PROJECT MANAGEMENT

STUDY GUIDE

PROGRAMME	:	**MBA Final Year**
CREDIT POINTS	:	**20 points**
NOTIONAL LEARNING	:	**200 hours over 1 semester**

REF:PM 2013

AIMS OF THE MODULE

The broad aims of this module are to:

- Provide an overview of the concepts and techniques used in generic project management.
- Equip the learner with specific knowledge on effective management of the constraints in project management, namely scope, cost, quality and time.
- Enable the learner to apply common techniques and tools used in project management to manage scope, time, cost and quality.
- Equip the learner with leadership skills to ensure proper management of human resources in project management.
- Ensure learners are familiar with project resource management, including project financial management.
- Provide knowledge on tools and techniques to ensure effective project communication and risk management.

OUTCOMES OF THE MODULE

Upon completion of this programme, students should be able to:

- Understand and apply generic project management concepts and definitions.
- Understand the significance and impact of and relationship among the constraints in a project environment.
- Demonstrate an understanding of the use of common tools and techniques used in the different stages of a project life cycle.
- Effectively apply common project management tools and techniques, such as Work Breakdown Structures, Gantt charts, Network diagrams and Critical Path Method, to manage project scope and time.
- Demonstrate an understanding of potential project resource problems, and apply project tools to alleviate these problems.
- Apply communication and risk management tools and techniques in a project management environment.
- Demonstrate an understanding of leadership expertise required to successfully manage and lead project teams, and to network with various project stakeholders.
- Understand project quality concepts, and apply tools used to monitor and improve project quality at different stages of the project life cycle.

Each section of the module has a more detailed list of outcomes.

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INTRODUCTION

1. Welcome

Welcome to the Master of Business Administration Final Year Programme. As part of your studies, you are required to study and successfully complete this elective module on Project Management.

2. Context of the Module

Project management is not uniquely confined to a specific context, and is a very adaptable field that can be applied to the manufacturing and services sectors across various industries. This module uses a variety of references so that students are to able apply the principles and concepts of project management to various manufacturing and production, scenarios at local and international facilities across most industries. The prescribed and recommended textbooks provide useful examples and some cases studies which enable one to apply the principles and concepts of project management in different contexts.

3. How to use this Module

This module should be studied using this Study Guide and the prescribed textbook. You should read about the topic that you intend to study in the appropriate section of this Study Guide before you start reading in detail in the prescribed and recommended textbooks. Ensure that you make your own notes/summaries as you work through the textbooks, other learning resources and this Study Guide.

At the commencement of each section of this Study Guide, you will find a list of learning outcomes. These learning outcomes outline the main points that you should understand when you have completed the section with its supporting chapters in the prescribed textbooks. Avoid reading all the material at once. Each study session should be no longer than two hours without a break.

As you work through the Study Guide you may come across:

- Think Points
- Activities
- Reading Activities
- Self Assessment Activities
- Study Group Discussion Activities

These are designed to help you study and prepare for the assignment and examination.

? **THINK POINT**

A think point asks you to stop and think about an issue. Sometimes you are asked to apply a concept to your own experience or to think of an example.

 **ACTIVITY**

You may come across activities which ask you to carry out specific tasks. The aim of these activities is to give you an opportunity to apply what you have learnt and / or explore an issue relevant to the particular section.

 **READING ACTIVITY**

Some sections of this Study Guide contain a reading activity. The reading activity requires that you read one or more of the recommended texts and then answer questions relevant to that text / document. Some of the recommended texts are available from the Emerald library facility and/or ***My Mancosa*** which learners may access via MANCOSA's website.

 **SELF ASSESSMENT ACTIVITY**

You may come across self-assessment questions which will test your understanding of what you have learnt so far. You should refer to the Study Guide and prescribed textbooks when attempting to answer the self-check activities.

 **STUDY GROUP DISCUSSION ACTIVITY**

Study group discussion activities may be provided at the end of each section of this Study Guide. You must have worked through the relevant section and supporting chapters in the prescribed textbooks prior to meeting as a study group. The study group discussion activities provide an opportunity for learners to apply what they have learnt, to share experiences with fellow learners and to learn from each other.

4. Reading

• Prescribed Textbook

Several recommended readings are provided in each section of the module guide. However, the textbook that has been prescribed for this module is:

Clements, J. P. and Gido, J. (2011). Effective Project Management. 5th Edition. Boston: Cengage Learning.

• Recommended Reading

Each section has a list of recommended reading material, which will allow you to develop an understanding of the issues beyond the perspective of the prescribed textbook and Study Guide. The following material is recommended in addition to the prescribed textbook:

Burke, R. (2009). Project Management Techniques. College Edition. Hampshire: Burke Publishing.

Burke, R.J. and Barron, S. (2007). Project Management Leadership. Hampshire: Burke Publishing.

Heizer, J. and Render, B. (2010). "Project Management" (Ch. 3) in Operations Management. 10th Edition. New Jersey: Pearson Education Inc.

PMI (2004). A Guide to the Project Management Body of Knowledge (PMBOK Guide). 3rd Edition. Pennsylvania: Project Management Institute.

Schwalbe, K. (2009). Introduction to Project Management. 2nd Edition. Boston: Cengage Learning.

5. Module Assessment

• **Assignment:** You will be required to complete and submit an assignment. This assignment is assessed as part of your coursework. Therefore, it is very important that you complete it.

• **Examination:** A three-hour examination will be written at the end of the semester. The assessment strategy will focus more on application of theory to practice.

SECTION 1

1. INTRODUCTION TO PROJECT MANAGEMENT

CONTENTS

Learning outcomes

Reading Material

1.1 Introduction

1.2 Definition and attributes of a project

1.3 Project constraints

1.4 The project life cycle

1.5 Summary of the project management process

1.6 Reasons for successful project management

1.7 Conclusion

Learning Outcomes:

The overall outcome for this section is that, on its completion, the learner should be able to demonstrate a basic understanding of the field of project management. This overall outcome will be achieved through the learner's mastery of the following specific outcomes, in that the learner will be able to:

1. Understand the definition and attributes of project management.
2. Explain the project constraints and project environment model.
3. Clearly explain the project life cycle in project management.
4. Provide a summary of the project management process.
5. Discuss the reasons for successful project management.

Reading Material:

READING

Prescribed reading:

Clements, J. P. and Gido, J. (2011). Effective Project Management. 5th Edition. Boston: Cengage Learning.

Recommended reading:

Heizer, J. and Render, B. (2010). "Project Management" (Ch. 3) in Operations Management. 10th Edition. New Jersey: Pearson Education Inc.

PMI (2004). A Guide to the Project Management Body of Knowledge (PMBOK Guide). 3rd Edition. Pennsylvania: Project Management Institute.

Schwalbe, K. (2009). Introduction to Project Management. 2nd Edition. Boston: Cengage Learning.

Pycraft, M., Singh, H., Phihlela, K., Slack, N., Chambers, S. and Johnston, R. (2010). Operations Management. 2nd Edition. Cape Town: Pearson Education South Africa (Pty) Ltd.

1.1 Introduction

Project Management is the application of knowledge, skills, tools and techniques to satisfy stakeholder expectations from a project (PMBOK Guide, 2004). According to Pycraft et al. (2010:461), project planning and control is important because all managers will, at some point, get involved in managing projects. Project management is also an essential skill for all general managers as new strategies can only be implemented through the careful selection and implementation of projects (Pycraft et al., 2010:461). Due to time-based competition and a quality mandate in current business, the value of project management as a strategic asset is realised.

READING ACTIVITY

Read the Case Study entitled "*Feds and Contractor Share Blame for Afghan Plant Delays*" (Chapter 1, page 2) in Clements and Gido (2011). Identify the major pitfalls of the contractors and subcontractors involved in the project. What could have been done more effectively to avoid these problems?

1.2 Definition and attributes of a project

Clements and Gido (2011:4) define a project as an "*endeavour to accomplish a specific objective through a unique set of interrelated tasks and the effective utilisation of resources*." Heizer and Render (2010:90) define a project as "*a series of related tasks directed toward a major output*." A project is a temporary endeavour undertaken to create a unique product, service or result (PMBOK Guide, 2004). All projects have some elements in common and, according to Pycraft et al. (2010:464), these include:

- *An objective*. A definable end result, output or product, which is defined in terms of cost, quality and timing.

- *Complexity*. Several tasks are required to be undertaken to achieve the objectives. The relationship between all these tasks can be extremely complex.
- *Uniqueness*. A project is usually a one-off undertaking.
- *Uncertainty*. As all projects are planned before they are executed, they carry a certain amount of risk.
- *Life cycle*. Projects normally go through three phases – planning, execution and phase-out.
- *Temporary nature*. Resources may be moved from one project to the next once the tasks have been completed.

READING ACTIVITY

Read the section entitled "Project Attributes" on page 4 of Chapter 1 in Clements and Gido (2011) and briefly describe each of the following ***project attributes***:

1. Clear objective: _____

_____

2. Interdependent tasks: _____

_____

3. Resource utilisation: _____

_____

4. Specific time frame: _____

_____

5. Unique or one-time endeavour: _____

_____

6. Project sponsor or customer: _____

_____

7. Degree of uncertainty: _____

_____

1.3 Project constraints

Like any human undertaking, projects need to be performed and delivered under certain constraints. Burke (2009:36) illustrates the relationship between time, cost and scope (the "triple constraint"), where a change in one parameter can affect the others (refer to Figure 1.1). This is accompanied by quality, the organisation breakdown structure (OBS), and an awareness of external issues in the environment. The *time* constraint refers to the amount of time available to complete a project. The *cost* constraint refers to the budgeted amount available for the project. The *scope* constraint refers to what must be done to produce the project's end result. These three constraints are often competing constraints: increased scope typically means increased time and increased cost, a tight time constraint could mean increased costs and reduced scope, and a tight budget could mean increased time and reduced scope.

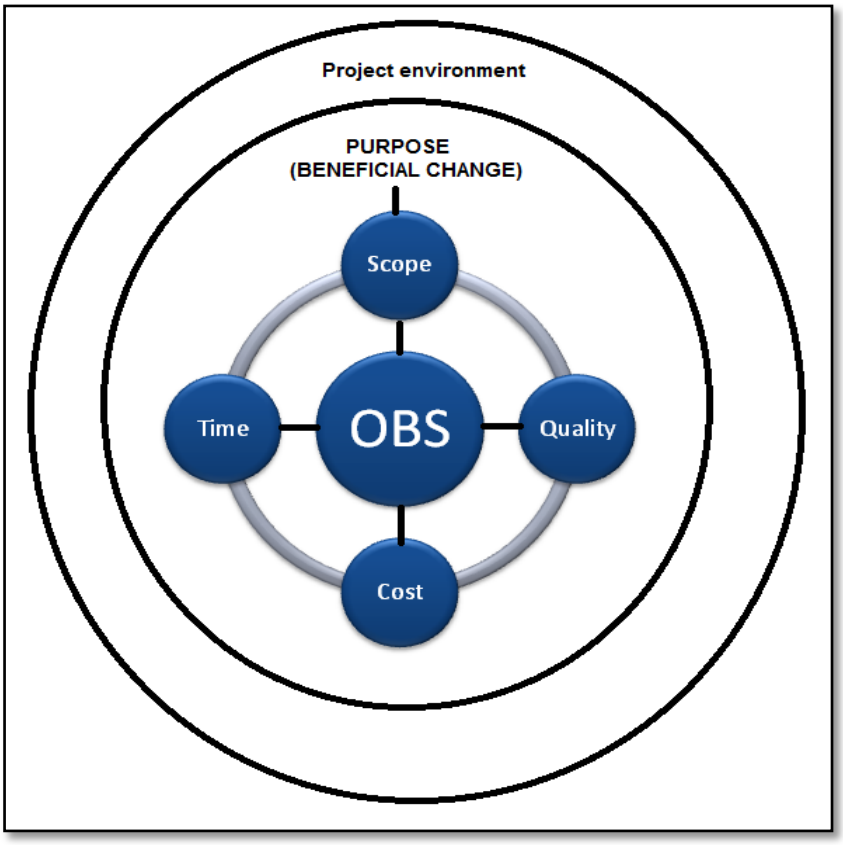


Figure 1.1: The Project Environmental Model (Source: Burke, 2009:36).

Clements and Gido (2011:6) also explain the project constraints consisting of scope, quality, schedule (time), budget, resources, risks and customer satisfaction. These constraints have to be considered before and during the planning and execution of a project.

1.4 The project life cycle

Project management is achieved by applying and integrating project management processes which include: initiating, planning, executing, control and monitoring, and closing. These are referred to as ***process groups*** and they dictate the life cycle of a project. Apart from process groups there are ***knowledge areas***, which are the backbone and knowledge base of project management. The knowledge areas consist of project integration, scope, time, cost, quality, human resources, communications, risk, and procurement management.

The four generic phases of a project life cycle (Figure 1.2) are: initiating, planning, performing (executing) and closing the project (Clements and Gido, 2011:9).

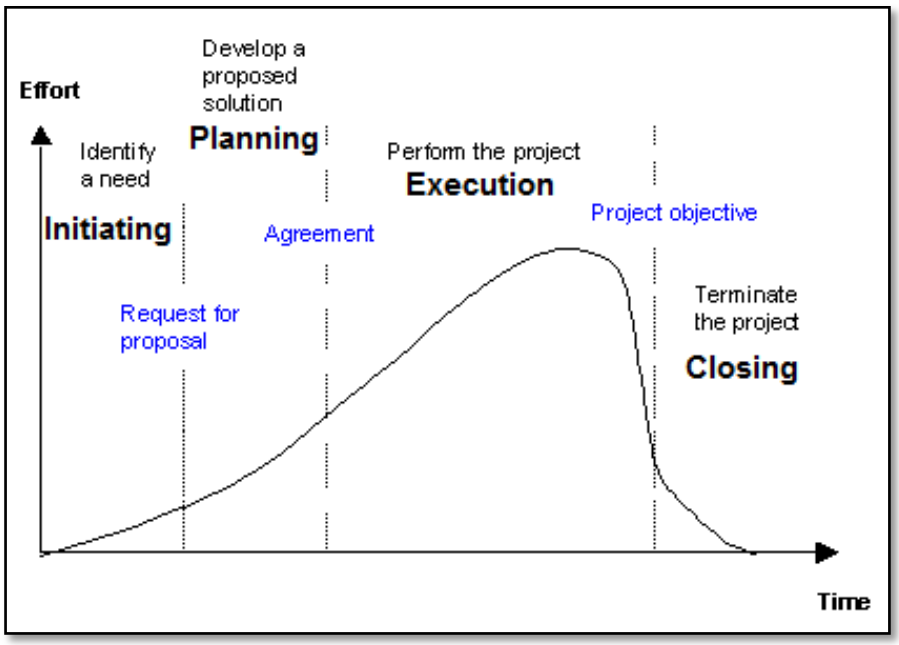


Figure 1.2: Project Life Cycle Effort (Adapted from Clements and Gido, 2011:9).

Alternatively, Pycraft et al. (2010) state that the three stages of a project are planning, execution and phase-out. However, according the Heizer and Render (2010), projects are divided into three phases, namely planning, scheduling and controlling.

Planning: includes goal setting, defining the project and team organisation.

Scheduling: relates people, money and supplies to specific activities and relates activities to each other.

Controlling: the firm monitors resources, costs, quality and budgets, and it also revises or changes plans to meet time and cost demands (Heizer and Render, 2010:90).

ACTIVITY

You have been tasked with the construction of a house. Using the project life cycle stages/phases, identify the activities that must be performed at each stage.

1.4.1 Project initiation

Projects are first selected based on the identification of a need, problem or opportunity. A sponsor of a project usually identifies these needs and provides the funds necessary for the project. Apart from the sponsor, a range of project *stakeholders* must also be identified in this phase of the project. The following is a list of typical stakeholders in a project:

- Project Sponsor – The person that provides the financial resources for the project.
- Project Manager – The single point responsibility of a project.
- PMO – The project management office provides support to the project.
- Customer or user – This is the person or entity that will use the project's product.
- Project management team – the members of the project team who are directly involved in executing the project management functions.
- Influencers – People or groups who are directly or indirectly interested or affected by the project. They can also influence the project positively or negatively.
- Investors – A person or entity making the investment in a project.
- Contractor – A contractor is normally the person or organization that is entrusted with supplying the services and/or goods to achieve project deliverables.
- Government – The government is in most cases a stakeholder in projects whether they are public or private sector projects because it has an interest in the project, e.g. collecting taxes.

1.4.1.1 Project Selection

Clements and Gido (2011:33) explain the following four steps in the selection of a project:

i. Develop a set of criteria against which the project will be evaluated. This must take into account, *inter alia*, the company goals, sales volume and market share, investment, risks, resources, competitors, regulations, etc.
ii. List the assumptions that will be used as the basis for each project.
iii. Gather data and information for each project.
iv. Evaluate each project against the identified criteria.

According to Schwalbe (2009), project selection may take place using one or more of the following methods:

- Focus on strategy and organisational needs
- Performing a financial model
- Using weighted scoring model
- Implementing a balanced scorecard
- Addressing problems, opportunities and directives
- Considering project time frames, and
- Considering project priorities.

1.4.1.2 Project Charter

Once a project is selected, it is formally authorised and primed using a *project charter* (Clements and Gido, 2011). The project charter includes the rationale or justification for the project and is usually the first official document that initiates a project.

ACTIVITY

Using the prescribed and recommended texts, identify the contents of a project charter and draft such a document for a project of your choice. Hint: Refer to Chapter 2 of Clements and Gido (2011:36-40) or Schwalbe (2009:90).

The typical contents of a *project charter* are:

- Project title and date of authorisation
- Background to the project
- Key assumptions
- Business needs and other commercial needs
- Scope of work
- Key milestones
- Project scheduling including estimated start and finish dates
- Project estimated budget
- Approach
- Roles and responsibilities of project team and project organisation.

1.4.1.3 Project Request for Proposal

A project that is outsourced requires the preparation of a Request for Proposal (RFP) document, the contents of which are outlined below (Clements and Gido, 2011):

- Project objective
- Statement of Work (SOW)
- Customer requirements
- Deliverables
- Acceptance criteria
- Customer-supplied items
- Approvals required by the customer
- Type of contract the customer intends to use
- Payment terms
- Required schedule for completion of the project and key milestones
- Instructions for the format and content of the contractor proposals
- Due date for proposals
- Evaluation criteria
- Funds that may be available for the project

1.4.1.4 Project Statement of Work

Schwalbe (2009) illustrate a typical Statement of Work (Figure 1.3) which also includes elements of a comprehensive RFP.

Contract Statement of Work
August 1, 2009

Project Name: Just-in-Time Training Project
Contract Name: Qualified-Sellers List
Scope of Work:
1. Develop a list of qualified sellers to develop and provide the training as described in Appendix A.
2. Provide a summary description and detailed evaluation of each seller. Provide company brochures, Web sites, annual reports, and other appropriate information.
3. Work with Global Construction to develop an evaluation system to assess each seller.
4. Provide an objective assessment of each seller using this evaluation system.
5. Develop a list of the top five sellers for each course.
6. Provide recommendations for developing partnerships/relationships with each of the top five sellers.
7. Complete the above work no later than September 9, 2009.

Location of Work:
The seller can perform the work at any location. The seller must physically meet with representatives from Global Construction in our corporate office at least twice during the term of the contract.

Period of Performance:
Work is expected to start on or around August 20, 2009, and end no later than September 9, 2009. The seller will prepare a detailed schedule for all work required, including dates for deliverables and meetings. After meeting with representatives from Global Construction to review and update the schedule, the seller will agree to the schedule for this work.

Deliverables Schedule:
The seller will prepare a detailed schedule for all of the work required, including dates for all deliverables and meetings. After meeting with representatives from Global Construction to review and update the schedule, the seller will agree to the schedule for this work.

Applicable Standards:
The seller will use standard software to produce the required documentation for this project. Draft and final documents will be sent via e-mail.

Acceptance Criteria:
The seller will work closely with the project manager, Kristin Maur, to clarify expectations and avoid problems in providing acceptable work. Kristin will provide written acceptance/non-acceptance of all deliverables.

Special Requirements:
The seller's staff assigned to work on this contract must have appropriate education and experience. Resumes of proposed staff will be provided as part of the proposal. The seller will work with Global Construction to make all travel arrangements and minimize travel costs.

Figure 1.3: Statement of Work with elements of a comprehensive RFP (Source: Schwalbe, 2009).

1.4.2 Project planning

The purposes of project planning are as follows:

- It determines the cost and duration of the project.
- It determines the level of resources that will be needed.
- It helps to allocate work and to monitor progress (who is responsible for what).
- It helps to assess the impact of any changes to the project (Pycraft et al., 2010).

Planning the project involves determining what needs to be done (scope, deliverables), how it will get done (sequence of activities), who will perform it (human resources), how long it will take (schedule), how much it will cost (budget) and what the risks are (Clements and Gido, 2011). These important considerations are generally included in a comprehensive project proposal (***Refer to Chapter 3 of Clements ad Gido, 2011***).

Planning may have to be carried out more than once during a project, due to changing circumstances and demands. The result of the planning process is a **baseline plan** (Clements and Gido, 2011:19). The basic stages in the planning process are illustrated in Figure 1.4.

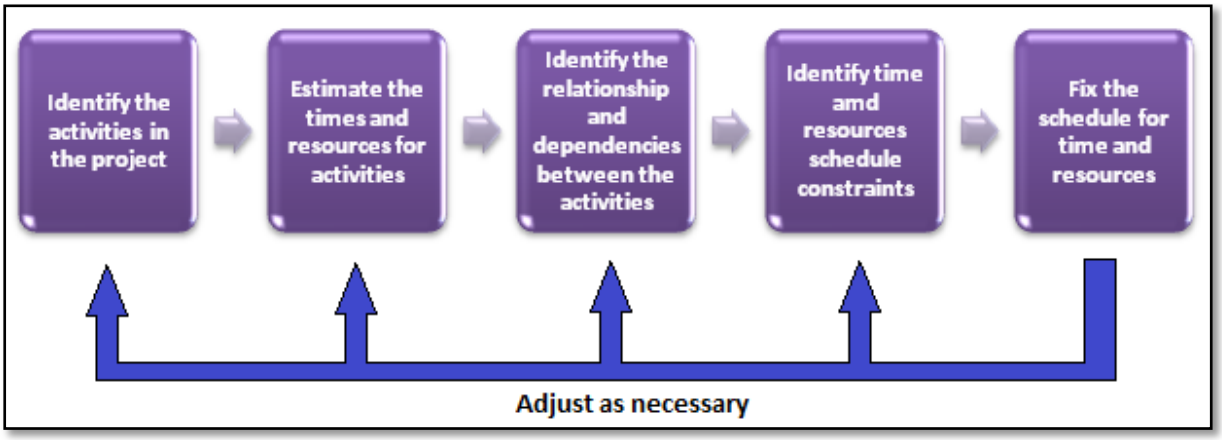


Figure 1.4: Stages in the project planning process (Source: Pycraft et al., 2010:472).

Preparing a project proposal is often a task that managers are presented with when they have identified a project that will enable them to solve a problem or fulfil a business opportunity. The essential elements of a project proposal are:

- Statement of customer's need or problem
- Assumptions

- Project scope
- Deliverables
- Resources
- Schedule of the project
- Price considerations
- Risks
- Expected benefits

? **THINK POINT**

Suppose you were the sponsor of a large project involving the construction of a hotel. What would be some of the critical success factors you would assess in the project proposal handed over to you for evaluation and approval?

1.4.3 Project execution (performing)

After planning the project, the third phase involves the accomplishment of the project objective(s) (Clements and Gido, 2011). 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.

Project execution entails fulfilling the deliverables of the project within the client's accepted specifications and budget and time constraints. The function that matters most during this phase is the monitoring and control of progress to ensure that everything is going according to plan.

Key outputs of the ***executing process*** relating to the project integration management include: project deliverables, requested changes, implemented change requests, implemented corrective actions, implemented preventive actions, and implemented defect repair. ***Executing outputs*** relating to project *quality* management include: requested changes, recommended corrective actions, organizational process assets update, and updated project management plans. Executing outputs relating to project *human resources* management knowledge area include: project staff assignments, resource availability, updated staffing management plan and, team performance assessment.

During this phase, monitoring and controlling project work involves collecting, measuring, and disseminating performance information as well as assessing measurements and analyzing trends to determine what process improvements can be made. On the other hand, performing integrated change control involves identifying, evaluating, and managing changes throughout the project's life cycle. Every project will experience changes at one point or another. It is therefore important to develop a process of monitoring controlling and documenting project changes.

1.4.4 Project closure

The closing process group is the most neglected project phase of all the phases in a project. This phase includes processes used to formally terminate all the activities of the project or phase. The project success or failure is evaluated and the project is handed over to the client. The project experiences or lessons learnt are documented. Closing projects involves stakeholder and customer acceptance of the final product or service, and bringing the project to an orderly end.

1.5 Summary of the project management process

According to Clements and Gido (2011), the project management process comprises the following steps:

i. Establish project objective.
ii. Define the scope.
iii. Create a work breakdown structure (WBS) by subdividing the scope into pieces or work packages.
iv. Assign responsibilities.
v. Define specific activities.
vi. Sequence the activities using a network diagram.

vii. Estimate activity resources.
viii. Estimate activity durations.
ix. Develop a project schedule.
x. Estimate activity costs.
xi. Determine the budget.

1.6 Reasons for successful project management

Pycraft et al. (2010:466) outline the following factors that can contribute to the success of a project:

- ***Clearly defined goals*.** This should include the general project philosophy or general mission of the project and a commitment to those goals on the part of the project team members.
- ***Competent project manager*.** A skilled leader who has the technical, interpersonal and administrative skills.
- ***Top-management support.*** Senior management commitment to the project must be openly displayed and communicated to all stakeholders.
- ***Competent project team members*.** Careful selection of team members is vital. Choose a 'winning' team.
- ***Sufficient resource allocation*.** Money, labour, machines, materials and other business related items must be available in the required quantities.
- ***Adequate communication channels*.** Up-to-date information must be available to the project team on a continual basis. Communication channels to the various role players must be established.
- ***Control mechanisms*.** A system to monitor actual events against planned outcomes must be set up.
- ***Feedback capabilities*.** All parties that are involved in the project must be able to review the project status on a regular basis and make suggestions and corrections through formal feedback channels or review meetings.
- ***Responsiveness to clients*.** All stakeholders must be kept informed regularly on the projects status.

- ***Trouble-shooting mechanisms*.** Set up a system or a set of procedures to tackle problems when they arise and the ability to trace back to the root cause of the problem.
- ***Project staff continuity*.** Key project personnel must be kept on for the duration of the project. Frequent staff turnover results in the project losing the wealth of knowledge, which may have been accumulated.

1.7 Conclusion

General managers often work closely with project managers in various projects within or sometimes outside the organisation, and are therefore required to have an understanding of project management and the techniques used in project planning and scheduling. Effective project management also allows firms to create products and services for global markets. However, project management techniques do not solve all project scheduling and management problems, and for this, good management practices, clear responsibilities for tasks, timely reporting systems and contingency plans are necessary.

The next section will deal with project scope and time management.

SELF ASSESSMENT ACTIVITY 1

Consider a project in which you are currently involved (or which you may be familiar with).

a) Describe the objectives, scope, schedule, cost and any assumptions made.

b) Where is the project in its life cycle?

c) Does the project have a baseline plan? If yes, describe it. If not, create it.

d) Are you or is anyone else monitoring the progress of the project? If so, how? If not, how could you do so?

e) Describe some unexpected circumstances that could jeopardize the success of the project.

f) Describe the anticipated benefits of the project.

SELF ASSESSMENT ACTIVITY 2

Develop an RFP for a real-world project such as landscaping the grounds surrounding a nearby business office, building a deck for your house, or holding a big graduation celebration. Be creative in specifying your needs.

SECTION 2

2. PROJECT SCOPE, QUALITY, WORK BREAKDOWN STRUCTURE AND NETWORK DIAGRAM

CONTENTS

Learning outcomes

Reading Material

2.1 Introduction

2.2 Establishing the project objective

2.3 Defining the scope of the project

2.4 Planning for quality

2.5 Creating a Work Breakdown Structure

2.6 Defining activities

2.7 Activity sequence and network diagrams

2.8 Conclusion

Learning Outcomes:

The overall outcome for this section is that, on its completion, the learner should be able to demonstrate an understanding of project scope, quality, responsibility and activity sequence. This overall outcome will be achieved through the learner's mastery of the following specific outcomes, in that the learner will be able to:

1. Identify and describe the knowledge areas of project management.
2. Develop project objectives.
3. Define the scope of a project using tools such as the scope management plan, scope statement (scope document), Work Breakdown Structure (WBS), and WBS dictionary.
4. Explain in the detail the meaning and implications of scope creep.
5. Plan for quality and describe the costs of quality.
6. Create a Work Breakdown Structure and describe different approaches to do so.
7. Apply activity sequencing and create network diagrams for projects.

Reading Material:

READING

Prescribed reading:

Clements, J. P. and Gido, J. (2011). Effective Project Management. 5th Edition. Boston: Cengage Learning.

Heizer, J. and Render, B. (2010). "Project Management" (Ch. 3) in Operations Management. 10th Edition. New Jersey: Pearson Education Inc.

Recommended reading:

PMI (2004). A Guide to the Project Management Body of Knowledge (PMBOK Guide). 3rd Edition. Pennsylvania: Project Management Institute.

Schwalbe, K. (2009). Introduction to Project Management. 2nd Edition. Boston: Cengage Learning.

2.1 Introduction

The success of the outcome of a project depends largely on the project manager managing the key components of scope, time, quality and staying within the set budget. Each project is unique and therefore requires a project plan to guide its execution. There are numerous tools at the project manager's disposal in order to meet the desired project outcome. As mentioned previously, project management includes four *core* knowledge areas:

- Scope management
- Time management
- Cost management
- Quality management

and five broader knowledge areas:

- Integration management
- Human resource management
- Communications management
- Risk management, and
- Procurement management

Project scope management involves work with stakeholders to define, gain written agreement on, and manage all work required for project success (Schwalbe, 2009:9). Burke (2009:116) describes scope management as defining what the project will accomplish, what it will deliver, what it will produce and where work packages start and finish. *Project time management* includes estimating the length of time to completion, developing a schedule with cost-effective use of resources and keeping the process on track to reach a timely completion (Schwalbe, 2009:9).

This section deals specifically with:

- Clearly defining the project objective
- Preparing a project scope document
- Understanding the importance of planning for quality
- Creating a Work Breakdown Structure (WBS)
- Defining specific activities
- Creating a network diagram

2.2 Establishing the project objective

The project objective is the "tangible end product that the project team or contractor must produce and deliver in order for the sponsor or customer to achieve the expected benefits from implementing the project" (Clements and Gido, 2011:90). The elements of a project objective are:

- Expected benefits that will arise from the project (i.e. why the project is being done).
- Primary project end product or deliverable(s)
- Date by which the project needs to be completed
- Budget within which the project must be completed.

? **THINK POINT**

Given the above elements of a project objective, can you come up with three examples of project objectives? Also remember the acronym "SMART"!

-
-
-

2.3 Defining the scope of the project

Project scope management involves defining and controlling what work is or is not included in a project. The main planning tasks include scope planning, scope definition and creating the WBS. The main documents produced are a ***scope management plan***, ***scope statement (scope document), WBS and WBS dictionary*** (Schwalbe, 2009; Clements and Gido, 2011). A *WBS dictionary* is a document that describes the actual tasks in detail, with the format differing according to project needs. It could be a short paragraph describing each work package, or a whole page describing all responsibilities, resources and costs. The *scope management plan* is a synthesis which provides the roadmap for scope planning, i.e. it is a document that includes descriptions of how the team will prepare the scope statement, create the WBS, verify completion of the project deliverables, and control requests for changes to the project scope (Schwalbe, 2009). In this module, we will deal with the scope statement and WBS in greater detail.

The scope of the project defines what needs to be done (all the work that must be done to achieve the deliverables). The project *scope document* (*scope statement*) includes many items contained in the project charter but in much more detail (Clements and Gido, 2011:91). This is a document to develop and monitor a common understanding of the project scope. Preliminary scope statements are often created at the start, with a more detailed statement prepared at a later stage. An initial scope statement at project initiation means that the project team can discuss the work related to the project scope. A more detailed scope statement develops at planning stages. There are often several versions with each one becoming more detailed as the project progresses. They must all expand on the information provided in the business case and project charter, or project mission (Schwalbe, 2009:94).

To improve accuracy and assign responsibility to key work areas, it is necessary to outline the content of the project, how to approach it and how it could solve problems. It identifies all the items of work required to complete the project, and subdivides the major project deliverables into smaller, more manageable components (Burke, 2009:118). This helps to improve accuracy and assign responsibility to the work packages.

2.3.1 Scope document contents

The contents of a scope statement vary according the project type, but they generally include the product or service requirements and characteristics, a summary of all major deliverables and the project success criteria. They could refer to other documents, such as specifications for particular products, policies, procedures and standards. There should also be a process for ensuring everyone agrees on scope throughout its cycle, and strategies for any changes (Schwalbe, 2009:95). As more information becomes available and decisions are made that affect project scope – the project team must update the scope statement. Different iterations should be named accordingly so the versions can be referred to. A typical scope document contains the following sections (Clements and Gido, 2011):

- Customer requirements
- Statement of Work (SOW): As discussed in Section 1, the SOW defines what the project team or contractor will do.
- Deliverables (products or outputs that the project team or contractor will produce.
- Acceptance criteria

- Work Breakdown Structure (WBS) (a hierarchical decomposition of the project work scope into work packages that produce the project deliverables).

ACTIVITY

Outline the major work elements that the SOW might include.

[Hint: Clements and Gido (2011:93)]

2.3.2 Scope creep

The project scope document eventually establishes the baseline for any changes that may be made to the scope during the performance of the project. However, it is very important to avoid ***scope creep***. The is when the project team or contractor informally makes changes to the project scope without appropriate approval or control, which may result in overspending of the budget (Clements and Gido, 2011:95). The project may also not be completed on time or additional work may be done due to scope creep.

2.3.3 Benefits of the scope document

It's important to update the scope statement as more information becomes available and decisions are made, since it:

- helps improve the accuracy of time, cost and resource estimates
- defines a baseline for performance measurement
- aids in communicating clear responsibilities
- ensures a common understanding among all parties
- ensures customer satisfaction, and
- prevents delays or scope creep – the tendency for project scope to continually increase (Schwalbe, 2009:114).

2.4 Planning for quality

Project quality planning and management includes the process required to ensure that the project will satisfy the needs for which it was undertaken. Burke (2007:254) offers two definitions of project quality management:

- "the processes required to ensure that the project will satisfy the need for which it was undertaken" (PMBOK Guide, 2004);
- "covering quality planning, quality control and quality assurance."

Project Quality Management will be covered in greater detail in the last section.

Quality management is concerned with:

- **Customer Satisfaction** – Customer satisfaction is the understanding, evaluation, definition, and management of expectations so that customer requirements are met. This approach requires conformance to requirements and a fitness of use for the product or service.
- **Prevention over inspection** – Prevention over inspection is the common sense principle that the cost of preventing mistakes is generally much less than the cost of correcting them. This is true especially when they are uncovered during an inspection.
- **Management responsibility** – Management responsibility to quality is to provide the resources needed to sustain success.
- **Continuous improvement** – Continuous improve is following the plan-do-check-act (PDCA) cycle of quality improvement.

Clements and Gido (2011) describe two quality management concepts, namely quality assurance and quality control. Furthermore, they highlight the importance of planning for quality by explaining that it prevents poor quality and avoids quality problems. There are also costs of quality that one needs to be familiar with from a quality management perspective for managing projects. These are:

- **Cost of Quality (COQ)** – Cost of quality refers to the total cost of all efforts related to quality. The appraisal, prevention, and failure costs are included in this term.
- **Cost of Poor Quality (COPQ)** – Cost of poor quality addresses the cost of not performing work correctly the first time or not meeting customers' expectations.

- **Cost of Doing Nothing Different (CODND)** – Cost of Doing Nothing Different is the cost of not changing standard practice, even when it is dysfunctional.

The *cost of quality* is the sum of costs a project will spend to prevent poor quality and any other costs incurred as a result of outputs of poor quality. Poor quality is the waste, errors, or failure to meet stakeholder needs and project requirements. The ***costs of poor quality*** can be broken down into the three categories of prevention, appraisal, and failure costs:

- **Prevention costs**: These are planned costs an organisation incurs to ensure that errors are not made at any stage during the delivery process of that product or service to a beneficiary.
- **Appraisal costs:** These include the costs of verifying, checking, or evaluating a product or service during the delivery process.
- **Failure costs**: A project incurs these costs because the product or service did not meet the requirements and had to be fixed or replaced, or the service had to be repeated (www.pm4dev.com).

ACTIVITY

Provide examples of the different costs of poor quality for a project that you may be familiar with.

Examples of costs of poor quality:

- Prevention costs: Examples of prevention costs include quality planning costs, education and training costs, quality administration staff costs, process control costs, market research costs, field testing costs, and preventative maintenance costs. The cost of preventing mistakes are always much less than the costs of inspection and correction.

- Appraisal costs: Examples of appraisal costs include receiving or incoming inspection costs, internal production audit costs, test and inspection costs, instrument maintenance costs, process measurement and control costs, supplier evaluation costs, and audit report costs.
- Failure costs: Costs of a product recall; costs of litigation; costs of negative publicity.

2.5 Creating a Work Breakdown Structure

After the project scope document is created, a detailed Work Breakdown Structure (WBS) must be created. The Work Breakdown Structure divides a project into tasks, which are subdivided into more detailed and manageable components; into a set of activities or work packages (and sometimes) with their related costs (Heizer and Render, 2009:56; Clements and Gido, 2011:97).

It is the deliverable-orientated grouping of work involved, and defines the total scope of the project, breaking all the work required into discrete tasks and grouping them into hierarchies. Tasks in the WBS represent work required to complete a project. With many people and many deliverables, it makes sense to organise in this way, and divide tasks into logical parts based on how these will be performed. It provides a basis for defining accountability and reporting mechanisms. Experts believe work should not be done if it is not included in the WBS, so it is essential to develop a comprehensive one (Schwalbe, 2009:116).

As shown in Figure 2.1, A WBS is often graphical, like an organisational chart, or represented as an indentured list (Clements and Gido, 2011). Not all branches of the WBS have to be broken down to the same level (Clements and Gido, 2011).

The name of the project is written in the top box: Level 1. The main groupings for work listed in the second tier are Level 2, and these can be broken down into further tiers. The organising must occur around project products, phases or other logical groupings (Schwalbe, 2009:118). The numbering system e.g. 2.1.3 uniquely identifies all the work packages. The scope of work is subdivided into further work packages with a corresponding increase in the level of detail. Three or four levels should be sufficient. The number of levels is influenced by the level of detail, risk, control, the estimated accuracy, and the work package value (Burke, 2009:135). Clements and Gido (2011:99-100) provide guidelines for deciding how many levels to includes in the WBS.

Work packages are work items at the lowest level on a WBS which represent a package of activities (tasks) that need to be done to complete the project. It must be organised so as to provide a basis for the project schedule. The focus for the WBS is on what works needs to be done, not when it will be done.

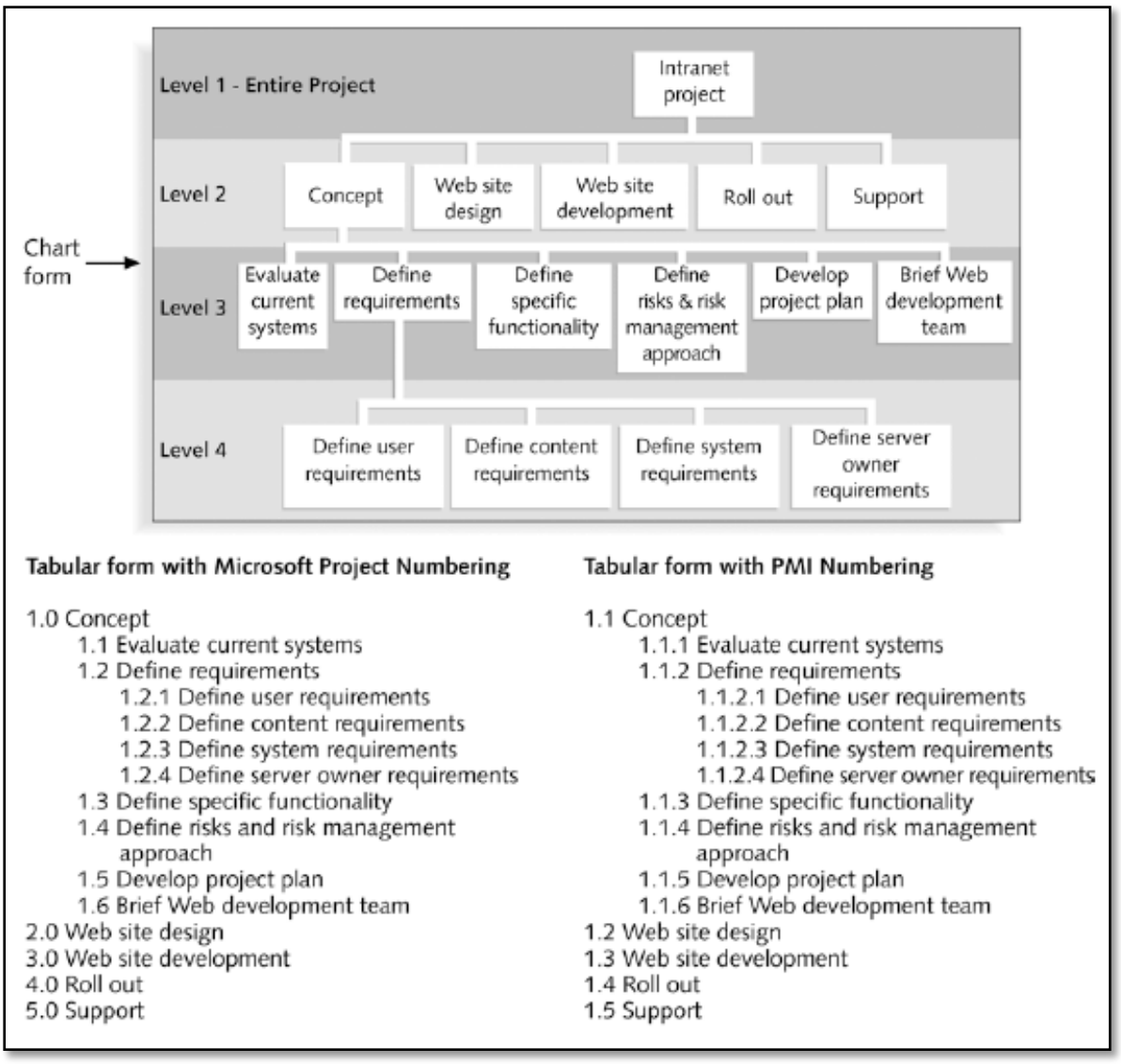


Figure 2.1: Example of a Work Breakdown Structure (Source: Schwalbe, 2009:119).

READING ACTIVITY

Read the guidelines in Clements and Gido (2011:99) for deciding the number of levels in a WBS. Develop a WBS with an appropriate number of levels (using the organisational chart and indentured list formats) for the planning and preparation of a friend's 21st birthday party.

Schwalbe (2009) describes ***five approaches to the development of a WBS:***

a. Using Guidelines:

Some organisations prescribe the form and content for the projects. If guidelines for a project exist, it is very important to follow them.

b. The Analogy Approach:

This uses similar projects' WBS as a starting point. Many organisations have sample WBSs from previous projects. It can save a lot of time but must ensure that it addresses the unique characteristics of the project at hand.

c. Top-Down Approach:

This is a conventional method that starts with the largest items and breaks them into subordinate items, refining down into greater amounts of detail. After breaking down the top-level items, resources should then be assigned at work package level. It is best suited to those who have vast technical insight and a big picture perspective.

d. The Bottom-Up Approach:

It is important to identify as many specific tasks related to the project as possible, which are aggregated and organised into summary activities or higher levels of the WBS. Some use post-it notes on the wall which help people to see logical groupings. It can be time consuming, but is effective and often used for entirely new projects. It can help create buy-in within the project team.

e. Mind mapping

This is a technique that uses branches which radiate out from a core idea to structure thoughts and ideas. It unlocks creativity, and increases participation and morale. Each of the main branches jutting out from the core is a Level 2 item. It can be used when applying the Top Down or Bottom Up approaches. A mind map could also be done for each major deliverable, and then merge all to form one large diagram for the project.

ACTIVITY

Imagine you have been appointed as an event manager at the Rugby World Cup in New Zealand. Outline how you would use the WBS to subdivide the event with attention to:

- the approach to developing the WBS
- the method of subdivision
- the possible number of levels

2.6 Defining activities

Once the WBS is developed, the resource responsible for each of the work packages must clearly define the specific activity(ies) that need to be performed to produce the end item or deliverable for that work package (Clements and Gido, 2011:103). An **activity (or task**) is defined as a "piece of work that consumes time" but doesn't always require the expenditure of effort by people (Clements and Gido, 2011:103). Once all activities are listed, the next step would be to sequence them using a network diagram.

2.7 Activity sequence and network diagrams

A project network diagram is an illustrated way of dividing the project in accordance with the WBS (Heizer and Render, 2009:57). It is a schematic display of the logical relationships among, or sequencing of, project activities (Schwalbe, 2009:131). Whilst the WBS defines *what* needs to be done, the network diagram describes the sequence of *how* the activities will get done (Clements and Gido, 2011).

2.7.1 Activity sequence

For effective time management, it is necessary to determine the activity sequencing and to review the activity list and milestones to determine ***relationships or dependencies***:

- **mandatory** – inherent in the nature of work, unavoidable or "hard logic";
- **discretionary** – defined by the project team;
- **external** – relationships between project and non-project activities (Schwalbe, 2009:130).

Once the activity list has been drawn up, to ensure all activities are accounted for, a milestone list is created. ***Milestones*** are significant events, and it often takes several activities to complete a milestone but it acts like a marker. They are useful tools for setting schedule goals and monitoring progress (Schwalbe, 2009:128).

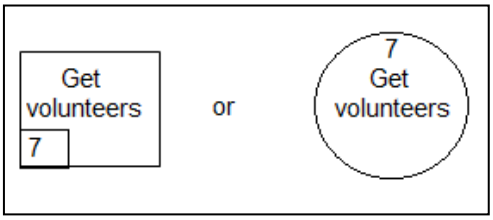
The next step is activity sequencing, which involves reviewing the activity list, scope statement, and milestone list to determine the relationships or dependencies. Without defining these it is not possible to use the powerful schedule tools available to project managers, namely network

diagrams and critical path analysis. Network diagrams show activity sequencing through a schematic display of logical relationships among the activities. The main output of activity sequencing is a network diagram (Schwalbe, 2009:130).

2.7.2 Network diagram

Clements and Gido (2011:104) describe some network principles that must be understood:

- Each activity is represented by a box or circle (***node***) in the network diagram (configuration of nodes may differ);



- The description of the activity or the activity code/number is written within the box/circle;
- Each activity is represented by one box/circle (node) only;
- Activities have a dependent (or precedence) relationship and are linked in a logical sequence;
- Arrows linking the activities show the direction of the precedence relationship;
- The network diagram is drawn from left to right;
- An activity cannot start until all of the preceding activities that are linked to it by arrows are finished;
- Some activities can be done concurrently and some only sequentially.
- Laddering is a technique which can be used to indicate that each resource can be used in the next activity as soon as it is done with one activity.

2.7.3 Creating the network diagram

When determining the sequence of activities, Clements and Gido (2011:106) suggest that the following questions should be asked:

- Which activities should be finished *immediately before* this activity can be started?
- Which activities can be done *concurrently* with this activity?
- Which activities cannot be started until *immediately after* this activity is finished?

There are two approaches for drawing a network diagram:

- The Activity-on-Arrow (AOA) Approach
- The Activity-on-Node (AON) Approach

2.7.3.1 Activity-on-Arrow (AOA) Approach

Also referred to as arrow diagramming, it is a network diagramming technique where activities are represented by arrows and connected at points called nodes – the starting or ending point - to illustrate the sequence. It represents *every* activity that must be done to complete the project, but only shows a finish-to-start dependency. Also, not every item from the WBS must be on the diagram, only those with dependencies. Some list all, to include all milestones, but this is a matter of preference (Schwalbe, 2009:132).

Creating an AOA diagram

1. Find all the activities that start at the first node (Start node). Draw their finish nodes and the arrows between Node 1 and each of those finish nodes. Name the associated arrow, and the duration estimate if available.
2. Continue drawing the network diagram working from left to right, looking for bursts and merges. **Bursts** occur when two or more activities follow a single node and **merges** when two or more precede a single node.
3. Continue until all activities are included.
4. Arrowheads should face right and no arrows should cross (Schwalbe, 2009:133).

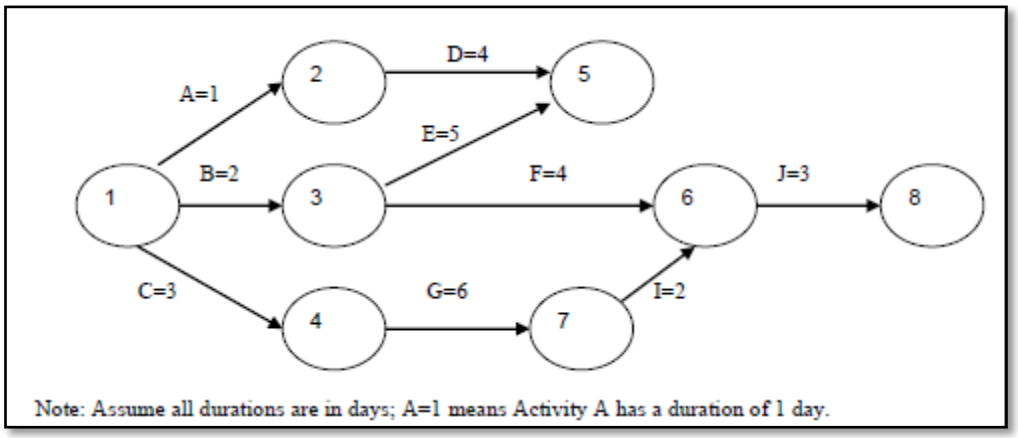


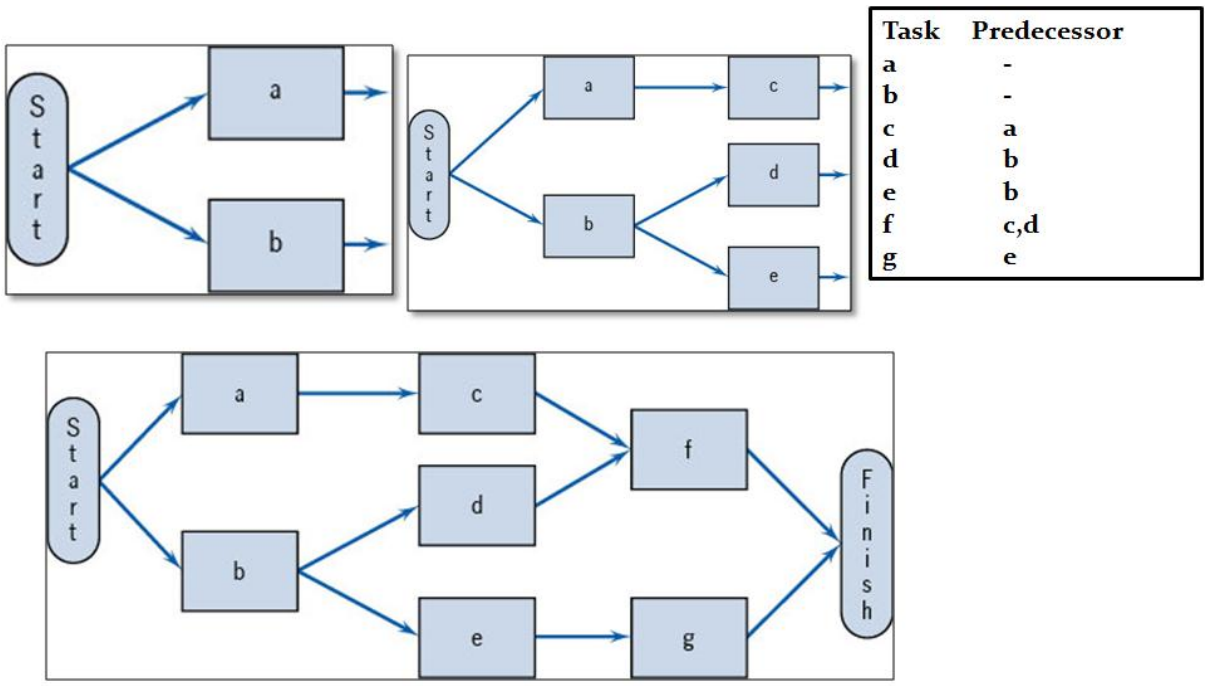
Figure 2.2: Example of an AOA network diagram (Source: Schwalbe, 2009:132).

The letters A through J represent the activities with dependencies required to complete the project. The arrows represent activity sequencing or relationships between tasks.

2.7.3.2 Activity-on-Node (AON) Approach

Constructing an AON diagram:

1. Begin with the START activity
2. Add activities without predecessors
   - There will always be one
   - There may be more than one
3. Add activities that have existing activities as predecessors
4. Repeat step 3 until no more activities



Task	Predecessor
a	-
b	-
c	a
d	b
e	b
f	c,d
g	e

Figure 4: Process of drawing an AON diagram.

READING ACTIVITY

Read the guidelines in Clements and Gido (2011:107-108) for deciding how detailed (in terms of the number of activities) a network diagram should be. Draw an AON network diagram for the planning and preparation of a friend's 21st birthday party (using the WBS that was drawn in the previous Reading Activity).

2.8 Conclusion

In planning a project, it is important to ensure that the scope of the project (*what* needs to be done) is well understood, and subsequently, the work breakdown structure (which establishes a framework for *how* the work will get done) must also be developed. Apart from scope and time management, quality management is one of the core elements which define the success of a project. This will be dealt with in greater detail later on. From the WBS, the network diagram provides a logical relationship between the specific activities that are identified from the work packages of the WBS. In the next section, we will see how the Gantt chart and network diagram can be used to schedule the project in order to satisfy time deadlines.

SECTION 3

3. DEVELOPING THE PROJECT SCHEDULE

CONTENTS

Learning outcomes

Reading Material

3.1 Introduction

3.2 Gantt charts

3.3 Estimating activity durations

3.4 Developing project scheduling using forward and backward pass

3.5 Critical Path

3.6 Working out the critical path

3.7 Benefits of CPM

3.8 Conclusion

Learning Outcomes:

The overall outcome for this section is that, on its completion, the learner should be able to demonstrate an understanding of the field of project scheduling. This overall outcome will be achieved through the learner's mastery of the following specific outcomes, in that the learner will be able to:

1. Describe benefits and disadvantages of Gantt charts when applied to projects.
2. Draw and label Gantt charts from project information that is provided.
3. Estimate activity durations using Programme Evaluation and Review Technique (PERT).
4. Develop project scheduling using the forward and backward pass methods.
5. Determine the Critical Path of a project using slack time calculations.
6. Describe the benefits of CPM.

Reading Material:

READING

Prescribed reading:

Clements, J. P. and Gido, J. (2011). Effective Project Management. 5th Edition. Boston: Cengage Learning.

Recommended reading:

Burke, R. (2009). Project Management Techniques. College Edition. Hampshire: Burke Publishing.

Heizer, J. and Render, B. (2010). "Project Management" (Ch. 3) in Operations Management. 10th Edition. New Jersey: Pearson Education Inc.

Schwalbe, K. (2009). Introduction to Project Management. 2nd Edition. Boston: Cengage Learning.

3.1 Introduction

In the previous section, we looked at scope management (*what* needs to be done). We will now look at aspects of project time management (*how* it should be done within a specific timeframe). Our particular focus in this section is on Gantt charts and network diagrams (paying attention to the critical path method or CPM). Since time is one of the major constraints of any project, it is important for managers to be able to properly schedule projects using appropriate tools such as Gantt charts and CPM.

3.2 Gantt charts

Once the activities of the project have been listed, and the sequence determined, this can be represented on both a Gantt chart and network diagram. Developed by Henry L. Gantt in 1917, a Gantt chart is a type of bar chart that illustrates a project schedule. Gantt charts provide a standard format for displaying scheduled information by listing activities with their corresponding start and finish dates against a calendar. The activities listed should coincide with the information on the WBS, activity and milestone lists (Schwalbe, 2009:138). A Gant chart is a low cost, easy to understand method using horizontal bars to depict each project activity along a time line to make sure:

- all activities are planned for
- their order of performance is accounted for
- activity time estimates are recorded, and
- overall project time is developed.

However, Gantt charts do not adequately illustrate interrelationships and dependencies between activities and resources (Heizer and Render, 2009:57).

A Gantt chart should be developed as a time structure for the procurement schedule, resource histogram and cash flow statement. The activities or scope of work are listed in the left hand column, with a time scale along the top. Scheduling for each activity is represented by a horizontal line showing start to finish. The calendar time scale can be shown in days or weeks, as well as hours or months or sometimes years (Burke, 2009:164).

3.2.1 Drawing a Gantt chart

The tabular reports provide the structure to present the information and should be used in conjunction with other planning documents – the network diagram is best to establish the logical sequence. It is obviously a good idea to have established the WBS before the Gantt chart (Burke, 2009:165). In the example below, there is a list of activity data for a house-building project. The information is taken and depicted with a calendar time scale.

Activity Description	Duration	Start Date	Finish Date
Lay foundations	4 days	1 March	4 March
Build walls	7 days	5 March	11 March
Install roof	3 days	12 March	14 March

A simple Gantt chart

Activity Description	Mon 1	Tue 2	Wed 3	Thur 4	Fri 5	Sat 6	Sun 7	Mon 8	Tue 9	Wed 10	Thur 11	Fri 12	Sat 13	Sun 14
Lay foundations	■	■	■	■										
Build walls					■	■	■	■	■	■	■			
Install roof												■	■	■

Figure 3.1: Example of a simple Gantt chart (Adapted from Burke, 2009:165).

3.2.2 Other features of a Gantt chart

Further to this, the information can be enhanced where necessary by an activity float, shown at the end of the activity from Early Finish (EF) to Late Finish (LF) denoted as a dotted line with a symbol at the end. Some are reluctant to show this as it could encourage working to the later finish (Burke, 2009:167). An **activity float** shows a "float" at the end of an activity from early finish, to late finish. It is denoted as a dotted line with a symbol at the end, usually a diamond or upturned triangle. By implication, we assume that an activity without a float is on the critical path. In practice though, there is a reluctance to show the float as it is only human nature for people to work to the late finish, with all activities then becoming critical (Burke, 2009:167).

A **hammock activity** is a summary activity to gather together a number of sub-activities into one master activity and can link with the WBS, e.g. in the house planning example, "Build walls" could be broken down into "Brickwork" and "Fit windows". The Gantt chart can thus be used to present at the required level of detail, fundamental to planning and control (Burke, 2009:168).

An **event** is a key point in time with zero duration – also called a key date or a milestone. These give focus to when work must be completed and a clear measure of progress. Remember:

- An event has no duration; it is a point in time.
- An event may be the start or finish of an activity, or WBS work package.
- An event focuses the project on a checkpoint, or a deliverable result.
- An event could be the interface between contractors.
- Data capture is more accurate if scope is subdivided into milestones

ACTIVITY

If you have access to the Microsoft Project software, carry out the exercise in Appendix 2 of Chapter 5 in Clements and Gido (2011:184) to practice how to contruct a Gantt chart using Microsoft Project.

3.2.3 Benefits and shortcomings of Gantt charts

Benefits:

- The chart presentation is easy to assimilate
- It displays activity progress very simply and clearly
- The activity float is easier to comprehend when actually displayed using a Gantt chart
- A scheduled Gantt chart is a prerequisite for forecasting the procurement schedule and the cash flow statement
- The revised Gantt chart is an excellent management tool
- It can be used to communicate and disseminate schedule information
- It is a key document for the management decision-making function (Burke, 2009:176).

Shortcomings:

- Showing interrelationships is difficult
- Multiple decision-making is difficult (Burke, 2009:176).

ACTIVITY

Can you think of other benefits and shortcomings of using Gantt charts to schedule projects? Are there any others?

3.3 Estimating activity durations

Only after estimates are made for the types and quantities of resources required for each activity in the project can one estimate the duration of each activity (Clements and Gido, 2011:132). It is important to brainstorm and evaluate alternatives related to resources, especially on projects that involve people from multiple disciplines (Schwalbe, 2009:136). **Duration** includes the actual amount of time spent working on an activity plus elapsed time. This is different to effort, which is the number of work hours it takes to complete a task. Duration relates to the time estimate, but of course, the two are related and assumptions must be documented.

A three-point estimate, for example, is an estimate that includes an optimistic, most likely and a pessimistic estimate (Schwalbe, 2009:136). This is required for performing PERT estimates – the Program Evaluation and Review Technique which is a network analysis to estimate project duration when there is a high degree of uncertainty about the individual activity duration estimates. This helps account for risk in individual activity estimates (Schwalbe, 2009:136).

The PERT technique uses the following formula to estimate activity durations (t):

$$t = \frac{a + 4m + b}{6}$$

- Optimistic time (a) is the time an activity will take if everything goes as planned.
- Most probable (expected) time (m) is the most realistic estimate of the time required to complete an activity.
- Pessimistic time (b) is the time an activity will take assuming very unfavourable conditions.
- Expected completion time (t) is the time that an activity is expected to take if one considers the optimistic, probable and pessimistic times.

ACTIVITY

Calculate the expected activity duration for each of the activities below:

ID	*Task Name*	*Predecessors*	*Optimistic Duration*	*Most probable Duration*	*Pessimistic Duration*
1	Start		0 days	0 days	0 days
2	a	1	10 days	22 days	22 days
3	b	1	20 days	20 days	20 days
4	c	1	4 days	10 days	16 days
5	d	2	2 days	14 days	32 days
6	e	3, 4	8 days	8 days	20 days
7	f	4, 3	8 days	14 days	20 days
8	g	3, 4	4 days	4 days	4 days
9	h	4	2 days	12 days	16 days
10	i	9, 8	6 days	16 days	38 days
11	j	5, 6	2 days	8 days	14 days
12	Finish	10, 11, 7	0 days	0 days	0 days

Solution to Activity:

ID	*Task Name*	*Predecessors*	*Duration*	*Optimistic Duration*	*Most probable Duration*	*Pessimistic Duration*
1	Start		0 days	0 days	0 days	0 days
2	a	1	20 days	10 days	22 days	22 days
3	b	1	20 days	20 days	20 days	20 days
4	c	1	10 days	4 days	10 days	16 days
5	d	2	15 days	2 days	14 days	32 days
6	e	3, 4	10 days	8 days	8 days	20 days
7	f	4, 3	14 days	8 days	14 days	20 days
8	g	3, 4	4 days	4 days	4 days	4 days
9	h	4	11 days	2 days	12 days	16 days
10	i	9, 8	18 days	6 days	16 days	38 days
11	j	5, 6	8 days	2 days	8 days	14 days
12	Finish	10, 11, 7	0 days	0 days	0 days	0 days

3.4 Developing project scheduling using forward and backward pass

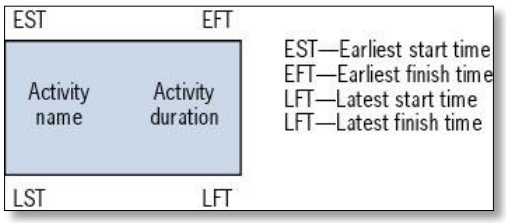
Now that you have estimated the duration of each activity (using the PERT technique), you should be able to work out the start and finish times of each activity using the forward and backward pass technique. This will eventually lead you to work out the critical path of the project.

READING ACTIVITY

Read through the CPM example in Chapter 3 in Heizer and Render (2010) to understand the forward and backward pass technique and Critical Path Method better.

After drawing the network diagram (refer to previous section), the forward and backward pass technique can be used to work out the start and finish times of each activity.

An appropriate configuration of each activity node must be used. An example is shown below:



3.4.1 Forward pass (overview)

This is the process that identifies all the earliest times, by calculating the early start date and early finish date for all the activities. If we take an example where there are two activities A and B, with a finish-to-start relationship, this means A must be completed before B can start. The earliest finish (EF) date of an activity is calculated by adding the activity duration to the early start date (Burke, 2009:147).

Two rules apply here:

- Earliest Start (ES) Time Rule: Before an activity can start, all its immediate predecessors must be finished.
- Earliest Finish (EF) Time Rule: The earliest finish time of an activity is the sum of its earliest start time and its activity time (Heizer and Render, 2010).

3.4.2 Backward pass (overview)

This is a process that finds all the latest times. It begins with the last activity in the project. For each activity, we first determine the latest finish (LF) time value followed by the latest start (LS) time value (Heizer and Render, 2010).

Two rules apply here:

- Latest Finish Time Rule: Before an activity can start, all its immediate predecessors must be finished. The LF of an activity = minimum LS of all activities that follow.
- Latest Start Time Rule: The latest start time (LS) of an activity is the difference of its latest finish time (LF) and its activity time. LS = LF – Activity Time

3.4.3 Applying the process

3.4.3.1 Forward pass

a) Start with the Start node
b) For each node: use the earliest start (ES) time (the greatest "earliest finish time of all this node's predecessors), add in the duration to calculate the earliest finish (EF) time
c) Repeat step 2 for each node in the set.

Forward pass rules:

- For Start node, ES= 0
- ES Time Rule: ES= Max {EF of immediate predecessors}
- EF Time Rule: EF= ES + activity duration

3.4.3.2 Backward pass

a) Start with End node and note its LS time
b) For each predecessor node: set the LF time to the lowest LS time of the successor(s) and subtract the duration to get the EF time
c) Repeat step 2 for each node, moving right to left.

Backward pass rules:

- For last activity, LF = EF
- LF= Min {LS of all immediate following activities}
- LS= LF – Activity duration

3.5 Critical Path

Once the network diagram is drawn, the activity durations estimated using PERT, and the ES, EF, LS and LF times are worked out using the forward and backward pass technique, one can work out the critical path of the project. Activities on the critical path, or the longest time line through the network, represent tasks that will delay the entire project if they are not completed on time (Heizer and Render, 2010). This comprises a number of critical dates or deadlines that must be met as it will impact on subsequent dates (Heizer and Render, 2010).

The **Critical Path Method** (CPM) uses network diagramming to predict the total project duration preventing schedule overruns. The critical path is a series of activities determining the earliest/shortest time of, and the longest path, to completion (Clements and Gido, 2011; Schwalbe, 2009:139). The longest path or the path containing the critical tasks is what is driving the completion date for the project.

One way to find out the critical path of the project is to look for all activities with the least or zero slack (Clements and Gido, 2011). The critical path has the least amount of **slack** or **float** – the amount of time one activity can be delayed without causing delays to the others or the finish date. Several tasks can be done in parallel, resulting in multiple paths on the diagram. The project only finishes when all tasks are completed (Schwalbe, 2009:139).

The ***activities with zero slack are called critical activities*** and are said to be on the critical path. The critical path is a continuous path through the project network that:

- Starts at the first activity in the project
- Terminates at the last activity in the project
- Includes only critical activities – with no slack time (Heizer and Render, 2009:68).

3.6 Working out the critical path

One of two ways can be used to work out the critical path:

a) For simple network diagrams with few pathways from start to finish, calculating the critical path involves adding the durations for all activities on each path through the network diagram. The **longest path is the critical path**; it shows the shortest time in which a project can be completed. If one or more activities on the critical path take longer than planned, the whole project will slip unless the project manager takes appropriate action. (Schwalbe, 2009).

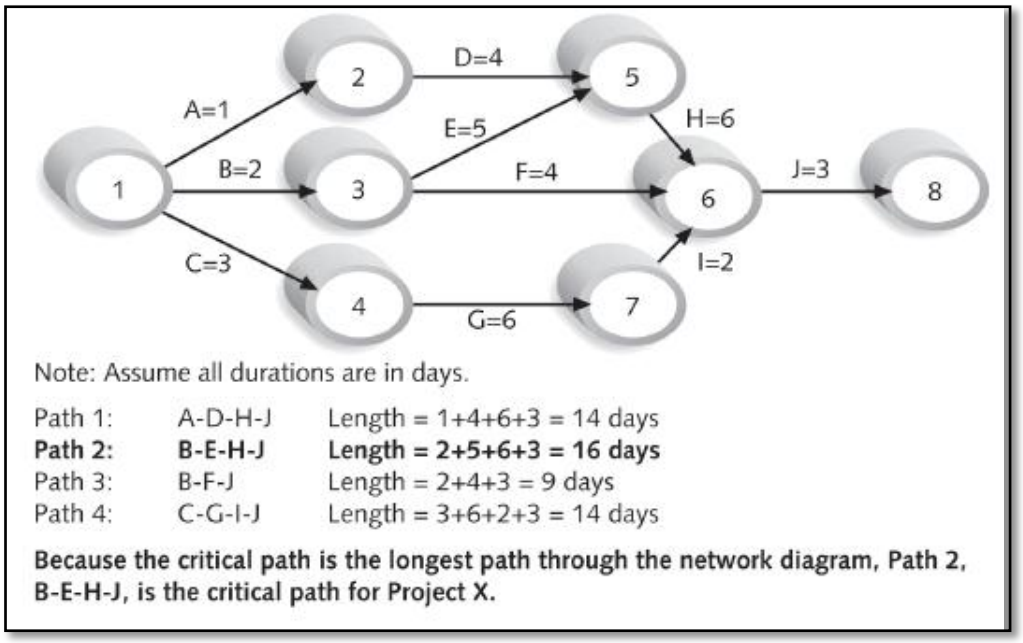


Figure 3.2: Finding the critical path (Source: Schwalbe, 2009:140).

b) In subsection 3.4, we learnt how to find the ES, EF, LS and LF of each activity in a network diagram. In subsection 3.5, we learnt that activities with zero slack are called critical activities and lie on the critical path. Therefore, to find the critical path, we need to find all activities with zero slack. Slack is calculated as follows:

SLACK = LS - ES (or) LF – EF

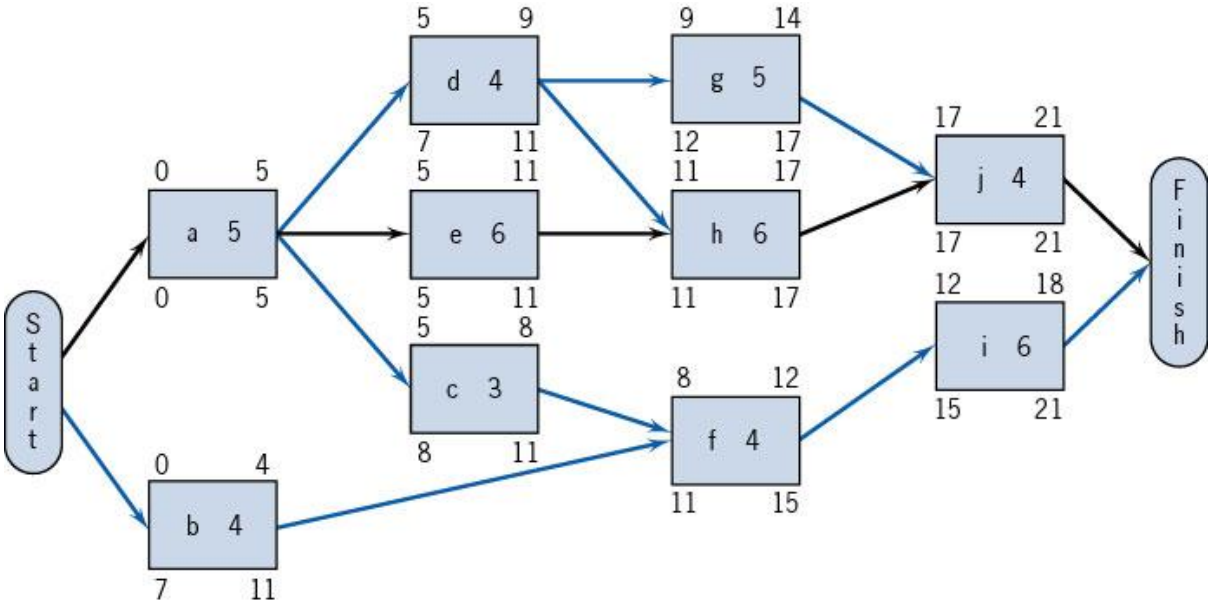
For example, the LS and ES and slack for each activity of an arbitrary project is shown below:

Activity	*LS*	*ES*	*Slack*
a	0	0	0
b	1	0	1
c	4	0	4
d	20	20	0
e	25	20	5
f	29	20	9
g	21	20	1
h	14	10	4
i	25	24	1
j	35	35	0

The critical path is therefore: A → D → J

ACTIVITY

Work out the critical path in the following network diagram using both of the methods described in subsection 3.6. Highlight the critical path on the network diagram. Assume time units are given in days.



HINT:

(See section 3.4 and apply rules to find the critical path)

Solution to Activity:

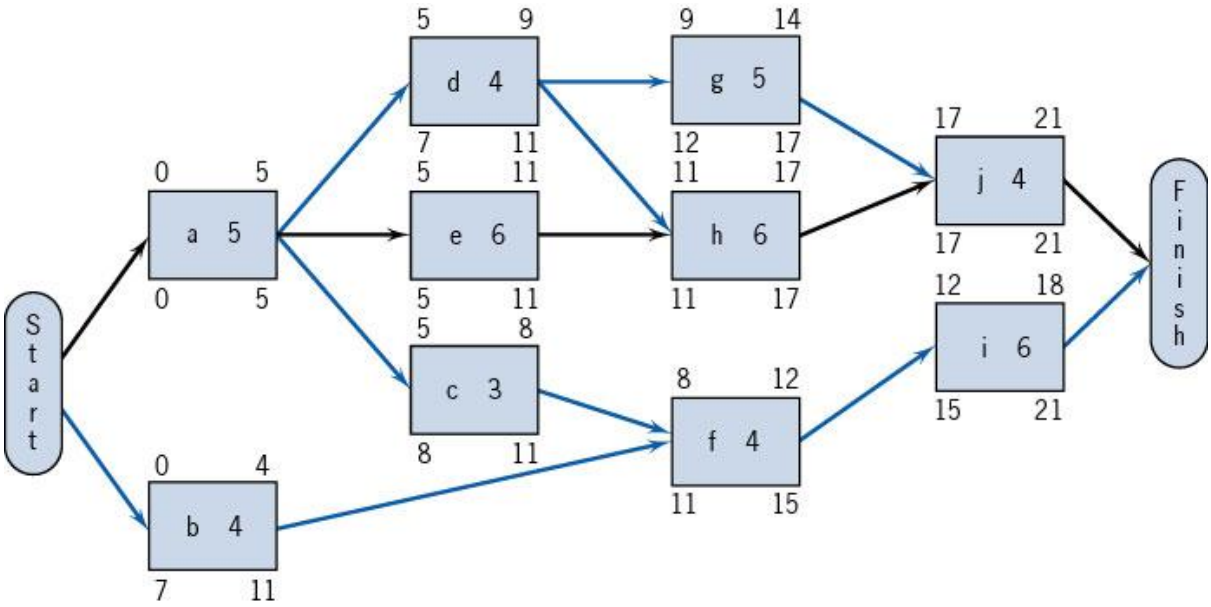
Method A:

- Path 1: Start → A → D → G → J → Finish = 18 days
- Path 2: Start → A → D → H → J → Finish = 19 days
- Path 3: Start → A → E → H → J → Finish = 21 days
- Path 4: Start → A → C → F → I → Finish = 18 days
- Path 5: Start → B → F → F → I → Finish = 14 days

Since Path 3 is the longest in duration, it is the critical path.

Method B:

The slack times for activities A, E, H and J are zero. Therefore this is the critical path.



NB. At a Masters level, it is expected that students understand and are able to use Method B if they are not instructed on which method to use to determine the critical path.

3.7 Benefits of CPM

CPM is important has it helps to address the following questions:

a. When will the entire project be completed?
b. What are the critical activities or tasks in the project – which will cause delay if they are late?
c. Which are the non critical activities – the ones that can run late without causing an overall delay?
d. What is the probability that the project will be completed by a specific date?
e. At any particular date, is the project on schedule, behind schedule, or ahead?
f. On any given date is the money spend equal to, less than, or greater than the budgeted figure.
g. Are there enough resources to finish the project on time?
h. If the project is to be finished in a shorter amount of time, what is the best way to accomplish this goal at the least cost? (Heizer and Render, 2009:59).

3.8 Conclusion

In this section, we learnt how to schedule projects using Gantt charts and network diagrams. Furthermore, techniques were described on how to go about determining the critical path of a project. By doing so, managers will be able to identify critical activities which could impact on the project deadlines. Activities with slack will also be identified. Managers could then manipulate the schedule and resources of the project by delaying activities with slack time and/or using methods such as crashing to ensure that the project deliverables are achieved within the specified constraints.

The next section will deal with project resource management.

SECTION 4

4. PROJECT RESOURCE MANAGEMENT

CONTENTS

Learning outcomes

Reading Material

4.1 Introduction

4.2 Project constraints

4.3 Resource scheduling problems

4.4 Resource requirements planning

4.5 Resource Gantt charts

4.6 Resource histograms

4.7 Resource loading and resource levelling (resource smoothing)

4.8 Increasing and reducing resources

4.9 Conclusion

Learning Outcomes:

The overall outcome for this section is that, on its completion, the learner should be able to demonstrate an understanding of project resource management. This overall outcome will be achieved through the learner's mastery of the following specific outcomes, in that the learner will be able to:

1. Discuss technical and resource constraints and their impact on a project.
2. Identify resource scheduling problems and explain the characteristics of time-constrained and resource-constrained resource scheduling.
3. Explain project resource requirements planning.
4. Develop and interpret resource Gantt charts and resource histograms.
5. Discuss resource loading situations and perform resource levelling (resource smoothing).
6. Explain ways of reducing and increasing resources in a project.

Reading Material:

READING

Prescribed reading:

Clements, J. P. and Gido, J. (2011). Effective Project Management. 5th Edition. Boston: Cengage Learning.

Recommended reading:

Gray, C.F. and Larson, E.W. (2006). Project Management: The Managerial Process. 3rd Edition. New York: McGraw-Hill.

PMI (2004). A Guide to the Project Management Body of Knowledge (PMBOK Guide). 3rd Edition. Pennsylvania: Project Management Institute.

Schwalbe, K. (2009). Introduction to Project Management. 2nd Edition. Boston: Cengage Learning.

4.1 Introduction

Project Resource Management is the global process for managing the allocation, application and utilization of resources (people, finances and equipment) throughout the project lifecycle. This section considers the importance of recognising resource constraints in a project, determining the resource requirements plan for a project, and resource smoothing. Furthermore, the different types of project constraints, including the types of resource constraints, are considered. Common resource management techniques such as resource Gantt charts and histograms are also discussed.

4.2 Project constraints

Clements and Gido (2011) identify technical constraints and resource constraints as potential limiting factors to the accomplishment of a project's deliverables. According to Gray and Larson (2006:242), project constraints impede or delay the start of activities. This could result in:

- A reduction in slack shown on the planned network.
- A decrease in scheduling flexibility.
- A possible decrease in the number of parallel activities.
- An increase in the likelihood of delaying the project.

In scheduling one must consider the following constraints:

4.2.1 Technical or Logical Constraints

These constraints address the sequence in which the project activities must occur. The project network depicts the technical constraints. For example, a network for a new software project could place the activities of "Design", "Code" and "Test" in the network as a sequence. The network diagram is depicted below:

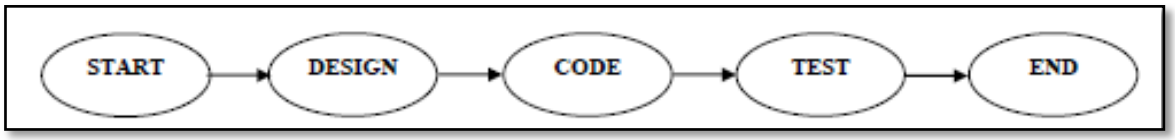


Figure 4.1: Technical constraints of a software project.

As can be seen one cannot not logically code unless the design is done or test the program unless the coding is done.

4.2.2 Physical Constraints

These constraints cause activities that would normally occur in parallel to be constrained by contractual or environmental conditions. For example, renovation of a ship compartment might allow only one person to perform an activity because of space limitation. Another example will be the erection of a tower and nearby ground work. The procedures for handling physical constraints are similar to those used for resource constraints.

4.2.3 Resource Constraints

These constraints address the sequence in which the project activities must occur. The project planner may assume adequate resources and show activities occurring in parallel. Parallel activities hold potential for resource conflicts, for example, if you are planning a wedding reception that includes four activities: 1) Plan; 2) Hire band; 3) Decorate hall; 4) Purchase refreshments. Clearly these activities can be done in parallel by different people. The network diagram would look like this:

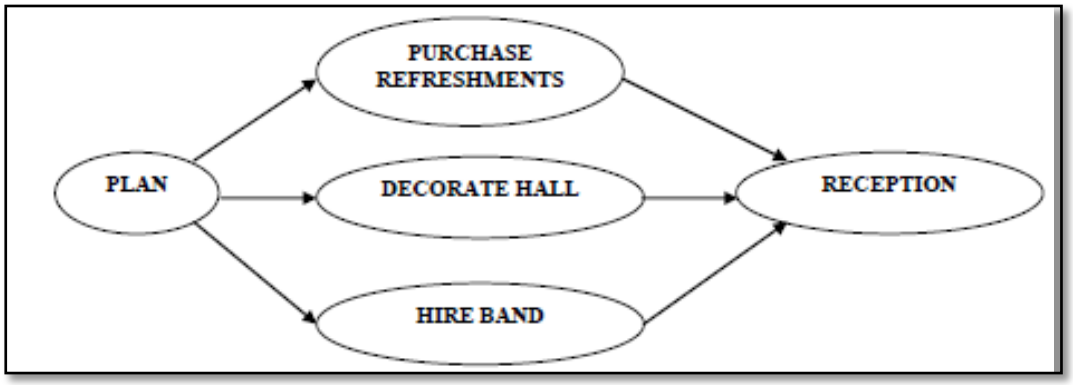


Figure 4.2: Resource constraints - Planning a wedding with various resources.

Activities 2, 3 and 4 could be done in parallel by different people, as can be seen in Figure 4.2 above. There are technical reasons or dependency of one on another. However, if one person must perform all activities, the resource constraint requires that the activities be performed in some sequence or series. Clearly the consequence is a delay of these activities and requires a very different set of network relationships as can be seen in Figure 4.3 below.

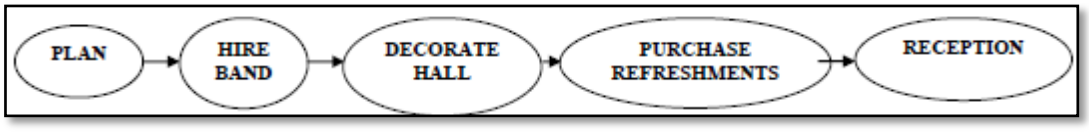


Figure 4.3: Resource constraints - Planning a wedding with a single resource.

As can be seen, the resource dependency takes priority over the technological dependency but does not violate the technological dependency, that is hire, decorate and purchase may now have to take place in sequence rather than concurrently, but they must all be completed before the reception can take place.

4.3 Resource scheduling problems

Resources are people, equipment and material than can be drawn on to accomplish something. In projects the availability and unavailability of resources will often influence the way projects are managed. The major resources project managers must marshal, schedule and manage on a daily basis are people, materials, equipment and working capital.

A project can be classified as either *time-constrained* or *resource-constrained*.

4.3.1 Time-constrained resource scheduling

A time-constrained project is one that must be completed by an imposed date. If required, resources can be added to ensure the project is completed by the due date. Although time is a critical factor, resource usage should be no more than is necessary and sufficient (Gray and Larson, 2006:244). Any resource overload will have to be addressed by increasing resources when they are required. This situation could occur when:

TIME CONSTRAINED ACTIVITY	CONSEQUENCES OF TIME DELAY
The project has heavy time penalties	Time penalties are designed to encourage contractors to meet the planned date
The project is part of another project with critical access dates	For example carpet fitters for an event only have a few hours to fit the carpets
Building a chalet for summer tourists	If the chalet is opened late income will be lost
Making a product for an event	If the product arrives the day after an event, the event will be cancelled

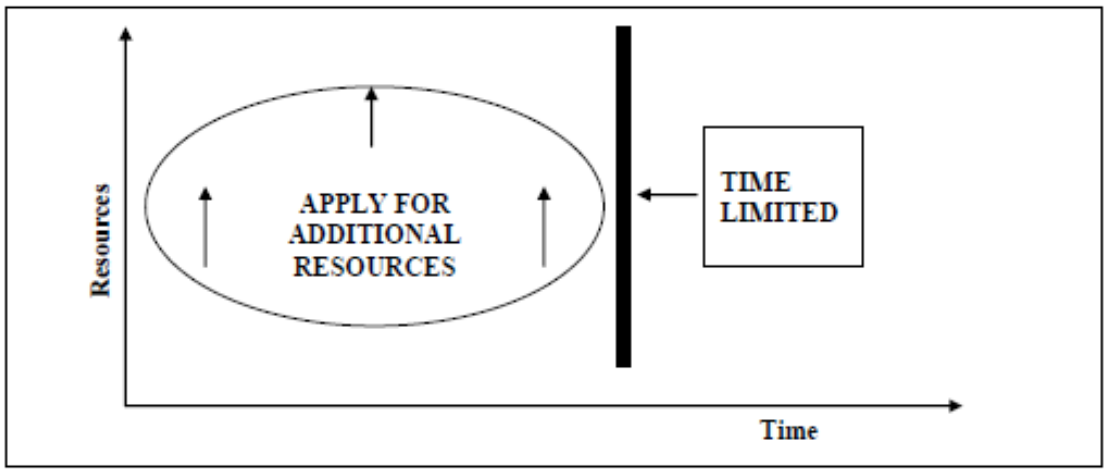


Figure 4.4: Time-constrained resource scheduling.

4.3.2 Resource-constrained resource scheduling

A resource-constrained project is one that assumes the level if resources available cannot be exceeded. If the resources are inadequate, it will be acceptable to delay the project but as little as possible (Gray and Larson, 2006:244). If there are any resource overloads then some planned activities will have to be delayed. If this process delays any critical activities, then the end date of the project will be extended. This situation could occur as follows:

RESOURCE CONSTRAINED ACTIVITY	EXAMPLE
A confined space will limit the number people able to work there	An engineer repairing a PC
When there are limited facilities	The number of workers on a ship may be limited to the number of bunks available
When there are equipment limitations	For example, the number of computers, machines, drawing boards, lifts or scaffolding for the work
Health and safety requirements may limit the number of workers in a certain area.	Restrict working overhead
Restricted access might limit the movement of materials and equipment	Busy downtown office blocks have limited parking and restricted road access

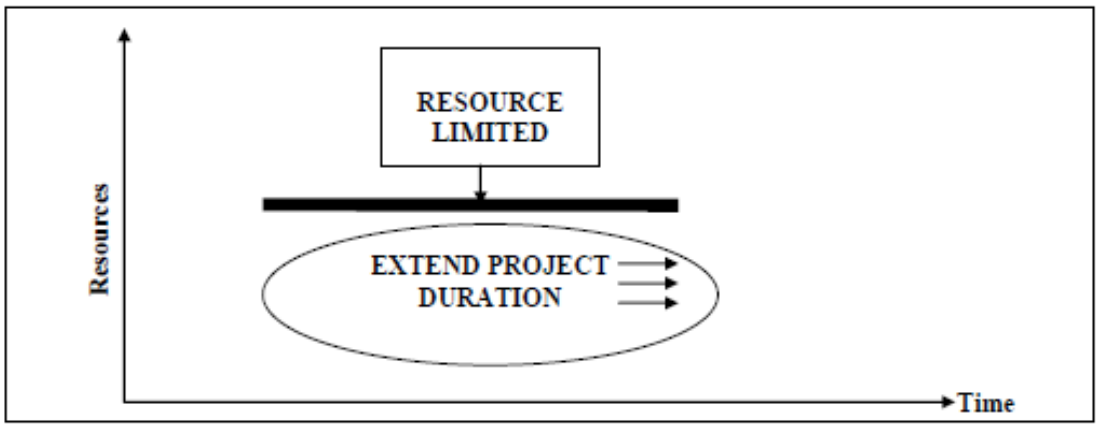


Figure 4.5: Resource-constrained resource scheduling.

4.4 Resource requirements planning

Clements and Gido (2011:198) illustrate an example of planning for resource requirements in a typical project. Project resource planning is mainly concerned with the trade-off analysis between:

- The cost of alternative schedules designed to accommodate resource shortages, and
- The cost of using alternative resources (for example, overtime to meet a schedule or subcontracting to accommodate a schedule change).

Resource planning involves: Resource Identification; Resources Estimating; Resource Forecasting; Resource Availability and Resource Loading.

4.4.1 Resource identification

This involves the identification of potential sources that could provide the specified resource (equipment or services). These sources could be identified either from the firm/project list of vendors or by advertising the need for procurement.

4.4.2 Resource estimating

Resource estimating is linked directly to the scope of work and bill of material (BOM). The scope of work may be expressed as the number of tonnes of steel, or number of square metres of wall to be painted. From this description the estimator can convert the scope of work into man-hours per unit "X".

One needs to consider the direct trade-off between the resource requirement and the activity's duration. This can be best explained using the following example:

The scope of work is to erect 12 tonnes of steel and the estimator knows from past experience that the work can be done in 150 man-hours per ton, and the men work 10-hour shifts, then the equation is:

$$\frac{12\,tonnes\,x\,150\,manhours\,per\,tonne}{10\,hours\,per\,day} = 180\,man\,days$$

The resource / duration trade-off would then be as follows:

Table 4.1: Resource-duration trade-off.

Man-days	Resource Available	Duration
180	10	18
180	11	16.4
180	12	15
180	13	13.8
180	14	12.9

As can be seen from Table 4.1, the duration is expressed as a fraction of a day. By varying the resource availability, the duration of the activity will change.

4.4.3 Resource forecasting

The next step is resource forecasting i.e. forecast the total resource requirement by discipline or interchangeable resource. An interchangeable resource is when you have a variety of workers and any one of them could perform the work. This is done by compiling all the resource estimates and presenting them in a structured resource table as depicted below:

Table 4.2: Example of a resource table.

Activity Number	Resource Type	Quantity per day	Resource Duration	Lead Time
100	Builder	2	2	0
200	Builder	4	4	2
300	Builder	3	2	6

From Table 4.2 above:

- Activity Number: this is the way to address the resource information. The timing of the resource can be linked directly with the schedule of that activity.
- Resource Type: this field is used to distinguish the different types of resources (it could be an engineer, welder, etc., but in the case above, it's a builder).
- Quantity per day: this field is used to enter the quantity of resources required per day.
- Duration: This field is used to indicate how many days the resource will be working on the activity.
- Lead Time: This is the difference between the activity's scheduled start and the resource's start. For Activity 200, the builder starts 2 days after the early start of the duration.

4.5 Resource Gantt charts

As discussed in Section 3, Gantt Charts list the activities (scope of work) in the left column (or activity number) against a time scale along the top of the chart. The scheduling of each activity is represented by a horizontal bar or line, from the activity's start to finish. Gantt Charts can be linked to the critical path method to present the schedule of a complex network and must be developed as a time structure for the procurement schedule, resource histogram and the cash flow statement. A typical resource Gantt chart drawn from Table 4.2 is shown:

Activity Number	Mon 1	Tue 2	Wed 3	Thu 4	Fri 5	Sat 6	Sun 7	Mon 8	Tue 9	Wed 10
100	2	2								
200	0	0	4	4	4	4				
300	0	0	0	0	0	0	3	3		
Total	2	2	4	4	4	4	3	3		

Figure 4.6: Example of a resource Gantt chart.

4.6 Resource histograms

Resource histogram gives a good visual presentation which is easy to assimilate and understand. The prerequisites for drawing the resource histogram are:

- Early start Gantt chart (after considering the procurement requirements which ensure the materials and equipment are available);
- Resource forecast per activity.

When one uses the early start Gantt chart, it is assumed that the planner wishes to start all activities as soon as possible and keep the activity float for flexibility. When the resource requirements have been added to the early start Gantt chart one day at a time, it gives the total resources required per day. The total daily resource requirements are then plotted vertically to give the resource histogram. *Separate resource histograms* are required for each resource type.

The following steps can be followed when constructing a resource histogram:

Step 1: Draw the resource Gantt chart.

Step 2: Transfer the resources per day from the resource table

Step 3: Add the resources per day vertically to give a total daily requirement

Step 4: Plot the resource histogram

The resource histogram for Figure 4.6 is shown below:

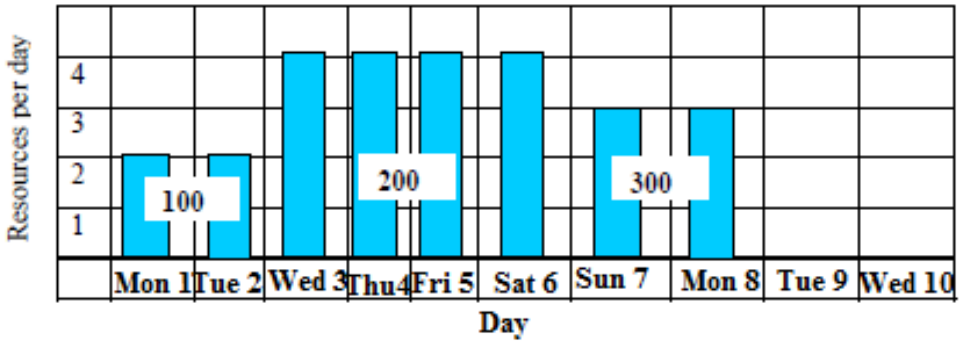


Figure 4.7: Example of a resource histogram.

SELF ASSESSMENT ACTIVITY

Draw a resource Gantt chart and resource histogram from the following information:

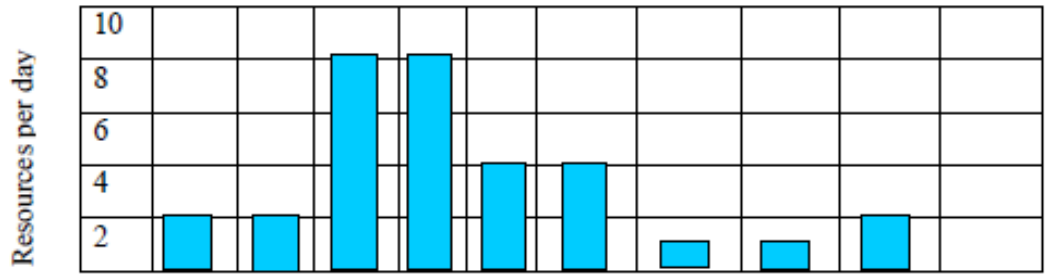
Activity No.	Start Date	Finish Date	Resource Per Day
100	1	2	2
200	3	4	2
300	3	4	6
400	5	6	3
500	7	10	1
600	11	11	2

SOLUTION TO SELF ASSESSMENT ACTIVITY

Resource Gantt chart:

Activity Number	Mon 1	Tue 2	Wed 3	Thu 4	Fri 5	Sat 6	Sun 7	Mon 8	Tue 9	Wed 10	Thu 11
100	2	2									
200			2	2							
300			6	6							
400					3	3					
500					1	1	1	1			
600									2		
Total	2	2	8	8	4	4	1	1	2		

Resource histogram:

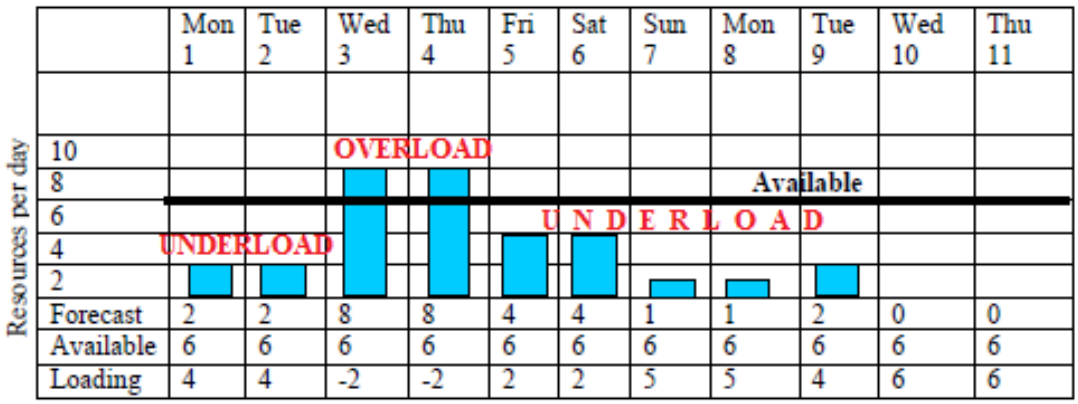


4.7 Resource loading and resource levelling (resource smoothing)

Once resource forecasting has been done, the resource forecast is now compared to the resources available. The ideal situation is when the resource requirements equal the resource available.

A *resource overload* is when the resource forecast requirement exceeds the available resources and will lead to some activities being delayed, which could delay the completion of the project whilst a *resource underload* will under-utilize the company resources which could have a detrimental effect on the company profitability and productivity.

A resource loading diagram merely reflects the forecast and available resources both as a histogram and numerically. In Figure 4.8, for example, the resource available per day is 6, whilst the forecast resources required each day depict the over- and under-load situation.



	Mon 1	Tue 2	Wed 3	Thu 4	Fri 5	Sat 6	Sun 7	Mon 8	Tue 9	Wed 10	Thu 11
10											
8											
6											
4											
2											
Forecast	2	2	8	8	4	4	1	1	2	0	0
Available	6	6	6	6	6	6	6	6	6	6	6
Loading	4	4	-2	-2	2	2	5	5	4	6	6

Figure 4.8: Resource loading diagram.

Resource Smoothing

Clements and Gido (2011:200) define resource levelling or smoothing as "a method for developing a scheduling that attempts to minimise the fluctuations in requirement for resources." Resource smoothing is the process of moving activities to improve the resource loading profile. The project manager has a number of resource smoothing options as tabulated below:

Table 4.3: Resource smoothing options.

Resource Smoothing	Assign resources to critical activities first because if a critical activity is delayed this will delay the whole project.
Time-limited resource scheduling	If the end date of the project is fixed, the resources must be increased to address any overloads.
Resource-limited resource scheduling	If the maximum number of resources is fixed, the end date may need to be extended to address any overload.
Increase Resources	To address an overload.
Reduce Resources	To address an underload (under utilised).

The first step is to select the resource to be smoothed. This can be done by considering:

- The resource that is most overloaded.
- The resource that is most used on the project.
- The least flexible resource; this could be the resource that comes from overseas, is difficult to get hold of, or is least available.
- The most expensive resource to hire.

After one has smoothed for the chosen resource, the other resource must follow the revised schedule.

4.8 Increasing and reducing resources

Options available to increase overloaded resources:

Working Overtime	Working overtime will increase the number of work hours available with out having to employ more staff.
Working Shifts	Working shifts will increase the utilization of machines, equipment and also increase the number of man hours worked in confined spaces.
Increase productivity	Productivity is improved through education and training.
Automation	Installing equipment will enable the products to be made with less resources.
Learning Curve	If the project involves a certain amount of repetitive work, the planner could expect to see the number of man hours reducing on units.
Sub Contractors	Sub –contractors will increase the workforce in the short term. The benefits is that there are no long term commitments. Using sub-contractors can also useful to compare the performance of your in house workforce.
Scope of Work	Reducing the scope of work will help meet a fixed end date.

Options available to reduce under-loaded resources:

- Move unemployed resources to critical activities.
- Move unemployed resources to R&D jobs, or fill–in jobs which either have a resale value or can be used by the company.
- Hire out resources internally or externally; the hire rate can be competitively reduced to at least make a contribution to their salary.
- Pre-manufacture components before they are needed.
- Maintenance of equipment during slack periods.
- Train your workforce during slack periods to gain new skills which will make them more productive and flexible in the future, or send them on leave.

4.9 Conclusion

Resource planning and scheduling using the appropriate tools, some of which were discussed in this section, is a crucial part of project management. Due to the project constraints that can be experienced, resource management plays a vital role in ensuring project deliverables are met without impacting significantly on time, cost and quality constraints. We will discuss project costs, budget and earned value in the next section.

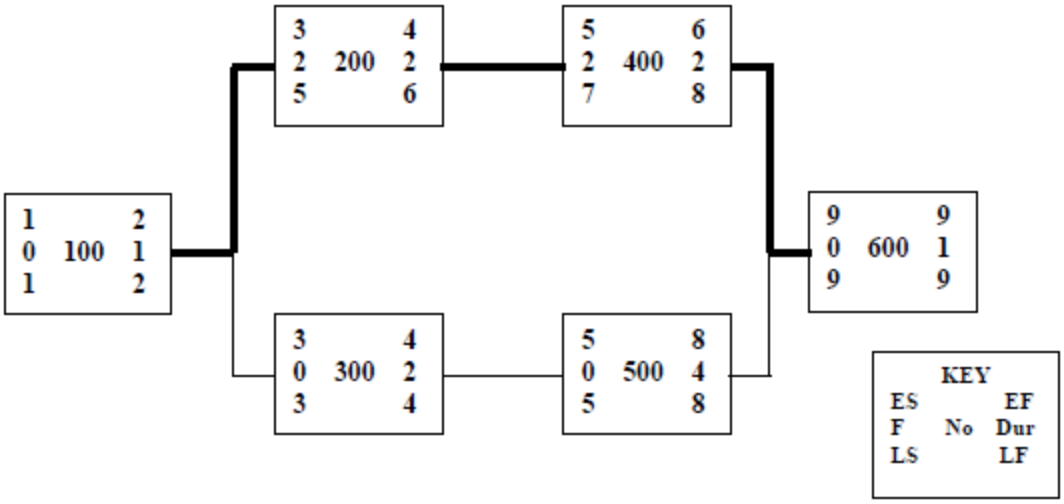
SELF ASSESSMENT ACTIVITY

Perform resource smoothing on the following project activities and draw the "smoothed" resource Gantt chart and resource histogram. Assume a resource availability of 6 per day.

Activity No.	Start Date	Finish Date	Resource Per Day
100	1	2	2
200	3	4	2
300	3	4	6
400	5	6	3
500	7	10	1
600	11	11	2

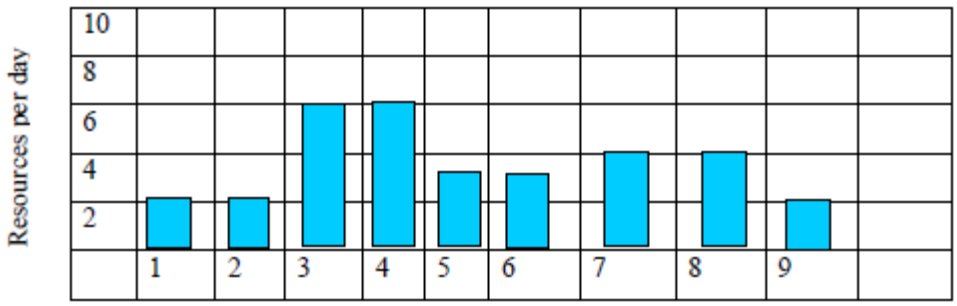
SOLUTION TO SELF ASSESSMENT ACTIVITY

The resource load can be addressed by simply moving activity 200 by 2 days. To see the impact of moving activity 200 by 2 days one needs to draw a critical path network diagram first:



As can be seen from the CPM diagram activity 200 has a *finish to start* relationship with activity 400, therefore activity 400 will also need to move forward by 2 days. The resulting Gantt chart and resource smoothed histogram will now look as follows:

Activity Number	Mon 1	Tue 2	Wed 3	Thu 4	Fri 5	Sat 6	Sun 7	Mon 8	Tue 9	Wed 10	Thu 11
100	2	2									
200					2	2					
300			6	6							
400							3	3			
500					1	1	1	1			
600									2		
Total	2	2	6	6	3	3	4	4	2		
Total Running	2	4	10	16	19	22	26	30	32		



SECTION 5

5. PROJECT COSTS, BUDGET AND EARNED VALUE

CONTENTS

Learning outcomes

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5.1 Introduction

5.2 Estimating activity costs

5.3 Project budget

5.4 Actual costs

5.5 Earned value management

5.6 Managing cash flow

5.7 Conclusion

Learning Outcomes:

The overall outcome for this section is that, on its completion, the learner should be able to demonstrate an understanding of project costs, budget and earned value management. This overall outcome will be achieved through the learner's mastery of the following specific outcomes, in that the learner will be able to:

1. Identify different project costs.
2. Explain different cost estimating techniques.
3. Apply project budgeting and determine actual costs during project execution.
4. Discuss the significance and process of earned value management.
5. Calculate and explain the meaning of each of the earned value management terms.

Reading Material:

READING

Prescribed reading:

Clements, J. P. and Gido, J. (2011). Effective Project Management. 5th Edition. Boston: Cengage Learning.

Recommended reading:

Burke, R. (2006). Project management: Planning and control techniques. 5th Edition. China: Burke Publishing.

Chandra, P. (2002). Projects: Planning, Analysis, Financing, Implementation and Review. 5th Edition. New Delhi: Tata McGraw-Hill Publishing Company Limited.

Goodpasture, J.C. 2004). Quantitative Methods in Project Management. 1st Edition. Mumbai: Shroff Publishers.

Schwalbe, K. (2009). Introduction to Project Management. 2nd Edition. Boston: Cengage Learning.

Turner, J.R. and Simister, S. (2004). Project Management: A Comprehensive Handbook. 1st Edition. New Delhi: Gower Publishing Limited.

5.1 Introduction

This section deals with the estimation of costs and determining the project budget. During the project execution, the actual costs must be monitored against the budget, and the earned value of the work performed must be determined. Clements and Gido (2011) state that the following cost-related parameters should be monitored during the project:

- Cumulative actual amount spent since the start of the project;
- Cumulative earned value of the work performed since the start of the project;
- Cumulative budgeted amount planned to be spent, based on the project schedule, from the start of the project.

Some important financial concepts that students will also become familiar with are: estimating costs of activities; determining a time-phased baseline budget and earned value of work performed; analysing, forecasting and controlling project costs; and managing cash flow.

5.2 Estimating activity costs

Cost estimating involves approximating or estimating the costs of resources required to complete a project. Cost budgeting involves the allocation of the overall cost estimate to individual tasks over time to establish a baseline for measuring performance. If a project manager wants to effectively plan and control a project, accurate estimating is vital. According to Burke (2009:84), the quality and accuracy of the estimate can be continually improved as the project is progressively executed, and more accurate and detailed information comes to the fore. However, the project manager is often forced to do a cost estimate at the tender or quotation stage when the amount of data and information is usually limited. Burke (2009:88) subdivides project cost estimates as follows:

- Direct and indirect costs
- Fixed and variable costs
- Time-related costs
- Labour, material and equipment costs
- Transport costs
- Preliminary and general (P&G) costs
- Project office costs
- Project team costs

Similarly, Clements and Gido (2011:227) describe the following costs:

- Labour costs
- Material costs
- Equipment costs
- Facilities costs
- Subcontractors and consultants costs
- Travel costs
- Contingency costs

According to Burke (2009:96), various estimating techniques may be used to predict the project's parameters and resource requirements quickly and accurately. These include:

- Jobbing
- Factoring
- Inflation
- Economies of scale
- Unit rates

Burke (2009:96) elaborates on the five estimating techniques (listed above) as follows:

5.2.1 Jobbing (or job costing or operational costing)

It is the process of including all the operations that are required for an activity or task. Table 5.1 below provides an example of a job that is subdivided into its component parts:

Table 5.1: Example of estimating costs using jobbing.

Task	Description	Labour	Materials	Plant hire	Transport	Total
100	Mark-out foundations	R2 000	R1 000			R3 000
200	Dig foundations	R10 000	R1 000	R2 000	R1 000	R14 000
300	Lay foundations	R6 000	R20 000	R6 000	R4 000	R36 000

Once the activity has commenced, job costing enables the progress to be quantified:

- It provides a cost estimate for all WBS packages and activities.
- Progress can be measured in terms of percentage complete or duration remaining.
- The profit or loss can be calculated when the activity is complete.

During the tender stage there may not be sufficient time or need to produce an estimate with this level of detail. We therefore need to examine other estimating techniques that are quicker to produce a reasonably accurate estimate.

5.2.2 Factoring (or Component ratio or Parametric method)

This technique can be used when data stored from previous projects indicates than an item of the project may be expressed as a percentage of a known or calculated core cost. Table 5.2 below provides an example:

Table 5.2: Example of estimating costs using factoring.

Management fee	6% of contract price
Quality assurance	2% of contract price
Engine beds	3% of engine costs
Pipe work	18% of generator costs
Consumables	12% of material costs
Profit	25% of construction price

Once core costs are in place, the associated ratios can be calculated very quickly.

5.2.3 Inflation (or Time based indices)

One cannot ignore the effects of inflation on project costs. If a current project is similar to one done a few years ago, the financial figures for the previous project may be used as the basis for the current estimate. Table 5.3 illustrates an example of this:

Table 5.3: Example of estimating costs using inflation.

	2010	2011		2012	
	Base cost	Inflation rate	New price	Inflation rate	New price
Labour	R250 000	10%	R275 000	8%	R297 000
Material	R200 000	15%	R230 000	5%	R241 500
Total	R450 000	12.22% average	R505 000	6.63% average	R538 500

One of the problems with this method is that different commodities escalate at different rates. This problem can be addressed by using a separate escalation factor for each cost component, as is evident in Table 5.3.

5.2.4 Economies of scale (or Cost capacity factor)

If a job is twice as large as the previous one, the question is whether it will cost twice as much. The answer is that it usually will not, for the following reasons:

- Indivisibility: There may be certain indivisibilities (or fixed costs) in the production process that are not related to output, e.g. manager, telephone, secretary etc. These costs are indivisible since one cannot have part of a manager if one wants to operate at a lower output.
- Specialisation: In small enterprises people have to do a variety of tasks but as the business grows, work is grouped and repetitive tasks are assigned to one person. This improves efficiency.
- Technical: Large scale production enables enterprises to benefit from the use of automated machinery. The high capital expenditure is divided over large production runs, thereby reducing the cost per unit.
- Scaling: The relationship between dimensions and volumes is not always linear e.g. the surface area on an oil tanker increases at two-thirds the rate of the volume. A tanker thus requires proportionally less steel per cubic metre of cargo as it increases in volume.
- Diseconomy of scale: It often happens that as output increases, the organisation structure becomes large and bureaucratic. As a result, co-ordination between the management departments become increasingly more complex, costly, and inefficient.

5.2.5 Unit rates (or Parameter costs)

Although each project is unique, a great deal of the work may be repetitive. Parameter costs are developed from unit rates for common items of work associated with previous projects. Table 5.4 shows some parameters:

Table 5.4: Examples of unit rate types.

Type of rate	Scope of work	Unit rate
Per linear metre	Piping, wiring, welding, textiles	
Per square metre	Decorating, painting, house building	
Per cubic metre	Concrete, water supply	
Per tonne	Ship building, cargo freight	
Per KW	Power, electrical supply, install a generator	
Per KM	Transport	
Per day	Plant hire, car hire	
Per hour	Labour	
Per minute	Fashion garment construction	

In a controlled work environment, unit rates work well. Unit rates are probably the most commonly used estimating technique as they provide a simple contract to measure and budget.

ACTIVITY

1. Using labour as an example, distinguish between direct and indirect costs.

2. If a project's duration is reduced or extended, will all costs change? Explain.

3. Discuss some of the major estimating techniques that may be used to provide a reasonably accurate estimate of costs for a project.

SOLUTIONS:

1. **Direct costs** are costs that can be specifically identified with an activity or project e.g. boilermakers, welders, and fitters are people who work on an activity. **Indirect costs** are costs that cannot be directly assigned to an activity or project, but are needed to keep the company operational e.g. receptionists and security staff are not directly involved in a project's activity.

2. No. Not all costs are time related. Costs like rent, water, and electricity increase with time but costs like fixed price contracts are unaffected by time.

3. Refer to paragraph 5.2

5.3 Project budget

According to Schwalbe (2009:151), project cost budgeting involves the allocation of project cost estimates to different tasks over time. These tasks are based on the work breakdown structure (WBS) of the project. The main aim of cost budgeting is to produce a cost baseline. A cost baseline may be defined as a time-phased budget that project managers use to measure and monitor cost performance. Estimating costs for each major project activity over time provides project managers and top management with a foundation for project cost control using earned value management which will be discussed later.

Clements and Gido (2011:229) describe the project budget as a two-step process:

- Aggregated total budgeted cost: The aggregated estimated costs of the specific activities for each work package will establish the total budgeted cost (TBC) or budget at completion (BAC). This aggregated budgeted cost should not exceed the total amount of funds that the sponsor budgeted for the project (Clements and Gido, 2011).
- Cumulative budgeted cost: Once the TBC for each work package is established, the next step is to distribute each TBC over the expected time span of its work package (Clements and Gido, 2011). This time-phased budget is useful to track the actual spend against the cumulative budgeted cost (CBC) for each time period.

5.4 Actual costs

Clements and Gido (2011) suggest the use of processes, procedures and forms for gathering data which reflects the costs actually expended. For example, weekly time sheets can be used to collect actual labour hours. As invoices are received, these must be charged to the correct work package number. *Committed costs (commitments, obligated costs or encumbered costs*) should be treated in a special way as they extend across several cost reporting periods (Clements and Gido, 2011).

As portions of actual costs, including committed costs, are collected for a particular work package period (cumulative actual costs or CAC), they must be compared against the cumulative budgeted cost (CBC).

5.5 Earned value management

Earned value management may be defined as "a management methodology for integrating scope, schedule and resources, and for objectively measuring project performance and progress" (Kloppenborg, 2009:393). *Earned value* may be described as the value of work completed expressed in terms of the approved budget allocated to that work. Clements and Gido (2011) define earned value as "the value of work actually performed" and state that it is a "key parameter that must be determined throughout the project. Earned value is calculated by collecting data on the percent complete for each work package, and then converting this percentage to a monetary value. The formula used is: ***EV = TBC of work package x Percent complete.***

Earned value, according Kloppenborg (2009:393), makes it possible for a project team to understand their project's progress with regard to cost and schedule as well as to make forecasts regarding the project's schedule and cost control until the completion of the project. Earned value is an important decision-making tool. The project manager can do a quick assessment of how the project is doing according to the baseline plan and whether the project would end without any significant cost/schedule impacts. The earned value data permits a project manager to determine the status of a project at any given point in time.

When interpreting earned value management, one must consider cost and schedule independently. Firstly, in terms of the planned schedule, a project can be either ahead or behind; and in terms of budget, a project can be either over or under. Secondly, all earned value terms relate to one of two time frames. Each of the above either represents the current status as of the last date that project data was collected, or a forecast for the end of the project. Table 5.5 lists 12 questions and answers that reflect all the earned value management terms.

Table 5.5: Earned value management terms (Source: Kloppenborg, 2009:395).

Question	Timing	Answer	Acronym
How much work *should* be done?	Now	Planned value	PV
How much work *is* done?	Now	Earned value	EV
How much *did* the "is done" work cost?	Now	Actual cost	AC
How much was the total project *supposed* to cost?	End	Budget at completion	BAC
How much *is* the project schedule ahead or behind?	Now	Schedule variance	SV
How much *is* the project over or under budget?	Now	Cost variance	CV
How efficient is the project *so far* with its schedule?	Now	Schedule performance index	SPI
How efficient is the project *so far* with its budget?	Now	Cost performance index	CPI
How much *more* do we expect to spend to finish the project?	End	Estimate to complete	ETC
What do we *now* think the total project will cost?	End	Estimate at completion	EAC

We now learn how to calculate each of the earned value management terms as explained by Kloppenborg (2009:396).

5.5.1 Currently known values

Suppose the following values are provided:

PV = R250 000; EV = R200 000; AC = R400 000; BAC = R750 000

- Planned value (PV) refers to the budget that has been authorised for the scheduled work to be completed. In our case it will be R250 000.
- Earned value (EV) may be described as the value of work completed expressed in terms of the approved budget allocated to that work, which in our case is R200 000.
- Actual cost (AC) reflects the total costs actually incurred to accomplish the work performed during a given time period. In our case, R400 000 is owed for the work that was completed.
- Budget at completion (BAC) is the sum of all budgeted values determined for the work to be done on a project. In other words, it's the total planned value of the project. In our case the approved budget for the entire project is R750 000.

5.5.2 Variances

Schedule variance (SV) measures schedule performance on a project. It is the difference between EV and PV. In our example the calculation will be:

EV – PV = R200 000 – R250 000 = –R50 000

The negative value is an indication that the project is behind schedule.

Cost variance (CV) measures the cost performance on a project. It is the difference between EV and AC. In our example the calculation is as follows:

EV – AC = R200 000 – R400 000 = –R200 000

The negative answer shows that the project is over budget.

These two variances shows in monetary terms how well or poorly the project is performing in terms of cost and schedule. Clearly, the performance is poor in terms of both cost and schedule.

5.5.3 Indices

Some project managers prefer to use efficiency measures in percentage terms to understand how well or poorly the project is performing. **Schedule performance index (SPI)** measures schedule efficiency on a project. It is calculated as follows:

$$\frac{EV}{PV} \times 100$$

In our case, SPI will be calculated as follows:

$$\frac{R200000}{R250000} \times 100 = 80\%$$

Since only 80% of what was planned has been accomplished, the project is behind schedule. When performance indexes are used: 100% means right on schedule; <100% means less efficient than planned; and >100% means more efficient than planned.

Cost performance index (CPI) measures cost efficiency on a project. It is calculated as follows:

$$\frac{EV}{AC} \times 100$$

In our case, CPI will be calculated as follows:

$$\frac{R200000}{R400000} \times 100 = 50\%$$

The project is over budget since only R0.50 (fifty cents) of results was received for every Rand that was spent.

5.5.4 Estimates

Now that we understand the performance in the project thus far, we now predict performance for the remainder of the project. The easiest way of estimating future performance is to predict that past performance will continue. The following calculations are based on this assumption.

Estimate to complete (ETC) refers to the expected cost required to complete the remaining work for the project.

Assuming that future performance will have the same efficiency as past performance, it is calculated as follows:

$$\frac{(BAC) - EV}{CPI}$$

In our case, it will be calculated as follows:

$$\frac{(R750000) - R200000}{50\%} = R1100000$$

Unless efficiency is improved, the company can expect to pay more for the remaining project work than the original cost of the project.

Estimate at completion (EAC) is the expected total cost of the project when the defined scope of work will be completed. It is calculated as follows:

$$EAC = AC + ETC$$

In our case, it will be calculated as follows:

R400 000 + R1 100 000 = R1 500 000

Since cost efficiency is only 50% of plan (refer to CPI), the original estimate will be double unless efficiency improves.

Each term in earned value management helps project managers understand something about the performance of the project. Collectively the terms provide project managers with added insight for monitoring and controlling cost and schedule.

SELF ASSESSMENT ACTIVITY

The following information is available for Project A:

PV = R250 000; EV = R175 000; AC = R275 000; BAC = R600 000

1. Calculate the following:

a) Schedule variance (SV)

b) Cost variance (CV)

c) Schedule performance index (SPI)

d) Cost performance index (CPI)

e) Estimate to complete (ETC)

f) Estimate at completion (EAC)

2. Describe the results of each calculation in question 1.

SOLUTIONS:

1a) Schedule variance = EV – PV = R175 000 – R250 000 = –R75 000

1b) Cost variance = EV – AC = R175 000 – R275 000 = –R100 000

1c) Schedule performance index (SPI)

$$\frac{R175000}{R250000} \times 100 = 70\%$$

1d) Cost performance index (CPI)

$$\frac{R175000}{R275000} \times 100 = 63.64\%$$

1e) Estimate to complete (ETC)

$$\frac{(R600000) - R175000}{63.64\%} = R667819$$

1f) Estimate at completion (EAC)

$$EAC = R275000 + R667819 = R942819$$

SOLUTIONS TO SELF ASSESSMENT ACTIVITY (CONTINUED)

2.

Schedule variance (SV): The project is behind schedule since the variation is negative.

Cost variance (CV): The project is over budget since the variation is negative.

Schedule performance index (SPI): The project is behind schedule since only 70% of what was planned was accomplished.

Cost performance index (CPI): The project is over budget since only R0.64 worth of results was received for every Rand spent.

Estimate to complete (ETC): The cost to complete the remaining work for the project is R667 819 which is even greater than the original cost of the entire project.

Estimate at completion (EAC): Since the cost efficiency is only about two thirds of the plan, unless there is greater efficiency, it can be expected that the company would have to pay just over 1½ times the original estimate.

5.6 Managing cash flow

According to Clements and Gido (2011), managing cash flow involves ensuring that the funds from the sponsor or income from payments received are carried out timeously so that there is enough money to cover the costs of executing the project. Cash must come in faster than it can go out. Payments to the contractor must also be made on time. Providing down payments at the start of the project, making equal monthly payments based on the expected duration of the project, or providing frequent payments are options to consider (Clements and Gido, 2011).

5.7 Conclusion

Financing a project is generally the first stage, and is beyond the scope of this module. Estimating costs is one of the early stages of project cost, budget and earned value management. This leads the project manager on to determining the budget for the project. Actual costs must then be gathered during the project and compared against the budget. Earned value management and its associated parameters is an important way of tracking project progress in terms of value gained from money spent.

The next section deals with communication and risk management.

SECTION 6

6. PROJECT COMMUNICATION AND DOCUMENTATION

CONTENTS

Learning outcomes

Reading Material

6.1 Introduction

6.2 Communication in a project environment

6.3 Personal communication

6.4 Significance of communication in project management

6.5 Project meetings

6.6 Project presentations

6.7 Project reports

6.8 Project communication plan

6.9 Conclusion

Learning Outcomes:

The overall outcome for this section is that, on its completion, the learner should be able to demonstrate an understanding of project communication and documentation. This overall outcome will be achieved through the learner's mastery of the following specific outcomes, in that the learner will be able to:

1. Describe communication in a project environment.
2. Distinguish between verbal and non-verbal communication.
3. Discuss the significance of communication in project management.
4. Identify and describe the different types of project meetings, and discuss the purpose and hosting of each.
5. Identify and describe the different types of project reports, and discuss the purpose each.
6. Describe and formulate a project communication plan.

Reading Material:

READING

Prescribed reading:

Clements, J. P. and Gido, J. (2011). Effective Project Management. 5th Edition. Boston: Cengage Learning.

Recommended reading:

Burke, R.J. and Barron, S. (2007). Project Management Leadership. Hampshire: Burke Publishing.

Schwalbe, K. (2009). Introduction to Project Management. 2nd Edition. Boston: Cengage Learning.

6.1 Introduction

Communication in any institution is critical to its success, and this is certainly true of projects. The aim of communication is to ensure that the information necessary for the management of projects is collected and exchanged or distributed on time, and that when required, is adequately stored for easier retrieval. This requires a communication plan, as part of the project plan, which specifies what information will be collected and when, who will be responsible for the collection and analysis of the data, and to whom, how and when it will be distributed.

Communication skills and planning are essential to address the issues and challenges associated with project management. Communication is the basis for gaining understanding between project team members, for discussing project issues and for settling team disputes. People in an institution must communicate, but the criteria that characterise project activities means that they must communicate effectively and efficiently if the work is to be well directed and managed.

The way project outcomes are communicated can affect how people perceive and accept those outcomes. Project managers and project team members should be effective communicators. Communication is a key tool that project team members must use in dealing with the concerns, service needs and enquiries of clients and role players.

In this section, a broad overview of personal communication is provided. Communication is defined within a project setting, after which the significance of communication in projects is explained. Project communication planning, documentation management and meeting and presentation fundamentals, also come under scrutiny. Lastly, the project communication plan is discussed.

6.2 Communication in a project environment

Communicating is a broader discipline and involves a substantial body of knowledge that is not unique to the project context.

For example:

- Sender-receiver models (feedback loops, barriers to communication, etc.);
- Choice of media (when to communicate in writing versus when to communicate orally; when to write an informal memo versus when to write a formal report; etc.);
- Writing style (active versus passive voice, sentence structure word choice, etc.);
- Presentation techniques (body language, design of visual aids, etc.);
- Management techniques (preparing a meeting agenda, dealing with conflict, etc.).

Project communication as an academic field embraces a large body of knowledge. Within a project management context, communication focuses on:

- How the project team members communicate with one another;
- How the project team, and specifically the project manager, liaise with senior management and internal stakeholders on project resources and progress;
- How the project team liaise with external stakeholders such as the media and community leaders;
- The distribution of information to all project stakeholders and role-players using appropriate media and technology;
- The planning and compilation of a project communication plan;
- Project-related documentation (progress reports, etc.).

ACTIVITY

Describe project communication in your own words.

6.3 Personal communication

Clements and Gido (2011:370) define and describe verbal versus non-verbal communication. These can be classified as follows:

Oral (Verbal)

According to Healy (1997:232), oral communication is the key form of communication in any project. Written documents, if often serve simply to record what has already been agreed upon during discussions. Oral or verbal communication, as part of project problem solving, takes place without written records. In any managerial hierarchy, work is done through oral communication, as well as through significant amounts of written records.

Written

There is always potential for conflict between the desire to limit the quantity of correspondence that is a feature of large projects, and the need to ensure that the essential communications are properly maintained. All project team members should be instructed to adopt the "need to know" principle, so that copies of written communications are limited to those who need the information. The need for clarity and simplicity in written communication also requires constant emphasis.

Graphical

Design and construction drawings (e.g. housing projects) are an essential basis for project management. In a large project there will be numerous drawings to be issued and approved. Charts and graphs are also used to convey information. This applies particularly to planning and progress data and reports. It is important that this data is presented in a clear and accurate way, and supported by adequate written explanations so that ambiguity is avoided.

Numerical

Tables of data are also used to convey project information. It is important that adequate explanatory notes are provided, so that readers gain a rapid and accurate understanding of the numerical information. Numerical data should be presented in a form that can be readily understood by management.

Electronic

In modern project management, applied and computer technology are in general use. There is a tendency to believe implicitly in the output from computers. However, output should be regarded critically. It will have the same degree of accuracy as the input.

6.4 Significance of communication in project management

Project communication, according to Healy (1997:227), has a dual purpose: the first is to cause some action or agreement to take place, and the second is to make a record that might be needed later. The larger the number of people involved in the project, the more communication paths there are, and the more project time is spent on simply sharing information and keeping stakeholders and role players up to date.

Inefficiencies in communication, and especially the lack of communication, can severely affect a project's schedule and chances for success. Communication management is even more necessary if the project team is spread out over different geographical areas and timelines.

Large projects generate huge quantities of information. If this information is to be used effectively to manage project activities, it must be organised systematically and structured to provide suitable information for the various levels of project management.

Proper communication in a project is a critical success factor for managing the expectations of the customer and the stakeholders. There is a much greater chance of problems and difficulties occurring due to differing levels of expectations. In fact, in many cases where conflicts arise, it is not because of the actual problem but because the customer or manager was surprised. Project communication management provides the critical link among people, ideas and information that is necessary for success. Everyone involved in the project 'language', must understand how the communications they are involved in as individuals, affect the project as a whole.

ACTIVITY

Projects are run by good communication. You have been appointed project manager of the construction of an offshore platform. Your presentation should outline how you will approach the following:

1. Communication cycle – data capture, processing, dissemination and storage.
2. Lines of communication.
3. Status-review and problem solving meetings.
4. Document control.

6.5 Project meetings

Clements and Gido (2011:374) distinguish between different types of project meetings:

- Project kick-off meetings
- Status review meetings
- Problem solving meetings
- Design review meetings
- Post-project evaluation meeting

Three of the above types of meetings will be discussed in this section.

6.5.1 Status review meetings

The primary purposes of such a meeting are to inform, identify problems, and to identify action items. According to Clements and Gido (2011), the following are some of the subjects that might be discussed as part of the agenda:

- Accomplishments since the last meeting
- Cost, schedule, and work scope (status)
- Cost, schedule, and work scope (trends)
- Cost, schedule, and work scope (forecasts)
- Cost, schedule, and work scope (variances)
- Risk assessment update
- Corrective actions
- Opportunities for improvement
- Action item assignment

6.5.2 Problem-solving meetings

The purpose is to identify and resolve the problem as early as possible for a project to be successful. According to Clements and Gido (2011:376), the problem solving meeting should follow a good problem solving approach, such as:

a) Develop a problem statement.
b) Identify potential causes of the problem.
c) Gather data and verify the most likely causes.
d) Identify possible solutions.
e) Determine the best solution.
f) Revise the project plan.
g) Implement the solution.
h) Determine whether the problem has been solved.

6.5.3 Design review meetings

Projects that involve a design phase, such as an information system project or development of a new marketing brochure, may require one or more technical design review meetings to ensure that the customer agrees with, or approves of, the design approach developed by the project contractor.

The two types of design review meetings are:

- A preliminary design review meeting.
- A final design review meeting.

Clements and Gido (2011:377) also describe some general steps to effectively prepare for meetings:

a) Determine whether a meeting is really necessary.
b) Determine the purpose of the meeting.
c) Determine who needs to participate in the meeting.
d) Distribute an agenda well in advance of the meeting.
e) Prepare visual aids or handouts.
f) Make meeting room arrangements.

Clements and Gido (2011:379-381) also describe steps to follow during and after each project meeting.

6.6 Project presentations

Clements and Gido (2011) also describe some important points to take note of in preparation of and during a presentation:

- Determine the purpose of the presentation.
- Know the audience.
- Make an outline of the presentation.
- Use simple language that the audience will understand.
- Prepare notes or a final outline that you will use or refer to during your presentation.
- Prepare visual aids and test them.
- Make copies of handout materials.
- Go into the meeting room when it is empty or not in use and get a feel for the surroundings.
- Include divergent views or issues.
- Break the material into short sections to facilitate questions and discussion.
- Create tension slides to help the audience move from one section or point to the next.
- Build-in variety, surprise, or changes of pace.
- Don't overwhelm the audience with information- make each slide comprehensible, simple, and tied with a common thread throughout the presentation.
- Identify and make arrangements for audiovisuals and other resources.
- Test the presentation equipment before the audience arrives.
- Monitor the time.
- Develop a strong conclusion related to the presentation content.
- Know the first two or three sentences of your presentation.
- Speak clearly and confidently.
- Use appropriate animation to help make a point.
- Do not stand in front of your visual aids.
- Keep to the key points in your outline.
- When making key points, explain to the audience why they are important.
- Allow time for interaction with the audience, if appropriate.
- When responding to questions, be sincere, candid, and confident.

6.7 Project reports

According to Clements and Gido (2011:384), the two most common types of project reports are: Progress /Status reports and Final Reports.

Items that might be included in a progress report include the following:

- Accomplishments.
- Current status of project performance.
- Progress toward resolution of previously identified problems.
- Problems or potential problems since prior report.
- Planned corrective actions.
- Milestones expected to be reached during the next reporting period.

The project final report is usually a summary of the project. The **final report** might include:

- Customer's original need.
- Original project objective.
- Customer's original requirements.
- Actual versus anticipated benefits to the customer as a result of the project.
- Degree to which the original project objective was met.
- Brief description of the project.
- Future considerations.
- A list of all deliverables.

6.8 Project communication plan

Communication planning involves determining the information and communication needs of the stakeholders: Who needs what information? When will they need it? and how will it be given to them. 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, are important factors for project success. A *project communication plan* defines the generation and distribution of project documentation among stakeholders throughout the project (Clements and Gido, 2011:388).

According to Clements and Gido (2011, 389-390), the following elements may be included in a project communication plan:

- Documents (e.g. project charter, contract, scope document, WBS, quality plan, etc.)
- Author or originator
- Required date or frequency
- Recipients
- Action required
- Comments

A typical template of a project communication plan appears below:

Documents	Author	Required date	Recipients	Action required	Comments

6.9 Conclusion

Project communication can take various forms and encompasses different types of documents, reports, meetings which are also incorporated into a project communication plan. Project managers must possess and master various communication skills for effective project management. This includes personal communication skills, conducting meetings and delivering presentations, and collaborating with all stakeholders.

SECTION 7

7. PROJECT RISK MANAGEMENT

CONTENTS

Learning outcomes

Reading Material

7.1 Introduction

7.2 Definitions

7.3 Categories and types of risk

7.4 Risk assessment

7.5 Risk management plan process

7.6 Conclusion

Learning Outcomes:

The overall outcome for this section is that, on its completion, the learner should be able to demonstrate an understanding of the field of project risk management. This overall outcome will be achieved through the learner's mastery of the following specific outcomes, in that the learner will be able to:

1. Define terms specifically related to project risk management.
2. Discuss the different categories and types of risk.
3. Carry out a risk assessment in a project environment.
4. Explain and apply the risk management plan process.

Reading Material:

READING

Prescribed reading:

Clements, J. P. and Gido, J. (2011). Effective Project Management. 5th Edition. Boston: Cengage Learning.

Recommended reading:

Burke, R.J. and Barron, S. (2007). Project Management Leadership. Hampshire: Burke Publishing.

Gray, C.F. and Larson, E.W. (2006). Project Management: The Managerial Process. 3rd Edition. New York: McGraw-Hill.

Schwalbe, K. (2009). Introduction to Project Management. 2nd Edition. Boston: Cengage Learning.

Schwartz, R.J. and Smith, C.W. (1997). Derivatives Handbook: Risk Management and Control. New York: John Wiley & Sons, Inc.

7.1 Introduction

This section outlines the most essential knowledge that you should acquire in the field of project risk management. Be aware that, as a manager or co-ordinator of projects, there will come a time when your efforts will fall short of necessary requirements. This failure could be ascribed to numerous factors but, by engaging in constructive project risk management, you will be able to mitigate the risks to your project.

7.2 Definitions

Risk

According to Clements and Gido (2011), risk is an uncertain event that can jeopardise the project objective. Risk includes the expected losses (economic, time, infrastructure or resources) that a particular phenomenon might cause. It is a function of the probability of particular occurrences and the losses that each would cause (severity).

Risk management

Risk management includes the processes concerned with identifying, analysing and responding to project risks. It includes both minimising the impact of adverse events and maximising the likelihood of positive outcomes. Project risk management includes the processes of risk assessment, risk mitigation and risk response.

Hazard

A hazard in the project management domain can be defined as a rare or extreme event, or the probability of an occurrence in the natural or human-made environment, that adversely effects the successful completion of the project, to the extent that it may cause economic, time, infrastructure or resource loss.

Vulnerability

Vulnerability is the degree of loss to a given element (economic, time, infrastructure or resources) that is at possible risk from the impact of a hazard of a given severity. It is specific to a particular project and can be expressed on a scale of 0 to 10 (0 indicating no loss, 10 indicating total damage).

Probability

Risk probability in a project can be defined as which the risk event that is likely to occur. The probability of certain risks influencing a project is determined by the nature of the project.

Frequency

Frequency refers to the number of times a particular risk can impact on a project, for example rain interruption of a building project or systems downtime in an information technology project.

Severity

The impact of a risk on a project can be defined by its severity. The severity of a risk is mostly quantified into monetary terms, although other measuring tools are also often used.

7.3 Categories and types of risk

Clements and Gido (2011:271) identify the following categories of risk:

- Technical
- Schedule
- Cost
- Human resources
- External
- Sponsor/customer

Some specific examples of risk include:

Market or price risk

Market or price risk is the risk of a decrease in the value of a financial portfolio as a result of adverse movement in the market variables such as prices, currency exchange rates and interest rates. In other words, market risk is the exposure arising from adverse changes in the market value of a financial instrument or portfolio.

Interest rates risk

This is the risk of a loss that an organisation could suffer as a result of adverse consequences due to fluctuations in interest rates. Most financial institutions face interest rate risk. Interest rate risk is known to fluctuate and is by nature a speculative type of financial risk, since interest rate movements can result in profits or losses. It can thus be urged that interest rate risk depends on the state of the economy.

Liquidity

Liquidity is an organisation's ability to meet its financial obligations within a given time period. This risk will be reflected in insufficient funds or marketable assets being available.

Legal risk

Legal risk is the risk arising from violations of, or non-compliance with laws, rules, regulations, prescribed policies and ethical standards. This risk also arises when laws or rules governing certain products or activities of an organisation's customers are unclear or untested. Non-compliance can expose the organisation to fines, financial penalties, payment of damages, and the voiding of contracts.

Operational risk

Operational risk is the risk of loss occurring as a result of inadequate systems and control, human error, or management failure. It is the risk of a loss arising from human error, management failure and fraud, or from shortcomings in systems or controls (Schwartz and Smith, 1997:322).

7.4 Risk assessment

Risk assessment is the identification, quantification and evaluation of the probability of the occurrence of risk events and the impact of the risk events on a project. Risk assessment addresses issues such as: What can go wrong? How likely is this to happen? If it does happen, what are the consequences? In essence, risk assessment is both proactive and reactive measures to project risk management. Clements and Gido (2011) suggest the preparation of a risk assessment matrix which would include *the specific risk, the impact of the risk, probability of the risk, degree of impact of the risk, action trigger, responsibility and response plan.*

A useful checklist for a risk assessment is provided below:

QUESTIONS	YES	NO
Has the project leader's authority been established?		
Is the core team appointed?		
Does the core team understand the project purpose?		
Have the stakeholders been identified		
Have stakeholder management responsibilities been allocated?		
Have the project objectives been established?		
Have the project benefits been identified and quantified?		
Are there clear deadlines and a project timescale?		
Is there a known business critical date established?		
Is there a scope statement?		
Are the project boundary limits clearly established?		
Is there an impact if the project fails?		
Are the right skills available in the team/organisation?		
Can the project brief be accurately derived?		
Have all the project constraints been identified?		
Are there identifiable consequences of late completion?		
Has the project brief been approved?		
Have all the key stages been clearly identified?		
Have the key stage dependencies been established and agreed on?		
Are the key stage durations agreed and accepted?		
Is the project schedule realistic and achievable?		
Have key stage responsibilities been allocated and accepted?		
Have workload priorities been clearly established?		
Have line managers accepted and committed their staff involvement?		
Have all resources required given commitment to their responsibilities?		
Has the plan been developed to a low enough level for effective control?		
Have key stakeholders signed off the project plans?		
Are project procedures established and understood?		
Has a milestone schedule been established?		
Have performance measures been derived?		

7.5 Risk management plan process

The risk management plan process includes the following steps:

a) Define objectives
b) Identify risk
c) Quantify risk
d) Develop a response
e) Risk control

a) Define objectives

Risk may be defined as any event or constraint that prevents the project manager or team from achieving the project's goals and objectives. It is therefore necessary at the outset to define these goals and objectives in some detail, and to indicate who is responsible for achieving them.

b) Identify risk

Having defined the business objectives by one of the above breakdown structures, the next step is to identify what areas of risk, uncertainty and triggers could prevent the progress team from achieving these stated objectives. Techniques for identifying risk include:

- Analysing historical records and closeout reports
- Safety reports (health and safety requirements)
- Structured questionnaires
- Structured interviews
- Brainstorming
- Structured checklists
- Flow charts
- Judgement based on knowledge
- Scenario analysis

c) Quantify risk

Having identified a range of possible risks, the next step is to quantify the probability (likelihood) of the risk occurring and the impact or consequence to the project, or to the amount at stake. These risks should be assessed in consultation with appropriate stakeholders.

For any given risk, whether it is a natural disaster, a liability, or a worker's compensation loss exposure, the following steps should be followed to analyse the frequency and severity of the risk:

i. Assign a category for the frequency of occurrence of a loss event.
ii. Assign a category for the severity of the loss event.
iii. Multiply the frequency value by the severity value.
iv. Prioritise the ratings for all loss exposures.

ACTIVITY

Consider the following case study and apply it to a risk matrix (use the Internet to read up more about risk matrices). Use your results to determine the frequency, severity, probability and risk scores.

You have been appointed as the project manager for a shopping centre construction project. The area in which you are building is prone to excessive rain and occasional flooding. You are working with unfamiliar construction teams. After initial consultation with the local traffic department, it has become clear that they are not satisfied with the road layout as per your building plans. However, they did give the preliminary go-ahead for the project, with the proviso that the town engineer and town planner reconsider the plans. To date, all the suppliers you have contacted can supply all the relevant material but cannot guarantee on-time delivery.

d) Develop a response

Risk response includes the development of proactive measures to counteract identified risks and changes in risk over the course of a contingency planning. Clements and Gido (2011) suggest the development of a separate risk response plan. Having identified, quantified and prioritised the risks, you need to develop a risk response plan which defines ways to address adverse risk and enhance entrepreneurial opportunities before they occur. The range of responses includes:

- Eliminate risk.
- Mitigate risk.
- Deflect risk.
- Accept risk (contingency).
- Turn risk into an opportunity.

A *contingency plan* must also be formulated. A typical contingency plan should contain the following information:

- Title
- WBS identification number
- Risk/risk events/threats
- Trigger events
- Contingency actions
- Responsible persons
- Cost implications
- Time implications
- Tasks effected
- Influence of critical path

e) Risk control

The risk control function implements the risk management plan to make it happen. This is the most important part, but surprisingly is often neglected. The risk management plan needs to be communicated to the entire project team, and where necessary, followed up with appropriate training and practice runs. The risk management plan should consider:

- Changes in the scope work.
- Changes in the build method.
- Changes in the team members.
- Changes in the suppliers.

The ultimate goal of risk management is *risk mitigation.* Risk mitigation involves defining the necessary steps to counter threats and to enhance opportunities. It is the active steps taken to lessen the effects that a particular identified risk might have on a project outcome. It is also the continuous measures taken during the life cycle of a project in order to ensure proactive actions to unforeseen circumstances.

7.6 Conclusion

Effective risk management involves:

- Commitment to risk management by stakeholders, top management, the project steering committee, the project manager and project team members, and
- An adequate project management approach (a capable project manager should take responsibility for risk management, and he/she and the project team should have an understanding of the technical and non-technical issues).

Risk management involves identifying, assessing, and responding to project risks in order to minimise the likelihood and impact of the consequences of adverse events on the achievement of the project objective. Risk identification includes determining which risks may adversely affect the project objective and what the consequences of each risk might be if they occur. Assessing each risk involves developing an action plan to reduce the impact or likelihood of each risk, establish a trigger point for when to implement the actions to address each risk, and assigning responsibility to specific individuals for implementing each response plan. During the project, it is important to evaluate all risks to determine if there are any of the risks, also, new risks maybe identified that were not considered as a risk earlier in the project.

SECTION 8

8. PROJECT MANAGEMENT LEADERSHIP

CONTENTS

Learning outcomes

Reading Material

8.1 Introduction

8.2 Project manager responsibilities and skills

8.3 Networking

8.4 Problem-solving and decision-making

8.5 Groups and teams

8.6 Delegation

8.7 Negotiation

8.8 Conclusion

Learning Outcomes:

The overall outcome for this section is that, on its completion, the learner should be able to demonstrate an understanding of the field of project leadership. This overall outcome will be achieved through the learner's mastery of the following specific outcomes, in that the learner will be able to:

1. Identify and describe the portfolio of skills and responsibilities of project managers.
2. Identify and explain the characteristics and traits to consider when selecting project managers.
3. Discuss some of the leadership styles and theories applicable to project management.
4. Discuss ways to develop project managers and employees.
5. Explain the significance of networking.
6. Describe and apply the problem-solving and decision-making processes.
7. Explain and apply negotiation strategies and tactics.
8. Describe formation of project groups and teams and suggest how teams can improve their performance.
9. Explain how to delegate work to project employees.

Reading Material:

READING

Prescribed reading:

Clements, J. P. and Gido, J. (2011). Effective Project Management. 5th Edition. Boston: Cengage Learning.

Burke, R.J. and Barron, S. (2007). Project Management Leadership. Hampshire: Burke Publishing.

Recommended reading:

Schwalbe, K. (2009). Introduction to Project Management. 2nd Edition. Boston: Cengage Learning.

8.1 Introduction

Project management leadership focuses on the human side of project management, and the leadership skills that the project manager needs to manage the project team and other stakeholders. Besides project management skills, the project manager also needs leadership skills to negotiate, motivate and inspire the team members, both individually and collectively. However, the project manager's challenges do not end there, the project manager also has to manage and lead all the other project stakeholders. This may also require excellent communication, bargaining and negotiation skills.

8.2 Project manager responsibilities and skills

Managing projects requires a diverse range of skills and abilities. A skill is defined as the ability to translate knowledge into an action that results in the desired performance. According to Clements and Gido (2011:302), project managers are responsible for planning, organising and controlling a project in order to accomplish project objectives. Burke and Barron (2007:25) illustrate a portfolio of skills required by project managers (Figure 8.1).

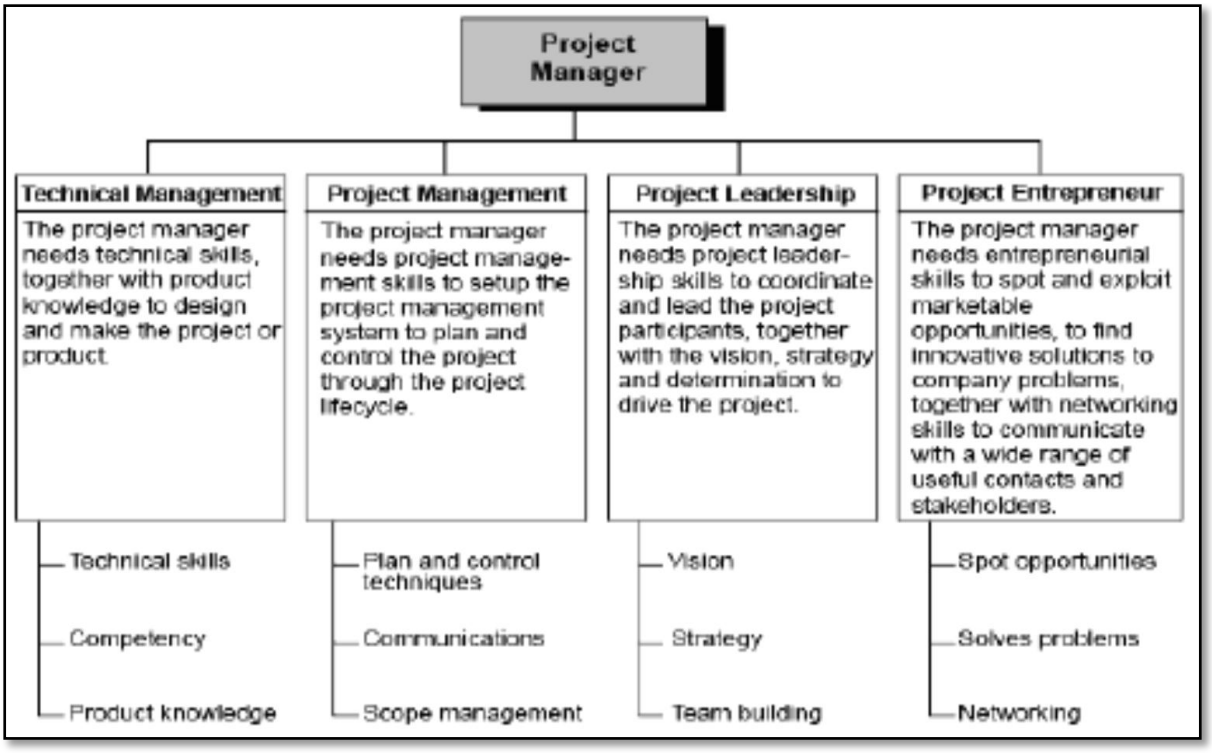

Figure 8.1: Project manager's portfolio of skills (Source: Burke and Barron, 2007:25).

Clements and Gido (2011:304) also describe the following set of skills necessary for the success of a project:

a) Leadership ability

- The project management leadership is not an end in itself, but rather its whole purpose is to make the other managerial skills happen. It is the project manager's leadership responsibility to:
  i. Lead the generation of entrepreneurial and innovative ideas, spot opportunities and respond to competition;
  ii. Lead the technical design and development of the product and incorporate new technology;
  iii. Oversee the project management planning and control process; and
  iv. Negotiate for project resources and inspire the project team.
- The leadership traits theory proposes that 'leaders are born not made', meaning that leaders with genetically 'inbred superiority' will naturally emerge as leaders because of their personal qualities, behaviour and characteristics. Leadership traits include: visionary, opportunist, inspiring, empowering, charismatic, determined, passionate, trustworthy, a good communicator, competent, etc.
- Some leadership styles are explained by the following theories:
  i. McGregor's Theory X and Y:
     - Theory X –Authoritarian Management Style: This style assumes that the average person will do their best to avoid work and responsibility and therefore must be directed and forced to work.
     - Theory Y- Participative Management Style: This style assumes that people enjoy work and will take responsibility by applying and directing themselves to further the aims of their project.
  ii. Action-centred leadership: The model focuses on leadership action and suggests that the leader should focus on three responsibilities: Task, Team and Individual, acting according to the demands of each
  iii. Situational leadership: This suggests that different styles are better in different situations and that effective leaders must be flexible enough to adapt their style depending on the working maturity of their followers. Hersey and Blanchard (cited in Burke and Barron, 2007: 242) characterised the situational leadership style in terms of the

amount of direction and support that the leader provides to their followers.

- Directing or "Telling" Leadership
- Coaching or "Selling" Leadership
- Supporting Leadership
- Delegating Leadership

iv. Emotional Intelligence leadership styles: Goleman (cited in Burke and Barron, 2007: 248) described six leadership styles that have some overlapping concepts with the Situational Leadership Model: Visionary, Coaching, Affiliative, Democratic, Commanding, and Pacesetting.

b) Ability to develop people

- The following ways can be used to develop a project manager and/or his/her team (Clements and Gido, 2011:314):
  i. Gain experience.
  ii. Learn from others.
  iii. Interview project managers who have skills that you want to develop in yourself.
  iv. Conduct a self-evaluation, and learn from your mistakes.
  v. Get a mentor.
  vi. Participate in education and training programmes.
  vii. Join relevant organisations, e.g. PMI.
  viii. Read journals, books, etc.
  ix. Earn a credential, e.g. Project Management Professional (PMP), Certified Associate of Project Management (CAPM), etc.
  x. Volunteer.

c) Communication skills (previously discussed)

d) Interpersonal skills

e) Ability to handle stress

f) Problem-solving and decision-making skills (discussed later)

g) Negotiating skills (discussed later)

h) Time management skills.

Selecting the project manager

The project's size, type and location will influence the selection of the type of project manager. On a small project, the project manager may be expected to do everything, but as the project increases in size and complexity, the project manager will have to manage the project through a project team, a project management office (PMO) and a fully integrated planning and control system. One view is that the project manager should be an expert in the field of the project. The following points support the argument that the project manager should be a technical expert: Technical decisions, Judgement, Team selection, Feasibility study, Respect, Lead technical - coordinating matrix, Knowledge.

Another view is that the project manager should be a generalist. The following points support this argument:

- Corporate ladder – leading and managing the project team assumes more importance rather than technical issues;
- Multi-disciplined project – wide range of technical skills which may not reside in one person;
- A technical expert as a leader can suppress innovation from other team members;
- Non-technical skills are required – leadership, human resource management, etc.

The project manager is delegated with responsibility and authority to carry out the following:

- Select the team
- Establish the project management office (PMO)
- Design the project management information system (PMIS)
- Estimate and tender
- Network
- Stakeholders
- Client relationships
- Correspondence

The first part of the job description focuses on how the project will be managed and work tenders. After the project has been awarded, the project manager's job then focuses on the planning, organising, leading and controlling of the project.

8.3 Networking

Working with stakeholders and networking is central to the need for the above skills set. It is an essential project management leadership function to identify all the stakeholders and determine their needs and expectations – particularly with respect to information and communication. It is likely that many of these needs and expectations will be different and in some cases conflicting. This is where project managers need to use their negotiation skills and influence on a common set of mutually acceptable objectives.

Project managers are expected to use their leadership skills to create an environment where the stakeholders are encouraged to contribute their skills and knowledge to the project environment. These needs and expectations should then be managed, influenced, balanced, and if necessary, prioritised, to ensure a successful outcome.

Networking may be defined as the active development and maintenance of a list of useful contacts which can help you achieve your objectives. In the project manager's case, it is the ability to network with a broad range of contacts who can supply useful information, advice and resources to make the project. Networking skills are possibly the most important entrepreneurial trait helping the project manager to achieve the project's objectives.

8.4 Problem-solving and decision-making

Problem-solving and decision-making are often used interchangeably and seen as part of the same process, but in the project context, they are in fact quite different:

- Problem-solving is the process of generating a number of practical and technical solutions to solve a problem.
- Decision-making is the process of considering the wider aspects of the situation and gaining commitment from the team and stakeholders for the selection of one course of action.

The above processes are illustrated in Figure 8.2.

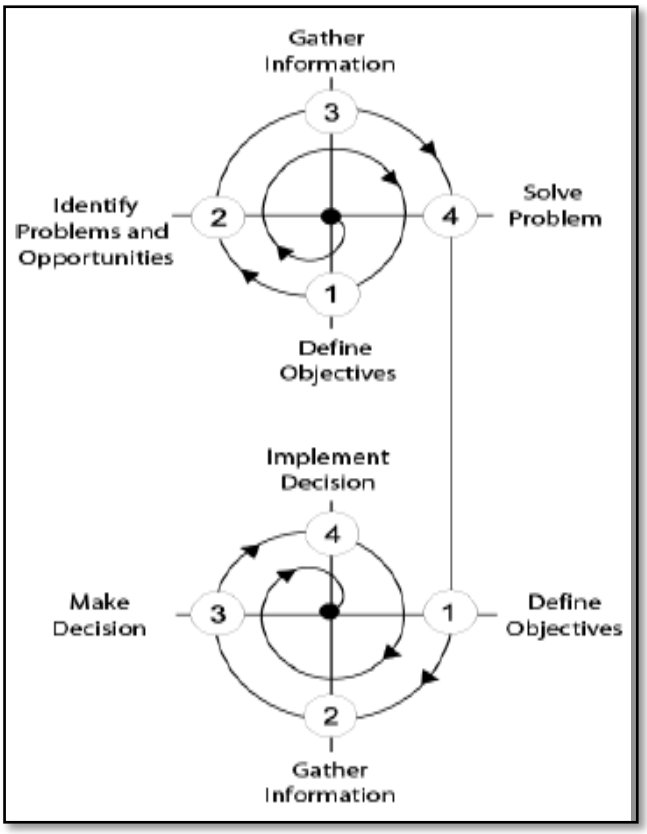

Figure 8.2: Problem-solving and decision-making process (Source: Burke and Barron, 2007:57).

8.4.1 Problem-solving cycle

a) Define objectives

The starting point for problem-solving is to define the project's goals and objectives because problems and opportunities can only be evaluated against these objectives. Objectives at the project level can be expressed as achieving the project charter and the baseline plan, together with addressing the stakeholders' needs and expectations.

b) Identify the problems or opportunities

Sensing and identifying problems is a skill and an art usually gained from experience. Problems and opportunities can be identified using the following techniques:

- Progress meetings and progress reports.
- Non-Conformance Report (NCR) - When the quality control department find work that does not achieve the required condition as set out in the project quality plan, they raise a NCR.

- Situation appraisal – The following questions should be raised- What is wrong with the current solution? What would happen if we did not address this problem? In appraising the situation, and with the help of stakeholders, specific challenges that help shape the problem can be identified.

c) Gather information

Useful sources include: Internet; Closeout reports; Stakeholders; Audits.

d) Solve the problem

This involves a combination of structured and unstructured methods for example:

- Sense making – This is an important part of problem solving. It is how we make sense of situations, how we determine what it means to us, and what it means to the project. As we review information about the problem, we internalize the knowledge and this forms part of our developing and understanding of the problem. It is useful to ask questions like: What? Why? When? How? Where? Who?
- Breaking down the problem – Choosing a goal that involves less uncertainty, or a level of uncertainty that is manageable, makes it achievable. In defining the problem, it should be written down in clear and concise terms that specifically states: what the expected benefit will be, the objectives and measures and the mandatory constraints.
- Brainstorming – This is also called a "mind shower". The process is usually used with a group, but can also work as a solo technique.
- Configuration management system – A project's configuration management system is designed to formally consider proposed changes to the scope of work. This enables all the nominated responsible people and stakeholders to consider the proposals, make comments, suggestions and recommendations.
- Quality circles - In the project context, the quality circle could include a representative from the project management office, the functional department, the supplier, the contractor and the client.

e) Present solutions and options

The output from the problem solving process is a number of possible solutions and options to solve the problem or take advantage of the opportunity.

8.4.2 Decision-making cycle

a) Determine objectives

Whereas the objectives in problem-solving referred to the project charter and the baseline plan, the objectives in the decision-making process also need to refer to the wider objectives of the project environment, the company and the external stakeholders. These objectives need to be known because a problem, by definition, is a situation which threatens the achievement of the objectives. Therefore, a decision needs to be made when the objectives are threatened and/or an opportunity is spotted which can enhance the project's competitive advantage. The need to make a decision will be triggered both by the project problem solving process and events threatening the other company objectives.

b) Gather information

The gathering of information function should try to obtain all relevant information, facts, figures and opinions together with identifying possible causes of problems, and establishing time constraints.

c) Decision-making

The next step is to decide on a course of action. One of the key features of decision-making is the power to influence the other people who must accept the decision. This may require a combination of negotiation and persuasion skills. The choice of an autocratic versus democratic leadership style also influences the decision-making process.

d) Issue instructions

The final step in the decision-making process is to make a decision and issue instructions. The implementation of the instructions has all the elements of a project and should be planned, monitored and controlled as a project. The project manager needs feedback on the performance of the decision because if the problem is not resolved, further corrective action may be required.

8.5 Groups and teams

A project team is a "group of individuals working independently to accomplish the project objective" (Clements and Gido, 2011:330). The terms "project team" and "project group" are often used interchangeably to describe a number of people who have complementary skills and who work to achieve a common goal, but in the project context that is where the similarity ends. The important distinction between a team and a group is how the people are managed and how they interact together, because they may be doing exactly the same work.

True teamwork implies participation and empowerment to give the team sufficient authority and autonomy to make their own decisions on a day-to- day basis. This helps make the team members feel motivated, responsible and accountable for their work. Group work implies that the project manager is the key person with a number of followers. All communication passes through the project manager, and the project manager makes all the decisions – this restricts group problem solving and decision-making and effectively kills creativity. Without the team member interaction, there is no cross-flow of information and therefore no team synergy.

Clements and Gido (2011:332-336) describe *Tuckman's 4-stage model* of team development:

- Forming
    - Initial stage which involves the transition from working as an individual to working as a team member.
- Storming
    - Team members feel frustrated, angry and hostile due to conflicting individual goals, before the project scope and objective become clearer to them.
- Norming
    - After struggling through the storming phase, team members develop strong relationships and interpersonal conflicts are resolved. Trust begins to develop.
- Performing
    - The team members become committed and eager to accomplish the project objectives.

Clements and Gido (2011) list five characteristics of effective teams:

- Clear understanding of the project objective
- Clear expectations of roles and responsibilities
- Results orientation
- High degree of cooperation and collaboration
- High level of trust

Katzenbach and Smith (cited in Burke and Barron, 2007:164) provide a series of suggestions for how teams can develop their performance:

- Themes and identity – Teams often adopt a theme or mission that establishes or conveys meaning about their purpose and identity. It is important that the themes have richness in their meaning to the team.
- Enthusiasm and energy level – Teams both work and play hard and with enthusiasm; they put in extra time (without being asked) in order to achieve their goals, and to outsiders, the energy and enthusiasm within the team are easily recognised.
- Personal commitment – When there is strong commitment to one another's development and success, there is always enrichment of the team's aspirations and sense of purpose. This trait is most prevalent in a high performing team and cannot be dictated from outside the team.
- Performance results – Effective teams need clearly established measures of performance that set expectations. These measures are the drivers for the team and indicate how their effectiveness can be assessed.

8.6 Delegation

Delegation involves "empowering the project team to accomplish the project objective and empowering each team member to achieve expected results for his/her area of responsibility" (Clements and Gido, 2011:315). There are two main reasons for delegating work:

- Delegate to take control of your time.
- Delegate to grow your people.

Some simple questions that can indicate appropriateness for delegation include:

- What tasks are easy to explain?
- What tasks can they perform?
- Can associated decisions be delegated?
- Will the task be motivating?
- Expectations of quality?
- Timing?
- Resource loading?

Some simple steps for successful delegation (Figure 8.3):

- Define the task
- Select the individual or team
- Determine ability and training needs
- State required results and deadlines
- Determine the required resources
- Confirm understanding and get suggestions
- Manage stakeholders, support and communicate
- Provide feedback on results

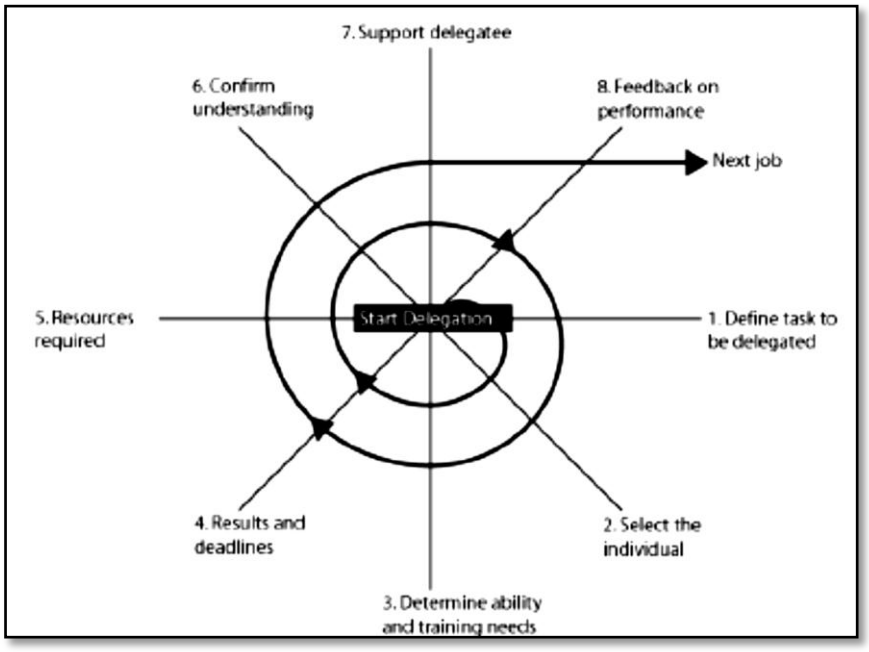

Figure 8.3: The delegation spiral (Burke and Barron, 2007:296).

8.7 Negotiation

Negotiation is the method used to reach an agreement by compromise, which is open to discussion or modification. Negotiation is the process of trying to get a better deal for the project than the project manager would get without negotiation.

The three basic negotiation strategies are:

a) Win-lose strategy: This strategy is a competitive adversarial bargaining approach where each party is searching for the other party's weakness and desires to capitalise on any weakness discovered. The consequence of this approach is that there is little or no sharing of information with the other party and consequently, no attempt is made to understand the other party's needs and expectations. There is also very little trust between the parties, which essentially kills effective two-way communication and goodwill. This strategy does not encourage teamwork or collaboration with functional managers which are two of the key leadership objectives.

b) Win-win strategy: This strategy is a collaborative approach where each party is trying to achieve the best deal for both parties – a mutually agreeable solution. Information is openly shared between parties in order to improve their understanding of each other's position. For this strategy to succeed there has to be a demonstrable climate of trust and honesty between the parties that allows an open exchange of views and expectations. The win-win strategy is essential when the functional managers' input and commitment are crucial to achieving the desired outcomes for the project now and in the future.

c) Lose-lose strategy: This strategy basically says: 'If I lose, I will make sure that you lose'. The implementation of this spiteful approach creates unnecessary enemies that could come back to haunt you in future negotiations. It is far better for long term business relations to ensure that each party leaves the negotiation table having won something.

The following outline provides a number of useful negotiation approaches which should improve the project manager's chances of getting a better deal:

- Prepare
- Develop a battle plan
- Exaggerate your position to weaken the other party's argument
- Organise frequent meetings
- Recognise that opinions are often temporary
- Solve easy differences first
- Give concessions on minor issues
- Force the issue

Bargaining is the process of giving up something to gain something – preferably giving up a little to gain a lot. To bargain effectively, you need to exaggerate your position and understate the other party's position – this gives you room to 'negotiate'. The settlement range is the area of mutually agreeable solutions. In the settlement range, both parties would rather compromise from their initial position, than stop the deal.

8.8 Conclusion

Project management leadership and managing project teams are part of the same spectrum of people management. Project managers are often faced with difficult problems that involve people management, and therefore they require a comprehensive set of skills, including problem-solving and decision-making skills to tackle adverse situations. Project managers' leadership traits and styles also influence team performance and effectiveness. The success of a project is thus heavily reliant on leadership skills of the project manager.

ADDITIONAL READING

The full-text of the following articles can be accessed from the EMERALD database through the library portal in the MyMancosa website.

ARTICLE ONE

Chui-Ha, N. and Walker, D. 2008. A study of project management leadership styles across lifecycle stages of an IT project in Hong Kong. International Journal of Managing Projects in Business. 1(3).404-427.

Abstract:

Purpose – The purpose of this paper is to provide a discussion of the way that teams and leaders interact over the life cycle stages of a project and how trust and confidence plays a vital part in this intimate relationship. Key issues relevant to this discussion are the nature of projects, the nature of trust and commitment and leadership style.

Design/methodology/approach – A case study was undertaken of an information and communication technology project delivered by an information technology (IT) company to a Hong Kong public sector organisation. The study extended over the whole of the project and data was gathered on how the leadership styles of individuals in "leader" positions of a project affected project management process success and failure from a critical historical event perspective. The study was considered over four stages: project initiation and design; development; testing and cut over; and finally project acceptance.

Findings – This paper highlights personnel changes in the leadership team. Issues relating to the leadership team of the public sector organisation and IT company are then explored, analysed and discussed. The source and use of power from the perspective of project delivery team leaders and the public sector organisation are explored to analyse how the adopted leadership style influenced the degree of trust and commitment exhibited by participants at each stage. Results suggest that team members should be considered as key project stakeholders and building their trust and confidence in the project leadership group is vital.

Practical implications – The paper explores cultural national issues that affect leadership style that are particularly relevant in a Confucian cultural context. While findings from one study cannot be more generally applied, they do help to build our understanding of processes at work and what critical incidents influence the way that these unfold – in this case, the way that leadership style affected the organisational form for example.

ADDITIONAL READING

ARTICLE TWO

Clarke, A.P. 2009. Leadership, beyond project management. Industrial and Commercial Training. 41(4) 187-194

Abstract:

Purpose – The purpose of this paper is to raise awareness of the need to understand the differences between management and leadership within the project environment. **Design/methodology/approach** – First stage research involved data analysis from forum, workshops, group to one, one to one interviews. Second stage research involved a five-year PhD study undertaken by the author. **Findings** – The paper highlights the need not only to understand the difference between project management and leadership, but also to use this differentiation in the identification, assessment and development of project services providers and as an integral part of organisational and people development for all companies involved in sponsoring, supporting or delivering projects. **Practical implications** – The premise is that the emphasis needs to be on project leadership to achieve a successful project

ARTICLE THREE

Jaques,P., Garger,J. and Thomas,M. 2008. Assessing leader behaviors in project managers. Management Research News.31(1)4-11.

Abstract:

Purpose – The purpose of this research was to explore the leadership style of graduate project management students vs other MBA students. **Design/methodology/approach** – Graduate project management and MBA students attending a regional comprehensive university in USA returned surveys that assess their leadership style emphasis of concern for task or concern for people. **Findings** – Project management students rate themselves significantly higher on the concern for people leadership style and were found to have a balance between the concern for task and concern for people leadership style vs MBA students. **Practical implications** – Individuals exhibiting a concern for people leadership style and those with a balance between concern for task and concern for people leadership styles are good candidates for project management positions as well as training/education in project management.

SECTION 9

9. PROJECT QUALITY MANAGEMENT

CONTENTS

Learning outcomes

Reading Material

9.1 Introduction

9.2 Concepts and definitions associated with quality management

9.3 Total Quality Management, International Organisation for Standardisation and Six Sigma

9.4 Costs of quality

9.5 Core project quality concepts

9.6 Project quality planning

9.7 Quality assurance

9.8 Quality control

9.9 Quality management tools

9.10 Conclusion

Learning Outcomes:

The overall outcome for this section is that, on its completion, the learner should be able to demonstrate an understanding of project quality management. This overall outcome will be achieved through the learner's mastery of the following specific outcomes, in that the learner will be able to:

1. Explain concepts and definitions associated with quality management.
2. Discuss and apply the core values, principles and/or processes of Total Quality Management, International Organisation for Standardisation and Six Sigma.
3. Identify and define the costs of quality.
4. Discuss the core project quality concepts.
5. Explain and apply quality planning, and the tools of quality control and assurance.
6. Differentiate between quality assurance and control.
7. Describe and apply common quality management tools and techniques.

Reading Material:

READING

Prescribed reading:

Clements, J. P. and Gido, J. (2011). Effective Project Management. 5th Edition. Boston: Cengage Learning.

Recommended reading:

Burke, R. (2009). Project Management Techniques. College Edition. Hampshire: Burke Publishing.

Kloppenborg, T.J. (2009). Project Management: A Contemporary Approach. Boston: Cengage Learning.

Rose, K.H. (2005). Project Quality Management: Why, What and How. Florida: J. Ross Publishing.

Schwalbe, K. (2009). Introduction to Project Management. 2nd Edition. Boston: Cengage Learning.

9.1 Introduction

The Project Management Institute defines quality as "the degree to which a set of inherent characteristics fulfil requirements" (Rose, 2005:6). Rose (2005:12) states that:

- Quality involves products, defects, processes, customers and systems.
- Quality is the ability of a set of inherent characteristics of a product, system, or process to fulfil requirements of customers and other interested parties.
- Quality is a fourth among equals in relation to the project triple constraint of time, cost and scope

Project quality management includes the process required to ensure that the project will satisfy the needs for which it was undertaken. Burke (2007:254) offers two definitions of project quality management:

- "the processes required to ensure that the project will satisfy the need for which it was undertaken" (PMBOK Guide, 2004);
- "covering quality planning, quality control and quality assurance."

Project quality management is about the synergy of continuous improvement of the project and the principle of project delivery. Using a quality approach plays a key role in assuring that the project meets customer requirements. Quality management is the process for ensuring that all project activities necessary to design, plan and implement a project are effective and efficient with respect to the purpose of the objective and its performance.

This section covers the broad concepts associated with quality management, the different costs of quality, quality planning, assurance and control, and quality management tools.

9.2 Concepts and definitions associated with quality management

Garvin developed a list of eight quality dimensions which describe product quality:

- Performance: the efficiency with which a product achieves its intended purpose;
- Features: attributes of a product that supplement the basic performance;
- Reliability: propensity of a product to perform consistently over its useful design life;
- Conformance: compliance with numeric dimensions (specifications);
- Durability: the degree to which a product tolerates stress or trauma without failing;

- Serviceability: the ease of repair of a product;
- Aesthetics: subjective sensory characteristics such as taste, feel, sound, look and smell. Quality is measured as the degree to which product attributes are matched to customer preferences in terms of aesthetics;
- Perceived quality: based on customer opinion (Foster, 2007:6).

Burke (2007: 255) provides the following definitions:

- Quality Management philosophy – the involvement of all project participants in order to ensure that the goals and objectives of the project and the resulting product or service meets the needs of the client, project team and other stakeholders.
- Quality Assurance - a systematic process of defining planning, implementing and reviewing the management processes in order to provide adequate confidence that the product will be consistently produced to the required condition.
- Quality Planning – the process of identifying the standards the project needs to comply with order to achieve the required condition.
- Quality Control – defines the method of inspection (testing), in-process inspection and final inspection to confirm that the product meets the required condition.
- Quality Audit – "a structured review of other quality management (QM) activities".
- Project Quality Plan – a detailed document explaining how the company will assure that the product will be made to the client's requirements.
- Project Quality Management includes the processes and activities that determine the quality policies, objectives, and responsibilities necessary to assure that project requirements are met. Processes critical to the Quality Management System include Quality Planning, Quality Assurance, and Quality Control.
- Quality Planning is an integral part of project management. It identifies relevant quality standards and determines how they can best be satisfied.
- Quality Assurance ensures that project management utilizes the quality processes needed to meet project requirements in a planned and systematic manner.
- Quality Control monitors specific project outputs and determines compliance with applicable standards. It also identifies project risk factors, their mitigation, and looks for ways to prevent and eliminate unsatisfactory performance.

The work of quality 'gurus' has been incorporated into three popular quality frameworks: Total Quality Management (TQM), International Organisation for Standardisation (ISO) and Six Sigma. Many organisations use these frameworks to define and organize their quality initiatives (Kloppenberg, 2009:284).

9.3 Total Quality Management, International Organisation for Standardisation and Six Sigma

Total Quality Management (TQM) considers the wider aspects of quality by integrating quality management components into a quality management system. TQM is a systems approach to quality management that focuses on the system and not any particular components of the system. TQM has a people focus and an outcome focus. It advances the rationale that each project needs a unique quality management system. It first identifies what the client really wants and how it can best be achieved. It keeps an emphasis on continuous improvement, but always endeavours to keep the customer satisfied. For quality to be effective, it needs to be introduced to all members and all aspects of the operations. TQM is underpinned by the following concepts:

- Quality is defined by customers,
- There must be a respect for people,
- All levels of the organization must want to participate,
- There must be an emphasis on continuous improvement,
- Prevention is better than detection (Burke, 2007:266).

Kloppenborg (2009:285) highlights the core values of TQM:

- Organisational and personal learning,
- Valuing employees,
- Agility,
- Focus on the future,
- Managing for innovation,
- Management by fact,
- Social responsibility,
- Focus on results and creating value,
- Systems perspective.

The ***ISO 9000*** series of standards addresses quality management systems. The ISO standards encompass eight quality management principles as listed in Table 9.1.

Table 9.1: ISO Principles (Source: Kloppenborg, 2009: 286).

Principle	Brief Description
Customer focus	Understand current and future customer needs; meet requirements; strive to exceed expectations; link organisation's needs to customer needs.
Leadership	Leaders establish unity of purpose and direction for the organisation.
Involvement of people	Motivated, committed, and involved people at all levels accept ownership of problems, evaluate their own performance, and freely share information.
Process approach	Activities and related resources are managed as processes resulting in predictable results and improvement opportunities.
Systems approach to management	Integrate and align processes; focus effort on key processes; understand interdependencies, capabilities and constraints before starting projects.
Continual improvement	Use a consistent organization-wide approach to continual improvement to include training in methods, goals to guide and measures to track.
Factual approach to decision-making	Ensure data and information are accurate, reliable and accessible; make decisions and take action based upon analyzing facts; challenge opinions and decisions.
Mutually beneficial supplier relationships	Identify and select key partners; jointly develop and improve with partners; openly share communication with them.

ISO implementation provides many benefits. It forces analysis of all quality management activities; it documents all aspects of the quality management system. The ISO approach is prevention based; it focuses on prevention, not inspection. It is a framework for quality improvement. Continual improvement is an essential part of the ISO approach (Rose, 2005:33).

Six Sigma uses a process called DMAIC (define, measure, analyse, improve and control) to plan and manage improvement. The DMAIC methodology is a 15-step process broken up into 5 phases (Figure 9.1).

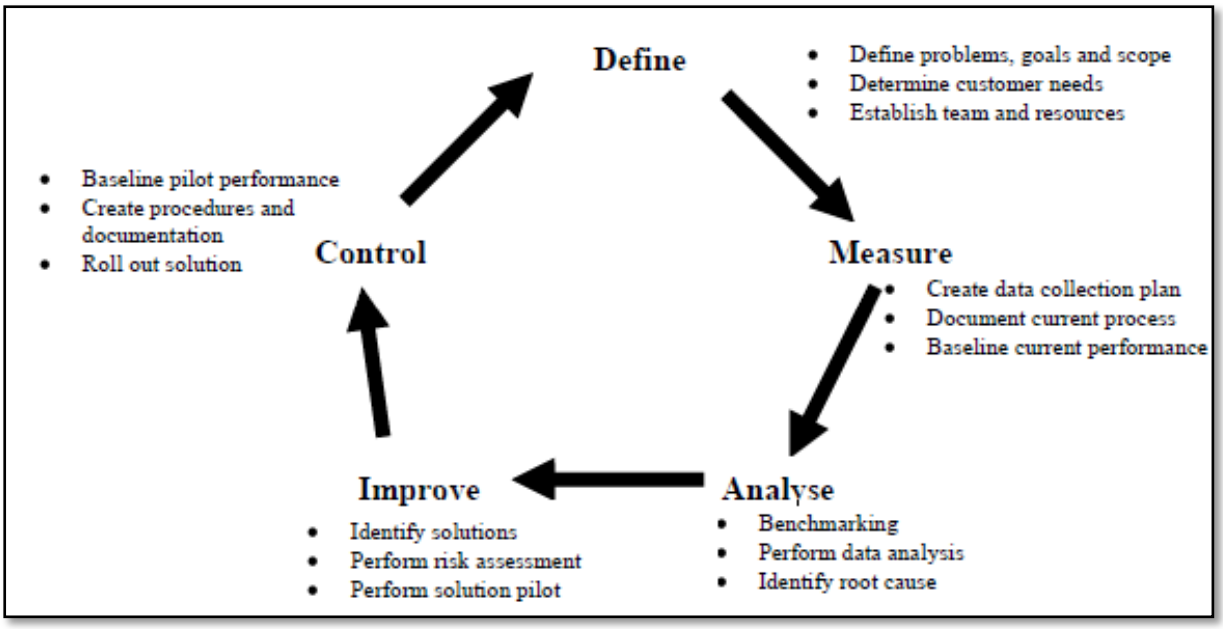

Figure 9.1: DMAIC Methodology (Source: Kloppenborg, 2009:287).

9.4 Costs of quality

Cost of quality refers to the total cost of all efforts related to quality. The appraisal, prevention, and failure costs are included in this term.

Cost of Poor Quality (COPQ): Cost of poor quality addresses the cost of not performing work correctly the first time or not meeting customer's expectations.
Cost of Doing Nothing Different (CODND): Cost of Doing Nothing Different is the cost of not changing standard practice, even when it is dysfunctional.

The cost of quality is the sum of costs a project will spend to prevent poor quality and any other costs incurred as a result of outputs of poor quality. Poor quality is the waste, errors, or failure to meet stakeholder needs and project requirements. The costs of poor quality can be broken down into the three categories of prevention, appraisal, and failure costs.

Prevention costs: These are planned costs an organisation incurs to ensure that errors are not made at any stage during the delivery process of that product or service to a beneficiary. Examples of prevention costs include quality planning costs, education and training costs, quality administration staff costs, process control costs, market research costs, field testing costs, and preventive maintenance costs (www.pm4dev.com).

Appraisal costs**:** These include the costs of verifying, checking, or evaluating a product or service during the delivery process. Examples of appraisal costs include receiving or incoming inspection costs, internal production audit costs, test and inspection costs, instrument maintenance costs, process measurement and control costs, supplier evaluation costs and audit report costs (www.pm4dev.com).

Failure costs: A project incurs these costs because the product or service did not meet the requirements and had to be fixed or replaced, or the service had to be repeated. (www.pm4dev.com).

9.5 Core project quality concepts

Kloppenborg (2009: 285) describes four core project quality concepts:

a. Stakeholder satisfaction
b. Process management
c. Fact-based management
d. Empowered performance

a) Stakeholder satisfaction

Stakeholder satisfaction consists of identifying all stakeholders, using a structured process to determine relevant quality standards, and understanding the ultimate quality goals with respect to stakeholders. The decision-process for developing relevant quality standards on a project consists of the following steps:

i. Identify all stakeholders
ii. Prioritise among the stakeholders
iii. Understand the prioritized stakeholders requirements
iv. Develop standards to ensure the requirements are met
v. Make trade-off decisions.

b) Process management

Kloppenborg (2009:290) defines a process as a set of interrelated actions and activities performed to achieve a set of products, results or services. In order to effectively manage project processes, project managers need to understand, control and improve them. One aspect of process management is process control. Control is comparing actual performance with planned performance, analysing variances, evaluating possible alternatives and recommending appropriate corrective action as needed. Another aspect of process management is process improvement. Processes can be improved in either a continuous or breakthrough fashion. Improvement models are based upon the plan-do-check-act (PDCA) improvement cycle (Figure 9.2).

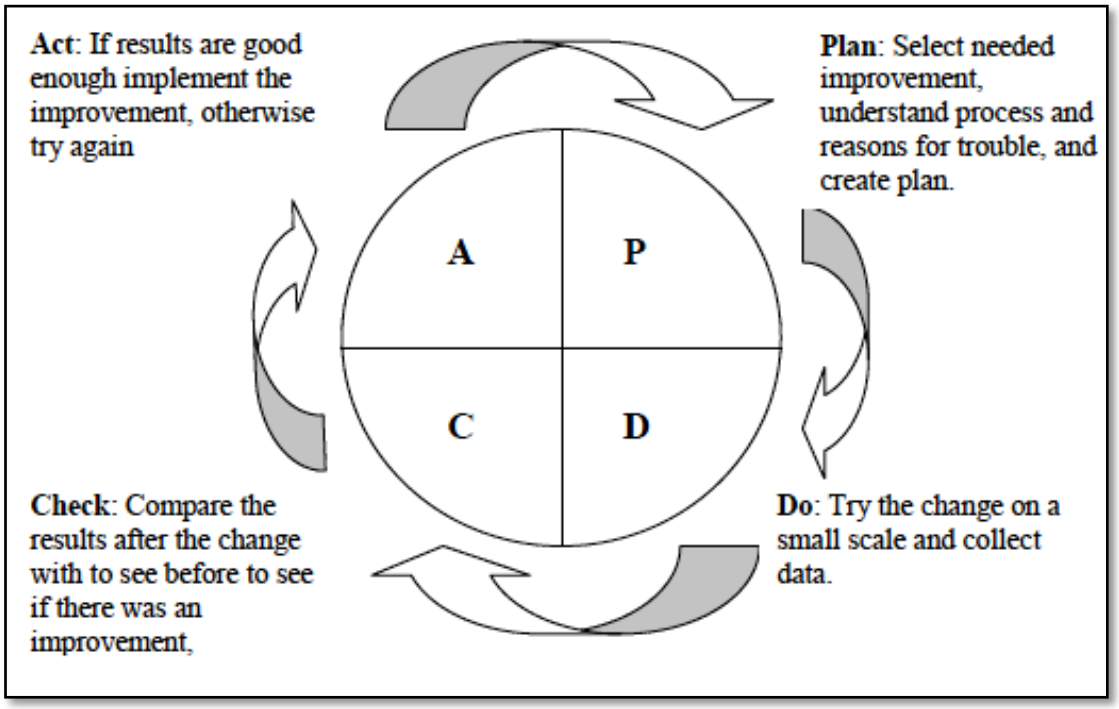

Figure 9.2: PDCA Cycle (Source: Kloppenborg, 2009:292).

c) Fact-based management

Making decisions based on facts is a challenge facing many project managers. Making decisions using facts is difficult because:

- Opinions get in the way
- It is hard to know what data needs to be collected, and
- Projects operate with time pressures so that decisions need to be made quickly.

Project decision-makers need to understand the difference between two types of variation (Kloppenborg, 2009). Common cause is a source of variation that is inherent in a system and predictable. On the other hand, special cause is a source of variation that is not inherent in a system, is not predictable and is intermittent. It is important to determine when there is a variation on a project whether it is within the range of what can be expected for that particular work activity or deliverable (common cause) or whether something unusual is happening (special cause). If the variation is common cause, and the results are not acceptable, some change will need to be made to the system (the way in which the work is accomplished). However, if the change is due to a particular cause, then the way to improve is to change that particular cause and not the entire system. Management by facts requires an understanding that variation can be either common or special cause, a determination to discover which type, and the resolve to act appropriately on that discovery (Kloppenborg, 2009).

d) Empowered performance

The goal of empowered performance is to have capable and willing workers at every level and every function within a project. Kloppenborg (2009:295) lists four components of empowered performance in order to create capable and willing workers:

- The recognition of individuality
- Being able to capitalise on individual strengths
- Emphasizing individual responsibilities, and
- Using appropriate collaboration.

9.6 Project quality planning

Rose (2005:57) provides a summary of project quality planning:

- Quality management includes quality planning, quality assurance, quality control, and quality improvement.
- The quality management plan is part of the project plan. It includes the quality policy (intended direction of the organisation regarding quality) and answers the questions: Who is in charge (infrastructure and responsibilities)? Where are we going (goals)? How are we going to get there (processes)?

- Quality planning is identifying which quality standards are relevant to the project and how to satisfy them.
- Customers (internal or external) are the base in project quality.
- Customer and requirement identification and prioritisation should be performed early in project planning so that the project starts in the right direction.
- Identifying specifications is also part of the quality journey. Specifications are specific and measurable statements of requirements.
- Operational definitions provide a link between requirements and specifications. Operational definitions remove ambiguity of terms by describing what something is and how it is measured.
- Standards are closely related to specifications. Standards address how something is to be done. Specifications provide specific targets for performance.

The inputs to quality planning are:

- Quality policy

  This is the overall intentions and direction of an organization with regard to quality, as formally expressed by the top management. In the case of a joint venture, a quality policy for the individual project should be developed. The management team is responsible for dissipating the quality policy to all project stakeholders through appropriate information distribution channels.
- Scope statement

  The scope statement is a key input to quality planning because it documents major project deliverables as well as project objectives which serve to define important stakeholder requirements.
- Product description

  Although the elements of the product description may be embodied in the scope statement, the product description often contains details of technical issues and other concerns that may affect quality planning.
- Standards and regulations

  The project management team any application-area-specific standards or regulations that may affect the project.

- Other process outputs

  In addition to the scope statement and product description, processes in other knowledge areas may produce outputs that should be considered as part of the quality planning.

The tools and techniques for quality planning are:

- Benefit / cost analysis

  The planning process must consider benefit/cost tradeoffs. The primary benefit is less work, higher productivity, lower costs and increased stakeholder satisfaction. The primary cost is the expenses associated with project quality management activities.
- Benchmarking

  Benchmarking involves comparing actual or planned project practices to those of other projects to generate ideas for improvement and provide a standard for measurement of performance.
- Flowcharting

  The flowcharting techniques in quality management generally include cause and effect diagrams and system or process flow charts. Flowcharting can help in anticipating probable quality problems and thus helps to develop approaches for dealing with them.
- Design of experiments

  This is an analytical technique which aims to define variables that have most influence on the overall outcome.

The outputs from quality planning are:

- Quality Management Plan

  The quality management plan should describe how a project management team will implement its quality policy. The plan should define the organisational structure, roles and responsibilities and resources needed for implementation of quality management. The quality management plan should address Quality Control of the project, Quality Assurance and Quality Improvement of the project.
- Quality metrics and quality checklists
- Process improvement plan and quality baseline.

9.7 Quality assurance

Quality assurance is evaluating the overall project performance on a regular basis to provide a confidence that the project will satisfy the relevant quality standards.

Inputs to Quality Assurance

- Quality management plan
- Operational definitions
- Results of quality control measurements which are records of quality control testing and measurement in a format of comparison or analysis.

Tools and techniques for Quality Assurance

- Quality planning tools and techniques
- Quality audits which are a structured review of other quality management activities. They may be timely or carried out randomly. They may be carried out by properly trained internal auditors or by third parties such as quality systems registration agencies.

Outputs from Quality Assurance

- Quality Improvement

  Quality improvement includes taking action to increase the effectiveness and efficiency of the project to be able to provide added benefits to the stakeholders of that project. In many cases, the implementation of quality improvements will require preparation of change requests or taking corrective actions and will be handled according to procedure for overall change control.
- Recommended corrective actions
- Organisational process assets updates
- Project management plan updates.

9.8 Quality control

Quality control involves monitoring specific project results to determine if they comply with relevant standards and identifying ways to eliminate causes of unsatisfactory results. Project results mentioned include both product results such as deliverables and management results such as cost and schedule performance. The project management team should have a working knowledge of statistical quality control especially sampling and probability to help evaluate and control outputs.

The project manager and team should be aware of the following:

- Prevention (keeping errors out of the process)
- Inspection (keeping errors out of the customer's hand)
- Special cause (unusual events)
- Random causes (normal process variations)
- Tolerances (where results should fall within a defined tolerance range)
- Control limits (the process is in control if it falls within these defined limits).

The inputs to Quality Control are:

- Work results: including both product results and process results
- The quality management plan
- Operational definitions
- Checklists.

Tools and techniques for Quality Control

- Inspection

  Inspection includes activities such as measuring, examining and testing undertaken to determine whether results conform to requirements. Inspection can be carried out on the level of a single activity or a final product. Inspections can be called reviews, product reviews, audit and walk-throughs.

- Control charts

  These charts are graphical representations that display the result of a process over time and are used to determine if the process is "in control". Control charts may be used to monitor any type of output variable. Control charts are most often used to monitor repetitive activity in production but can also be used to monitor cost and schedule variances.

- Pareto diagram

  A Pareto diagram is a histogram ordered by frequency of occurrence which shows how many results were generated by what category or identified cause. Typically the Pareto diagram reflects that a relatively small number of causes are responsible for the majority of the problems or defects.

- Statistical sampling involves choosing a part of a population of interest for inspection.
- Flowcharting is used in quality control to help analyse how a problem occurs.
- Trend analysis involves the use of mathematical techniques to forecast future outcomes based on historical results. It is often used to monitor technical performance and cost and schedule performance.

The outputs for Quality Control are:

- Quality improvement
- Acceptance decisions, where the inspected items will either be accepted or rejected and those rejected may be reworked.
- Rework, which is action taken to bring defects or nonconforming items into compliance with requirements and specifications. Rework is a frequent cause of project over-runs.
- Completed checklists
- Process adjustments which involves immediate corrective or preventive action as a result of quality control measurements. In some cases the adjustment may need to be handled according to procedures for overall change control.

Difference between Quality Assurance and Quality Control

Quality assurance is often confused with quality control; quality control is done at the end of a process or activity to verify that quality standards have been met. Quality control by itself does not provide quality, although it may identify problems and suggest ways to improving it. In contrast, quality assurance is a systematic approach to obtaining quality standards.

Quality assurance is something that must be planned for from the earliest stages of a project, with appropriate measures taken at every stage. Unfortunately, far too many development projects are implemented with no quality assurance plan, and these projects often fail to meet quality expectations of the donor and beneficiaries (www.pm4dev.com).

9.9 Quality management tools

a) Check sheets

Check sheets are data gathering tools. They are used to compile and record data from observations or historical data.

b) Graphs

The purpose of a graph is to organise, summarise and display data, usually over time. The different types of graphs include line graphs, bar graphs and circle graphs.

c) Histograms

A histogram is a type of bar graph that deals with data that exist in a continuous range from a low number to a high number. Histograms display frequency distribution.

d) Pareto charts

Pareto charts are used to identify and prioritise problems to be solved. They are actually frequency charts that are aided by the 80/20 rule. This rule states that roughly 80% of problems are created by roughly 20% of causes (Pareto Principle). This means that there are a vital few causes that create most of the problems. A Pareto chart is a bar graph with data in descending order. It involves identifying the vital few contributors that account for most quality problems in a system and uses a histogram or column chart that can help identify and prioritize problem areas.

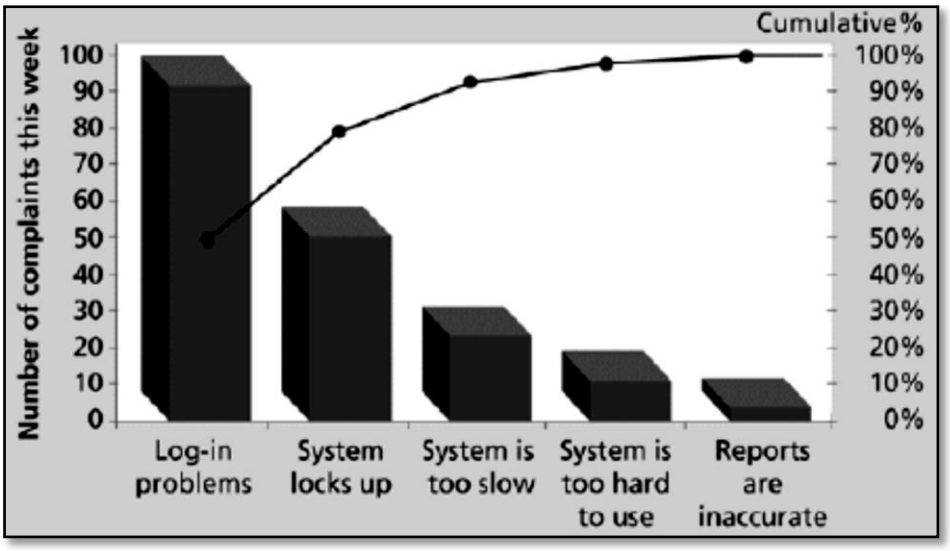

Figure 9.3: An example of a Pareto chart.

Pareto charts disclose two important types of information. First, the left-most bar indicates the greatest opportunity for improvement because it represents the source of error responsible for the most problems. Second, the chart identifies the "vital few", those sources that account for most of the defects or errors, and the "trivial many". The steps in Pareto analysis include:

a. Gathering categorical data relating to quality problems.
b. Drawing a frequency chart of the data (the data is arranged in descending order from left to right on the chart).
c. Focusing on the tallest bars first when solving the problem.

e) Scatter diagrams

A scatter diagram identifies possible relationships between two variables. The closer data points are to a diagonal line, the more closely the two variables are related.

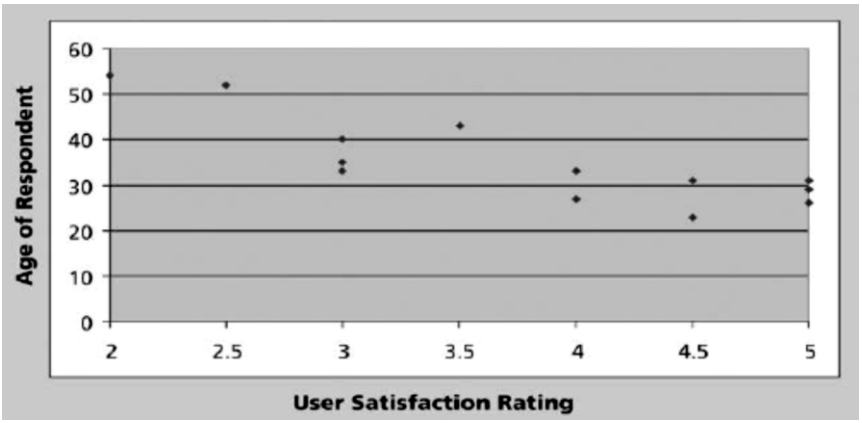

Figure 9.4: An example of a scatter diagram.

f) Flowcharts

A flow chart identifies the sequence of events in a process. Flow charts are graphic displays of the logic and flow of processes that help analyse how problems occur and how processes can be improved. They show activities, decision points, and the order of how information is processed.

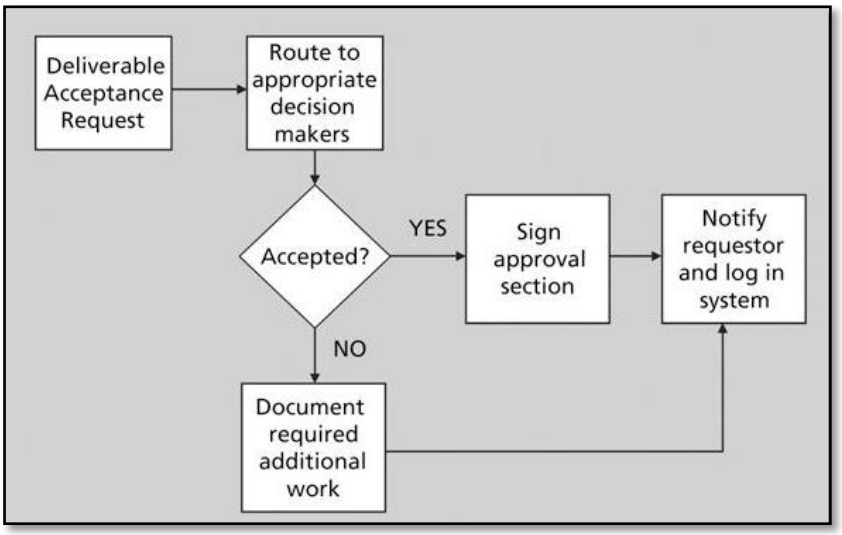

Figure 9.5: An example of a flow chart.

f) Run charts

A run chart is used to observe process performance over time. It is a line graph with data that vary around a centre-line, usually the mean. Run charts a used for the following:

- Display the history and pattern of variation of a process over time.
- Are line charts that show data points plotted in the order in which they occur.
- Can be used to perform trend analysis to forecast future outcomes.

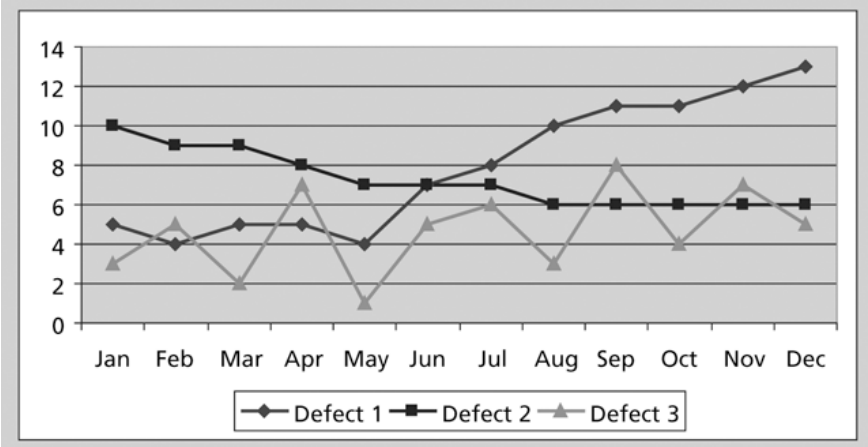

Figure 9.6: An example of a run chart.

g) Quality control charts

Control charts are tools for monitoring, controlling and improving processes over time.

Quality control charts:

- Are a graphic display of data that illustrates the results of a process over time.
- Are mainly used to prevent defects, rather than to detect or reject them.
- Allow the determination of whether a process is in control or out of control.

When a process is in control, any variations in the results of the process are created by random events; processes that are in control do not need to be adjusted. When a process is out of control, variations in the results of the process are caused by non-random events; one needs to identify the causes of those non-random events and adjust the process to correct or eliminate them. Quality control charts and the **seven-run rule** can be used to look for patterns in data. The **seven-run-rule** states that if seven data points in a row are all below the mean, above the mean, or are all increasing or decreasing, then the process needs to be examined for non-random problems.

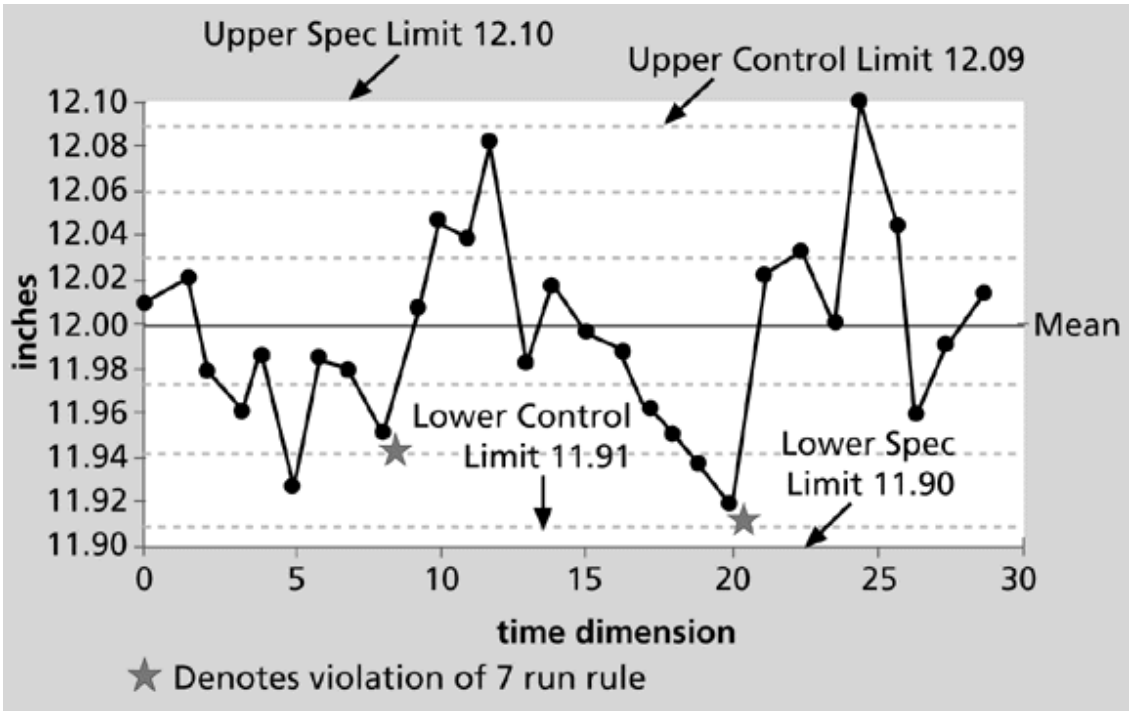

Figure 9.7: An example of a quality control chart and the seven-run rule.

h) Cause and effect diagrams (Fishbone or Ishikawa diagrams)

These are used to identify, explore and graphically display all possible causes related to a problem. Cause-and-effect diagrams are used to:

- Trace complaints about quality problems back to the responsible production operations.
- Help find the root cause of a problem.
- Can also use the **5-whys** technique where question "Why" is repeated five times to peel away the layers of symptoms that can lead to the root cause.

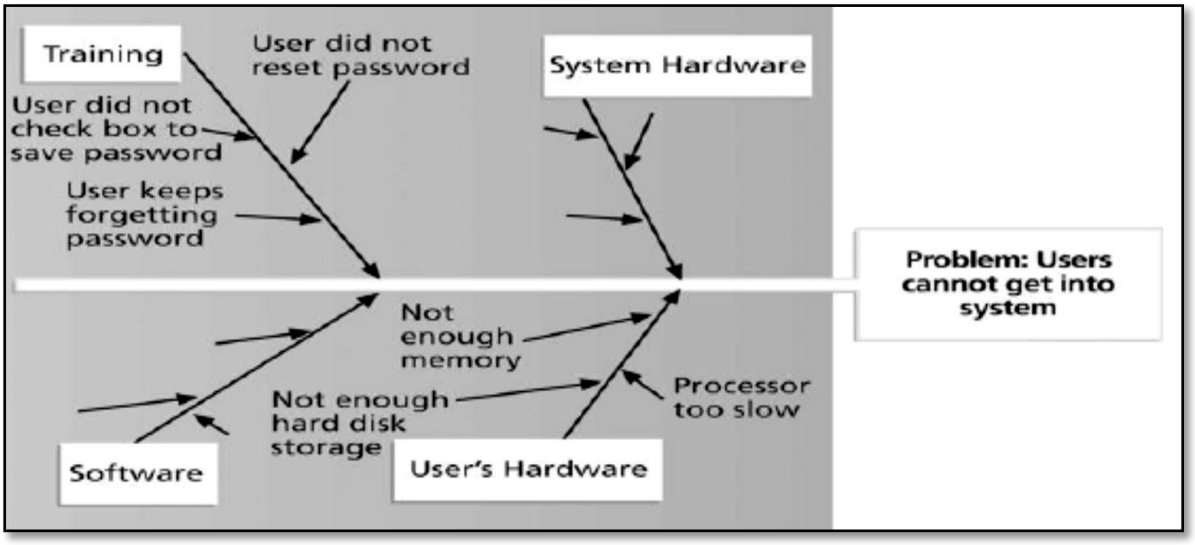

Figure 9.8: An example of a fishbone diagram.

9.10 Conclusion

Quality management is the process for ensuring that all project activities necessary to design, plan and implement a project are effective and efficient with respect to the purpose of the objective and its performance. Quality management is a continuous process that starts and ends with the project. It is more about preventing and avoiding than measuring and fixing poor quality outputs. It is part of every project management process from the moment the project initiates to the final steps in the project closure phase. Quality planning, assurance and control are the three main components of quality management. Various quality management tools can be used to ensure that these three processes are facilitated.

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