15.** You are the project manager of the JHD Project. Your project will cost your organisation \$250,000 to complete over the next eight months. Once the project is completed, the deliverables will begin earning the company \$3,500 per month. Which of the following represents the time to recover the costs of the project?

- A. Not enough information to know
- B. Eight months
- C. 72 months
- D. Five years

**16.** You are the project manager for the consulting company. Your company has two possible projects to manage, but they can only choose one. Project KJH is worth \$17,000, while Project ADS is worth \$22,000. Management elects to choose Project ADS. The opportunity cost of this choice is which one of the following?

- A. \$5,000
- B. \$17,000
- C. \$22,000
- D. Zero, as project ADS is worth more than Project KJH

**17.** You are the project manager for the CSR Training Project, and 21,000 customer service reps are invited to attend the training session. Attendance is optional. You have calculated the costs of the training facility, but the workbook expense depends on how many students register for the class. For every 5,000 workbooks created, the cost is reduced by a percentage of the original printing cost. The workbook expense is an example of which one of the following?

- A. Fixed costs
- B. Parametric costs
- C. Variable costs
- D. Indirect costs

**18.** You are the project manager of a construction project scheduled to last 24 months. You have elected to rent a piece of equipment for the duration of a project, even though you will need the equipment only periodically throughout the project. The costs of the equipment rental per month are \$890. This is an example of which of the following?

- A. Fixed costs
- B. Parametric costs
- C. Variable costs
- D. Indirect costs

**19.** You are the project manager for the Hardware Inventory Project. You have a piece of equipment that was purchased recently for \$10,000 and is expected to last five years in production. At the end of the five years the expected worth of the equipment will be \$1,000. Using straight-line depreciation, what is the amount that can be written off each year?

- A. Zero
- B. \$1,000
- C. \$1,800
- D. \$2,000

**20.** You are the project manager of the LKG Project. The project has a budget of \$290,000 and is expected to last three years. The project is now ten-percent complete and is on schedule. What is the BAC?

- A. \$29,000
- B. \$290,000
- C. \$96,666
- D. \$9,666

**21.** Your project has a budget of \$130,000 and is expected to last ten months, with the work and budget spread evenly across all months. The project is now in month three, the work is on schedule, but you have spent \$65,000 of the project budget. What is your variance?

- A. \$65,000
- B. \$39,000
- C. \$26,000
- D. \$64,999

**22.** You are the project manager of the Carpet Installation Project for a new building. Your BAC is \$600,000. You are now 40-percent complete with the project, though your plan called for you to be 45-percent complete with the work by this time. What is your earned value?

- A. \$240,000
- B. \$270,000
- C. \$30,000
- D. -\$30,000

**23.** You are the project manager of the Carpet Installation Project for a new building. Your BAC is \$600,000. You have spent \$270,000 of your budget. You are now 40-percent done with the project, though your plan called for you to be 45-percent done with the work by this time. What is your CPI?

- A. 100
- B. 89
- C. .89
- D. .79

**24.** You are the project manager for the Facility Installation Project. The project calls for 1500 units to be installed into a new baseball stadium. Your team wants to know why you have not assigned the same amount of time for the last 800 units as you had for the first 500 units. You tell them it is because of the learning curve. Which one of the following best describes this theory?

- A. Production increases as workers become more efficient with the installation procedure.
- B. Efficiency increases as workers become more familiar with the installation procedure.
- C. Costs decrease as workers complete more of the installation procedure.
- D. Time decreases as workers complete more of the installation procedure in the final phases of a project.

**25.** Of the following, which one is the most reliable source of information for estimating project costs?

- A. Historical information from a recently completed project
- B. An SME's opinion
- C. Recollections of team members that have worked on similar projects
- D. Vendor's white papers

## 8 Project Quality Management

### Introduction

Quality is "the degree to which a set of inherent characteristics fulfill requirements", therefore Quality is the process of completing the scope to stated or implied needs. Quality is prevention-driven, meaning it costs less to plan quality into a project than to fix issues down the track.

Quality and grade are not the same. Grade is a category assigned to products or services having the same functional use but different technical characteristics. Low quality is always a problem; low grade may not be. For example, a software product can be of high quality (no obvious defects, readable manual) and low grade (a limited number of features), or of low quality (many defects, poorly organised user documentation) and high grade (numerous features).

*Project Quality Management processes include all the activities of the performing organisation that determine quality policies, objectives, and responsibilities so that the project will satisfy the needs for which it was undertaken.* It implements the quality management system through the policy, procedures, and *the three (3) processes of quality planning, quality assurance, and quality control*, with continuous process improvement activities conducted throughout, as appropriate.

A critical element of quality management in the project context is *to turn stakeholder needs, wants, and expectations into requirements through Stakeholder Analysis*, performed during Project Scope Management.

The table at 8.1 provides an overview of the Project Quality Management processes. The Project Quality Management processes

include the following:

- 1. Quality Planning** - Identifying which quality standards (and regulations) are relevant to the project and determining how to satisfy them.
- 2. Perform Quality Assurance** - Applying the planned, systematic quality activities to ensure that the project employs all processes needed to meet requirements.
- 3. Perform Quality Control** - Monitoring specific project results to determine whether they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory performance.

These processes interact with each other and with the processes in the other Knowledge Areas as well. Each process can involve effort from one or more persons or groups of persons based on the needs of the project. Each process occurs at least once in every project and occurs in one or more project phases, if the project is divided into phases. Although the processes are presented here as discrete elements with well-defined interfaces, in practice they may overlap and interact in ways not detailed here.

The basic approach to quality management described in this section is intended to be compatible with that of the *International Organisation for Standardisation (ISO)*. This *generalised approach* should also be compatible with *proprietary approaches* to quality management such as those recommended by *Deming, Juran, Crosby* and others, and *non-proprietary approaches* such as *Total Quality Management (TQM), Six Sigma, Failure Mode and Effect Analysis, Design Reviews, Voice of the Customer, Cost of Quality (COQ), and Continuous Improvement*.

Project Quality Management must address the management of the project and the product of the project. While Project Quality Management applies to all projects, regardless of the nature of their product, product

quality measures and techniques are specific to the particular type of product produced by the project. In either case, failure to meet quality requirements in either dimension (*i.e. project quality vs. product quality*) can have serious negative consequences for any or all of the project stakeholders. For example:

- Meeting customer requirements by overworking the project team may produce negative consequences in the form of increased employee attrition, unfounded errors, or rework.
- Meeting project schedule objectives by rushing planned quality inspections may produce negative consequences when errors go undetected.

The *project manager and the project team* are responsible for determining and delivering the required levels of both *quality and grade*.

# PROJECT QUALITY MANAGEMENT

8.1 Quality Planning	8.2 Perform Quality Assurance	8.3 Perform Quality Control
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**Table 8.1 – Project Quality Management Overview**

## **The Relationship of Project Quality Management and Project Phases**

Modern quality management complements project management. For example, both disciplines recognise the importance of:

- *Customer satisfaction.* Understanding, evaluating, defining, and managing expectations so that customer requirements are met. This requires a *combination of conformance to requirements (the project must produce what it said it would produce) and fitness for use (the product or service must satisfy real needs).*
- *Prevention over inspection.* The cost of preventing mistakes is generally much less than the cost of correcting them, as revealed by inspection.
- *Management responsibility.* Success requires the participation of all members of the team, but it remains the responsibility of management to provide the resources needed to succeed.
- *Continuous improvement.* The **plan-do-check-act cycle** is the **basis** for quality improvement. In addition, quality improvement initiatives undertaken by the performing organisation, such as TQM and Six Sigma, can improve the quality of the project's management as well as the *quality of the project's product.*

Project quality management is important at all stages of project operations. The summary below is an outline of the main activities at the different stages.

**Initiating phase** – i.e. before a project proposal is submitted (initiation/concept phase) involves exploring and determining a broad framework of quality for the project with the aim to ensure that project specifications will be accurate. The framework will include:

- the processes to be used

- the specifications of the outputs and outcomes to be delivered
- identifying experts to monitor and check quality throughout the project and at the end
- quality criteria that must be met before project sign off can occur.

**Planning phase** – once a project is approved (planning/development) will include:

- developing and agreeing on the quality criteria that will be applied to different aspects of the project
- the processes for measuring, monitoring and reporting compliance with the quality criteria.

**Executing, Monitoring and Controlling phases** – when the project is underway (delivery) will include:

- clearly defining and communicating to all stakeholders and project team members the performance indicators and their measures
- collecting information on the products/services and processes at different times to monitor progress in achieving quality measures
- incorporating feedback from quality monitoring into processes and outputs to ensure continuous improvement.
- Throughout the implementation phase all those involved in the project will have varying degrees of responsibility for quality assurance, depending on their role.

**Closing phase** -review (finalisation) involves checking the products and project outcomes for compliance with specifications/requirements. This may require sign off by key stakeholders.

Responsibilities for managing project quality

Quality is not the responsibility of quality managers or specialist quality

assurance teams, but is the responsibility of all project team members. Everyone should monitor the quality of their own processes and products/services and seek and implement ways to improve them. The table below lists responsibilities in relation to quality, by all those involved in the project.

Personnel	Responsibility
Project Manager	<ul style="list-style-type: none"> <li>Development of project quality plan</li> <li>Monitor collection of feedback on quality processes and products</li> <li>Manage incorporation of feedback into project processes and products</li> <li>Manage team delivery of quality outcomes</li> <li>Manage communication and reporting on project quality to project sponsor and stakeholders</li> </ul>
Authorising agent/agency	<ul style="list-style-type: none"> <li>Identify and communicate required quality standards for project outcomes/processes</li> <li>Agree on monitoring and reporting processes</li> <li>Evaluate quality outcomes against requirements</li> </ul>
Project Sponsor	<ul style="list-style-type: none"> <li>Agree and monitor project quality criteria and how they are met</li> <li>May lead external project quality monitoring processes such as project management committees etc</li> </ul>
Project Team Member(s)	<ul style="list-style-type: none"> <li>Understand quality standards required (for products and processes)</li> <li>Comply with quality requirements</li> <li>Provide feedback to other team members and project manager on quality issues as they arise</li> </ul>

	Contribute to collecting, checking and reporting quality issues
Stakeholders	Identify quality criteria required to be met by the project e.g. environmental standards, product specifications; consultation processes etc Identify processes for monitoring how the project meets that criteria (ongoing and at the end).

Table 8.3 - Stakeholder involvement in project quality management

Project stakeholders have a specific and clearly definable stake/interest in the project. Stakeholders are usually both internal and external to the organisation that is authorising the project. It is anyone who is affected by the project processes or the project results.

Different stakeholders of the project will have different views about quality, depending on their interests and expertise. For example the project sponsor's focus on quality may be on producing outcomes that meet specifications, within budget and timeframes; funding bodies may be looking for reliability and value in project products ensuring they contribute to strategic objectives; and consumers may be primarily concerned with the quality of consultation processes. Failure to meet stakeholder expectations of quality can often be very damaging to an otherwise successful project. For example a building must not just satisfy a customer's design, but must also comply with all relevant local regulations.

## **8.1 Quality Planning**

Quality planning involves identifying which quality standards are relevant to the project and determining how to satisfy them. It is one of the key processes when doing the Planning Process Group and during development of the project management plan, and should be performed in parallel with the other project planning processes. For example, the required changes in the product to meet identified quality standards may require cost or schedule adjustments, or the desired product quality may require a detailed risk analysis of an identified problem. Quality planning involves studying the project requirements and creating a Quality plan that details how the deliverables will be implemented to the appropriate level of quality.

The quality planning techniques discussed here are those techniques most frequently used on projects. There are many others that may be useful on certain projects or in some application areas. One of the fundamental tenets of modern quality management is: quality is planned, designed, and built in---not inspected in.

### **Quality Planning: Inputs**

#### **.1 Enterprise Environmental Factors**

Governmental agency regulations, rules, standards, and guidelines specific to the application area may affect the project. Some of examples of such enterprise and organisational environmental factors which must be considered include among others, the following:

- a. Organisational or company culture and structure;

- b. Governmental or industry standards (e.g. Regulatory agency regulations, product standards, quality standards, and workmanship standards)
- c. Infrastructure
- d. Existing human resources (eg. Skills, disciplines, and knowledge)
- e. Personnel administration (eg. human resources recruiting policies)
- f. Stake holder tolerances
- g. Market place conditions
- h. Project Management information systems

## **.2 Organisational Process Assets**

Organisational quality policies, procedures and guidelines, historical databases and lessons learned from previous projects specific to the application area may affect the project. The quality policy, as endorsed by senior management, is the intended direction of a performing organisation with regard to quality. The quality policy of the performing organisation for their products often can be adopted "as is" for use by the project.

However, if the performing organisation lacks a formal quality policy, or if the project involves multiple performing organisations (as with a joint venture), then the project management team will need to develop a quality policy for the project. Regardless of the origin of the quality policy, the project management team is responsible for ensuring that the project stakeholders are fully aware of the policy through the appropriate distribution of information.

## **.3 Project Scope Statement**

The project scope statement is a key input to quality planning since it documents major project deliverables, the project objectives that serve to define requirements (which were derived from

stakeholder needs, wants, and expectations), thresholds, and acceptance criteria.

Thresholds, which are defined as cost, time, or resource values used as parameters, can be part of the project scope statement. If these threshold values are exceeded, it will require action from the project management team. Acceptance criteria include performance requirements and essential conditions that must be achieved before project deliverables are accepted.

The definition of acceptance criteria can significantly increase or decrease project quality costs. The result of the deliverables satisfying all acceptance criteria implies that the needs of the customer have been met. Formal acceptance validates that the acceptance criteria have been satisfied. The product scope description, embodied in the project scope statement, will often contain details of technical issues and other concerns that can affect quality planning.

#### **.4 Project Management Plan**

The project management plan contains the schedule management plan, cost management plan, project scope management plan, and risk management plan. It includes the following inputs:

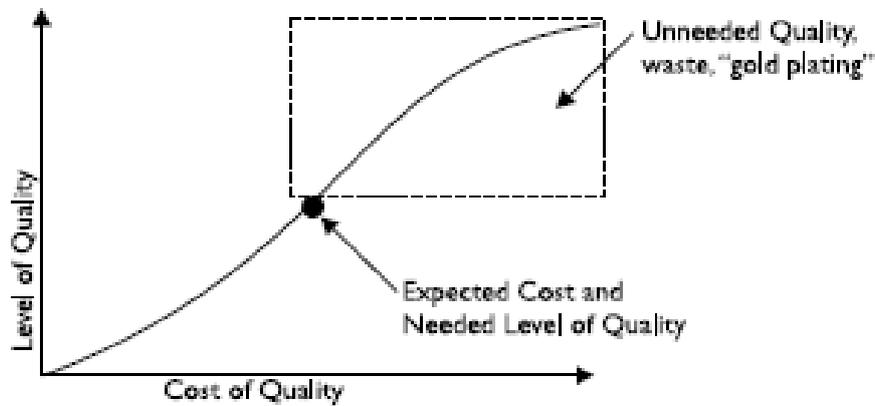
- a. Preliminary Project Scope Statement
- b. Project Management Processes
- c. Enterprise Environmental Factors
- d. Organisational Process Assets

### **Quality Planning: Tools and Techniques**

#### **.1 Cost-Benefit Analysis**

Quality planning must consider cost-benefits tradeoffs. The primary benefit of meeting quality requirements is less rework, which means higher productivity, lower costs, and increased stakeholder

satisfaction. The primary cost of meeting quality requirements is the expense associated with Project Quality Management activities.



**Figure 8-1. Cost-Benefit Analysis**

## **.2 Benchmarking**

Benchmarking involves comparing actual or planned project practices to those of other projects to generate ideas for improvement and to provide a basis by which to measure performance. These other projects can be within the performing organisation or outside of it, and can be within the same or in another application area.

## **.3 Design of Experiments**

Design of experiments (DOE) is a statistical method that helps identify which factors may influence specific variables of a product or process under development or in production. It also plays a role in the optimisation of products or processes. An example is where an organisation can use DOE to reduce the sensitivity of product performance to sources of variations caused by environmental or manufacturing differences.

The most important aspect of this technique is that it provides a statistical framework for systematically changing all of the important

factors, instead of changing the factors one at a time. The analysis of the experimental data should provide the optimal conditions for the product or process, highlighting the factors that influence the results, and revealing the presence of interactions and synergisms among the factors. For example, automotive designers use this technique to determine which combination of suspension and tires will produce the most desirable ride characteristics at a reasonable cost.

#### **.4 Cost of Quality (COQ)**

Quality costs are the total costs incurred by investment in preventing nonconformance to requirements, appraising the product or service for conformance to requirements, and failing to meet requirements. The costs of quality can be things like costs for Quality planning, training, appraisals, rework, product recalls. Failure costs are often categorised into internal and external. Failure costs are also called cost of poor quality.

*The cost of quality refers to the total cost of all efforts related to quality. Project decisions can impact operational costs of quality as a result of product returns, warranty claims, and recall campaigns. However, the temporary nature of the project means that investments in product quality improvement, especially defect prevention and appraisal, can often be borne by the performing / acquiring organisation, rather than the project, since the project may not last long enough to reap the rewards. The following are considered generally the various costs of quality:*

<i>Prevention Costs</i>	<i>Appraisal Costs</i>	<i>Failure Costs</i>
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Costs associated with preventing defects from occurring - taking a <i>proactive</i> or <i>preventative</i> approach. Some examples include: Planning for Quality Training Audits	Costs associated with checking the product to separate the defectives from the acceptable products - <i>reactive</i> approach. Some examples include: Inspections Reviews Testing	Costs associated with products that have failed to meet the quality requirements. Failure can be internal as well as external - <i>Impact</i> of poor quality. Some examples include: Scrap Repair and rework Product recalls
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**Table 8.2 – Costs of Quality**

## **.5 Additional Quality Planning Tools**

Other quality planning tools are also often used to help better define the situation and help plan effective quality management activities. These include brainstorming, affinity diagrams, force field analysis, nominal group techniques, *matrix diagrams*, *flowcharts*, and *prioritisation matrices*.

## **Quality Planning: Outputs**

### **.1 Quality Management Plan**

The quality management plan describes how the project management team will implement the performing organisation's quality policy. The quality management plan is a component or a subsidiary plan of the project management plan. The quality management plan provides input to the overall project management plan and must address quality control (QC), quality assurance (QA), and continuous process improvement for the project.

The quality management plan may be formal or informal, highly detailed or broadly framed, based on the requirements of the project. The quality management plan should include efforts at the front end of a project to ensure that the earlier decisions, for example on concepts, designs and tests, are correct. These efforts should be

performed through an independent peer review and not include individuals that worked on the material being reviewed. The benefits of this review can include reduction of cost and schedule overruns caused by rework.

## **.2 Quality Metrics**

A metric is an operational definition that describes, in very specific terms, what something is and how the quality control process measures it. A measurement is an actual value. For example, it is not enough to say that meeting the planned schedule dates is a measure of management quality.

The project management team must also indicate whether every activity must start on time or only finish on time and whether individual activities will be measured, or only certain deliverables and if so, which ones. Quality metrics are used in the QA and QC processes. Some examples of quality metrics include defect density, failure rate, availability, reliability, and test coverage.

## **.3 Quality Checklists**

A checklist is a structured tool, usually component-specific, used to verify that a set of required steps has been performed. Checklists may be simple or complex. Many organisations have standardised checklists available to ensure consistency in frequently performed tasks. In some application areas, checklists are also available from professional associations or commercial service providers. Quality checklists are used in the quality control process.

## **.4 Process Improvement Plan**

The process improvement plan is a subsidiary of the project

management plan. The process improvement plan details the steps for analysing processes that will facilitate the identification of waste and non-value added activity, thus increasing customer value, such as:

- a) Process boundaries. Describes the purpose, start, and end of processes, their inputs and outputs, data required, if any, and the owner and stakeholders of processes.
- b) Process configuration. A flowchart of processes to facilitate analysis with interfaces identified.
- c) Process metrics. Maintain control over status of processes.
- d) Targets for improved performance. Guides the process improvement activities.

## **.5 Quality Baseline**

The quality baseline records the quality objectives of the project. The quality baseline is the basis for measuring and reporting quality performance as part of the performance measurement baseline.

## **.6 Project Management Plan (Updates)**

The project management plan will be updated through the inclusion of a subsidiary quality management plan and process improvement plan. Requested changes (additions, modifications, deletions) to the project management plan and its subsidiary plans are processed by review and disposition through the Integrated Change Control process.

## **8.2 Perform Quality Assurance**

Quality assurance (QA) is the application of planned, systematic quality activities to ensure that the project will employ all processes needed to meet requirements. A quality assurance department, or similar organisation, often oversees quality assurance activities. Quality Assurance concerns the entire project performance, not just the deliverables.

QA support, regardless of the unit's title, may be provided to the project team, the management of the performing organisation, the customer or sponsor, as well as other stakeholders not actively involved in the work of the project. QA also provides an umbrella for another important quality activity, continuous process improvement. Continuous process improvement provides an iterative means for improving the quality of all processes.

Continuous process improvement reduces waste and non-value-added activities, which allows processes to operate at increased levels of efficiency and effectiveness. Process improvement is distinguished by its identification and review of organisational business processes. It may be applied to other processes within an organisation as well, from micro processes, such as the coding of modules within a software program, to macro processes, such as the opening of new markets.

### **Perform Quality Assurance: Inputs**

#### **.1 Quality Management Plan**

The quality management plan describes how QA will be

performed within the project. The quality management plan describes how the project management team will implement the performing organisation's quality policy. The quality management plan is a component or a subsidiary plan of the project management plan. The quality management plan provides input to the overall project management plan and must address quality control (QC), quality assurance (QA), and continuous process improvement for the project.

The quality management plan may be formal or informal, highly detailed or broadly framed, based on the requirements of the project. The quality management plan should include efforts at the front end of a project to ensure that the earlier decisions, for example on concepts, designs and tests, are correct. These efforts should be performed through an independent peer review and not include individuals that worked on the material being reviewed. The benefits of this review can include reduction of cost and schedule overruns caused by rework.

## **.2 Quality Metrics**

A metric is an operational definition that describes, in very specific terms, what something is and how the quality control process measures it. A measurement is an actual value. For example, it is not enough to say that meeting the planned schedule dates is a measure of management quality.

The project management team must also indicate whether every activity must start on time or only finish on time and whether individual activities will be measured, or only certain deliverables and if so, which ones. Quality metrics are used in the QA and QC processes. Some examples of quality metrics include defect density, failure rate, availability, reliability, and test coverage.

### **.3 Process Improvement Plan**

The process improvement plan is a subsidiary of the project management plan. The process improvement plan details the steps for analysing processes that will facilitate the identification of waste and non-value added activity, thus increasing customer value, such as:

- a. Process boundaries. Describes the purpose, start, and end of processes, their inputs and outputs, data required, if any, and the owner and stakeholders of processes.
- b. Process configuration. A flowchart of processes to facilitate analysis with interfaces identified.
- c. Process metrics. Maintain control over status of processes.
- d. Targets for improved performance. Guides the process improvement activities.

### **.4 Work Performance Information**

Work performance information, including technical performance measures, project deliverables status, required corrective actions, and performance reports are important inputs to QA and can be used in areas such as audits, quality reviews, and process analyses.

### **.5 Approved Change Requests**

Approved change requests can include modifications to work methods, product requirements, quality requirements, scope, and schedule. Approved changes need to be analysed for effects upon the quality management plan, quality metrics, or quality checklists. Approved changes are important inputs to QA and can be used in areas such as audits, quality reviews, and process analyses. All changes should be formally documented in writing and verbally discussed. Undocumented changes should not be implemented.

## **.6 Quality Control Measurements**

Quality control measurements are the results of quality control activities that are fed back to the QA process for use in re-evaluating and analysing the quality standards and processes of the performing organisation.

## **.7 Implemented Change Requests**

Approved change requests that have been implemented by the project management team during project execution.

## **.8 Implemented Corrective Actions**

The approved corrective actions that have been implemented by the project management team to bring expected future project performance into conformance with the project management plan.

## **.9 Implemented Defect Repair**

During project execution, the project management team has implemented approved product defect corrections.

## **.10 Implemented Preventive Actions**

The approved preventive actions that have been implemented by the project management team to reduce the consequences of project risks.

## **Perform Quality Assurance: Tools and Techniques**

### **.1 Quality Planning Tools and Techniques**

The quality planning tools and techniques also can be used for QA activities.

## **.2 Quality Audits**

A quality audit is a structured, independent review to determine whether project activities comply with organisational and project policies, processes, and procedures. The objective of a quality audit is to identify inefficient and ineffective policies, processes, and procedures in use on the project.

The subsequent effort to correct these deficiencies should result in a reduced cost of quality and an increase in the percentage of acceptance of the product or service by the customer or sponsor within the performing organisation. Quality audits may be scheduled or at random, and may be carried out by properly trained in-house auditors or by third parties, external to the performing organisation. Quality audits confirm the implementation of approved change requests, corrective actions, defect repairs, and preventive actions.

## **.3 Process Analysis**

Process analysis follows the steps outlined in the process improvement plan to identify needed improvements from an organisational and technical standpoint. This analysis also examines problems experienced, constraints experienced, and non-value-added activities identified during process operation. Process analysis includes root cause analysis, a specific technique to analyse a problem/situation, determine the underlying causes that lead to it, and create preventive actions for similar problems.

## **.4 Quality Control Tools and Techniques**

The Tools and Techniques of Quality Control can be used for QA Activities and are as follows (a more detailed description of each tool

and technique can be found in the following lesson on Quality Control):

- a. Cause and Effect Diagram – also called Ishikawa diagrams or fishbone diagrams illustrate how factors might be linked to potential problems or effects.
- b. Control Charts – the purpose of which is to determine whether or not a process is stable or has predictable performance. Control charts may serve as a data gathering tool to show when a process is subject to special cause variation, which creates an out-of-control condition.
- c. Flowcharting – helps to analyse how problems occur. A flowchart is a graphical representation of a process. There are many styles, but all process flowcharts show activities, decision points, and the order of processing.
- d. Histogram – is a bar chart showing a distribution of variables. Each column represents an attribute or characteristic of a problem/situation. This tool helps identify the cause of problems in a process by the shape and width of the distribution.
- e. Pareto Chart – is a specific type of histogram, ordered by frequency of occurrence, which shows how many defects were generated by type or category of identified cause. The Pareto technique is used primarily to identify and evaluate nonconformities.
- f. Run Chart – is a line graph that shows data points plotted in the order in which they occur and shows the history and pattern of variation.
- g. Scatter Diagram – is a diagram that shows the pattern of relationship between two variables. This tool allows the quality team to study and identify the possible relationship between changes observed in two variables.

There are more advanced tools and techniques to measure and control quality and include:

- a. Statistical Sampling – involves choosing part of a population of interest for inspection. Appropriate sampling can often reduce the cost of quality control.
- b. Inspection – is the examination of a work product which can be conducted at any level to determine whether it conforms to standards.
- c. Defect Repair Review – is an action taken by the quality control department or similarly titled organisation to ensure that product defects are repaired and brought into compliance with requirements or specifications.

## **Perform Quality Assurance: Outputs**

### **.1 Requested Changes**

Quality improvement includes taking action to increase the effectiveness and efficiency of the policies, processes, and procedures of the performing organisation, which should provide added benefits to the stakeholders of all projects.

### **.2 Recommended Corrective Actions**

Quality improvement includes recommending actions to increase the effectiveness and efficiency of the performing organisation. Corrective action is an action that is recommended immediately as a result of quality assurance activities, such as audits and process analyses.

### **.3 Organisational Process Assets (Updates)**

Updated quality standards provide validation of the effectiveness and efficiency of the performing organisation's quality standards and

processes to meet requirements. These quality standards are used during the Perform Quality Control process.

#### **.4 Project Management Plan (Updates)**

The project management plan will be updated from changes to the quality management plan that result from changes to the Perform Quality Assurance process. These updates can include incorporation of processes that have been through continuous process improvement and are ready to repeat the cycle, and improvements to processes that have been identified and measured, and are ready to be implemented. Requested changes (additions, modifications, deletions) to the project management plan and its subsidiary plans are processed by review and disposition through the Integrated Change Control process.

### 8.3 Perform Quality Control

Performing Quality Control (QC) involves *monitoring specific project results* to determine whether they *comply with relevant quality standards* (e.g. inspection) and identifying ways to eliminate causes of unsatisfactory results. *It should be performed throughout the project.* Quality standards include project processes and product goals. *Project results include deliverables and project management results, such as cost and schedule performance.*

QC is *often* performed by a *quality control department* or similarly titled organisational unit. QC can include taking action to eliminate causes of unsatisfactory project performance. The *project management team should have a working knowledge of statistical quality control, especially sampling and probability,* to help evaluate QC outputs. Among other subjects, the project team may find it useful to know the differences between the following pairs of terms:

- a. *Prevention* (keeping errors out of the process) and *inspection* (keeping errors out of the hands of the customer).
- b. *Attribute sampling* (the result conforms, or it does not) and *variables sampling* (the result is rated on a continuous scale that measures the degree of conformity).
- c. *Special causes* (unusual events) and *common causes* (normal process variation). Common causes are also called *random causes*.
- d. *Tolerances* (the result is acceptable if it falls within the range specified by the tolerance) and *control limits* (the process is in control if the results fall within the control limits).
- e. *Standards* (*compliance ensures acceptance*) and *regulations* (*compliance is mandatory*)

- f. *Quality (conformance to requirements and fitness for use) and grade (the category or rank given based on different technical characteristics or features and functions. Low quality may be a problem, but low grade may not be)*

## **Perform Quality Control: Inputs**

### **.1 Quality Management Plan**

The quality management plan describes how QC will be performed within the project. *The quality management plan describes how the project management team will implement the performing organisation's quality policy.* The quality management plan is a component or a subsidiary plan of the project management plan. The quality management plan provides input to the overall project management plan and must address *quality control (QC), quality assurance (QA), and continuous process improvement for the project.*

*The quality management plan may be formal or informal, highly detailed or broadly framed, based on the requirements of the project.* The quality management plan should include efforts at the front end of a project to ensure that the earlier decisions, for example on concepts, designs and tests, are correct. *These efforts should be performed through an independent peer review and not include individuals that worked on the material being reviewed.* The benefits of this review can include reduction of cost and schedule overruns caused by rework.

### **.2 Quality Metrics**

*A metric is an operational definition that describes, in very specific terms, what something is and how the quality control process measures it. A measurement is an actual value. For example, it is not enough to say that meeting the planned schedule dates is a measure*

of management quality.

The project management team must also indicate whether every activity must start on time or only finish on time and whether individual activities will be measured, or only certain deliverables and if so, which ones. Quality metrics are used in the QA and QC processes. *Some examples of quality metrics include defect density, failure rate, availability, reliability, and test coverage.*

### **.3 Quality Checklists**

A checklist is a structured tool, usually component-specific, used to verify that a set of required steps has been performed. Checklists may be simple or complex. *They are usually phrased as imperatives ("Do this!") or interrogatories ("Have you done this?"). Many organisations have standardised checklists available to ensure consistency in frequently performed tasks.* In some application areas, checklists are also available from professional associations or commercial service providers. *Quality checklists are used in the quality control process.*

### **.4 Organisational Process Assets**

When developing the project charter and subsequent project documentation, any and all of the assets that are used to influence the project's success can be drawn from organisational process assets. Any and all of the organisations involved in the project can have formal and informal policies, procedures, plans, and guidelines whose effects must be considered.

Organisational process assets also represent the organisations' learning and knowledge from previous projects; for example, completed schedules, risk data, and earned value data. Organisational process assets can be organised differently, depending on the type of industry, organisation, and application area. For

example, the organisational process assets could be grouped into two categories:

- a. Organisation's processes and procedures for conducting work:
  - i. Organisational standard processes, such as standards, policies (e.g., safety and health policy, and project management policy), standard product and project life cycles, and quality policies and procedures (e.g., process audits, improvement targets, checklists, and standardised process definitions for use in the organisation).
  - ii. Standardised guidelines, work instructions, proposal evaluation criteria, and performance measurement criteria
  - iii. Templates (e.g., risk templates, work breakdown structure templates, and project schedule network diagram templates)
  - iv. Guidelines and criteria for tailoring the organisation's set of standard processes to satisfy the specific needs of the project
  - v. Organisation communication requirements (e.g., specific communication technology available, allowed communication media, record retention, and security requirements)
  - vi. Project closure guidelines or requirements (e.g., final project audits, project evaluations, product validations, and acceptance criteria)
  - vii. Financial controls procedures (e.g., time reporting, required expenditure and disbursement reviews, accounting codes, and standard contract provisions)
  - viii. Issue and defect management procedures defining issue and defect controls, issue and defect identification and resolution, and action item tracking
  - ix. Change control procedures, including the steps by which official company standards, policies, plans, and procedures-

or any project documents-will be modified, and how any changes will be approved and validated

- x. Risk control procedures, including risk categories, probability definition and impact, and probability and impact matrix
- xi. Procedures for approving and issuing work authorisations.
- b Organisational corporate knowledge base for storing and retrieving information:
  - i. Process measurement database used to collect and make available measurement data on processes and products
  - ii. Project files (e.g., scope, cost, schedule, and quality baselines, performance measurement baselines, project calendars, project schedule network diagrams, risk registers, planned response actions, and defined risk impact)
  - iii. Historical information and lessons learned knowledge base (e.g., project records and documents, all project closure information and documentation, information about both the results of previous project selection decisions and previous project performance information, and information from the risk management effort).
  - iv. Issue and defect management database containing issue and defect status, control information, issue and defect resolution, and action item results.
  - v. Configuration management knowledge base containing the versions and baselines of all official company standards, policies, procedures, and any project documents.
  - vi. Financial database containing information such as labor hours, incurred costs, budgets, and any project cost overruns.

## **.5 Work Performance Information**

Work performance information, including technical performance measures, project deliverables completion status, and the implementation of required corrective actions, are important inputs to QC. Information from the project management plan about the planned or expected results should be available along with information about the actual results and implemented change requests.

## **.6 Approved Change Requests**

Approved change requests can include modifications such as revised work methods and revised schedule. The timely correct implementation of approved changes needs to be verified.

## **.7 Deliverables**

A deliverable is any unique and verifiable product, result or capability to perform a service that is identified in the project management planning documentation, and must be produced and provided to complete the project.

## **Perform Quality Control: Tools and Techniques**

The first seven of these are known as the Seven Basic Tools of Quality.

### **.1 Cause and Effect Diagram**

Cause and effect diagrams (figure 8-2), also called *Ishikawa diagrams* or *fishbone diagrams*, illustrate *how various factors might be linked to potential problems or effects*.

Figure 1: Cause & Effect Diagram Example:  
A Manager's Analysis of Problems with a Branch Office

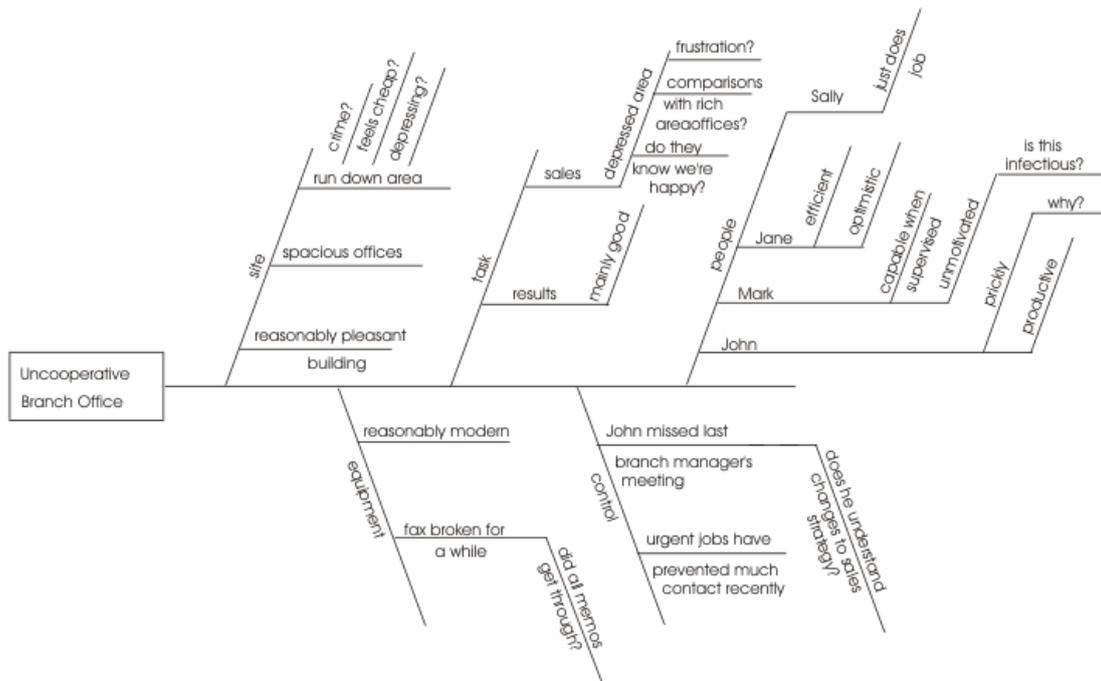


Figure 8-2. Cause and Effect Diagram

## .2 Control Charts

A control chart's purpose is to *determine whether or not a process is stable or has predictable performance*. Control charts may serve as a data gathering tool to *show when a process is subject to special cause variation, which creates an out-of-control condition*. Control charts also illustrate how a process behaves over time. They are a graphic display of the interaction of process variables on a process to answer the question: Are the process variables within acceptable limits? Examination of the non-random pattern of data points on a control chart may reveal wildly fluctuating values, sudden process jumps or shifts, or a gradual trend in increased variation. *By monitoring the output of a process over time, a control chart can be employed to assess whether the application of process changes resulted in the desired improvements*. When a process is within

acceptable limits, the process **need not** be adjusted. When a process is outside acceptable limits, the process **should be** adjusted. The **upper control limit** and **lower control limit** are usually set at **+/- 3 sigma (i.e., standard deviation)**.

Value	Percent Correct
+/- 1 sigma	68.26 percent
+/- 2 sigma	95.46 percent
+/- 3 sigma	99.73 percent
+/- 6 sigma	99.99 percent

**Table 8-4. The Four Sigma Values Representing Normal Distribution**

(Source: PMP Study Guide, Phillips 2006)

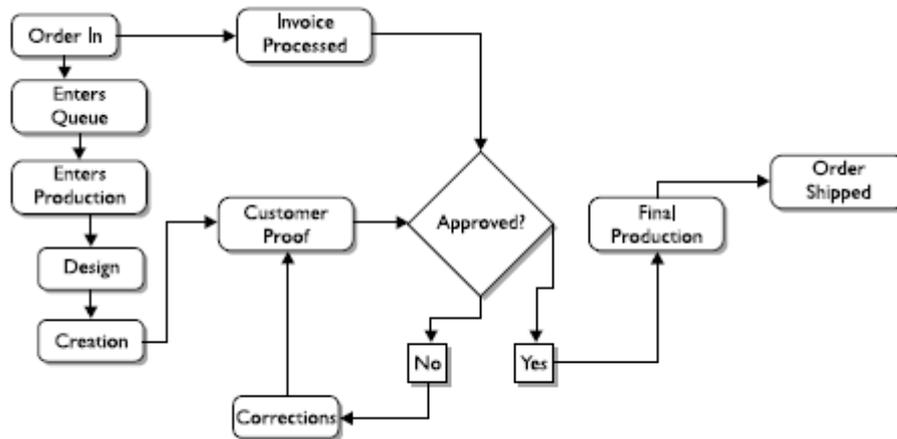
Control charts can be used for both project and product life cycle processes. An example of project use of control charts is determining whether cost variances or schedule variances are outside of acceptable limits (for example, +/- 10 percent).

An example of product use of control charts is evaluating whether the number of defects found during testing are acceptable or unacceptable in relation to the organisation's standards for quality. Control charts can be used to monitor any type of output variable. Although used most frequently to track repetitive activities, such as manufactured lots, control charts also can be used to monitor cost and schedule variances, volume and frequency of scope changes, errors in project documents, or other management results to help determine if the project management process is in control.

### **.3 Flowcharting**

A flowchart is a graphical representation of a process. Flowcharting helps to analyse how problems occur. There are many styles, but all process flowcharts show activities, decision points, and the order of processing. Flowcharts show how various elements of a

*system interrelate*. Figure 8-3 is an example of a process flowchart for design reviews. Flowcharting can *help the project team anticipate* what and where quality problems might occur and, thus, can help develop approaches for dealing with them.



**Figure 8-3. Flowcharts demonstrate how processes within a system are related.**

*(Source: PMP Study Guide, Phillips 2006)*

#### **.4 Histogram**

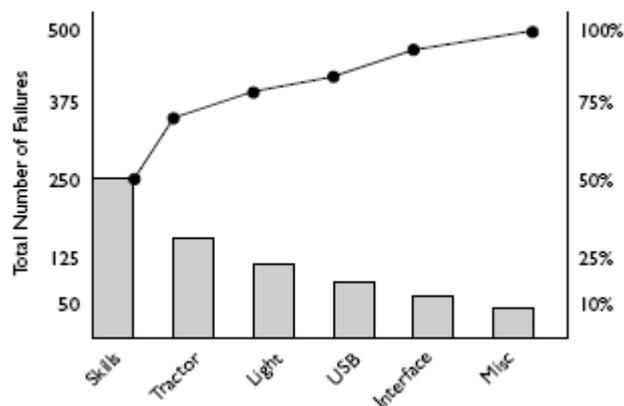
A *histogram is a (vertical) bar chart showing a distribution of variables. Each column represents an attribute or characteristic of a problem/situation*. The height of each column represents the relative frequency of the characteristic. This tool helps identify the cause of problems in a process *by the shape and width of the distribution*.

#### **.5 Pareto Chart**

A **Pareto chart** is a specific type of histogram, ordered by frequency of occurrence, *which shows how many defects were generated by type or category of identified cause*. The Pareto technique is used *primarily to identify and evaluate nonconformities*.

In Pareto diagrams (figure 8-4), *rank ordering* is used to guide corrective action. The *project team should take action to fix the problems that are causing the greatest number of defects first*. Pareto

diagrams are conceptually related to **Pareto's Law**, which holds that a relatively small number of causes will typically produce a large majority of the problems or defects. This is commonly referred to as the **80/20 principle**, where 80 percent of the problems are due to 20 percent of the causes. Pareto diagrams also can be used to summarise all types of data for 80/20 analyses.



**Figure 8-4. A Pareto diagram is a histogram that ranks the issues from largest to smallest.** (Source: *PMP Study Guide, Phillips 2006*)

## .6 Run Chart

A run chart shows the history and pattern of variation. A run chart is a line graph that shows data points plotted in the order in which they occur. Run charts show **trends** in a process over time, **variation over time**, or declines or improvements in a process over time. Trend analysis is performed using run charts. Trend analysis involves using mathematical techniques to *forecast future* outcomes based on historical results. Trend analysis is often used to monitor:

- Technical performance. How many errors or defects have been identified, how many remain uncorrected?
- Cost and schedule performance. How many activities per period were completed with significant variances?

## .7 Scatter Diagram

A scatter diagram *shows the pattern of relationship between two variables*. This tool allows the quality team to study and identify the possible relationship between changes observed in two variables. *Dependent variables versus independent variables are plotted. The closer the points are to a diagonal line, the more closely they are related.*

## **.8 Statistical Sampling**

Statistical sampling involves *choosing part of a population of interest for inspection* (for example, selecting ten engineering drawings at random from a list of seventy-five). *Appropriate sampling can often reduce the cost of quality control*. There is a substantial body of knowledge on statistical sampling; in some application areas, it may be necessary for the project management team to be familiar with a variety of sampling techniques.

## **.9 Inspection**

An inspection is the examination of a work product to determine whether it conforms to standards. Generally, the results of an inspection include measurements. Inspections can be conducted at any level. For example, the results of a single activity can be inspected, or the final product of the project can be inspected. Inspections are also called reviews, peer reviews, audits, and walkthroughs. In some application areas, these terms have narrow and specific meanings. Inspections are also used to validate defect repairs.

## **.10 Defect Repair Review**

Defect repair review is an action taken by the quality control department or similarly titled organisation to ensure that product defects are repaired and brought into compliance with requirements or specifications.

## **Perform Quality Control: Outputs**

### **.1 Quality Control Measurements**

Quality control measurements represent the results of QC activities that are fed back to QA to re-evaluate and analyse the quality standards and processes of the performing organisation.

### **.2 Validated Defect Repair**

The repaired items are reinspected and will be either accepted or rejected before notification of the decision is provided. Rejected items may require further defect repair.

### **.3 Quality Baseline (Updates)**

The base line records the quality objectives of the project. The quality baseline is for measuring and reporting quality performance s par to the performance measurement baseline.

### **.4 Recommended Corrective Actions**

Corrective action involves actions taken as a result of a QC measurement that indicates that the manufacturing or development process exceeds established parameters.

### **.5 Recommended Preventive Actions**

Preventive action involves action taken to forestall a condition that may exceed established parameters in a manufacturing or development process, which may have been indicated through a QC measurement.

### **.6 Requested Changes**

If the recommended corrective or preventive actions require a change to the project, a change request should be initiated in accordance with the defined Integrated Change Control process.

### **.7 Recommended Defect Repair**

*A defect is where a component does not meet its requirements or specifications, and needs to be repaired or replaced. Defects are identified and recommended for repair by the QC department or similarly titled organisation. The project team should make every reasonable effort to minimise the errors that cause the need for defect repair. A defect log can be used to collect the set of recommended repairs. This is often implemented in an automated problem-tracking system.*

### **.8 Organisation Process Assets (Updates)**

- a. *Completed checklists.* When checklists are used, the completed checklists should become part of the project's records.
- b. *Lessons learned documentation.* The causes of variances, the reasoning behind the corrective action chosen, and other types of lessons learned from quality control *should be documented so that they become part of the historical database for both this project and the performing organisation. Lessons learned are documented throughout the project life cycle, but, at a minimum, during project closure.*

### **.9 Validated Deliverables**

A goal of quality control is to determine the correctness of deliverables. The results of the execution quality control processes are validated deliverables.

## **.10 Project Management Plan (Updates)**

The project management plan is updated to reflect changes to the quality management plan that result from changes in performing the QC process. Requested changes (additions, modifications, or deletions) to the project management plan and its subsidiary plans are processed by review and disposition through the Integrated Change Control process.

## **Summary and Self Test**

### **TWO-MINUTE DRILL**

#### **Ensuring Project Quality**

- ❑ The project manager is responsible for the overall quality management of the project and must set quality expectations based on the requirements of the customers and stakeholders.
- ❑ The project manager must integrate the quality control of the project with the quality assurance program of the performing organisation.
- ❑ Quality is planned into a project, not inspected in.

#### **Enforcing Project Quality**

- ❑ The project team members (the people actually completing the project work) are responsible for the quality of the deliverables.
- ❑ The project team, as guided by the project manager and the quality management plan, should be empowered to stop the project work when preset, quality thresholds are exceeded.
- ❑ Quality planning is an iterative process. As quality concerns creep into the project, the planning processes are revisited to ensure actions—preventive and corrective actions—are taken to ensure quality.

#### **Implementing Quality Assurance**

- ❑ Quality assurance monitors overall results.
- ❑ Quality assurance may use a QA program to set quality standards.
- ❑ Quality assurance represents the implementation of the quality plan.

#### **Implementing Quality Control**

- ❑ Quality control monitors specific results within a project.
- ❑ Quality control should ensure that the results satisfy relevant quality standards.

- ❑ Quality control can rely on using root cause analysis to eliminate unsatisfactory results.
- ❑ Quality control is completed through inspection.

### **Relying on Quality Management**

- ❑ Quality management is the process to ensure the project is completed with no deviations from the requirements. There are several quality management philosophies.
- ❑ With total quality management (TQM), the organisation strives for the constant improvement of products and business practices.
- ❑ Kaizen is used in an organisation to apply small changes to products and processes in order to improve consistency, reduce costs, and provide overall quality improvements.

### **Evaluating Quality Costs**

- ❑ The cost of quality is the amount of monies the performing organisation must spend to satisfy the quality standards. This can include training, safety measures, and additional activities implemented to prevent non-conformance.
- ❑ The cost of non-conformance to quality is the monies or events attributed to not satisfying the quality demands. These can include loss of business, downtime, wasted materials, rework, and cost and schedule variances.
- ❑ Optimal quality is reached when the cost of quality meets or exceeds the incremental cost to achieve quality.

### **Charting Quality Control**

- ❑ A fishbone diagram is a cause-and-effect diagram that illustrates the factors which may be contributing to quality issues or problems. It is also known as an Ishikawa diagram.
- ❑ Flowcharts demonstrate how a system works from start to finish, and illustrate how system components are integrated.

- Pareto diagrams are histograms that are related to Pareto's 80/20 rule, "80 percent of the problems come from 20 percent of the issues." The diagram charts the problems, categories, and frequency. The project team should first solve the larger problems and then move on to smaller issues.
- A histogram is bar chart showing the frequency of variables within a project. It's nothing more than a bar chart.
- A run chart is a line graph that shows the results of inspection in the order in which each inspection occurred. The goal of a run chart is to first demonstrate the results of a process over time and then use trend analysis to predict when certain trends may re-emerge.
- Control charts plot out the results of inspections against a mean to examine performance against expected results. Upper and lower control limits are typically set to  $\pm$  three or six sigma. Results that are beyond the control limit value are considered out of control. Out-of-control results have an assignable cause that requires investigation to determine why the result occurred. In addition, seven consecutive results on one side of the mean indicate an assignable cause and are known as the "Rule of Seven."

## **SELF TEST**

**1.** Who of the following is responsible for the quality of the project deliverables?

- A. The project champion
- B. The project team
- C. Stakeholders
- D. Customers

**2.** You are the project manager for the BBB Project. Stacy, a project team member, is confused about what QA is. Which of the following best describes QA?

- A. QA is quality assurance for the overall project performance.
- B. QA is quality acceptance according to scope verification.
- C. QA is quality assurance for the project deliverable.
- D. QA is quality assurance for the project stakeholders.

**3.** You are the project manager for the Photo Scanning Project. This project is similar to another project you have completed. Your project is to electronically store thousands of historical photos for your city's historical society. Quality is paramount on this project. Management approaches you and asks why you have devoted so much of the project time for planning. Your response is which of the following?

- A. This is a first-time, first-use project, so more time is needed for planning.
- B. Planning for a project of this size, with this amount of quality, is mandatory.
- C. Quality is planned into a project, not inspected in.
- D. Quality audits are part of the planning time.

**4.** You are the project manager for the Floor Installation Project. Today, you plan to meet with your project team to ensure the project is

completed with no deviations from the project requirements. This process is which of the following?

- A. Quality planning
- B. Quality management
- C. Quality control
- D. Quality assurance

**5.** You are the project manager for the ASE Project which must map to industry standards in order to be accepted by the customer. You and your team have studied the requirements and have created a plan to implement the deliverables with the appropriate level of quality. What is this process called?

- A. Quality planning
- B. Quality management
- C. Quality control
- D. Quality assurance

**6.** Which of the following is an example of internal failure cost?

- A. Rework
- B. Quality audits
- C. Random quality audits
- D. Project team training

**7.** Quality Control (QC) is typically a(n) \_\_\_\_\_ process.

- A. Management
- B. Project manager
- C. Audit
- D. Inspection

**8.** Quality Assurance (QA) is typically a(n) \_\_\_\_\_ process.

- A. Management
- B. Project manager

- C. Audit
- D. Inspection

**9.** You are the project manager for a large manufacturer of wood furniture. Your new project is the Shop Table Project, which will involve the creation and manufacturing of a new table for woodworkers to use in their wood shops. For this project you have elected to use JIT for scheduling. Which of the following is an advantage to using JIT?

- A. It requires materials to be readily available.
- B. It allows the project team to have control over the materials.
- C. It decreases the inventory investment.
- D. It allows for a broad range of deviation compared to other inventory solutions.

**10.** Your company has elected to use ISO 9000 standards. What is an attribute of ISO 9000?

- A. It ensures your company follows its own quality procedures.
- B. It ensures that your company follows the set phases in each project from initiation to closure.
- C. It ensures that your company maps its processes to a proven process within the program.
- D. It ensures that QA and QC are integrated into the product or service your organisation offers.

**11.** You are the project manager of the Halogen Installation Project. As this project gets underway, you receive notice from the program manager that the organisation will be moving to Kaizen technologies as part of its quality management program. What are Kaizen technologies?

- A. Small improvements for small results
- B. Small improvements for all projects
- C. Small process and product improvements that are carried out on a continuous basis

D. Small process improvements that are made to shorten the project duration

**12.** A fishbone diagram is the same as a(n) \_\_\_\_\_ chart.

- A. Ishikawa
- B. Pareto
- C. Flow
- D. Control

**13.** Management has asked you to define the correlation between quality and the project scope. Which of the following is the best answer?

- A. The project scope will include metrics for quality.
- B. Quality metrics will be applied to the project scope.
- C. Quality is the process of completing the scope to meet stated or implied needs.
- D. Quality is the process of evaluating the project scope to ensure quality exists.

**14.** Which of the following is most true about quality?

- A. It will cost more money to build quality into the project.
- B. It will cost less money to build quality into the project process.
- C. Quality is inspection-driven.
- D. Quality is prevention-driven.

**15.** Which of the following can be described as a business philosophy to find methods that will continuously improve products, services, and business practices?

- A. TQM (Total Quality Management)
- B. ASQ
- C. QA
- D. QC

**16.** In quality management, which of the following is not an attribute of the cost of non-conformance?

- A. Loss of customers
- B. Downtime
- C. Safety measures
- D. Rework

**17.** You are the project manager for the KOY Project which requires quality that maps to federal guidelines. To ensure you can meet these standards, you have elected to put the project team through training specific to the federal guidelines your project must adhere to. The costs of these classes can be assigned to which of the following?

- A. The cost of doing business
- B. Cost of quality
- C. Cost of adherence
- D. Cost of non-conformance

**18.** You are the project manager for the KOY Project which requires quality that maps to federal guidelines. During a quality audit, you discover that a portion of the project work is faulty and must be done again. The requirement to do the work is an example of which of the following?

- A. Cost of quality
- B. Cost of adherence
- C. Cost of non-conformance
- D. The cost of doing business

**19.** Optimal quality is reached at what point?

- A. When the stakeholder accepts the project deliverable.
- B. When revenue from improvements equals the costs of conformance.

- C. When revenue from improvement equals the incremental costs to achieve the quality.
- D. When revenue from corrective actions equals the costs of the improvement.

**20.** You are the project manager of the JKL Project which currently has some production flaws. Which analysis tool will allow you to determine the cause-and-effect of the production faults?

- A. A flowchart
- B. A Pareto diagram
- C. An Ishikawa diagram
- D. A control chart

**21.** Linda is the project manager of a manufacturing project. She and her project team are using design of experiments to look for ways to improve quality. Which of the following best describes design of experiments?

- A. It allows the project manager to move the relationship of activities to complete the project work with the best resources available.
- B. It allows the project manager to experiment with the project design to determine what variables are causing the flaws.
- C. It allows the project manager to experiment with variables to attempt to improve quality.
- D. It allows the project manager to experiment with the project design document to become more productive and to provide higher quality.

**22.** You are the project manager of the Global Upgrade Project. Your project team consists of 75 project team members around the world. Each project team will be upgrading a piece of equipment in many different facilities. Which of the following could you implement to ensure the project team members are completing all of the steps in the install procedure with quality?

- A. Checklists
- B. WBS (Work Breakdown Structure)
- C. PND (Project Network Diagram)
- D. The WBS dictionary

**23.** Mark is the project manager of the PMH Project. Quality audits of the deliverables show there are several problems. Management has asked Mark to create a chart showing the distribution of problems and their frequencies. Given this, management wants which of the following?

- A. A control chart
- B. An Ishikawa chart
- C. A Pareto diagram
- D. A flowchart

## **9 Project Human Resource Management**

### **Introduction**

Project human resource management is multifaceted. It is the ability to lead, direct, and orchestrate the project team, the customers, project partners, contributors, and any other stakeholders to achieve the desired results for the project's purpose.

Project human resource management relies on the following general management skills:

- Leading
- Communicating
- Negotiating
- Problem solving
- Influencing

Project managers must find ways to motivate the project team to complete the work. There is a tendency, in many projects, for the project team to be very excited about the project at the start and then the excitement wanes as the project moves toward completion. The project manager must coach and mentor to develop the project team to ensure that the excitement, willingness, and dedication to the project work continues.

Throughout the project, the project manager will have to address project team retention, labour relations, performance appraisals, and, depending on the nature of the project work, health and safety issues. As most projects are new and temporary, so too are the relationships between the project team members and the project manager.

As the project progresses, the number of stakeholders in the project may change. The project manager and the project team will need to be aware of the coming flux of stakeholders and how this change may affect

the dynamics of the project team and the project work. An approach to project human resources may work well in one phase of the project but not in another due to the stakeholders that have become involved.

Project human resource management may not be completely in the hands of the project manager. The performing organisation's HR department may have control over the majority of the assignment and the recruitment of the project team, but the project manager will need some knowledge as to their responsibility, power, and autonomy in order to comply with the organisation's policies.

Project Human Resource Management includes the processes that *organise and manage the project team as shown in figure 9-1*. The project team is comprised of the people who have assigned roles and responsibilities for completing the project. While it is common to speak of roles and responsibilities being assigned, *team members should be involved in much of the project's planning and decision-making*.

*Early involvement of team members adds expertise during the planning process and strengthens commitment to the project*. The type and number of project team members can often change as the project progresses. Project team members can be referred to as the project's staff.

The *project management team* is a subset of the *project team* and (*project management team*) is responsible for project management activities such as *planning, controlling, and closing*. This group can be called the core, executive, or leadership team.

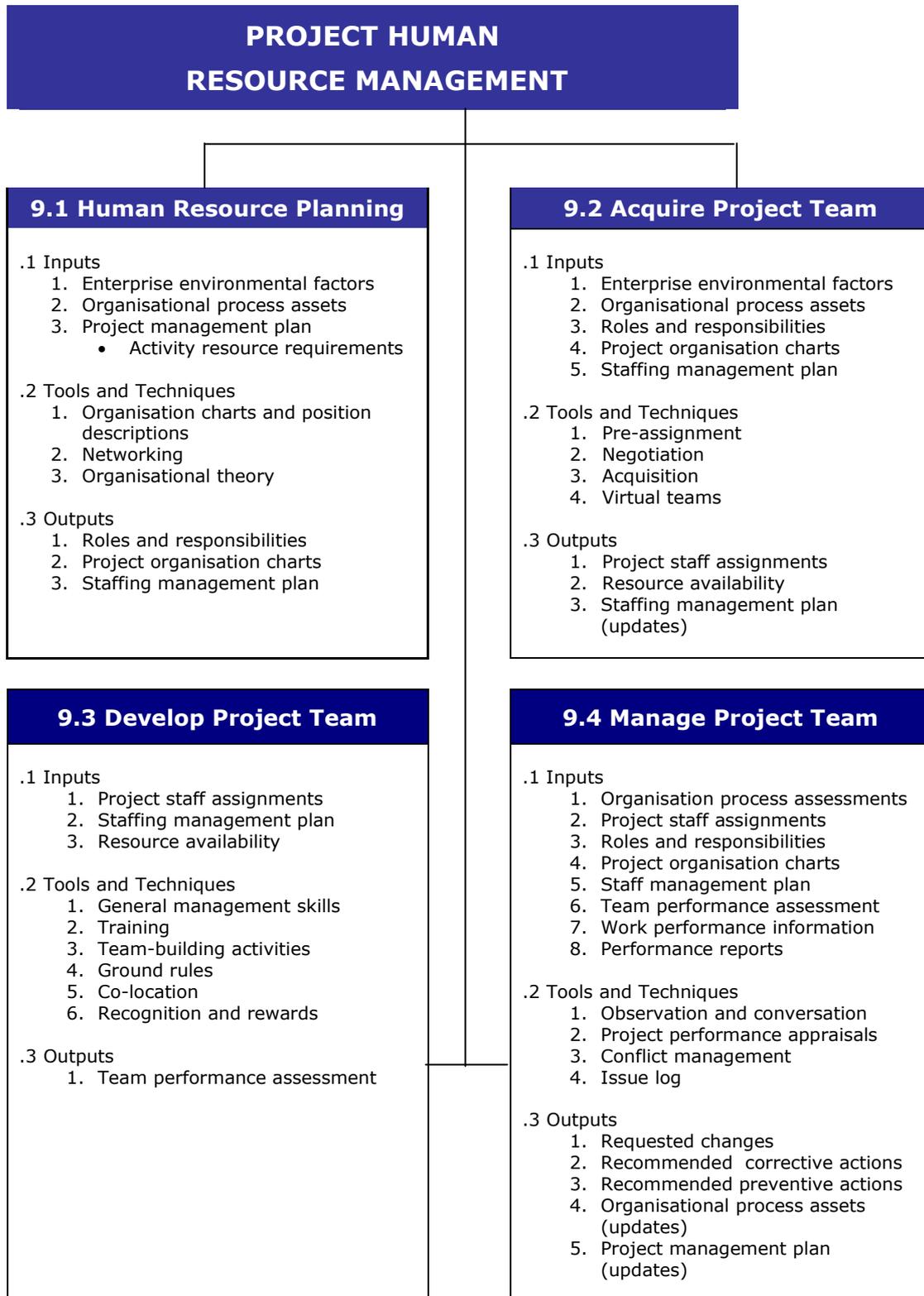
For smaller projects, the project management responsibilities can be shared by the entire team or administered solely by the project manager. The project sponsor works with the project management team, typically assisting with matters such as project funding, clarifying scope questions,

and influencing others in order to benefit the project.

The Project Human Resource Management processes include the following as described in figure 9-1:

- 1. Human Resource Planning** - Identifying and documenting project roles, responsibilities, and reporting relationships, as well as creating the staffing management plan.
- 2. Acquire Project Team** - Obtaining the human resources needed to complete the project.
- 3. Develop Project Team** - Improving the competencies and interaction of team members to enhance project performance.
- 4. Manage Project Team** - Tracking team member performance, providing feedback, resolving issues, and coordinating changes to enhance project performance.

These processes interact with each other and with processes in the other Knowledge Areas as well. Each process can involve effort from one or more persons or groups of persons based on the needs of the project. Each process occurs at least once in every project, and occurs in one or more project phases, if the project is divided into phases.



**Figure: 9-1. Project Human Resource Management Overview.**  
 (Source: PMBOK Guide 3<sup>rd</sup> E, 2004)

## **9.1 Human Resource Planning**

Human Resource Planning *determines project roles, responsibilities, and reporting relationships, and creates the staffing management plan.* Project roles can be designated for persons or groups. Those persons or groups can be from inside or outside the organisation performing the project.

The *staffing management plan* can include *how and when project team members will be acquired, the criteria for releasing them from the project, identification of training needs, plans for recognition and rewards, compliance considerations, safety issues, and the impact of the staffing management plan on the organisation.*

### **Human Resource Planning: Inputs**

#### ***.1 Enterprise Environmental Factors***

The definition of project roles and responsibilities is developed with an understanding of the ways that existing organisations will be involved and how the technical disciplines and people currently interact with one another. Some of the relevant enterprise environmental factors involving organisational culture and structure are:

- *Organisational.* - *Which organisations or departments will be involved in the project? What are the current working arrangements among them? What formal and informal relationships exist among them?*
- *Technical.* - *What are the different disciplines and specialties that will be needed to complete this project? Are there different types of software languages, engineering approaches, or kinds of equipment that will need to be coordinated? Do the transitions from one life cycle phase to the next present any unique challenges?*

- *Interpersonal.* - What types of formal and informal reporting relationships exist among people who are candidates for the project team? What are the candidates' job descriptions? What are their supervisor-subordinate relationships? What are their supplier-customer relationships? What cultural or language differences will affect working relationships among team members? What levels of trust and respect currently exist?
- *Logistical.*- How much distance separates the people and units that will be part of the project? *Are people in different buildings, time zones, or countries?*
- *Political.* - What are the individual goals and agendas of the potential project stakeholders? *Which groups and people have informal power in areas important to the project? What informal alliances exist?*

In addition to the factors listed above, constraints limit the project team's options. *Examples of constraints that can limit flexibility in the Human Resource Planning process are:*

- *Organisational structure* - An organisation whose *basic structure is a weak matrix* means a relatively weaker role for the project manager.
- *Collective bargaining agreements* - *Contractual agreements with unions* or other employee groups can require certain roles or reporting relationships.
- *Economic conditions* - *Hiring freezes, reduced training funds, or a lack of travel budget are examples of economic conditions that can restrict staffing options.*

## ***.2 Organisational Process Assets***

As project management methodology matures within an organisation, lessons learned from past Human Resource Planning experiences are available as organisational process assets to help plan the current project.

Roles and Responsibilities definitions of completed similar projects can be used to expedite the HR planning process for this project. Templates and checklists reduce the amount of planning time needed at the beginning of a project and reduce the likelihood of missing important responsibilities.

- *Templates* - Templates that can be helpful in Human Resource Planning include project organisation charts, position descriptions, project performance appraisals, and a standard conflict management approach.
- *Checklists* - Checklists that can be helpful in Human Resource Planning include common project roles and responsibilities, typical competencies, training programs to consider, team ground rules, safety considerations, compliance issues, and reward ideas.

### ***.3 Project Management Plan***

The *project management plan* includes the activity resource requirements, plus descriptions of project management activities, such as quality assurance, risk management, and procurement that will help the project management team identify all of the required roles and responsibilities.

- Activity Resource Requirements. *Human Resource Planning uses activity resource requirements to determine the human resource needs for the project.* The preliminary requirements regarding the required people and competencies for the project team members are refined as part of the Human Resource Planning process.

### **Human Resource Planning: Tools and Techniques**

Human resources planning is the process of mapping the project's roles, responsibilities, and reporting relationships to the appropriate people or groups of people. HR planning identifies the people involved

with the project and determines what their role in the project is, whom they may report to—or receive a report from—and what their overall influence on the project work is.

For example, consider a project to create a community park. The project manager works for a commercial entity that will complete the project work. He/She identifies the people responsible for activities within the organisation, the designers, engineers, installers, management, and so on. He/She will also have functional managers to coordinate employees' availability, financing to arrange procurement of resources needed for project completion, and senior management to report the status of the project work.

The project manager will also work and communicate with government officials for approval of the design, change requests, and overall schedule of the project. There'll be safety issues, landscaping questions, and other concerns that will come up as the project progresses. Finally, the project manager will likely communicate with stakeholders that are not internal to her organisation—for example, the people that live in the community and enjoy the park, unions, or various government officials. These stakeholders will need to be involved in the planning and design of the park to ensure it satisfies the community's needs.

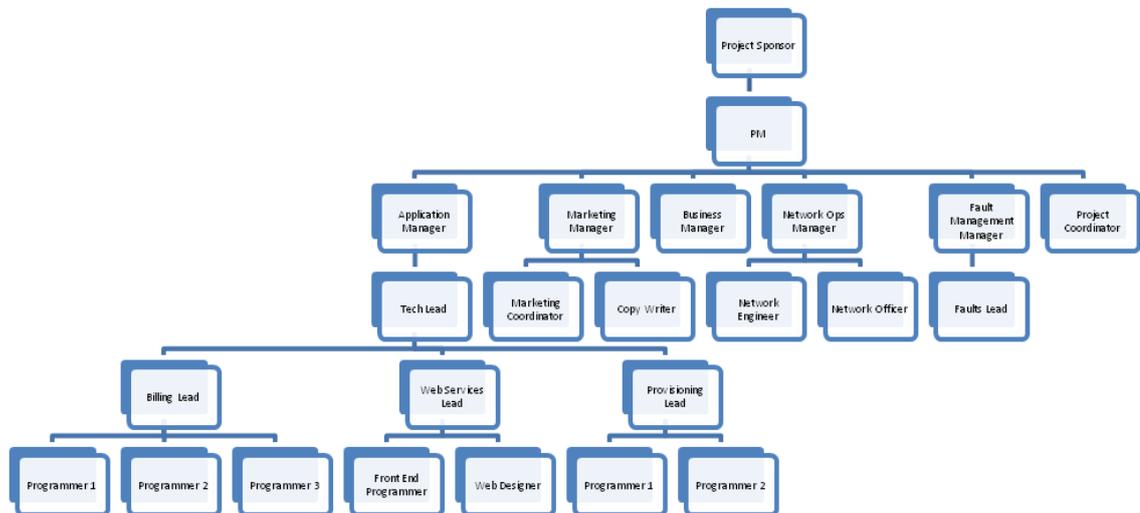
From the above example, one can deduce how HR can involve both internal and external stakeholders. In most projects, organisational planning happens early in the project planning phase—but it should be reviewed and adjusted as the environment changes. Organisational planning is all about ensuring that the project performs properly in the environment it is working in. Some of the factors which a project manager must consider while planning the human resource requirements for a project include the following:

## **.1 Organisation Charts and Position Descriptions**

Various formats exist to document team member *roles and responsibilities*. Most of the formats fall into one of three types *hierarchical, matrix, and text-oriented*. Additionally, some project assignments are listed in subsidiary project plans, such as the risk, quality, or communication plans. Where you have worked on a previous project of a similar nature you can shortcut this organisational planning process by using the roles and responsibilities of the previous project.

Whichever combination of methods is used, the objective is to ensure that each work package has an unambiguous owner and that all team members have a clear understanding of their roles and responsibilities.

- ***Hierarchical-type charts.*** - The traditional organisation chart structure can be used to show positions and relationships in a graphic, top-down format as illustrated in figure 9-3. *Work breakdown structures (WBS)* that are primarily designed to show how project deliverables are broken down into work packages become one way to show *high-level areas of responsibility*. *The Organisational Breakdown Structure (OBS)* looks similar to the WBS, but *instead of being arranged according to a breakdown of project deliverables, it is arranged according to an organisation's existing departments, units, or teams*. The project activities or work packages are listed under each existing department. This way, an operational department such as information technology or purchasing can see all of its project responsibilities by looking at its portion of the OBS.



**Figure 9-3. Hierarchical –type Organisation Chart**

The resource breakdown structure (RBS) is another hierarchical chart. *It is used to break down the project by types of resources.* For example, an RBS can depict all of the welders and welding equipment being used in different areas of a ship even though they can be scattered among different branches of the OBS and WBS. *The RBS is helpful in tracking project costs, and can be aligned with the organisation's accounting system. The RBS can contain resource categories other than human resources.*

- *Matrix-based charts. A responsibility assignment matrix (RAM) is used to illustrate the connections between work that needs to be done and project team members.* On larger projects, RAMs can be developed at various levels. For example, a high-level RAM can define what project team group or unit is responsible for each component of the WBS, while lower-level RAMs are used within the group to designate roles, responsibilities, and levels of authority for specific activities.

The matrix format, sometimes called a table, allows a person to see all activities associated with one person or to see all people associated with one activity.

The matrix shown in Figure 9-4 is a type of RAM called a RACI chart because the names of roles being documented are Responsible, Accountable, Consult, and Inform. The sample chart shows the work to be done in the left column as activities, but RAMs can show responsibilities at various levels of detail. The people can be shown as persons or groups.

RACI Chart	Person				
Activity	David	Jess	Rory	Sarah	Theron
Define	A	R	I	I	I
Design	I	A	R	C	C
Develop	I	A	R	C	C
Test	A	I	I	R	I

R=Responsibility, A=Accountable, C=Consult, I=Inform

**Figure:9-4. Responsibility Assignment Matrix (RAM) using a RACI format** (Source: PMBOK Guide, 3<sup>rd</sup> Ed, 2004)

The matrix shown in Figure 9-4-1 is a Roles and Responsibilities Matrix. This depicts the resource needs and the associated activities.

Title	Role	Responsibilities
Project Manager	The Project Manager is responsible for developing, in conjunction with the Project Sponsor, the project charter. The Project Manager ensures that the project is delivered on time, within budget, and to the required quality standards.	<ul style="list-style-type: none"> <li>• Manage and lead the project team.</li> <li>• Manage the coordination of the partners and the working groups.</li> <li>• Develop and maintain a detailed project plan.</li> </ul>
<Title>	<Role>	• <Responsibility>
<Title>	<Role>	• <Responsibility>

**Figure:9-4-1. Roles and Responsibility Matrix (RAM)**

- *Text-oriented formats.* Team member *responsibilities that require detailed descriptions* can be specified in text-oriented formats. Usually in outline form, the documents provide information such as responsibilities, authority, competencies, and qualifications. The documents are known by various names, including position descriptions and role-responsibility-authority forms. These descriptions and forms make excellent templates for future projects, especially when the information is updated throughout the current project by applying lessons learned.
- *Other sections of the project management plan.* Some responsibilities related to managing the project are listed and explained in other sections of the project management plan. For example, the risk register lists risk owners, the communication plan lists team members responsible for communication activities, and the quality plan designates people responsible for carrying out quality assurance and quality control activities.

## **.2 Networking**

*Informal interaction with others in an organisation or industry is a constructive way to understand political and interpersonal factors that will impact the effectiveness of various staffing management options.*

Human resources *networking activities include* proactive correspondence, luncheon meetings, informal conversations, and trade conferences. While concentrated networking can be a useful technique at the beginning of a project, carrying out networking activities on a regular basis before a project begins is also effective.

## **.3 Organisational Theory**

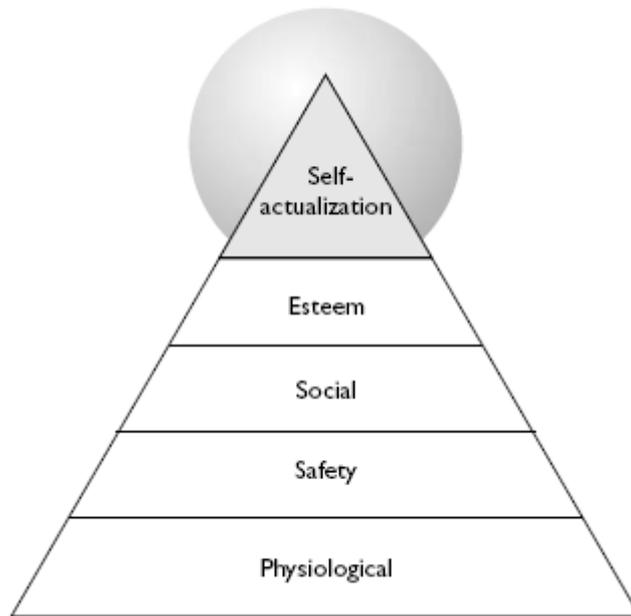
Organisational theory provides information regarding the ways that people, teams, and organisational units behave. Applying proven principles shortens the amount of time needed to create the Human Resource Planning outputs and improves the likelihood that the planning will be effective. There are many different organisational theories that a project manager can rely on to identify weakness and strengths, guide the project team, and move the project forward. Some of the more commonly found organisational theories which a project manager must consider include:

### **Maslow's Hierarchy of Needs**

According to Maslow, people work to take care of a hierarchy of needs. The pinnacle of their needs is self-actualisation. People want to contribute, prove their work, and use their skills and ability.

Maslow's five layers of needs, from the bottom-up, are as follows:

- **Physiological** The necessities to live: air, water, food, clothing, and shelter.
- **Safety** People need safety and security; this can include stability in life, work, and culture.
- **Social** People are social creatures and need love, approval, and friends.
- **Esteem** People strive for the respect, appreciation, and approval of others.
- **Self-actualisation** At the pinnacle of needs, people seek personal growth, knowledge, and fulfillment.



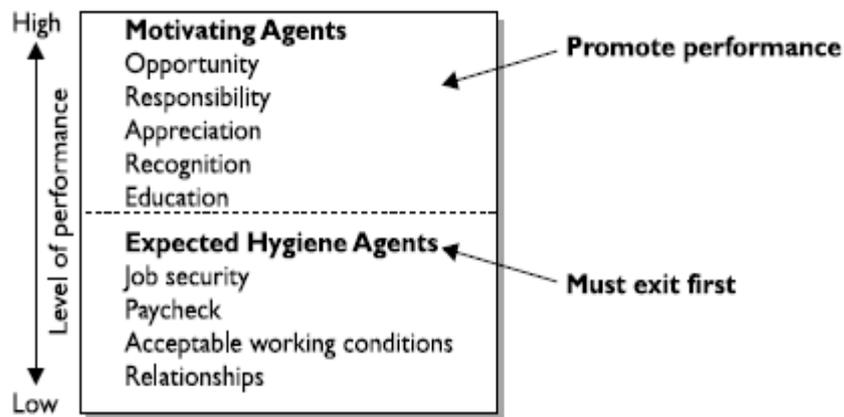
**Figure 9-5. Maslow's Hierarchy of Needs – People work for self-actualisation** (Source: PMP Study Guide, Phillips 2006)

### **Herzberg's Theory of Motivation**

According to Frederick Herzberg, a psychologist and authority on the motivation of work, there are two catalysts for success with people:

- **Hygiene agents** These elements are the expectations all workers have: job security, a paycheck, clean and safe working conditions, a sense of belonging, civil working relationships, and other basic attributes associated with employment.
- **Motivating agents** These are the elements that motivate people to excel. They include responsibility, appreciation of work, recognition, the chance to excel, education, and other opportunities associated with work other than just financial rewards.

This theory says the presence of hygiene factors will not motivate people to perform, as these are expected attributes. However, the absence of these elements will demotivate performance.



**Figure 9-6. Herzberg's Theory of Motivation** (Source: PMP Study Guide, Phillips 2006)

### McGregor's Theory of X and Y

McGregor's Theory states that management believes there are two types of workers, good and bad, as shown in Figure 9-3:

- X is bad. These people need to be watched all the time, micromanaged, and distrusted. X people avoid work, responsibility, and have no ability to achieve.
- Y is good. These people are self-led, motivated, and can accomplish new tasks proactively.



**Figure 9-7. McGregor's Theory of X and Y – X people are 'bad', Y people are 'good'.** (Source: PMP Study Guide, Phillips 2006)

### Ouchi's Theory Z

William Ouchi's Theory Z is based on the participative management

style of the Japanese. This theory states that workers are motivated by a sense of commitment, opportunity, and advancement. Workers in an organisation subscribing to Theory Z learn the business by moving up through the ranks of the company.

Ouchi's Theory Z also credits the idea of "lifetime employment." Workers will stay with one company until they retire because they are dedicated to the company that is in turn dedicated to them.

### **Expectancy Theory**

Expectancy Theory states that people will behave based on what they expect as a result of their behavior. In other words, people will work in relation to the expected reward of the work. If the attractiveness of the reward is desirable to the worker, they will work to receive the reward. In other words, people expect to be rewarded for their effort.

### **Management Styles**

In addition to these fine theories, there are also different approaches to managing the project team. Here's a quick rundown of the four major management styles:

- **Autocratic** The project manager makes all of the decisions.
- **Democratic** The project team is involved in the decision-making process.
- **Laissez faire** The project manager has a hands-off policy and the team is entirely self-led regarding the decision-making process.
- **Exceptional** The project manager only pays attention to the top ten percent of the project performers and the bottom ten percent of the project team performers.

## **Human Resource Planning: Outputs**

### ***.1 Roles and Responsibilities***

The assignment of the roles and responsibilities determines what actions the project manager, project team member, or individual contributor will have in the project. Roles and responsibilities generally support the project scope since this is the required work for the project. The following items should be addressed when listing the roles and responsibilities needed to complete the project:

- *Role-* The label describing the portion of a project for which a person is accountable. Examples of project roles are civil engineer, court liaison, business analyst, and testing coordinator. Role clarity concerning authority, responsibilities, and boundaries is essential for project success.
- *Authority-* The right to apply project resources, make decisions, and sign approvals. Examples of decisions that need clear authority include the selection of a method for completing an activity, quality acceptance, and how to respond to project variances. *Team members operate best when their individual levels of authority matches their individual responsibilities*
- *Responsibility-* The work that a project team member is expected to perform in order to complete the project's activities.
- *Competency-* The *skill and capacity required to complete project activities*. If project team members do not possess required competencies, performance can be jeopardised. When such mismatches are identified, proactive responses such as training, hiring, schedule changes, or scope changes are initiated.

### ***.2 Project Organisation Charts***

A project organisation chart is a graphic display of project team members and *their reporting relationships*. It can be formal or informal, highly detailed or broadly framed, based on the needs of the project. For

example, the project organisation chart for a 3,000-person disaster response team will have greater detail than a project organisation chart for an internal, twenty-person project.

### ***.3 Staffing Management Plan***

The project manager will rely on the staffing management plan as an input to acquiring project team members. The staffing management plan details how project team members will be brought onto the project and released from the project as conditions within the project demand. The staffing management plan is a subsidiary plan that documents the staffing requirements of the project.

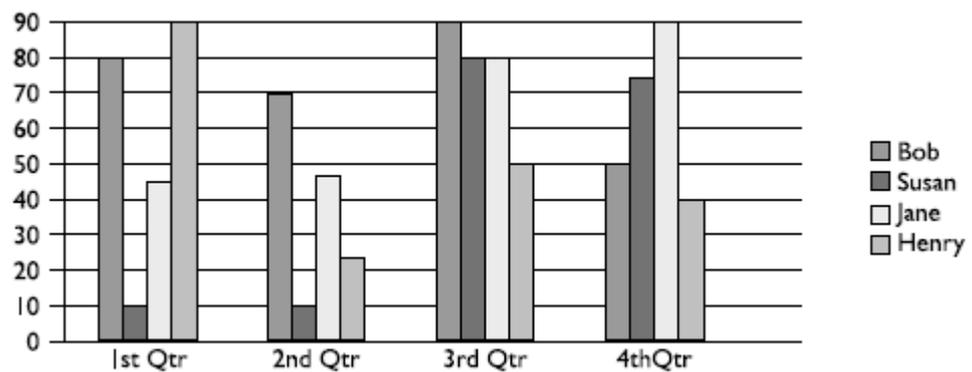
The *staffing management plan*, a subset of the *project management plan*, describes when and how human resource requirements will be met. The staffing management plan can be formal or informal, highly detailed or broadly framed, based on the needs of the project.

The plan is updated continually during the project to direct ongoing team member acquisition and development actions. Information in the staffing management plan varies by application area and project size, but items to consider include:

- *Staff acquisition*- Staff acquisition defines a number of questions that arise when planning the acquisition of project team members. For example, will the human resources come from within the organisation or from external, contracted sources? Will team members need to work in a central location or can they work from distant locations? What are the costs associated with each level of expertise needed for the project? How much assistance can the organisation's human resource department provide to the project management team?
- *Timetable*- The staffing management plan describes necessary time frames for project team members, either individually or collectively, as well as when acquisition activities such as recruiting should start. One tool for charting human resources is

a resource histogram. This bar chart illustrates the number of hours that a person, department, or entire project team will be needed each week or month over the course of the project. The chart can include a horizontal line that represents the maximum number of hours available from a particular resource.

Bars that extend beyond the maximum available hours identify the need for a resource leveling strategy, such as adding more resources or extending the length of the schedule. A sample resource histogram is illustrated in Figure 9-7, below:



**Figure 9-8. Resource histograms illustrate the demand for labor.**  
 (Source: PMP Study Guide, Phillips 2006)

- *Release criteria* - Determining the method and timing of releasing team members benefits both the project and team members. When team members are released from a project at the optimum time, payments made for people who are finished with their responsibilities can be eliminated and the costs reduced. *Morale is improved when smooth transitions to upcoming projects are already planned.*

*Training needs* - The project team may require training to complete the project work, function as a project team, or participate in management skills such as finance or formal communications. Training can include such things as:

- Formal education
- Classroom training
- On-the-job training

- Coaching and mentoring (shadowing)
- *Recognition and rewards.- Clear criteria for rewards and a planned system for their use will promote and reinforce desired behaviors.*  
To be effective, recognition and rewards should be based on activities and performance under a person's control. For example, a team member who is to be rewarded for meeting cost objectives should have an appropriate level of control over decisions that affect expenses. Creating a plan with established times for rewards ensures that recognition takes place and is not forgotten. Recognition and rewards are awarded as part of the Develop Project Team process.
- *Compliance.-* The staffing management plan can include strategies for complying with applicable government regulations, union contracts, and other established human resource policies.
- *Safety-* Policies and procedures that protect team members from safety hazards can be included in the staffing management plan as well as the risk register.

## 9.2 Acquire Project Team

A project not only needs a project team but needs a good, qualified, competent project team. Their competency, experience, and availability will directly influence the success of the project. Armed with this notion, the project manager may rely on a few different tools and techniques to obtain the needed project team resources. Acquire Project Team is the *process of obtaining the human resources needed to complete the project*. The *project management team may or may not have control over team members* selected for the project.

### Acquire Project Team: Inputs

#### **.1 Enterprise Environmental Factors**

Project team members are drawn from all available sources, both internal and external. Whatever the reasoning behind the assignment of the staff to the project, the project manager should evaluate the project team for skills gaps, the availability to complete the project work, and the expectations of the project team members. When recruitment policies or guidelines are in place within the performing organisation, they act as a project constraint. The project manager must address any discrepancies between the requirements of the project work and the project team's ability to complete the work. The project manager as a minimum must consider the following when acquiring project human resources:

- **Availability** Will the project team members desired for the project be available? Project managers should confer with functional managers on the availability of the potential team member.
- **Ability** What is the competency and proficiency of the available project team members?
- **Experience** What is the experience of the project team member? Have they done similar work in the past—and have they done it well?

- **Interest level** Are the project team members interested in working on this project?
- **Costs** How much will this individual team member cost the project?

## ***.2 Organisational Process Assets***

The project manager has to follow the rules of the organisations involved in the project. For example, an organisation may forbid a project manager from approaching a worker directly to discuss their availability and desire to work on a project. The project manager may instead have to speak with the employee's functional manager to obtain the resource. One or more of the organisations involved in the project may have policies, guidelines, or procedures governing staff assignments. The human resource departments also can assist with recruitment, hiring and orientation of project team members.

## ***.3 Roles and Responsibilities***

Roles and responsibilities define the positions, skills, and competencies that the project demands.

## ***.4 Project Organisation Charts***

Project organisation charts provide an overview regarding the number of people needed for the project.

## ***.5 Staffing Management Plan***

The staffing management plan, along with the project schedule, identifies the time periods each project team member will be needed and other information important to acquiring the project team.

## **Acquire Project Team: Tools and Techniques**

### ***.1 Pre-Assignment***

Project team members are often pre-assigned to a project for a number of reasons such as:

- The availability of the individual
- They were promised as part of a competitive contract
- They were required as part of the project charter of an internal project
- It gives the staff member an opportunity to complete on-the-job training

In some cases, project team members are known in advance; that is, they are pre-assigned. This situation can occur if the project is the result of specific people being promised as part of a competitive proposal, if the project is dependent on the expertise of particular persons, or if some staff assignments are defined within the project charter.

### ***.2 Negotiation***

Most projects require the project manager to negotiate for resources. The project manager will likely have to negotiate with functional managers to obtain the needed resources to complete the project work. The functional managers and the project manager may struggle over an employee's time due to demands in ongoing operations, other projects, and the effective utilisation of resources. In other instances, functional managers may want to assign underutilised resources on projects to account for their employees' time.

Project managers may also have to negotiate with other project managers to share needed resources among projects. Scheduling the needed resources between the project teams will need to be coordinated so both projects may complete successfully.

An organisation's politics certainly come into play with staff

acquisitions. Functional managers may want project managers to carry extra resources on the project in exchange for key personnel, added deliverables to the project, or other “favours” for the manager.

*The project management team's ability to influence others plays an important role in negotiating staff assignments, as do the politics of the organisations involved.* For example, a functional manager will weigh the benefits and visibility of competing projects when determining where to assign exceptional performers that all project teams desire.

### **.3 Acquisition**

In some instances, the project manager may have no alternative but to procure the project team or individuals to complete the project work. In relation to project team procurement, reasons why the project manager can use this alternative include, but are not limited to, the following:

- The performing organisation lacks the internal resources with the needed skills to complete the project work.
- The work is more cost-effective to procure.
- The project team members are present within the organisation, but they are not available to the current project.
- The project team members are present within the organisation, but they cannot complete the needed work due to other project assignments.

### **.4 Virtual Teams**

Virtual teams are project teams that share a common goal—to complete the project work—but they are not co-located and may rarely, if ever, meet face-to-face with other project team members. The virtual team relies on e-mail, video, and telephone conferences to communicate on the project. Virtual teams allow the following:

- Teams composed of geographically dispersed individuals
- The ability to add experts to the project team that may not be in the same geographical area

- The inclusion of workers from home offices
- The ability to create project teams of individuals with varying working hours
- The inclusion of people with mobility handicaps
- The deletion or reduction of travel

*Communications Planning becomes increasingly important in a virtual team environment.* Additional time may be needed to set clear expectations, develop protocols for confronting conflict, include people in decision-making, and share credit in successes.

## **Acquire Project Team: Outputs**

### *.1 Project Staff Assignments*

The project is staffed when appropriate people have been assigned to work on it. Documentation can include a project team directory, memos to team members, and names inserted into other parts of the project management plan, such as project organisation charts and schedules.

### *.2 Resource Availability*

Resource availability documents the time periods each project team member can work on the project. Creating a reliable final schedule depends on having a good understanding of each person's schedule conflicts, including vacation time and commitments to other projects.

### *.3 Staffing Management Plan (Updates)*

As specific people fill the project roles and responsibilities, changes in the staffing management plan may be needed because people seldom fit the exact staffing requirements that are planned. Other reasons for changing the staffing management plan include promotions, retirements, illnesses, performance issues, and changing workloads.

### **9.3 Develop Project Team**

Throughout the project, the project manager will have to work to develop the project team. The project manager may have to develop the ability of the individual team members so that they can complete their assignments. The project manager will also have to work to develop the project team as a whole so the team can work together to complete the project.

In matrix organisations, the project team members are accountable to the project manager and their functional managers. The development of the project team can prove challenging since the project team members may feel pulled between multiple bosses. The project manager must strive to involve and develop the project team members as individuals completing project work—and as team members completing the project objectives together. *Develop Project Team improves the competencies and interaction of team members to enhance project performance.* Objectives include:

- Improve skills of team members in order to increase their ability to complete project activities.
- Improve feelings of trust and cohesiveness among team members in order to raise productivity through greater teamwork.

Examples of *effective teamwork include assisting one another when workloads are unbalanced, communicating in ways that fit individual preferences, and sharing information and resources.* Team development efforts have greater benefit when conducted early, but should take place throughout the project life cycle.

#### **Develop Project Team: Inputs**

The project manager will rely on several pieces of information to prepare for team development such as:

### *.1 Project Staff Assignments*

Team development starts with a list of the project team members. Project staff assignment documents identify the people who are on the team. The assignments of the project team members define the skills of the project team members, their need for development, and their ability to complete the project work as individuals, and as part of the collective team.

### *.2 Staffing Management Plan*

The staffing management plan identifies training strategies and plans for developing the project team. As the project progresses, items such as rewards, feedback, additional training, and disciplinary actions are added to the plan as a result of ongoing team performance assessments and other forms of project team management.

### *.3 Resource Availability*

Resource availability information identifies times that project team members can participate in team development activities.

### *.4 Project plan*

The project plan defines the expectations of the project team, how the team will operate, and how the team will be expected to communicate, function, and perform.

### *.5 Performance Reports*

As the project team completes work, performance reports will reflect on the quality, timeliness, and success of the project team.

## **Develop Project Team: Tools and Techniques**

Due to the temporary and short-term nature of projects, it can be

tough for a group of strangers to come together, form relationships, and immediately create a successful project. Team development is the guidance, direction, and leadership the project manager offers to influence a project team.

The project managers are the power on the project team. While there may be some resistance of the project team to cooperate with the project manager, complete assigned duties, or participate as requested, the project team should realise the project manager is the project authority. There are five types of powers that the project manager wields:

- **Reward** The project manager has the authority to reward the project team.
- **Coercive/Punishment** The project manager has the authority to discipline the project team members. This is also known as "penalty power." When the team is afraid of the project manager, it's coercive.
- **Expert** The authority of the project manager comes from experience with the technology the project focuses on.
- **Formal/Legitimate** The project manager has been assigned by senior management and is in charge of the project. Also known as "positional power."
- **Referent** Power is referred to the Project Manager by an influential person in the organisation, e.g. CEO. This power can also mean the project team wants to work on the project or with the project manager due to the high priority and impact of the project. While developing the project team, the project manager should consider the following influences:

### *.1 General Management Skills*

A chunk of project management relies on general management skills. Specifically, the project manager relies on the following:

- **Leading** - Leading is the art of establishing direction, aligning people, and motivating the project team to complete the project work.
- **Communicating** - Good project managers are good communicators. Remember, half of communicating is listening.
- **Negotiating** - Project managers will likely negotiate for scope, cost, terms, assignment, and resources.
- **Problem solving** - Project managers must have the ability to confront and solve problems.
- **Influence** - Project managers use their influence to get things done.

Interpersonal skills, sometimes known as "soft skills," are particularly important to team development. *By understanding the sentiments of project team members, anticipating their actions, acknowledging their concerns, and following up on their issues, the project management team can greatly reduce problems and increase cooperation. Skills such as empathy, influence, creativity, and group facilitation are valuable assets when managing the project team.*

## .2 Training

Training includes all activities designed to enhance the competencies of the project team members. Training can be formal or informal. Examples of training methods include classroom, online, computer-based, on-the-job training from another project team member, mentoring, and coaching.

*If project team members lack necessary management or technical skills, such skills can be developed as part of the project work. Scheduled training takes place as stated in the staffing management plan. Unplanned training takes place as a result of observation, conversation, and project performance appraisals conducted during the controlling process of managing the project team.*

### *.3 Team-Building Activities*

Team-building activities can vary from a five-minute agenda item in a status review meeting to an off-site, professionally facilitated experience designed to improve interpersonal relationships. Some group activities, such as developing the WBS, may not be explicitly designed as team-building activities, but can increase team cohesiveness when that planning activity is structured and facilitated well.

*It also is important to encourage informal communication and activities because of their role in building trust and establishing good working relationships.* Teambuilding strategies are particularly valuable when team members operate virtually from remote locations, without the benefit of face-to-face contact.

### *.4 Ground Rules*

*Ground rules establish clear expectations regarding acceptable behavior by project team members.* Early commitment to clear guidelines decreases misunderstandings and increases productivity.

The process of discussing ground rules allows team members to discover values that are important to one another. *All project team members share responsibility for enforcing the rules once they are established.*

### *.5 Co-Location*

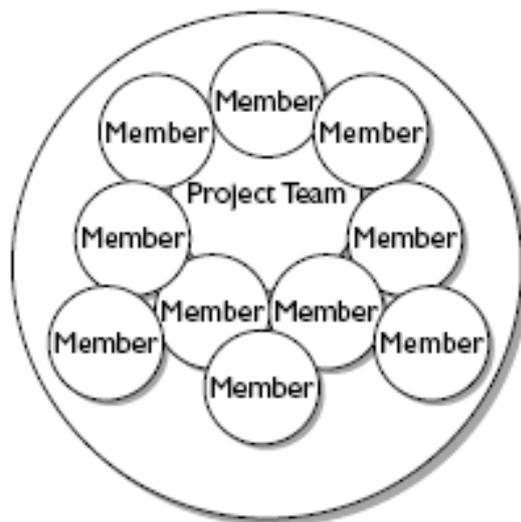
Co-located teams are teams that work geographically close together to improve team dynamics and team relations as illustrated in figure 9-9. On large projects, it may be particularly valuable to bring all of the project team members together to a central location to work collectively on the project, so that their ability to work as a team is greatly enhanced.

When co-location is not feasible, the project manager must make attempts to bring the project team together for team interaction, face-to-

face meetings, and other avenues of communication to bolster relations.

*Co-location involves placing many or all of the most active project team members in the same physical location to enhance their ability to perform as a team.* Co-location can be temporary, such as at strategically important times during the project, or for the entire project.

Co-location strategy can include a meeting room, sometimes called a war room, with *electronic communication devices, places to post schedules, and other conveniences that enhance communication and a sense of community.* While co-location is considered good strategy, the use of virtual teams will reduce the frequency that team members are located together.



**Figure 9-9. Example of co-locating a team around the project**  
(Source: PMP Study Guide, Phillips 2006)

#### .6 Recognition and Rewards

A reward and recognition system encourages, emphasises, and promotes good performance and behavior by the project team. The reward and recognition system should be a formal, achievable approach for the project team to perform and be rewarded for their outstanding performance. Part of the team development process involves recognising and rewarding desirable behavior. The original plans concerning ways to

reward people are developed during Human Resource Planning. Award decisions are made, formally or informally, during the process of managing the project team through performance appraisals. *Only desirable behavior should be rewarded.*

For example, the willingness to work overtime to meet an aggressive schedule objective should be rewarded or recognised; needing to work overtime as the result of poor planning should not be rewarded. *Win-lose (zero sum) rewards that only a limited number of project team members can achieve, such as team member of the month, can hurt team cohesiveness.*

Rewarding win-win behavior that everyone can achieve, such as turning in progress reports on time, tends to increase support among team members. *Recognition and rewards should consider cultural differences.* For example, developing appropriate team rewards in a culture that encourages individualism can be difficult.

## **Develop Project Team: Outputs**

### *.1 Team Performance Assessment*

Team development is an ongoing process. Optimum team performance doesn't happen on the first day of the project, but hopefully it does kick in well before the final day of the project. The primary goal of team development is to improve project team performance.

Improvements can include the following:

- **Individuals** Improvements to individual skill sets may allow the individual to complete their assigned work better, faster, or with more confidence.
- **Team** Improvements to the project team may allow the team to perform with a focus on technical requirements, project work, and working together (in harmony) to complete the project work.

- **Individuals and team** Improvements to either team members or the project team as a whole may lead to the better good of the project by finding better ways of completing the project work.

Another result of team development is the input to performance reviews of the project team members. Hopefully, all goes well and the project manager can report successful, willing, and cooperative team members. As development efforts such as training, team building, and co-location are implemented, the project management team makes informal or formal assessments of the project team's effectiveness.

## 9.4 Manage Project Team

One of the trickiest parts of project management is managing the project team, which involves such things as:

- Tracking individual project team members' performance
- Providing feedback to the project team members about their performance and project work
- Finding solutions and facilitating conversations to find solutions for project issues
- Managing changes to the project and project processes to improve overall project performance
- Providing communications among the project team, project stakeholders, and in a matrix structure communicating with functional managers

Manage Project Team *involves tracking team member performance, providing feedback, resolving issues, and coordinating changes to enhance project performance.* The *project management team* observes team behavior, manages conflict, resolves issues, and appraises team member performance.

As a result of managing the project team, the staffing management plan is updated, change requests are submitted, issues are resolved, input is given to organisational performance appraisals, and lessons learned are added to the organisation's database.

Management of the project team is complicated when team members are accountable to both a functional manager and the project manager within a matrix organisation. Effective management of this *dual reporting relationship is often a critical success factor for the project, and is generally the responsibility of the project manager.*

## **Manage Project Team: Inputs**

### ***.1 Organisational Process Assets***

*The project management team should utilise an organisation's policies, procedures, and systems for rewarding employees during the course of a project. Organisational recognition dinners, certificates of appreciation, newsletters, bulletin boards, Web sites, bonus structures, corporate apparel, and other organisational perquisites should be available to the project management team as part of the project management process.*

### ***.2 Project Staff Assignments***

Project staff assignments provide a list of the project team members to be evaluated during this monitoring and controlling process.

### ***.3 Roles and Responsibilities***

A list of the staff's roles and responsibilities is used to monitor and evaluate performance.

### ***.4 Project Organisation Charts***

Project organisation charts provide a picture of the reporting relationships among project team members.

### ***.5 Staffing Management Plan***

The staffing management plan lists the time periods that team members are expected to work on the project, along with information such as training plans, certification requirements, and compliance issues.

### ***.6 Team Performance Assessment***

The project management team makes ongoing formal or informal assessments of the project team's performance. By continually assessing the project team's performance, actions can be taken to resolve issues,

modify communication, address conflict, and improve team interaction.

### ***.7 Work Performance Information***

As part of the Direct and Manage Project Execution process (Section 4.4), the project management team directly observes team member performance as it occurs. Observations related to areas such as a team member's meeting participation, follow-up on action items, and communication clarity are considered when managing the project team.

### ***.8 Performance Reports***

Performance reports provide documentation about performance against the project management plan. Examples of performance areas that can help with project team management include results from schedule control, cost control, quality control, scope verification, and procurement audits.

The information from performance reports and related forecasts assists in determining future human resource requirements, recognition and rewards, and updates to the staffing management plan.

## **Manage Project Team: Tools and Techniques**

### ***.1 Observation and Conversation***

*Observation and conversation are used to stay in touch with the work and attitudes of project team members.* The project management team monitors indicators such as progress toward project deliverables, accomplishments that are a source of pride for team members, and interpersonal issues. Before talking, however, the project manager needs to observe the project team members. This means paying attention to the work, the work results, the attitude, project team accomplishments, and any interpersonal issues among team members. Knowing what to discuss with the project team is more important than just talking. Communication is a paramount factor in project team management.

## **.2 Project Performance Appraisals**

Project team members need feedback. They need to know when they're doing a good job and a not-so-good job. But before the project manager can begin offering appraisals, organisational policies and procedures must determine the type of appraisals the project manager provides. The project manager should understand the organisational policies, labour contracting requirements, and whether the project even qualifies for formal appraisals. Smaller, lower-priority projects may not have a need for appraisals at all. The need for formal or informal project performance appraisals depends on the length of the project, complexity of the project, organisational policy, labour contract requirements, and the amount and quality of regular communication. *Project team members receive feedback from the people who supervise their project work.*

Evaluation information also can be gathered from people who interact with project team members by using *360-degree feedback principles*. The term "360-degree" means that feedback regarding performance is provided to the person being evaluated from many sources, including superiors, peers, and subordinates.

*Objectives for conducting performance appraisals during the course of a project can include re-clarification of roles and responsibilities, structured time to ensure team members receive positive feedback in what might otherwise be a hectic environment, discovery of unknown or unresolved issues, development of individual training plans, and the establishment of specific goals for future time periods.*

## **.3 Conflict Management**

Successful conflict management results in greater productivity and positive working relationships. *Sources of conflict include scarce resources, scheduling priorities, and personal work styles.*

*Team ground rules, group norms, and solid project management practices, like communication planning and role definition, reduce the amount of conflict. When managed properly, differences of opinion are healthy, and can lead to increased creativity and better decision-making.*

When the differences become a negative factor, *project team members are initially responsible for resolving their own conflicts. If conflict escalates, the project manager should help facilitate a satisfactory resolution.* Conflict should be addressed *early and usually in private, using a direct, collaborative approach.* If disruptive conflict continues, increasingly formal procedures will need to be used, including the possible use of disciplinary actions. The following are seven reasons for conflict, in order of most common to least common:

1. Schedules
2. Priorities
3. Resources
4. Technical beliefs
5. Administrative policies and procedures
6. Project costs
7. Personalities

There are five different approaches to conflict resolution:

- **Confrontation/Problem solving** - This approach confronts the problem head-on and is the preferred method of conflict resolution. Win-Win.
- **Forcing** - The person with the power makes the decision. The decision made may not be the best decision for the project, but it's fast. Yeild-Lose.
- **Compromising** - This approach requires that both parties give up something. The decision made is a blend of both sides of the argument. Because neither party really wins, it is considered a lose-lose solution. The project manager can thus use this approach when

the relationships are equal and no one can truly “win.” This approach can also be used to avoid a fight.

- **Smoothing** - Smoothing “smooths” out the conflict by minimising the perceived size of the problem. It is a temporary solution but can calm team relations and boisterous discussions. Smoothing may be acceptable when time is of the essence or when none of the proposed solutions will settle the problem. This can be considered a lose-lose situation since no one really wins in the long term.
- **Withdrawal** - This is the worst conflict resolution approach because one side of the argument essentially walks away from the problem, usually in disgust. The conflict is not resolved and it is considered a leave-lose solution.

#### **.4 Issue Log**

As issues arise in the course of managing the project team, a *written log* can document persons responsible for resolving specific issues by a target date. *The log helps the project team monitor issues until closure.*

*Issue resolution addresses obstacles that can block the team from achieving its goals. These obstacles can include factors such as differences of opinion, situations to be investigated, and emerging or unanticipated responsibilities that need to be assigned to someone on the project team.*

### **Manage Project Team: Outputs**

#### **.1 Requested Changes**

*Staffing changes, whether by choice or by uncontrollable events, can affect the rest of the project plan. When staffing issues are going to disrupt the project plan, such as causing the schedule to be extended or the budget to be exceeded, a change request can be processed through the Integrated Change Control process.*

## **.2 Recommended Corrective Actions**

*Corrective action for human resource management includes items such as staffing changes, additional training, and disciplinary actions. Staffing changes can include moving people to different assignments, outsourcing some work, and replacing team members who leave. The project management team also determines how and when to give out recognition and rewards based on the team's performance.*

## **.3 Recommended Preventive Actions**

When the project management team identifies potential or emerging human resource issues, preventive action can be developed to reduce the probability and/or impact of problems before they occur.

*Preventive actions can include cross-training in order to reduce problems during project team member absences, additional role clarification to ensure all responsibilities are fulfilled, and added personal time in anticipation of extra work that may be needed in the near future to meet project deadlines.*

## **.4 Organisational Process Assets (Updates)**

- *Input to organisational performance appraisals.* Project staff generally should be prepared to provide input for regular organisational performance appraisals of any project team member with whom they interact in a significant way.
- *Lessons learned documentation.* All knowledge learned during the project should be documented so it becomes part of the historical database of the organisation.

Lessons learned in the area of human resources can include:

1. *Project organisation charts, position descriptions, and staffing management plans that can be saved as templates*
2. *Ground rules, conflict management techniques, and recognition*

*events that were particularly useful*

*3. Procedures for virtual teams, co-location, negotiation, training, and team building that proved to be successful*

*4. Special skills or competencies by team members that were discovered during the project*

*5. Issues and solutions documented in the project issue log.*

#### **.5 Project Management Plan (Updates)**

Approved change requests and corrective actions can result in updates to the staffing management plan, a part of the project management plan. Examples of plan update information include new project team member roles, additional training, and reward decisions.

## Summary and Self Test

### TWO-MINUTE DRILL

#### Planning for Project Human Resource Management

- ❑ Project human resource management focuses on utilising the people involved in the project in the most effective way. The people involved in the project are more than just the project team members, though they're the most obvious.
- ❑ The project manager can't forget to involve other stakeholders: customers, management, individual contributors, the project sponsor, and any other stakeholder unique to the project.
- ❑ Organisational planning calls on the project manager to identify the roles and responsibilities of the project and the reporting relationship within the organisation.
- ❑ Reporting relationships can be internal, such as to management, or external, such as to a customer or community. The relationships and the procedure to communicate with these project interfaces must be documented.

#### Documenting Human Resources Management

- ❑ Because projects are often similar, the project manager can rely on templates to re-create the success of historical projects. Reporting structures, role and responsibility matrices, and other human resource models can be replicated, and adjusted, between projects.
- ❑ The staffing management plan describes the process that the project manager must follow to bring resources onto a project, or to dismiss them from a project when the resources are no longer needed.
- ❑ The policies and procedures of the performing organisation should be documented within the staffing management plan to ensure the guidelines are followed as management intends.

- ❑ The staffing management plan will also detail the policies of how the project manager can recruit project team members. In addition, the plan may detail the procedure to procure resources for the project from vendors or consultants.

### **Involving the Project Stakeholders**

- ❑ Throughout the project, the project manager must work with the project team to develop their ability to complete their project work, grow as a team, and focus on completing the project work accurately and on time.
- ❑ A reward and recognition system can help the project manager motivate the project team to perform as hoped.
- ❑ Special care to involve the project team must be given when the team is scattered geographically. The project manager can rely on face-to-face meetings, videoconferences, or teleconferences to promote non-collocated teams.

### **Developing the Project Team**

- ❑ Ideally, the project is co-located and has access to a war room to refer to project information, research, schedules, and other project team members.
- ❑ The goal of team development is outstanding performance for the good of the project. Through training, the project team may increase their ability to work together and individually with a higher level of confidence, performance, and teamwork.
- ❑ The result of team development is project performance improvements. The improvements should be noted in an honest appraisal of the project team members' effort and contributions to the project.

## **SELF TEST**

**1.** You are the project manager for the JHG Project. This project requires coordination with the Director of Manufacturing, Human Resources, the IT department, and the CIO. This is an example of what type of input to organisational planning?

- A. Organisational interfaces
- B. Technical interfaces
- C. Interpersonal interfaces
- D. Human resource coordination

**2.** Your project requires an electrician at month eight. This is an example of which of the following?

- A. Organisational interfaces
- B. Activity Resource requirements
- C. Contractor requirements
- D. Resource constraints

**3.** You are the project manager of the PUY Project. This project requires a chemical engineer for seven months of the project, but there are no available chemical engineers within your department. This is an example of which of the following?

- A. Organisational interfaces
- B. Resource requirements
- C. Contractor requirements
- D. Resource constraints

**4.** You are the project manager in an organisation with a weak matrix. Who will have the authority on your project?

- A. The project manager
- B. The customer
- C. Functional management
- D. The team leader

**5.** You are the project manager for the LMG Project. Your project will have several human resource issues that must be coordinated and approved by the union. Which of the following statements is correct about this scenario?

- A. The union is considered a resource constraint.
- B. The union is considered a management constraint.
- C. The union is considered a project stakeholder.
- D. The union is considered a project team member.

**6.** You are the project manager of the PLY Project. This project is very similar to the ACT Project you earlier completed. What method can you use to expedite the process of organisation planning?

- A. Use the project plan of the ACT Project on the PLY Project.
- B. Use the roles and responsibilities definitions of the ACT Project on the PLY Project.
- C. Use the project team reward structure of the ACT Project on the PLY Project.
- D. Use the project team of the ACT Project on the PLY Project.

**7.** In your organisation, management is referred to as coaches. As a project manager, you are referred to as a project coach. A human resource document should be created to handle this scenario. What should it cover?

- A. How coaches are separate from managers
- B. How coaches are the same as managers
- C. How a coach is to complete his or her job
- D. How the project team is to work for a coach

**8.** Management has requested that you create a chart depicting all of the project resource needs and the associated activities. Management is looking for which type of chart?

- A. A roles chart
- B. A roles matrix
- C. A roles and responsibilities matrix
- D. A Gantt chart

**9.** Which of the following is an example of Theory X?

- A. Self-led project teams
- B. Micromanagement
- C. Team members able to work on their own accord
- D. Earned Value Management (EVM)

**10.** You are the project manager of the PLN Project. The team members are somewhat “afraid” of you as project manager because they see you as management. They know that a negative review from you about their project work will impact their yearly bonus. This is an example of which of the following?

- A. Formal power
- B. Coercive power
- C. Expert power
- D. Referent power

**11.** You are the project manager of the MMB Project. The president of the company has spoken to the project team and told them the confidence and respect he has in you to lead the project to a successful completion. The project manager has what type of power on this project?

- A. Formal power
- B. Coercive power
- C. Expert power
- D. Halo power

**12.** Management has approached Tyler, one of your project team members. Tyler is a database administrator and developer, whose work is

always on time, accurate, and of quality. He also has a reputation of being a "good guy" and is well liked. Because of this, management has decided to move Tyler into the role of a project manager for a new database administration project. This is an example of which of the following?

- A. Management by exception
- B. The halo effect
- C. Management by objectives
- D. McGregor's Theory of X and Y

**13.** Susan is the project manager for the PMG Project. She makes all decisions on the project team regardless of the project team objections. This is an example of which of the following management styles?

- A. Autocratic
- B. Democratic
- C. Laissez faire
- D. Exceptional

**14.** Which problem-solving technique is the best for most project management situations?

- A. Confronting
- B. Compromising
- C. Forcing
- D. Avoidance

**15.** Theron is a very outspoken project team member. All of the project team members respect Theron for his experience with the technology, but things usually have to be done as Theron sees fit, otherwise things don't go well. During a discussion on a solution, a project team member throws up her arms and says, "Fine, Theron, do it your way." This is an example of which of the following?

- A. A win-win solution
- B. A leave-lose solution

- C. A lose-lose solution
- D. A yield-lose solution

**16.** You are the project manager for the GBK Project. This project affects a line of business and the customer is anxious about the success of the project. Which of the following is likely not a top concern for the customer?

- A. Project priorities
- B. Schedule
- C. Cost
- D. Personality conflicts

**17.** Which theory believes that workers need to be involved with the management process?

- A. McGregor's Theory of X and Y
- B. Ouchi's Theory Z
- C. Herzberg's Theory of Motivation
- D. The Expectancy Theory

**18.** Which of the following states that as long as workers are rewarded they will remain productive?

- A. McGregor's Theory of X and Y
- B. Ouchi's Theory Z
- C. Herzberg's Theory of Motivation
- D. The Expectancy Theory

**19.** You are the project manager for Industrial Lights Project. You have been hired by your organisation specifically because of your vast experience with the technology and with projects of this nature. The project is aware of your experience. You likely have what type of power on this project?

- A. Formal power

- B. Coercive power
- C. Expert power
- D. Referent power

**20.** You are the project manager for GHB Project. You have served as a project manager for your organisation for the past ten years. Practically all of your projects come in on time and on budget. The project team has worked with you in the past and they consider you to be an expert project manager. They also like working with you. Given all of this, you likely have what type of power on this project?

- A. Formal power
- B. Coercive power
- C. Expert power
- D. Referent power

**21.** Which of the following is an example of coercive power?

- A. A project manager that has lunch with the project team every Thursday
- B. A project manager that will openly punish any team member who is late with an activity
- C. A project manager that has worked with the technology on the project for several years
- D. A project manager that is friends with all of the project team members

**22.** Charles is the project manager for the WAC Project. The customer and a project team member are in conflict over the level of quality needed on a sampling. Charles decides to split the difference between what the two stakeholders want. This is an example of which of the following?

- A. A win-win solution
- B. A win-lose solution
- C. A lose-lose solution

D. A leave-lose solution

**23.** Mike is the project manager for a project with a very tight schedule. The project is running late and Mike feels that he does not have time to consider all the possible solutions that two team members are in disagreement over. Mike quickly decides to go with the team member with the largest amount of seniority. This is an example of which of the following?

- A. Problem solving
- B. Compromising
- C. Forcing
- D. Withdrawal

**24.** You are a project manager in a projectised organisation. Your job as a project manager can be described best by which of the following?

- A. Full-time
- B. Part-time
- C. Expeditor
- D. Coordinator

**25.** What is the benefit of using a co-located team?

- A. The project team is dispersed so the team is self-led.
- B. The project team is dispersed so communication increases.
- C. The project team is in the same physical location so their ability to work as a team is enhanced.
- D. The project team is in the same physical location so project costs are greatly reduced.

## 10 Project Communications Management

### Introduction

Project managers spend about 90 percent of their time communicating. Think about it: meetings, phone calls, memos, e-mails, reports, presentations—the list goes on and on. Project managers spend the bulk of their day communicating news, ideas, and knowledge. They are communicators. Communication is successful when the sender and receiver have the same understanding, indicating a transfer of knowledge from one party to the other.

Project communications management centres on determining who needs what information and when—and then producing a plan to provide that needed information. Project communications management includes generating, collecting, disseminating, and storing communication. Successful projects require successful communication — therefore, communication is the key link between people, ideas, and information.

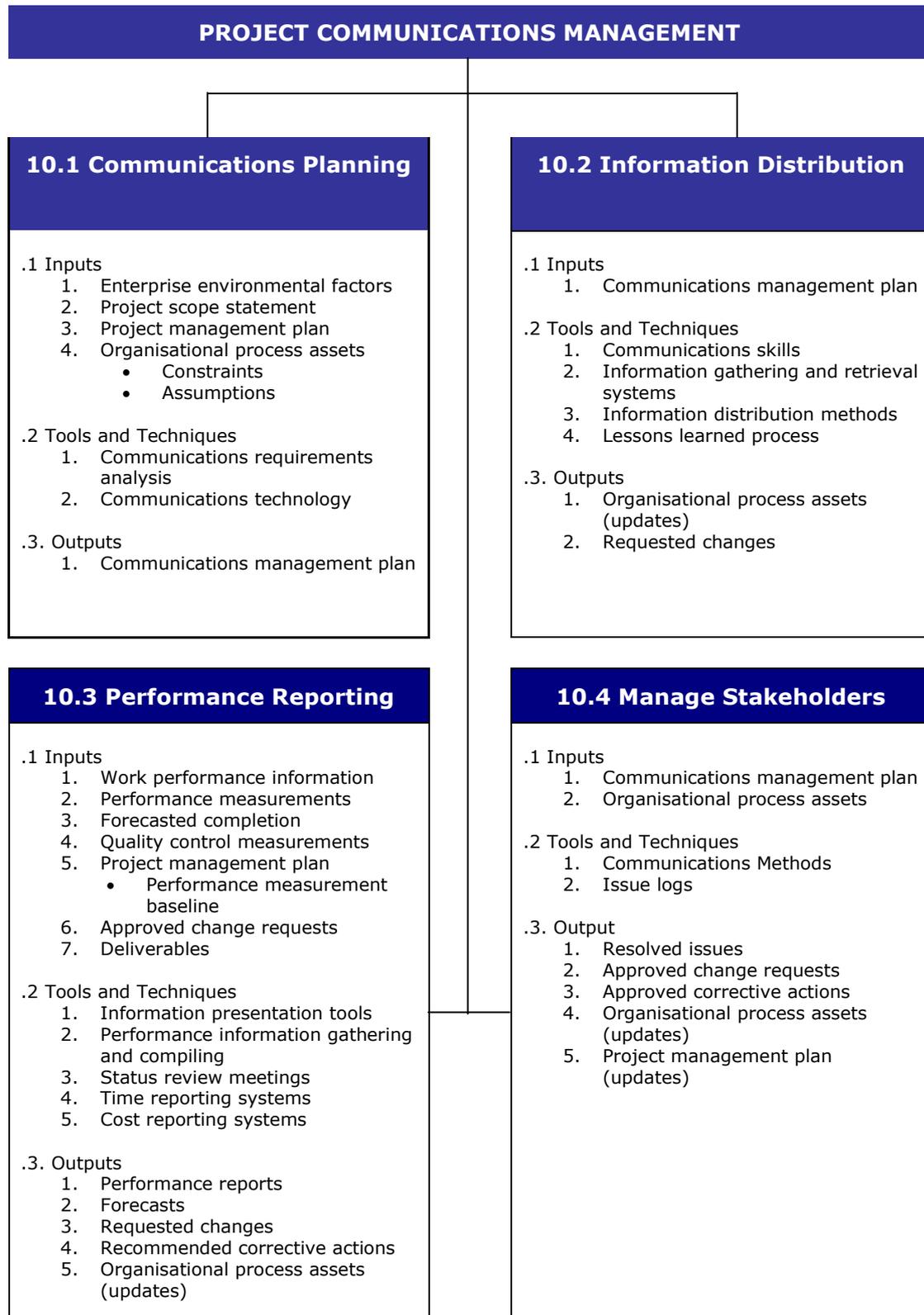
Project Communications Management is the Knowledge Area that employs the processes required to ensure timely and appropriate generation, collection, distribution, storage, retrieval, and ultimate disposition of project information. Project communications management includes four processes (Figure 10.1), which may overlap each other and other knowledge areas. The four processes include the following:

- **Communication planning** The project manager needs to identify the stakeholders and their communication needs and determine how to fulfil their requirements.
- **Information distribution** The project manager needs to get the correct information on the correct schedule to the appropriate stakeholders.
- **Performance reporting** The project manager relies on Earned Value Management (EVM) and other performance measurement

to create status reports, measure performance, and forecast project conditions.

- **Managing stakeholders** Stakeholder management isn't easy, but it's vital to a project's success. As the project moves forward, the project manager needs to communicate project successes and setbacks—and resolve issues with stakeholders.

These processes interact with each other and with the processes in the other knowledge areas as well. Each process can involve effort from one or more persons or groups of persons based on the needs of the project.



**Figure: 10-1. Project Communications Management Overview.** (Source: PMBOK Guide 3<sup>rd</sup> E, 2004)

## Communications Options

Communications skills are related to, but are not the same as, project management communications. The art of communications is a broad subject and involves a substantial body of knowledge including:

- **Sender-receiver models.** Feedback loops and barriers to communication.
- **Choice of media.** When to communicate in writing versus orally, when to write an informal memo versus a formal report, and when to communicate face-to-face versus by e-mail. The media chosen for communication activities will depend upon the situation.
- **Writing style.** Active versus passive voice, sentence structure, and word choice.
- **Presentation techniques.** Body language and design of visual aids.
- **Meeting management techniques.** Preparing an agenda and dealing with conflict

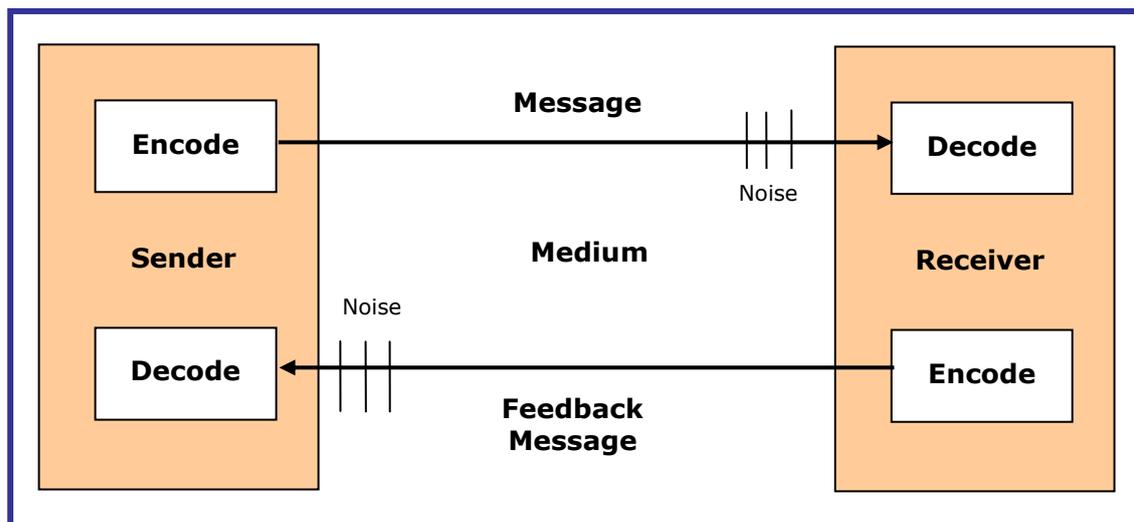
## Communications Model

The goal of communication is the transfer of information, whereby the sender and receiver have the same understanding of the message.

A basic model of communication, shown in Figure 10.2, demonstrates how ideas or information is sent and received between two parties, defined as the sender and the receiver. The key **components** of the model include

- **Encode.** To translate thoughts or ideas into a language that is understood by others.
- **Message.** The output of encoding.
- **Medium.** The method used to convey the message.
- **Noise.** Anything that interferes with the transmission and understanding of the message (e.g. distance).

- **Decode.** To translate the message back into meaningful thoughts or ideas. Inherent in the model shown in Figure 10-2 is an action to acknowledge a message. Acknowledgement means that the receiver signals receipt of the message, but not necessarily agreement with the message. Another action is the response to a message, which means that the receiver has decoded, understands, and is replying to the message.



**Figure 10-2. Communication – Basic model** (source: PMBOK Guide, 3<sup>rd</sup> Ed)

The components in the communications model need to be taken into account when discussing project communications. There are many challenges in using these components to effectively communicate with project stakeholders. Consider a highly technical, multi-national project team. For one team member to successfully communicate a technical concept to another team member in a different country can involve encoding the message in the appropriate language, sending the message using a variety of technologies, and having the receiver decode the message. Any noise introduced along the way compromises the original meaning of the message. A breakdown in communications can negatively impact the project.

## **10.1 Communications Planning**

Project managers spend much of their time communicating, hence it's essential for them to provide adequate planning for communication. Such planning focuses on who needs what information and when they need it. A project manager must identify the stakeholders' requirements for communication, determine what information is actually needed, and then plan to deliver the needed information on a preset schedule or based on project conditions.

Communications planning is typically completed early in the project. As part of this planning, the modality of the communications is documented. Some stakeholders may prefer a hard copy document rather than an e-mail. Later in the project, these needs can change. Throughout the project, the needs of the stakeholders, the type of information requested, and the modality of the information should be reviewed for accuracy—and updated if needed.

The Communications Planning process determines the information and communications needs of the stakeholders; for example, who needs what information, when they will need it, how it will be given to them, and by whom. While all projects share the need to communicate project information, the informational needs and methods of distribution vary widely.

Identifying the informational needs of the stakeholders and determining a suitable means of meeting those needs is an important factor for project success. On most projects, the majority of Communications Planning is done as part of the earliest project phases. However, the results of this planning process are reviewed regularly throughout the project and revised as needed to ensure continued applicability. Communications Planning is often tightly linked with

enterprise environmental factors and organisational influences, since the project's organisational structure will have a major effect on the project's communications requirements.

## **Communications Planning: Inputs**

### **.1 Enterprise Environmental Factors**

Project managers should first consider their enterprise environmental factors when planning project communications. The following are the basic enterprise environmental factors that need to be considered for communications planning:

- Organisational culture and structure
- Relevant standards and regulations
- Organisational infrastructure
- Human resources
- Marketplace conditions
- Risk tolerances
- Project management information systems

These factors can help the project management team determine what needs to be communicated—and to whom. The project manager can also rely on organisational process assets. The two that the project manager should pay most attention to during communications planning are lessons learned and historical information. The project manager can use this proven information from the past to make decisions about the present project.

In addition to the above, the project manager will rely on the project scope statement as part of communications planning. This is because the scope statement ensures that everyone involved in the project understands the project's goals and the scope statement provides a common point of reference for all stakeholders. This will come in useful when the project manager is managing the project stakeholders.

## **.2 Organisational Process Assets**

While all of the assets described in are used as inputs for this process, lessons learned and historical information are of particular importance. Lessons learned and historical information can provide both decisions and results based on previous similar projects concerning communications issues.

## **.3 Project Scope Statement**

The project scope statement provides a documented basis for future project decisions and for confirming a common knowledge of project scope among the stakeholders. Stakeholder analysis is completed as part of the Scope Definition process.

## **.4 Project Management Plan**

The project management plan provides background information about the project, including dates and constraints that may be relevant to Communications Planning. Every project has constraints and assumptions.

**Constraints** are any force that limits the project's options. A project constraint, such as contractual obligations, may require extensive communications. The requirements of the contract should be evaluated against the demands of the project staff to determine if extra resources will be needed to handle the communications. Constraints the project manager should consider when it comes to communications include such things as the following:

- The project team members' geographical locale
- The compatibility of communications software
- Technical capabilities
- Language barriers
- Telephone and videoconferencing abilities

**Assumptions** will no doubt vary from project to project. Thus, the project manager and the project team should attempt to identify the assumptions made in the project that may hinder successful project communications. Consider a project operating under the assumption that communications with management can happen only through e-mail. Management, however, expects the project manager to provide formal status reports and daily updates via memos, and also needs staffing updates from each of the project team members. This false assumption can impose time demands that the project manager doesn't expect.

## **Communications Planning: Tools and Techniques**

### **.1 Communications Requirements Analysis**

Stakeholders will need different types of information depending on their interest in the project and the priority of the project. The project manager will need to complete an analysis of the identified stakeholders to determine what information they actually need—and how often the information is needed.

There is no value in expending resources on generating information, reports, and analyses for stakeholders who have no interest in the information. An accurate assessment of stakeholders' needs for information is required early in the project planning processes. As a rule of thumb, provide information when its presence contributes to success or when a lack of information can contribute to failure.

The project manager and the project team can identify the demand for communications using the following:

- Organisation charts
- The project structure within the performing organisation
- Stakeholder responsibility relationships

- Departments and disciplines involved with the project work
- The number of individuals involved in the project and their locale
- Internal and external information needs
- Stakeholder information

The analysis of the communications requirements results in the sum of the information needs of the project stakeholders. These requirements are defined by combining the type and format of information needed with an analysis of the value of that information. Project resources are expended only on communicating information that contributes to success, or where a lack of communication can lead to failure. This does not mean that "bad news" should not be shared; rather, the intent is to prevent overwhelming stakeholders with minutiae.

- The project manager should consider the number of potential communication channels or paths as an indicator of the complexity of a project's communications. The total number of communication channels is  $n(n-1)/2$ , where  $n$  = number of stakeholders. Thus, a project with 10 stakeholders has 45 potential communication channels which is based on the following:

<b>Formula</b>	<b>Action</b>	<b>Result</b>
$\frac{N(N-1)}{2}$	$\frac{10(10-1)}{2}$	45

## .2 **Communications Technology**

The methodologies used to transfer information among project stakeholders can vary significantly. For example, a project management team may include brief conversations all the way through to extended meetings, or simple written documents to material (e.g., schedules and databases) that is accessible online as methods of communication.

Communications technology factors that can affect the project include:

- The urgency of the need for information. Is project success dependent upon having frequently updated information available on a moment's notice, or would regularly issued written reports suffice?
- The availability of technology. Are the systems already in place appropriate, or do project needs warrant change?
- The expected project staffing. Are the proposed communications systems compatible with the experience and expertise of the project participants, or is extensive training and learning required?
- The length of the project. Is the available technology likely to change before the project is over?
- The project environment. Does the team meet and operate on a face-to-face basis or in a virtual environment?

## **Communications Planning: Outputs**

### **.1 Communications Management Plan**

There are many different avenues a project manager and a project team can take to communicate. Project teams can effectively communicate through hallway meetings or formal project status meetings. Information can be transferred from stakeholder to stakeholder through written notes to complex online databases and tracking systems.

The communications management plan is contained in, or is a subsidiary plan of, the project management plan. The communications management plan provides:

- Stakeholder communication requirements
- Information to be communicated, including format, content, and level of detail
- Person responsible for communicating the information
- Person or groups who will receive the information

- Methods or technologies used to convey the information, such as memoranda, e-mail, and/or press releases
- Frequency of the communication, such as weekly
- Escalation process-identifying time frames and the management chain (names) for escalation of issues that cannot be resolved at a lower staff level
- Method for updating and refining the communications management plan as the project progresses and develops
- Glossary of common terminology.

The project manager should identify which are the preferred methods of communicating based on the conditions of the message to be communicated. Consider the following, which may have an effect on the communication plan:

- **Urgency of the information** When the information is communicated can often be as important as what's being communicated. For some projects, information should be readily available while other projects are less demanding.
- **Technology** Because of the demands of the project, there may be technology changes needed to fulfill the project request. For example, the project may require an internal web site that details project progress. If such a web site does not exist, then time and monies will need to be invested into this communication requirement.
- **Project staffing** The project manager should evaluate the abilities of the project team to determine if appropriate levels of competency exist to fulfill the communication requirements or if training will be required for the project team.
- **Project length** The length of the project can have an influence on the project technology. Advances in technology may replace a long-term project's communication model. A short-term project may not have the same technology requirements as a long-term project but

could nevertheless benefit from the successful model a larger project uses.

- **Project environment** How a team communicates often depends on their structure. Consider a co-located team versus a virtual team. Each type can be effective, but there will be differing communications demands for each type of team.

The communications management plan can also include guidelines for project status meetings, project team meetings, e-meetings, and e-mail. The communications management plan can be formal or informal, highly detailed or broadly framed, and based on the needs of the project. The communications management plan is contained in, or is a subsidiary plan of, the overall project management plan. Sample attributes of a communications management plan can include:

- **Communications item.** The information that will be distributed to stakeholders.
- **Purpose.** The reason for the distribution of that information.
- **Frequency.** How often that information will be distributed.
- **Start/end dates.** The time frame for the distribution of the information.
- **Format/medium.** The layout of the information and the method of transmission.
- **Responsibility.** The team member charged with the distribution of information. Communication Planning often entails creation of additional deliverables that, in turn, require additional time and effort. Thus, the project's work breakdown structure, project schedule, and project budget are updated accordingly.

## 10.2 Information Distribution

Information distribution is the process of ensuring that the proper stakeholders get the appropriate information when and how they need it. Essentially, it's the implementation of the communications management plan. The communications management plan details how the information is to be created and dispersed—and also how the dispersed information is archived. Three elements serve as inputs to information distribution:

- **Work results** Work results, good or bad, serve as inputs to communication because they show progress (or lack of progress), quality issues, and other relevant information.
- **The communications management plan** This plan serves as the guide for communicating project issues within the performing organisation.
- **The project plan** The comprehensive project may have information, requirements, or described conditions that are integrated with communications.

### Information Distribution: Inputs

#### .1 Communications Management Plan

This plan serves as the guide for communicating project issues within the performing organisation. *(Please see previous section for complete details on the Communications Management Plan).*

### Information Distribution: Tools and Techniques

#### .1 Communications Skills

Communications skills are part of general management skills and are used to exchange information. General management skills related to communications include ensuring that the right persons get the right information at the right time, as defined in the communications management plan. General management skills also include the art of

managing stakeholder requirements, including the important relationship with the customer where direct communication can facilitate consensus among both parties.

Figure 10-2 demonstrates a few different communication models. All models, regardless of the technology involved, have a sender, a message, and a recipient. Depending on the communication model, several additional elements can be included. Here's a summary of all the different parts of communication models:

- **Sender** The person or group sending the message to the receiver.
- **Encoder** The device or technology that encodes the message to travel over the medium. For example, a telephone encodes the sender's voice to travel over the medium, the telephone wires.
- **Medium** This is the path the message takes from the sender to the receiver. This is the modality in which the communication travels and typically refers to an electronic model, such as e-mail or telephone.
- **Decoder** This is the inverse of the encoder. If a message is encoded, a decoder translates it back to usable format. For example, the sender's message is encoded to travel the telephone wires, and the receiver's phone system translates the message back to a usable format.
- **Receiver** This is, of course, the recipient of the message.
- **Noise** Anything that disrupts the transfer of the message.
- **Acknowledgement** Verbal and/or non-verbal signs that the message has been received. Just because a message has been received doesn't mean the receiver necessarily agrees with the message.

As part of the communications process, the sender is responsible for making the information clear and complete so that the receiver can receive it correctly, and for confirming that it is properly understood.

The receiver is responsible for making sure that the information is received in its entirety and understood correctly. Communicating has many dimensions:

- Written and oral, listening, and speaking
- Internal (within the project) and external (customer, the media, the public)
- Formal (reports, briefings) and informal (memos, ad hoc conversations)
- Vertical (up and down the organisation) and horizontal (with peers).

## **.2 Information Gathering and Retrieval Systems**

What good is information if no one can find it? An information retrieval system allows for fast and accurate access to project information. It can be a simple manual filing system, an advanced database of information storage, or a robust project management software suite. Whatever the approach, the information must be accessible, organised, and secure.

The project team, the project manager, the customer, and other stakeholders may need access to design specs, blueprints, plans, and other project information. A good information retrieval system is reliable and easy to navigate and is updated as new information becomes available.

Information can be gathered and retrieved through a variety of media including manual filing systems, electronic databases, project management software, and systems that allow access to technical documentation, such as engineering drawings, design specifications, and test plans.

## **.3 Information Distribution Methods**

Throughout the project, the project manager, the project sponsor, the project team, and other stakeholders are going to need and supply

information to one another. Information Distribution is information collection, sharing, and distribution to project stakeholders in a timely manner across the project life cycle. The methods for distributing information can vary—but the best modality is the one that's most appropriate to the information being conveyed. In other words, an e-mail may not be the correct format in which to share variance information regarding project costs.

Information can be distributed through some of the following methods, given project demands and available technology:

- Project meetings
- Hard-copy documentation
- Databases
- Faxes
- E-mail
- Telephone calls
- Videoconferences
- A project web site

#### **.4 Lessons Learned Process**

A lessons learned session focuses on identifying project successes and project failures, and includes recommendations to improve future performance on projects. During the project life cycle, the project team and key stakeholders identify lessons learned concerning the technical, managerial, and process aspects of the project. The lessons learned are compiled, formalised, and stored through the project's duration. The focus of lessons learned meetings can vary. In some cases, the focus is on strong technical or product development processes, while in other cases, the focus is on the processes that aided or hindered performance of the work.

Teams can gather information more frequently if they feel that the increased quantity of data merits the additional investment of time and

money. Lessons learned provide future project teams with the information that can increase effectiveness and efficiency of project management. In addition, phase-end lessons learned sessions provide a good team-building exercise. Project managers have a professional obligation to conduct lessons learned sessions for all projects with key internal and external stakeholders, particularly if the project yielded less than desirable results. Some specific results from lessons learned include:

- Update of the lessons learned knowledge base
- Input to knowledge management system
- Updated corporate policies, procedures, and processes
- Improved business skills
- Overall product and service improvements
- Updates to the risk management plan.

## **Information Distribution: Outputs**

### **.1 Organisational Process Assets (Updates)**

Information distribution results in the following:

- **Lessons learned** - When lessons-learned sessions are completed, they're available to be used and applied. They are now part of the organisation's process assets. Documentation includes the causes of issues, reasoning behind the corrective action chosen, and other types of lessons learned about Information Distribution. Lessons learned are documented so that they become part of the historical database for both this project and the performing organisation.
- **Project records** - All the business of the project communications are also part of the organisational process assets. This includes e-mails, memos, letters, and faxes. In some instances, the project team can also contribute by keeping their records in a project notebook.

- **Project reports** - Reports are formal (and informal) communications on project activities, their status, and conditions. Management, customers, and policies within the performing organisation may have differing requirements for reports.
- **Project presentations** - Presentations are useful in providing information to customers, management, the project team, and other stakeholders. The delivery and degree of formality of the presentation should be appropriate for the conditions and information being delivered within the project.
- **Feedback from stakeholders** - Stakeholders are usually happy to offer their feedback on the project performance. Project managers should then document this feedback and apply it to improve the project's performance.
- **Stakeholder notifications** - As the project rolls along there will be notifications to the stakeholders about resolved issues, approved changes, and the overall health of the project. This information should be kept for future reference.

## .2 Requested Changes

Changes to the Information Distribution process should trigger changes to the project management plan and the communications management plan. Requested changes (additions, modifications, revisions) to the project management plan and its subsidiary plans are reviewed, and the disposition is managed through the Integrated Change Control process.

## **10.3 Performance Reporting**

Throughout the project, customers and other stakeholders are going to need updates on the project performance. The work performance information, the status of what's been completed and what's left to do, is always at the heart of performance reporting. Stakeholders want to be kept abreast of how the project is performing.

The performance reporting process involves the collection of all baseline data, and distribution of performance information to stakeholders. Generally, this performance information includes how resources are being used to achieve project objectives.

Performance reporting covers more than just cost and schedule, though these are the most common concerns. Another huge issue is the influence of risks on the project success. The project manager and the project team must continue to monitor and evaluate risks, including pending risks, and their impact on project success.

Performance reporting should generally provide information on scope, schedule, cost, and quality. Many projects also require information on risk and procurement. Reports may be prepared comprehensively or on an exception basis. Exception reports are prepared when you are outside of acceptable thresholds for the project.

### **Performance Reporting: Inputs**

#### **.1 Work Performance Information**

Work performance information on the completion status of the deliverables and what has been accomplished is collected as part of project execution, and is fed into the Performance Reporting process. Collecting the work performance information is discussed in further detail in the Direct and Manage Project Execution process.

## **.2 Performance Measurements**

The calculated schedule variance (SV) and the schedule performance index (SPI) values for WBS components, in particular the work packages and control accounts, are documented and communicated to stakeholders.

## **.3 Forecasted Completion**

Either a calculated Estimate at Completion (EAC) value or a performing organisation-reported EAC value is documented and the value communicated to stakeholders. Either a calculated Estimate To Complete (ETC) value or a reported ETC value provided by the performing organisation is documented and the value communicated to stakeholders.

## **.4 Quality Control Measurements**

Quality control measurements represent the results of QC activities that are fed back to QA to reevaluate and analyse the quality standards and processes of the performing organisation.

## **.5 Project Management Plan**

The project management plan provides baseline information.

- Performance measurement baseline. Performance measurement baselines an approved plan for the project work against which project execution is compared, and deviations are measured, for management control. The performance measurement baseline typically integrates scope, schedule, and cost parameters of a project, but may also include technical and quality parameters.

## **.6 Approved Change Requests**

Approved change requests are requested changes to expand or contract project scope, to modify the estimated cost, or to revise activity duration estimates that have been approved and are ready for implementation by the project team.

## **.7 Deliverables**

Deliverables are any unique and verifiable product, result, or capability to perform a service that must be produced to complete a process, phase, or project. The term is often used more narrowly in reference to an external deliverable that is subject to approval by the project sponsor or customer.

## **Performance Reporting: Tools and Techniques**

### **.1 Information Presentation Tools**

Software packages that include table reporting, spreadsheet analysis, presentations, or graphic capabilities can be used to create presentation-quality images of project performance data.

### **.2 Performance Information Gathering and Compilation**

Information can be gathered and compiled from a variety of media including manual filing systems, electronic databases, project management software, and systems that allow access to technical documentation, such as engineering drawings, design specifications and test plans, to produce forecasts as well as performance, status and progress reports.

### **.3 Status Review Meetings**

The project manager will host status review meetings to ascertain the progress and level of success the project team is having with the project work. Status review meetings focus on the work that has been completed and how the work results are living up to the time and cost estimates. In addition, the project manager and the project team will evaluate the project scope to protect it from change and creep. The project manager and the project team will also examine quality and its effect on the project as a whole. Finally, the project manager must lead a discussion on

pending or past risks and then determine any new risks—as well as the overall risk likelihood—and its potential impact on the project’s success.

Performance review meetings are not the only tools the project manager uses to assess project performance. Prior to the performance reviews, or spurred by a performance review, the project manager needs to examine the time, scope, quality, and cost variances within the project. The project manager will examine the estimates supplied for the time and cost of activities and compare it to the time and cost actually experienced. The goals of analysing project variances include the following:

- Prevent future variances
- Determine the root cause of variances
- Determine if the variances are an anomaly or if the estimates were flawed
- Determine if the variances are within a predetermined acceptable range, such as negative ten percent or plus five percent
- Determine if the variances can be expected on future project work.

In addition to examining the time and cost variances, which are the most common, the project manager must also examine any scope, resource, and quality variances. A change in the scope can skew time and cost predictions. A variance in resources, such as the expected performance by a given resource, can alter the project schedule and even the predicted costs of a project. Quality variances may result in rework, lost time, lost monies, and even the rejection of the project product.

#### **.4 Time Reporting Systems**

Time reporting systems record and provide time expended for the project.

## **.5 Cost Reporting Systems**

Cost reporting systems record and provide the cost expended for the project.

## **Performance Reporting: Outputs**

### **.1 Performance Reports**

These are the results and summation of the project performance analysis. The communications management plan will detail the type of report needed based on the conditions within the project, the timing of the communication, and the demands of the project stakeholder.

### **.2 Forecasts**

Will the project end on schedule? Will the project be on budget? How much longer will it take to complete the project? And how much more money will this project need to finish? Forecasts are updated and reissued based on work performance information provided as the project is executed. This information is about the project's past performance that could impact the project in the future, for example, estimate at completion and estimate to complete.

### **.3 Requested Changes**

Performance results may prompt change requests to some area or areas of the project. The change requests should flow into the Change Control System for consideration and then approval or denial. Analysis of project performance often generates requested changes to some aspect of the project. These requested changes are processed and dispositioned through the Integrated Change Control process.

### **.4 Recommended Corrective Actions**

Recommended corrective actions include changes that bring the

expected future performance of the project in line with the project management plan.

#### **.5 Organisational Process Assets (Updates)**

Lessons learned documentation includes the causes of issues, reasoning behind the corrective action chosen, and other types of lessons learned about performance reporting. Lessons learned are documented so that they become part of the historical database for both this project and the performing organisation.

## **10.4 Manage Stakeholders**

Stakeholder management refers to managing communications to satisfy the needs of, and resolve issues with, project stakeholders. The project manager is responsible for managing stakeholders, who often require, or demand, attention from the project manager. Therefore, the project manager must make time to answer questions, get the stakeholders involved in the project, and, at a minimum, communicate the project status. Stakeholder management is vital to a project's success for several reasons:

- It leads to resolving stakeholder issues.
- It promotes synergy.
- It limits disruptions during the project.
- It promotes project buy-in.

Stakeholder management relies on the communication management plan to direct what needs to be communicated and when. The communications management plan will also define the goals and expectations of the stakeholders, which in turn will guide conversations between the project manager and the project stakeholders.

### **Manage Stakeholders: Inputs**

#### **. 1 Communications Management Plan**

Stakeholder requirements and expectations provide an understanding of stakeholder goals, objectives, and level of communication during the project. The needs and expectations are identified, analysed, and documented in the communications management plan, which is a subsidiary of the project management plan.

#### **.2 Organisational Process Assets**

As project issues arise, the project manager should address and resolve them with the appropriate project stakeholders.

## **Manage Stakeholders: Tools and Techniques**

### **.1 Communications Methods**

What's the best way to communicate when resolving stakeholder issues? Face-to-face? Maybe, but sometimes an e-mail or phone call is quicker and more appropriate for what's being communicated—but when it comes to resolving issues with stakeholders, a project manager can't go wrong with face-to-face meetings. As a result of stakeholder communications and management, the project manager will document project issues in an issue log. Issue logs acknowledge the problem and the importance of the issue to the project manager and the project stakeholders. Most times, an owner is assigned to the issue and a date for the issue to be resolved by is likewise assigned.

But what happens if these issues don't get addressed, documented, or assigned to an owner? The project manager can expect conflict, project delays, and unhappy stakeholders. Ideally, the issues in the issue log are resolved and documentation on how the issue was resolved is included.

### **.2 Issue Logs**

An issue log or action-item log is a tool that can be used to document and monitor the resolution of issues. Issues do not usually rise to the importance of becoming a project or activity, but are usually addressed in order to maintain good, constructive working relationships among various stakeholders, including team members. An issue is clarified and stated in a way that it can be resolved. An owner is assigned and a target date is usually established for closure. Unresolved issues can be a major source of conflict and project delays.

## **Manage Stakeholders: Outputs**

### **.1 Resolved Issues**

As stakeholder requirements are identified and resolved, the issues log will document concerns that have been addressed and closed.

Examples include:

- Customers agree to a follow-on contract, which ends protracted discussion of whether requested changes to project scope are within or outside the scope of the current project
- More staff are added to the project, thus closing the issue that the project is short on required skills
- Negotiations with functional managers in the organisation competing for scarce human resources end in a mutually satisfactory solution before causing project delays
- Issues raised by board members about the financial viability of the project have been answered, allowing the project to move forward as planned.

### **.2 Approved Change Requests**

Approved change requests include stakeholder issued status changes in the staffing management plan, which are necessary to reflect changes to how communications with stakeholders will occur.

### **.3 Approved Corrective Actions**

Approved corrective actions include changes that bring the expected future performance of the project in line with the project management plan.

### **.4 Organisational Process Assets (Updates)**

Lessons learned documentation includes the causes of issues, the reasoning behind the corrective action chosen, and other types of lessons learned about stakeholder management. Lessons learned are documented

on an ongoing basis so that they become part of the historical database for both this project and the performing organisation to help future teams to complete their projects more accurately.

#### **.5 Project Management Plan (Updates)**

The project management plan is updated to reflect the changes made to the communications plan.

## **Summary and Self Test**

### **TWO-MINUTE DRILL**

#### **Planning for Communication**

- Communication centers on who needs what, and when, and how you are going to give it to them.
- Communication requirements are set by stakeholders.
- Communication planning is accomplished early in the planning processes.
- Communications are linked to the organisational structure of the performing organisation.
- Constraints and assumptions can affect the communications planning.
- Acknowledgment of a message can be positive or negative. Just because a receiver got the message, doesn't mean she has to agree with it.

#### **The Communications Management Plan**

- Provides instructions on how to gather and disseminate project information.
- Provides instructions on the communications methods, such as hard copies, reports, and e-mail.
- Includes a schedule of expected communications, such as reports and meetings.
- Provides a method to access needed information between regularly scheduled communications.

#### **Performance Reporting**

- Status reporting provides current information on the project.
- Progress reporting provides information on what the team has accomplished—and may include information on what is yet to be

accomplished.

- ❑ Forecasting provides information on how the remainder of the project or phase is expected to go.
- ❑ Variance analysis examines the reason why cost, schedule, scope, quality, and other factors may vary from what was planned.
- ❑ Trend analysis is the study of trends over time to reveal patterns and expectations of future results.
- ❑ Earned value analysis is a series of formulas that reveal and predict project performance.
- ❑ Change requests may stem from performance reports.

### **Stakeholder Management**

- ❑ Face-to-face meetings are best for resolving issues with stakeholders.
- ❑ The project manager is responsible for managing project stakeholders.
- ❑ Issue logs document issues between the stakeholders and the project. When issues are resolved, the issue log should be updated to reflect the resolution.
- ❑ Stakeholder involvement increases the odds that a project will not veer off track.

*Source: PMP Study Guide, Phillips 2006*

## SELF TEST

- 1.** Of the following, which one is an example of noise?
  - A. Fax machine
  - B. Ad-hoc conversations
  - C. Contractual agreements
  - D. Distance
  
- 2.** You are the project manager of a large technical project. You believe that Jose has received the message but does not agree with it based on his body language. This is known as what?
  - A. Acknowledgment
  - B. Transmission
  - C. Negotiation
  - D. Decoder
  
- 3.** You are the project manager for the LKH Project. Management has requested that you create a document detailing what information will be expected from stakeholders and to whom that information will be disseminated. Management is asking for which one of the following?
  - A. The roles and responsibilities matrix
  - B. The scope management plan
  - C. The communications management plan
  - D. The communications worksheet
  
- 4.** Which of the following will help you, the project manager, complete the needed communications management plan by identifying the stakeholders' communication needs?
  - A. Identification of all communication channels
  - B. Formal documentation of all communication channels
  - C. Formal documentation of all stakeholders
  - D. Lessons learned from previous similar projects
  
- 5.** You are the project manager for the JGI Project. You have 32 stakeholders on this project. How many communication channels do you have?
  - A. Depends on the number of project team members
  - B. 496
  - C. 32
  - D. 1
  
- 6.** You are the project manager for the KLN Project. You had 19 stakeholders on this project, and have added three team members to the project. How many more communication channels do you have now compared to before?
  - A. 171

- B. 231
- C. 60
- D. 1

**7.** A memo has been sent to you, the project manager, project team members, and the project customers from the project sponsor. In this instance, who is the encoder?

- A. Project sponsor
- B. Project manager
- C. Project team members
- D. Project customers

**8.** Which one of the following is an example of a project communication constraint?

- A. Ad-hoc conversations
- B. Demands for formal reports
- C. Stakeholder management
- D. Team members in different geographical locales

**9.** Project managers can present project information in many different ways. Which one of the following is not a method a project manager can use to present project performance?

- A. Histograms
- B. S-curves
- C. Bar charts
- D. RACI charts

**10.** Of the following, which term describes the pitch and tone of an individual's voice?

- A. Paralingual
- B. Feedback
- C. Effective listening
- D. Active listening

**11.** You are the project manager of the KMH Project. This project is slated for the next eight years. You have just used Earned Value Management (EVM) and have a Cost Variance (CV) of  $-\$3500$ , which is outside of the acceptable thresholds for your project. What type of report is needed for management?

- A. Progress report
- B. Forecast report
- C. Exception report
- D. Trends report

**12.** You are presenting your project performance to your key stakeholders. Several of the stakeholders are receiving phone calls during your presentation and this is distracting from your message. This is an example of what?

- A. Noise
- B. Negative feedback
- C. Outside communications
- D. Message distracter

**13.** You are the project manager for the OOK Project. You will be hosting project meetings every week. Of the following, which one is not a valid rule for project meetings?

- A. Schedule recurring meetings as soon as possible
- B. Allow project meetings to last as long as needed
- C. Distribute meeting agendas prior to the meeting start
- D. Allow the project team to have input to the agenda

**14.** The three basic elements needed for communication in project management include which of the following?

- A. Words, sentences, paragraphs
- B. Proper grammar, spelling, ideas
- C. Verbal, nonverbal, action
- D. Sender, receiver, message

**15.** Which one of the following is a technology factor that may affect project communication?

- A. Communications management
- B. Management by walking around
- C. The project length
- D. Variance analysis reporting

**16.** What percentage of a message is sent through nonverbal communications, such as facial expressions, hand gestures, and body language?

- A. Greater than 50 percent
- B. 30 to 40 percent
- C. 20 to 30 percent
- D. 10 to 20 percent

**17.** When does lessons-learned identification take place?

- A. At the end of the project
- B. At the end of each project phase
- C. Throughout the project life cycle
- D. Whenever a lesson has been learned

**18.** Why should a project team complete lessons-learned documentation?

- A. To ensure project closure
- B. To show management what they've accomplished in the project
- C. To show the project stakeholders what they've accomplished in the project
- D. To help future project teams complete their projects more accurately

**19.** Often in project management you will have to negotiate. Negotiations work best in which environment?

- A. Caution and yielding
- B. Sincerity, honesty, and extreme caution
- C. Mutual respect and admiration
- D. Mutual respect and cooperation

**20.** You are the project manager for the PMU Project. Your project has 13 members. You have been informed that next week your project will receive the seven additional members you requested. How many channels of communication will you have next week?

- A. 1
- B. 78
- C. 190
- D. 201

**21.** Performance reporting should generally provide information on all of the following except for which one?

- A. Scope
- B. Schedule
- C. Labor issues
- D. Quality

**22.** Which one of the following is an output from performance reporting?

- A. Trend analysis
- B. Earned Value Management (EVM)
- C. Variance analysis
- D. Change requests

**23.** The process of sending information from the project manager to the project team is called what?

- A. Functioning
- B. Matrixing
- C. Blended communications
- D. Transmitting

**24.** George is the project manager of the 7YH Project. In this project, George considers the relation between himself and the customer to be of utmost importance. Which one of the following is a valid reason for George's belief in the importance of the relationship between the customer and himself?

- A. The customer will complete George's performance evaluation. A poor communication model between George and the customer will affect his project bonus.
- B. The customer is not familiar in project management. George must educate the customer about the process.
- C. The customer is always right.
- D. The communication between the customer and George can convey the

project objectives more clearly than can the language in the project contract.

**25.** Which one of the following means that communications occur?

- A. The transfer of knowledge
- B. The outputting of knowledge
- C. The presence of knowledge
- D. The transmission of knowledge

## 11 Project Risk Management

### Introduction

Risks are uncertain events that can impact our projects. Risk is everywhere. From driving a car to parachuting, it's inherent in the activities we choose. Within a project, risks are unplanned events or conditions that can have a positive or negative effect on its success. Not all risks are bad, but almost all are seen as a threat.

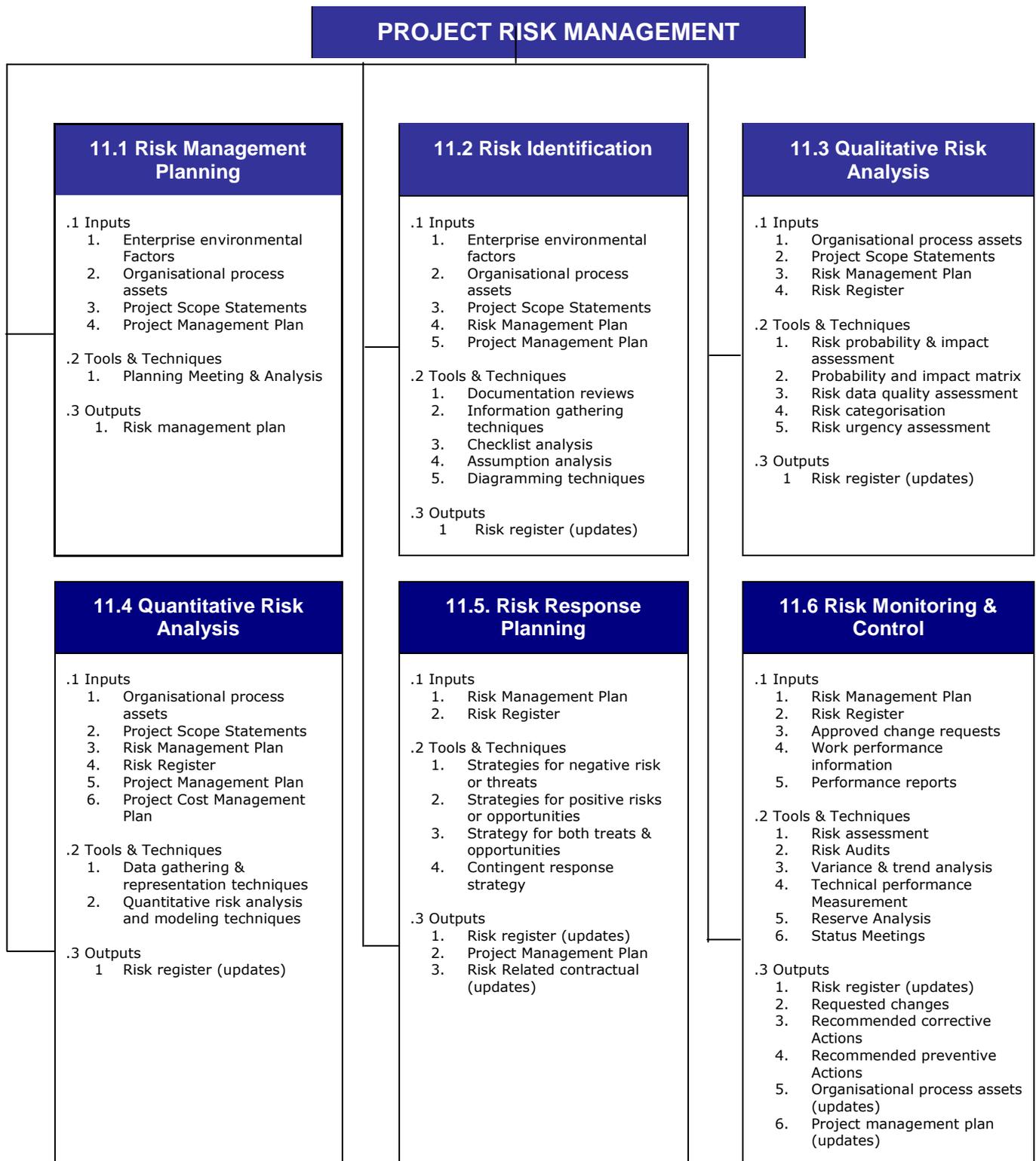
Project managers, to some extent, are like thrill seekers. Parachutists complete training, pack their chutes, check and double-check their equipment, and make certain there's an emergency chute for those "just-in-case" scenarios. Project managers—good project managers—take a similar approach.

Risks in a project, should they come to fruition, can mean total project failure, increased costs, and extended project duration among other things. Risk often has a negative connotation, but like the parachutist, the acceptance of the risk can also offer a reward. For the parachutist, the risk is certain death—but the reward is the thrill of the activity. For project managers, risk can mean failure, but the reward can mean time or cost savings, as well as other benefits.

Risk management is the process in which the project manager and project team identify project risks, analyse and rank them, and determine what actions, if any, need to be taken to avert these threats. Associated with this process are the costs, time, and quality concerns of the project brought about by the solutions to those risks. In addition, the reactions to risks are analysed for any secondary risks the solutions may have created.

Project risk management includes the processes concerned with risk

management planning, risk identification, analysis, response planning, and the monitoring and control of the identified risks as outlined in figure 11.1.



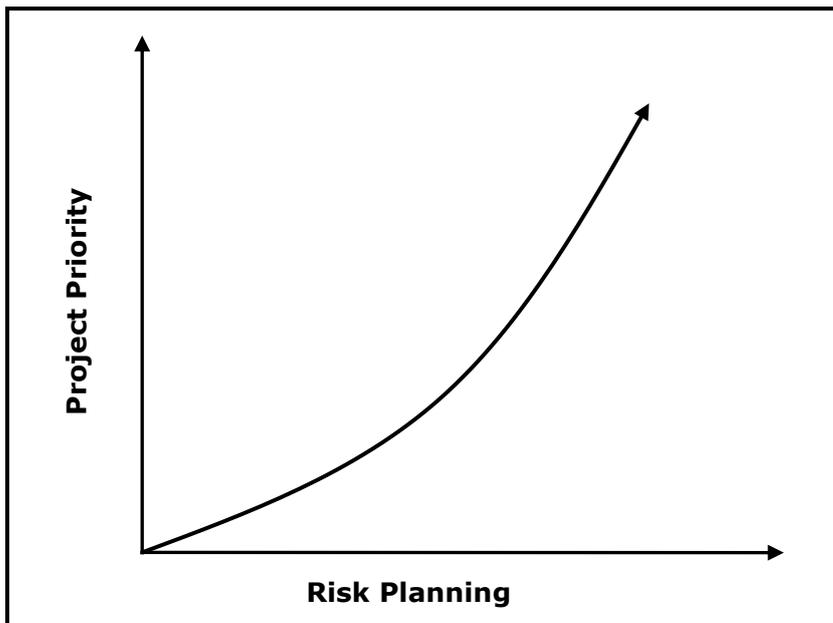
**Figure 11.1. Project Risk Management Process Overview.** (Source PMBOK 3<sup>rd</sup> Ed)

## 11.1 Risk Management Planning

Risk management planning is about making decisions. The project manager, the project team, and other key stakeholders are involved to determine the risk management processes. The risk management process is related to the scope of the project, the priority of the project within the performing organisation, and the impact of the project deliverables (see figure 11.2). In other words, a simple, low-impact project won't have the same level of risk planning as a high-priority, complex project. It's important to complete risk management planning in order to successfully manage, plan for, analyse, and react to identified risks.

Careful and explicit planning enhances the possibility of success of the five other risk management processes. Risk Management Planning is the process of deciding how to approach and conduct the risk management activities for a project.

Planning of risk management processes is important to ensure that the level, type, and visibility of risk management are commensurate with both the risk and importance of the project to the organisation, to provide sufficient resources and time for risk management activities, and to establish an agreed-upon basis for evaluating risks.



**Figure 11.2- Relationship between Risk Planning and Project Priority**

### **Risk Management Planning: Inputs**

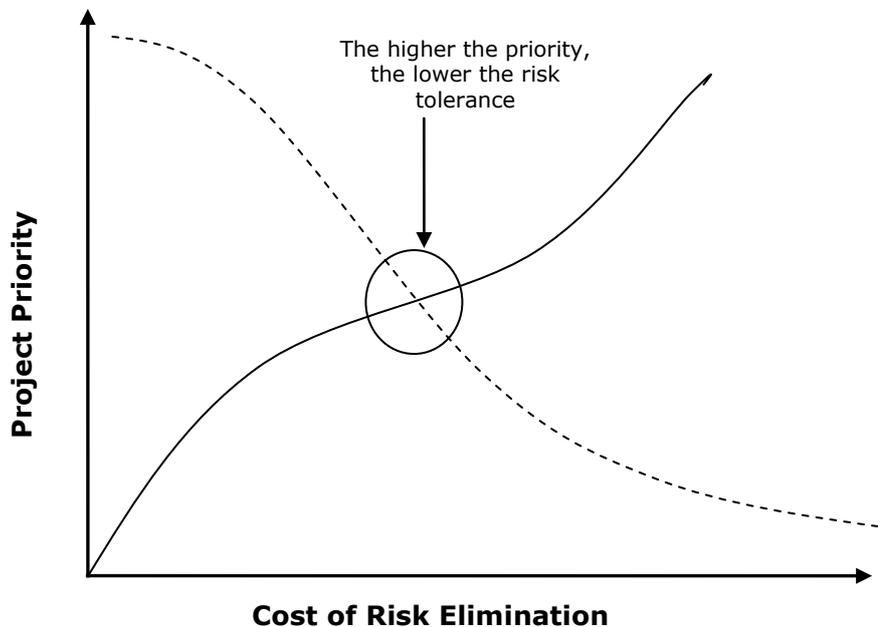
#### *1. Enterprise Environmental Factors*

The attitudes toward risk and the risk tolerance of organisations and people involved in the project will influence the project management plan. Risk attitudes and tolerances may be expressed in policy statements or revealed in actions. Depending on the project, the conditions, and the potential for loss or reward, stakeholders will have differing tolerances for risk. Stakeholders' risk tolerance may be known at the launch of the project, through written policy statements, or by their actions during the project.

Consider a project to install new medical equipment in a hospital: there's little room for acceptance of errors because life and death are on the line. No shortcuts or quick fixes are allowed. Now, consider a project to create a community garden. Not only are life and death not on the line in the garden project, but the acceptance of risk is different as well.

A person's willingness to accept risk is known as the utility function or risk tolerance. The time and money costs required to eliminate the chance of failure is in proportion to the stakeholders' tolerance of risk on the

project. The cost of assuring there are no threats must be balanced with the confidence that the project can be completed without extraordinary costs. Figure 11.3 demonstrates the risk tolerance in relation to project priorities.



**Figure 11-3. The priority of the project is relevant to the risk tolerance**

## 2. Organisational Process Assets

Organisations often have a predefined approach to risk management. The policies can define the activities to initiate, plan, and respond to risk. The project manager must map the project risk management to these policies to conform to the organisation's requirements. Within the confines of the risk management policy, the project manager must identify any component that can hinder the success of the project. Risk management policies are considered part of the organisational process assets.

## 3. Project Scope Statement

The project scope statement describes, in detail, the project's deliverables and the work required to create those deliverables. *Please refer to Study Guide on Project Scope Management for further details.*

#### *4. Project Management Plan*

The project management plan defines how the project is executed, monitored and controlled, and closed. The project management plan documents the collection of outputs of the planning processes of the Planning Process Group. *Please refer to Study Guide on Project Integration for further details.*

### **Risk Management Planning: Tools and Techniques**

#### *Planning Meetings and Analysis*

Project teams hold planning meetings to develop the risk management plan. Attendees at these meetings may include the project manager, selected project team members and stakeholders, anyone in the organisation with responsibility to manage the risk planning and execution activities, and others, as needed. Basic plans for conducting the risk management activities are defined in these meetings. Attendees should include:

- The project manager
- Project team leaders
- Key stakeholders
- Personnel specific to risk management
- Any other persons of authority involved or who have input required for the risk management processes.

The goals of the meeting include:

- Defining the project's risk management activities
- The costs of risk elements
- Risk schedule activities
- The assignment of risk responsibilities
- The reliance on templates for risk categories
- Definitions for the level of risk

- The relevant risk probability and impact matrix definitions for the project type.

The risk management meetings are an iterative process that guide the identification, ranking, and responses to the identified risks. Risk management meetings will be held throughout the project duration to assess risk, risk responses, and the overall status of risks within the project. Risk cost elements and schedule activities will be developed for inclusion in the project budget and schedule, respectively. Risk responsibilities will be assigned. General organisational templates for risk categories and definitions of terms such as levels of risk, probability by type of risk, impact by type of objectives, and the probability and impact matrix will be tailored to the specific project. The outputs of these activities will be summarised in the risk management plan.

### **Risk Management Planning: Outputs**

#### *Risk Management Plan*

The risk management plan describes how risk management will be structured and performed on the project. It becomes a subset of the project management plan. The risk management plan does not detail the planned responses to individual risks within the project—this is the purpose of the risk response plan. The risk management plan is responsible for determining:

- How risks will be identified
- How quantitative analysis will be completed
- How qualitative analysis will be completed
- How risk response planning will happen
- How risks will be monitored
- How ongoing risk management activities will happen throughout the project life cycle

The risk management plan includes, but not limited to, the following:

## **Methodology**

The methodology is concerned with how the risk management processes will take place. The methodology asks the following:

- What tools are available to use for risk management?
- What approaches are acceptable within the performing organisation?
- What data sources can be accessed and used for risk management?
- What approach is best for the project type, and the phase of the project and which is most appropriate given the conditions of the project?
- How much flexibility is available for the project given the conditions, the timeframe, and the project budget?

## **Roles and Responsibilities**

The roles and responsibilities identify the groups and individuals that will participate in the leadership and support of each of the risk management activities within the project plan. In some instances, risk management teams outside of the project team may have a more realistic, unbiased approach to the risk identification, impact, and overall risk management needs than the actual project team.

## **Budgeting**

Based on the size, impact, and priority of the project, a budget may need to be established for the project's risk management activities. A project with high priority and no budget allotment for risk management activities may face uncertain times ahead. A realistic dollar amount is needed for risk management activities if the project is to be successful.

## **Scheduling**

The risk management process needs a schedule to determine

how often and when risk management activities should happen throughout the project. If risk management happens too late in the project, then the project could be delayed because of the time needed to identify, assess, and respond to the risks. A realistic schedule should be developed early in the project to accommodate risks, risk analysis, and risk reaction.

### **Risk Analysis Scoring**

Prior to beginning quantitative and qualitative analysis, a clearly defined scoring system and interpretation of the scoring system must be in place. Altering the scoring process during risk analysis—or from analysis to analysis—can skew the seriousness of a risk, its impact, and the effect of the risk on the project. The project manager and the project team must have clearly defined scores that will be applied to the analysis to ensure consistency throughout the project.

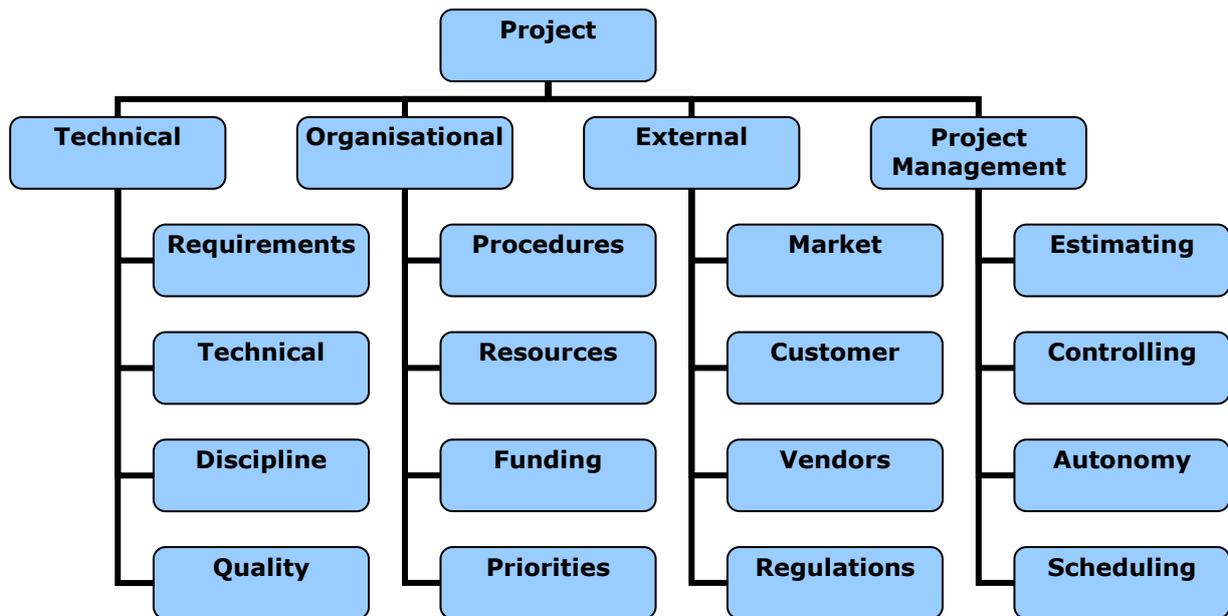
### **Risk categories**

Based on the nature of the work, there should be identified categories of risks within the project. Figure 11-4 is one approach to identifying risk categories by using a risk breakdown structure (RBS). Throughout the project, the risk categories should be revisited to update and reflect the current status of the project. If a previous similar project's risk management plan is available, the project team may elect to use this plan as a template and tailor the risk categories to the specific project.

### **Creating Risk Categories**

As risks are identified within the project, they should be categorised. Risk categories should be identified before risk identification begins—and should include common risks that are typical in the industry where the project is occurring. Risk categories help organise, rank, and isolate risks within the project. There are four major categories of risks:

- **Technical, quality, or performance risks** Technical risks are associated with new, unproven, or complex technologies being used on the project. Changes to the technology during the project implementation can also be a risk. Quality risks are the levels set for expectations of impractical quality and performance. Changes to industry standards during the project can also be lumped into this category of risks.
- **Project management risks** These risks deal with faults in the management of the project: the unsuccessful allocation of time, resources, and scheduling; unacceptable work results (low-quality work); and lousy project management as a whole.
- **Organisational risks** The performing organisation can contribute to the project's risks through unreasonable cost, time, and scope expectations; poor project prioritisation; inadequate funding or the disruption of funding; and competition with other projects for internal resources.
- **External risks** These risks are outside of the project but directly affect it: legal issues, labor issues, a shift in project priorities, and weather. Force majeure risks can be scary and usually call for disaster recovery rather than project management. These are risks caused by earthquakes, tornados, floods, civil unrest, and other disasters.



**Figure 11-4. Example of a Risk Breakdown Structure (RBS) identifying, and categorising project risks.**

**Definitions of risk probability and impact:** The quality and credibility of the Qualitative Risk Analysis process requires that *different levels of the risks' probabilities and impacts be defined*. General definitions of probability levels and impact levels are tailored to the individual project during the Risk Management Planning process for use in the Qualitative Risk Analysis process.

A relative scale representing probability values from "very unlikely" to "almost certainty" could be used. Alternatively, assigned numerical probabilities on a general scale (e.g., 0.1, 0.3, 0.5, 0.7, and 0.9) can be used. Another approach to calibrating probability involves developing descriptions of the state of the project that relate to the risk under consideration (e.g., the degree of maturity of the project design).

The impact scale reflects the significance of impact, either negative for threats or positive for opportunities, on each project objective if a risk occurs. Impact scales are specific to the objective potentially impacted, the type and size of the project, the

organisation's strategies and financial state, and the organisation's sensitivity to particular impacts. Relative scales for impact are simply rank-ordered descriptors such as "very low," "low," "moderate," "high," and "very high," reflecting increasingly extreme impacts as defined by the organisation. Alternatively, numeric scales assign values to these impacts.

These values may be linear (e.g., 0.1, 0.3, 0.5, 0.7, 0.9) or nonlinear (e.g., 0.05, 0.1, 0.2, 0.4, 0.8). Nonlinear scales may represent the organisation's desire to avoid high-impact threats or exploit high-impact opportunities, even if they have relatively low probability. In using non linear scales, it is important to understand what is meant by the numbers and their relationship to each other, how they were derived, and the effect they may have on the different objectives of the project.

### **Probability and impact matrix**

Risks are prioritised according to their potential implications for meeting the project's objectives. The typical approach to prioritising risks is to use a look-up table or a Probability and Impact Matrix. The specific combinations of probability and impact that lead to a risk being rated as "high," "moderate," or "low" importance, with the corresponding importance for planning responses to the risk are usually set by the organisation. They are reviewed and can be tailored to the specific project during the Risk Management Planning process.

### **Thresholds**

Values used as parameters to indicate acceptable threshold levels. Where these are exceeded action from the project team is required.

**Revised stakeholders' tolerances**

Stakeholders' tolerances may be revised in the Risk Management Planning process, as they apply to the specific project.

**Reporting formats**

Describes the content and format of the risk register as well as any other risk reports required. Defines how the outcomes of the risk management processes will be documented, analysed, and communicated.

**Tracking**

Documents how all facets of risk activities will be recorded for the benefit of the current project, future needs, and lessons learned. Documents whether and how risk management processes will be audited.

**Using a Risk Management Plan Template**

The performing organisation may rely on templates for the risk management plan. The template can guide the project manager and the project team through the planning processes, the risk identification, and the values that may trigger additional planning. Hopefully, the organisation allows the template to be modified or appended based on the nature of the project. Since most projects resemble other historical projects, the template may need only minor changes to be adapted to the current project.

A risk management plan may provide the project manager decision-making abilities on risks below a certain threshold. Risks above a preset threshold will have to be escalated to a Change Control Board for a determination of their cost and impact on the project's success.

## 11.2 Risk Identification

Risk Identification determines which risks might affect the project and documents their characteristics. Participants in risk identification activities can include the following, where appropriate: project manager, project team members, risk management team (if assigned), subject matter experts from outside the project team, customers, end users, other project managers, stakeholders, and risk management experts. While these personnel are often key participants for risk identification, all project personnel should be encouraged to identify risks.

Risk Identification is an iterative process because new risks may become known as the project progresses through its life cycle. The frequency of iteration and who participates in each cycle will vary from case to case. The project team should be involved in the process so that they can develop and maintain a sense of ownership of, and responsibility for, the risks and associated risk response actions.

Stakeholders outside the project team may provide additional objective information. The Risk Identification process usually leads to the Qualitative Risk Analysis process. Alternatively, it can lead directly to the Quantitative Risk Analysis process when conducted by an experienced risk manager. On some occasions, simply the identification of a risk may suggest its response, and these should be recorded for further analysis and implementation in the Risk Response Planning process.

### **Risk Identification: Inputs**

#### *1. Enterprise Environmental Factors*

Published information, including commercial databases, academic studies, benchmarking, or other industry studies, may also be useful in identifying risks.

#### *2. Organisational Process Assets*

Information on prior projects may be available from previous project

files, including actual data and lessons learned.

### *3. Project Scope Statement*

Project assumptions are found in the project scope statement. Uncertainty in project assumptions should be evaluated as potential causes of project risk.

### *4. Risk Management Plan*

Key inputs from the risk management plan to the Risk Identification process are the assignments of roles and responsibilities, provision for risk management activities in the budget and schedule, and categories of risk, which are sometimes expressed in an RBS (Figure 11-4).

### *5. Project Management Plan*

The Risk Identification process also requires an understanding of the schedule, cost, and quality management plans found in the project management plan. Outputs of other Knowledge Area processes should be reviewed to identify possible risks across the entire project.

## **Risk Identification: Tools and Techniques**

### *1. Documentation Reviews*

A structured review may be performed of project documentation, including plans, assumptions, prior project files, and other information. The quality of the plans, as well as consistency between those plans and with the project requirements and assumptions, can be indicators of risk in the project. This structured review takes a very broad look at the project plan, the scope, and the activities defined within the project.

### *2. Information Gathering Techniques*

Examples of information gathering techniques used in identifying risk can include:

- *Brainstorming.* Brainstorming is likely the most common approach to risk identification. *The goal of brainstorming is to obtain a comprehensive list of project risks.* The risks are identified in broad terms and posted, and then the risks' characteristics are detailed. The identified risks are categorised and will pass through qualitative and quantitative risk analysis later. A multidisciplinary team, hosted by a project facilitator, can also complete brainstorming. It's usually completed together as a project team to identify the risks within the project.
- *Delphi technique.* The Delphi Technique is an anonymous method to query experts about foreseeable risks within a project, phase, or component of a project. The Delphi technique is a way to *reach a consensus of experts.* A facilitator uses a questionnaire to solicit ideas about the important project risks. The responses are summarised and are then re-circulated to the experts for further comment. *Consensus* may be reached in a few rounds of this process. The Delphi technique *helps reduce bias* in the data and *keeps any one person from having undue influence* on the outcome.
- *Interviewing.* Interviewing experienced project participants, stakeholders, and subject matter experts is an excellent approach to identifying risks on the current project based on the interviewees' experience. The people responsible for risk identifications share the overall purpose of the project, the project's WBS, and likely the same assumptions as the interviewee.

The interviewee, through questions and discussion, shares his insight on what risks he perceives within the project. The goal of the process is to learn from the expert what risks may be hidden within the project, what risks this person has encountered on similar work, and what insight the person has

into the project work.

- *Root cause identification.* This is an inquiry into the essential causes of a project's risks. It sharpens the definition of the risk and allows grouping risks by causes. Effective risk responses can be developed if the root cause of the risk is addressed.
- *Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis.* This technique ensures examination of the project from each of the SWOT perspectives, *to increase the breadth of considered risks.* For example, a technology project may identify SWOT as:
  - **Strengths** The technology to be installed in the project has been installed by other large companies in the same industry.
  - **Weaknesses** We have never installed this technology before.
  - **Opportunities** The new technology will allow us to reduce our cycle time for time-to-market on new products. Opportunities are things, conditions, or events that allow an organisation to differentiate itself from competitors and improve its standing in the marketplace.
  - **Threats** The time to complete the training and simulation may overlap with product updates, new versions, and external changes to our technology portfolio.

### 3. Checklist Analysis

Risk identification checklists can be developed based on historical information and knowledge that has been accumulated from previous similar projects and from other sources of information. The lowest level of the RBS can also be used as a risk checklist. While a checklist can be

quick and simple, it is impossible to build an exhaustive one. Care should be taken to explore items that do not appear on the checklist. The checklist should be reviewed during project closure to improve it for use on future projects.

#### 4. Assumptions Analysis

Every project is conceived and developed based on a set of hypotheses, scenarios, or assumptions. Assumptions analysis is a tool that explores the validity of assumptions as they apply to the project. It identifies risks to the project from inaccuracy, inconsistency, or incompleteness of assumptions. False assumptions can ruin a project. They can wreck time, cost, and even the quality of a project deliverable. Assumptions, for this reason, are treated as risks and must be tested and weighed to truncate the possibility of an assumption turning against the project. Assumptions are weighed using two factors:

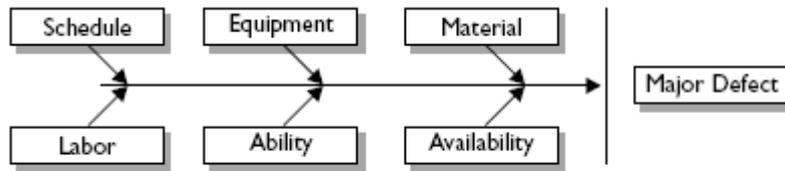
- **Assumption stability** How reliable is the information that led to this assumption?
- **Assumption consequence** What is the effect on the project if this assumption is false?

The answers to these two questions will help the project team be able to deliver the project with more confidence. Should an assumption prove to be false, the weight of the assumption consequence may be low to high—depending on the nature of the assumption.

#### 5. Diagramming Techniques

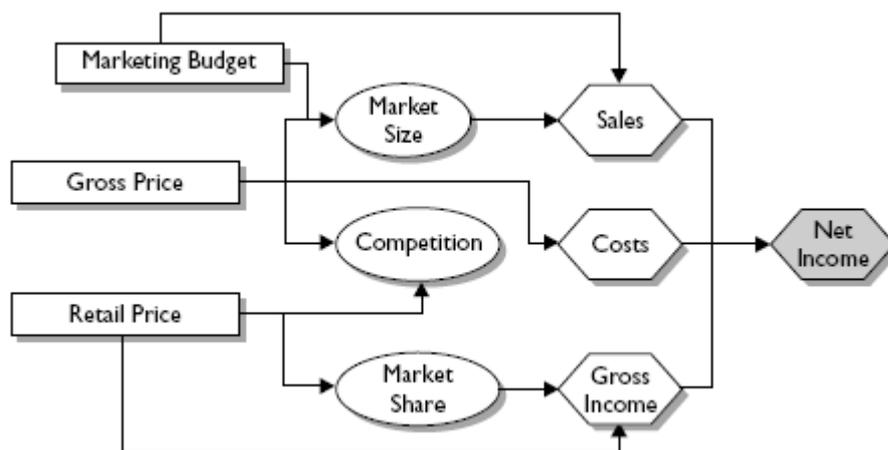
There are several diagramming techniques that can be utilised by the project team to identify risks:

- *Cause-and-effect diagrams.* These are also known as *Ishikawa* or *fishbone diagrams*, and are useful for identifying *causes of risks*.



**Figure 11-5. A example of an Ishikawa or fishbone diagram** (Source: PMP Study Guide, Phillips 2006)

- *System or process flow charts.* These show how various elements of a system interrelate, and the *mechanism of causation*.
- *Influence diagrams.* These are graphical representations of situations *showing causal influences, time ordering of events,* and other relationships among variables and outcomes.



**Figure 11-6. An Influence Diagram** (Source: PMP Study Guide, Phillips 2006)

## Risk Identification: Outputs

### 1 Risk Register

The outputs from Risk Identification are typically contained in a document that can be called a risk register. The risk register is a project plan component that contains all of the information related to the risk management activities. It's updated as risk management activities are conducted to reflect the status, progress, and nature of the project risks. The risk register includes the following:

- **Risks** Of course the most obvious output of risk identification is the risk that has been successfully identified. Recall that a risk is an uncertain event or condition that could potentially have a positive or negative effect on the project's success.
- **Potential responses** During the initial risk identification process, there may be solutions and responses to identified risks. This is fine as long as the responses are documented here. Along with the risk responses, the identification of risk triggers may also occur. Triggers are warning signs or symptoms that a risk has occurred or is about to occur. For example, should a vendor fail to complete their portion of the project as scheduled, the project completion may be delayed.
- **The root causes of risk** Risk identification can identify why risk conditions exist.
- **Updated risk categories** Risk identification may prompt the project team to identify new categories of risks. These new categories should be documented in the risk register, and if a risk breakdown structure is utilised, it will need to be updated as well.

The risk register will be continually updated and contains the outcomes of all the other risk management processes.

### 11.3 Qualitative Risk Analysis

Qualitative risk “qualifies” the risks that have been identified in the project. Specifically, qualitative risk analysis examines and prioritises the risks based on their probability of occurring and the impact on the project if the risks did occur. Qualitative risk analysis is a broad approach to ranking risks by priority, which then guides the risk reaction process.

Qualitative Risk Analysis is usually a rapid and cost-effective means of establishing priorities for Risk Response Planning, and lays the foundation for Quantitative Risk Analysis, if this is required. Qualitative Risk Analysis should be revisited during the project's life cycle to stay current with changes in the project risks. Qualitative Risk Analysis requires outputs of the Risk Management Planning and Risk Identification processes. The end result of qualitative risk analysis (once risks have been identified and prioritised) can lead to more in-depth quantitative risk analysis, or move directly into risk response planning.

#### Qualitative Risk Analysis: Inputs

##### *1. Organisational Process Assets*

Data about risks on past projects and the lessons learned knowledge base can be used in the Qualitative Risk Analysis process. All risks are based upon some belief, proof, and data. The accuracy and source of the data must be evaluated to determine the level of confidence in the identified risks. A hunch that an element is a risk is not as reliable as measured statistics, historical information, or expert knowledge that an element is a risk. The data precision is in proportion to the reality of the risk.

##### *2. Project Scope Statement*

Projects of a common or recurrent type tend to have more well-understood risks. Projects using state-of-the-art or first-of-its-kind

technology, and highly complex projects, tend to have more uncertainty. This can be evaluated by examining the project scope statement.

### *3. Risk Management Plan*

The risk management plan is the key input to qualitative risk analysis. The plan will dictate the process, the methodologies to be used, and the scoring model for identified risks. Key elements of the risk management plan for Qualitative Risk Analysis include roles and responsibilities for conducting risk management, budgets, and schedule activities for risk management, risk categories, definition of probability and impact, the probability and impact matrix, and revised stakeholders' risk tolerances. These inputs are usually tailored to the project during the Risk Management Planning process. If they are not available, they can be developed during the Qualitative Risk Analysis process.

### *4. Risk Register*

A key item from the risk register for Qualitative Risk Analysis is the list of identified risks which are used to perform an analysis. These are the risks that will be scored and ranked based on their probability and impact.

## **Qualitative Risk Analysis: Tools and Techniques**

Not all risks are worth responding to, while others demand attention. Qualitative analysis is a subjective approach to organising and prioritising risks. Through a methodical and logical approach, the identified risks are rated according to probability and potential impact.

The outcome of the ranking determines four things:

- It identifies the risks that require additional analysis through quantitative risk analysis.
- It identifies the risks that may proceed directly to risk response planning.

- It identifies risks that are not critical, project-stopping risks, but that still must be documented.
- It prioritises risks.

### *1. Risk Probability and Impact Assessment*

The project risks are rated according to their probability and impact. Risk probability is the likelihood that a risk event may happen, while risk impact is the consequence that the result of the event will have on the project objectives. Each risk is measured based on its likelihood and its impact. Two approaches exist to ranking risks:

- Cardinal scales identify the probability and impact on a numerical value from .01 (very low) to 1.0 (certain).
- Ordinal scales identify and rank the risks as very high to very unlikely.

*Risk impact assessment investigates the potential effect on a project objective such as time, cost, scope, or quality, including both negative effects for threats and positive effects for opportunities. Probability and impact are assessed for each identified risk.* Risks can be assessed in interviews or meetings with participants selected for their familiarity with the risk categories on the agenda. Project team members and, perhaps, knowledgeable persons from outside the project, are included.

Expert judgment is required, since there may be little information on risks from the organisation's database of past projects. An experienced facilitator may lead the discussion, since the participants may have little experience with risk assessment. The level of probability for each risk and its impact on each objective is evaluated during the interview or meeting. Explanatory detail, including assumptions justifying the levels assigned, is also recorded. Risk probabilities and impacts are rated according to the definitions given in the risk management plan. *Sometimes, risks with obviously low ratings of probability and impact will not be rated, but will be included on a watch list for future monitoring.*

## 2. Probability and Impact Matrix

Each identified risk is fed into a probability-impact matrix, as seen in table 11-2. The matrix maps out the risk, its probability, and its possible impact. The risks with higher probability and impact are a more serious threat to the project objectives than the risks with lower impact and consequences. The risks that are threats to the project require quantitative analysis to determine the root of the risks, the methods to control the risks, and effective risk management. Risks can be prioritised for further quantitative analysis and response, based on their risk rating. *Ratings are assigned to risks based on their assessed probability and impact.*

Identified Risk	Probability (Odds)	Impact	Score/Rating
Data Loss	Low	High	Moderate
Network Speed	Moderate	Moderate	Moderate
Server Downtime	High	Low	Moderate
E-mail Service Down	Low	Low	Low

**Table 11-2. A probability-impact matrix measures the identified risks within the project.**

Evaluation of each risk's importance and, hence, priority for attention is typically conducted using a look-up table or a probability and impact matrix (Table 11-3). Such a matrix specifies combinations of probability and impact that lead to rating the risks as low, moderate, or high priority.

The project is best served when the probability scale and the impact scale are predefined prior to qualitative analysis. For example, the probability scale rates the likelihood of an individual risk happening and can be on a linear scale (.1, .3, .5, .7, .9) or the scale can be the ordinal scale. The scale, however, should be defined and agreed upon in the risk management plan. The impact scale, which measures the severity of the risk on the project's objectives, can also be ordinal or cardinal.

The value of identifying and assigning the scales to use prior to the

process of qualitative analysis allows all risks to be ranked by the system and allows for future identified risks to be measured and ranked by the same system. A shift in risk rating methodologies mid-project can cause disagreements in the method of handling the project risks.

A probability-impact matrix multiplies the value for the risk probability by the risk impact for a total risk score. The risk's scores can be cardinal, as seen in Table 11-3, and then preset values can qualify the risk for a risk response. For example, an identified risk in a project is the possibility that the vendor may be late in delivering the hardware. The probability is rated at .9, but the impact of the risk on the project is rated at .10. The risk score is calculated by multiplying the probability times the impact—in this case, resulting in a score of .09.

The scores within the probability-impact matrix can be referenced against the performing organisation's policies for risk reaction. Based on the risk score, the performing organisation can place the risk in differing categories to guide risk reaction. There are three common categories based on risk score:

- **Red condition** High risk; these risk scores are high in impact and probability.
- **Amber condition (also known as yellow condition)** These risks are somewhat high in impact and probability.
- **Green condition** Risks with a green label are generally fairly low in either impact or probability, or both.

Risk Scores						
Probability						
0.9	0.05	0.09	0.18	0.36	0.72	
0.7	0.04	0.07	0.14	0.28	0.56	
0.5	0.03	0.05	0.10	0.20	0.40	
0.3	0.02	0.03	0.06	0.12	0.24	
0.1	0.01	0.01	0.02	0.04	0.08	
	0.05	0.10	0.20	0.40	0.80	
	<b>Impact</b>					

**Table 11-3. The results of a probability impact matrix create a risk score**

### *3. Risk Data Quality Assessment*

One of the toughest parts of qualitative risk analysis is the biased, subjective nature of the process. A project manager and the project team must question the reliability and reality of the data that lead to the ranking of the risks. A qualitative risk analysis requires accurate and unbiased data if it is to be credible.

Analysis of the quality of risk data is a technique to evaluate the degree to which the data about risks is useful for risk management. It involves examining the degree to which the risk is understood and the accuracy, quality, reliability, and integrity of the data about the risk. The use of low-quality risk data may lead to a qualitative risk analysis of little use to the project. If data quality is unacceptable, it may be necessary to gather better data. Often, collection of information about risks is difficult, and consumes time and resources beyond that originally planned.

Data precision ranking takes into consideration the biased nature of the ranking, the accuracy of the data submitted, and the reliability of the nature submitted to examine the risk scores. Data precision ranking is concerned with the following:

- The level of understanding of the project risk
- The available data and information about the identified risk
- The quality of the data and information of the identified risk
- The reliability of the data about the identified risk

### *4. Risk Categorisation*

Risks to the project can be categorised by sources of risk (e.g., using the RBS), the area of the project affected (e.g., using the WBS), or other useful category (e.g., project phase) to determine areas of the project most exposed to the effects of uncertainty. Grouping risks by common root causes can lead to developing effective risk responses.

### 5. Risk Urgency Assessment

Risks requiring near-term responses may be considered more urgent to address. Indicators of priority can include time to effect a risk response, symptoms and warning signs, and the risk rating.

## Qualitative Risk Analysis: Outputs

### 1. Risk Register (Updates)

Qualitative risk analysis happens throughout the project and the risk register is updated with information from the Qualitative Risk Analysis, and the updated risk register is included in the project management plan. As new risks become evident and identified, the project manager should route the risks through the qualitative risk analysis process. The end results of qualitative risk analysis, as shown in the following, are all updated in the risk register:

- Relative ranking or priority list of project risks. The probability and impact matrix can be used to classify risks according to their individual significance. The project manager can then use the prioritised list to focus attention on those items of high significance to the project, where responses can lead to better project outcomes. Risks may be listed by priority separately for cost, time, scope, and quality, since organisations may value one objective over another. A description of the basis for the assessed probability and impact should be included for risks assessed as important to the project.
- Risks grouped by categories. Risk categorisation can reveal common root causes of risk or project areas requiring particular attention. Discovering concentrations of risk may improve the effectiveness of risk responses.
- List of risks requiring response in the near-term. Those risks that require an urgent response and those that can be handled at a later date may be put into different groups.

- List of risks for additional analysis and response. Some risks might warrant more analysis, including Quantitative Risk Analysis, as well as response action.
- Watch lists of low priority risks. Risks that are not assessed as important in the Qualitative Risk Analysis process can be placed on a watch list for continued monitoring.
- Trends in qualitative risk analysis results. As the analysis is repeated, a trend for particular risks may become apparent, and can make risk response or further analysis more or less urgent/important.

## 11.4 Quantitative Risk Analysis

Quantitative risk analysis attempts to numerically assess the probability and impact of the identified risks. Quantitative Risk Analysis is performed on risks that have been prioritised by the Qualitative Risk Analysis process as potentially and substantially impacting the project's competing demands. The *Quantitative Risk Analysis process analyses the effect of those risk events and assigns a numerical rating to those risks*. It also presents a quantitative approach to making decisions in the presence of uncertainty. This process uses techniques such as *Monte Carlo simulation* and *decision- tree analysis* to:

- *Quantify the possible outcomes for the project and their probabilities*
- *Assess the probability of achieving specific project objectives*
- *Identify risks requiring the most attention by quantifying their relative contribution to overall project risk*
- *Identify realistic and achievable cost, schedule, or scope targets, given the project risks*
- *Determine the best project management decision when some conditions or outcomes are uncertain.*

Qualitative risk analysis typically precedes quantitative analysis. All or a portion of the identified risks in qualitative risk analysis can be examined in the quantitative analysis. The performing organisation may have policies on the risk scores in qualitative analysis, which require the risks to advance to the quantitative analysis. The availability of time and budget may also be a factor in the determination of which risks should pass through quantitative analysis. Quantitative analysis is a more time-consuming process, and is therefore also more expensive. In some cases, Quantitative Risk Analysis may not be required to develop effective risk responses.

Availability of time and budget, and the need for qualitative or quantitative statements about risk and impacts, will determine which method (s) to use on any particular project. Quantitative Risk Analysis

should be repeated after Risk Response Planning, as well as part of Risk Monitoring and Control, to determine if the overall project risk has been satisfactorily decreased. Trends can indicate the need for more or less risk management action. It is an input to the Risk Response Planning process.

## **Quantitative Risk Analysis: Inputs**

### *1. Organisational Process Assets*

Information on prior, similar completed projects, studies of similar projects by risk specialists, and risk databases that may be available from industry or proprietary sources.

### *2. Project Scope Statement*

Projects of a common or recurrent type tend to have more well-understood risks. Projects using state-of-the-art or first-of-its-kind technology, and highly complex projects, tend to have more uncertainty. This can be evaluated by examining the project scope statement.

### *3. Risk Management Plan*

Key elements of the risk management plan for Quantitative Risk Analysis include *roles and responsibilities for conducting risk management, budgets, and schedule activities for risk management, risk categories, the RBS, and revised stakeholders' risk tolerances*.

### *4. Risk Register*

Key items from the *risk register* for Quantitative Risk Analysis include the list of identified risks, the *relative ranking or priority list* of project risks, and the risks grouped by categories.

### 5. Project Management Plan

The project management plan includes:

- Project schedule management plan. The project schedule management plan sets the format and establishes criteria for developing and controlling the project schedule.
- Project cost management plan. The project cost management plan sets the format and establishes criteria for planning, structuring, estimating, budgeting, and controlling project costs.

## Quantitative Risk Analysis: Tools and Techniques

### 1. Data Gathering and Representation Techniques

- *Interviewing.*

Interviewing techniques are *used to quantify the probability and impact of risks on project objectives (such as total project cost, total project completion time, etc)*. The information needed depends upon the type of probability distributions that will be used.

For instance, information would be gathered on the *optimistic (best-case), pessimistic (worst-case), and most likely (normal) scenarios* for some commonly used distributions, and *the mean and standard deviation for others*. Examples of three-point estimates for a cost estimate are shown in table 11-4. Documenting the *rationale of the risk ranges* is an important component of the risk interview, because it can provide information *on reliability and credibility of the analysis*.

**Range of Project Cost Estimates**

WBS Element	Low	Most Likely	High
<b>Design</b>	\$4M	\$6M	\$10M
<b>Build</b>	\$16M	\$20M	\$35M
<b>Test</b>	\$11M	\$15M	\$23M
<b>Total Project</b>		\$41M	

**Table 11-4. Range of Project Cost Estimates Collected during the risk interview** (Source: PMBOK Guide 3<sup>rd</sup> Ed)

- *Probability distributions.*

Continuous probability distribution is an examination of the probability of all possibilities within a given range. For each variable, the probability of a risk event, and the corresponding consequence for the event, may vary. In other words, dependent on whether the risk event occurs and how it happens, a reaction to the event may also occur. The distribution of the probabilities and impact include the following as shown in the figure 11-7:

- Uniform
- Normal
- Triangular
- Beta
- Lognormal



**Figure 11-7 shows five sample distributions: normal, triangular, uniform, beta, and lognormal.** (Source: PMP Study Guide, Phillips 2006)

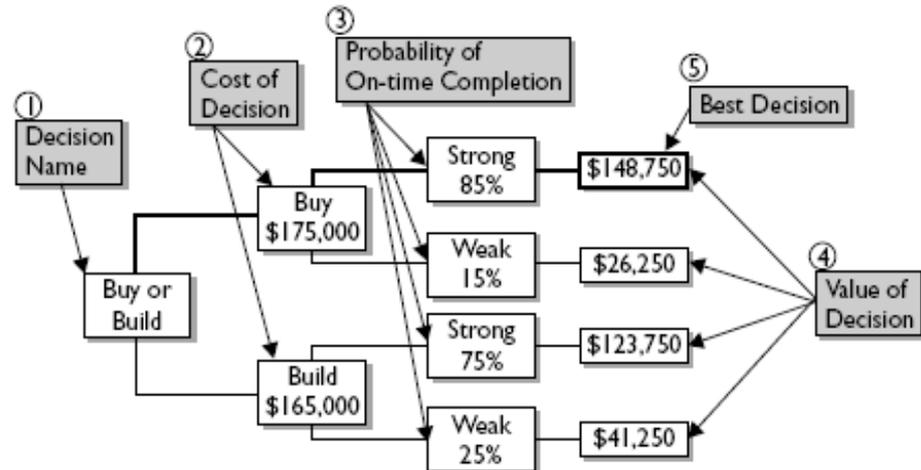
- *Expert judgment.* Subject matter experts internal or external to the organisation, such as engineering or statistical experts, validate data and techniques.

## 2. Quantitative Risk Analysis and Modeling Techniques

Commonly used techniques in Quantitative Risk Analysis include:

- *Sensitivity analysis.* Sensitivity analysis helps to determine *which risks have the most potential impact on the project.* It examines the extent to which the uncertainty of each project element affects the objective being examined when *all other uncertain elements are held at their baseline values.* One typical display of sensitivity analysis is the *tornado diagram*, which is useful for comparing relative importance of variables that have a high degree of uncertainty to those that are more stable.
- *Expected Monetary Value analysis:* Expected Monetary Value (Expected Monetary Value (EMV)) analysis is a *statistical concept* that *calculates the average outcome when the future includes scenarios that may or may not happen (i.e., analysis under uncertainty).* The expected monetary value of a project or event is based on the probability of outcomes that are uncertain. For example, one risk may cost the project an additional \$10,000 if it occurs, but there's only a 20-percent chance of the event occurring. In the simplest form, the expected monetary value of this individual risk impact is thus \$2,000. Project managers can also find the expected monetary value of a decision by creating a decision tree.

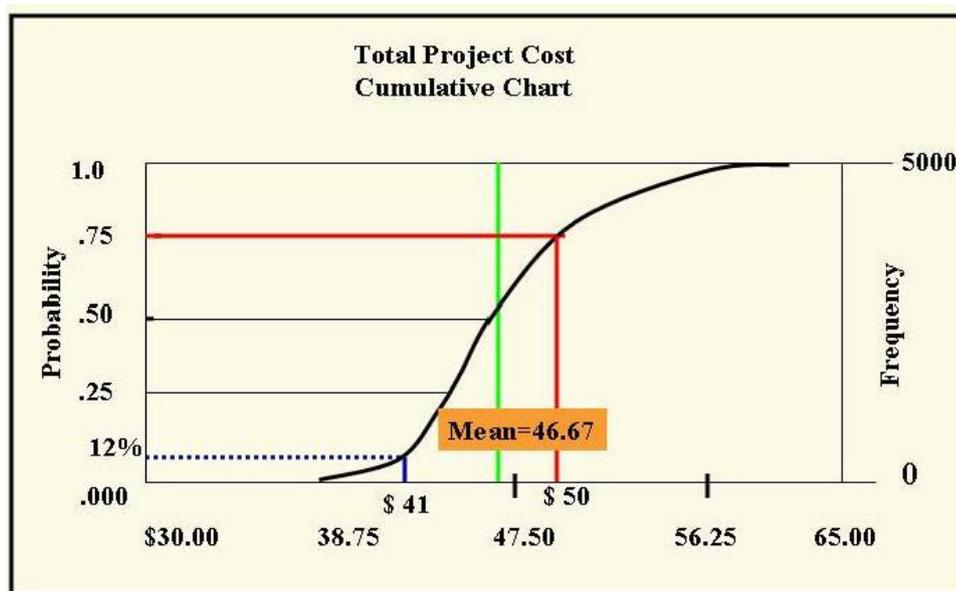
A common use of this type of analysis is in *decision tree analysis*. Modeling and simulation are recommended for use in cost and schedule risk analysis, because they are more powerful and less subject to misuse than Expected Monetary Value (EMV) analysis



**Figure 11-8. Decision trees analyse the probability of events and calculate decision values** (Source: PMP Study Guide, Phillips, 2006)

- Decision tree analysis.* Decision tree analysis is usually structured using a decision tree diagram that describes a situation under consideration, and the implications of each of the available choices and possible scenarios. It incorporates the cost of each available choice, the probabilities of each possible scenario, and the rewards of each alternative logical path. Solving the decision tree provides the Expected Monetary Value (EMV) (or other measure of interest to the organisation) for each alternative, when all the rewards and subsequent decisions are quantified.
- Modeling and simulation.* A project simulation uses a model that translates the uncertainties specified at a detailed level of the project into their potential impact on project objectives. Simulations are typically performed using the *Monte Carlo* technique. In a simulation, the project model is computed many times (iterated), with the input values randomised from a probability distribution function (e.g., cost of project elements or duration of schedule activities) chosen for each iteration from the probability distributions of each variable. A probability distribution (e.g., total cost or completion date) is calculated.

For a *cost risk analysis*, a simulation can use the traditional project WBS or a cost breakdown structure as its model. For a *schedule risk analysis*, the precedence diagramming method (PDM) schedule model is used. A cost risk simulation is shown in Figure 11-9.



**Figure 11-9 Cost Risk Simulation Results** (Source: PMBOK Guide, 3<sup>rd</sup> Ed)

## Quantitative Risk Analysis: Outputs

### .1 Risk Register (Updates)

The risk register is initiated in the Risk Identification process and updated in Qualitative Risk Analysis. It is further updated in Quantitative Risk Analysis. *The risk register is a component of the project management plan.* Updates include the following main components:

- *Probabilistic analysis of the project:* Estimates are made of potential project schedule and cost outcomes, listing the possible completion dates and costs with their associated confidence levels. This output, typically expressed as a cumulative distribution, is used with stakeholder risk tolerances to permit *quantification of the cost and time contingency reserves*. Such contingency reserves are needed to bring the risk of overrunning stated project objectives to a level

acceptable to the organisation. For instance, in Figure 11-9, *the cost contingency to the 75th percentile is \$9, or about 22% versus the \$41 sum of the most likely estimates.*

- *Probability of achieving cost and time objectives:* With the risks facing the project, the probability of achieving project objectives under the current plan can be estimated using quantitative risk analysis results. For instance, in Figure 11-9, *the likelihood of achieving the cost estimate of \$41 (from Table 11-4) is about 12% only.*
- *Prioritised list of quantified risks:* This list of risks includes those that pose the greatest threat or present the greatest opportunity to the project. These include the risks that require the greatest cost contingency and those that are most likely to influence the critical path.
- *Trends in quantitative risk analysis results.* As the analysis is repeated, a trend may become apparent that leads to conclusions affecting risk responses.

## 11.5 Risk Response Planning

Risk Response Planning is the *process of developing options, and determining actions to enhance opportunities and reduce threats to the project's objectives*. It follows the Qualitative Risk Analysis and Quantitative Risk Analysis processes. *It includes the identification and assignment of one or more persons (the "risk response owner") to take responsibility for each agreed-to and funded risk response.*

Risk Response Planning addresses the risks by their priority, inserting resources and activities into the budget, schedule, and project management plan, as needed. *Planned risk responses must be appropriate to the significance of the risk, cost effective in meeting the challenge, timely, realistic within the project context, agreed upon by all parties involved, and owned by a responsible person.* Selecting the best risk response from several options is often required.

The Risk Response Planning section presents commonly used approaches to planning responses to the risks. *Risks include threats and opportunities that can affect project success, and responses are discussed for each.*

### **Risk Response Planning: Inputs**

#### *1. Risk Management Plan*

Important *components of the risk management plan include* roles and responsibilities, risk analysis definitions, risk thresholds for low, moderate, and high risks, and the time and budget required to conduct Project Risk Management.

Outputs from the Risk Management Planning process that are important inputs to Risk Response Planning can include probabilistic analysis of the project, probability of achieving the cost and time objectives, prioritised list of quantified risks, and trends in quantitative risk analysis results.

## 2. Risk Register

The *risk register* is first developed in the Risk Identification process, and is updated during the Qualitative and Quantitative Risk Analysis processes. The Risk Response Planning process may have to refer back to identified risks, root causes of risks, lists of potential responses, risk owners, symptoms, and warning signs in developing risk responses.

Important inputs to Risk Response Planning include the relative rating or priority list of project risks, a list of risks requiring response in the near term, a list of risks for additional analysis and response, trends in qualitative risk analysis results, root causes, risks grouped by categories, and a *watch list of low priority risks*. The risk register is further updated during the Quantitative Risk Analysis process.

### **Risk Response Planning: Tools and Techniques**

Several risk response strategies are available. The strategy or mix of strategies most likely to be effective should be selected for each risk. *Risk analysis tools, such as **decision tree analysis**, can be used to choose the most appropriate responses.* Then, specific actions are developed to implement that strategy. Primary and backup strategies may be selected.

*A fallback plan can be developed for implementation if the selected strategy turns out not to be fully effective, or if an accepted risk occurs. Often, a contingency reserve is allocated for time or cost.* Finally, contingency plans can be developed, along with identification of the conditions that trigger their execution.

#### 1. Strategies for Negative Risks or Threats

Three strategies typically deal with threats or risks that may have negative impacts on project objectives if they occur. These strategies are to *avoid, transfer, or mitigate*:

- *Avoid.* Risk avoidance involves changing the project management plan to eliminate the threat posed by an adverse

risk, to isolate the project objectives from the risk's impact, or to relax the objective that is in jeopardy, such as extending the schedule or reducing scope. Some risks that arise early in the project can be avoided by clarifying requirements, obtaining information, improving communication, or acquiring expertise.

- *Transfer.* Risk transference requires *shifting the negative impact* of a threat, *along with ownership of the response, to a third party. Transferring the risk simply gives another party responsibility for its management; it does not eliminate it.* Transferring liability for risk is *most effective in dealing with financial risk exposure.* Risk transference nearly always *involves payment of a risk premium* to the party taking on the risk. *Transference tools* can be quite diverse and include, but are not limited to, *the use of insurance, performance bonds, warranties, guarantees, etc.* Contracts may be used to transfer liability for specified risks to another party. *In many cases, use of a cost-type contract may transfer the cost risk to the buyer, while a fixed-price contract may transfer risk to the seller, if the project's design is stable.*
- *Mitigate.* Risk mitigation implies a *reduction in the probability and/or impact of an adverse risk event to an acceptable threshold.* Taking early action to reduce the probability and/or impact of a risk occurring on the project is often more effective than trying to repair the damage after the risk has occurred. *Adopting less complex processes, conducting more tests, or choosing a more stable supplier are examples of mitigation actions.* Mitigation may require *prototype development to reduce the risk* of scaling up from a bench-scale model of a process or product. Where it is not possible to reduce probability, a mitigation response might address the risk impact by targeting linkages that determine the severity.

For example, *designing redundancy into a subsystem may reduce the impact from a failure of the original component.*

## 2. Strategies for Positive Risks or Opportunities

Three responses are suggested to deal with risks with potentially positive impacts on project objectives. These strategies are to exploit, share, or enhance.

- *Exploit.* This strategy may be selected for risks with positive impacts where the organisation wishes to ensure that the opportunity is realised. This strategy seeks to eliminate the uncertainty associated with a particular upside risk by making the opportunity definitely happen. Directly exploiting responses include assigning more talented resources to the project to reduce the time to completion, or to provide better quality than originally planned.
- *Share.* Sharing a positive risk involves allocating ownership to a third party who is best able to capture the opportunity for the benefit of the project. Examples of sharing actions include forming risk-sharing partnerships, teams, special-purpose companies, or joint ventures, which can be established with the express purpose of managing opportunities.
- *Enhance.* This strategy modifies the "size" of an opportunity by increasing probability and/or positive impacts, and by identifying and maximising key drivers of these positive-impact risks. Seeking to facilitate or strengthen the cause of the opportunity, and proactively targeting and reinforcing its trigger conditions, might increase probability. Impact drivers can also be targeted, seeking to increase the project's susceptibility to the opportunity.

## 3. Strategy for Both Threats and Opportunities

**Acceptance:** *A strategy that is adopted because it is seldom possible to eliminate all risk from a project.* This strategy indicates that the project

team has decided not to change the project management plan to deal with a risk, or is unable to identify any other suitable response strategy. *It may be adopted for either threats or opportunities.* This strategy can be either passive or active. *Passive acceptance requires no action,* leaving the project team to deal with the threats or opportunities as they occur. The most common *active acceptance strategy is to establish a contingency reserve, including amounts of time, money, or resources* to handle known-unknown threats or opportunities. It is suitable to accept a risk when the risk is balance with the reward of accepting the risk.

#### 4. Contingent Response Strategy

Some responses are designed for use only if certain events occur. For some risks, it is appropriate for the project team to make a response plan that will only be executed under certain predefined conditions, if it is believed that there will be sufficient warning to implement the plan. Events that trigger the contingency response, such as missing intermediate milestones or gaining higher priority with a supplier, should be defined and tracked.

### **Risk Response Planning: Outputs**

#### 1. Risk Register (Updates)

The risk register is developed in Risk Identification, and is updated during Qualitative Risk Analysis and Quantitative Risk Analysis. In the Risk Response Planning process, appropriate responses are chosen, agreed-upon, and included in the risk register. The risk register should be written to a level of detail that corresponds with the priority ranking and the planned response. Often, the high and moderate risks are addressed in detail. Risks judged to be of low priority are included in a "watch list" for periodic monitoring. *Components of the risk register* at this point can include:

- Identified risks, their descriptions, area(s) of the project (e.g., WBS element) affected, their causes (e.g., RBS element), and how they may affect project objectives
- Risk owners and assigned responsibilities
- Outputs from the Qualitative and Quantitative Risk Analysis processes, including prioritised lists of project risks and probabilistic analysis of the project
- Agreed-upon response strategies
- Specific actions to implement the chosen response strategy
- Symptoms and warning signs of risks' occurrence
- Budget and schedule activities required to implement the chosen responses
- Contingency reserves of time and cost designed to provide for stakeholders' risk tolerances
- Contingency plans and triggers that call for their execution
- Fallback plans for use as a reaction to a risk that has occurred, and the primary response proves to be inadequate
- Residual risks that are expected to remain after planned responses have been taken, as well as those that have been deliberately accepted
- Secondary risks that arise as a direct outcome of implementing a risk response
- Contingency reserves that are calculated based on the quantitative analysis of the project and the organisation's risk thresholds.

## *2. Project Management Plan (Updates)*

The project management plan is updated as response activities are added after review and disposition through the Integrated Change Control process. Integrated change control is applied in the Direct and Manage Project Execution process to ensure that agreed-upon actions are implemented and monitored as part of the ongoing project. Risk response

strategies, once agreed to, must be fed back into the appropriate processes in other Knowledge Areas, including the project's budget and schedule.

### *3. Risk-Related Contractual Agreements*

Contractual agreements, such as agreements for insurance, services, and other items as appropriate, can be prepared to specify each party's responsibility for specific risks, should they occur.

## 11.6 Risk Monitoring and Control

Risks must be actively monitored and new risks must be responded to as they are discovered. Risk monitoring and control is the process of monitoring identified risks for signs that they may be occurring, controlling identified risks with the agreed responses, and looking for new risks that may creep into the project. Risk monitoring and control also is concerned with the documentation of the success or failure of risk response plans, and keeping records of metrics that signal risks are occurring, fading, or disappearing from the project.

Risk monitoring and control is an active process that requires participation from the project manager, the project team, key stakeholders, and, in particular, risk owners within the project. As the project progresses, risk conditions may change and require new responses, additional planning, or the implementation of a contingency plan.

There are several goals to risk monitoring and control:

- To confirm risk responses are implemented as planned
- To determine if risk responses are effective or if new responses are needed
- To determine the validity of the project assumptions
- To determine if risk exposure has changed, evolved, or declined due to trends in the project progression
- To monitor risk triggers
- To confirm policies and procedures happen as planned
- To monitor the project for new risks
- To determine the risk associated with approved scope changes

Risk Monitoring and Control can involve choosing alternative strategies, executing a contingency or fallback plan, taking corrective action, and modifying the project management plan. The risk response

owner reports periodically to the project manager on the effectiveness of the plan, any unanticipated effects, and any mid-course correction needed to handle the risk appropriately. Risk Monitoring and Control also includes updating the organisational process assets, including project lessons-learned databases and risk management templates for the benefit of future projects.

## **Risk Monitoring and Control: Inputs**

### *1. Risk Management Plan*

This plan has key inputs that include the assignment of people, including the risk owners, time, and other resources to project risk management.

### *2. Risk Register*

The risk register has key inputs that include identified risks and risk owners, agreed-upon risk responses, specific implementation actions, symptoms and warning signs of risk, residual and secondary risks, a watchlist of low priority risks, and the time and cost contingency reserves.

### *3. Approved Change Requests*

Approved change requests can include modifications such as work methods, contract terms, scope, and schedule. Approved changes can generate risks or changes in identified risks, and those changes need to be analysed for any effects upon the risk register, risk response plan, or risk management plan. All changes should be formally documented. Any verbally discussed, but undocumented, changes should not be processed or implemented.

### *4. Work Performance Information*

Work performance information, including project deliverables' status, corrective actions, and performance reports, are important inputs to Risk

Monitoring and Control.

### *5. Performance Reports*

Performance reports provide information on project work performance, such as an analysis that may influence the risk management processes.

## **Risk Monitoring and Control: Tools and Techniques**

### *1. Risk Reassessment*

Risk Monitoring and Control *often requires identification of new risks and reassessment of risks*, using the processes of this chapter as appropriate. Project risk reassessments should be regularly scheduled. *Project Risk Management should be an agenda item at project team status meetings*. The amount and detail of repetition that is appropriate depends on how the project progresses relative to its objectives. For instance, if a risk emerges that was not anticipated in the risk register or included on the watch list, or if its impact on objectives is different from what was expected, the planned response may not be adequate. It will then be necessary to perform additional response planning to control the risk.

### *2. Risk Audits*

Risk audits examine and document the effectiveness of risk responses in dealing with identified risks and their root causes, as well as the effectiveness of the risk management process.

### *3. Variance and Trend Analysis*

Trends in the project's execution should be reviewed using performance data. Earned value analysis and other methods of project variance and trend analysis may be used for monitoring overall project performance. Outcomes from these analyses may forecast potential deviation of the project at completion from cost and schedule targets.

*Deviation from the baseline plan may indicate the potential impact of threats or opportunities.*

#### *4. Technical Performance Measurement*

Technical performance measurement compares technical accomplishments during project execution to the project management plan's schedule of technical achievement. Deviation, such as demonstrating more or less functionality than planned at a milestone, can help to forecast the degree of success in achieving the project's scope.

#### *5. Reserve Analysis*

Throughout execution of the project, some risks may occur, *with positive or negative impacts on budget or schedule contingency reserves*. Reserve analysis compares the amount of the contingency reserves remaining to the amount of risk remaining at any time in the project, in order to determine if the remaining reserve is adequate.

#### *6. Status Meetings*

*Project risk management can be an agenda item at periodic status meetings*. That item may take no time or a long time, depending on the risks that have been identified, their priority, and difficulty of response. Risk management becomes easier the more often it is practiced, and frequent discussions about risk make talking about risks, particularly threats, easier and more accurate.

### **Risk Monitoring and Control: Outputs**

#### *1. Risk Register (Updates)*

An updated risk register contains:

- Outcomes of risk reassessments, risk audits, and periodic risk reviews. These outcomes may include updates to probability, impact, priority, response plans, ownership, and other elements

of the risk register. Outcomes can also include closing risks that are no longer applicable.

- The actual outcomes of the project's risks, and of risk responses that can help project managers plan for risk throughout the organisation, as well as on future projects. This completes the record of risk management on the project, is an input to the Close Project process and becomes part of the project closure documents.

## *2. Requested Changes*

Implementing contingency plans or workarounds frequently results in a requirement to change the project management plan to respond to risks. Requested changes are prepared and submitted to the Integrated Change Control process as an output of the Risk Monitoring and Control process. Approved change requests are issued and become inputs to the Direct and Manage Project Execution process and to the Risk Monitoring and Control process.

## *3. Recommended Corrective Actions*

Recommended corrective actions *include contingency plans and workaround plans. The workarounds are responses that were not initially planned, but are required to deal with emerging risks that were previously unidentified or accepted passively. Workarounds should be properly documented and included in both the Direct and Manage Project Execution and Monitor and Control Project Work processes.* Recommended corrective actions are inputs to the Integrated Change Control process.

## *4. Recommended Preventive Actions*

Recommended preventive actions are used to bring the project into compliance with the project management plan.

## *5. Organisational Process Assets (Updates)*

The six Project Risk Management processes produce information that

can be used for future projects, and should be captured in the organisational process assets. The templates for the risk management plan, including the probability and impact matrix, and risk register, can be updated at project closure. Risks can be documented and the RBS updated. Lessons learned from the project risk management activities can contribute to the lessons learned knowledge database of the organisation. Data on the actual costs and durations of project activities can be added to the organisation's databases. The final versions of the risk register and the risk management plan templates, checklists, and RBSs are included.

#### *6. Project Management Plan (Updates)*

If the approved change requests have an effect on the risk management processes, then the corresponding component documents of the project management plan are revised and reissued to reflect the approved changes.

## Summary and Self Test

### TWO-MINUTE DRILL

#### Planning for Risk Management

- ❑ Risk management planning is determining how the risk management activities within the project will take place. It is not the response or identification of risks, but the determination of how to manage project risks.
- ❑ Risk management planning is accomplished through planning meetings with the project team, management, customers, and other key stakeholders.
- ❑ A utility function is a person's willingness to accept risks.
- ❑ The output of risk management planning is the risk management plan.

#### Managing Risk

- ❑ Risks are uncertain events that can affect a project's objectives for good or bad.
- ❑ Risks can be placed into four different categories: technical, quality, or performance risks; project management risks; organisational risks; and external risks.
- ❑ Project files from published information and previous projects can serve as input to risk identification.
- ❑ The Delphi Technique allows participants to identify risk anonymously without fear of embarrassment. A survey allows results to be shared with all participants for comments on each other's anonymous input. Rounds of surveying and analysis can create consensus on the major project risks.
- ❑ Triggers are warning signs that a risk is about to happen or has happened.

### **Analysing Identified Risks**

- ❑ Risks are evaluated for their impact and likelihood.
- ❑ Risks can be ranked in an ordinal fashion by using such indicators as very low, low, moderate, high, and very high.
- ❑ Risks can also be analysed using a cardinal ranking system of numerical values that are assigned to each risk based on its impact and probability.
- ❑ An overall project risk ranking can be used to compare the current projects with other projects in the organisation.
- ❑ The risks can be moved into quantitative analysis for further study.
- ❑ Risks are assigned an expected monetary value, such as there is a 50-percent likelihood that the risk will occur, causing a \$10,000 cost.
- ❑ Risks, their impact, status, responses, and updates are all recorded in the risk register.

### **Risk Management Methods**

- ❑ The Monte Carlo simulation can determine the likelihood of the project's success, predict the costs of a specific risk exposure, and identify realistic time, scope, and cost objectives. Interviews with stakeholders and subject-matter experts are an excellent way to begin quantitative risk analysis.
- ❑ Decision trees help determine the cost, benefit, and value of multiple decisions. They are based on the cost of the decision and the probability of completing an objective.

### **Responding to Identified Risks**

- ❑ Risk response planning focuses on reducing threats and increasing opportunities as a result of risks. Risk thresholds, defined in risk management planning, describe the acceptable level of risk within a company.
- ❑ Risk owners are the individuals or groups that are responsible for a

- risk response, and should participate in the risk response planning
- ❑ Risk avoidance changes the project plan to avoid the risk (as well as conditions that promote the risk), or it attempts to reduce the risk's impact on the project's success.
  - ❑ Risk transference moves the risk consequence to a third party. The risk doesn't go away, just the responsibility of the risk. However, ultimately, the performing organisation still retains the ultimate accountability and results of the risk event.
  - ❑ Risk mitigation involves actions designed to reduce the likelihood of a risk occurring, reduce the impact of a risk on the project objectives, or both.
  - ❑ Risk acceptance acknowledges that the risk exists but that it isn't worthy of a more in-depth response, or a more in-depth response isn't available for the risk.
  - ❑ Residual risks are risks that remain after avoidance, transference, mitigation, and acceptance. Secondary risks are new risks that arise from a risk response.
  - ❑ To exploit a risk requires that an organisation implement measures to ensure the positive risk definitely happens.
  - ❑ Sharing a risk assigns ownership of the positive risk to an organisation that is most likely to utilise the positive risks for the benefit of the project.
  - ❑ To enhance a risk requires that the organisation take steps to increase the probability and/or impact of the positive risk.

### **Completing Iterative Risk Management**

- ❑ Identified risks must be tracked, monitored for warning signs, and documented. The responses to the risks are monitored and documented as successful or less successful than expected.
- ❑ Issue logs, action-item lists, jeopardy warnings, and escalation notices are all types of communication reports that the project team

and risk owners must use to document and track identified risks.

- ❑ Risk response audits measure the success of the responses and the effectiveness of the cost, scope, and quality values gained or lost by the risk responses.
- ❑ Earned value analysis can measure project performance, but it can also predict and signal pending risks within the project.
- ❑ As unexpected risks arise, the project team may elect to use workarounds to diminish the impact and probability of those risks. Workarounds, however, should be documented and incorporated into the project plan and risk response plan as they occur.

**SELF TEST**

- 1.** When is it appropriate to accept a project risk?
  - A. It is never appropriate to accept a project risk.
  - B. All risks must be mitigated or transferred.
  - C. It is appropriate to accept a risk if the project team has never completed this type of project work before.
  - D. Only if the risk is in balance with the reward by accepting the project risk.
  
- 2.** Frances is the project manager of the LKJ Project. Which of the following techniques will she use to create the risk management plan?
  - A. Risk tolerance
  - B. Status meetings
  - C. Planning meetings
  - D. Variance meetings
  
- 3.** Which of the following is not part of a risk management plan?
  - A. Roles and responsibilities
  - B. Methodology
  - C. Technical Assessment Board compliance
  - D. Risk categories
  
- 4.** You are the project manager of the GHK Project. You and the manufacturer have agreed to substitute the type of plastic used in the product to a slightly thicker grade should there be more than a seven-percent error in production. The thicker plastic will cost more and require the production to slow down, but the errors should diminish. This is an example of which of the following?
  - A. Threshold
  - B. Tracking
  - C. Budgeting

D. JIT manufacturing

**5.** An organisation's risk tolerance is also known as what?

- A. The utility function
- B. Herzberg's Theory of Motivation
- C. Risk acceptance
- D. The risk-reward ratio

**6.** A risk trigger is also called which of the following?

- A. A warning sign
- B. A delay
- C. A cost increase
- D. An incremental advancement of risk

**7.** The customers of the project have requested additions to the project scope. The project manager brings notice that additional risk planning will need to be added to the project schedule. Why?

- A. The risk planning should always be the same amount of time as the activities required by the scope change.
- B. Risk planning should always occur whenever the scope is adjusted.
- C. Risk planning should only occur at the project manager's discretion.
- D. The project manager is incorrect. Risk planning does not need to happen at every change in the project.

**8.** Which one of the following best describes the risk register?

- A. It documents all of the outcomes of the other risk management processes.
- B. It's a document that contains the initial risk identification entries.
- C. It's a system that tracks all negative risks within a project.
- D. It's part of the project's PMIS for integrated change control

**9.** \_\_\_\_\_ include(s) fire, theft, or injury, and

offer(s) no chance for gain.

- A. Business risks
- B. Pure risks
- C. Risk acceptance
- D. Life risks

**10.** Complete this sentence: A project risk is a(n) \_\_\_\_\_ occurrence that can affect the project for good or bad.

- A. Known
- B. Potential
- C. Uncertain
- D. Known unknown

**11.** When should risk identification happen?

- A. As early as possible in the initiation process
- B. As early as possible in the planning process
- C. Throughout the product management life cycle
- D. Throughout the project life cycle

**12.** You are the project manager of the KLJH Project. This project will last two years and has 30 stakeholders. How often should risk identification take place?

- A. Once at the beginning of the project
- B. Throughout the execution processes
- C. Throughout the project
- D. Once per project phase

**13.** Which one of the following is an acceptable tool for risk identification?

- A. Decision tree analysis
- B. Decomposition of the project scope
- C. The Delphi Technique

D. Pareto charting

**14.** You are the project manager for a project that will create a new and improved web site for your company. Currently, your company has over eight million users around the globe. You would like to poll experts within your organisation with a simple, anonymous form asking about any foreseeable risks in the design, structure, and intent of the web site. With the collected information, subsequent anonymous polls are submitted to the group of experts. This is an example of \_\_\_\_\_.

- A. Risk identification
- B. A trigger
- C. An anonymous trigger
- D. The Delphi Technique

**15.** Which of the following describes SWOT?

- A. An analysis of strengths, weakness, options, and timing
- B. An analysis of strengths, weakness, opportunities, and threats
- C. An elite project team that comes in and fixes project risks and threats
- D. Ratings of 1 to 100

**16.** Which risk analysis provides the project manager with a risk ranking?

- A. Quantifiable
- B. Qualitative
- C. The utility function
- D. SWOT analysis

**17.** A table of risks, their probability, impact, and a number representing the overall risk score is called a \_\_\_\_\_.

- A. Risk table
- B. Probability and impact matrix
- C. Quantitative matrix

## D. Qualitative matrix

**18.** You are presented with the following table:

Risk Event	Probability	Impact Cost/Benefit	Expected Monetary Value (EMV)
1	.20	-4,000	
2	.50	5,000	
3	.45	-300	
4	.22	500	
5	.35	-4,500	

What is the Expected Monetary Value (EMV) for Risk Event 3?

- A. \$135
- B. -\$300
- C. \$45
- D. -\$135

**19.** You are presented with the following table:

Risk Event	Probability	Impact Cost/Benefit	Expected Monetary Value (EMV)
1	.35	-4,000	
2	.40	50,000	
3	.45	-300,000	
4	.30	50,000	
5	.35	-45,000	

Based on the preceding numbers, what is the amount needed for the contingency fund?

- A. Unknown with this information
- B. 249,000
- C. 117,150
- D. 15,750

**20.** The water sanitation project manager has determined the risks

associated with handling certain chemicals are too high. He has decided to allow someone else to complete this portion of the project, and so has outsourced the handling and installation of the chemicals and filter equipment to an experienced contractor. This is an example of which of the following?

- A. Avoidance
- B. Acceptance
- C. Mitigation
- D. Transference

**21.** A project manager and the project team are actively monitoring the pressure gauge on a piece of equipment. Sarah, the engineer, recommends a series of steps to be implemented should the pressure rise above 80 percent. The 80-percent mark represents what?

- A. An upper control limit
- B. The threshold
- C. Mitigation
- D. A workaround

**22.** You are presented with the following table:

Risk Event	Probability	Impact Cost/Benefit	Expected Monetary Value (EMV)
1	.20	-4,000	
2	.50	5,000	
3	.45	-300	
4	.22	500	
5	.35	-4,500	
6			

What are the inputs for Risk 6, based on the following information: Marty is 60-percent certain that he can get the facility needed for \$45,000, which is \$7,000 less than what was planned for?

- A. .60, 45,000, 27,000

- B. .60, 52,000, 31,200
- C. .60, 7,000, 4,200
- D. .60, -7,000, -4,200

**23.** What can a project manager use to determine whether it is better to make or buy a product?

- A. A decision tree analysis
- B. A fishbone model
- C. An Ishikawa diagram
- D. An ROI analysis

**24.** Which of the following can determine multiple scenarios given various risks and the probability of their impact?

- A. Decision trees
- B. Monte Carlo simulations
- C. Pareto charts
- D. Gantt charts

**25.** A project can have many risks with high-risk impact scores, but have an overall low risk score. How is this possible?

- A. The risk scores are graded on a bell curve.
- B. The probability of each risk is low.
- C. The impact of each risk is not accounted for until it comes to fruition.
- D. The risks are rated High/Medium/Low.

## 12 Project Procurement Management

### Introduction

Projects routinely require procurements. They need materials, equipment, consultants, training, and many other goods and services. Project procurement management is the process of purchasing the products necessary for meeting the needs of the project scope. It involves planning, acquiring the products or services from sources, choosing a source, administering the contract, and closing out the contract.

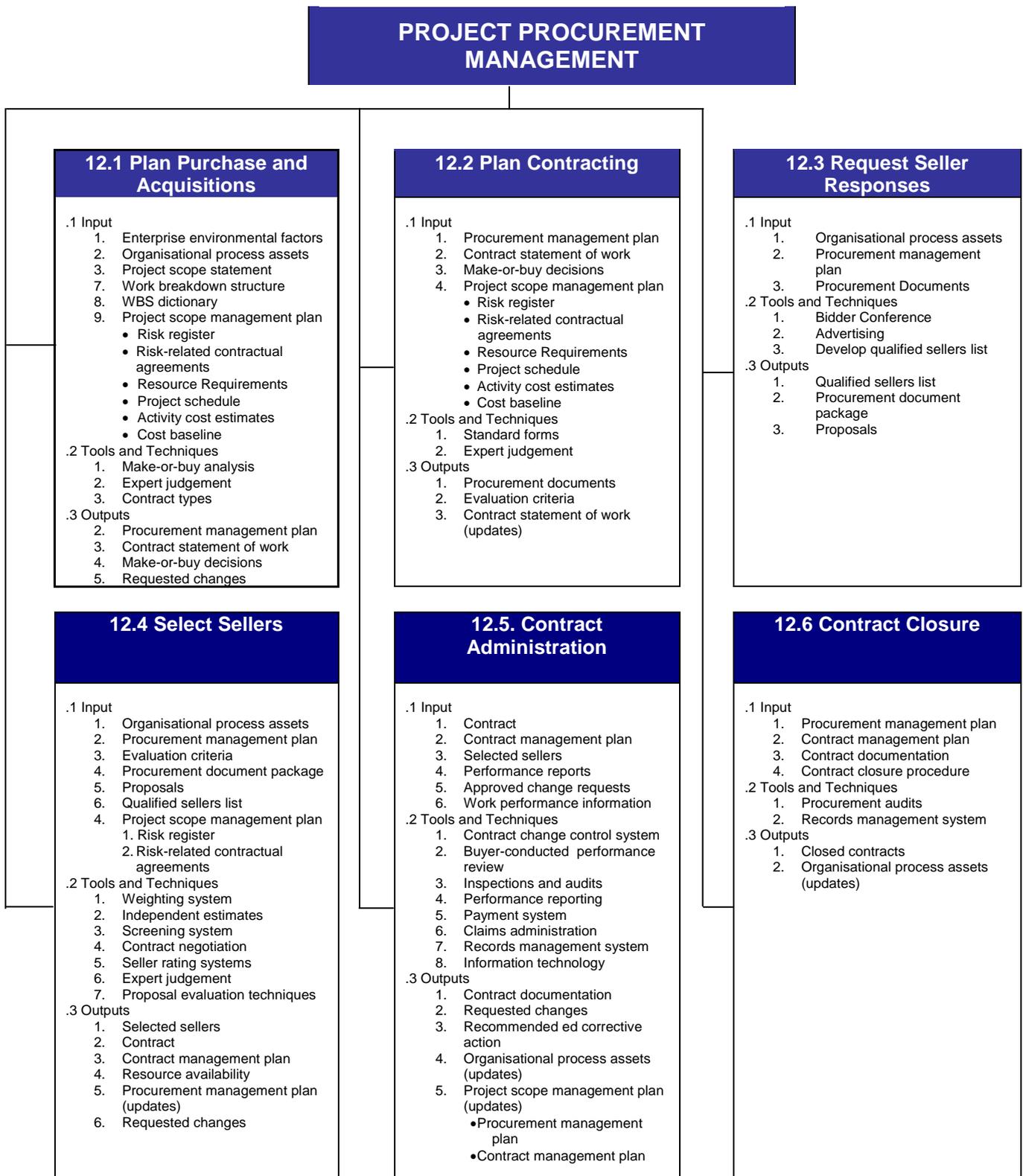
Project Procurement Management includes the processes to purchase or acquire the products, services, or results needed from outside the project team to perform the work. This chapter presents two perspectives of procurement. The organisation can be either the buyer or seller of the product, service, or results under a contract. Project Procurement Management includes the contract management and change control processes required to administer contracts or purchase orders issued by authorised project team members.

Project Procurement Management also includes administering any contract issued by an outside organisation (the buyer) that is acquiring the project from the performing organisation (the seller), and administering contractual obligations placed on the project team by the contract.

The Project Procurement Management processes include the following:

- 1. Plan Purchases and Acquisitions** - determining what to purchase or acquire and determining when and how.
- 2. Plan Contracting** - documenting products, services, and results requirements and identifying potential sellers.
- 3. Request Seller Responses** - obtaining information, quotations, bids, offers, or proposals, as appropriate.
- 4. Select Sellers** - reviewing offers, choosing among potential sellers, and negotiating a written contract with each seller.
- 5. Contract Administration** - managing the contract and relationship between the buyer and seller, reviewing and documenting how a seller is performing or has performed to establish required corrective actions and provide a basis for future relationships with the seller, managing contract-related changes and, when appropriate, managing the contractual relationship with the outside buyer of the project.
- 6. Contract Closure** - completing and settling each contract, including the resolution of any open items, and closing each contract applicable to the project or a project phase.

Table 12-1 provides an overview of the Project Procurement Management processes.



**Table 12-1. Overview of Project Procurement Management Processes**

These processes interact with each other and with the processes in the other Knowledge Areas as well. Each process can involve effort from one or more persons or groups of persons, based on the requirements of

the project. Each process occurs at least once in every project and occurs in one or more project phases, if the project is divided into phases. Although the processes are presented here as discrete components with well-defined interfaces, in practice they overlap and interact in ways not detailed here.

The Project Procurement Management processes involve contracts that are legal documents between a buyer and a seller. A contract is a mutually binding agreement that obligates the seller to provide the specified products, services, or results, and obligates the buyer to provide monetary or other valuable consideration. A contract is a legal relationship subject to remedy in the courts.

The agreement can be simple or complex, and can reflect the simplicity or complexity of the deliverables. A contract includes terms and conditions, and can include other items such as the seller's proposal or marketing literature, and any other documentation that the buyer is relying upon to establish what the seller is to perform or provide. It is the project management team's responsibility to help tailor the contract to the specific needs of the project.

Depending upon the application area, contracts can also be called an agreement, subcontract, or purchase order. Most organisations have documented policies and procedures specifically defining who can sign and administer such agreements on behalf of the organisation. Although all project documents are subject to some form of review and approval, the legally binding nature of a contract usually means that it will be subjected to a more extensive approval process.

In all cases, the primary focus of the review and approval process ensures that the contract language describes products, services, or results that will satisfy the identified project need. In the case of major projects undertaken by public agencies, the review process can include public review of the agreement. The project management team may seek support early from specialists in the disciplines of contracting, purchasing,

and law. Such involvement can be mandated by an organisation's policy.

The various activities involved in the Project Procurement Management processes form the life cycle of a contract. By actively managing the contract life cycle and carefully wording the terms and conditions of the contract, some identifiable project risks can be avoided or mitigated. Entering into a contract for products or services is one method of allocating the responsibility for managing or assuming potential risks.

A complex project can involve managing multiple contracts or subcontracts simultaneously or in sequence. In such cases, each contract life cycle can end during any phase of the project life cycle. Project Procurement Management is discussed within the perspective of the buyer-seller relationship. The buyer-seller relationship can exist at many levels on any one project, and between organisations internal to and external to the acquiring organisation.

Depending on the application area, the seller can be called a contractor, subcontractor, vendor, service provider, or supplier. Depending on the buyer's position in the project acquisition cycle, the buyer can be called a client, customer, prime contractor, contractor, acquiring organisation, governmental agency, service requestor, or purchaser. The seller can be viewed during the contract life cycle first as a bidder, then as the selected source, and then as the contracted supplier or vendor.

The seller will typically manage the work as a project if the acquisition is not just for materiel, goods, or common products. In such cases:

- Buyer becomes the customer, and is thus a key project stakeholder for the seller
- Seller's project management team is concerned with all the processes of project management, not just with those of this Knowledge Area

- Terms and conditions of the contract become key inputs to many of the seller's management processes. The contract can actually contain the inputs (e.g., major deliverables, key milestones, cost objectives), or it can limit the project team's options (e.g., buyer approval of staffing decisions is often required on design projects).

This chapter assumes that the buyer of items for the project is within the project team and that the seller is external to the project team. This relationship is true if the performing organisation is the seller of a project to a customer. This relationship is also true if the performing organisation is the buyer from other vendors or suppliers of products, services, results, or subproject components used on a project. This chapter assumes that a formal contractual relationship is developed and exists between the buyer and the seller. However, most of the discussion in this chapter is equally applicable to non-contractual formal agreements entered into with other units of the project team's organisations.

## 12.1 Plan Purchases and Acquisitions

Procurement planning is the process of identifying which part of the project should be procured from resources outside of the organisation. Generally, procurement decisions are made early on in the planning processes. Procurement planning centres on four elements:

- Whether or not procurement is needed
- What to procure
- How much to procure
- When to procure

The Plan Purchases and Acquisitions process identifies which project needs can best be met by purchasing or acquiring products, services, or results outside the project organisation, and which project needs can be accomplished by the project team during project execution. This process involves consideration of whether, how, what, how much, and when to acquire.

When the project obtains products, services, and results required for project performance from outside the performing organisation, the processes from Plan Purchases and Acquisitions through Contract Closure are performed for each item to be purchased or acquired. The Plan Purchases and Acquisitions process also includes consideration of potential sellers, particularly if the buyer wishes to exercise some degree of influence or control over contracting decisions.

Consideration should also be given to who is responsible for obtaining or holding any relevant permits and professional licenses that may be required by legislation, regulation, or organisational policy in executing the project. The project schedule can significantly influence the Plan Purchases and Acquisitions process. Decisions made in developing the

procurement management plan can also influence the project schedule and are integrated with Schedule Development, Activity Resource Estimating, and make or- buy decisions.

The Plan Purchases and Acquisitions process includes reviewing the risks involved in each make-or-buy decision; it also includes reviewing the type of contract planned to be used with respect to mitigating risks and transferring risks to the seller.

## **Plan Purchases and Acquisitions: Inputs**

### **.1 Enterprise Environmental Factors**

Part of procurement management is to determine what sources are available to provide the needed products or services for the project. An evaluation of the marketplace is needed to determine what products and services are available and from whom and on what terms and conditions they are available.

While in most free market enterprise societies there are multiple vendors offering comparable products, there may be times when choices of vendors are limited. The following are three specific terms to know for the PMP exam that you may encounter.

- **Sole source** Only one qualified seller exists in the marketplace.
- **Single source** The performing organisation prefers to contract with a specific seller.
- **Oligopoly** There are very few sellers and the actions of one seller will have a direct effect on the other seller's prices and the overall market condition.

Enterprise environmental factors that are considered include the conditions of the marketplace and what products, services, and results are available in the marketplace, from whom and under what terms and conditions. If the performing organisation does not have formal

purchasing or contracting groups, then the project team will have to supply both the resources and the expertise to perform project procurement activities.

## **.2 Organisational Process Assets**

Organisational process assets provide the existing formal and informal procurement-related policies, procedures, guidelines, and management systems that are considered in developing the procurement management plan and selecting the contract types to be used. Organisational policies frequently constrain procurement decisions.

These policy constraints can include limiting the use of simple purchase orders and requiring all purchases above a certain value to use a longer form of contract, requiring specific forms of contracts, limiting the ability to make specific make-or-buy decisions, and limiting, or requiring, specific types or sizes of sellers. Organisations in some application areas also have an established multi-tier supplier system of selected and pre-qualified sellers to reduce the number of direct sellers to the organisation and establish an extended supply chain.

## **.3 Project Scope Statement**

The project's scope statement serves as input to making procurement decisions. Because the project scope statement defines the project work, and only the required work, to complete the project, it also defines the limitations of the project. Knowing the limits of what the project includes can help the project manager, the contract specialists, and other procurement professionals determine what needs to be purchased and what does not.

The project scope statement describes the project boundaries, requirements, constraints, and assumptions related to the project scope. Constraints are specific factors that can limit both the buyer's and seller's options. One of the most common constraints for many projects is

availability of funds. Other constraints can involve required delivery dates, available skilled resources, and organisational policies.

Assumptions are factors that will be considered to be true, and which can include items such as the assumed availability of multiple sellers or a sole-source seller. Requirements with contractual and legal implications can include health, safety, security, performance, environmental, insurance, intellectual property rights, equal employment opportunity, licenses, and permits.

The project scope statement provides important information about project needs and strategies that are considered during the Plan Purchases and Acquisitions process. The project scope statement also provides the list of deliverables and acceptance criteria for the project and its products, services, and results.

Consideration is given to all such factors that may need to be included in the procurement documentation and flowed down within a contract to sellers. The product scope description component of the project scope statement provides important information about any technical issues or concerns related to the products, services, and results of the project that are considered during the Plan Purchases and Acquisitions process.

The work breakdown structure (WBS) and WBS dictionary components of the project scope statement provide the structured and detailed plan for the project scope:

#### **.4 Work Breakdown Structure and WBS Dictionary**

The WBS and the WBS dictionary define the specific contracted work, which must support the requirements for acceptance of the project. This information also serves as valuable input to what needs to be procured—

and to what does not. The WBS defines what the end result of the project will be. When dealing with vendors to procure a portion of the project, the work to be procured must support the requirements of the project customer.

A statement of work (SOW) may define the work to be accomplished within the project, but it generally does not define the product description as a whole. However, when an entire project is to be procured from a vendor, the SOW and the product description become one and the same. The Work Breakdown Structure provides the relationship among all the components of the project and the project deliverables.

The WBS dictionary provides detailed statements of work that provide an identification of the deliverables and a description of the work within each WBS component required to produce each deliverable.

## **.6 Project Management Plan**

The project management plan is also needed during the procurement planning processes because it will guide how the project should progress and each subsidiary plan may need to be referenced for procurement guidelines. For example, the cost management plan, the scope management plan, the quality management plan, and the staffing management plan may all be needed for effective procurement planning. One of the biggest things to consider during procurement management is the reliance on the risk response transference. Recall that transference is the assignment of a risk to a third party—typically with a fee involved. Insurance and contractors for dangerous work are two common examples of transference. The risk register will help identify the costs associated with the identified risks and the contractual agreements for transference will be referenced as part of the project costs.

The project management plan provides the overall plan for managing the project and includes subsidiary plans such as a scope management

plan, procurement management plan, quality management plan, and contract management plans, which provide guidance and direction for procurement management planning. To the extent that other planning outputs are available, those other planning outputs are considered during the Plan Purchases and Acquisitions process. Other planning outputs that are often considered include:

- Risk register. Contains risk-related information such as the identified risks, risk owners, and risk responses.
- Risk-related contractual agreements. Includes agreements for insurance, services, and other items as appropriate, that are prepared to specify each party's responsibility for specific risks, should they occur.
- Activity resource requirements.
- Project schedule.
- Activity cost estimates.
- Cost baseline.

## **Plan Purchases and Acquisitions: Tools and Techniques**

### **.1 Make-or-Buy Analysis**

The decision to make or buy a product is a fundamental aspect of management. Under some conditions, it is more cost-effective to buy—while in others it makes more sense to create an in-house solution. The make-or-buy analysis should be made in the initial scope definition to determine if the entire project should be completed in-house or procured. As the project evolves, additional make-or-buy decisions are needed.

The initial costs of the solution for the in-house or procured product must be considered, but so too must the ongoing expenses of the solutions. For example, a company may elect to lease a piece of equipment. The ongoing expenses of leasing the piece of equipment should be weighed against the expected ongoing expenses of purchasing the equipment and the monthly costs to maintain, insure, and manage the

equipment.

The make-or-buy analysis is a general management technique and a part of the project Plan Purchases and Acquisition process that can be used to determine whether a particular product or service can be produced by the project team or can be purchased.

Any project budget constraints are factored in the make-or-buy decisions. If a buy decision is to be made, then a further decision of whether to purchase or rent is also made. The analysis includes both indirect as well as direct costs. For example, the buy-side of the analysis includes both the actual out-of-pocket costs to purchase the product as well as the indirect costs of managing the purchasing process.

In a make-or-buy analysis, if a buy decision is to be made, it also reflects the perspective of the project team's organisation as well as the immediate needs of the project. For example, purchasing an item (anything from a construction crane to a personal computer) rather than renting or leasing it may or may not be cost effective from the perspective of the project.

However, if the project team's organisation has an ongoing need for the item, the portion of the purchase cost allocated to the project could be less than the cost of the rental. The cost allocation could be based upon a margin analysis. The long-range strategy of the project team's organisation is also a component in the make-or-buy analysis.

Items needed for the performance of the project may not be available within the organisation. However, the organisation may anticipate future requirements for those items and the organisation's plans may also be based on making the items in the future. Such considerations can lead to a make decision in spite of the current project constraints and

requirements. When this occurs, the costs charged to the project can be less than the actual costs, with the difference representing the organisation's investment for the future.

There are multiple reasons why an organisation may choose to make or buy. The following are some common examples or reasons for making and buying:

<b>Reasons to Make</b>	<b>Reasons to Buy</b>
Less Costly	Less costly
Use in house skills	In house skills are not available or don't exist
Control of work	Small volume of work
Control of intellectual property	More efficient
Learn new skills	Transfer risks
Available staff	Available vendor
Focus on core project work	Allows project team to focus on other work items

## .2 Expert Judgment

Procurement planning can rely on expert judgment. It may be beneficial to rely on the wisdom of others—those in the performing organisation or subject matter experts—to determine the need for procurement. Expert judgment for procurement management planning can come from the following:

- Units or individuals within the performing organisation
- Consultants and subject matter experts
- Professional, trade, or technical associations
- Industry groups

Expert technical judgment will often be required to assess the inputs to and outputs from this process. Expert purchasing judgment can also be

used to develop or modify the criteria that will be used to evaluate offers or proposals made by sellers.

Expert legal judgment may involve the services of a lawyer to assist with nonstandard procurement terms and conditions. Such judgment and expertise, including business expertise and technical expertise, can be applied to both the technical details of the procured products, services, or results and to various aspects of the procurement management processes.

### .3 Contract Types

There are multiple types of contracts when it comes to procurement. The project work, the market, and the nature of the purchase determine the contract type. The following are some general rules that project managers should know:

- A contract is a formal agreement between the buyer and the seller. Contracts can be oral or written—though written is preferred.
- The United States backs all contracts through the court system.
- Contracts should clearly state all requirements for product acceptance.
- Any changes to the contract must be formally approved, controlled, and documented.
- A contract is not fulfilled until all of the requirements of the contract are met.
- Contracts can be used as a risk mitigation tool, as in transferring the risk. All contracts have some level of risk—depending on the contract type, the risk can be transferred to the seller. If a risk response strategy is to transfer, risks associated with procurement are considered secondary risks and must go through the risk management process.
- There are legal requirements governing contracts. In order for a contract to be valid, it must:

- Contain an offer
- Have been accepted
- Provide for a consideration (payment)
- Be for a legal purpose
- Be executed by someone with capacity and authority
- The terms and conditions of the contract should define breaches, copyrights, intellectual rights, and force majeure.

Different types of contracts are more or less appropriate for different types of purchases. The type of contract used and the specific contract terms and conditions set the degree of risk being assumed by both the buyer and seller. Contracts generally fall into one of three broad categories:

- **Fixed-price or lump-sum contracts.** This category of contract involves a fixed total price for a well-defined product. Fixed-price contracts can also include incentives for meeting or exceeding selected project objectives, such as schedule targets. The simplest form of a fixed-price contract is a purchase order for a specified item to be delivered by a specified date for a specified price. The fixed price contract has the least risk to the buyer.
- **Cost-reimbursable contracts.** This category of contract involves payment (reimbursement) to the seller for seller's actual costs, plus a fee typically representing seller profit. Costs are usually classified as direct costs or indirect costs. Direct costs are costs incurred for the exclusive benefit of the project (e.g., salaries of full-time project staff).

Indirect costs, also called overhead and general and administrative costs, are costs allocated to the project by the project team as a cost of doing business (e.g., salaries of management indirectly involved in the project, cost of electric utilities for the office). Indirect costs are usually calculated as a percentage of direct costs. Cost-reimbursable contracts often

include incentive clauses where if the seller meets or exceeds selected project objectives, such as schedule targets or total cost, then the seller receives an incentive or bonus payment. Three common types of cost-reimbursable contracts are CPF, CPFF, and CPIF.

**a. Cost-Plus-Fee (CPF) or Cost-Plus-Percentage of Cost (CPPC).** Seller is reimbursed for allowable costs for performing the contract work and receives a fee calculated as an agreed-upon percentage of the costs. The fee varies with the actual cost.

**b. Cost-Plus-Fixed-Fee (CPFF).** Seller is reimbursed for allowable costs for performing the contract work and receives a fixed fee payment calculated as a percentage of the estimated project costs. The fixed fee does not vary with actual costs unless the project scope changes.

**c. Cost-Plus-Incentive-Fee (CPIF).** Seller is reimbursed for allowable costs for performing the contract work and receives a predetermined fee, an incentive bonus, based upon achieving certain performance objective levels set in the contract. In some CPIF contracts, if the final costs are less than the expected costs, then both the buyer and seller benefit from the cost savings based upon a pre-negotiated sharing formula.

- **Time and Material (T&M)** contracts. Typically T&M contracts consist of an hourly rate times material costs. T&M contracts are a hybrid type of contractual arrangement that contains aspects of both cost-reimbursable and fixed-price type arrangements. These types of contracts resemble cost reimbursable type arrangements in that they are open ended. The full value of the agreement and the exact quantity of items to be delivered are not defined by the buyer at the time of the contract award. Thus, T&M contracts can grow in contract value as if they were cost-reimbursable type

arrangements. Conversely, T&M arrangements can also resemble fixed-price arrangements. For example, unit rates can be preset by the buyer and seller when both parties agree on the rates for a specific resource category. T&M are often charged as a hourly rate and all material costs.

The requirements (e.g., standard or custom product version, performance reporting, cost data submittals) that a buyer imposes on a seller, along with other planning considerations such as the degree of market competition and degree of risk, will also determine which type of contract will be used. In addition, the seller can consider some of those specific requirements as items that have additional costs.

Another consideration relates to the future potential purchase of the product or service being acquired by the project team. Where such potential can be significant, sellers may be inclined or induced to charge prices that are less than would be the case without such future sale potential. While this can reduce the costs to the project, there are legal ramifications if the buyer promises such potential and it is not, in fact, realised.

### **Plan Purchases and Acquisitions: Outputs**

Procurement planning is a process that should happen early in the planning processes. The outputs of procurement planning allow the project manager and the project team to proceed with confidence in the procuring of products and services needed to successfully complete the project. If it is determined early in the project that there isn't a need for procurements, then obviously the balance of the procurement processes is not necessary for the project.

#### **.1 Procurement Management Plan**

The procurement management plan describes how the procurement

processes will be managed from developing procurement documentation through contract closure. The procurement management plan can include:

- Types of contracts to be used
- Who will prepare independent estimates and if they are needed as evaluation criteria
- Those actions the project management team can take on its own, if the performing organisation has a procurement, contracting, or purchasing department
- Standardised procurement documents, if they are needed
- Managing multiple providers
- Coordinating procurement with other project aspects, such as scheduling and performance reporting
- Constraints and assumptions that could affect planned purchases and acquisitions
- Handling the lead times required to purchase or acquire items from sellers and coordinating them with the project schedule development
- Handling the make-or-buy decisions and linking them into the Activity Resource Estimating and Schedule Development processes
- Setting the scheduled dates in each contract for the contract deliverables and coordinating with the schedule development and control processes
- Identifying performance bonds or insurance contracts to mitigate some forms of project risk
- Establishing the direction to be provided to the sellers on developing and maintaining a contract work breakdown structure
- Establishing the form and format to be used for the contract statement of work
- Identifying pre-qualified selected sellers, if any, to be used
- Procurement metrics to be used to manage contracts and evaluate sellers.

A procurement management plan can be formal or informal, can be

highly detailed or broadly framed, and is based upon the needs of the project. The procurement management plan is a subsidiary component of the project management plan.

## **.2 Contract Statement of Work**

In the contract statement of work (SOW), the seller fully describes the work to be completed and/or the product to be supplied. The contract SOW becomes part of the contract between the buyer and the seller. The contract SOW is typically created as part of the procurement planning process, and allows the seller to determine if it can meet the written requirements of the SOW.

Each contract statement of work defines, for those items being purchased or acquired, just the portion of the project scope that is included within the related contract. The statement of work (SOW) for each contract is developed from the project scope statement, the project work breakdown structure (WBS), and WBS dictionary. The contract SOW describes the procurement item in sufficient detail to allow prospective sellers to determine if they are capable of providing the item.

Sufficient detail can vary, based on the nature of the item, the needs of the buyer, or the expected contract form. A contract SOW describes the products, services, or results to be supplied by the seller. Information included in a contract SOW can include specifications, quantity desired, quality levels, performance data, period of performance, work location, and other requirements. The contract SOW is written to be clear, complete, and concise.

It includes a description of any collateral services required, such as performance reporting or post-project operational support for the procured item. In some application areas, there are specific content and format requirements for a contract SOW. Each individual procurement

item requires a contract SOW. However, multiple products or services can be grouped as one procurement item within a single contract SOW.

The contract SOW can be revised and refined as required as it moves through the procurement process until incorporated into a signed contract. For example, a prospective seller can suggest a more efficient approach or a less costly product than that originally specified.

### **.3 Make-or-Buy Decisions**

The documented decisions of what project products, services, or results will be either be acquired or will be developed by the project team. This may include decisions to buy insurance policies or performance bonds contracts to address some of the identified risks. The make-or-buy decisions document can be as simple as a listing that includes a short justification for the decision. These decisions can be iterative as subsequent procurement activities indicate a need for a different approach.

### **.4 Requested Changes**

Requested changes to the project management plan and its subsidiary plans and other components may result from the Plan Purchases and Acquisition process. Requested changes are processed for review and disposition through the Integrated Change Control process.

## 12.2 Plan Contracting

Contracting planning is the process of preparing to acquire sellers to provide products that the project needs. It's a pretty straightforward business. The Plan Contracting process prepares the documents needed to support the Request Seller Responses process and Select Sellers process.

### Plan Contracting: Inputs

**.1 Procurement Management Plan:** This subsidiary plan sets out the methodologies and expectations of procurement within the performing organisation.

**.2 Contract Statement of Work:** The contract SOW provides detailed information on what the seller will be providing for the performing organisation. Recall that this document allows the seller to determine if it can provide the product and meet the requirements of the project team.

**.3 Make-or-Buy Decisions:** The make-or-buy decisions are documented in the issued list of items to be purchased or acquired and those items to be produced by the project team.

**.4 Project Management Plan:** The project management plan provides other planning output documents, which may have been modified and may need to be reviewed again as part of the procurement documentation development. In particular, development of procurement documentation is closely aligned with scheduled delivery dates in the project schedule.

- Risk register. Contains risk-related information such as the identified risks, root causes of risks, risk owners, risk analyses results, risk prioritisation, risk categorisation, and risk responses generated by the risk management processes.

- Risk-related contractual agreements. Includes agreements for insurance, services, and other items as appropriate that are prepared to specify each party's responsibility for specific risks, should they occur.
- Activity resource requirements.
- Project schedule.
- Activity cost estimates.
- Cost baseline.

## **Plan Contracting: Tools and Techniques**

### **.1 Standard Forms**

Standard forms include standard contracts, standard descriptions of procurement items, non-disclosure agreements, proposal evaluation criteria checklists, or standardised versions of all parts of the needed bid documents. Organisations that perform substantial amounts of procurement can have many of these documents standardised. Buyer and seller organisations performing intellectual property transactions ensure that non-disclosure agreements are approved and accepted before disclosing any project specific intellectual property information to the other party.

### **.2 Expert Judgment**

Expert technical judgment will often be required to assess the inputs to and outputs from this process. Expert purchasing judgment can also be used to develop or modify the criteria that will be used to evaluate offers or proposals made by sellers.

Expert legal judgment may involve the services of a lawyer to assist with nonstandard procurement terms and conditions. Such judgment and expertise, including business expertise and technical expertise, can be applied to both the technical details of the procured products, services, or

results and to various aspects of the procurement management processes.

## **Plan Contracting: Outputs**

### **.1 Procurement Documents**

One of the primary outputs of contracting planning are the procurement documents. These documents guide the relationship between the buyer and seller. Communication between the buyer and the seller should always be specific as to the requirements and expectations of the seller. In initial communications, especially when requesting a price or proposal, the buyer should include the SOW, relevant specifications, and, if necessary, any non-disclosure agreements (NDA). Requests from buyers to sellers should be specific enough to give the seller a clear idea of what the buyer is requesting, but general enough to allow the seller to provide viable alternatives.

Procurement documents are used to seek proposals from prospective sellers. A term such as bid, tender, or quotation is generally used when the seller selection decision will be based on price (as when buying commercial or standard items), while a term such as proposal is generally used when other considerations, such as technical skills or technical approach, are paramount. However, the terms are often used interchangeably and care is taken not to make unwarranted assumptions about the implications of the term used.

Common names for different types of procurement documents include invitation for bid, request for proposal, request for quotation, tender notice, invitation for negotiation, and contractor initial response. The buyer structures procurement documents to facilitate an accurate and complete response from each prospective seller and to facilitate easy evaluation of the bids.

These documents include a description of the desired form of the response, the relevant contract statement of work and any required contractual provisions (e.g., a copy of a model contract, non-disclosure provisions). With government contracting, some or all of the content and structure of procurement documents can be defined by regulation. The complexity and level of detail of the procurement documents should be consistent with the value of, and risk associated with, the planned purchase or acquisition.

Procurement documents are rigorous enough to ensure consistent, comparable responses, but flexible enough to allow consideration of seller suggestions for better ways to satisfy the requirements. Inviting the sellers to submit a proposal that is wholly responsive to the request for bid and to provide a proposed alternative solution in a separate proposal can do this.

Issuing a request to potential sellers to submit a proposal or bid is done formally in accordance with the policies of the buyer's organisation, which can include publication of the request in public newspapers, in magazines, in public registries, or on the Internet. The following are some specific terms the project manager should be familiar with:

<b>Document</b>	<b>Purpose</b>
Bid	From seller to buyer. Price is the determining factor in the decision-making process
Quotation	From seller to buyer. Price is the determining factor in the decision-making process
Proposal	From seller to buyer. Other factors such as skills sets, reputation, ideas for the project solution – may be used in the decision-making process.
Invitation for	From buyer to seller. Requests the seller to provide a

Bid (IFB)	Price for the procured solution or product.
Request for quote (RFQ)	From buyer to seller. Requests the seller to provide a price for the procured solution or product.
Request for proposal (RFP)	From buyer to seller. Requests the seller to provide a proposal to complete the procured work or to provide the procured product.

## .2 Evaluation Criteria

Evaluation criteria are developed and used to rate or score proposals. They can be objective (e.g., "The proposed project manager needs to be a certified Project Management Professional, PMP®") or subjective (e.g., "The proposed project manager needs to have documented previous experience with similar projects"). Evaluation criteria are often included as part of the procurement documents. Evaluation criteria can be limited to purchase price if the procurement item is readily available from a number of acceptable sellers. Purchase price in this context includes both the cost of the item and ancillary expenses such as delivery. Other selection criteria can be identified and documented to support an assessment for a more complex product or service. For example:

- Understanding of need. How well does the seller's proposal address the contract statement of work?
- Overall or life-cycle cost. Will the selected seller produce the lowest total cost (purchase cost plus operating cost)?
- Technical capability. Does the seller have, or can the seller be reasonably expected to acquire, the technical skills and knowledge needed?
- Management approach. Does the seller have, or can the seller be reasonably expected to develop, management processes and procedures to ensure a successful project?
- Technical approach. Do the seller's proposed technical methodologies, techniques, solutions, and services meet the

procurement documentation requirements or are they likely to provide more than the expected results?

- Financial capacity. Does the seller have, or can the seller reasonably be expected to obtain, the necessary financial resources?
- Production capacity and interest. Does the seller have the capacity and interest to meet potential future requirements?
- Business size and type. Does the seller's enterprise meet a specific type or size of business, such as small business, women-owned, or disadvantaged small business, as defined by the buyer or established by governmental agency and set as a condition of being award a contract?
- References. Can the seller provide references from prior customers verifying the seller's work experience and compliance with contractual requirements?
- Intellectual property rights. Does the seller assert intellectual property rights in the work processes or services they will use or in the products they will produce for the project?
- Proprietary rights. Does the seller assert proprietary rights in the work processes or services they will use or in the products they will produce for the project?

### **.3 Contract Statement of Work (Updates)**

Modifications to one or more contract statements of work can be identified during procurement documentation development.

## **12.3 Request Seller Responses**

The Request Seller Responses process obtains responses, such as bids and proposals, from prospective sellers on how project requirements can be met. The prospective sellers, normally at no direct cost to the project or buyer, expend most of the actual effort in this process.

### **Request Seller Responses: Inputs**

#### **.1 Organisational Process Assets**

Some organisations, as part of their organisational process assets, maintain lists or files with information on prospective and previously qualified sellers, sometimes called bidders, who can be asked to bid, propose, or quote on work. These lists will generally have information on relevant past experience and other characteristics of the prospective sellers. Some organisations maintain preferred sellers lists that include only sellers already selected through some qualification methodology.

#### **.2 Procurement Management Plan**

*Please see previous section*

#### **.3 Procurement Documents**

*Please see previous section*

### **Request Seller Responses: Tools and Techniques**

#### **.1 Bidder Conferences**

Bidder conferences (also called contractor conferences, vendor conferences, and pre-bid conferences) are meetings with prospective sellers prior to preparation of a bid or proposal. They are used to ensure that all prospective sellers have a clear, common understanding of the procurement (e.g., technical requirements and contract requirements).

Responses to questions can be incorporated into the procurement documents as amendments. All potential sellers are given equal standing during this initial buyer and seller interaction to produce the best bid. Bidder conferences allow sellers to query the buyer on the details of the product to help ensure that the seller's proposal is adequate and appropriate for the proposed agreement. At this point of the process, all sellers are considered equal.

## **.2 Advertising**

In most circumstances, advertisements inviting bidders are expected. These advertisements can run in newspapers or trade journals specific to the industry of the organisation. Some government agencies require advertisements inviting sellers to acquire the project work, attend a bidder conference, or present a proposal for the described work. Existing lists of potential sellers can often be expanded by placing advertisements in general circulation publications such as newspapers or in specialty publications such as professional journals. Some government jurisdictions require public advertising of certain types of procurement items; most government jurisdictions require public advertising of pending government contracts.

## **.3 Develop Qualified Sellers List**

Many organisations use a qualified sellers list to guide their procurement decisions. The project team may elect to create their own qualified sellers list, use the organisation's list, or rely on a third-party qualified sellers list through the Internet or other third-party resources. Qualified sellers lists can be developed from the organisational assets if such lists or information are readily available. Whether or not that data is available, the project team can also develop its own sources. General information is widely available through the Internet, library directories, relevant local associations, trade catalogs, and similar sources. Detailed information on specific sources can require more extensive effort, such as

site visits or contact with previous customers. Procurement documents can also be sent to determine if some or all of the prospective sellers have an interest in becoming a qualified potential seller.

## **Request Seller Responses: Outputs**

### **.1 Qualified Sellers List**

The qualified sellers list are those sellers who are asked to submit a proposal or quotation.

### **.2 Procurement Document Package**

The procurement document package is a buyer-prepared formal request sent to each seller and is the basis upon which a seller prepares a bid for the requested products, services, or results that are defined and described in the procurement documentation.

### **.3 Proposals**

Proposals are seller-prepared documents that describe the seller's ability and willingness to provide the requested products, services, or results described in the procurement documentation. Proposals are prepared in accordance with the requirements of the relevant procurement documents and reflect the application of applicable contract principles.

The seller's proposal constitutes a formal and legal offer in response to a buyer's request. After a proposal is formally submitted, the buyer sometimes requests the seller to supplement its proposals with an oral presentation. The oral presentation is meant to provide additional information with respect to the seller's proposed staff, management proposal, and technical proposal, which can be used by the buyer in evaluating the seller's proposal.

## 12.4 Select Sellers

Once the sellers have presented their proposals, bids, or quotes (depending on what the buyer requested of them), their documents are examined so that the project manager can select which sellers are the best choice for the project work. In many instances, price may be the predominant factor for choosing a particular seller—but not always. The Select Sellers process receives bids or proposals and applies evaluation criteria, as applicable, to select one or more sellers who are both qualified and acceptable as a seller. Many factors such as the following can be evaluated in the seller selection decision process:

- Price or cost can be the primary determinant for an off-the-shelf item, but the lowest proposed price may not be the lowest cost if the seller proves unable to deliver the products, services, or results in a timely manner.
- Proposals are often separated into technical (approach) and commercial (price) sections, with each evaluated separately. Sometimes, management sections are required as part of the proposal and also have to be evaluated.
- Multiple sources could be required for critical products, services, and results to mitigate risks that can be associated with issues such as delivery schedules and quality requirements. The potentially higher cost associated with such multiple sellers, including any loss of possible quantity discounts, and replacement and maintenance issues, are considered. The tools and techniques described here can be used alone or in combination to select sellers. For example, a weighting system can be used to:
  - Select a single seller that will be asked to sign a standard contract.
  - Establish a negotiating sequence by ranking all proposals by the weighed evaluation scores assigned to each proposal.

On major procurement items, the overall process of requesting

responses from sellers and evaluating sellers' responses can be repeated. A short list of qualified sellers can be established based on a preliminary proposal. A more detailed evaluation can then be conducted based on a more detailed and comprehensive proposal that is requested from the sellers on the short list.

## **Select Sellers: Inputs**

### **.1 Organisational Process Assets**

The organisational process assets of the organisations involved in project procurement typically have formal policies that affect the evaluation of proposals.

### **.2 Procurement Management Plan**

*Please see previous section*

### **.3 Evaluation Criteria**

Evaluation criteria can include samples of the supplier's previously produced products, services, or results for the purpose of providing a way to evaluate the supplier's capabilities and quality of products. Evaluation criteria also can include a review of the supplier's history with the contracting organisation and others.

### **.4 Procurement Document Package**

*Please see previous section*

### **.5 Proposals**

Seller proposals prepared in response to a procurement document package form the basic set of information that will be used by an evaluation body to select one or more successful bidders (sellers).

## **.6 Qualified Sellers List**

*Please see previous section*

## **.7 Project Management Plan**

The project management plan provides the overall plan for managing the project and includes subsidiary plans and other components. To the extent that other component documents are available, they are considered during the Select Sellers process. Other documents that are often considered include:

- Risk register.
- Risk-related contractual agreements.

## **Select Sellers: Tools and Techniques**

For the performing organisation to finalise the process of seller selection, there must first be eligible sellers. Assuming there is more than one seller that can satisfy the demands of the project, there are some tools and techniques the project manager can rely on:

### **.1 Weighting System**

A weighting system takes out the personal preferences of the decision-maker in the organisation to ensure that the best seller is awarded the contract. Weights are assigned to the values of the proposals and each proposal is scored. Because the weights are determined before reviewing the proposals, the process is guaranteed to be free of personal preferences and bias. The seller with the highest score is awarded the contract. A weighting system is a method for quantifying qualitative data to minimise the effect of personal prejudice on seller selection. Most such systems involve assigning a numerical weight to each of the evaluation criteria, rating the prospective sellers on each criterion, multiplying the weight by the rating, and totaling the resultant products to compute an overall score.

## **.2 Independent Estimates**

These estimates are often referred to as “should cost” estimates. They are created by the performing organisation, or outside experts, to predict what the cost of the procured product should be. If there is a significant difference between what the organisation has predicted and what the sellers have proposed, either the statement of work was inadequate or the sellers misunderstood the requirements. For many procurement items, the procuring organisation can either prepare its own independent estimates or have prepared an independent estimate of the costs as a check on proposed pricing. This independent estimate is sometimes referred to as a “should-cost” estimate. Significant differences from these cost estimates can be an indication that the contract statement of work was not adequate, that the prospective seller either misunderstood or failed to respond fully to the contract statement of work, or that the marketplace changed.

## **.3 Screening System**

A screening system is a method to remove sellers from consideration if they do not meet given conditions. For example, screening could require that sellers must be certified by a specific organisation, have prior experience with the project technology, or meet other values. Sellers that don’t meet the requirements are removed from the selection process and their proposals are not considered. A screening system involves establishing minimum requirements of performance for one or more of the evaluation criteria, and can employ a weighting system and independent estimates. For example, a prospective seller might be required to propose a project manager who has specific qualifications before the remainder of the proposal would be considered. These screening systems are used to provide a weighted ranking from best to worst for all sellers who submitted a proposal.

#### **.4 Contract Negotiation**

Contract negotiation clarifies the structure and requirements of the contract so that mutual agreement can be reached prior to signing the contract. Final contract language reflects all agreements reached. Subjects covered include responsibilities and authorities, applicable terms and law, technical and business management approaches, proprietary rights, contract financing, technical solution, overall schedule, payments, and price.

Contract negotiations conclude with a document that can be signed by both buyer and seller, that is, the contract. The final contract can be a revised offer by the seller or a counter offer by the buyer. For complex procurement items, contract negotiation can be an independent process with inputs (e.g., an issues or open items list) and outputs (e.g., documented decisions) of its own. For simple procurement items, the terms and conditions of the contract can be fixed and non-negotiable, and only need to be accepted by the seller.

The project manager may not be the lead negotiator on the contract. The project manager and other members of the project management team may be present during negotiations to provide, if needed, any clarification of the project's technical, quality, and management requirements.

#### **.5 Seller Rating Systems**

Seller rating systems are developed by many organisations and use information such as the seller's past performance, quality ratings, delivery performance, and contractual compliance. The seller performance evaluation documentation generated during the Contract Administration process for previous sellers is one source of relevant information. These rating systems are used in addition to the proposal evaluations screening system to select sellers.

## **.6 Expert Judgment**

Expert judgment is used in evaluating seller proposals. The evaluation of proposals is accomplished by a multi-discipline review team with expertise in each of the areas covered by the procurement documents and proposed contract. This can include expertise from functional disciplines, such as contracts, legal, finance, accounting, engineering, design, research, development, sales, and manufacturing.

## **.7 Proposal Evaluation Techniques**

Many different techniques can be used to rate and score proposals, but all will use some expert judgment and some form of evaluation criteria. The evaluation criteria can involve both objective and subjective components. Evaluation criteria, when used for a formalised proposal evaluation, are usually assigned predefined weightings with respect to each other.

The proposal evaluation then uses inputs from multiple reviewers that are obtained during the Select Sellers process, and any significant differences in scoring are resolved. An overall assessment and comparison of all proposals can then be developed using a weighting system that determines the total weighted score for each proposal. These proposal evaluation techniques also can employ a screening system and use data from a seller rating system.

## **Select Sellers: Outputs**

### **.1 Selected Sellers**

The sellers selected are those sellers who have been judged to be in a competitive range based upon the outcome of the proposal or bid evaluation, and who have negotiated a draft contract, which will be the actual contract when an award is made.

## .2 Contract

The one output of seller selection is a contract between the buyer and the seller. A contract is a legally binding agreement between the buyer and seller in which the seller provides the described product and the seller pays for the product. Contracts are known by many names:

- Agreement
- Subcontract
- Purchase order
- Memorandum of understanding

A contract is awarded to each selected seller. The contract can be in the form of a complex document or a simple purchase order. Regardless of the document's complexity, a contract is a mutually binding legal agreement that obligates the seller to provide the specified products, services, or results, and obligates the buyer to pay the seller.

A contract is a legal relationship subject to remedy in the courts. The major components in a contract document generally include, but are not limited to, section headings, statement of work, schedule, period of performance, roles and responsibilities, pricing and payment, inflation adjustments, acceptance criteria, warranty, product support, limitation of liability, fees, penalties, incentives, insurance, performance bonds, subcontractor approval, change request handling, and a termination and disputes resolution mechanism. Liquidated damages are damages whose amount the parties designate during the formation of a contract for the injured party to collect as compensation upon a specific breach (e.g., late performance). Damages are awarded based on who caused the delay and why (e.g. damages can not be enforced on the supplier where delivery is late due to delays on the customer side).

## .3 Contract Management Plan

For significant purchases or acquisitions, a plan to administer the contract is prepared based upon the specific buyer-specified items within

the contract such as documentation, and delivery and performance requirements that the buyer and seller must meet. The plan covers the contract administration activities throughout the life of the contract. Each contract management plan is a subset of the project management plan.

#### **.4 Resource Availability**

The quantity and availability of resources and those dates on which each specific resource can be active or idle are documented.

#### **.5 Procurement Management Plan (Updates)**

The procurement management plan is updated to reflect any approved change requests that affect procurement management.

#### **.6 Requested Changes**

Requested changes to the project management plan and its subsidiary plans and other components, such as the project schedule and procurement management plan, may result from the Select Sellers process. Requested changes are processed for review and disposition through the Integrated Change Control process.

## 12.5 Contract Administration

Contract administration is the process of ensuring that the seller lives up to the agreements in the contract. The project manager and the contract administrator must work together to make certain the seller meets its obligations. If the seller does not fulfill its contractual requirements, then legal remedies may ultimately be pursued. Another aspect of contract administration, especially on larger projects with multiple sellers providing various products, is the coordination between the contractors. The project manager or contract officer schedules and confirms the performance of the sellers so that the deliverables, schedule, and performance of a contractor do not infringe or adversely affect the performance of another contractor.

The contract must also include the terms of payment. Typically, the performance and progress of the contractor is directly linked to payments it receives. The project manager must track performance and quality to approve or decline payment as needed. The contract should define the metrics for acceptance to avoid disagreements on performance. Both the buyer and the seller administer the contract for similar purposes. Each party ensures that both it and the other party meet their contractual obligations and that their own legal rights are protected. The Contract Administration process ensures that the seller's performance meets contractual requirements and that the buyer performs according to the terms of the contract.

On larger projects with multiple products, services, and results providers, a key aspect of contract administration is managing interfaces among the various providers. The legal nature of the contractual relationship makes it imperative that the project management team is acutely aware of the legal implications of actions taken when administering any contract. Because of the legal considerations, many

organisations treat contract administration as an administrative function separate from the project organisation.

While a contract administrator may be on the project team, this individual typically reports to a supervisor from a different department. This is usually true if the performing organisation is also the seller of the project to an external customer. Contract Administration includes application of the appropriate project management processes to the contractual relationship (s), and integration of the outputs from these processes into overall management of the project. This integration will often occur at multiple levels when there are multiple sellers and multiple products, services, or results involved. The project management processes that are applied include, but are not limited to:

- Direct and Manage Project Execution to authorise the contractor's work at the appropriate time.
- Performance Reporting to monitor contractor cost, schedule, and technical performance.
- Perform Quality Control to inspect and verify the adequacy of the contractor's product.
- Integrated Change Control to assure that changes are properly approved, and that all those with a need to know are aware of such changes.
- Risk Monitoring and Control to ensure that risks are mitigated.

Contract administration also has a financial management component that involves monitoring of payments to the seller. This ensures that payment terms defined within the contract are met and that seller compensation is linked to seller progress, as defined in the contract.

The Contract Administration process reviews and documents how well a seller is performing or has performed based on the contract and established corrective actions. Also, the performance is documented as a basis for future relationships with the seller. Seller performance evaluation

by the buyer is primarily carried out to confirm the competency or lack of competency of the seller, relative to performing similar work on the project or other projects.

Similar evaluations are also carried out when it is necessary to confirm that a seller is not meeting the seller's contractual obligations, and when the buyer contemplates corrective actions. Contract administration includes managing any early termination of the contracted work (for cause, convenience, or default) in accordance with the termination clause of the contract. Contracts can be amended any time prior to contract closure by mutual consent, in accordance with the change control terms of the contract. Such amendments may not always be equally beneficial to both the seller and the buyer.

## **Contract Administration: Inputs**

### **.1 Contract**

A contract is a legally binding agreement between the buyer and seller in which the seller provides the described product and the seller pays for the product. Contracts are known by many names:

- Agreement
- Subcontract
- Purchase order
- Memorandum of understanding

### **.2 Contract Management Plan**

*Please see previous section*

### **.3 Selected Sellers**

*Please see previous section*

#### **.4 Performance Reports**

Within the contract, the terms for acceptance are defined. Reports on the seller's performance are needed to compare with the requirements of the contracted work. Seller performance-related documentation includes:

- Seller-developed technical documentation and other deliverables information provided in accordance with the terms of the contract
- Seller performance reports.

#### **.5 Approved Change Requests**

Change requests can complicate contract administration. The performing organisation's Change Control System must somehow mesh with the seller's Change Control System. Changes to the project that affect the contracted work require changes to the contract, addendums to the contract, or a new contract for the additional or changed work. In some instances, the seller and the buyer may disagree about the cost of the changes. These differences may be labeled as claims, disputes, or appeals—and may ultimately slow the project's progress if not remedied. Approved changes requests can include modifications to the terms and conditions of the contract, including the contract statement of work, pricing, and description of the products, services, or results to be provided. All changes are formally documented in writing and approved before being implemented. Any verbally discussed, but undocumented, changes do not need to be processed or implemented.

#### **.6 Work Performance Information**

Work performance information, including the extent to which quality standards are being met, what costs have been incurred or committed, seller invoices, etc., is collected as part of project execution. The seller's performance reports indicate which deliverables have been completed and which have not. The seller must also submit invoices (sometimes called bills or requests for payment) on a timely basis to request payment for

work performed. Invoicing requirements, including necessary supporting documentation, are defined within the contract.

## **Contract Administration: Tools and Techniques**

### **.1 Contract Change Control System**

The contract change control system defines the procedures for how the contract may be changed. The process for changing the contract includes the forms, documented communications, tracking, conditions within the project, business, or marketplace that justify the needed changes, dispute resolution procedures, and the procedures for getting the changes approved within the performing organisation. The system is part of integrated change control. A contract change control system defines the process by which the contract can be modified. It includes the paperwork, tracking systems, dispute resolution procedures, and approval levels necessary for authorising changes. The contract change control system is integrated with the integrated change control system.

All proposed changes must go through the contract change control system.

### **.2 Buyer-Conducted Performance Review**

As the vendor completes the contracted work, the seller will need to inspect the work for progress, compliance with contract requirements, and adherence to agreed-to time, cost, and quality constraints. A procurement performance review is a structured review of the seller's progress to deliver project scope and quality, within cost and on schedule, as compared to the contract. It can include a review of seller-prepared documentation and buyer inspections, as well as quality audits conducted during seller's execution of the work. The objective of a performance review is to identify performance successes or failures, progress with respect to the contract statement of work, and contract non-compliance that allows the buyer to quantify the seller's demonstrated ability or

inability to perform work.

### **.3 Inspections and Audits**

Inspections and audits, required by the buyer and supported by the seller as specified in the contract documentation, can be conducted during execution of the project to identify any weaknesses in the seller's work processes or deliverables. If authorised by contract, some inspection and audit teams can include buyer procurement personnel.

### **.4 Performance Reporting**

Performance reporting provides management with information about how effectively the seller is achieving the contractual objectives. Contract performance reporting is integrated into performance reporting.

### **.5 Payment System**

Payments to the seller are usually handled by the accounts payable system of the buyer. On larger projects with many or complex procurement requirements, the project can develop its own payment system. In either case, the payment system includes appropriate reviews and approvals by the project management team, and payments are made in accordance with the terms of the contract.

### **.6 Claims Administration**

Contested changes and constructive changes are those requested changes where the buyer and seller cannot agree on compensation for the change, or cannot agree that a change has even occurred. These contested changes are variously called claims, disputes, or appeals. Claims are documented, processed, monitored, and managed throughout the contract life cycle, usually in accordance with the terms of the contract. If the parties themselves do not resolve a claim, it may have to be handled in accordance with the dispute resolution procedures established in the contract. These contract clauses can involve arbitration

or litigation, and can be invoked prior to or after contract closure.

### **.7 Records Management System**

A records management system is a specific set of processes, related control functions, and automation tools that are consolidated and combined into a whole, as part of the project management information system. A records management system is used by the project manager to manage contract documentation and records. The system is used to maintain an index of contract documents and correspondence, and assist with retrieving and archiving that documentation.

### **.8 Information Technology**

The use of information and communication technologies can enhance the efficiency and effectiveness of contract administration by automating portions of the records management system, payment system, claims administration, or performance reporting and providing electronic data interchange between the buyer and seller.

## **Contract Administration: Outputs**

### **.1 Contract Documentation**

Contract documentation includes, but is not limited to, the contract, along with all supporting schedules, requested unapproved contract changes, and approved change requests. Contract documentation also includes any seller-developed technical documentation and other work performance information, such as deliverables, seller performance reports, warranties, financial documents including invoices and payment records, and the results of contract-related inspections.

### **.2 Requested Changes**

Requested changes to the project management plan and its subsidiary plans and other components, such as the project schedule and

procurement management plan, may result from the Contract Administration process. Requested changes are processed for review and approval through the Integrated Change Control process. Requested changes can include direction provided by the buyer, or actions taken by the seller, that the other party considers a constructive change to the contract. Since any of these constructive changes may be disputed by one party and can lead to a claim against the other party, such changes are uniquely identified and documented by project correspondence.

### **.3 Recommended Corrective Actions**

A recommended corrective action is anything that needs to be done to bring the seller in compliance with the terms of the contract.

### **.4 Organisational Process Assets (Updates)**

- Correspondence. Contract terms and conditions often require written documentation of certain aspects of buyer/seller communications, such as warnings of unsatisfactory performance and requests for contract changes or clarifications. This can include the reported results of buyer audits and inspections that indicate weaknesses the seller needs to correct. In addition to specific contract requirements for documentation, a complete and accurate written record of all written and oral contract communications, as well as actions taken and decisions made, are maintained by both parties.
- Payment schedules and requests. This assumes that the project is using an external payment system. If the project has its own internal system, the output here would simply be payments.
- Seller performance evaluation documentation. Seller performance evaluation documentation is prepared by the buyer. Such performance evaluations document the seller's

ability to continue to perform work on the current contract, indicate if the seller can be allowed to perform work on future projects, or rate how well the seller is performing the project work. These documents can form the basis for early termination of the seller's contract, or determining how contract penalties, fees, or incentives are administered. The results of these performance evaluations can also be included in the appropriate qualified seller lists.

#### **.5 Project Management Plan (Updates)**

- Procurement management plan. The procurement management plan is updated to reflect any approved change requests that affect procurement management.
- Contract management plan. Each contract management plan is updated to reflect any approved change requests that affect contract administration.

## 12.6 Contract Closure

Contract closeout is analogous to administrative closure. Its purpose is to confirm that the obligations of the contract were met as expected. The project manager, the customer, key stakeholders, and, in some instances, the seller may finalise product verification together to confirm the contract has been completed. Contract closeout can also be linked to administrative closure, because it is the process of confirming that the work was finished. In instances where the contract was terminated, contract closeout is reviewed and is considered closed because of the termination. The project records should be updated to reflect the contract closeout and the acceptance of the work or product.

The Contract Closure process supports the Close Project process, since it involves verification that all work and deliverables were acceptable. The Contract Closure process also involves administrative activities, such as updating records to reflect final results and archiving such information for future use. Contract closure addresses each contract applicable to the project or a project phase.

In multi-phase projects, the term of a contract may only be applicable to a given phase of the project. In these cases, the Contract Closure process closes the contract (s) applicable to that phase of the project. Unresolved claims may be subject to litigation after contract closure. The contract terms and conditions can prescribe specific procedures for contract closure.

Early termination of a contract is a special case of contract closure, and can result from a mutual agreement of the parties or from the default of one of the parties. The rights and responsibilities of the parties in the event of an early termination are contained in a terminations clause of the contract. Based upon those contract terms and conditions, the buyer may

have the right to terminate the whole contract or a portion of the project, for cause or convenience, at any time. However, based upon those contract terms and conditions, the buyer may have to compensate the seller for seller's preparations and for any completed and accepted work related to the terminated part of the contract.

## **Contract Closure: Inputs**

### **.1 Procurement Management Plan**

*Please see previous section*

### **.2 Contract Management Plan**

*Please see previous section*

### **.3 Contract Documentation**

*Please see previous section*

### **.4 Contract Closure Procedure**

*Please see previous section*

## **Contract Closure: Tools and Techniques**

### **.1 Procurement Audits**

A procurement audit is a structured review of the procurement process from the Plan Purchases and Acquisitions process through Contract Administration. The objective of a procurement audit is to identify successes and failures that warrant recognition in the preparation or administration of other procurement contracts on the project, or on other projects within the performing organisation.

### **.2 Records Management System**

*Please see previous section*

## **Contract Closure: Outputs**

### **. 1 Closed Contracts**

The buyer, usually through its authorised contract administrator, provides the seller with formal written notice that the contract has been completed. Requirements for formal contract closure are usually defined in the terms of the contract, and would be included in the contract management plan, if one was prepared.

### **.2 Organisational Process Assets (Updates)**

- **Contract file.** A complete set of indexed contract documentation, including the closed contract, is prepared for inclusion with the final project files.
- **Deliverable acceptance.** The buyer, usually through its authorised contract administrator, provides the seller with formal written notice that the deliverables have been accepted or rejected. Requirements for formal deliverable acceptance, and how to address non-conforming deliverables, are usually defined in the contract.
- **Lessons learned documentation.** Lessons learned analysis and process improvement recommendations are developed for future purchasing and acquisition planning and implementation.

## Summary and Self Test

### TWO-MINUTE DRILL

#### Procurement Planning

- ❑ Procurement planning is determining which aspects of the project can best be fulfilled by procuring the specified products or services.
- ❑ The project scope serves as a key input, as this describes the work, and only the required work, needed to complete the project.
- ❑ A clearly defined product description is needed in order to successfully procure the product.
- ❑ Make-or-buy analysis calculates and predicts which is better: for the performing organisation to make the product or to hire an entity outside of the organisation to make the product.
- ❑ Some contracts can transfer the risk to the seller, while other contract types require the buyer to retain the risk of cost overruns.

#### Contracting Planning

- ❑ The procurement management plan describes the procedures for procuring work or products.
- ❑ Bids and quotes are needed when the decision is made on price. Proposals are needed when decisions are based on other factors, such as experience, qualifications, and approaches to the project work.
- ❑ The buyer should provide the seller with a SOW, details on the type of response needed—such as a proposal, quote, or bid, and any information on contractual provisions, such as non-disclosure agreements or a copy of the model contract that the buyer intends to use.

#### Contracting

- ❑ Contracting is requesting the potential sellers to provide bids, proposals, or quotes to complete the project work or supply the described product.
- ❑ An organisation may retain a qualified seller list from which the project team is forced to select a vendor. In other instances, the project team can rely on trade associations, industry directories, and other resources to locate qualified sellers.
- ❑ Advertisements for the procured process in newspaper and trade publications can increase the list of sellers the buyer can choose from. Many government entities must publish procurement opportunities.
- ❑ Bidder conferences allow sellers to meet with the buyer to query the buyer on details of the procurement process. The goal of the bidder conference is to ensure that all prospective sellers have the same information and all of the needed information to complete an accurate bid or proposal.

**Source Selection**

- ❑ Samples of the sellers' previous, related products or services can serve as evaluation criteria.
- ❑ Contract negotiation focuses on finding a fair and reasonable price for both the buyer and the seller.
- ❑ Weighting systems are unbiased approaches to determine which seller has the best offer to complete the procured product or service.
- ❑ Screening systems allow an organisation to screen out sellers that do not qualify for the procured product or service.
- ❑ "Should cost" estimates are completed by the performing organisation to determine if sellers completely understand the requirements of the project work.

**Contract Administration**

- ❑ Contract administration ensures the sellers are meeting their contractual obligations.
- ❑ Change requests may require updates to the contract between the buyer and the seller. Contract change requests are part of the integrated change control system.
- ❑ The project manager must document and report to the seller and management on how the seller is meeting its contract obligations.

**Contract Closeout**

- ❑ Contract closeout is similar to administrative closure.
- ❑ Contract documentation—such as the contract, schedules, relevant documentation, approved contract changes, performance reports, and other pertinent information—is needed to complete contract closeout.
- ❑ Procurement audits are intended to review, document, and share the successes and failures of the current project's procurement process. The information can be applied to other projects within the organisation.
- ❑ A contract file is created and is included with the project records as part of the historical information of the current project.

**SELF TEST**

- 1.** Which of the following may be used as a risk mitigation tool?
  - A. A vendor proposal
  - B. A contract
  - C. A quotation
  - D. Project requirements
  
- 2.** A contract cannot have provisions for which one of the following?
  - A. A deadline for the completion of the work
  - B. Illegal activities
  - C. Subcontracting the work
  - D. Penalties and fines for disclosure of intellectual rights
  
- 3.** You are the project manager for the 89A Project. You have created a contract for your customer. The contract must have what two things?
  - A. An offer and consideration
  - B. Signatures and the stamp of a notary public
  - C. The value and worth of the procured item
  - D. A start date and an acceptance of the start date
  
- 4.** The WBS and the WBS dictionary can help a project manager plan for purchases and acquisitions. Which one of the following best describes this process?
  - A. The WBS defines the specific contracted work
  - B. The WBS defines the requirements for the specific contract work
  - C. The WBS defines the specific contracted work, which must support the requirements of the project customer
  - D. Both parties must have and retain their own copy of the WBS
  
- 5.** Yolanda has outsourced a portion of the project to a vendor. The vendor has discovered some issues that will influence the cost and schedule of its portion of the project. How must the vendor and Yolanda update the agreement?
  - A. As a new contract signed by Yolanda and the vendor
  - B. By submitting the change request to the contract change control system
  - C. As a memo and SOW signed by Yolanda and the vendor
  - D. By submitting the change request to the cost change control system
  
- 6.** The United States backs all contracts through which of the following?
  - A. Federal law
  - B. State law
  - C. Court system
  - D. Lawyers

**7.** Terry is the project manager of the MVB Project. She needs to purchase a piece of equipment for her project. The Accounting department has informed Terry she needs a unilateral form of contract. Accounting is referring to which of the following?

- A. The Statement Of Work (SOW)
- B. A legal binding contract
- C. A purchase order
- D. An invoice from the vendor

**8.** Bonnie is the project manager for the HGH Construction Project. She has contracted a portion of the project to the ABC Construction Company and has offered a bonus to ABC if they complete their portion of the work by August 30. This is an example of which one of the following?

- A. A project requirement
- B. A project incentive
- C. A project goal
- D. A fixed-price contract

**9.** You are a project manager for your organisation and are progressing through the procurement management processes. Who should receive the procurement document package?

- A. Your client
- B. Your project sponsor
- C. Your accounting/finance department
- D. Each seller that will participate in the bidding

**10.** Privity is what?

- A. The relationship between the project manager and a known vendor
- B. The relationship between the project manager and an unknown vendor
- C. The contractual, confidential information between the customer and vendor
- D. The professional information regarding the sale between the customer and vendor

**11.** Sammy is the project manager of the DSA Project. He is considering proposals and contracts presented by vendors for a portion of the project work. Of the following, which contract is least dangerous to the DSA Project?

- A. Cost plus fixed fee
- B. Cost plus percentage of cost
- C. Cost plus incentive fee
- D. Fixed-price

**12.** Of the following contract types, which one requires the seller to assume the risk of cost overruns?

- A. Cost plus fixed fee

- B. Cost plus incentive fee
- C. Lump sum
- D. Time and materials

**13.** Benji is the project manager of the PLP Project. He has hired an independent contractor for a portion of the project work. The contractor is billing the project \$120 per hour, plus materials. This is an example of which one of the following?

- A. Cost plus fixed fee
- B. Time and materials
- C. Unit price
- D. Lump sum

**14.** Mary is the project manager of the JHG Project. She has created a contract Statement Of Work (SOW) for a vendor. All of the following should be included in the contract SOW except for which one?

- A. The items being purchased
- B. The signatures of both parties agreeing to the SOW
- C. The expected quality levels
- D. A description of the collateral services required

**15.** You are the project manager for a software development project for an accounting system that will operate over the Internet. Based on your research, you have discovered it will cost you \$25,000 to write your own code. Once the code is written, you estimate you'll spend \$3,000 per month updating the software with client information, government regulations, and maintenance. A vendor has proposed to write the code for your company and charge a fee based on the number of clients using the program every month. The vendor will charge you \$5 per month per user of the web-based accounting system. You will have roughly 1,200 clients using the system each month. However, you'll need an in-house accountant to manage the time and billing of the system, so this will cost you an extra \$1,200 per month. How many months can you use the system before it's better to write your own code rather than hire the vendor?

- A. Three months
- B. Four months
- C. Six months
- D. 15 months

**16.** You are completing the closeout of a project to design a warehouse in Columbus, Ohio. The contract is a cost plus incentive fee contract. The target costs are \$300,000, with a 10-percent target profit. However, the project came in at \$275,000. The incentive split is 80/20. How much will the total contract cost?

- A. \$300,000
- B. \$275,000
- C. \$310,000
- D. \$330,000

- 17.** A contract between an organisation and a vendor may include a clause that penalises the vendor if the project is late. The lateness of a project has a monetary penalty. Thus, the penalty should be enforced or waived based on which one of the following?
- A. Whether the project manager could have anticipated the delay
  - B. Whether the project manager knew the delay was likely
  - C. Whether the delay was because of an unseen risk
  - D. Who caused the delay and the reason why
- 18.** A single-source seller means what?
- A. There is only one qualified seller
  - B. There is only one seller the company wants to do business with
  - C. There is a seller that can provide all aspects of the project procurement needs
  - D. There is only one seller in the market
- 19.** Which one of the following is not a valid evaluation criterion for source selection?
- A. The age of the contact person at the seller
  - B. The technical capability of the seller
  - C. Financial capacity
  - D. Price
- 20.** Henry has sent the ABN Contracting Company a letter of intent. This means which one of the following?
- A. Henry intends to sue the ABN Contracting Company
  - B. Henry intends to buy from the ABN Contracting Company
  - C. Henry intends to bid on a job from the ABN Contracting Company
  - D. Henry intends to fire the ABN Contracting Company
- 21.** Martha is the project manager of the MNB Project. She wants a vendor to offer her one price to do all of the detailed work. Martha is looking for which type of document?
- A. A request for proposal
  - B. A request for information
  - C. A proposal
  - D. An invitation for bid
- 22.** Which one of the following is true about procurement document packages?
- A. They offer no room for bidders to suggest changes
  - B. They ensure the receipt of complete proposals
  - C. They inform the performing organisation why the bid is being created
  - D. The project manager creates and selects the bid

- 23.** In what process group does seller selection happen?
- A. Initiating
  - B. Planning
  - C. Executing
  - D. Closing
- 24.** Within your organisation, all project managers are required to document the performance quality ratings, delivery performance, and contractual compliance of each vendor they interact with. This is known as what?
- A. A requirement
  - B. A seller rating system
  - C. Procurement selection
  - D. An incentive contract
- 25.** You are the project manager for a seller, but are managing another company's project as well. Things have gone well on the project, and the work is nearly complete. There is still a significant amount of funds in the project budget. The buyer's representative approaches you and asks that you complete some optional requirements to use up the remaining budget. You should do which one of the following?
- A. Negotiate a change in the contract to take on the additional work
  - B. Complete a contract change for the additional work
  - C. Submit the proposed change through the contract change control system
  - D. Deny the change because it was not in the original contract

## **D. Appendices**

### **Glossary of Terms**

**Balanced Matrix** - A balanced matrix is where the power is balanced between project managers and functional managers.

**Closing** - Brings a formal, orderly end to the activities of a project phase or to the project itself.

**Deliverable** - An output that must be produced, reviewed, and approved to bring the phase or project to completion.

**Executing** - Involves putting the project management plan into action by coordinating and directing project resources to meet the objectives of the project plan

**Fast tracking** - A schedule compression technique where two activities that were previously scheduled to start sequentially start at the same time. Fast tracking reduces schedule duration if applied to the critical path.

**Feasibility study** - Feasibility studies are undertaken to determine if the project is a viable project, the probability of project success, and the viability of the product of the project.

**Functional organisation** - A form of organisational structure. Functional organisations are traditional organisations with hierarchical reporting structures. The functional manager traditionally has more authority in this type of organisation than the project manager has.

**Handsoff** - The process of ending one project life cycle phase and beginning the next.

**Historical information** - An input to several Planning processes that refers to information or records regarding past projects and their performance. Records are available for reference on the existing project.

**Initiating** - This is the first project management process group and generally the first phase of a project life cycle. It acknowledges that the project, or the next phase in an active project, should begin.

**Iterative** - To repeat processes more than once. The five process groups are repeated throughout the project's life due to change requests, responses to change, corrective action, and so on.

**Leaders** - Leaders impart vision, gain consensus for strategic goals, establish direction, and inspire and motivate others.

**Managers** - Managers focus on results and are concerned with getting the job done according to the requirements.

**Matrix organisation** - A form of organisation structure. Employees in a matrix organisation report to one functional manager and at least one project manager. Functional managers assign employees to projects and carry out administrative duties, while project managers assign tasks associated with the project to team members and execute the project.

**Monitoring and Controlling** - This is the fourth project management process group. The Monitoring and Controlling process group involves taking performance measurements and analysing them to determine if the project is staying true to the project plan. Corrective action is applied where necessary to get the project activities realigned with the project

plan.

**Operations** - An ongoing endeavor typically involving repetitive processes that produce the same results.

**Planning** - This is the second project management process group. The Planning process group consists of processes that involve formulating and revising project goals and objectives and creating the project management plan that will be used to achieve the goals the project was undertaken to address. Planning involves determining alternative courses of action and selecting from among the best of those to produce the project's goals. The Planning process group is where the project requirements are determined and stakeholders are identified.

**Politics** - A technique used to influence people to perform. It involves getting groups of people with different interests to cooperate creatively even in the midst of conflict and disorder.

**Portfolio Management** - The management of collections of programs and projects to meet and maximise the strategic objectives of the business. Involves monitoring active projects, balancing the portfolio among other investments, assuring efficient use of resources, and assessing the value of projects and potential projects against the portfolio's strategic objectives.

**Portfolios** - Collection of projects or programs that meet a specific business goal or objective.

**Power** - A technique used to influence people to perform. It's the ability to get people to do things they wouldn't do otherwise, to change minds and the course of events, and to influence outcomes.

**Product scope** - A description of the product features typically documented in the project description.

**Program management** - The central management and coordination of groups of related projects and operations work to obtain benefits and administer controls that aren't possible when the projects and operations are managed individually to achieve the program's strategic objectives.

**Programs** - A grouping of projects that are managed together. The individual projects are usually part of one bigger project and are therefore related.

**Progressive elaboration** - The process of taking incremental steps to examine and refine the characteristics of the product of the project. Processes may be progressively elaborated as well.

**Project Communications Management** - One of the nine knowledge areas of project management. Project Communications Management ensures proper and timely communications and includes these processes: Communications Planning; Information Distribution, Performance Reporting, and Manage Stakeholders.

**Project Cost Management** - One of the nine knowledge areas of project management. Project Cost Management ensures proper cost planning, budgets, and controls and includes these processes: Cost Estimating, Cost Budgeting, and Cost Control.

**Project Human Resource Management** - One of the nine knowledge areas of project management, Project Human Management ensures effective use of human resources and includes these processes: Human Resource Planning, Acquire Project Team, Develop Project Team, and Manage Project Team.

**Project Integration Management** - One of the nine knowledge areas of project management, Project Integration Management involves coordinating all aspects of the project and includes these processes: Develop Project Charter, Preliminary Project Scope Statement, Develop Project Management Plan, Direct and Manage Project Execution, Monitor and Control Project Work, Integrated Change Control, and Close Project.

**Project life cycle** - The grouping of project phases in a sequential order from the beginning of the project to the close.

**Project management** - The process that's used to initiate, plan, execute, monitor, control, and close out projects by applying skills, knowledge, and project management tools and techniques to fulfill the project requirements.

**Project management Knowledge Areas** These nine project management groupings – known as knowledge areas – bring together common or related processes.

**Project Management Office** - Office established by organisations to create and maintain procedures and standards for project management methodologies to be used throughout the organisation.

**Project Managers** - The individual responsible for managing a project.

**Project Procurement Management** - A subset of project management that includes the processes required to acquire goods and services to attain project scope from outside the performing organisation. It consists of procurement planning, solicitation planning, solicitation, source selection, contract administration, and contract closeout.

**Project Quality Management** - A subset of project management that includes the processes required to ensure that the project will satisfy the needs for which it was undertaken. It consists of quality planning, quality assurance, and quality control.

**Project Risk Management** - Risk management is the systematic process of identifying, analysing, and responding to project risk. It includes maximising the probability and consequences of positive events and minimising the probability and consequences of events adverse to project objectives. It includes the processes of risk management planning, risk identification, qualitative risk analysis, quantitative risk analysis, risk response planning, and risk monitoring and control.

**Project Scope** -The work that must be done to deliver a product with the specified features and functions.

**Project Scope Management** - A subset of project management that includes the processes required to ensure that the project includes all of the work required, and only the work required, to complete the project successfully. It consists of initiation, scope planning, scope definition, scope verification, and scope change control.

**Project Sponsor** - Usually an executive in the organisation. The project sponsor has the authority to assign resources and enforce decisions regarding the project.

**Project Time Management** - A subset of project management that includes the processes required to ensure timely completion of the project. It consists of activity definition, activity sequencing, activity duration estimating, schedule development, and schedule control.

**Projectised Organisations** - Any organisational structure in which the

project manager has full authority to assign priorities and to direct the work of individuals assigned to the project.

**Projects** - A temporary endeavor undertaken to create a unique product, service, or result.

**Stakeholders** - Individuals and organisations that are actively involved in the project, or whose interests may be positively or negatively affected as a result of project execution or project completion. They may also exert influence over the project and its results.

**Tailoring** - The tailoring of requirements is the responsibility of the acquirer (customer), suggested tailoring may be provided by prospective and selected developers (prior to contract agreement).

## **Project Integration Management - Terminology**

**Assumptions:** Beliefs considered to be true, real, or certain for the sake of planning.

**Benefit measurement methods:** Used in comparing the value of one project against the value, or benefits, of another; often used in project selection models.

**Benefit/cost analysis** The process of determining the pros and cons of any project, process, product, or activity.

**Benefit/cost ratios** These models examine the cost-to-benefit ratio.

**Change control board:** A board that determines the validity and need of (thus approving or denying) project change requests.

**Change Control System** A system to formally accept, review, and act upon project change requests.

**Configuration management:** Activities focusing on controlling the characteristics of a product or service. A documented process of controlling the features, attributes, and technical configuration of any product or service. Sometimes considered a rigorous Change Control System.

**Constrained optimisation methods:** These are complex mathematical formulas and algorithms that are used to predict the success of projects, the variables within projects, and the tendencies to move forward with selected project investments. Examples include linear programming, integer algorithms, and multi-objective programming.

**Constraints:** Any influence on the project that may limit the options of the project team in performing the project work.

**Earned value (EV):** The value of the work that has been completed and the budget for that work, the equation for which is  $EV = \%complete \times BAC$ .

**Future value:** A formula to calculate the future value of present money.

**Historical information:** Information the project may use from previous projects.

**Internal rate of return (IRR):** The IRR is a complex formula to calculate when the present value of the cash inflow equals the original investment.

**Lessons learned:** An ongoing documentation of things the project manager and project team have learned throughout the project. Lessons learned are supplied to other project teams and project managers to apply to their ongoing projects. They are documented throughout the project, not just at the end of the project.

**Net present value (NPV):** NPV calculates the present value of monies returned on a project for each time period the project lasts.

**PMIS:** Project management information system (PMIS) is typically a computer-program to assist in project management activities, recordkeeping, and forecasting.

**Present value:** A formula to calculate the present value of future money.

**Project baselines:** The accepted plans against which actual results are

compared to identify variances.

**Project charter:** The charter authorises the project, the project manager, and the required resources to complete the project work.

**Project integration management:** The day-to-day actions of the project manager to ensure that all parts of the project work together. Composed of project plan development, project plan execution, and integrated change control.

**Project plan:** The project plan is a collection of documents that is developed with the project team, stakeholders, and management. It is the guide to how the project should flow and how the project will be managed. It also reflects the values and priorities of, and the conditions influencing, the project.

**Project scope** The work that has to be done in order to create the product. The project scope is concerned with the work—and only the required work—to complete the project.

**Project scope management** Project scope management, according to the PMBOK, is “the processes to ensure that the project includes all of the work required, and only the work required, to complete the project successfully.”

**Scope statement** A document that describes the work, and only the required work, to meet the project objectives. The scope statement establishes a common vision among the project stakeholders to establish the point and purpose of the project work. It is used as a baseline against which all future project decisions are made to determine if proposed changes or work-results are aligned with expectations.

**Scoring models (also called weighted scoring models)** These models use a common set of values for all of the projects up for selection. Each value has a weight: assigned values of high importance have a high weight, while values of lesser importance have a lesser weight. The projects are measured against these values and assigned scores according to how well they match the predefined values. The projects with high scores take priority over projects with lesser scores.

**Statement of work (SOW)** This fully describes the work to be completed, the product to be supplied, or both. The SOW becomes part of the contract between the buyer and the seller. The SOW is typically created as part of the procurement planning process and is used by the seller to determine whether it can meet the project's requirements.

**Status review meetings:** Regularly scheduled meetings to record the status of the project work. These commonly employed meetings provide a formal avenue for the project manager to query the team on the status of its work, record delays and slippage, and to forecast what work is about to begin.

**Supporting detail:** Any information that supports decisions—including the logic employed and rationales—and the project plan as a whole. Supporting detail can include books, articles, web sites, vendor information, test results, historical information, and many other information sources.

## **Project Scope Management – Terminology**

**Change requests** – Requests to expand or reduce the project scope, modify policies, processes, plans, or procedures, modify costs, or budgets, or revise schedules. Requests for a change can be direct or indirect, externally or internally initiated, and legally or contractually mandated or optional. Only formal documented requested changes are processes and only approved change requests are implemented.

**Decomposition** – A planning technique that subdivides the project scope and project deliverables into smaller, more manageable components, until the project work associated with accomplishing the project scope and providing the deliverables is defined in sufficient detail to support executing, monitoring, and controlling the work.

**Project scope** The work that has to be done in order to create the product. The project scope is concerned with the work—and only the required work—to complete the project.

**Project scope management** Project scope management, according to the PMBOK, is “the processes to ensure that the project includes all of the work required, and only the work required, to complete the project successfully.”

**Product scope** – The features and functions that characterise a product, service or result.

**Project Management Plan** – A formal, approved document that defines how the project is executed, monitored and controlled. It may be summary or detailed and may be composed of one or more subsidiary management plans and other planning documents.

**Scope** – The sum of the products, services and results to be provided as a project. See also product scope and project scope.

**Scope Baseline** – The approved time phased plan for a project, a work breakdown structure; component, a work package or a schedule activity, plus or minus approved projects scope, cost, schedule, and technical changes. Generally refers to the current baseline, but may refer to the original or some other baseline.

**Scope Change** – Any change to the project scope. A scope change almost always requires an adjustment to the project cost or schedule.

**Scope Control** – The process of controlling changes to the project scope.

**Scope Creep** – Adding features and functionality without addressing the effects on time, costs, and resources, or without customer approval.

**Scope Definition** – The process of developing a detailed project scope statement as the basis for future project decisions.

**Scope Planning** – The process of creating a project scope management plan.

**Scope statement** - A document that describes the work, and only the required work, to meet the project objectives. The scope statement establishes a common vision among the project stakeholders to establish the point and purpose of the project work. It is used as a baseline against which all future project decisions are made to determine if proposed changes or work-results are aligned with expectations.

**Scope verification** - The process of the project customer accepting the project deliverables. Scope verification happens at the end of each project

phase and at the end of the project. Scope verification is the process of ensuring the deliverables the project creates are in alignment with the project scope.

**Work breakdown structure (WBS)** - The WBS is a deliverable-orientated collection of project components. Work that isn't in the WBS isn't in the project. The point of the WBS is to organise and define the project scope.

**Work breakdown structure dictionary** - A reference tool to explain the WBS components, the nature of the work package, the assigned resources, and the time and billing estimates for each element.

**Work breakdown structure template** - A master WBS that is used in organisations as a starting point in defining the work for a particular project. This approach is recommended, as most projects in an organisation are similar in their project life cycles, and the approach can be adapted to fit a given project.

## **Project Time Management – Terminology**

**Activity Definition** - This process identifies the specific activities that must be performed to produce the product or service of the project.

**Activity list** An extension of the WBS that contains all the activities of the project and a description of each activity. The activity list is an output of the Activity Definition process.

**Activity on arrow (AOA)** - A diagramming method that places activities on arrows, which connect to dependent activities using nodes. This is also known as the arrow diagramming method.

**Activity on node (AON)** A diagramming method that places activities on nodes, which connect to dependent activities using arrows. This is also known as the precedence diagramming method.

**Activity Sequencing** This process sequences activities in logical order and determines if dependencies exist among the activities.

**Analogous estimating** This relies on historical information to predict estimates for current projects. Analogous estimating is also known as top-down estimating and is a form of expert judgment.

**Arrow diagramming method (ADM)** A diagramming method that places activities on arrows, which connect to dependent activities using nodes.

**Balanced Matrix** A balanced matrix is where the power is balanced between project managers and functional managers

**Closing** Brings a formal, orderly end to the activities of a project phase or to the project itself

**Crashing** This is the addition of more resources to activities on the critical path in order to complete the project earlier. Crashing results in higher project costs.

**Critical chain method** A scheduling approach that considers the availability of the resources needed to complete the project work. Unavailable resources may cause the network diagram to be reconfigured or the project duration to take longer than originally planned.

**Critical path method (CPM)** The CPM is the most common approach to calculating when a project may finish. It uses a “forward” and “backward” path to reveal which activities are considered critical, and which contain float. If activities on the critical path are delayed, the project end date will be delayed.

**Deliverable** An output that must be produced, reviewed, and approved to bring the phase or project to completion.

**Dependencies** Dependencies between two project activities whereby one activity must do something (finish or start) before another activity can do something (start or finish). Logical relationships can also exist between an activity and a milestone. These are also known as precedence relationships. The four types of logical relationships are finish-to-start, finish-to-finish, start-to-start, start-to-finish.

**Discretionary dependencies** Dependencies defined by the project management team. Discretionary dependencies are usually process or procedure driven. They are also known as preferred logic, soft logic, and preferential logic. See also logical relationships.

**Executing** Involves putting the project management plan into action by coordinating and directing project resources to meet the objectives of the project plan

External dependencies Dependencies that are external to the project.

**Fast tracking** A schedule compression technique where two activities that were previously scheduled to start sequentially start at the same time. Fast tracking reduces schedule duration if applied to the critical path.

**Feasibility study** Feasibility studies are undertaken to determine if the project is a viable project, the probability of project success, and the viability of the product of the project.

**Finish-to-Finish** This relationship means Task A must complete before Task B can complete. Ideally, two tasks must finish at exactly the same time, but this is not always the case.

**Finish-to-Start** This relationship means Task A must complete before Task B can begin. This is the most common relationship.

Float The amount of time a task can be delayed without delaying the project's completion. Technically, there are three different types of float: Free float is the total time a single activity can be delayed without delaying the early start of any successor activities. Total float is the total time an activity can be delayed without delaying project completion. Project float is the total time the project can be delayed without passing the customer's expected completion date.

**Fragnets(also called subnets)** Portions of a network diagram that branch off the project and are not on the critical path.

**Functional organisation** A form of organisational structure. Functional organisations are traditional organisations with hierarchical reporting structures. The functional manager traditionally has more authority in this type of organisation than the project manager has.

**Handsoff** The process of ending one project life cycle phase and beginning the next.

**Hammocks** Summary-level activities or aggregate activities shown as a summary activity on a project schedule network diagram.

**Hard dependencies** Dependencies that are directly related to the nature of the work being performed. This is also known as mandatory dependencies or hard logic.

**Hard logic** See hard dependencies.

**Historical information** An input to several Planning processes that refers to information or records regarding past projects and their performance. Records are available for reference on the existing project.

**Initiating** This is the first project management process group and generally the first phase of a project life cycle. It acknowledges that the project, or the next phase in an active project, should begin.

**Iterative** To repeat processes more than once. The five process groups are repeated throughout the project's life due to change requests, responses to change, corrective action, and so on.

**Lags** Lags delay successor activities and require the dependent activity to have time added either to the start date or to the finish date of the activity.

**Leads** Leads speed up successor activities and require time to be subtracted from the start date or the finish date of the dependent activity.

**Logical relationships** Dependencies between two project activities whereby one activity must do something (finish or start) before another activity can do something (start or finish). Logical relationships can also exist between an activity and a milestone. These are known as precedence relationships. The four types of logical relationships are finish-to-start, finish-to-finish, start-to-start, start-to-finish.

**Leaders** Leaders impart vision, gain consensus for strategic goals, establish direction, and inspire and motivate others.

**Managers** Managers focus on results and are concerned with getting the job done according to the requirements.

**Mandatory dependencies** This refers to the logical relationship between activities based on the type of work. For example, the foundation of a house must be created before the frame of the house can be built. This is also known as hard logic.

**Matrix organisation** A form of organisation structure. Employees in a matrix organisation report to one functional manager and at least one project manager. Functional managers assign employees to projects and carry out administrative duties, while project managers assign tasks associated with the project to team members and execute the project.

**Monte Carlo analysis** Predicts how scenarios may work out given any number of variables. The process doesn't actually generate a specific answer, but a range of possible answers. When Monte Carlo is applied to a schedule, it can present, for example, the optimistic completion date, the

pessimistic completion date, and the most likely completion date for each activity in the project.

**Monitoring and Controlling** This is the fourth project management process group. The Monitoring and Controlling process group involves taking performance measurements and analysing them to determine if the project is staying true to the project plan. Corrective action is applied where necessary to get the project activities realigned with the project plan.

**Operations** An ongoing endeavor typically involving repetitive processes that produce the same results.

**Planning** This is the second project management process group. The Planning process group consists of processes that involve formulating and revising project goals and objectives and creating the project management plan that will be used to achieve the goals the project was undertaken to address. Planning involves determining alternative courses of action and selecting from among the best of those to produce the project's goals. The Planning process group is where the project requirements are determined and stakeholders are identified.

**Politics** A technique used to influence people to perform. It involves getting groups of people with different interests to cooperate creatively even in the midst of conflict and disorder.

**Portfolio Management** The management of collections of programs and projects to meet and maximise the strategic objectives of the business. Involves monitoring active projects, balancing the portfolio among other investments, assuring efficient use of resources, and assessing the value of projects and potential projects against the portfolio's strategic objectives.

**Portfolios** Collection of projects or programs that meet a specific business goal or objective.

**Power** A technique used to influence people to perform. It's the ability to get people to do things they wouldn't do otherwise, to change minds and the course of events, and to influence outcomes.

**Precedence diagramming method (PDM)** A diagramming method that places activities on nodes, which connect to dependent activities using arrows. This is also known as activity on node.

**Precedence relationships** Dependencies between two project activities whereby one activity must do something (finish or start) before another activity can do something (start or finish). Logical relationships can also exist between an activity and a milestone. These are known as precedence relationships. The four types of logical relationships are finish-to-start, finish-to-finish, start-to-start, start-to-finish.

**Preferential logic** Dependencies defined by the project management team. Discretionary dependencies are usually process or procedure driven. They are also known as preferred logic, soft logic, and preferential logic. See also logical relationships.

**Preferred logic** Dependencies defined by the project management team. Discretionary dependencies are usually process or procedure driven. They are also known as preferred logic, soft logic, and preferential logic. See also logical relationships.

**Product scope** A description of the product features typically documented in the project description.

**Program management** The central management and coordination of groups of related projects and operations work to obtain benefits and administer controls that aren't possible when the projects and operations are managed individually to achieve the program's strategic objectives.

**Programs** A grouping of projects that are managed together. The individual projects are usually part of one bigger project and are therefore related.

**Progressive elaboration** The process of taking incremental steps to examine and refine the characteristics of the product of the project. Processes may be progressively elaborated as well.

**Project calendar** A calendar that defines the working times for the project. For example, a project may require the project team to work nights and weekends so as not to disturb the ongoing operations of the organisation during working hours. In addition, the project calendar accounts for holidays, working hours, and work shifts that the project will cover.

**Project Communications Management** One of the nine knowledge areas of project management. Project Communications Management ensures proper and timely communications and includes these processes: Communications Planning; Information Distribution, Performance Reporting, and Manage Stakeholders.

**Project Cost Management** One of the nine knowledge areas of project management. Project Cost Management ensures proper cost planning, budgets, and controls and includes these processes: Cost Estimating, Cost Budgeting, and Cost Control.

**Project Human Resource Management** One of the nine knowledge areas of project management, Project Human Management ensures effective use of human resources and includes these processes: Human Resource Planning, Acquire Project Team, Develop Project Team, and Manage Project Team.

**Project Integration Management** One of the nine knowledge areas of project management, Project Integration Management involves coordinating all aspects of the project and includes these processes: Develop Project Charter, Preliminary Project Scope Statement, Develop Project Management Plan, Direct and Manage Project Execution, Monitor and Control Project Work, Integrated Change Control, and Close Project.

**Project life cycle** The grouping of project phases in a sequential order from the beginning of the project to the close.

**Project management** The process that's used to initiate, plan, execute, monitor, control, and close out projects by applying skills, knowledge, and project management tools and techniques to fulfill the project requirements.

**Project management Knowledge Areas** These nine project management groupings – known as knowledge areas – bring together common or related processes.

**Project Management Office** Office established by organisations to create and maintain procedures and standards for project management methodologies to be used throughout the organisation

**Project Managers** The individual responsible for managing a project

**Project Procurement Management** A subset of project management that includes the processes required to acquire goods and services to attain project scope from outside the performing organisation. It consists

of procurement planning, solicitation planning, solicitation, source selection, contract administration, and contract closeout

**Project Quality Management** A subset of project management that includes the processes required to ensure that the project will satisfy the needs for which it was undertaken. It consists of quality planning, quality assurance, and quality control.

**Project Risk Management** Risk management is the systematic process of identifying, analysing, and responding to project risk. It includes maximising the probability and consequences of positive events and minimising the probability and consequences of events adverse to project objectives. It includes the processes of risk management planning, risk identification, qualitative risk analysis, quantitative risk analysis, risk response planning, and risk monitoring and control.

**Project Scope** The work that must be done to deliver a product with the specified features and functions.

**Project Scope Management** A subset of project management that includes the processes required to ensure that the project includes all of the work required, and only the work required, to complete the project successfully. It consists of initiation, scope planning, scope definition, scope verification, and scope change control.

**Project Sponsor** Usually an executive in the organisation. The project sponsor has the authority to assign resources and enforce decisions regarding the project.

**Project Time Management** A subset of project management that includes the processes required to ensure timely completion of the project. It consists of activity definition, activity sequencing, activity

duration estimating, schedule development, and schedule control.

**Projectised Organisations** Any organisational structure in which the project manager has full authority to assign priorities and to direct the work of individuals assigned to the project.

**Projects** A temporary endeavor undertaken to create a unique product, service, or result.

**Resource calendar** The resource calendar shows when resources, such as project team members, consultants, and SMEs, are available to work on the project. It takes into account vacations, other commitments within the organisation, restrictions on contracted work, overtime issues, and so on.

**Resource leveling heuristics** A method to flatten the schedule when resources are overallocated or allocated unevenly. Resource leveling can be applied in different methods to accomplish different goals. One of the most common methods is to ensure that workers are not overextended on activities.

**Schedule control** Part of integrated change management, schedule control is concerned with three processes: the project manager confirms that any schedule changes are agreed upon; the project manager examines the work results and conditions to know if the schedule has changed; and the project manager manages the actual change in the schedule.

**Subnets(also called fragnets)** Portions of a network diagram that branch off the project and are not on the critical path.

**Schedule Management Plan** A subsidiary plan of the overall project plan. It is used to control changes to the schedule. A formal schedule

management plan has procedures that control how changes to the project plan can be proposed, accounted for, and then implemented.

**Schedule variance** The difference between the planned work and the earned work.

**Soft logic** Dependencies defined by the project management team. Discretionary dependencies are usually process or procedure driven. They are also known as preferred logic, soft logic, and preferential logic. See also logical relationships.

**Stakeholders** Individuals and organisations that are actively involved in the project, or whose interests may be positively or negatively affected as a result of project execution or project completion. They may also exert influence over the project and its results.

**Start-to-Finish** This relationship requires that Task A start so that Task B may finish; it is unusual and is rarely used.

**Start-to-Start** This relationship means Task A must start before Task B can start. This relationship allows both activities to happen in tandem.

**Tailoring** The tailoring of requirements is the responsibility of the acquirer (customer), suggested tailoring may be provided by prospective and selected developers (prior to contract agreement).

**Three point estimate** An estimate that uses optimistic, most likely, and pessimistic values to determine the cost or duration of a project component.

## **Project Cost Management – Terminology**

**Actual cost (AC)** Used in earned value measurements; the actual cost of the work performed.

**Analogous estimating** This relies on historical information to predict estimates for current projects. Analogous estimating is also known as top-down estimating and is a form of expert judgment.

**Bottom-up estimating** A technique where an estimate for each component in the WBS is developed and then totaled for an overall project budget. This is the longest method to complete, but it provides the most accurate estimate.

**Budget at completion (BAC)** The predicted budget for the project; what the project should cost when it is completed.

**Chart of accounts** A coding system used by the performing organisation's accounting system to account for the project work.

**Cost baseline** This shows what the project is expected to spend. It's usually shown in an S-curve and allows the project manager and management to predict when the project will be spending monies and over what duration. The purpose of the cost baseline is to measure and predict project performance.

**Cost budgeting** A process of assigning a cost to an individual work package. This process shows costs over time. The cost budget results in an S-curve that becomes the cost baseline for the project.

**Cost change control** This is part of the integrated change control system and documents the procedures to request, approve, and incorporate changes to project costs.

**Cost control** An active process to control the causes of cost changes, to document cost changes, and to monitor cost fluctuations within the project. When changes occur, the cost baseline must be updated.

**Cost estimating** The process of calculating the costs, by category, of the identified resources to complete the project work.

**Cost of conformance** The cost of completing the project work to satisfy the project scope and the expected level of quality. Examples include training, safety measures, and quality management activities.

**Cost of quality** The cost of quality is the expense of all the activities within a project to meet quality objectives.

**Cost performance index (CPI)** An index that measures how well the project is performing on cost:  $CPI = EV/AC$ .

**Cost variance** The Cost Variance (CV) is the difference between the earned value (EV) and the actual cost (AC).

**Earned value (EV)** The value of the work that has been completed and the budget for that work, the equation for which is  $EV = \%complete \times BAC$ .

**Earned value management** Earned value management integrates scope, schedule, and cost to give an objective, scalable point-in-time assessment of the project. Earned Value Management (EVM) calculates the performance of the project and compares current performance against

planned. Earned Value Management (EVM) can also be a harbinger of things to come. Results early in the project can predict the likelihood of the project's success or failure.

**Estimate at completion (EAC)** A hypothesis of what the total cost of the project will be. Before the project begins, the project manager completes an estimate for the project deliverables based on the WBS. As the project progresses, there will likely be some variances between what the cost estimate was and what the actual cost is. The EAC is calculated to predict what the new estimate at completion will be.

**Estimate to complete (ETC)** Represents how much more money is needed to complete the project work. Its formula is  $ETC = EAC - AC$ .

**Estimating publications** Typically, a commercial reference to help the project estimator confirm and predict the accuracy of estimates. If a project manager elects to use one of these commercial databases, the estimate should include a pointer to this document for future reference and verification.

**Parametric modelling** A mathematical model based on known parameters to predict the cost of a project. The parameters in the model can vary based on the type of work being done. A parameter can be cost per cubic yard, cost per unit, and so on.

**Planned value (PV)** The worth of the work that should be completed by a specific time in the project schedule.

**Risk** An unplanned event that can have a positive or negative influence on the project success.

**Schedule performance index (SPI)** The SPI reveals the efficiency of work. The closer the quotient is to 1, the better. Its equation is  $SPI = EV/PV$ .

**Schedule variance** The difference between the planned work and the earned work.

**Top-down estimating** A technique that bases the current project's estimate on the total of a similar project. A percentage of the similar project's total cost may be added to—or subtracted from—the total, depending on the size of the current project.

**Variance** The difference between what was planned and what was experienced; typically, used for costs and schedules.

**Variance at completion** The difference between the BAC and the EAC. Its formula is  $VAC = BAC - EAC$ .

## **Project Quality Management – Terminology**

**Balanced Matrix** A balanced matrix is where the power is balanced between project managers and functional managers

**Closing** Brings a formal, orderly end to the activities of a project phase or to the project itself

**Cost of Quality (COQ)** The costs incurred to ensure quality. The cost of quality includes quality planning, quality control, quality assurance, and rework.

**Deliverable** An output that must be produced, reviewed, and approved to bring the phase or project to completion.

**Executing** Involves putting the project management plan into action by coordinating and directing project resources to meet the objectives of the project plan

**Fast tracking** A schedule compression technique where two activities that were previously scheduled to start sequentially start at the same time. Fast tracking reduces schedule duration if applied to the critical path.

**Feasibility study** Feasibility studies are undertaken to determine if the project is a viable project, the probability of project success, and the viability of the product of the project.

**Functional organisation** A form of organisational structure. Functional organisations are traditional organisations with hierarchical reporting structures. The functional manager traditionally has more authority in this type of organisation than the project manager has.

**Handsoff** The process of ending one project life cycle phase and beginning the next.

**Historical information** An input to several Planning processes that refers to information or records regarding past projects and their performance. Records are available for reference on the existing project.

**Initiating** This is the first project management process group and generally the first phase of a project life cycle. It acknowledges that the

project, or the next phase in an active project, should begin.

**Inspection** A tool and technique of the Scope Verification, Perform Quality Control, and Contract Administration processes that involves physically looking at, measuring, or testing results to determine if they conform to the requirements of the quality standards.

**Iterative** To repeat processes more than once. The five process groups are repeated throughout the project's life due to change requests, responses to change, corrective action, and so on.

**Leaders** Leaders impart vision, gain consensus for strategic goals, establish direction, and inspire and motivate others.

**Managers** Managers focus on results and are concerned with getting the job done according to the requirements.

**Matrix organisation** A form of organisation structure. Employees in a matrix organisation report to one functional manager and at least one project manager. Functional managers assign employees to projects and carry out administrative duties, while project managers assign tasks associated with the project to team members and execute the project.

**Monitoring and Controlling** This is the fourth project management process group. The Monitoring and Controlling process group involves taking performance measurements and analysing them to determine if the project is staying true to the project plan. Corrective action is applied where necessary to get the project activities realigned with the project plan.

**Monitor and Control Project Work** Monitor and Control Project Work is concerned with monitoring all the processes in the Initiating, Planning, Executing, and Closing process groups. Collecting data, measuring results, and reporting on performance information are some of the activities performed during this process.

**Operations** An ongoing endeavor typically involving repetitive processes that produce the same results.

**Pareto charts** Pareto charts are a tool and technique of the Perform Quality Control process. They rank-order the most important factors such

as delays, costs, or defects by their frequency over time and are displayed as histograms.

**Perform Quality Assurance process** This process involves performing systematic quality activities and uses quality audits to determine which processes should be used to achieve the project requirements and to assure that they are performed efficiently and effectively.

**Perform Quality Control** This process is concerned with monitoring work results to see if they fulfill the quality standards set out in the quality management plan. The Perform Quality Control process determines if the end product conforms to the requirements and product description defined during the Planning processes.

**Performance Reporting** This process concerns collecting information regarding project progress and project accomplishments and reporting it to the stakeholders, project team members, management team, and other interested parties. It also makes predictions regarding future project performance.

**Planning** This is the second project management process group. The Planning process group consists of processes that involve formulating and revising project goals and objectives and creating the project management plan that will be used to achieve the goals the project was undertaken to address. Planning involves determining alternative courses of action and selecting from among the best of those to produce the project's goals. The Planning process group is where the project requirements are determined and stakeholders are identified.

**Politics** A technique used to influence people to perform. It involves getting groups of people with different interests to cooperate creatively even in the midst of conflict and disorder.

**Portfolio Management** The management of collections of programs and projects to meet and maximise the strategic objectives of the business. Involves monitoring active projects, balancing the portfolio among other investments, assuring efficient use of resources, and assessing the value of projects and potential projects against the

portfolio's strategic objectives.

**Portfolios** Collection of projects or programs that meet a specific business goal or objective.

**Power** A technique used to influence people to perform. It's the ability to get people to do things they wouldn't do otherwise, to change minds and the course of events, and to influence outcomes.

**Prevention** Keeps errors from occurring in the process. Prevention is a quality concern.

**Process analysis** Process analysis is a tool and technique of the Perform Quality Assurance process. It looks at process improvement from an organisational and technical perspective. Process analysis steps are documented in the process improvement plan and examine problems experienced while conducting the project, the constraints of the project, and inefficient and ineffective processes identified during process operation.

**Product verification** This determines if the work described in the contract was completed accurately and satisfactorily. It's one of the purposes of the Contract Closure process.

**Product scope** A description of the product features typically documented in the project description.

**Program management** The central management and coordination of groups of related projects and operations work to obtain benefits and administer controls that aren't possible when the projects and operations are managed individually to achieve the program's strategic objectives.

**Programs** A grouping of projects that are managed together. The individual projects are usually part of one bigger project and are therefore related.

**Progressive elaboration** The process of taking incremental steps to examine and refine the characteristics of the product of the project. Processes may be progressively elaborated as well.

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ensures proper and timely communications and includes these processes: Communications Planning; Information Distribution, Performance Reporting, and Manage Stakeholders.

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**Project life cycle** The grouping of project phases in a sequential order from the beginning of the project to the close.

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**Project Managers** The individual responsible for managing a project

**Project Procurement Management** A subset of project management

that includes the processes required to acquire goods and services to attain project scope from outside the performing organisation. It consists of procurement planning, solicitation planning, solicitation, source selection, contract administration, and contract closeout

**Project Quality Management** A subset of project management that includes the processes required to ensure that the project will satisfy the needs for which it was undertaken. It consists of quality planning, quality assurance, and quality control.

**Project Risk Management** Risk management is the systematic process of identifying, analysing, and responding to project risk. It includes maximising the probability and consequences of positive events and minimising the probability and consequences of events adverse to project objectives. It includes the processes of risk management planning, risk identification, qualitative risk analysis, quantitative risk analysis, risk response planning, and risk monitoring and control.

**Project Scope** The work that must be done to deliver a product with the specified features and functions.

**Project Scope Management** A subset of project management that includes the processes required to ensure that the project includes all of the work required, and only the work required, to complete the project successfully. It consists of initiation, scope planning, scope definition, scope verification, and scope change control.

**Project Sponsor** Usually an executive in the organisation. The project sponsor has the authority to assign resources and enforce decisions regarding the project.

**Project Time Management** A subset of project management that includes the processes required to ensure timely completion of the project. It consists of activity definition, activity sequencing, activity duration estimating, schedule development, and schedule control.

**Projectised Organisations** Any organisational structure in which the project manager has full authority to assign priorities and to direct the work of individuals assigned to the project.

**Projects** A temporary endeavor undertaken to create a unique product, service, or result.

**Rework** Failing to meet quality requirements or standards may result in rework (performing the work again to make it conform). Rework may increase the project schedule.

**Run chart** Run chart is a tool and technique of the Perform Quality Control process that are used to show variation in the process over time. They may also show trends in the process.

**Scatter diagrams** Scatter diagrams are a tool and technique of the Perform Quality Control process. They use two variables, an independent variable, which is an input, and a dependent variable, which is an output, to display the relationship between these two elements as points on a graph.

**Stakeholders** Individuals and organisations that are actively involved in the project, or whose interests may be positively or negatively affected as a result of project execution or project completion. They may also exert influence over the project and its results.

**Statistical sampling** Taking a sample number of parts from the whole population and examining them to determine if they fall within the variances outlined by the quality control plan. Statistical sampling is a tool and technique of the Perform Quality Control process.

**Tailoring** The tailoring of requirements is the responsibility of the acquirer (customer), suggested tailoring may be provided by prospective and selected developers (prior to contract agreement).

**Technical performance measurements** These measurements are usually determined during trend analysis (which is used with the run chart tool and technique of the Perform Quality Control process) to compare the technical accomplishments of project milestones completed to the technical milestones defined in the project planning processes.

**Tolerable results** Quality measurements that fall within a specified range. Tolerable results are a concern of the Perform Quality Control process. These are also known as tolerances.

## **Project Human Resource Management – Terminology**

**360-degree appraisal** – a form of project performance appraisal (tool and technique of the Manage project process) that solicit feedback from everyone the team member interacts with, including stakeholders, customers, project managers, peers, subordinates, and others

**Coercive power** The type of power that comes with the authority to discipline the project team members. This is also known as “penalty power.” Generally used to describe the power structure when the team is afraid of the project manager.

**Collective bargaining agreements** These are contractual agreements initiated by employee groups, unions, or other labor organisations; they may act as a constraint on the project.

**Compromising** - A conflict resolution method; this approach requires both parties to give up something. The decision ultimately made is a blend of both sides of the argument. Because neither party completely wins, it is considered a lose-lose solution.

**Expectancy Theory** - People will behave on the basis of what they expect as a result of their behavior. In other words, people will work in relation to the expected reward of their work.

**Expert power** - A type of power where the authority of the project manager comes from experience with the area that the project focuses on.

**Forcing** - A conflict resolution method where one person dominates or forces their point of view or solution to a conflict.

**Formal power** - The type of power where the project manager has been assigned by senior management to be in charge of the project.

**Herzberg's Theory of Motivation** - This posits that there are two catalysts for workers: hygiene agents and motivating agents. Hygiene agents do nothing to motivate employees, but their absence can demotivate workers. Hygiene agents are the expectations all workers have, such as job security, paychecks, clean and safe working conditions, a sense of belonging, civil working relationships, and other basic attributes associated with employment. Motivating agents are components such as reward, recognition, promotion, and other values that encourage individuals to succeed.

**Maslow's Hierarchy of Needs** - A theory stating there are five layers of needs for all humans: physiological, safety, social, esteem, and the crowning jewel, self-actualisation.

**Matrix structures** An organisational structure. There are three matrix structures: weak, balanced, and strong. The different structures are reflective of the project manager's authority in relation to the functional manager's authority.

**McGregor's Theory of X and Y** This theory states that "X" people are lazy, don't want to work, and need to be micromanaged. "Y" people, on the other hand, are self-led, motivated, and strive for accomplishments.

**Ouchi's Theory Z** - This theory posits that workers are motivated by a sense of commitment, opportunity, and advancement. Thus, employees will work if they are challenged and motivated.

**Problem solving** - The ability to determine the best solution for a problem in a quick and efficient manner.

**Referent power** - Power that is present when the project team is attracted to, or wants to work on the project with, the project manager.

Referent power also exists when the project manager references another more powerful person, such as the CEO.

**Resource histogram** - A bar chart reflecting when individual employees, groups, or communities are involved in a project. Often used by management to see when employees are most or least active in a project.

**Responsibility** - Who decides what in a project.

**Reward power** - The project manager's authority to reward the project team.

**Role** - Who decides what in a project.

**Smoothing** - A conflict resolution method that "smooths" out the conflict by minimising its size. It is a temporary solution, but it can calm team relations and reduce the boisterousness of discussions. Smoothing may be acceptable when time is of the essence or any of the proposed solutions will work.

**Staffing management plan** - This subsidiary plan documents how project team members will be brought onto the project and excused from it.

**War room** - A centralised office or locale for the project manager and the project team to work on the project. It can house information on the project, including documentation and support materials. It allows the project team to work in close proximity.

**Withdrawal** A conflict resolution method that is used when the issue is not important or the project manager is out-ranked. The project manager pushes the issue aside for later resolution. It can also be used as a method for cooling down. The conflict is not resolved, and it is considered

a yield-lose solution.

## **Project Communication Management – Terminology**

**Active listening:** This occurs when the receiver confirms the message is being received. It can be done by way of feedback, questions, prompts for clarity, and other signs of having received the message.

**Communications management plan:** A plan that documents and organises the stakeholder needs for communication. This plan covers the communications system, its documentation, the flow of communication, modalities of communication, schedules for communications, information retrieval, and any other stakeholder requirements for communications.

**Decoder:** This is a part of the communications model; it is the inverse of the encoder. If a message is encoded, a decoder translates it back to a usable format.

**Effective listening:** The receiver is involved in the listening experience by paying attention to visual cues given by the speaker, as well as paralingual intentions, and by asking relevant questions.

**Encoder:** Part of the communications model; the device or technology that packages the message to travel over the medium.

**Feedback:** A response, question for clarification, or other confirmation once a sent message is received.

**Forecasting:** An educated estimate of how long the project will take to complete. Can also refer to how much the project may cost to complete.

**Issues:** A point or matter in question or dispute, or a point or matter that is not settled and is under discussion or over which there are opposing views or disagreements.

**Medium:** Part of the communications model—the path the message takes from the sender to the receiver. This is the modality in which the communication travels, and typically refers to an electronic model, such as e-mail or the telephone.

**$N(N - 1) / 2$ : Communication channel formula** A formula to predict the number of communication channels within a project; the formula is  $N(N - 1)/2$ , where  $N$  represents the number of stakeholders.

**Nonverbal Communication:** Approximately 55 percent of oral communication is nonverbal. Facial expressions, hand gestures, and body language contribute to the message.

**Paralingual:** The pitch, tone, and inflections in the sender's voice that affect the message being sent.

**Progress reports:** These provide current information on the project work completed to date.

**Receiver:** Part of the communications model: the recipient of the message.

**Sender:** Part of the communications model: the person or group delivering the message to the receiver.

**Status reports:** These provide current information on the project cost, budget, scope, and other relevant information.

## **Project Risk Management – Terminology**

**Acceptance:** This is a response to a risk event, generally made when the probability of the event and/or its impact are small. It is used when mitigation, transference, or avoidance are not selected.

**Avoidance:** This is one response to a risk event. The risk is avoided by planning a different technique to remove the risk from the project.

**Brainstorming:** The most common approach to risk identification; it is performed by a project team to identify the risks within the project. A multidisciplinary team, hosted by a project facilitator, can also perform brainstorming.

**Cause-and-effect diagrams: (also called Ishikawa diagrams and fishbone diagrams)** Used for root cause analysis of what factors are creating the risks within the project. The goal is to identify and treat the root of the problem, not the symptom.

**Contingency reserve:** A time or dollar amount allotted as a response to risk events that may occur within a project.

**Decision tree analysis:** A type of analysis that determines which of two decisions is the best. The decision tree assists in calculating the value of the decision and determining which decision costs the least.

**Delphi Technique:** A method to query experts anonymously on foreseeable risks within the project, a phase of the project, or one of its components. The results of the survey are analysed and organised and then circulated to the experts. Several rounds of anonymous discussions can be held using the Delphi Technique. The goal is to gain a consensus on project risks, and the anonymous nature of the process ensures that no one expert's advice overtly influences the opinion of any other participant.

**Enhance:** To enhance a risk is to attempt to modify its probability and/or its impact in order to realise the most gains from the identified risk.

**Exploit:** Action where the organisation wants to ensure that the identified risk does happen to realise the positive impact associated with the risk event.

**Influence diagram:** An influence diagram charts out a decision problem. It identifies all of the elements, variables, decisions, and objectives and how each factor may influence another.

**Interviewing:** Interviewing subject-matter experts and project

stakeholders is an approach to identify risks on the current project based on the interviewees' experience.

**Qualitative risk analysis:** An examination and prioritisation of the risks based on their probability of occurring and the impact on the project if they do occur. Qualitative risk analysis guides the risk reaction process.

**Quantitative risk analysis:** A numerical assessment of the probability and impact of the identified risks. Quantitative risk analysis also creates an overall risk score for the project.

**Residual risks:** Risks that are left over after mitigation, transference, and avoidance. These are generally accepted risks. Management may elect to add contingency costs and time to account for the residual risks within the project.

**Risk:** An unplanned event that can have a positive or negative influence on the project success.

**Risk categories** These help organise, rank, and isolate risks within the project.

**Risk database** A database of recognised risks; the planned response and the outcome of the risk should be documented and recorded in an organisation-wide risk database. The risk database can serve other project managers as historical information. Over time, the risk database can become a Risk Lessons Learned program.

**Risk management plan** A subsidiary project plan for determining how risks will be identified, how quantitative and qualitative analysis will be completed, how risk response planning will happen, how risks will be monitored, and how ongoing risk management activities will occur throughout the project life cycle.

**Risk owners** The individuals or groups responsible for a risk response.

**Risk register:** The document containing the results of the qualitative risk analysis, quantitative risk analysis, and risk response planning. The risk register details all identified risks, including description, category, cause, probability of occurring, impact, on objectives, proposed responses, owners, and current status. The risk register is a component of the project management plan.

**Scales of probability and impact:** Each risk is assessed according to its likelihood and its impact. There are two approaches to ranking risks: Cardinal scales identify the probability and impact by a numerical value, ranging from .01 as very low to 1.0 as certain. Ordinal scales, on the other hand, identify and rank the risks descriptively from "very high" to

“very unlikely.”

**Secondary risks:** Risks that stem from risk responses. For example, the response of transference may call for hiring a third party to manage an identified risk. A secondary risk caused by the solution is the failure of the third party to complete its assignment as scheduled. Secondary risks must be identified, analysed, and planned for just as any identified risk.

**Sensitivity analysis:** This examines each project risk on its own merit to assess the impact on the project. All other risks in the project are set at a baseline value.

**Share:** Sharing is nice. When sharing the risk, ownership is transferred to the organisation that can most capitalise on the risk opportunity.

**Simulation:** These allow the project team to play “what-if” games without affecting any areas of production.

**System or process flowcharts:** These show the relation between components and how the overall process works. They are useful for identifying risks between system components.

**Transference:** A response to risks in which the responsibility and ownership of the risk is transferred to another party (for example, through insurance).

**Triggers:** Warning signs or symptoms that a risk has occurred or is about to occur (for example, a vendor failed to complete its portion of the project as scheduled).

**Utility function:** A person’s willingness to accept risk.

**Workarounds:** Workarounds are unplanned responses to risks that were not identified or accepted.

## **Project Procurement Management - Terminology**

**Contract Management Plan** A document outlining strategies for management of a contract including but not limited to roles and responsibilities, timelines, performance management and financial matters.

**Contract Variation** A contract variation is an additional or alternation of the products or services provided under a contract that is within the general scope of original contract.

**Expression of Interest (EOI)** The first of a two stage publicly advertised tender process. Registration of interest are invited, responses evaluated and short-listed of possible providers identified. The second stage is where short-listed bidders are asked to respond for tender.

**Evaluation Criteria** A list of measures used to assess the suitability of a tender against the tender specifications.

**Intellectual Property** Legally protected property such as copyright, patents, and registered designs, as well as ideas and information of commercial value which an organisation has developed.

**Probity** Honest, proper, fair and ethical conduct, especially in relation to tendering processes.

**Purchase Order** A document generated by an organisation's financial management system which shows that purchase details have been recorded and payment will be made.

**Risk Management** The identification, assessment, allocation, mitigation and monitoring of risks associated with a project.

**Request for Tender (RFT)** A publicly advertised method of seeking offers from providers or suppliers based on a written statement or specification of the required products and/or services.

**Request for Quotation (RFQ)** An invitation to selected supplier to make an offer to supply products or services. A RFQ is generally used for low value purchases.

**Specification** A statement which clearly and accurately describes the essential requirements for products, products or services. Specification may also include the procedures by which it will be determined that the requirements have been met.

**Standing Offer Agreement** A contract that sets out rates for products and services which are available for the term of the agreement. However, no commitment is made under the agreement to purchase a specified value or quantity of products or services.

**Tender** The process of inviting parties to submit an offer by public advertisement, followed by evaluation of offers and selecting a successful bidder. The document containing an offer from an organisation responding to a request for tender.

**Tenderer** A party submitting the tender.

**Tender Briefing** A forum held where project representatives briefs prospective tenderers regarding a tender process, and responds to questions.

## **E. References**

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