AAiT

Lecture Note for Construction Management (CEng 5214)

March 2020

COURSE DESCRIPTION

Construction in the national economy; Parties in construction industry; Construction and consulting organizations; Design and construction procedure of public projects; Preparation of TOR; Body of Knowledge of Management: project management knowledge areas such as integration, scope, time, cost, quality, human resource, communication, risk and procurement management, Project management and planning techniques; Financial project appraisal and cash-flow analysis; Personnel management; Site organizations; Insurance in construction industry; Individual/Group term paper preparation and presentation.

COURSE OBJECTIVE

- Understand functions of management, roles of managers and levels of management in construction,
- Understand the nature of construction industry, the characteristic features which distinguish the Ethiopian construction industry, its challenges and prospects,
- Fully understand project management knowledge areas such as integration, scope, time, cost, quality, human resource, communication, risk and procurement management,
- Understand the different types of construction project scheduling techniques,
- Understand the different methods of project appraisal and economic comparisons,
- Understand the role of insurance in the construction industry and
- Understand safety and health provisions in construction activities.

COURSE OUTLINE

1. **Introduction**
   - 1.1. Construction Industry
   - 1.2. Fundamentals of management
2. **Introduction to PMBOK**
   - 2.1.General introduction
   - 2.2.Knowledge areas of project management
   - 2.3.Construction specific knowledge areas
3. **Project Appraisal**
   - 3.1.General
   - 3.2.Financial appraisal methods
   - 3.3.Multiple alternatives
   - 3.4.Depreciation
4. **Procurement and Contracts**
   - 4.1.Procurement
   - 4.2.Contracts
   - 4.3.Contract documents
5. **Construction Planning and Scheduling**
   - 5.1.Construction Planning
   - 5.2.Construction Scheduling
6. **Construction Project Management**
   - 6.1.Introduction
   - 6.2.Monitoring and control
   - 6.3.Resource management
   - 6.4.Documentation and communication
   - 6.5.Contracts management/administration
7. **Construction Project Closeout**
   - 7.1.General
   - 7.2.Completing the work
   - 7.3.Closing out the project
8. **Insurance in Construction Industry**
   - 8.1.Introduction
   - 8.2.Insurance policy
   - 8.3.Construction insurance checklist
9. **Health and Safety in Construction**
   - 9.1.Introduction
   - 9.2.Problem of health and safety
   - 9.3.Causes of construction site accidents

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CHAPTER ONE: CONSTRUCTION INDUSTRY

1.1 General

Project in general is some form of human activity that has a beginning, a productive phase and an end, creating something that did not exist before. Construction Project is an investment of scarce resources with a definite objective, time horizon and geographical boundary. Construction projects are mostly constructed on the ground and exposed fully to the local environment and have different scale and complexities. It ranges from improvements to large investments. But, every project is an investment of resources, and a cause of irreversible change.

Common characteristics of construction projects:

- It has a specific starting and finishing time.
- It has usually geographical and sometimes organizational boundary.
- It has clearly defined set of objectives.
- It entails the investment of scarce resources in the expectation of future benefits.
- It may be planned, financed and implemented as a unit.
- Construction Industry

1.1.1 Study of Construction

Study of Construction mainly covers two themes:

I. Construction Technology: Relates to methods and techniques used to place the physical materials and elements of construction at the Job site.

II. Construction Management: Addresses how available resources will be applied.

1.1.2 Construction Industry Category

Construction Industry can be categorized into three major sectors:

- Transport and Communication Sector - Road, Railway, Airway, and Telecommunication related physical works;
- Water and Energy Works - Hydropower development, transmission lines, wind power, irrigation projects; and
- Buildings and Other Physical Infrastructures.

1.1.3 Construction Industry Attributes

1.1.3.1 Nature of Construction Industry

CI is among the leading industry in producing employment and contributes to the overall national development.

- Requires big capital investment thus is highly affected by the economy of the nation.
- Consumes much of the national budget in developing countries like Ethiopia.

The Nature of production in construction industry is mainly on site. And around the site there is

- Changing supply-chain relationship and production site.
- Exposed to extreme weather condition.
- Seasonal disruption.
- Health and safety concerns.

The nature of product in the industry is mainly large, heavy, durable, expensive, heterogeneous, and immobile. The Demand for the product acquired in the construction industry is usually driven by 'other sectors' and it is not directly controlled by industry. In the majority of cases, clients define requirements before the industry provides it, and Time lags between demand and supply is long.

Construction process is a team output and requires motivated and skilled workers. The industry by its very nature is an overwhelmingly domestic and labor-intensive industry despite the advancement in modern technologies.

1.1.3.2 Uniqueness of Construction Industry:

- Fragmented industry

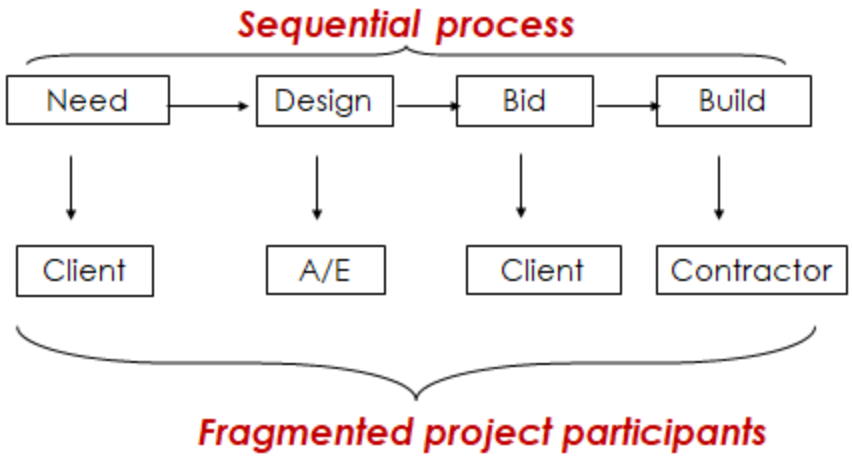

Figure 1.1 Fragmentation of Construction Industry

- **Long production cycle;**

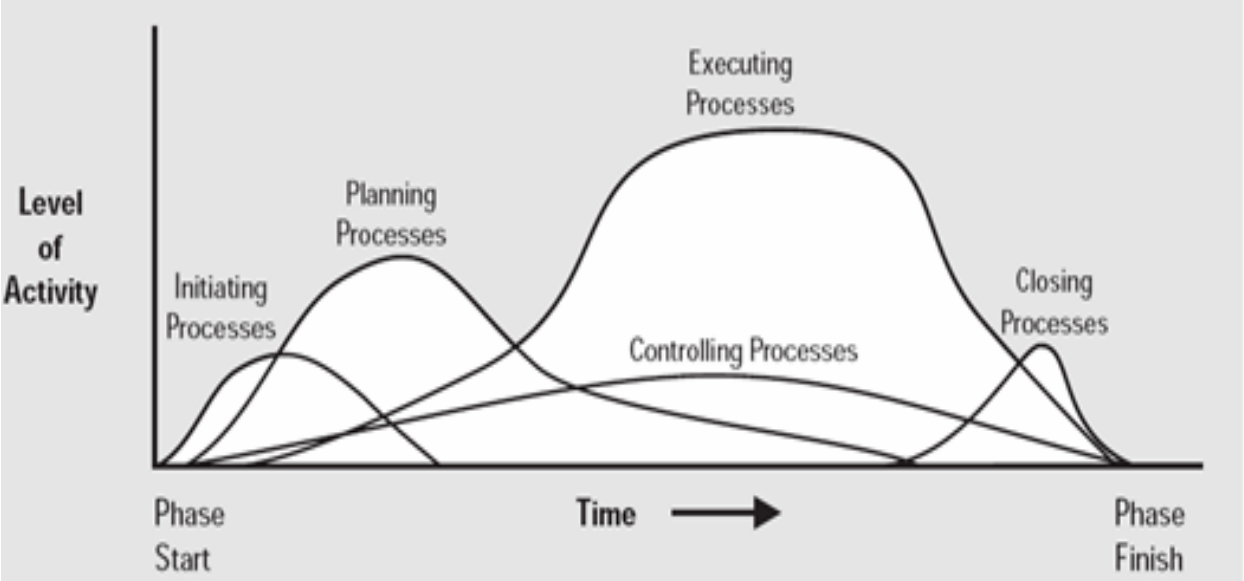

Figure 1.2: Production Cycle of Construction Activities

- Large uncertainty;
- Temporary organization nature;
- Unpredictable work load; and
- Subject to environmental impact.

1.1.4 Roles of Construction Industry

Construction Industry is the most important enabler for social, economic and political development of countries. It provides the basis upon which other sectors can grow by constructing the physical facilities required for the production and distribution of goods and services. Specifically this fact is true for least developing countries like Ethiopia because projects are:

- Inter-sectorial;
- Source of employment; and
- Demands huge capital budget.

1.1.5 Construction Project Lifecycle

The project life cycle of a construction project as shown on Figure 1.3 may be viewed as a process through which a project is implemented from cradle to grave (vital)

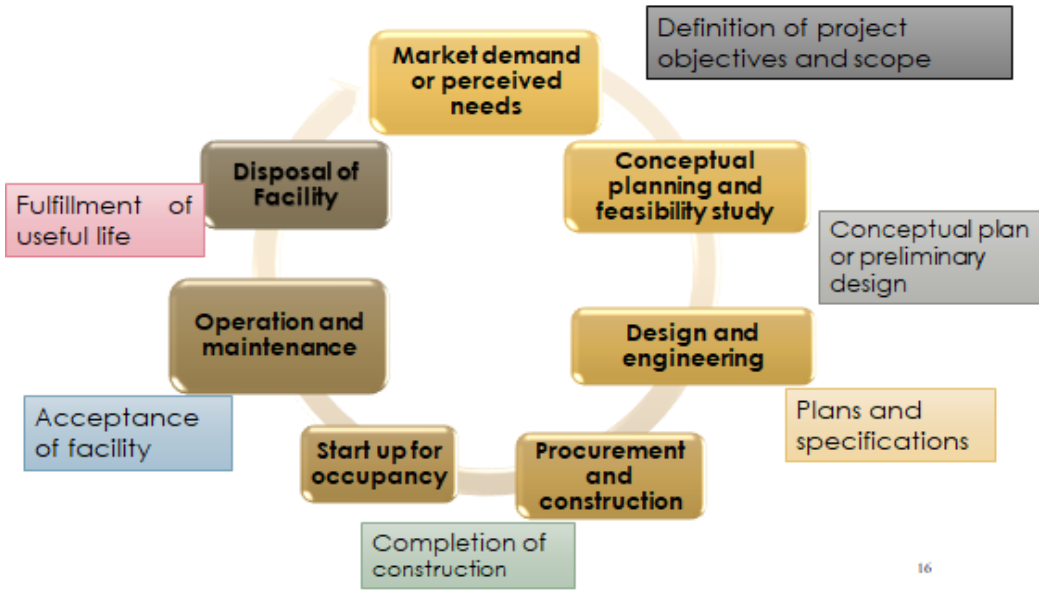

Figure 1.3: Construction Project Life Cycle

1.1.6 Stakeholders of Construction sector

Construction Industry involves many people, organization, agencies, ministries, designers, contractors, project managers, equipment suppliers, material suppliers, testing Laboratories, etc.

- **Contractual stakeholders** include**:**
  - Employer/Client,

- Consultant/Engineer, and
- Contractor.

- **Non-contractual stakeholders** include**:**
  - Public agencies: Statutory Agencies (EEPCo, AAWSA, Fire Authority), Public authorities and Municipalities (land and building permit),
  - Suppliers, and
  - End users etc.

1.1.6.1 Employer/client

Employer/Client is the initiator and owner of the project (it can be public or private client). The client is the most important party who is active from inception to completion and event to post-occupancy maintenance.Duties of the client encompass the following:

- Availability and cost of land,
- Location & accessibility
- Required Infrastructure
- Legal constraints
- Current & future development
- Soil characteristics of land
- Site preparation (right of way)
- Permits

1.1.6.2 Consultant

The main role of the consultant is to interpret the client's project requirement into a specific design and possibly the supervision.The consultants' team shall:

- Ascertain (understand), interpret and formulate the client's requirement into an *understandable project*.
- Design the project to much requirements and constraints (imposed by statutory obligations, technical feasibility, environmental factors, site conditions, cost, etc)

- Assess client's cost limit to decide on materials & the like.
- Prepare contract documents.
- Supervise the project and constantly inform the client on the progress
- Approve payments
- Resolve contractual disputes
- Issue provisional and final acceptance certification

1.1.6.3 Contractor

These are groups **established mainly** as **commercial companies**, that contract to construct development projects. Responsibilities of contractors are:

- Carry out a full site investigation prior to submission of tender,
- Submit tender,
- Plan, Program, Control the construction process.
- Notify the consultant about delays, discrepancies,
- Effect all payments to his employees, suppliers, subcontractors,
- Rectify all defects on completion of works, etc
- Provide post occupancy repair and maintenance if required.

1.8. Resources for Construction Industry

The following resources are vital that make up an integral components for construction industry:

- Human Resources (Labor or Workmen);
- Financial Resources (Fund);
- Physical Resources (Materials, Equipment and Other Assets); and
- Information Resources;
- Services and Management.

1.2 Domestic Construction Industry

1.2.1 Domestic Construction Industry: Historical Aspect

Previous monarchies had contributed to the development of construction in Ethiopia. Historic chronicles of the 17th and 18th centuries showed that there were a number of small roads, palaces and river improvement works. Among the Emperors Atse Fasil, Atse Tewodros and Atse Menilik were noted for their major contributions. Modern construction however had started during the reign of Emperor Menilik II (The road from Addis Ababa to Asmara).

The construction development can be reviewed into six distinct periods based on the historical paradigm shifts in the construction industry in Ethiopia:

I. **Pre 1968**: Foreign Companies dominated construction Industry.

II. **1968-1982**: Emergence of Small scale Domestic construction companies,

III. **1982-1987**: Parastatal companies dominated Construction Industry,

IV. **1987-1991**: Fragmentation between Design services & Construction works,

V. **1991-2001**: Parastatal Domination legally abolished, and re-emergence of private construction companies,

VI. **2001- to date**: Integration and Capacity Building.

1.2.2 Current Status of Local Construction Industry

Current status of the construction industry is distinguished by:

- Lack of clear developmental objectives for the industry;
- Inadequate co-ordination of planning between the industry and infrastructure programs in the various sectors of the economy;
- Heavy dependence on foreign resources such as materials, equipment and expertise, which continue to be supplied to a major extent by foreign consultants and contractors;
- Transport bottlenecks to the distribution of construction materials and equipment;
- Inadequate relevant local construction regulations and standards;
- Control of the construction sector by small-to-medium sized firms and parastatal construction enterprises operating at low levels of capacity and with inadequate working capital;

- Inadequate and ineffective organizations representing the interests of contractors, consultants and engineers;
- Inadequate numbers of suitably qualified and experienced personnel, at all levels: engineers, technicians, mechanics, operators and foremen etc.;
- Inadequate consideration given to the use of local resources (including community participation in labor-based works);
- Little consideration given to the concept or cost of maintenance as a component of investment costs.

1.2.3 Current Status of Local Construction Industry: Deficiencies

The general state of the domestic construction industry in Ethiopia is characterized by the following five major deficiencies:

- An inadequate capital base;
- Old and limited numbers of equipment;
- Low levels of equipment availability and utilization;
- Deficiencies in technical, managerial, financial and entrepreneurial skills; and
- Insufficient and ineffective use of labor-based construction and maintenance technology.

1.2.4 Challenges of Domestic Construction Industry

Some of the major challenges faced in the Ethiopian construction industry are:

- Lack of equipment and material;
- Obstacles posed by government regulations;
- Scarcity of finance;
- Big projects off-limits to domestic firms;
- Inefficient custom and clearance(allowance);
- Lack of skilled labor; and
- Construction project delays:- Delays are common to construction projects in Ethiopia.

1.3 Fundamentals of Management

1.3.1 Management: Definition

Management is a means of achieving political, economic, and social objectives. It is also a means of integrating resources (materials, finance, human resources, information, etc.,) in order to achieve organizational objectives efficiently and effectively. And it can be considered as process of establishing (vision, mission, values, objectives, goals, and strategies) and guiding and empowering others to accomplish them.

1.3.2 Management Functions

Management is the process of coordinating all resources through the four major functions of planning, organizing, leading, and controlling to achieve organizational objective.

- Planning: devising a systematic approach for attaining the goals of the organization.
- Organizing: determining how activities and resources are grouped and the composition of work groups and the way in which work and activities are to be coordinated.
- Leading: guiding, leading and overseeing of employees to achieve organizational goals.
- Controlling: establishing performance standards and comparing results and expectations to make appropriate changes.

1.3.2.1 Planning

Management starts with planning. Without a plan organizations will never succeed. If they do, it will have been by luck or chance and is not repeatable. Plan, will help us in determining:

- What to accomplish (goals);
- When to accomplish the goals;
- What resources to use;
- Who should accomplish what; and
- What methods to use.
- Assess all possible scenarios including the best and worst and what actions to take.

1.3.2.2 Organizing

Organizing refers to the process of designing jobs and departments and determining authority relationships in organizations. Organizing as a process will:

- Permits people to work together in order to achieve goals;
- Helps to achieve synergy (interaction);
- Avoid duplication of resources;
- Establish authority ; and
- And facilitate communication.

Other issues addressed in organizing include:

- Specialization (division of labor);
- Grouping jobs into departments and structuring (functional, product, customer, geographic);
- Determining authority relationships (span of control, chain of command);
- Delegation of authority; and
- Centralization and decentralization.

1.3.2.3 Leading

Leading is a process of influencing, inspiring and empowering employees to work towards the leaders' vision. It involves:

- Building successful groups and teams in organizations;
- Motivating people;
- Communication; and
- Developing organizational change.

1.3.2.4 Controlling

Controlling is the process of measuring performance, comparing it with the objectives, and making any necessary adjustments. The purpose of control includes:

- Adapting to changes;
- Minimizing consequences of errors;
- Helping the organization cope with complexities; and
- Improving efficiency

The control function, in turn, has four basic purposes as indicated in Figure 1.4.

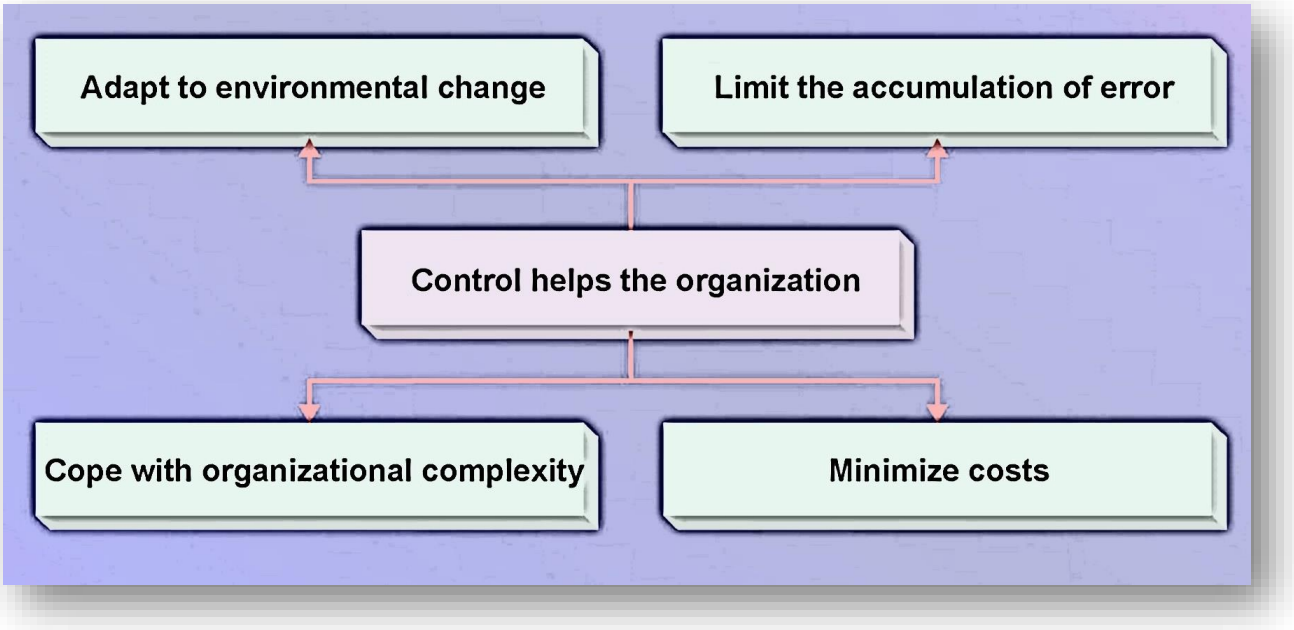

Figure 1.4: The control Function

1.3.3 Levels of Management

Manager: Definition

A manager is someone whose primary responsibility is to carry out the management process. The manager will plans and makes decisions, organizes, leads, and controls (human, financial, physical, and information resources). As part of the decision making process managers will exercise formal authority over the activities and performance of other people in pursuit of organizational goals. As a classification of managers there are:

A. **Top Managers:** The relatively small group of executives who manage the organization's overall goals, strategy, and operating policies.

B. **Middle Managers:** Largest group of managers in organizations who are primarily responsible for implementing the policies and plans of top managers. They supervise and coordinate the activities of lower-level managers.

C. **First-Line Managers:** Managers who supervise and coordinate the activities of operating employees.

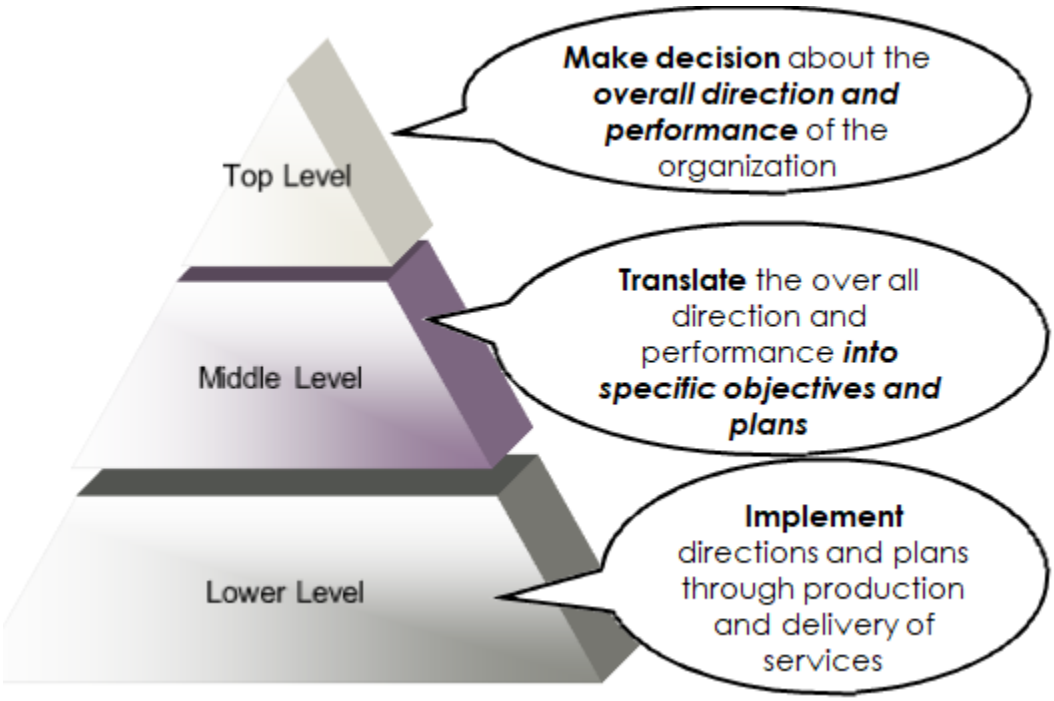

Figure 1.5 Management Functions

1.3.4 Managerial skills

Managerial skills include conceptual, interpersonal and technical skills.

- **Conceptual skills:** the capacity to think in the abstract and to see the organization as a complete unit and to integrate and give direction to its diverse activities so that objectives are achieved.
- **Interpersonal skills:** the ability to communicate with, understand and motivate both individuals and groups.
- **Technical skills**: skills necessary to accomplish or understand the specific kind of work being done in an organization.

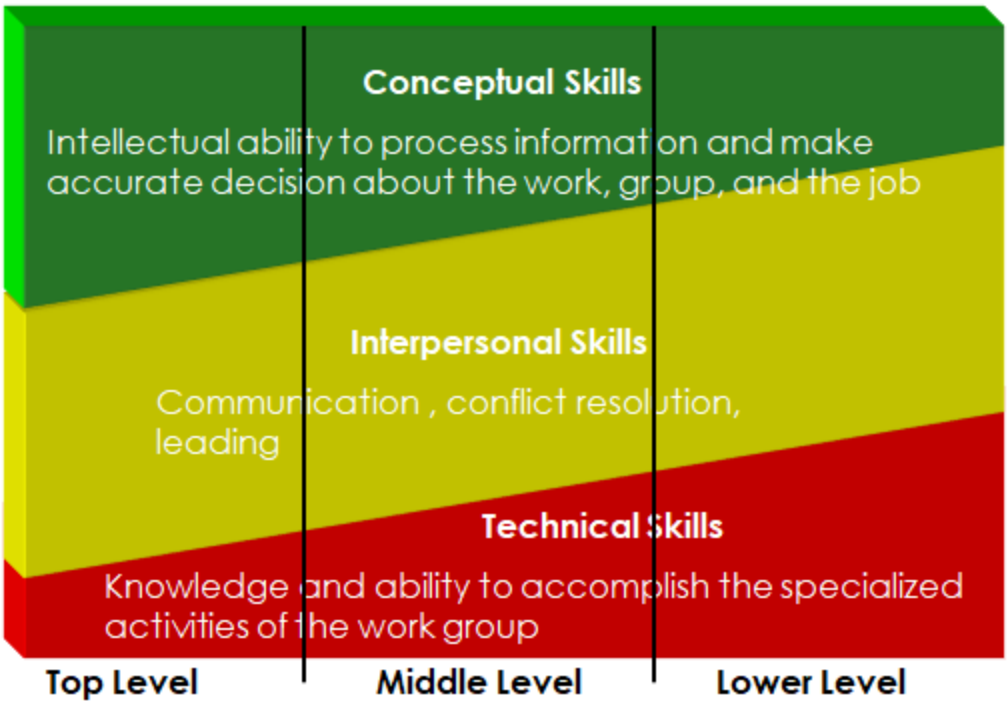

Figure 1.6: Management Level

1.3.5 Construction Management

The management of construction is an enterprise that involves many people with diverse interests, talents and backgrounds. The owner, design professional and contractor comprise the primary parties, however, others such as subcontractors, material suppliers, bankers, insurance and bonding companies, attorneys (lawyers) and public agency officials, are vital elements of the project team whose interrelated roles must be coordinated to assure a successful project.

The functions of project management for construction include:

- Specification of project objectives and plans including delineation of scope, budgeting, scheduling, setting performance requirements, and selecting project participants.
- Maximization of efficient resource utilization through procurement of labor, materials and equipment according to the prescribed schedule and plan.
- Implementation of various operations through proper coordination and control of planning, design, estimating, contracting and construction in the entire process.
- Development of effective communications and mechanisms for resolving conflicts among the various participants.

1.3.6 Organization Management

A. Organization

- A consciously coordinated social unit composed of two or more people influencing each other that functions on a relatively continuous basis to achieve a common goal or set of goals.
- It is a structured process in which people interact and influence each other in order to achieve objectives.

B. Components of Organization

- People,
- Influence ,
- Goals or Purpose,
- Structure, and
- Technology.

C. Organization Environment

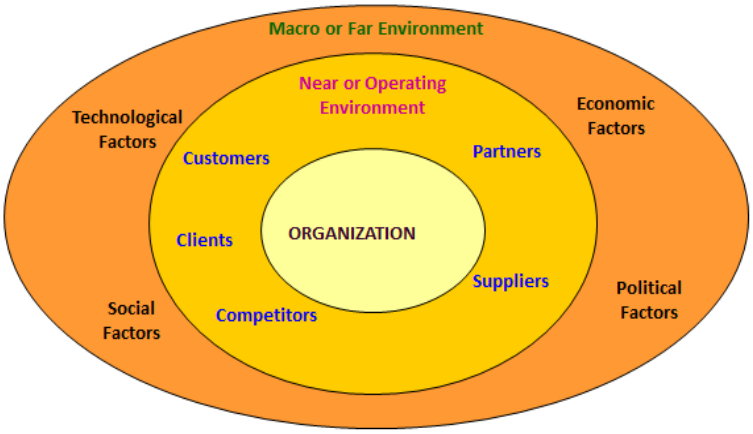

Figure 1.7 Management Environments

1.3.7 Organizational Structure

Organizational structures can fall into either mechanistic or organic forms.

- **Mechanistic organizations** are rather rigid in that they comprise distinctly delineated jobs, clearly defined hierarchical structure and are driven primarily by top-down command and control. Mechanistic organizations are tall structures, consisting of hierarchies with several layers of management levels.

- **Organic structures** are is relatively flexible. They are structurally decentralized, empowering employees at all levels of the organization to take personal responsibility for the processes and activities in which they are engaged.

Organizational design is creating an appropriate organizational structure that will enable the organization to accomplish its goals. The organization can choose from among functional, divisional or matrix designs, whichever is appropriate. It involves:

- Identifying tasks to be performed;
- Allocating the tasks among members; and
- Integrating efforts to achieve its objectives.

In organization structure the key concepts are:

- **Span of Management Control:** The number of subordinates reporting directly to a given manger;
- **Chain of Command:** The plan that specifies who reports to whom in an organization, such reporting lines are prominent features of organization chart;
- **Coordination:** The integration of the activities of the separates parts of an organization to accomplish organizational goals; and
- **Downsizing:** A version of organizational restructuring which results in decreasing the size of the organization and often results in a flatter organizational structure.

1.3.7.1 Functional Organization

In a functional organization, tasks or jobs of similar nature are grouped together and structured as a unit. Each unit is staffed by functional specialists shown on Figure 1.8. Structuring the organization along the functional lines facilitates good coordination and makes supervision of the unit easy for managers as they only need to be familiar with a narrow set of skills.

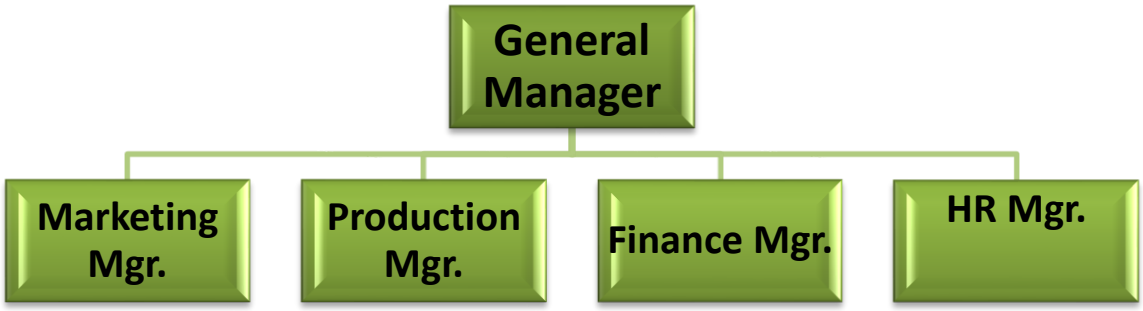

Figure 1.8: Functional Organization

1.3.7.2 Divisional Organization

Divisional structures are grouped according to workflow and structures are made up of independent strategic organizational units. The workflow can be broken into product lines, geographic regions, etc.

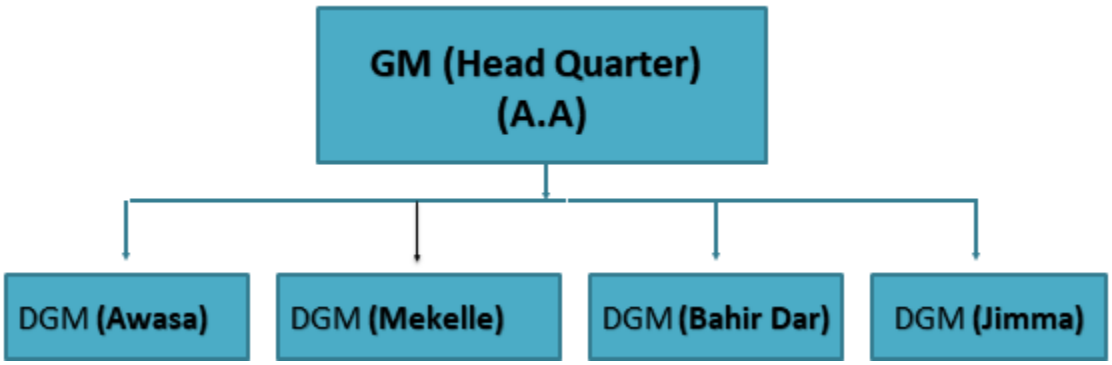

Figure 1.9: Divisional Organization

1.3.7.3 Matrix Organization

In matrix organization, individuals are made responsible both to their line manager and the project manager involved. The matrix concept facilitates working on concurrent projects by creating a dual chain of command, the project (program, systems, or product) manager and the functional manager. It utilizes functional and divisional chains of command simultaneously in the same part of the organization, commonly for one-of-a-kind projects.

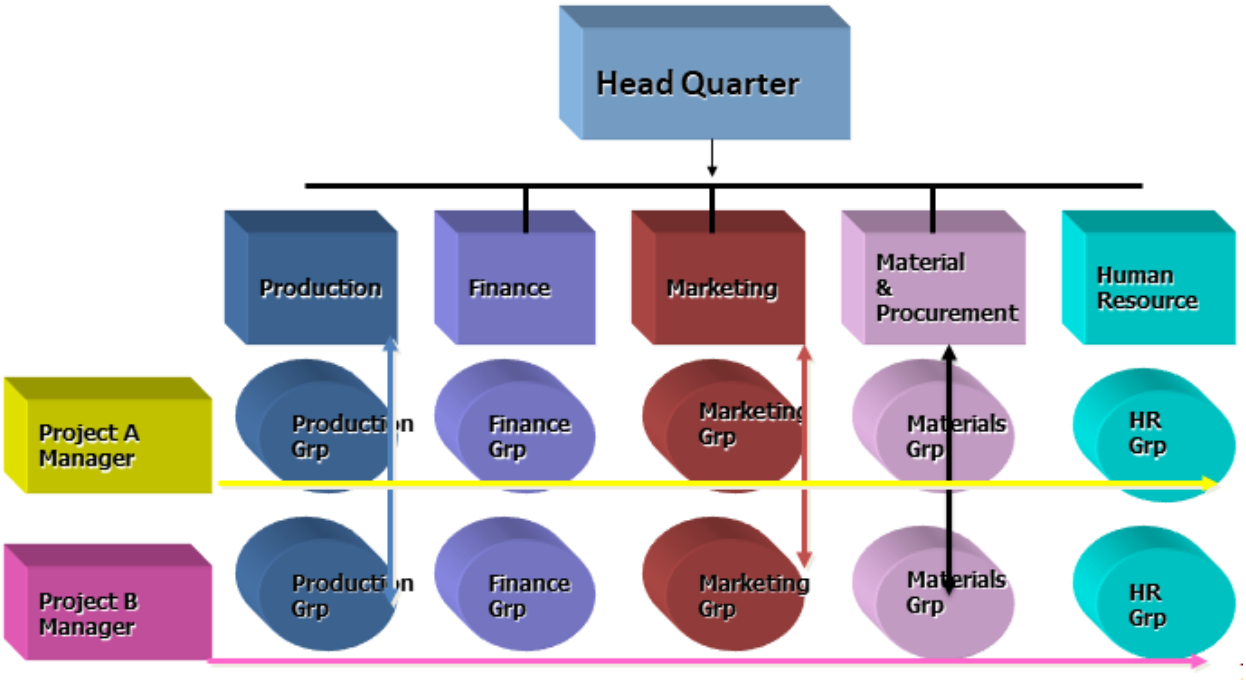

Figure 1.10: Matrix Organization

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CHAPTER TWO: INTRODUCTION OF PMBOK

2.1 General Introduction

2.1.1 Introduction

The Project Management Body of Knowledge, PMBOK, is the sum of knowledge within the profession of project management. It is produced by the Project Management Institute. The Project Management Institute (PMI) views this standard as a foundational project management reference for its professional development programs and certifications

As with other professions such as law, medicine, and accounting, the body of knowledge rests with the practitioners and academics that apply and advance it. The complete PMBOK includes proven traditional practices that are widely applied, as well as innovative practices that are emerging in the profession, including published and unpublished material.

2.1.2 PMBOK Guide Structure

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The PMBOK is organized into **three sections**:

Section I: The Project Management Framework;

Section II: The Standard for Project management of a Project; and

Section III: The Project Management Knowledge Areas.

Section I: The Project Management Framework

The Project Management Framework provides a basic structure for understanding project management. It consists of:

- **Introduction**: defines key terms and provides an overview for the PMBOK guide.
- **Project Life Cycle and Organization**: describes the environment in which projects operate.

Section II: The Standard for Project Management of a Project

The Standard for Project Management of a Project specifies all the project management processes (known as process groups/PMPG) that are used by the project team to manage a project. This Standard describes the nature of project management processes in terms of:

- The integration between the processes,
- Their interaction, and
- Purpose they serve.

The Project Management Process Groups for any project are grouped into five categories. The five Process Groups are:

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

Interaction among process groups

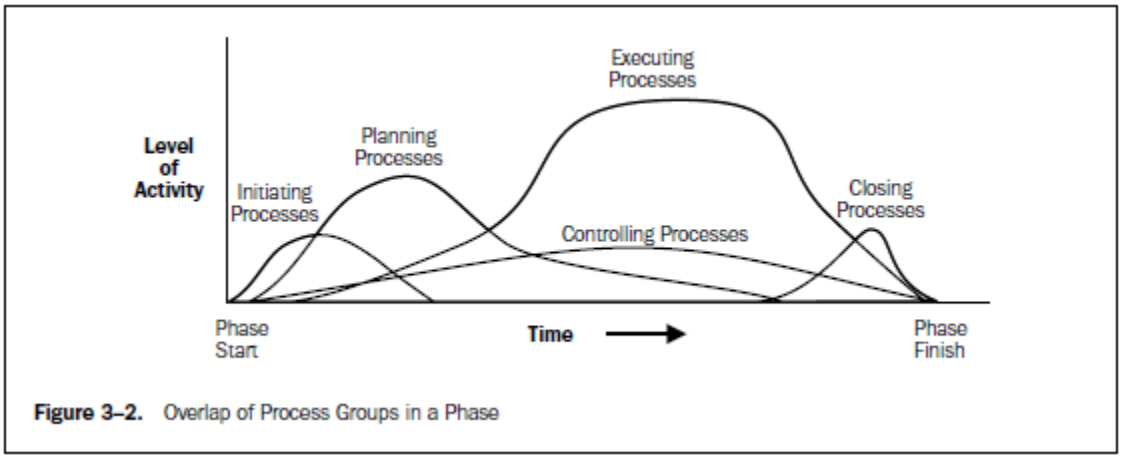


Figure 3–2. Overlap of Process Groups in a Phase

Figure 2.1: Overlap of Process groups in a phase

Section III: The Project Management Knowledge Areas

Construction Project Specific Knowledge Areas

2.1.3 PMBOK Areas of Expertise

Much of the knowledge and many of the tools and techniques for managing projects are unique to project management, such as work breakdown structures, critical path analysis, and earned value management. However, understanding and applying the knowledge, skills, tools, and techniques, which are generally recognized as good practice, are not sufficient alone for effective project management.

Effective project management requires that the project management team understand and use knowledge and skills from at least five areas of expertise shown on Figure 2.2:

- The Project Management Body of Knowledge, PMBOK;

- Application area knowledge, standards, and regulations;
- Understanding the project environment;
- General management knowledge and skills; and
- Interpersonal skills.

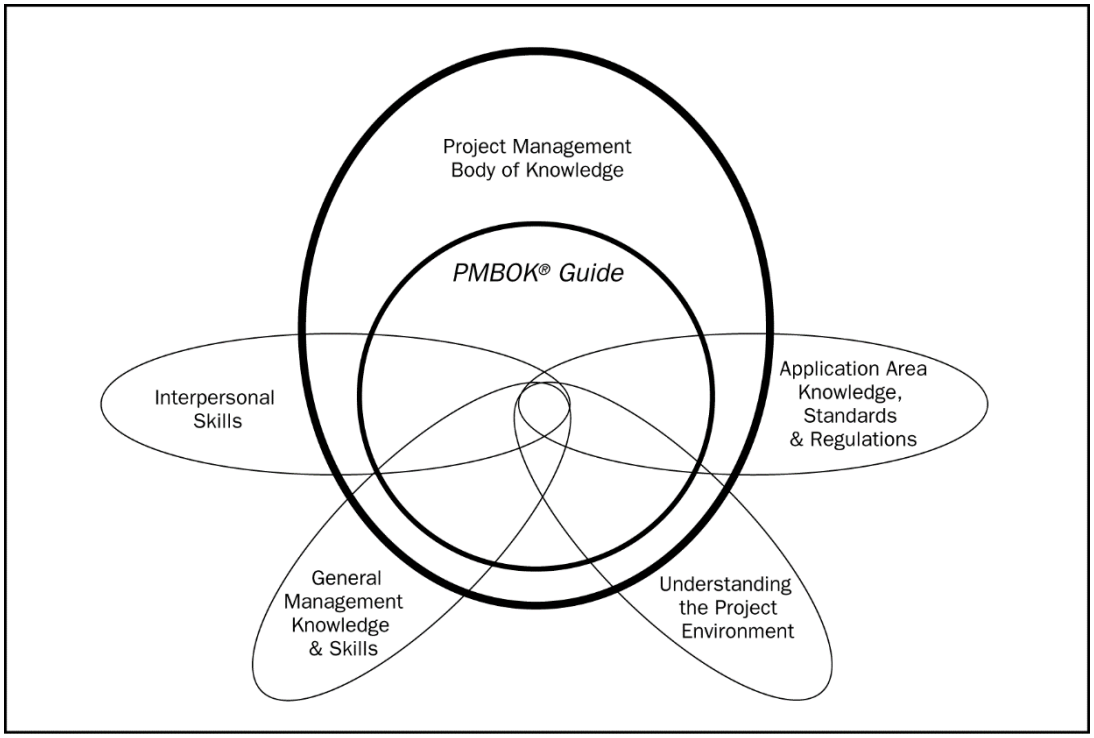


Figure 2.2: Areas of Expertise for a project management team

2.1.3.1 *The Project Management Body of Knowledge, PMBOK*

The PMBOK describes knowledge unique to the project management field and that overlaps other management disciplines. The knowledge of project management described in the PMBOK Guide consists of:

- Project life cycle definition;
- Five Project Management Process Groups; and
- Nine Knowledge Areas.

2.1.3.2 Application Area: Knowledge, Standards and Regulations

Application areas are categories of projects that have common elements significant in such projects, but are not needed or present in all projects. Each application area generally has a set of accepted standards and practices, often codified in regulations.

- A **standard** is a "document established by consensus and approved by a recognized body".
- A **regulation** is a government-imposed requirement, which specifies product, process or service characteristics. **E.g Building codes**

2.1.3.3 Understanding the Project Environment

Virtually all projects are planned and implemented in a social, economic, and environmental context, and have intended and unintended positive and/or negative impacts. The project team should consider the project in its cultural, social, international, political, and physical environmental contexts.

2.1.3.4 General Management Knowledge and Skills

General Management encompasses planning, organizing, staffing, executing, and controlling the operations of an ongoing enterprise. It includes supporting disciplines such as:

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

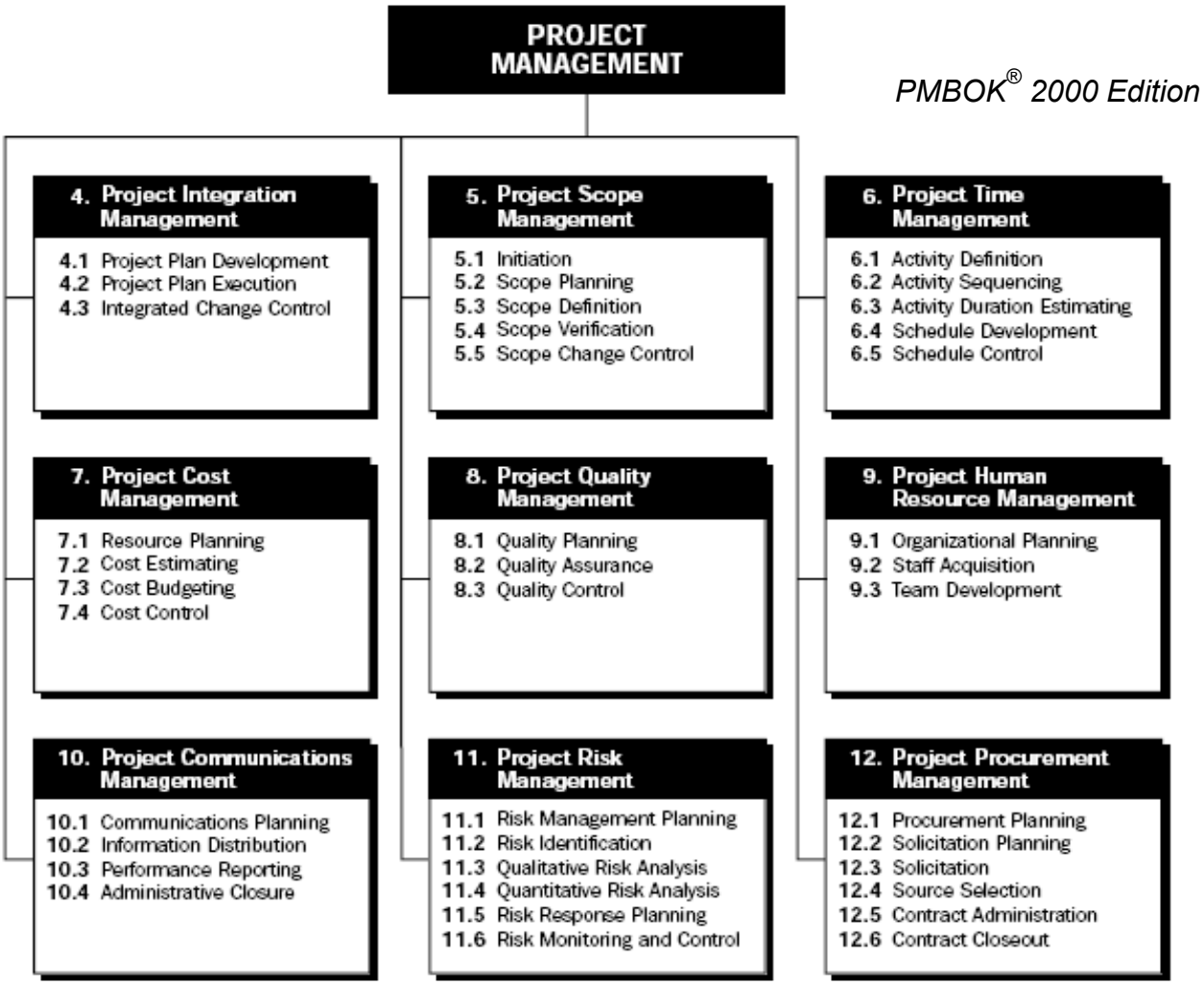
2.1.3.5 Interpersonal Skills

The management of interpersonal relationships includes:

- **Effective communication**:- the exchange of information;
- **Influencing the organization**:- the ability to "get things done";
- **Leadership**:- Developing a vision and strategy, and motivating people to achieve that vision and strategy
- **Motivation**:- Energizing people to achieve high levels of performance and to overcome barriers to change
- **Negotiation and conflict management**:- Conferring with others to come to terms with them or to reach an agreement
- **Problem solving**:- The combination of problem definition, alternatives identification and analysis, and decision-making.

2.2 Knowledge Areas of PMBOK

The PMBOK organizes the 9 knowledge areas and different process under the knowledge areas.



2.2.1 Project Integration Management

Project integration management includes the processes **required to ensure** that the various elements of projects are **properly coordinated**.

> A subset of project management that includes:
>
> "The processes and activities needed to identify, define, combine, unify, and coordinate the various processes and project management activities within the Project Management Process Groups."
>
> *PMBoK® Guide, 5th Edition, p. 63*

The processes in integration management include:

- Develop project charter;
- Develop project management plan;
- Develop preliminary project scope statement;
- Direct and manage project execution;
- Monitor and control project work;
- Integrated change control; and
- Close project.

PMBoK® Guide, 2013, 5th Edition

Knowledge Area	Project Management Process Groups				
	Initiating	Planning	Executing	Monitoring & Controlling	Closing
4. Project Integration Management	4.1 Develop Project Charter	4.2 Develop Project Management Plan	4.3 Direct and Manage Project Work	4.4 Monitor and Control Project Work 4.5 Perform Integrated Change Control	4.6 Close Project or Phase

Across Project Management Process Groups

PMBoK® 2000 Edition

Process Groups / Knowledge Area	Initiating	Planning	Executing	Controlling	Closing
4. Project Integration Management		4.1 Project Plan Development	4.2 Project Plan Execution	4.3 Integrated Change Control	

Develop Project Charter: – **developing the project charter** that formally authorizes a project or a project phase and document initial requirements.

Definition: ***"The process of developing a document that formally authorizes the existence of a project and provides the project manager with the authority to apply organizational resources to the project activities"***

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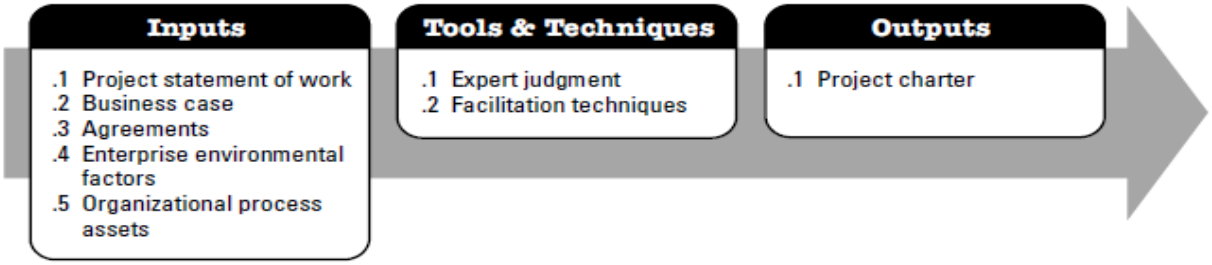
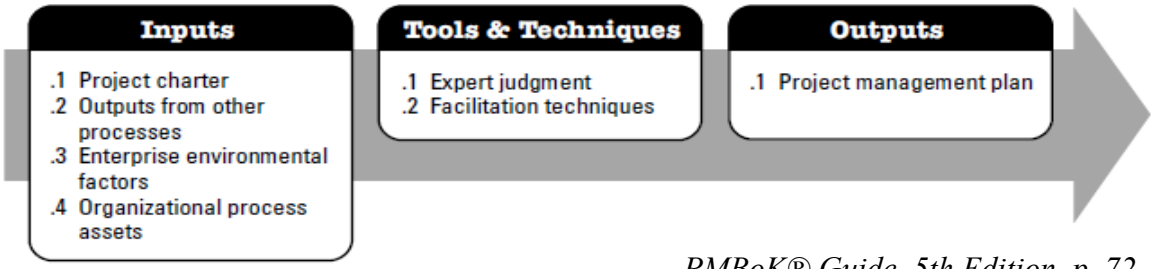


Develop Project Management Plan: – documenting the actions necessary to define, prepare, integrate, and coordinate all subsidiary plans into a project management plan.

Definition: ***"The process of defining, preparing, and coordinating subsidiary plans and integrating them into a comprehensive project management plan."***

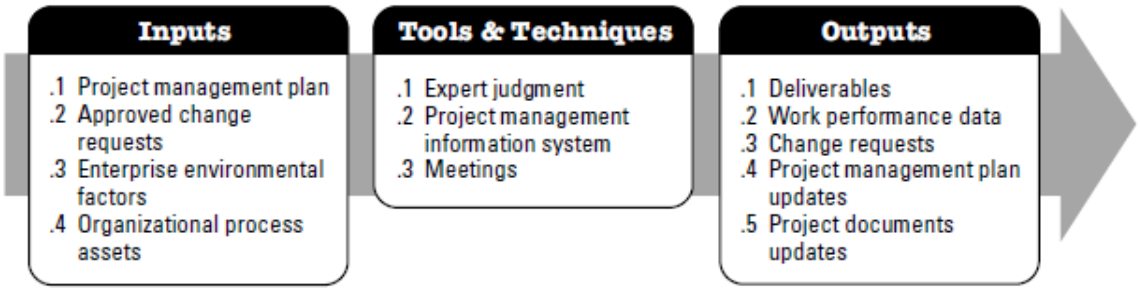
PMBoK® Guide, 5th Edition, p. 72



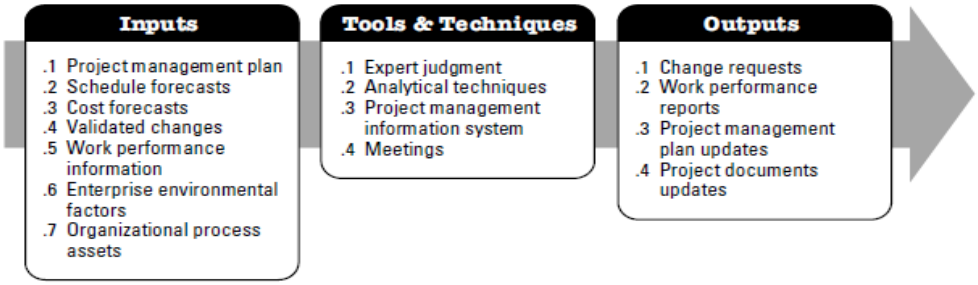
PMBoK® Guide, 5th Edition, p. 72

Develop Preliminary Project Scope Statement: – developing the preliminary project scope statement that provides a high-level scope narrative.

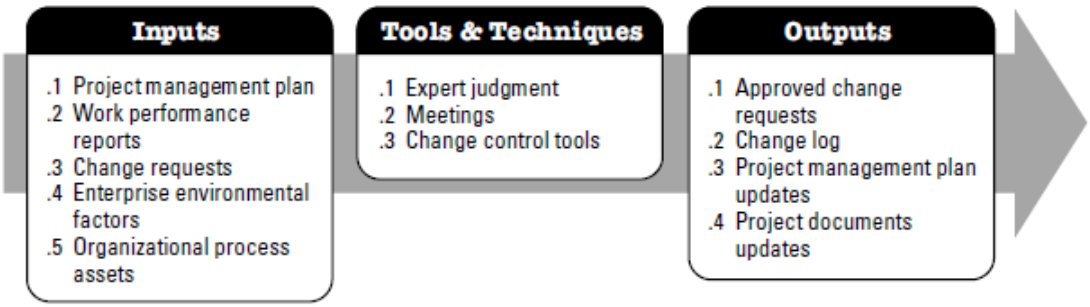
Direct and Manage Project Execution: – executing the work defined in the project management plan to achieve the project's requirements defined in the project scope statement.



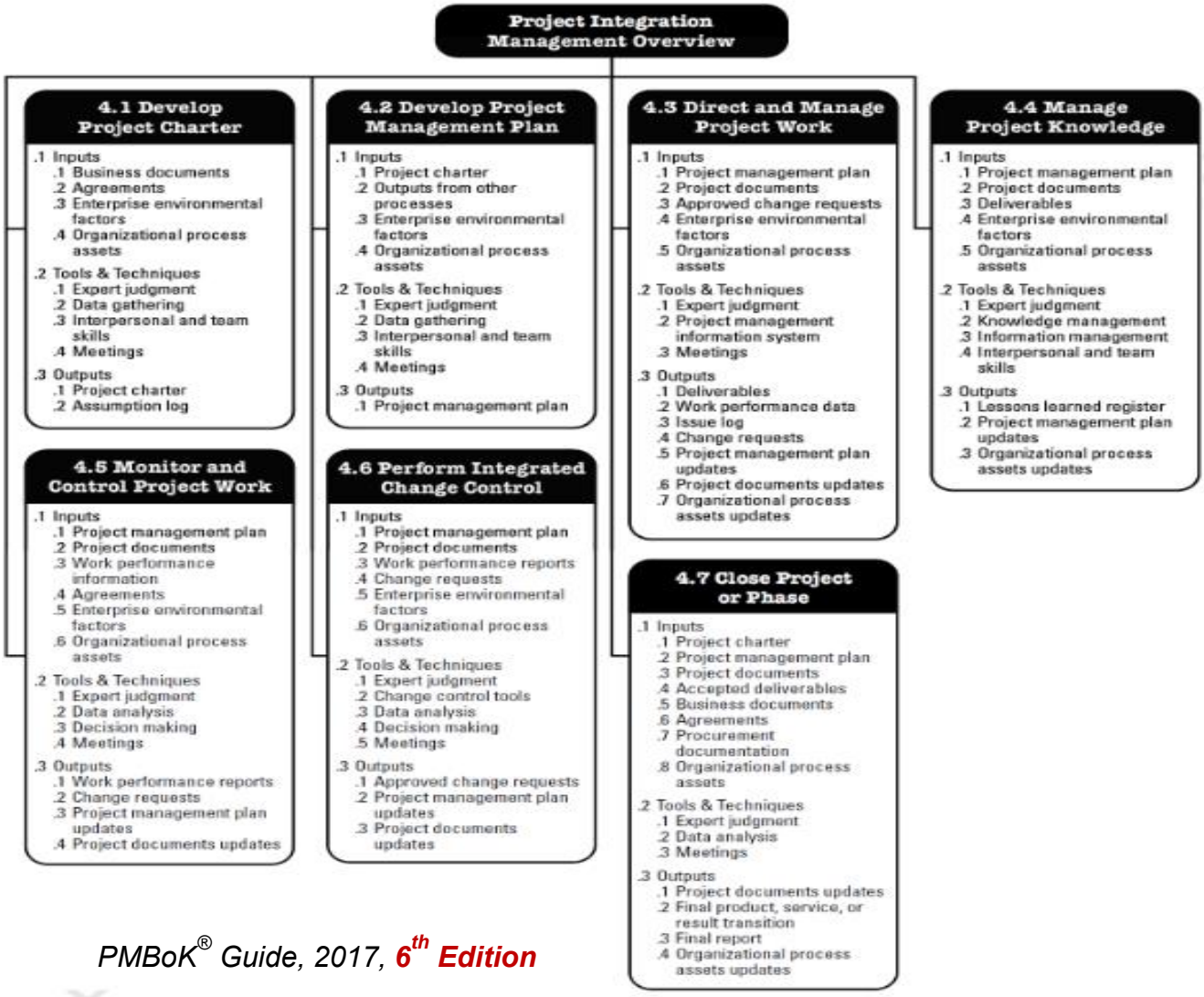
Monitor and Control Project Work:–The process of tracking, reviewing, and reporting the progress to the meet the performance objectives defined in the project management plan.



Integrated Change Control: – Reviewing all change requests, approving changes, and managing changes to the deliverables and organizational process assets.



Close Project: – Finalizing all activities across all of the Project Management Process Groups to formally close the project or a project phase.



PMBoK® Guide, 2017, 6th Edition

2.2.2 Project Scope Management

Project Scope Management includes the processes required to ensure that the project includes all the work required, and only the work required, to complete the project successfully. Project scope management is primarily concerned with defining and controlling what is and is not included in the project. Project scope management includes:

- Scope Planning;
- Scope Definition;
- Creating WBS;
- Scope Verification; and

- Scope Control.

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

Scope definition: - is the process of developing a detailed description of the project. The preparation of a detailed project scope statement is critical to project success and builds upon the major deliverables, assumptions, and constraints that are documented during project initiation in the preliminary project scope statement.

Create WBS: - the WBS organizes and defines the total scope of the project and it subdivides the project work into smaller, more manageable pieces of work, with each descending level of the WBS representing an increasingly detailed definition of the project work. A WBS example for a small residential building is shown in Figure 2.3.

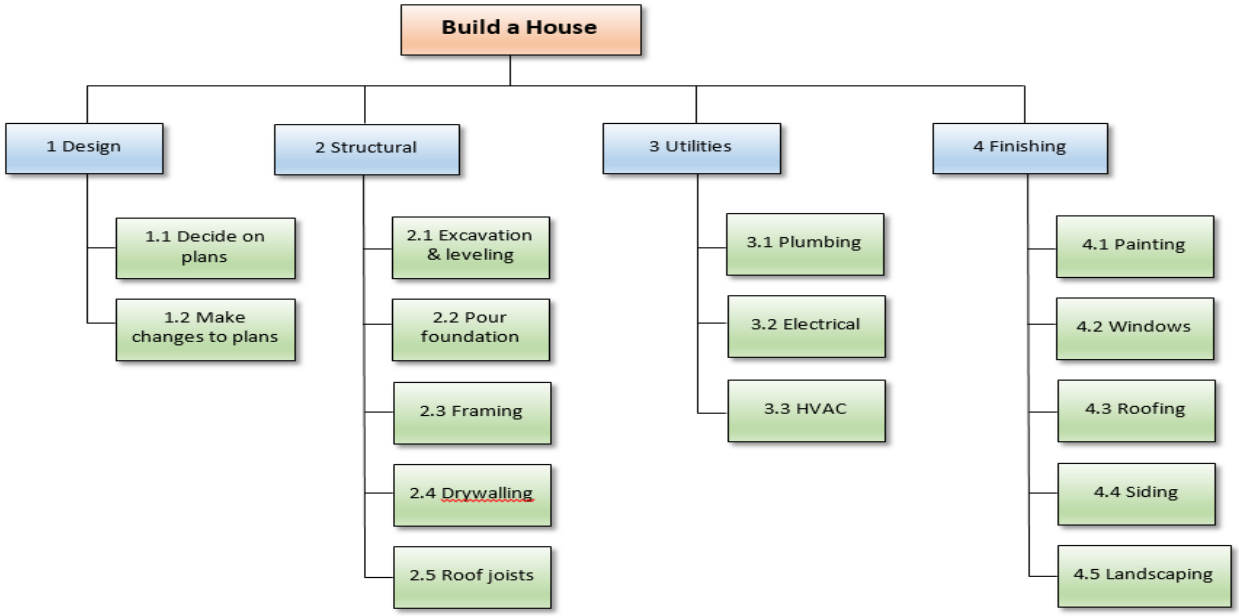


Figure 2.3: Areas of Expertise for a project management team

Scope Control: - Project scope control is concerned with influencing the factors that create project scope changes and controlling the impact of those changes.

Scope Verification: - is the process of obtaining the stakeholders' formal acceptance of the completed project scope and associated deliverables. Verifying the project scope includes reviewing deliverables to ensure that each is completed satisfactorily.

2.2.3 Project Time Management

Project **Time Management** includes the **processes required to manage timely completion** of the project. The Project Time Management processes include the following:

- **Activity Definition**: – identifying the specific actions that need to be performed to produce the various project deliverables.
- **Activity Sequencing**: – identifying and documenting dependencies/relationships among schedule activities.
- **Activity Resource Estimating**: – estimating the type and quantities of resources required for performing each schedule activity.
- **Activity Duration Estimating**: – estimating the number of work periods that will be needed to complete individual schedule activities with estimated resources.

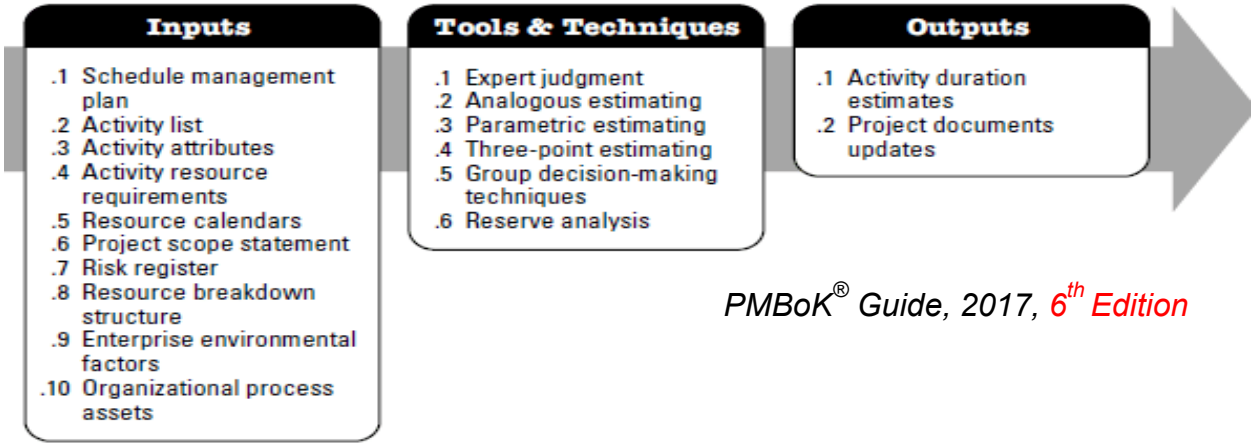


Figure 6-14. Estimate Activity Durations: Inputs, Tools & Techniques, and Outputs

- **Schedule Development**: – analyzing activity sequences, durations, resource requirements, and schedule constraints to create the project schedule.

- **Schedule Control**:–controlling changes to the project schedule. (monitoring the status of the project to update progress and managing changes to schedule)

2.2.4 Project Quality Management

Project Quality Management processes include all the activities of the performing organization that determine quality policies, objectives, and responsibilities so that the project will satisfy the needs for which it was undertaken. It implements the quality management system through the policy, procedures, and processes of quality planning, quality assurance, and quality control, with continuous process improvement activities conducted throughout, as appropriate.

The Project Time Management processes include the following:

- **Quality Planning**: – identifying which quality standards are relevant to the project and determining and document how to satisfy them.
- **Quality Assurance**: – applying the planned, systematic quality activities to ensure that the project employs all processes needed to meet requirements.
- **Quality Control**: – monitoring specific project results to determine whether they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory performance.

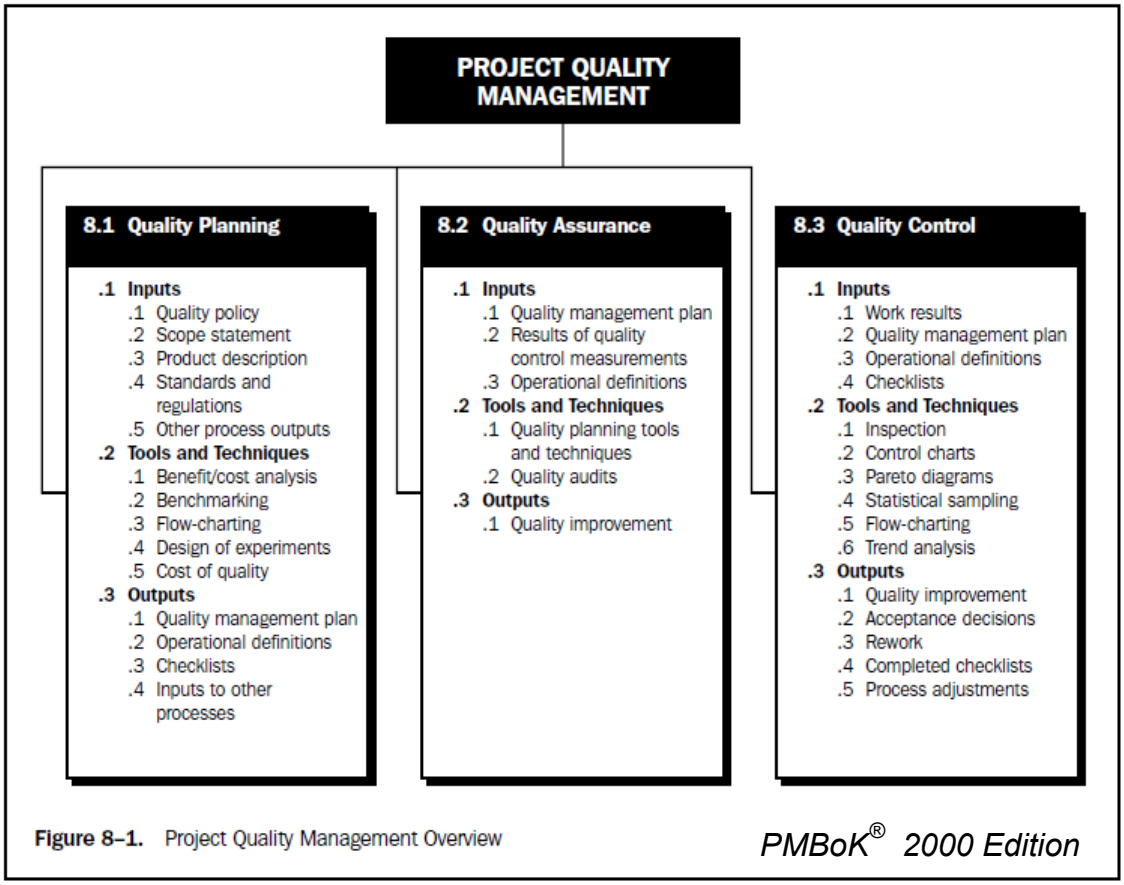


Figure 8–1. Project Quality Management Overview

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2.2.5 Project Human Resource Management

Project Human Resource Management includes the processes that organize and manage the project team. The project management team is a subset of the project team and is responsible for project management activities such as planning, controlling, and closing. The Project Human Resource Management processes include the following:

- **Human Resource Planning**: – Identifying and documenting project roles, responsibilities, and reporting relationships, as well as creating the staffing management plan.

- **Acquire Project Team**: – Obtaining the human resources needed to complete the project.

- **Develop Project Team**: – Improving the competencies and interaction of team members to enhance project performance.

- **Manage Project Team**: – Tracking team member performance, providing feedback, resolving issues, and coordinating changes to enhance project performance.

2.2.6 Project Communications Management

Project Communications Management is the Knowledge Area that employs the processes required to ensure timely and appropriate generation, collection, distribution, storage, retrieval, and ultimate disposition of project information. The Project Communications Management processes provide the critical links among people and information that are necessary for successful communications. It Includes:

- **Communications Planning**: – determining the information and communications needs of project stakeholders.
- **Information Distribution**: – making needed information available to project stakeholders in a timely manner.
- **Performance Reporting**: – collecting and distributing performance information. This includes status reporting, progress measurement, and forecasting.
- **Manage Stakeholders**: – managing communications to satisfy the requirements and addressing issues with project stakeholders as they occur.
- **Administrative Closure**: – generating, gathering, and disseminating information to formalize a project completion.

2.2.7 Project Cost Management

Project Cost Management includes the processes involved in planning, estimating, budgeting, and controlling costs so that the project can be completed within the approved budget.

- **Plan Cost Management**: – The Cost Management Plan establishes things like the methodologies with which the project budget will be established, the criteria for changes, and control procedures.
- **Cost Estimating**: – developing an approximation of the costs of the resources needed to complete project activities.

- **Cost Budgeting**: – aggregating the estimated costs of individual activities or work packages to establish a cost baseline.
- **Cost Control**: – influencing the factors that create cost variances and controlling changes to the project budget.

2.2.8 Project Risk Management

The Project Risk Management processes include the following:

- **Risk Management Planning**: – deciding how to approach, plan, and execute the risk management activities for a project.
- **Risk Identification**: – determining which risks might affect the project and documenting their characteristics.
- **Qualitative Risk Analysis**: – prioritizing risks for subsequent further analysis or action by assessing and combining their probability of occurrence and impact.
- **Quantitative Risk Analysis**: – numerically analyzing the effect on overall project objectives of identified risks.
- **Risk Response Planning**: – developing options and actions to enhance opportunities, and to reduce threats to project objectives.
- **Risk Monitoring and Control**: – tracking identified risks, monitoring residual risks, identifying new risks, executing risk response.

2.2.9 Project Procurement Management

Project Procurement Management includes the processes necessary to purchase or acquire the products, services, or results needed from outside the project team to perform the work. It includes the contract management and change control processes required to administer contracts or purchase orders issued by authorized project team members. The Project Procurement Management processes include the following:

- **Plan Purchases and Acquisitions**: – determining what to purchase or acquire and determining when and how.

- **Plan Contracting**: – documenting products, services, and results requirements and identifying potential sellers.
- **Request Seller Responses**: – obtaining information, quotations, bids, offers, or proposals, as appropriate.
- **Select Sellers**: – reviewing offers, choosing among potential sellers, and negotiating a written contract with each seller.
- **Contract Administration**: – managing the contract and relationship between the buyer and seller, reviewing and documenting how a seller is performing or has performed to establish required corrective actions and provide a basis for future relationships with the seller, managing contract-related changes and, when appropriate, managing the contractual relationship with the outside buyer of the project.
- **Contract Closure**: – completing and settling each contract, including the resolution of any open items, and closing each contract applicable to the project or a project phase.

Process Groups / Knowledge Area	Initiating	Planning	Executing	Controlling	Closing
4. Project Integration Management		4.1 Project Plan Development	4.2 Project Plan Execution	4.3 Integrated Change Control	
5. Project Scope Management	5.1 Initiation	5.2 Scope Planning 5.3 Scope Definition		5.4 Scope Verification 5.5 Scope Change Control	
6. Project Time Management		6.1 Activity Definition 6.2 Activity Sequencing 6.3 Activity Duration Estimating 6.4 Schedule Development		6.5 Schedule Control	
7. Project Cost Management		7.1 Resource Planning 7.2 Cost Estimating 7.3 Cost Budgeting		7.4 Cost Control	
8. Project Quality Management		8.1 Quality Planning	8.2 Quality Assurance	8.3 Quality Control	
9. Project Human Resource Management		9.1 Organizational Planning 9.2 Staff Acquisition	9.3 Team Development		
10. Project Communications Management		10.1 Communications Planning	10.2 Information Distribution	10.3 Performance Reporting	10.4 Administrative Closure
11. Risk Project Management		11.1 Risk Management Planning 11.2 Risk Identification 11.3 Qualitative Risk Analysis 11.4 Quantitative Risk Analysis 11.5 Risk Response Planning		11.6 Risk Monitoring and Control	
12. Project Procurement Management		12.1 Procurement Planning 12.2 Solicitation Planning	12.3 Solicitation 12.4 Source Selection 12.5 Contract Administration		12.6 Contract Closeout

Figure 2.4: Mapping of Project Management Processes to the process groups and Knowledge areas

2.3 Construction Specific Knowledge Areas

The construction specific knowledge areas comprise 13 processes under 4 knowledge areas.

2.3.1 Claim Management

According to Webster dictionary "claim is a demand for something due or believed to be due". In construction "something" is usually additional compensation for work claimed to be extra to the contract or an extension of time for completion or both. What distinguishes a claim form a change is the element of disagreement between the parties as to what is due or whether or not anything is due. If agreement is reached, then the claim disappears and become a change. If not, the claim may proceed to negotiation, mediation, arbitration, and finally to litigation before it is ultimately resolved.

The process of Claim Management in construction includes:

- Claim Identification;
- Claim quantification;
- Claim prevention; and
- Claim resolution.

2.3.1.1 Claim Identification

The identification of a claim starts with sufficient knowledge of the scope and contract terms to be aware when some activity appears to be a change in scope or terms requiring a contract adjustment. Proper identification involves not only an interpretation of what the contract requires but also a documented description of the activity viewed as extra to that required by the contract.

2.3.1.2 Claim Quantification

Once an activity has been reviewed and a decision made that it is worthy of pursuing as a claim, the next step is to quantify it in terms of additional compensation or a time extension to the contract completion or other milestone date. Quantity measurement, Cost estimation, refereeing Contract law and procedures and schedule analysis are the main inputs for quantifying claims.

2.3.1.3 Claim Prevention

Clearly the best way to prevent claims is to have no claims to prevent! Thus, the emphasis is on how to avoid or prevent claims from arising. The prefect, well-scoped and risk allocated contract that is well executed will very likely not produce any claim. Since perfection is widely

unobtainable, all that most owners and contractors can do is their best toward that goal i.e. preventing claims. Some of the major causes of claims are:

- Variations;
- Defect in contract document;
- Unforeseen condition; and
- Failure in contract administration.

2.3.1.4 Claim Resolution

Even with a concerted effort to prevent claims they still may arise. There may be a justifiable disagreement as to whether the claim in question is a change to the contract or not, or whether the claimed amount of compensation or time requested is correct. When this situation arises, there begins a step-by-step process to resolve these questions.

The process begins with negotiation before moving on to mediation, arbitration, and litigation; depending on the remedies afforded by the contract. Because of the propagation of claims in construction and the expense of litigation, alternative methods of resolution have been increasingly used. Dispute resolution methods include:

- Preventive;
- Non-judgmental/amicable, (Negotiation, mediation, conciliation):
- Judgmental, (Adjudication, Arbitration and litigation).

2.3.2 Safety Management

Safety management includes the processes required to assure safety within the construction site to prevent accident that causes or has a potential to cause personal injury or property damage. Safety management is a major concern to the construction industry both in terms of humanitarian loss and direct and indirect cost to the industry. The management of safety includes the following processes:

- Safety planning;
- Safety plan execution; and
- Administration and reporting.

2.3.2.1 Safety Planning

Safety planning for construction project involves a job site analysis of the hazards inherent in the work and making decision as to the measures to be taken to deal effectively with them. This analysis includes a survey of the geographical and physical hazards of the site as well as a review of the normal hazards in the type of construction anticipated.

In addition to these: government laws and regulations; contract and owner requirements must be considered in developing the project safety plan which will be the guiding document for a safety project.

2.3.2.2 Safety Plan Execution

Execution of the project safety plan involves the application and implementation of the safe construction practices on site in accordance with the requirement of the plan. On large construction project there may be a separate safety staff of several persons headed by the safety officer.

2.3.2.3 Safety Administration and Records

Along with government laws and regulation that apply to safe construction practice, there are often requirements for record keeping and reporting. Insurance companies also usually require periodic activity and accident reports. The contract may also require additional records and reports. Finally it is good practice to keep track of safety performance for use in improving performance and for use in making future service

2.3.3 Financial Management

Financial Management includes the processes to acquire and manage the financial resources for the project and is more concerned with revenue sources and analyze/updating net cash flow for construction project than is cost management. Financial management is distinctly different from cost management which relates more to managing the day to day cost of the project for labor and material. The processes involved are as follows:

- Financial planning;
- Financial control; and
- Financial administration and records.

2.3.3.1 Financial Planning

Planning as with any other areas is starting phase of financial management for construction project and is the phase where all projects requirements of a financial nature are identified and provided for. Financial planning is not different than standard project planning and task must be identified, the requirements placed on a time scale and quantified, resources are also required to ensure that the financial tasks are completed timely.

2.3.3.2 Financial Control

Financial control ensure that the bonds are reduced when necessary, calls for funds from project partners are made as needed, and all insurance and bank withdrawals/deposits are done at the appropriate times. Financial control and cost control are executed in most effective way to ensure all items are within budget and the financial cash forecast.

2.3.3.3 Financial Administration and Records

This process includes project financial plan and status report as well as understanding contract requirements. Attention must be paid to contract clauses for invoicing and possible bond reduction that may require a certificate of tax paid and specific statements of completion. Some contract requires written indemnity for the client, certification, and salaries paid to employees and subcontractors for payment progresses invoice.

2.3.4 Environmental Management

Project Environment Management includes the processes required to ensure that the impact of the project execution to the surrounding environment will remain within the limits stated in legal permits. It is related with:

- Identifying the environmental characteristics surrounding the construction may bring to the environment;
- Planning the approach towards avoiding environmental impacts and achieving environmental conservation;
- Auditing the plan and controlling the result; and
- Inspecting environmental conditions.

2.3.4.1 Environmental Planning

Environmental planning involves identifying which environmental standards are relevant to the project and determining how to satisfy them. It is one of the key facilitating processes during construction project planning and it should be performed regularly and in parallel with the other project planning processes.

It includes assessing the environmental condition surrounding the project site, the nature of the project activities and consequences of their performance to the environment.

2.3.4.2 Environmental Assurance

Environmental assurance is all the planned and systematic activities implemented within the environmental system to provide confidence that project will satisfy the relevant environmental standards. It should be performed throughout the project. Environmental assurance should be provided to all stakeholders as environmental conservation is a matter of global interest.

2.3.4.3 Environmental Control

Environmental control involves monitoring specific project results to determine if they comply with relevant environmental standards and identifying ways to eliminate causes and effects of unsatisfactory results. While quality control monitoring project results for all aspects of the project; a specific control processes should exist for environmental management due to its particular requirements expressed in standard and regulation and its importance to all stakeholders.

REFRENCE

1. A Guide to the Project Management Body of Knowledge (PMBOK Guide) Fourth edition, Pennsylvania, USA: Project Management Institute, Inc., 2000.
2. A Guide to the Project Management Body of Knowledge (PMBOK Guide) Fourth edition, Pennsylvania, USA: Project Management Institute, Inc., 2013.
3. A Guide to the Project Management Body of Knowledge (PMBOK Guide) Fourth edition, Pennsylvania, USA: Project Management Institute, Inc., 2017.

CHAPTER THREE: PROJECT FINANCIAL APPRAISAL

3.1 General

3.1.1 Basic Definitions

3.1.1.1 Asset

An asset represents how much a company owns at a given time of reporting usually, it is within the budget year. Assets are divided into:

- Current assets: *include cash at hand and other assets* which can *easily be converted into cash* in less than a year (e.g. cash at hand, accounts receivable).
- Fixed assets: *permanent properties which can't be easily converted into cash* within a year (e.g. land, equipment, buildings).
- Other assets: *include other investments* (investment made in other company) and *good will*.

3.1.1.2 Liabilities

Liabilities represents what the company owes like loans, debts etc. Liabilities are divided into:

- Current liabilities: *debts to be settled in a short period* of time.
- Other liabilities: *includes long term loans*, performance bonds, wages, etc**.**

3.1.1.3 Stakeholders Equity

Stakeholders' equity (capital) represents the capital provided by owners of the company.

3.2 Time Value of Money

3.2.1 Basic Concepts

The concept of the time value of money is as old as money itself which evolves from the fact that a dollar today is worth considerably more than a promise to pay a dollar at some future date. A dollar today *could be invested and be earning interest* such that, at some time in the future, the interest earned would make the investment worth considerably more than one dollar.

Money has a time value because its purchasing power changes over time (inflation). Time value of money is measured in terms of interest rate. Interest is the cost of money i.e. a cost to the borrower and an earning to the lender.

3.2.2 Terminologies

P (**Principal**): Initial amount of money invested or borrowed.

i (**Interest rate**): expressed as a percentage per period of time.

n (**Interest period**): determines how frequently interest is calculated.

N (**Number of interest periods**): duration of transaction.

A_n (**a plan for receipts or disbursements**): a particular cash flow pattern.

F (**Future Amount**): cumulative effects of the interest.

3.2.3 Cash Flow Diagrams

The graphic presentation of the costs and benefits over the time is called the cash flow diagram. It is a presentation of what costs have to be incurred and what benefits are received at all points in time. The following conventions are used in the construction of the cash flow diagram:

- The horizontal axis represents time;
- The vertical axis represents costs and benefits;
- Costs are shown by downward arrows; and
- Benefits are shown by upward arrows.

All the benefits and/or costs incurred during a period are assumed to have been incurred *at the end of that period*. Since the period is normally a year, this is called the "end of the year" rule. In order to view problems clearly, cash flow diagrams are drawn in such a way that horizontal lines show time and vertical ones represent cash flows. It shows the time profile of all the costs and benefits.

3.2.4 Methods of Calculating Interest

3.2.4.1 Simple Interest

Simple interest is the practice of charging an interest rate only to an initial sum (principal amount).

$$F_n = P + (iP)\ N = P(1+i\ N)$$

Example: calculate the future value of ETB 1,500 at the end of three years with an interest rate of 9%.

Table 1: Simple Interest Calculation

End of Year	Beginning Balance (P)	Interest (I = 9%)	Ending Balance (F)
0			1, 500
1	1, 500	135	1, 635
2	1, 635	135	1, 770
3	1, 770	135	1, 905

3.2.4.2 Compound Interest

Compound interest is the practice of charging an interest rate to an initial sum and to any previously accumulated interest that has not been withdrawn.

Example*: Compute example 1 using compound interest.*

Table 2: Compound Interest Calculation

End of Year	Beginning Balance (P)	Interest (I = 9%)	Ending Balance F)
0			1, 500
1	1, 500	135	1, 635
2	1, 635	147.15	1, 782.15
3	1, 782.15	160.40	1, 942.55

Compounding Process of compound interest is shown below.

$$\mathbf{F = \$1{,}500(1+0.09)^3}$$

$$\mathbf{= \$1{,}942.54}$$

Compound interest compounding Process equation derivation:

n=0: P	$F_1 = p(1+i) = p + pi$
n= 1: F_1=P (1+i)	$F_2 = p(1+i) + p(1+i)i = p(1+i)(1+i) = p(1+i)^2$
n=2: F_2=F_1 (1+i)= P(1+i)^2	$F_3 = p(1+i)^2 + p(1+i)^2 i$
.	$= p(1+i)^2(1+i) = p(1+i)^3$
.	$F_n = p(1+i)^n$
.	
n=N: F=P(1+i)^N	

3.2.4.3 Equivalence Calculation

Equivalence calculations are usually made to compare alternatives. There are certain rules that one should follow to make these calculations.

- They need to have a common time basis;
- Equivalence is dependent on interest rate; and
- Equivalence is maintained regardless of anything.

3.2.5 Interest Formula in Different Cash Flow Categories

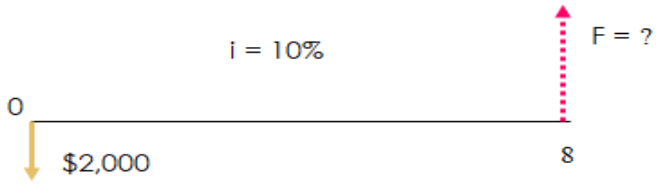
3.2.5.1 Single Cash Flows

a) Future (Compound) Sum

$F = P(1+i)^n \rightarrow (1+i)^n$ Single Payment Compound (Growth) Amount Factor

$= P(F/P, i, n)$

Example: If you had $2,000 now and invested it at 10%, how much would it be worth in 8 years?



Given: P = $2,000
I = 10%
N = 8 Years

Req'd: **F**

Solution: $F = \$2,000(1+0.10)^8$

$F = \$2,000\ (P/F, 10\%, 8)$

F = $4,287.18

EXCEL command: = FV(10%, 8, 0, 2000, 0) = $4,287.20

b) Present worth (Discount) Sum

$P = F(1+i)^{-n} \rightarrow (1+i)^{-n}$ Single payment Present Worth (Discount) Factor

$= F(P/F, i, n)$

Given: F = $1,000
i = 12%
N = 5 Years

Req'd: P

Solution: $P = \$1,000(1+0.12)^{-5}$

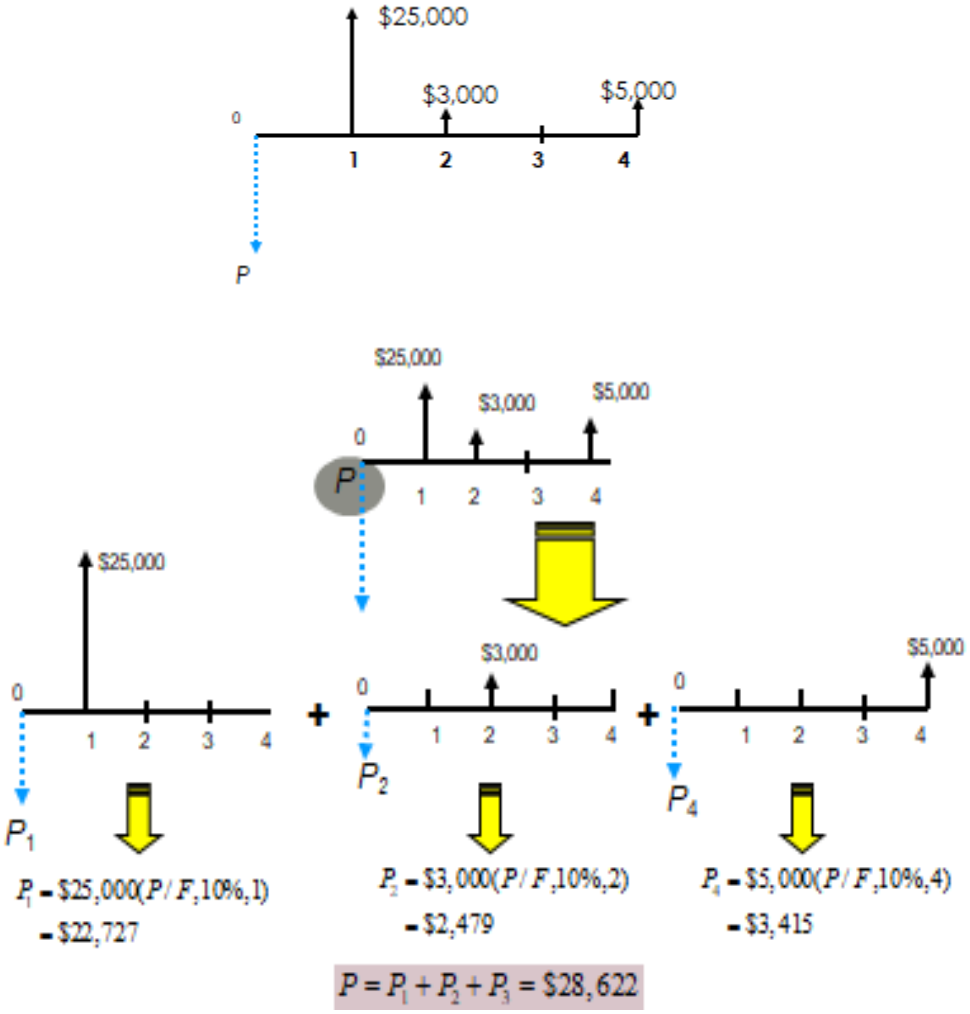
$P = \$1,000\ (F/P, 12\%, 5)$

P = $567.40

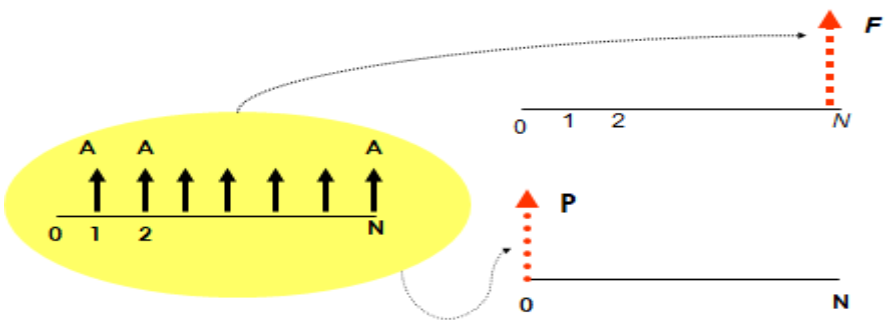
3.2.5.2 Multiple Payments

a) Uneven Payment Series

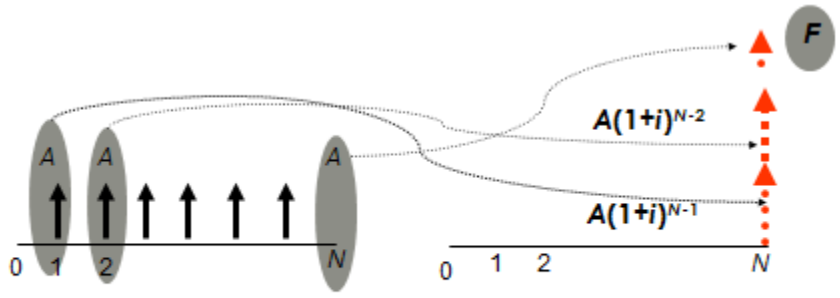
Example: How much do you need to deposit today (P) to withdraw $25,000 at n =1, $3,000 at n = 2, and $5,000 at n =4, if your account earns 10% annual interest?



b) Uniform (Equal) Payment Series

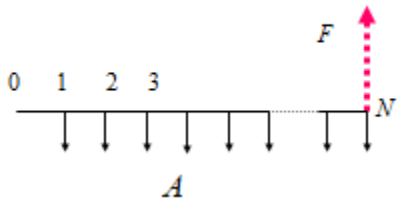


i. Compound Amount Factor (Future Value/Annuity)



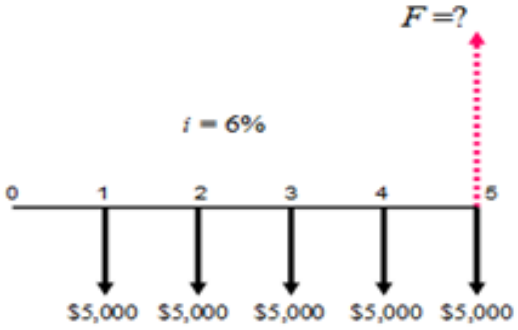
$$F = A(1+i)^{N-1} + A(1+i)^{N-2} + \cdots + A$$

Example:
Given: A = $5,000, N = 5 years, and i = 6%
Req'd: F
Solution: F = $5,000(F/A,6%,5) = **$28,185.46**



$$F = A\frac{(1+i)^N - 1}{i}$$
$$= A(F/A, i, N)$$

$$\$5,000(1+0.06)^4 = \$6,312.38$$
$$\$5,000(1+0.06)^3 = \$5,955.08$$
$$\$5,000(1+0.06)^2 = \$5,618.00$$
$$\$5,000(1+0.06)^1 = \$5,300.00$$
$$\$5,000(1+0.06)^0 = \$5,000.00$$
$$\$28.185.46$$



ii. Sinking Fund Factor

Example: College Savings Plan

Given: F = $100,000, N = 8 years, and i = 7%
Req'd: A
Solution: A = $100,000(A/F,7%,8) = $9,746.78

$$A = F\frac{i}{(1+i)^N - 1}$$
$$= F(A/F, i, N)$$

iii. Capital Recovery Factor

Example: Paying Off Education Loan
Given: P = $21,061.82, N = 5 years, and i = 6%
Req'd: A
Solution: A = $21,061.82(A/P,6%,5) = $5,000

$$A = P\frac{i(1+i)^N}{(1+i)^N - 1}$$
$$= P(A/P,i,N)$$

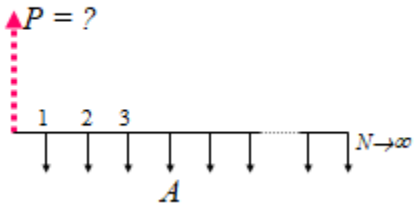
iv. Present Worth Factor

Example: Powerball Lottery
Given: A = $7.92M, N = 25 years, and i = 8%
Req'd: P
Solution: P = $7.92M(P/A,8%,25) = $84.54M

$$P = A\frac{(1+i)^N - 1}{i(1+i)^N}$$
$$= A(P/A,i,N)$$

v. Present Worth of Perpetuities

Perpetuity: A stream of cash flows that continues forever.



$$P = \frac{A}{i}$$

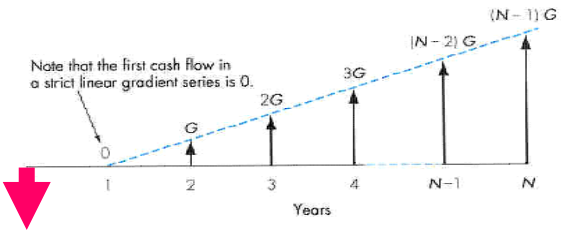
3.2.5.3 Gradient Series

a) Linear Gradient Series

G>0: increasing gradient series

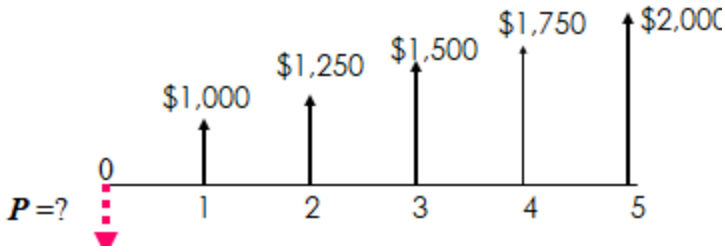
G<0: decreasing gradient series

$$P = G\left[\frac{(1+i)^N - iN - 1}{i^2(1+i)^N}\right]$$
$$= G(P/G,i,N)$$

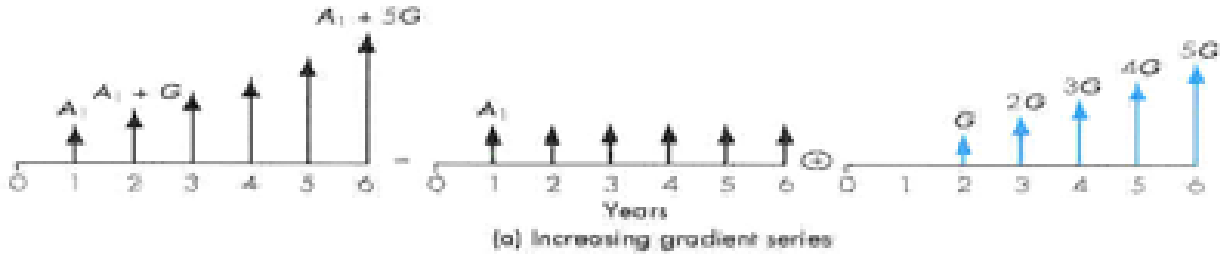


Example: Present value calculation for a gradient series.

How much do you have to deposit now in a savings account that earns a 12% annual interest, if you want to withdraw the annual series as shown in the figure?



b) Gradient Series as a Composite Series



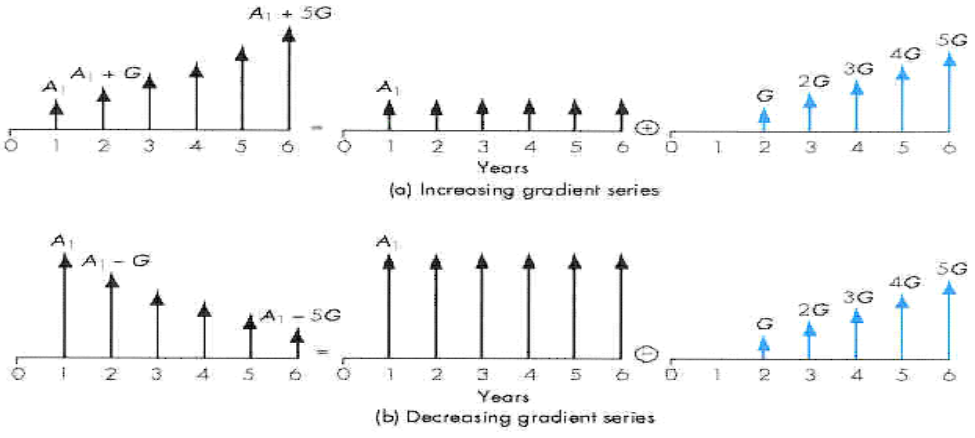
P=P1+P2

P=A(P/A,*i*,N)+G(P/G,*i*,N)

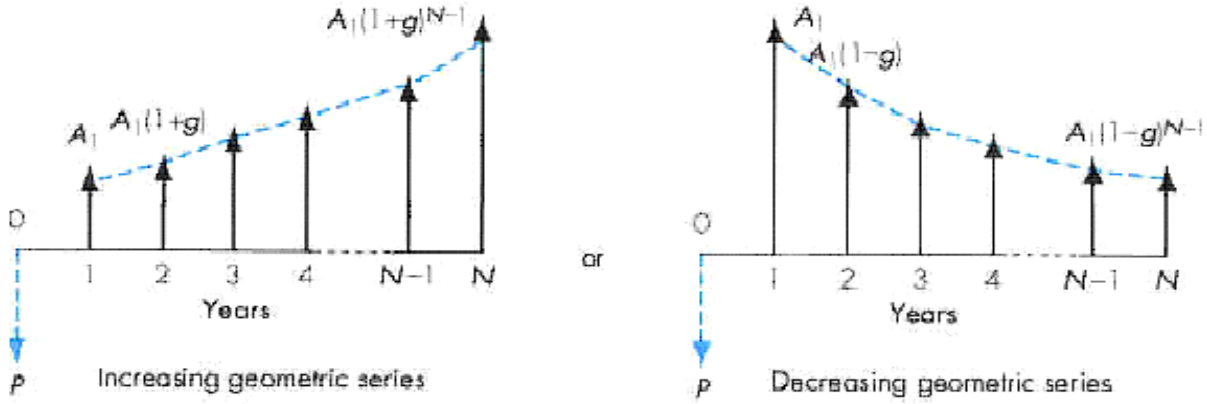
P=1000(P/1000,12%,5)+250(P/250, 12%,5)

P=(1000*3.6048)+(250*6.397)

P=$5,204



c) Geometric Gradient Series



$$P = \begin{cases} A_1\left[\dfrac{1-(1+g)^{N}(1+i)^{-N}}{i-g}\right] & \text{if } i \neq g \\ A_1\left(\dfrac{N}{1+i}\right) & \text{if } i = g \end{cases}$$

3.3 Financial Appraisal Methods

A trial and error approach is no longer valid for the construction industry and proper planning is now vital. The amount of detailing in planning is likely to be the function of the size of the firm, the complexity of the project and the expertise of the management. Usually many things interfere with construction thus making the task of planning and controlling much difficult. Obviously planning will not automatically solve or answer these problems. It serves as a guideline, which is flexible enough to accommodate the changes and be used for checking planned against the actual executed work.

Project appraisal is a process of exploration, review and evaluation taken on by the decision maker as the alternative options for development are defined within the project planning process. It can also be expressed in terms of a number of mathematical techniques that simplify the comparison of project options on the basis of agreed criterion or set of criteria. These techniques provide a rational and significant approach to evaluating divers' aspects of different alternatives and the ability of these alternatives to achieve a set objective. These aspects can be purely

economic or can be more broadly set to encompass technical, environmental and social concerns as well.

The primary objective of financial appraisal method is to aid in the process of making informed and rational choices regarding the most effective use of available scarce resources.

3.3.1 Investment Alternatives

There are two categories of investment alternatives while dealing with multiple alternatives. These are independent investment and mutually exclusive investment.

- **Independent Investment**: This means that a decision on one investment does not affect the other.
- **Mutually Exclusive Investment**: In this case acceptance of one automatically eliminates the others.

3.3.2 Financial (Investment) Appraisal Methods

The common methods used for financial appraisal of projects are:

- Straight cost Method;
- Pay back Method;
- Rate of return Method;
- Benefit - Cost Ratio;
- Present worth or Net Present Value Method;
- Future Value Method;
- Annual Equivalent Cost Method; and
- Internal Rate of Return Method.

3.3.3 Source of Finance

Sources of finance mean the ways for mobilizing various terms of finance to the industrial concern. Sources of finance state that, how the companies are mobilizing finance for their requirements. The companies belong to the existing or the new which need sum amount of finance to meet the long-term and short-term requirements such as purchasing of fixed assets, construction of office building, purchase of raw materials and day-to-day expenses.

Sources of finance may be classified under various categories according to the following important heads:

1. Based on the Period

Sources of Finance may be classified under various categories based on the period.

Long-term sources: Finance may be mobilized by long-term or short-term. When the finance mobilized with large amount and the repayable over the period will be more than five years, it may be considered as long-term sources. Share capital, issue of debenture, long-term loans from financial institutions and commercial banks come under this kind of source of finance. Long-term source of finance needs to meet the capital expenditure of the firms such as purchase of fixed assets, land and buildings, etc.

Long-term sources of finance include:

- Equity Shares
- Preference Shares
- Debenture
- Long-term Loans
- Fixed Deposits

Short-term sources: Apart from the long-term source of finance, firms can generate finance with the help of short-term sources like loans and advances from commercial banks, moneylenders, etc. Short-term source of finance needs to meet the operational expenditure of the business concern.

Short-term source of finance include:

- Bank Credit
- Customer Advances
- Trade Credit
- Factoring

- Public Deposits
- Money Market Instruments

2. Based on Ownership

Sources of Finance may be classified under various categories based on the period:

Ownership source of finance include

- Shares capital, earnings
- Retained earnings
- Surplus and Profits

Borrowed capital include

- Debenture
- Bonds
- Public deposits
- Loans from Bank and Financial Institutions.

3. Based on Sources of Generation

Sources of Finance may be classified into various categories based on the period.

Internal source of finance includes

- Retained earnings
- Depreciation funds
- Surplus

External sources of finance may be include

- Share capital
- Debenture
- Public deposits
- Loans from Banks and Financial institutions

4. Based in Mode of Finance

Security finance may be include

- Shares capital
- Debenture

Retained earnings may include

- Retained earnings
- Depreciation funds

Loan finance may include

- Long-term loans from Financial Institutions
- Short-term loans from Commercial banks.

3.3.3.1 EQUITY FINANCING

Equity Shares also known as ordinary shares, which means, other than preference shares. Equity shareholders are the real owners of the company. They have a control over the management of the company. Equity shareholders are eligible to get dividend if the company earns profit. Equity share capital cannot be redeemed during the lifetime of the company. The liability of the equity shareholders is the value of unpaid value of shares. Includes share companies, Private companies and stocks

- Share Company: - retained earnings.
- Private company: - re-investment of profits.
- Issuance of stocks: - Eg. Ayat Real Estate a couple of years ago.

FEATURES OF EQUITY SHARES Equity shares consist of the following important features:

- **Maturity of the shares:** Equity shares have permanent nature of capital, which has no maturity period. It cannot be redeemed during the lifetime of the company.
- **Residual claim on income:** Equity shareholders have the right to get income left after paying fixed rate of dividend to preference shareholder. The earnings or the income available to the shareholders is equal to the profit after tax minus preference dividend.
- **Residual claims on assets:** If the company wound up, the ordinary or equity shareholders have the right to get the claims on assets. These rights are only available to the equity shareholders.
- **Right to control:** Equity shareholders are the real owners of the company. Hence, they have power to control the management of the company and they have power to take any decision regarding the business operation.

- **Voting rights:** Equity shareholders have voting rights in the meeting of the company with the help of voting right power; they can change or remove any decision of the business concern. Equity shareholders only have voting rights in the company meeting and also they can nominate proxy to participate and vote in the meeting instead of the shareholder.
- **Pre-emptive right:** Equity shareholder pre-emptive rights. The pre-emptive right is the legal right of the existing shareholders. It is attested by the company in the first opportunity to purchase additional equity shares in proportion to their current holding capacity.
- **Limited liability:** Equity shareholders are having only limited liability to the value of shares they have purchased. If the shareholders are having fully paid up shares, they have no liability.

3.3.3.2 PREFERENCE SHARES

The parts of corporate securities are called as preference shares. It is the shares, which have preferential right to get dividend and get back the initial investment at the time of winding up of the company. Preference shareholders are eligible to get fixed rate of dividend and they do not have voting rights.

3.3.3.3 DEFERRED SHARES

Deferred shares also called as founder shares because these shares were normally issued to founders. The shareholders have a preferential right to get dividend before the preference shares and equity shares. According to Companies Act 1956 no public limited company or which is a subsidiary of a public company can issue deferred shares. These shares were issued to the founder at small denomination to control over the management by the virtue of their voting rights.

3.3.3.4 DEBENTURES

A Debenture is a document issued by the company. It is a certificate issued by the company under its seal acknowledging a debt. According to the Companies Act 1956, “debenture includes debenture stock, bonds and any other securities of a company whether constituting a charge of the assets of the company or not.”

3.3.3.5 INTERNAL FINANCE

A company can mobilize finance through external and internal sources. A new company may not raise internal sources of finance and they can raise finance only external sources such as shares, debentures and loans but an existing company can raise both internal and external sources of finance for their financial requirements. Internal finance is also one of the important sources of finance and it consists of cost of capital while compared to other sources of finance.

Internal source of finance may be broadly classified into two categories:

A. Depreciation Funds

B. Retained earnings

Depreciation Funds

Depreciation funds are the major part of internal sources of finance, which is used to meet the working capital requirements of the business concern. Depreciation means decrease in the value of asset due to wear and tear, lapse of time, obsolescence, exhaustion and accident.

Generally depreciation is changed against fixed assets of the company at fixed rate for every year. The purpose of depreciation is replacement of the assets after the expired period. It is one kind of provision of fund, which is needed to reduce the tax burden and overall profitability of the company.

Retained Earnings

Retained earnings are another method of internal sources of finance. Actually is not a method of raising finance, but it is called as accumulation of profits by a company for its expansion and diversification activities.

Retained earnings are called under different names such as; self-finance, inter finance, and plugging back of profits. According to the Companies Act 1956 certain percentage, as prescribed by the central government (not exceeding 10%) of the net profits after tax of a financial year have to be compulsorily transferred to reserve by a company before declaring dividends for the year. Under the retained earnings sources of finance, a part of the total profits is transferred to various reserves such as general reserve, replacement fund, reserve for repairs and renewals, reserve funds and secrete reserves, etc.

3.3.3.6 LOAN FINANCING

Loan financing is the important mode of finance raised by the company. Loan finance may be divided into two types:

(a) Long-Term Sources

(b) Short-Term Sources

Loan finance can be raised through the following important institutions as shown on Figure 5.1.

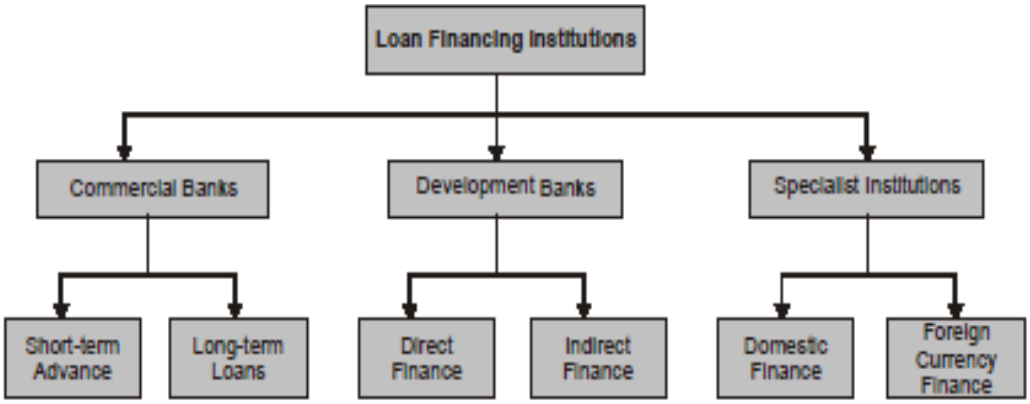


Figure 5.1: Load Financial Institution

Financial Institutions

With the effect of the industrial revaluation, the government established nationwide and state wise financial industries to provide long-term financial assistance to industrial concerns in the country. Financial institutions play a key role in the field of industrial development and they are meeting the financial requirements of the business concern.

Commercial Banks

Commercial Banks normally provide short-term finance which is repayable within a year.

The major finance of commercial banks is as follows:

Short-term advance: Commercial banks provide advance to their customers with or without securities. It is one of the most common and widely used short-term sources of finance, which are needed to meet the working capital requirement of the company.

Short-term Loans

Commercial banks also provide loans to the business concern to meet the short-term financial requirements. When a bank makes an advance in lump sum against some security it is termed as loan. Loan may be in the following form:

(a) Cash credit: A cash credit is an arrangement by which a bank allows his customer to borrow money up to certain limit against the security of the commodity.

(b) Overdraft: Overdraft is an arrangement with a bank by which a current account holder is allowed to withdraw more than the balance to his credit up to a certain limit without any securities.

Development Banks

Development banks were established mainly for the purpose of promotion and development the industrial sector in the country. Presently, large numbers of development banks are functioning with multidimensional activities. Development banks are also called as financial institutions or statutory financial institutions or statutory non-banking institutions.

Development banks provide two important types of finance:

(a) Direct Finance

(b) Indirect Finance/Refinance

3.4 Depreciation

3.4.1 Depreciation: Definition

Depreciation is a business expense the government allows to offset the loss in value of business assets. Depreciation deductions reduce the taxable income of businesses and thus reduce the amount of tax paid.

Accountants define depreciation as: "a systematic allocation of the cost of an asset over its useful or depreciable life."

3.4.2 Classification of Depreciation

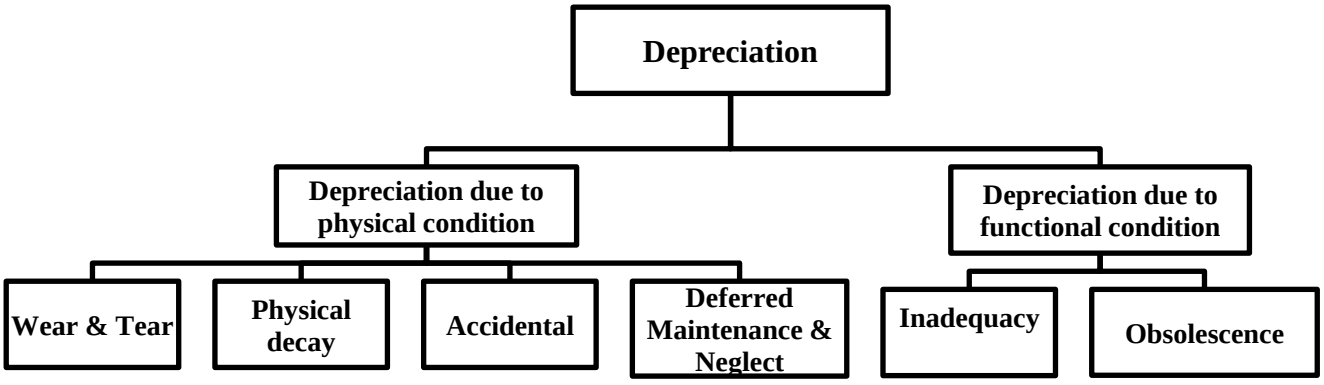


Figure 5.2: Classification of Depreciation

3.4.3 Depreciation Calculation Fundamentals and Methods

3.4.3.1 Depreciation Calculation Methods

The following are the methods for calculating depreciation.

- **Straight line Methods**,
- **Declining Balance Method (esp. DDB)**,
- **The Sum of the Year's Digits (SOYD) Method**,
- Sinking fund Method,
- Annuity Charging method,
- The Insurance policy method,
- The Revaluation or Regular Valuation method, and
- Machine Hour Basis method.

Depreciation of Depreciable Assets and Business Intangibles

  - *The tax payer shall be allowed a deduction for the amount by which the depreciable assets and business intangibles of the taxpayer decline in value*

- The straight-line method

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FEDERAL NEGARIT GAZETTE

OF THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

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23rd Year, No.82
ADDIS ABABA,24 th, August , 2017

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CONTENT

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ንዑስ ክፍል ሁለት የእርጅና ቅናሽ ፴፮. ዋጋቸው የሚቀንስ ሀብቶች እና ግዙፋዊ ሀልምት የሌላቸው የንግድ ሥራ ሀብቶች የእርጅና ቅናሽ	SUB-SECTION TWO DEPRECIATION DEDUCTION 36. Depreciation Deduction of Depreciable Assets and Business Intangibles

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CHAPTER FOUR: PROCUREMENT AND CONTRACT MANAGEMENT

4.1 Procurement

4.1.1 Procurement: Definition

Procurement is the acquisition of appropriate goods, works and/or services at the best possible total cost of ownership to meet the needs of the purchaser in terms of quality, quantity, time, and location. In short, Procurement is obtaining goods, works, consultancy or other services through purchasing, hiring or obtaining by any other contractual means. Corporations and public bodies often define processes intended to promote fair and open competition for their business while minimizing exposure to fraud and collusion. Procurement can range from contracting for an entire service to purchasing small assets such as office equipment

The procurement process does not end at the commissioning or contract award stage, but spans the entire life cycle of the product or service from inception and design through to contract

management and disposal of any redundant assets or the end of the useful life of an asset. It involves options, appraisal and the critical 'make or buy' decision. Procurement differs from purchasing in that purchasing merely reflects the act of acquisition, while procurement encompasses more elements of the supply chain (logistics, transportation etc.).

4.1.2 What is to be procured?

Goods: include raw material, products and equipment and commodities in solid, liquid or gaseous form, marketable software as well as installation, transport, maintenance or similar obligations related to the supply of the goods if their value does not exceed that of the goods themselves.

Works: all works associated with the construction, reconstruction, up grading, demolition, repair or renovation of a building, road, or structure, as well as services incidental to works, if the value of those services does not exceed that of the works themselves; and includes build-own-operate, build- own-operate-transfer and build operate- transfer contracts.

Consultancy Services: a service of an intellectual and advisory nature provided by consultants using their professional skills to study, design and organize specific projects, advice clients, conduct training and transfer knowledge.

Services: mean any object of procurement not related to professional skills other than works, goods and consultancy services; such as transportation, printing and duplicating books, maintenance, security, janitorial, electricity, telecommunication and water supply services.

4.1.3 Why Outsource?

- To access skills and technologies
- To reduce both fixed and recurrent costs
- To allow the client organization to focus on its core business
- To provide flexibility
- To increase accountability

4.1.4 How Do We Manage Procurement?

Procurement can range from contracting for an entire service to purchasing small assets such as office equipment. It is the process required to supply equipment, material, service and other

resources needed to carry out a project that satisfy customer. The procurement management process has four steps shown on Figure 6.1:

- Plan Procurements
- Conduct Procurements
- Administer Procurements
- Close Procurements

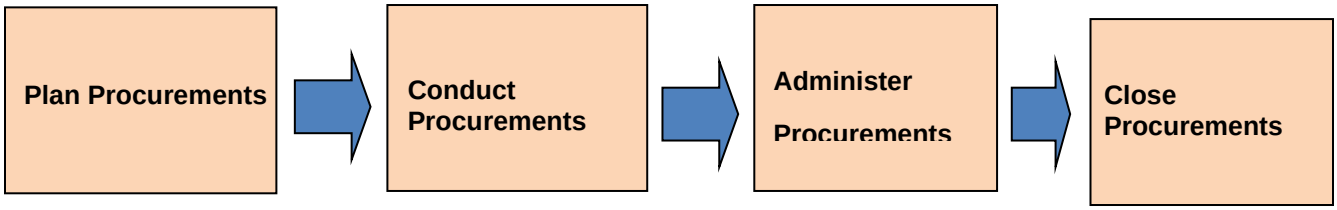
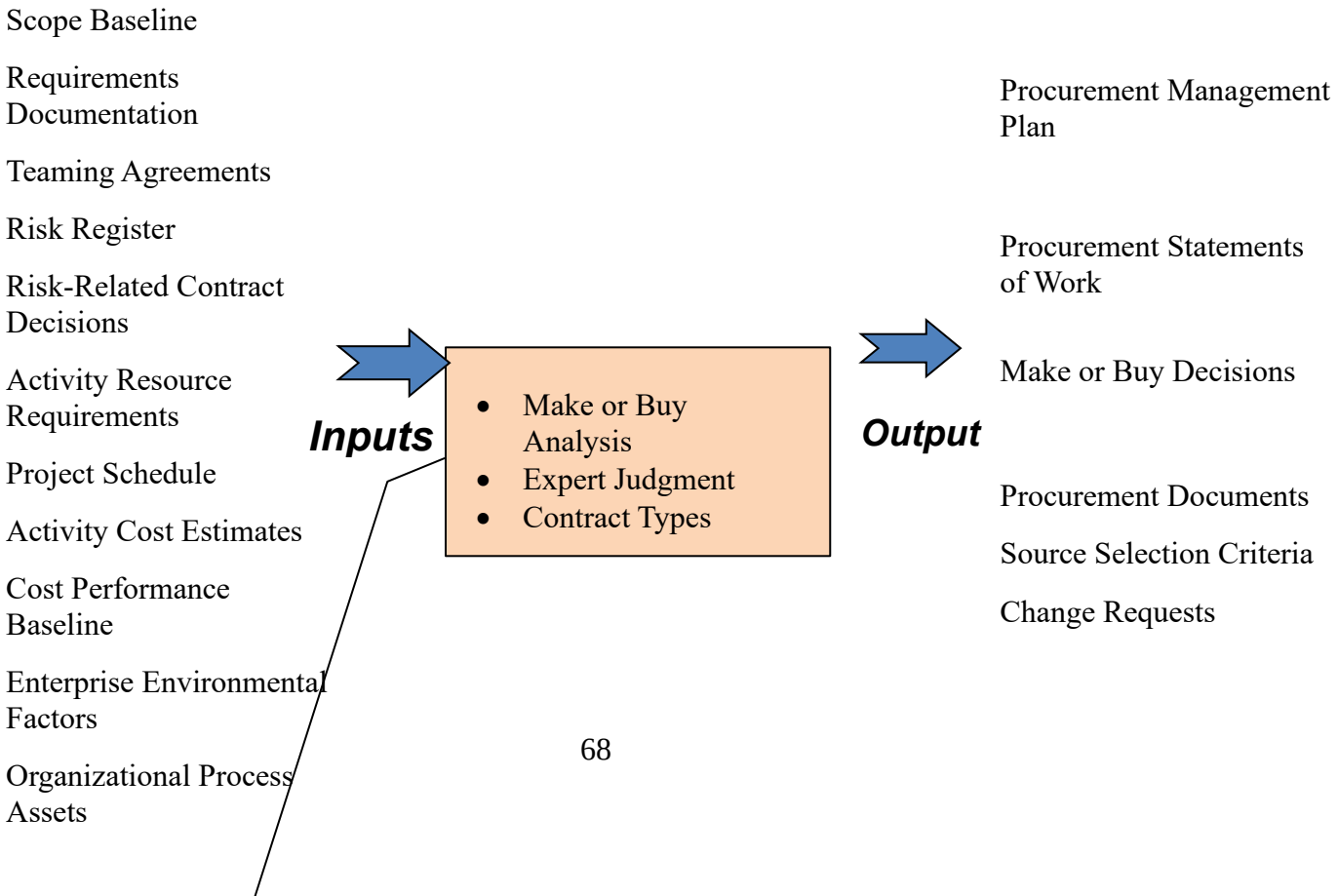
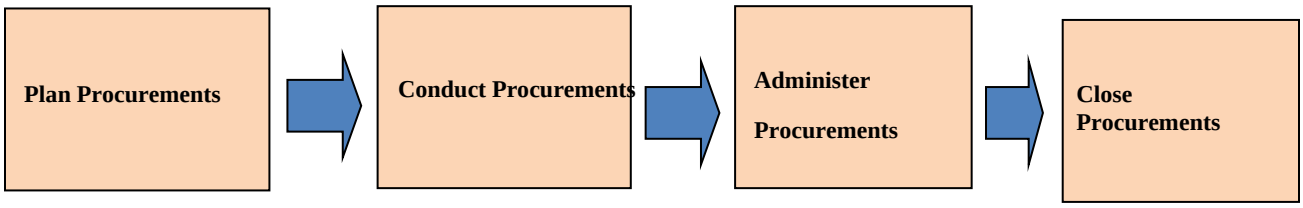


Figure 6.1 procurement management process





4.1.5 Why Procurement Management?

Construction Industry involves procurement and contract management systems in order to ensure fair competition and distributions of obligations and rights among stakeholders. The Competition helps the Project Owners' to acquire the five rights (Counterpart, Cost, Time, Quality and Quantity), the Project Financiers' & Regulators' to get effective utilization of finance, and the Project Providers' by giving impartial & neutral Opportunity for business.

4.2 Project Delivery Systems

Contract/project delivery system is the way project Owners together with project regulators and financiers determine the assignment of responsibilities to project stakeholders along the construction process. Project delivery method describes how the participants are organized to interact, transforming the owner's project goals and objectives into a finished facility. It is often determined during the basic planning phase of the construction project.

The owner usually considers the following factors to decide how project resources are to be organized:

- Past practices, traditions, and experience;
- The advice of consultants;
- Funding sources and constraints;
- The effective use of staff and working capital;
- The interests of other project stakeholders.

Delivery systems are basically classified in to two broad areas:

1. Force Account, and
2. Outsourced.

4.2.1 Force Account

When the project owners engage themselves to undertake the project, it is called a force account delivery system. Such a system is often promoted if the Project Owners believe that there is a comparative advantage in quality, cost and time.

4.2.2 Outsourced delivery systems

The **criteria** for such category are based on: **segmentation**, **integration** and **financing**.

- ***Integrated Process Delivery Methods***
  - Design-Build-Operate;
  - Design-Build-Operate-Maintain;
  - Design-Build-Finance-Operate;
- ***Segmented Delivery Methods***
  - Design-Bid-Build;
  - Design-Build;
  - Construction Management;
  - Pure Operations and Maintenance (O&M)
- ***External Financing Methods***
  - Design-Build-Finance-Operate;
  - Build-Own-Operate;
  - Build-Own-Operate-Transfer;

4.2.2.1 Design-Bid-Build, DBB (Traditional Method)

After Project Owners prepare the Basic Planning that identifies construction project programs, they call upon the participation of Design and/or Supervision Consultants. For many years, DBB has been the most common method of project delivery for public projects, and for many private projects as well.

DBB is effective on projects:

- Where the owner needs both professional design services and construction services
- Where the designer does not require detailed knowledge of the means and methods of construction.
- DBB provides the owner with a high degree of control.

Advantages:

- Applicable to a wide range of projects,
- Well established and easily understood,
    - Well-defined contractual relationship
    - Clearly defined roles for all parties,
- Provides the lowest initial price that competitive bidders can offer,
- Discourages favouritism in spending public funds while stimulating competition in the private sector.
- Insurance and bonding are well defined.
    - Contains considerable contractual protection to owner

Disadvantages:

- Innovation not optimized;
    - Tends to yield base level quality
    - No built-in incentives for contractors to provide enhanced performance
- Least-cost approach requires higher level of inspection by the Consultant
    - Usually low bid-incentive for change orders;
- Greatest potential for cost/time growth (in comparison to other delivery methods)
- Tends to create an adversarial relationship among the contracting parties
    - Disputes between parties;
- Lack of input from the contactor during the design stage exposes the agency to claims related to design and constructability issues
- Client retains risks;
- Owner responsible for errors and omissions.

4.2.2.2 Design-Build, DB (Turnkey)

Design Build or Turnkey, in principle, reduces numbers of procurement processes engaged in the fragmented process and employ only one procurement process and a single design-build contractor to provide the entire Construction Implementation Process (design and construction). The design-builder performs design and construction according to design parameters, performance criteria and other requirements established by the employer or his representative.

This type of project delivery method provides the owner with a single point of contact for project responsibilities, eliminating the need to assist in resolving designer-contractor disputes. Selection can be based on low price or on a set of value criteria (experience, staff, bonding capacity, etc.) or both. Provides the owner with a single point of contact for project responsibilities, eliminating the need to assist in resolving designer-contractor disputes.

Advantages:

- Single source responsibility both for design and construction;
    - Reduction in administration;
    - Minimal contractual relationships;
- Integrating design and construction;
    - Allows construction input early in design phase
- Accelerated project delivery by:
    - Fast-tracking design and construction
    - Close coordination between designer and contractor
- Cost containment by minimizing owner's exposure to design errors and omissions
- Innovation and quality improvements:
    - Alternative designs and construction methods suited to the contractor's capabilities
    - Flexibility in the selection of design, materials, and construction methods
- Most risks transferred to the design-builder;

Disadvantages:

- Reduced opportunities for smaller, local construction firms
- Fewer competitors and increased risk may result in higher initial costs
- Elimination of traditional checks and balances, Designer is no longer agency's advocate
- Traditional funding may not support fast-tracking construction or may require accelerated cash flow

4.2.2.3 Construction Management, CM

Many owners engage construction managers (CMs) to assist in developing bid documents and overseeing project construction. Under CM the Owner contracts separately, but somewhat simultaneously, with a design consultant and with a firm whose primary expertise is construction (the Construction Manager). The owner procures the management services of the Construction Manager (in most cases a general contracting construction firm) early in the design phase.

Types of CM delivery system:

- CM at Free: as agent,
- CM at Risk: as a constructor.

4.2.2.3.1 Construction Management, CM Agency

Agency-CM (also known as Program Management for multiple contracts or programs) is a fee-based service in which the construction manager (CM) is exclusively responsible to the agency and acts as the agency's representative at every stage of the project. CM acts as an agent of the owner and extends the owner's internal capabilities in performing traditional owner responsibilities.

CM responsibilities may include

- Providing advice during the design phase,
- Evaluating bids from prime contractors,
- Overseeing construction, and
- Managing project cost, schedule, and quality.

The CM may work with the designer or contractor to reduce the cost, but does not guarantee take on the contractual responsibility for design and construction.

Advantages

- Earlier involvement of CM bridges design and construction phases

- Provides an independent point of view regarding constructability, budget, (No inherent bias towards design or construction)
- Furnishes construction expertise to designer

Disadvantage

- Added project management cost for CM services
- CM not at risk for construction cost
- Unlike CM at-Risk, Agency-CM services are not regulated by state licensing laws for contractors or A/E firms

4.2.2.3.2 Construction Management, CM at Risk

In Such type of project delivery method the CM firm enters into a contract with the owner, which assures the project will be constructed for no more than the amount designated in the signed contract, and no longer than the agreed completion date. Guaranteed Maximum Price (GMP) is typically based on a partially completed design and includes the CM's estimated cost for the remaining design features, general conditions, a CM fee, and construction contingency.

CM-at-risk typically contracts with the owner in two stages.

- Manages and undertakes services during conceptual & preliminary design phases with the design professional.
- On completion of design, owner and CM-at-risk then agree on a price and schedule for the completion of the construction work.

Advantages

- Allows for innovation and constructability recommendations in the design phase.
- Reduced change orders and claims.
- Use of a GMP with a fixed-fee and opportunity for shared savings provides an incentive for CM to control costs and work within funding limits.

Disadvantage

- Once construction begins, the CM assumes the role of a general contractor, leading to possible tensions with the owner over project quality, budget, and schedule.
- Use of a GMP may lead to disputes over the completeness of the design and what constitutes a change to the contract.

4.2.2.4 Design-Build-Operate, DBO

In DBO project delivery method the public sector finances the project and sets performance objectives. A private partner, the DBO contractor, is engaged to design, construct, maintain, and operate the facility. The DBO contractor serves as the single point of responsibility for all aspects of design, construction, and operation for the term of the service contract, which is typically 15 to 20 years following project acceptance. Ownership of the assets remains with the local government.

The service contract provides for the payment of an annual fixed service fee for the performance of the operations and maintenance services, subject to an indexed inflation adjustment factor. In addition to assuming the risks associated with design and construction, the DBO contractor assumes risks associated with project operations, including the risks of project performance and the costs of operations and maintenance.

4.2.2.5 Build-Operate-Transfer, BOT

BOT is a form of procurement and contract delivery system that promotes Public Private Partnership (PPP) in which a private company is contracted to finance, design, construct, operate for a certain period (usually 10 years) and transfer the facility to the Project Owner. The typical BOT project contract is the process whereby a government grants a concession to a project development company to develop and operate what would normally be a public sector project, for a given period of time known as the concession period. BOT project involves a potentially complex contractual structure.

In BOT, the private partner provides the capital required for investment. The private partner owns the assets, sufficient enough to recover investment costs through user charges. The private party collects user charges. At the end of the contract, the ownership of asset reverts back to the government.

4.3 Stages of Civil Engineering Projects

The **major stages** in construction projects encompass:

- Pre-design stage
- Design stage
- Processing construction bids stage
- Construction stage
- Completion and hand over (contract closeout)

4.3.1 Pre-design stage

It encompasses the following major activities:

- Carryout feasibility study,
- Selection of suitable site,
- Preparation of tentative cost estimates,
- Making topography of the site,
- Preliminary sub-surface investigation.

4.3.2 Design stage

It encompasses the preparation of:

- Concept design,
- Preliminary design,
- Final design,
- Engineer's cost estimate,
- Bid documents,
- Drawings and design reports.

4.3.3 Tender/Bid stage

The following activities need attention during processing of construction bids.

A. Bid documents and related issues:

- Preparation of bid documents

- Clarity of bid documents,
- Validity of bid security,
- Amendment of bid document (if any),
- Site visit,
- Performance Security etc.

B. Bid processing and award of contract:

- Determination of project category (possible procurement method),
    - Competitive bidding (ICB, NCB),
    - Limited/restricted bidding (ICB, NCB),
    - Direct contracting (appointment/negotiated contract)
    - Force account
- Announcement of invitation for pre-qualification,
- Public bid opening,
- Bid evaluation and award process,
    - Preliminary examination of bids
    - Evaluating bids
    - Propose award
    - Bid evaluation report
    - Contract award
- Rejection of all bids,
- Preparation of contract document,
- Signing of contract.

4.3.3.1 Bid Preparation

The first step in preparing for bid is organizing the bid document. The Bidding document shall incorporate all information necessary for prospective bidders to prepare their bids. The detail and complexity of bid documents may vary with the size and nature of the proposed bid package and

contract. Bid documents for works includes bidding information and contractual information. Contractors are responsible for all duties, taxes and other levies; hence, bidders shall take these factors into consideration in preparing their bids.

In Bidding Information the bidders are required to respond (provide their offer, data, information) in accordance with the requirement of the documents within the bidding period. It comprises: Invitation for bid (IFB), Instruction to bidders (ITB), Bid Data Sheet (BDS), Bid forms including BOQ, and Addenda (Bid Amendment). In Contractual information, documents will be provided the tender document to furnish bidders with full and detailed information of the project for application after winning the contract. The bidder should utilize such information to provide a fair and reasonable offer to the bidding document. Contractual information comprises:

- Agreement form (Contract Agreement),
- Standard (General) Conditions of contract,
- Particular or special conditions of contract,
- Technical specifications and Methods of measurement,
- Drawings, and
- Appendix to Contract Agreement.

4.3.3.2 Principles of bid evaluation

The Engineer evaluates and compare the bids after the public opening and submit recommendation to contract award/purchase committee for its review or approval. Information relating the examination, clarification and evaluation of bids shall not be disclosed to bidders or other persons not officially concerned with this process until the successful bidder is notified of the award of contract. The engineer may request in writing clarifications of bidders concerning ambiguities or inconsistencies in the bid, the response from bidders shall also be in writing. Under this process no change in the price or scope of the original offer is accepted.

Prior to detail evaluation, preliminary examination shall be undertaken. Its purpose is to identify and reject bids that are incomplete, invalid or substantially non-responsive to the bidding documents. The following points shall be examined:

- Check if each page is signed or initialed;
- Verify amount of bid security corresponds to the requirement;
- Check if all requisite information has been filled in the document; and
- Verify that all pages of the bid document are in order.

The Engineer recommend the award of contract to the bidder whose bid has been responsive to the bid document and who has offered the lowest evaluated bid price. The engineer may consider rejection of all bids if: none of the bids are found to be responsive, bids are unreasonably high in price, or none of the bidders are qualified. The engineer shall prepare a detailed report on the evaluation and comparison of bids setting forth the specific reasons on which the recommendation is based for the award of contract

4.3.3.3 **Selection *of Bidders***

It is a contract award procedure which involves the selection of contractors to be invited to tender or negotiate. The selection should be made on the basis of objective criteria. Bid qualification procedures take the following forms:

- Negotiated bid,
- Competitive bid.
    - Short listed,
    - Open bid.
        - Single stage, single envelope,
        - Single stage, two envelope,
        - Two stage, two envelope.

4.3.3.3.1 Negotiated Bid

Negotiated contracts are made particularly when the contactor has special skills to undertake particular work which require a high degree of technical competence or is capable of completing the works within a required time period. The amount of detail in the BOQ and the price will be agreed upon by both parties

Advantages

- The contractor can give advice during the development of design
- Early contractor appointment in the design phase leads to a beneficial contribution as his or her skills and work experience are made available to the design team.
- Early start on site may be achieved to meet the client's development strategy.
- Client's tendering costs are substantially reduced owing to the production of minimal tendering information.
- If overlapping of design and construction phases eventuates as a result of the negotiation, it condenses the development period with attendant savings in costs.
- It minimizes tardy delivery of projects as the contractor can carry out some construction planning during the progress of negotiations.
- All the important points of the construction project (e.g. construction programme, method and procedure) are discussed during the negotiation and this effects the rational price.

Disadvantages

- Client obtains an offer which is not truly competitive and does not reflect what the construction market can bear.
- There may exist legal implications of joint design when the negotiation results in design and production overlap.
- Contactor experiences difficulty in estimating on outline information.
- It may not satisfy the requirements of public accountability in construction projects for public sector clients.
- cost of work is likely to be higher than in competitive bidding

4.3.3.3.2 Competitive Bid

In this method the client advertises in local, national or international press giving brief details and key information of the proposed works and inviting interested contractors to apply for the relevant contract documents. Inviting contractors in the method does not bind the client to accept the lowest or any offer.

Advantages:

- It allows all interested contractors to tender

- It ensures good competition and prevents contracts from forming rings
- Open competitive tenders make it possible for keen contractors to obtain the work and offer a good service to clients.
- It helps contractors willing to grow or expand their market segment to find new clients. As the public sector clients seek price through this method, construction companies who rely on their area, respond positively to the press advertisements.

Disadvantages

- There can be many contractors tendering which can take long time for evaluation.
- Estimators take long time to make good pricing and in included in the contractor overhead.
- Public accountability may be questioned if the lowest offer is not accepted.
- The lowest bidder if discovers that his price is too low, he may decrease the quality of the works or submit numerous claims.
- Good contractors may not participate unless they are forced to, due to lack of work.
- Increased cost of tendering in terms of extensive production of contract documentation and estimating.
- Less satisfactory contractor performance may leave the client with a bad job which may be expensive to rectify.

4.3.4 Construction stage

Construction stage is the critical phase since the result of all prior planning, design and the total pre-construction decisions are brought to fruition. The success of this stage mainly depends on the relation and strength of the construction team (main stakeholders). The main activities in construction phase are construction supervision and contract administration.

I. **Construction supervision**: This process covers:
   - Site control,
   - Quality control,
   - Quantity control,
   - Monthly and quarterly progress evaluation meetings.
   - Site control,

- Quality control,
- Quantity control,
- Monthly and quarterly progress evaluation meetings.

II. **Contract administration**:

It covers the major activities of addressing changes, payments, claims etc.

4.3.5 Contract closeout stage

This process is a transition from design and construction to the actual use of the constructed facility. Actual activity costs and durations should be recorded and compared with that was planned. The management team must also provide documentation, shop drawings, as-built drawings, and operation manuals to the owner organization. Assessment of the project team's performance is crucial in this stage for avoiding mistakes in the future.

4.4 Contract: Definition

A contract is an agreement between two parties. Normally it is a written document but it can also be oral agreement. Construction contract is entered into between the client and the contractor. The client wants to get his/her facility constructed. He has the fund but he doesn't have the expertise, skilled and unskilled workforce, and equipment to carry out the work. The contractor is in the business of constructing structures and making profit. This mutuality or overlap of interest brings them together to enter into a contract. The second important element that makes parties enter into contract is that each party must contribute something of value to the other party in return for the other party's promise or action. Both parties should be better of at the end of the contract. The terms of a contract are legally binding and are enforced by codes of law. In some countries they have separate codes for resolution of construction disputes but here in Ethiopia the normal penal and civil codes are applied to resolve construction disputes.

The earliest recorded reference to a building contract comes from one of the laws of Hammurabi, the Babylonian conqueror:

> "If a contractor builds a house for a man this man shall give the contractor two shekels of silver as recompense. If a contractor builds a house and does not build it strong enough and it collapses and kills the owner the contractor shall be put to death."

This ancient law explicitly express the rights, obligations and penalties for non-compliance of contracting parties

Construction contracts are unique and are not as simple as contracts in other areas. By virtue of the changes clause which is contained in almost all construction contracts. The changes clause allows the owner to make changes within the scope of the contract. The contractor will be compensated for the changes and the contractor is entitled to an equitable adjustment for the costs and time associated with the change. This unique feature, plus several other aspects, of construction contracts are why many projects end up in disputes.

Construction contracts have another feature that makes foster adversarial relationships. That feature is the special role that the drafter of the contract plays. In most cases, the designer drafts the construction contract. In many situations, the contractor has no ability to negotiate the terms of the contract, particularly in public projects which are competitively bid. Thus, it may be somewhat one-sided from the outset. The designer generally fulfills the role of the interpreter of the contract, and this is specifically stated in many instances. If a question arises as to the meaning of clauses in the contract, the designer renders a decision. Finally, the designer is usually specified as the decision maker for appeals to any problems that arise.

Contracts are legal documents and if the decision given by the designer did not satisfy the contractor, they are settled by arbitration, mediation or in courts of law. According to Art. 1675 of the 1960 Civil Code of Ethiopia: *"A contract is an agreement whereby two or more people as between themselves create, vary or extinguish obligations of a proprietary nature."*

The definition encompass the following main points:

- The contract is an agreement;
- The agreement is to be made between two or more persons;
- The agreement is binding between such two or more people;
- The agreement is to create, vary and extinguish obligations;
- The nature of obligations is proprietary.

Therefore, for a contract to be valid and enforceable by law, it must meet certain criteria, which are the following:

- There must be mutual agreement
- There must be an offer. An offer can normally be withdrawn until the time it is accepted, except the bid documents used in public works which generally state that the bid may not be withdrawn once submitted.
- The offer must be accepted. In low-bid construction, the acceptance is the award of the contract to the low bidder.
- There must be consideration for the service performed - payment
- The subject matter of the contract must be lawful. A contract to commit a crime is not legal and not enforceable.
- The contracting parties must have the legal capacity to enter into a contract. Contracts are signed by representatives of both the owner and contractor who have the legal authority to sign for their organizations.

A successful project manager manages well as to avoid conflicts and use the contract to control risk and reduce problems. In all cases it is strongly recommended that contracts shall be reviewed by a qualified attorney (construction attorney if possible) before entering. There are several standard contract forms in use in the developed world produced by different groups. This serves as a good starting point to draft contract document and tailor it to one's own need. We do not have these in Ethiopia and people use documents used in other projects as starting points.

Effects of contract may have two dimensions:

- The time when the contract is considered bound by the contracting parties; and
- The fulfillment or performance of the set of promises prescribed in the contract;

The first one relates to the effectiveness of the contract, whereas the second is related to the performance of obligations of the contracting parties under the contract.

4.4.1 Components of Construction Contracts

The typical contract documents in a given large and complex construction contract include the following components; ***legal***, ***commercial***, ***technical*** and ***technological*** parts.

A. **Legal Part**

- The Contract Agreement;
- Minutes of Meeting, if any;
- Letter of Acceptance(Award), if any;
- The Tender (NB: Including the Appendix to Tender, if any);
- Special Conditions of Contract;
- General Conditions of Contract;
- Others, if any.

B. **Commercial Part**

- Performance Security Form;
- Advance Payment Guarantee Form;
- Bid Security Form;
- Insurance Forms;
- Retention Money Security Form;
- Others, if any.

C. **Technical Part**

- Technical Specifications,
- Drawings,
- Bill of Quantities, BOQ
- Schedule of Requirements, if any,
- Others, if any.

D. **Technological Part**

It is vital in relation to some process aspect of the construction project, if any;

4.4.2 Types of Construction Contracts

While construction contracts serve as a means of pricing construction, they also structure the allocation of risk to the various parties involved. The owner has the sole power to decide what type of contract should be used for a specific facility to be constructed and to set forth the terms in a contractual agreement. It is important to understand the risks of the contractors associated with different types of construction contracts.

Construction contracts are classified on the basis of payment methods (fixed price or cost plus fee) adopted by the employer/client/owner/promoter.

Construction contracts take the following forms:

- **Competitive (fixed price) contract**:
    - Lump Sum, and
    - Unit price/Ad-measurement.
- **Negotiated (Cost plus) contract**:
    - Cost plus fixed fee,
    - Cost plus fixed percentage,
    - Cost plus variable fee,
    - Target cost/estimate, and
    - Guaranteed maximum price.

The following factors affect the choice of specific type of contract:

- Nature and complexity of the works;
- Size and duration of contract;
- Degree of definition (scope, risk, uncertainty);
- Status of design;
- Technical/Supervisory resource of Employer;
- Budgetary/Financing/Borrowing constraints;
- Previous experience of Employer; and

- Standard documents of funding agency.

4.4.2.1 Lump Sum Contract

Lump sum contracts are typically used for buildings. The quantities of materials required can be calculated with sufficient accuracy during the bidding process to allow contractors to submit a single lump sum price for the work. In a lump sum contract, the owner has essentially assigned all the risk to the contractor, who in turn can be expected to ask for a higher markup in order to take care of unforeseen contingencies. Beside the fixed lump sum price, other commitments are often made by the contractor in the form of submittals such as a specific schedule, the management reporting system or a quality control program. If the actual cost of the project is underestimated, the underestimated cost will reduce the contractor's profit by that amount. An overestimate has an opposite effect, but may reduce the chance of being a low bidder for the project.

4.4.2.2 Unit Price Contract

In a unit price contract, the risk of inaccurate estimation of uncertain quantities for some key tasks has been removed from the contractor. However, some contractors may submit an "unbalanced bid" when it discovers large discrepancies between its estimates and the owner's estimates of these quantities. Depending on the confidence of the contractor on its own estimates and its propensity on risk, a contractor can slightly raise the unit prices on the underestimated tasks while lowering the unit prices on other tasks. If the contractor is correct in its assessment, it can increase its profit substantially since the payment is made on the actual quantities of tasks; and if the reverse is true, it can lose on this basis. Furthermore, the owner may disqualify a contractor if the bid appears to be heavily unbalanced. To the extent that an underestimate or overestimate is caused by changes in the quantities of work, neither error will affect the contractor's profit beyond the markup in the unit prices.

4.4.2.3 Cost Plus Fixed Percentage Contract

For certain types of construction involving new technology or extremely pressing needs, the owner is sometimes forced to assume all risks of cost overruns. The contractor will receive the actual direct job cost plus a fixed percentage, and have little incentive to reduce job cost. Furthermore, if there are pressing needs to complete the project, overtime payments to workers are common and will further increase the job cost. Unless there are compelling reasons, such as the urgency in the construction of military installations, the owner should not use this type of contract.

4.4.2.4 Cost Plus Fixed Fee Contract

Under this type of contract, the contractor will receive the actual direct job cost plus a fixed fee, and will have some incentive to complete the job quickly since its fee is fixed regardless of the duration of the project. However, the owner still assumes the risks of direct job cost overrun while the contractor may risk the erosion of its profits if the project is dragged on beyond the expected time.

4.4.2.5 Cost Plus Variable Percentage Contract

For this type of contract, the contractor agrees to a penalty if the actual cost exceeds the estimated job cost, or a reward if the actual cost is below the estimated job cost. In return for taking the risk on its own estimate, the contractor is allowed a variable percentage of the direct job-cost for its fee. Furthermore, the project duration is usually specified and the contractor must abide by the deadline for completion. This type of contract allocates considerable risk for cost overruns to the owner, but also provides incentives to contractors to reduce costs as much as possible.

4.4.2.6 Target Estimate Contract

This is another form of contract which specifies a penalty or reward to a contractor, depending on whether the actual cost is greater than or less than the contractor's estimated direct job cost. Usually, the percentages of savings or overrun to be shared by the owner and the contractor are

predetermined and the project duration is specified in the contract. Bonuses or penalties may be stipulated for different project completion dates.

4.4.2.7 Guaranteed Maximum Cost Contract

When the project scope is well defined, an owner may choose to ask the contractor to take all the risks, both in terms of actual project cost and project time. Any work change orders from the owner must be extremely minor if at all, since performance specifications are provided to the owner at the outset of construction. The owner and the contractor agree to a project cost guaranteed by the contractor as maximum. There may be or may not be additional provisions to share any savings if any in the contract. This type of contract is particularly suitable for *turnkey* operation.

4.5 Contract Documents

Construction Documents are defined as the written and graphic documents prepared or assembled by the Engineer/Architect for communicating the design of the project and administering the contract for its construction.

The two major components that make up construction documents include:

- Bidding requirements, and
- Contract documents.

4.5.1 Bidding requirements

Bidding Requirements: are used to attract bidders and explain the procedures to be followed in preparing and submitting bids. Bidding requirements help bidders follow established procedures and submit bids that will not be disqualified because of technicalities. They do not become part

of the contract documents. Bidding Documents: all of the construction documents issued to bidders before the signing of an owner-contractor agreement. It comprises:

- Invitation to bid (notice to bidders),
- Instruction to bidders, and
- Bid forms and attachments.

Bid Package: documents available to the contractor and on which he must make a decision to bid or not. A set of plans and technical specifications, proposal form, general conditions, special conditions etc. that shows the description of the project to be constructed

Instruction to Bidders, ITB: It describe the scope of the bid and also include the following points:

- Source of fund (if it is financed from other agency);
- Fraudulent and fraud practices;
- Eligible bidders;
- Eligible Materials, Equipment and Services;
- Clarification of Bidding Document;
- Site Visit;
- Pre-Bid Meeting; and
- Amendment of Bidding Document.

Bid Data Sheet, BDS: The ***BDS*** include the following ***fundamental essence*** of the ***contract***:

- Defects Liability Period, Amount of Interim Payment Certificates;
- Percentage of Retention, Limit of Retention Money, Amount of Advance Payment;
- Start Repayment of Advance Payment, Monthly Recovery of Advance Payment;
- Number of Copies of Statement of Completion and Final Statement;
- Procedure for Settlement of Disputes;
- Notice to Employer and Engineer; and
- Origin of Materials and Plant.

4.5.2 Essential Contract Documents

Contract Documents (graphic and written) describe the proposed construction (the 'Work') that results from performing services, furnishing labor, and supplying and incorporating materials and equipment into the construction.

There are many documents that make up a construction Contract. The five essential documents are:

- The Agreement
- The General & Special Conditions
- The General & particular Specifications
- The Drawings, addenda (optional)

4.5.2.1 Agreement

The agreement is the document that represents and reflects the legal contract between the owner and the contractor. Obviously there is also a contract between the owner and the designer, and between the general contractor (GC) and the sub-contractors, or between the contractors and the suppliers for those contracts. The purpose of the agreement is to record in written form those items agreed between the owner and the contractor. It is simply a letter that constitutes legal evidence that a contract exists, and forms the basis for its enforcement. The agreement must contain:

- Date of the agreement
- Names and addresses of the contracting parties
- Description of the scope of work
- Time limitations
- Contract considerations
- Payment conditions
- Reference to other documents
- Signatures

4.5.2.2 General Conditions

A document called the General Conditions is an essential part of the contract. It defines the responsibilities of the parties involved in the contract- the owner and the general contractor. It describes the guidelines that will be used in the administration of the contract. It is often referred

to as boilerplate, implying that the same documents are standard to all contracts. Contractors must know exactly what is contained in the boilerplate. Various standard forms of General Conditions have been development by different organizations. These forms are familiar to all parties concerned, and the wording is not only clearly understood, but has also been tested in the courts.

General Conditions state about

- The Owner
- The Contractor
- Administration of the contract
- Subcontractors
- Subcontractors
- Construction by Owner or by Separate Contract
- Changes in the Work
- Time
- Payments and Completion
- Protection of Persons and Property
- Insurance and Bonds
- Uncovering and Correction of work
- Miscellaneous Provisions
- Termination or Suspension of the Contract

A definition of the contract documents that lists and gives a brief description of the documents that form the contract.

- Document precedence, which clearly states which document will have precedence over the other in case of discrepancy.
- Duties and responsibilities of the owner and contractor while the constriction is in progress.
- A definition of how a portion of the work can be awarded to a subcontractor, and the working relationships between subcontractors.
- The time for completion of the work.

- The mode and the frequency of payment, or the stages of work that determine when the contractor will be paid. This selection also contains the rights of both parties with respect to **retain age,** and the definition of completion.
- The requirements and penal value of bonds and insurance. This section includes bid bonds, as well as payment and performance bonds.
- The conditions that constitute a change of work must be clearly defined, and the steps to be taken when a change order is required must also be clear.
- The system for dispute resolution, such as arbitration or mediation, must be defined. Also the rights of each party to terminate the contract must be detailed.
- There are always some miscellaneous provisions such as the governing laws, delegation of work, requirements for inspections and tests, approvals during the work, and statutory limits.

4.5.2.3 Supplementary Conditions

The Supplementary Conditions are sometimes known as Special Provisions or Special Conditions. The purpose of the Supplementary Conditions is to provide an extension of the General Provisions of the contract to fit the specific project at hand. They serve as amendments or augmentation to the General Conditions. Items included in the Supplementary Conditions are entirely subject to the discretion of the owner, and may include topics such as:

- The number of copies of contract documents to be received by the contractor
- Survey information to be provided by the owner
- Materials provided by the owner
- Changes in insurance requirements
- Phasing requirements
- Site visit
- Start date of the construction
- Requirements for security and temporary facilities
- Procedures for submittal and processing of shop drawings.
- Cost and schedule reporting requirements
- Traffic control and street cleaning requirements
- Responsibilities for testing of materials

- Actions to be taken in the event of discovery of artifacts or items of historical value

4.5.2.4 Specifications

Specification may also be known as Technical provisions. They are written instruments to be used in conjunction with the drawings, so together the drawings and the specifications fully describe and define the requirements of the contract, to include the quality that is to be achieved. They supplement the drawings and provide information that cannot be shown in graphic form, or information that is too lengthy to be placed within the drawings. They guide bidders in the preparation of cost proposals as well as field execution of the work. They also guide the contractor through the processes of ordering materials and construction and installation of the facility. Specifications provide information regarding:

- The quality of materials
- The quality of workmanship
- Erection and installation methods
- Test and inspection requirements and methods

Specifications have restricted application, usually to a specific item or work operation. The designer or specification writer is therefore able to assign responsibility for each provision of the specifications to the desired specific party.

- Specifications must satisfy these basic criteria:
- Technical accuracy and adequacy
- Definite and clear stipulations
- Fair and equitable requirements
- A format that is easy to use during bidding and construction
- Legal enforceability
- There are several general types of specifications. Performance specifications state how the finished product must perform without dictating how the contractor is to do the work.
- An example of performance specifications would be a requirement for concrete that has 28-day strength of 3.500 psi. It is the contractor’s responsibility to provide concrete that meets the requirement.
- Design specifications, also known as materials and workmanship specifications or prescriptive specifications, state how work is to be performed. For example, a typical

wall specification requires that the studs be placed 16 cm. on center, and may even specify the nailing pattern.

- The contractor is not free to make changes to the spacing of the studs. By using a design specification, the designer assumer liability for the performance of the product. Looked at another way, the designer warrants the performance of the product.
- Open specifications allow any product that will meet the requirement. Closed specifications allow only products of a certain type.
- Proprietary specifications allow only one product, without any allowance for substitutions. Equal specifications normally specify one product, but allow the substitution of others that are "equal".
- In case of a conflict between specifications and drawings, the specifications have precedence. The other option is to require that the architect resolve any conflicts between plans and specifications.

4.5.2.5 Drawings

Drawings are the means by which the designer conveys the physical, quantitative, and visual description of the project to the contractor. The drawings are a two-dimensional representation of the physical structure that meets the objectives of the owner. They are also known as plans or blueprints. The contract drawings are organized into sections. The architectural drawings show the layout of the project.

They are numbered sequentially beginning with page A-1 (mechanical drawings being with M-1, electrical drawings begin with E-a, structural drawings begin with s-a, etc.).

- The architectural drawings are the core drawings of the contract in building projects.
- They show the floor plans, exterior elevations, interior elevations, details, windows, doors, and finish schedules.
- The structural drawings show the load-carrying systems.
- They show how the structural members will support the building and transmit the loads to the foundation and the ground.
- The mechanical drawings show the plumbing; heating, venting air-conditioning (HVAC); and fire protection.
- The electrical drawings show the various electrical installation details,

- The drainage plan and systems such as sanitary sewer and utilities.

4.5.2.6 Addenda

Any change to the bid documents after they are released for bidding but before bids are actually received requires the issuance of an addendum. This formal document changes the original bid documents and becomes a part of the bid package. At the time of **bid opening,** bidders must in their bid documents, acknowledge all addenda. Technically addenda may be issued to change the bid opening date, to modify the original design, to delete or add items, or to correct errors. Addenda may not be issued within about five days of bid opening unless the bid date is also extended accordingly.

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CHAPTER FIVE: CONSTRUCTION PROJECT SCHEDULING TECHNIQUES

5.1 Planning Studies

Planning serves as a foundation to several related functions such as cost estimating, scheduling, project control, quality control, safety management. It provides an answer to question such as what is going to be done, how, how much, where, by whom, when.

Planning is one of the process group Project Management Body of Knowledge presents and addresses it as “those processes performed to establish the total scope of the effort, define and refine the objectives, and develop the course of action required to attain those objectives” .

It can also be defined as “the process of choosing the one method and order of work to be adopted for a project from all the various ways and sequences in which it could be done” [Callahan, Quackenbush Rowings, 1992].

A trial and error approach is no longer valid for the construction industry and proper planning is now vital. Planning is a vital and most difficult part of a construction project. Though it is very important and can be practiced at all construction projects the amount of detailing in planning is likely to vary among projects. The variation in planning is a function of the size of the firm, the complexity of the project and the expertise of the management.

Advantages of Planning: planning has advantages at all of the following stages of construction.

A. Before the project is started

The parties of a given construction contract can experience several advantages form using planning at start of a project. It will help the client in estimating the required resources and project duration. It is also helpful in the evaluation of tenders submitted by contractors.

B. During the construction stage

Using the planning in during the construction stage the project management team can order materials or resources in general. Not only will it be used for ordering the resources but also control the resource utilization like equipment.

C. After completion of a project

It evident lesson learned from each project experience is worth recording, as it could be referred upon for future projects. Similarly up on completion of a project the lesson learned in this aspect will serve as a data base for future planning and scheduling.

5.1.1 Construction Planning-Initial Stage

There are several steps a team working on preparing a plan for a project needs to pass through. Before the actual formation of the plan planning and scheduling technique to be used; number and type of programs required; and purpose of the program should be considered.

Considering the development of planning at a construction project there are several programs that are developed. The programs that are usually developed are performance based on financial Schedule; equipment schedule; material delivery schedule; and manpower schedule. As to the classification a very simple and common classification is the one presented on the Figure 5.1(1) below.

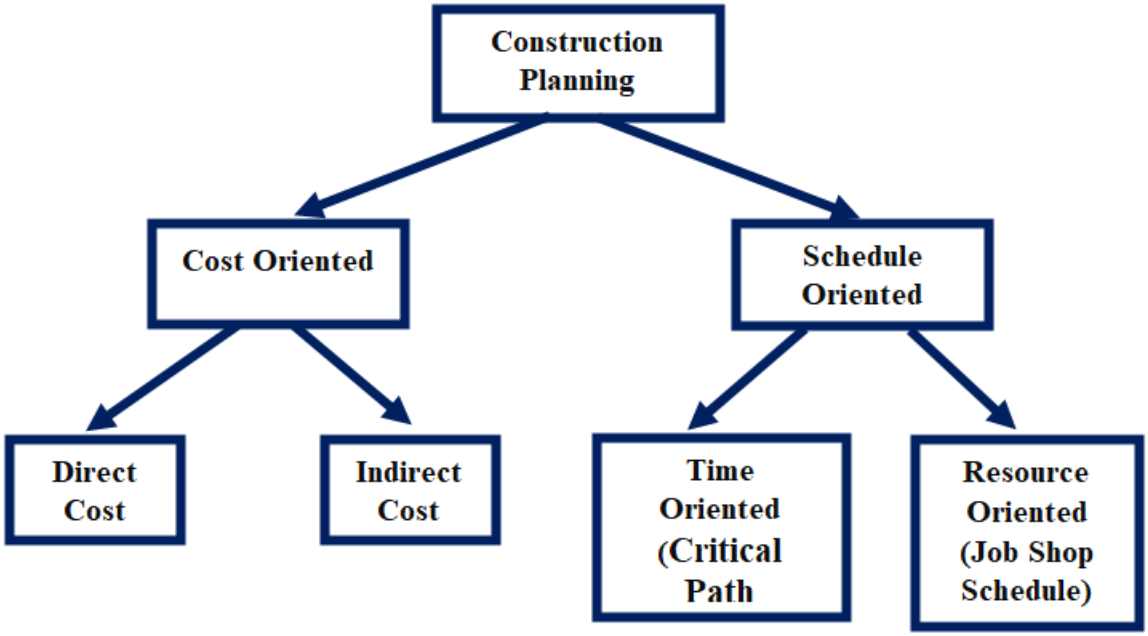


Figure 5.1 (1): Classification of planning

5.1.2 Construction Planning: Steps

Project management is the discipline of planning, organizing and managing resources to bring about the successful completion of a specific project goals and objectives. Evidently, before the actual formation of the plan consideration should be give issues such as the choice of technology and construction method; determination of the job steps or 'work activities'(WBS); determination of duration of activities; sequential relationships among these activities; and preparing the schedule or network.

A. Determination of the job steps or work activities

It involves the decomposition of major project deliverables into smaller, more manageable components until the deliverables are defined in sufficient detail to support development of project activities (PMBOK 2004).

The WBS is a tool that defines the project, group the project's discrete work elements to help organize and define the total work scope of the project. It provides the necessary framework for detailed cost estimation and control along with providing guidance for schedule development and control. Each descending level of the WBS represents an increased level of detailed definition of

the project work.The WBS is often displayed graphically as a hierarchical tree. It has multiple levels of detail, as displayed in Figure 5.1 (a).

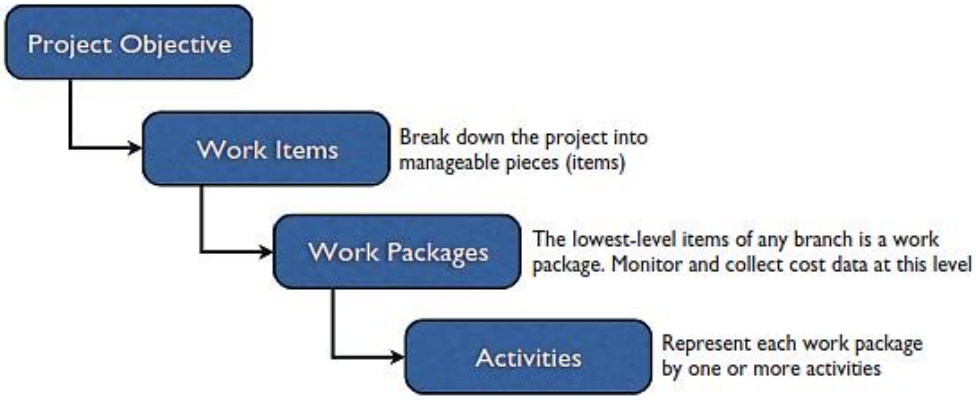
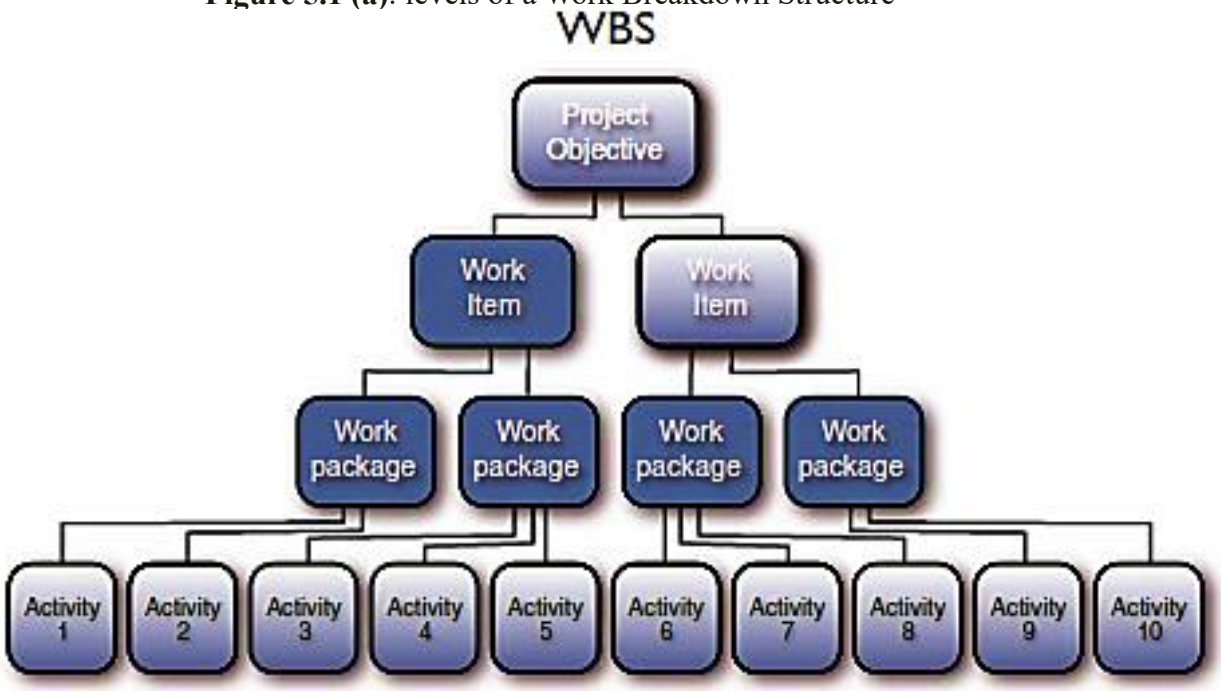


Figure 5.1 (a): levels of a Work Breakdown Structure



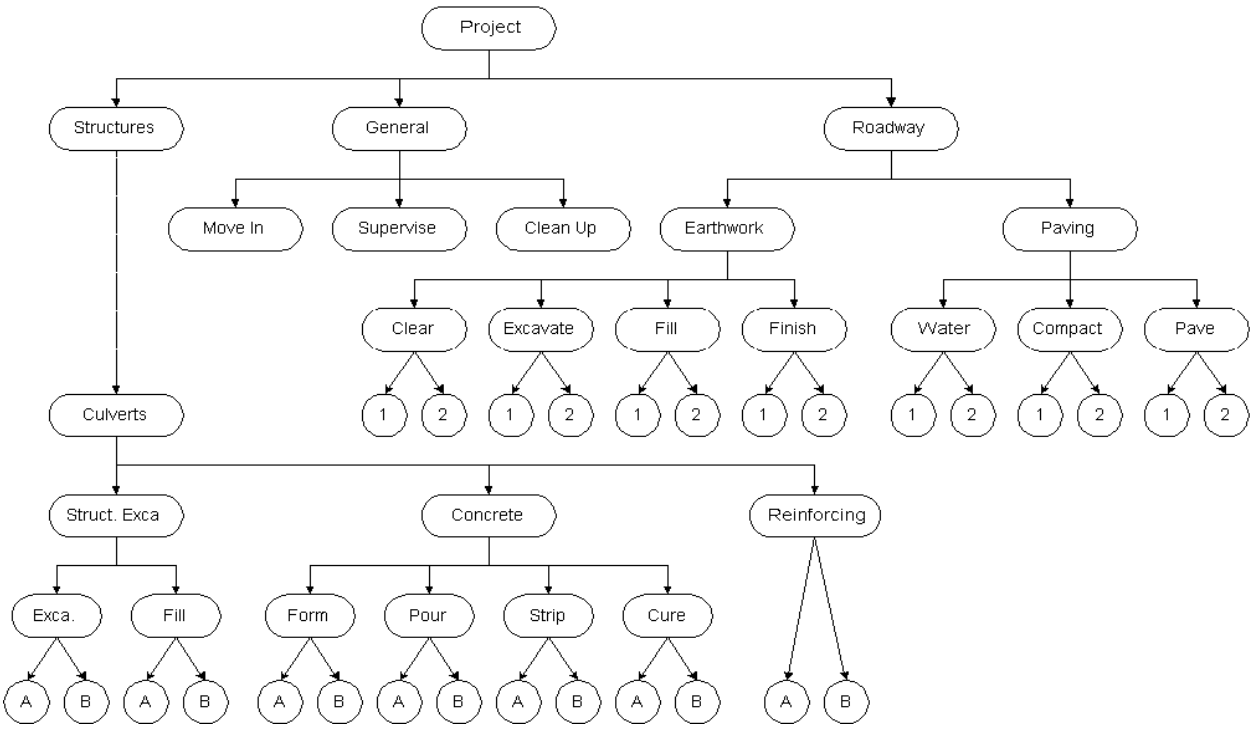


Figure 5.1 (b): Examples of work breakdown structures.

B. Developing sequential relationships among these activities

After the activity list of the project has been developed, then comes the need for deciding on the order in which the activities will be performed and communicate the information to those responsible for carrying out the work. The construction plan is normally represented by a logic diagram or network.

In this step the person developing the plan need only take each activity in turn and answer the following questions about that activity and related work activities:

1. What other work must be completed before the activity can begin?
2. What other work cannot begin before the activity is completed?
3. What other work can be performed at the same time as the activity and not interfere with the activity?

Table below shows an example of list of activities along with their expected sequential relationship.

Precedence relations for a project		
Activity	**Description**	**Predecessors**
A	Site clearing	-
B	Removal of stress	-
C	General excavation	A
D	Grading general area	A
E	Excavation for utility trenches	B,C
F	Placing formwork and reinforcement for concrete	B,C
G	Installing sewer lines	D,E
H	Installing other utilities	D,E
I	Pouring concrete	F,G

C. Determination of duration of activities

Theoretically, duration can be estimated using the following equation which put into consideration the productivity of the method deployed.

$$D_{ij} = A_{ij} / (P_{ij} * N_{ij})$$

The following important rules apply to the estimation of activity durations:

- Evaluate activities one at a time, independently of all others. For a given activity, assume that materials, labor, equipment and other needs will be available when required,
- For each activity assume a normal level of manpower and/or equipment. Compute the estimate duration by applying a crew or equipment production rate to the total number of units of work to done.

5.2 Construction Scheduling

Planning and scheduling are two terms that are often thought of as synonymous, though they are not. Scheduling is the determination of the timing and sequence of operations in the project and their assembly to give the overall completion time. It is just one part of the planning effort. Planning must be done before the project can be intelligently scheduled.

Scheduling is a mechanical process for formalizing the planning function, assigning time boundaries for each part of the work in such a manner that the work proceeds in logical sequence and in an orderly and systematic manner. Scheduling focuses on one part of the planning effort. It deals with when on a detailed level.

In the definition phase, the organization defines the project objectives which needs to be refined and translated into a list of activities, a set of technological precedence relations and the resource availabilities and requirements. In doing so, the organization decides in detail on how it is going to achieve these objectives. The refinement of the objectives activities and precedence relations will result the activity network and we could assign the resource availabilities and requirements on to it.

Once the network is developed the scheduling phase that aims on the construction of a timetable for the project activities could follow. Detailed overview of the scheduling principles using different techniques and aiming at reaching different targets is discussed. While executing the project the controlling phase needs to be exercised as the project has to be monitored and controlled to check whether it is executed according to the existing schedule.

If and when deviations occur, corrective actions have to be taken. This controlling concept is incorporated in the project life cycle shown by Figure 5.2 by means of the feedback loop between the control phase and the scheduling phase.

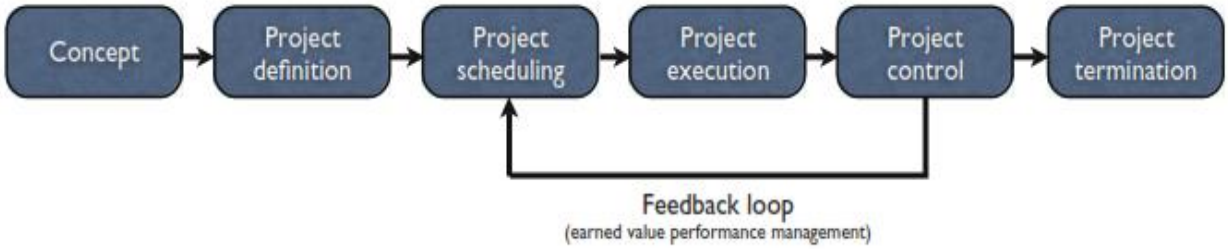


Figure 5.2: Illustrative project life cycle [1]

Execution and project control phases: the project has to be monitored and controlled to see whether it is performed according to the existing schedule.

The feedback loop between the control phase and the scheduling phase: is a control mechanism which allows the use of corrective action when deviations occur.

An update of a schedule can be done in two basic ways:

Reactive scheduling: a deterministic schedule, without taking possible risk factors or uncertainty events into account

Proactive scheduling: uncertainty is embedded in. This schedule is robust and protected against possible uncertain events.

A thorough knowledge of the tools and techniques available is necessary to create a realistic project schedule. The characteristics of the project and the background and knowledge of the project manager are some of the issues that need to be considered in the selection of the right tool and technique. Figure 5.3 present a two-dimensional project mapping approach considering complexity and uncertainty.

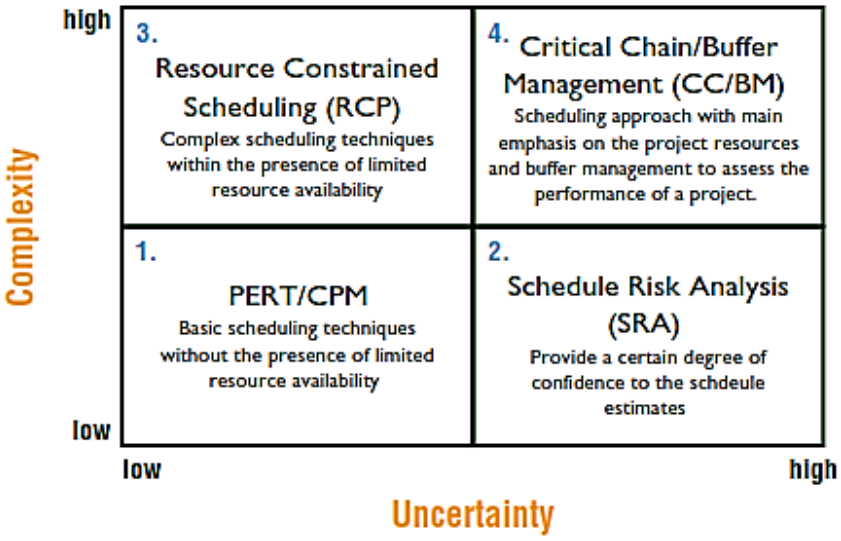


Figure 5.3: Project mapping approach [1]

- **Complexity:** it is related to the absence or presence of resources during the construction of a schedule.
- **Uncertainty:** When the level of uncertainty is assumed to be high, the schedule of a project becomes more and more subject to unexpected changes during project progress and certain knowledge of risk is therefore often indispensable. Hence incorporates project risk analysis.

Looking at the level of constraint involved we can classify construction as schedule without constraint and resource constrained schedule.

- **Scheduling without constraint:** It is assumed that projects belong to the first quadrant of the project mapping matrix of Figure 5.3 and hence are assumed to have no resource limits and a low level of uncertainty.
- **Resource-constrained project scheduling:** project activities are executed by resources (usually people) which mostly have a limited availability over the complete time horizon of the project.

It is the process of constructing a project schedule within the limited amount of resources available. It requires the examination of the possible unbalanced use of resources over time to resolve over-allocations (the so-called resource conflicts) when more resources are required than available. The project program represents the plan for the schedule of the work. Likewise, the budget is the plan for the cost aspects of the work.

In a similar way, the contractor will have plans for the management of quality, safety and environmental concerns. During project operations, it is essential that actual performance be compared with planned performance in all of these areas and action taken to remedy any indicated deficiencies.

This responsibility is termed as monitoring and control, where monitoring refers to methods for comparing actual with planned performance and control denotes the actions taken to attempt to bring deficient aspects of the project into conformance.

5.2.1 Schedule Updating

Periodically, perhaps monthly, the contractor will compare schedule progress with that shown on the project program. The purpose is to determine whether the various activities that were planned to be active during the previous period were actually active, the extent of their progress and, especially, the anticipated project completion date based on progress to date. Another purpose of the update is to incorporate any new information about already planned activities, to add information about any new work not previously planned and to determine their impacts on other activities and on the overall project completion date.

There are various methods to produce a schedule:

- Bar charts,
- Critical path method (CPM),
- Program evaluation and review technique (PERT),

- Line of balance, and
- Computer Software's:
    - Primavera,
    - MS Project, etc.

A. Bar/Gantt Chart

The bar chat was originally developed by Henry L. Gantt and is alternatively called a Gant chart, Where each activity is represented by a bar line. Bar charts list activities and identify a time for each activity to start and a time for each activity to finish as well as progress.

They are easy to produce. Bar charts may provide information at different levels of detail. It can adopt different time scale and will show it as days, weeks, or months. They may be used to present summary information to senior management or detailed information to work gangs. Different bar charts may be used to show activities for the whole project or only a section of the works. Figures 5.2.1 (a) - (c) show examples of bar chart.

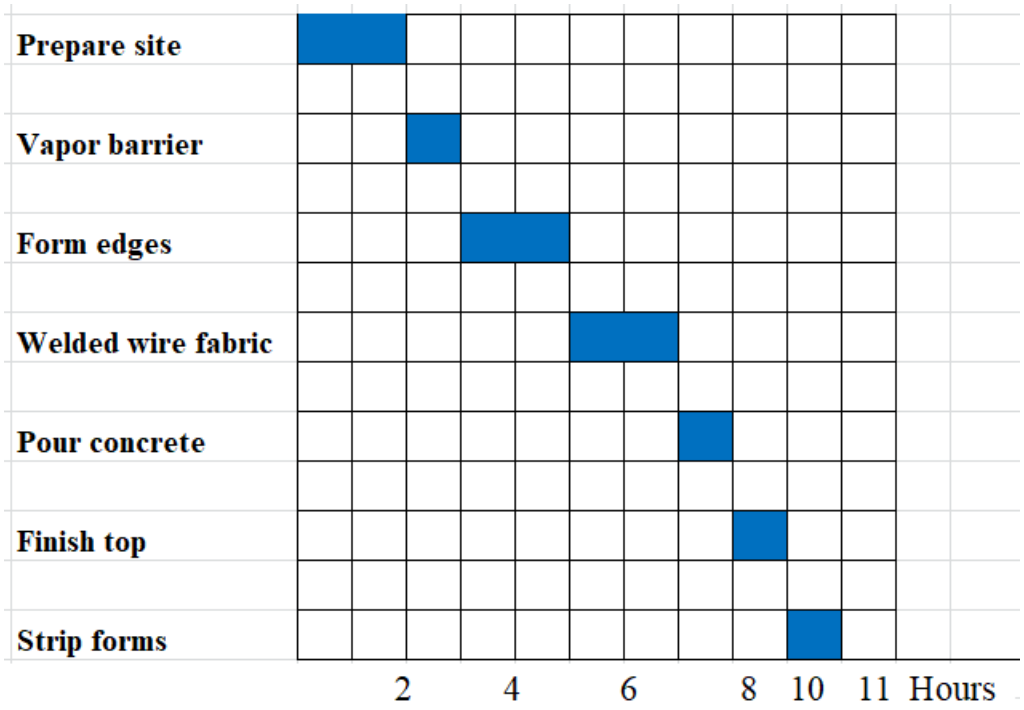


Figure 5.2.1 (a)

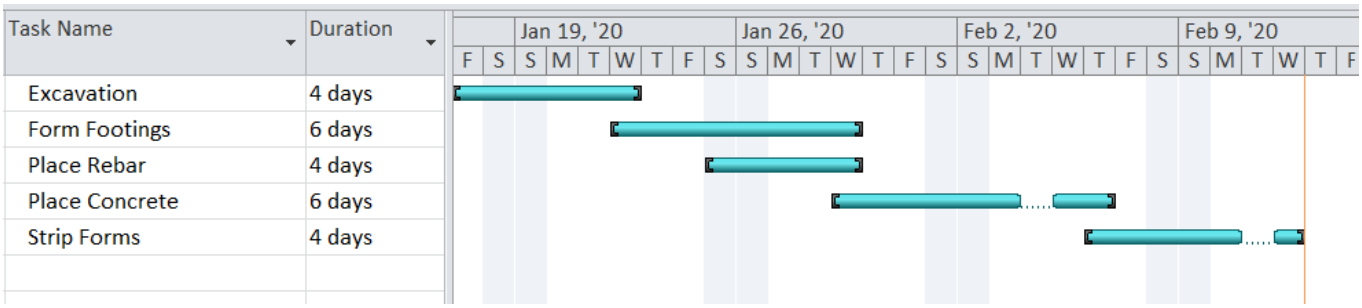


Figure 5.2.1 (b)

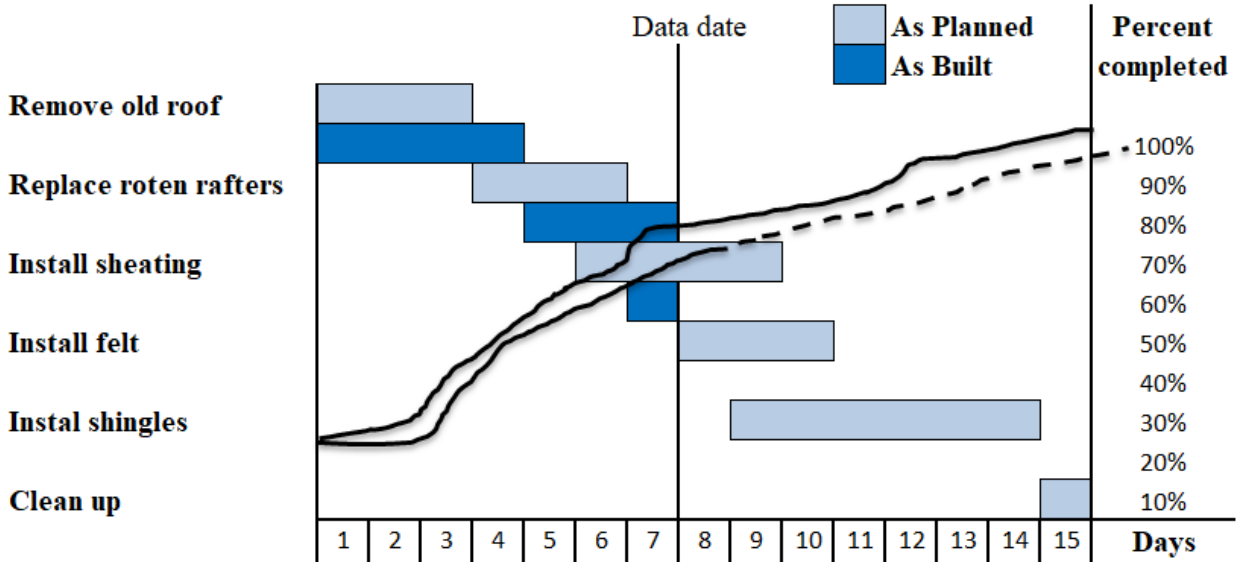


Figure 5.2.1 (c)

Advantages of Bar chart:

- Useful to report information to Top Management;
- A simple format and readily understood at all levels of management; and
- It can provide a quick, visual overview of a project in a convenient way to monitor job progresses, schedule equipment and crews and record project advancement.

Disadvantages of Bar chart:

- Interdependencies among activities are difficult to show. The bar chart itself doesn't provide a basis for ascertaining which activities are critical and which are floaters.

- It is not an adequate planning and scheduling tool because it doesn't portray a detailed, integrated and complete plan of operations.
- Can't tell what will be the effect of a delay today will have on the timing of future activities.

5.2.2 Network Scheduling

Network is a model consisting of nodes and links connecting between these nodes. Network scheduling is a method of scheduling activities by joining them in a series of interconnected links, which reflect relationships of activities by the planner.

A. Basic Assumptions

The project can be broken down into a group of activities. Each activities can be assigned a duration. The logical relationship among activities are known and fixed in the network chains.

2.3.2 Rules for Preparing the Network Diagram

- No activity can start before the preceding activity is finalized.
- There is only one start and finish for an activity.
- No activity leads back and forms a loop.
- The logical precedence, concurrent and subsequent activities must be clearly developed.

B. Dummy Activity

A dummy activity is established only to show relationship. A dummy activity is assumed to have duration of zero time units and it is introduced on the network when it is necessary.

C. Presentation of Networks

- Network is a **graphical display** of the **proposed** plan.
- It shows the job **activities** and their **order** of **sequence** (**logic**) in **pictorial form**.

There are two methods namely Arrow Diagram Method (ADM) or Activity on Arrow (AoA) and Precedence Diagram Method (PDM) or Activity on Node (AoN).

Table 5.2.2 : CPM types

Scheme	Representation	
	Activity	Relation
Arrow diag.	Link Arrow	Node (Circle)

Precedence diag.	Node (Square)	Link arrow

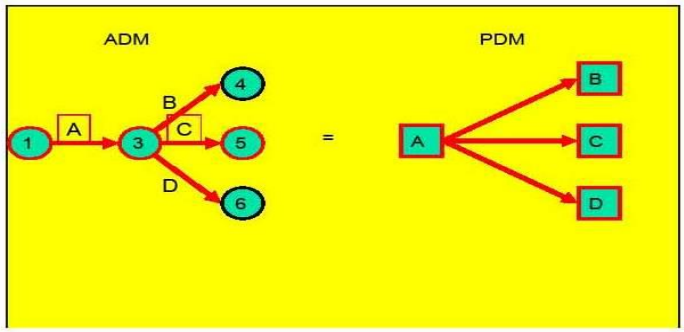


Figure 5.2.2 (a): Arrow diagram Vs Precedence diagram

These relationships between activities, also known as links, can be expressed in one of the four different ways:

- **Finish-to-start (FS)**
- **Start-to-Start (SS)**
- **Finish-to-Finish (FF)**
- **Start-to-Finish (SF)**

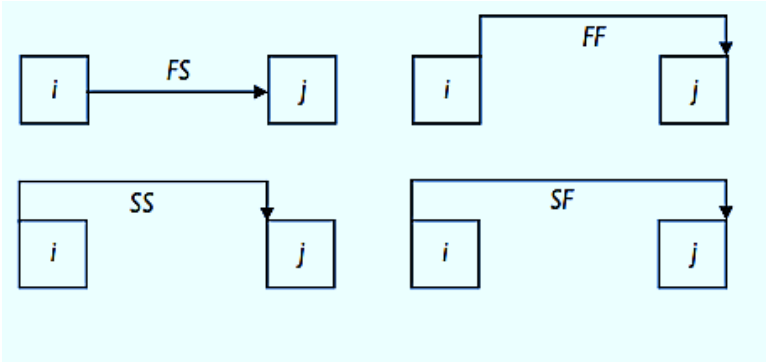
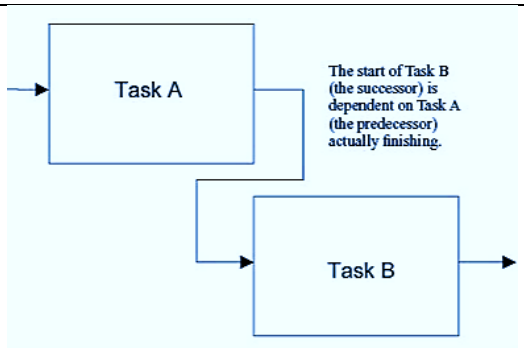
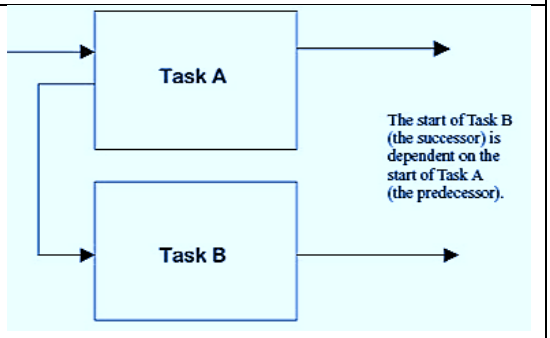
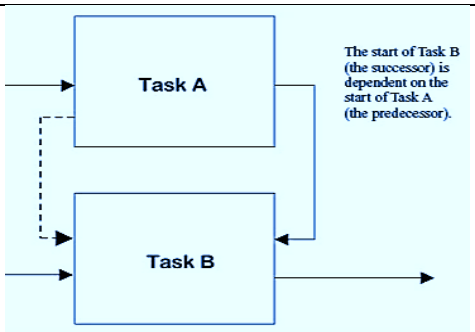
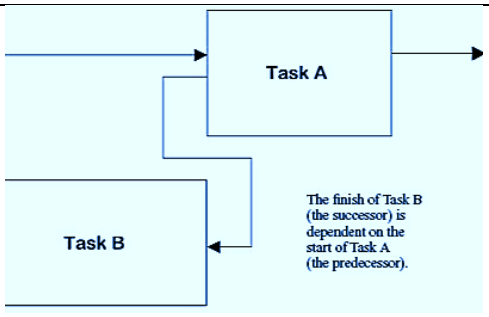


Figure 5.2.2 (b): Relationship between activities

• **Finish-to-Start**: such a relationship means that the successor cannot start until the predecessor has actually finished.	
▪ **Start-to-Start**: the start of the successor is dependent on the predecessor actually starting. ▪ does not mean that two tasks start at the same time	

• **Finish-to-Finish:** the successor cannot finish until the predecessor has actually finished. • activities will not necessarily finish at the same time.	
▪ **Start-to-Finish**: when the start of a task (considered the predecessor because its start drives the relationship) allows the task that has been going on (the successor) to finish.	

D. Lags and Leads

There are situations where we may not want the start or the finish of the successor to happen immediately after the start or the finish of the predecessor. For example, it is after finishing the activity of plastering we carry out painting; however, there is some time that must go by

["dead" time]after we plaster to allow it to dry. If the plasterers are expected to go do something else while the paint is drying, the planner may choose to use a "lag."

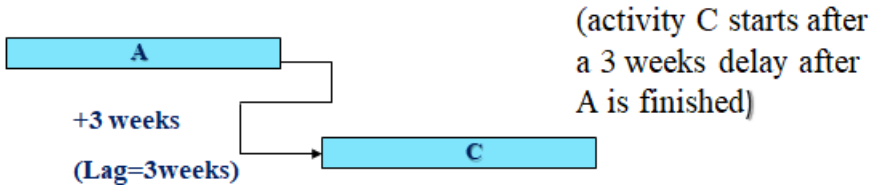


Figure 5.2.2 (c): Finish-to-Start relationship with lag

A lag is defined as a minimum waiting period between the finish or start of an activity and the start (or finish) of its successor. Arrow networks cannot accommodate lags. The only solution in such networks is to treat it as a real activity with a real duration, no resources, and a 0 budget.

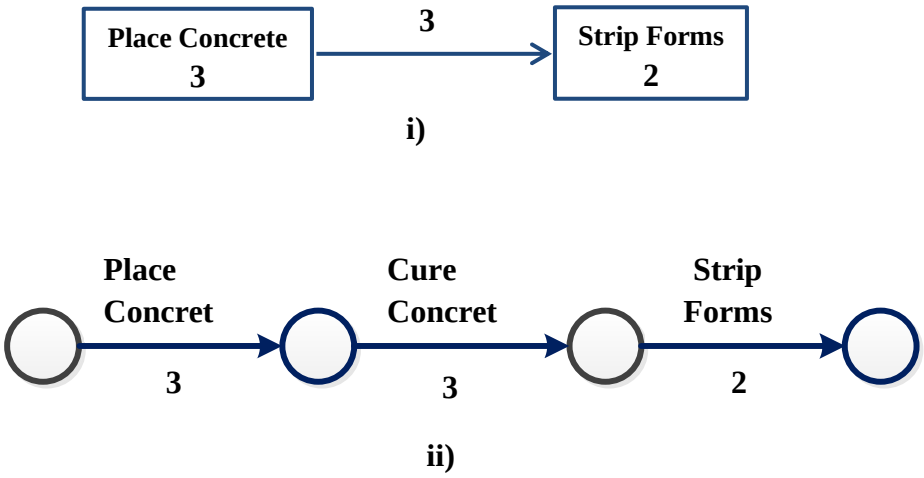


Figure 5.2.2 (d): (i) A lag in a node network; (ii) a lag in an arrow network

The term lead simply means a negative lag. Lead is a dependency that allows acceleration of successor activity. It is seldom used in construction. In simple language, a positive time gap (lag) means "after" and a negative time gap (lead) means "before.

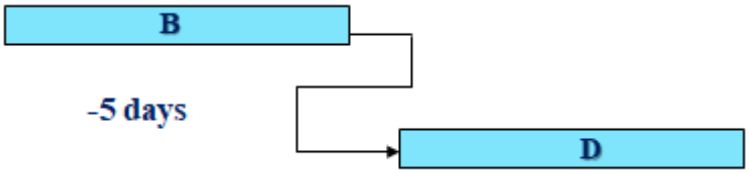


Figure 5.2.2 (e): Shows lead (means activity D accelerated for 5 days)

i. Activity on Arrow / Arrow Diagram Method

Rules that need to be followed when constructing an AOA:

- AOA is also called i-j method because activities are defined by the from node, i, and the to node, j. Hence, each activity must have a unique i – j numbers, where i (the number at the tail of the arrow) is smaller than j (the number at the head of the arrow).
- It is recommended to have a gap between numbers (i.e., 5, 10, 15, etc.). This will allow for accommodation of missed activities.

Example 1: Consider the following example where the precedence of the activities is presented with table below:

Activity	Immediately Preceding Activity (IPA)
A	-
B	A
C	A
D	B
E	C,D

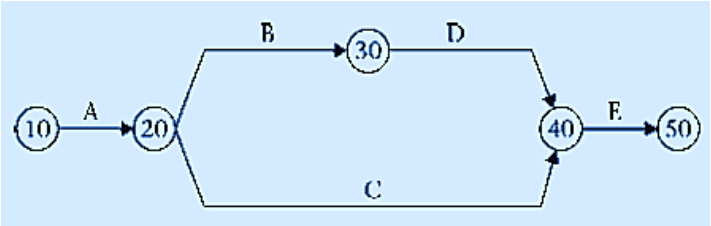


Figure 1: AOA logic network

➔ **Successor and predecessor to an activity**

- A starts the project. [Activity A has successors but no predecessors.]
- Activities B and C follow, but independently. Activities B and C may occur concurrently, overlap, or occur consecutively). However, both B and C cannot start until A is complete. [Activity A is considered a predecessor activity to activities B and C.]
- Activity D must wait until activity B is complete. [Activity B is a predecessor to activity D.]

- Once both C and D are complete, activity E can start. The end of activity E means the project is completed. [Activity E has predecessors but no successors.]
- All other activities have both successors and predecessors.
- Conversely, we can say that B and C are successor activities to A, D is a successor to B, and so on.

Example 2: If we were asked to draw the arrow network for the project given on table below and drew as was given on Figure 2a: Do you notice any problem?

Activity	IPA
A	-
B	A
C	A
D	B

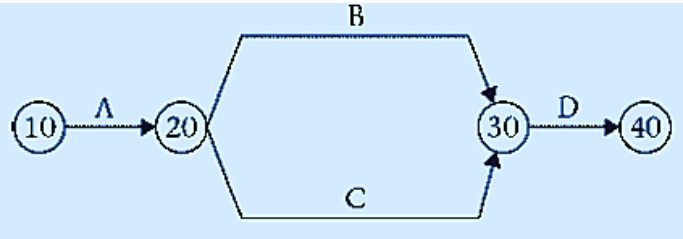


Figure 2a

→ Dummy Activity

- The main problem in this case is that both activities B and C start from node 20 and finish at node 30. Hence, both are identified as 20–30. This will create an identity problem.
- To solve this problem, we introduce a fictitious activity and an additional node. This fictitious activity is called a dummy activity, d.
- The proper representation could as presented with Figure 2b. In this case, activity B is identified as 20–30, whereas activity C is 20–40.

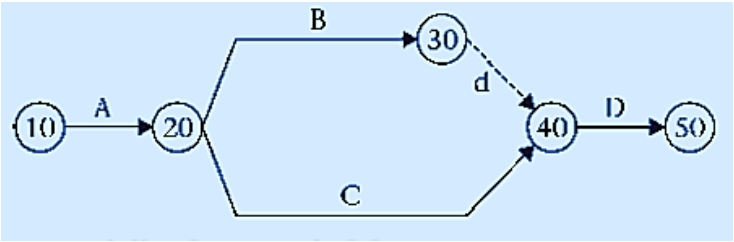


Figure 2b

- The position of the dummy is not unique in this example; it can be inserted in different positions, as shown in Figure 2c.

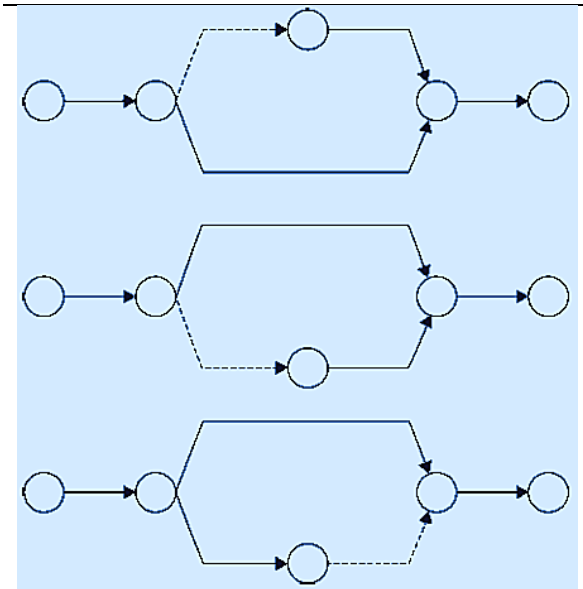


Figure 2c

Example 3: First exercise drawing the arrow network for the project given next.

Activity	IPA
A	-
B	A
C	A
D	B
E	B,C

In drawing the preceding logic correctly we need to show that activity E depends on both B and C, whereas D depends only on activity B. The solution can only be achieved by using a dummy activity.

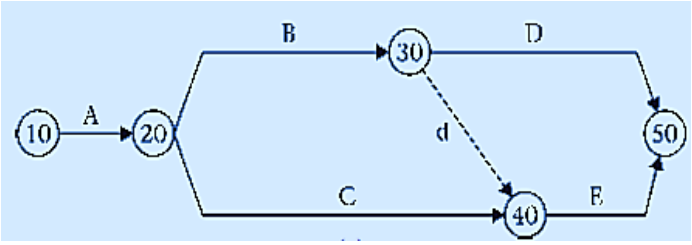
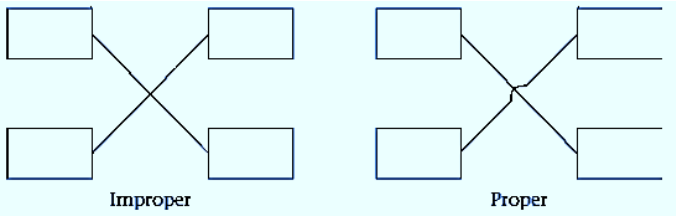


Figure 3

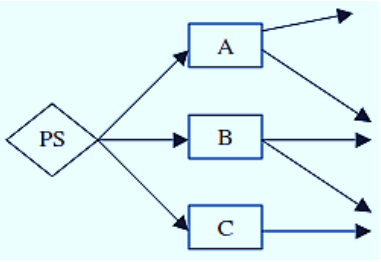
ii. Activity on Node / Precedence Diagram Method

In node networks, we use a different notation for representation: a node represents an activity. Nodes (activities) are connected with arrows (or lines) that represent logical relationships.

- Try to minimize line crossings. When two lines (relationships) must intersect, make a "jump" on one of them to indicate that they do not intersect or meet.



- Start the network with one node and finish it with one node. If it does not start with only one activity, then insert a PS (Project Start) milestone node at the start.



Example 4: Consider the following example where the precedence of the activities is presented with a table:

Activity	Immediately Preceding Activity (IPA)
A	-
B	A
C	A
D	B
E	C,D

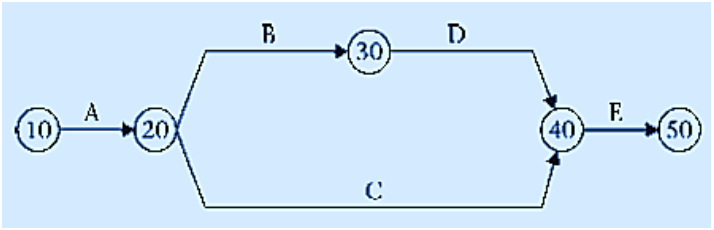


Figure 1a: AOA logic network

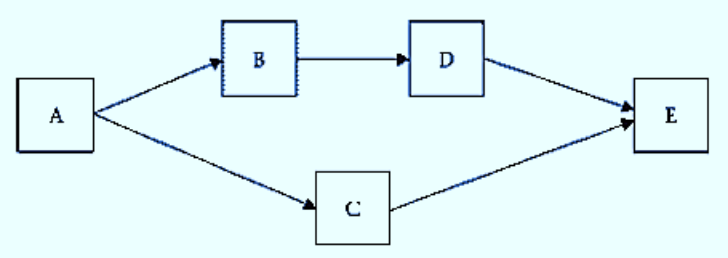


Figure 1b: AON logic network

Example 5: If we were asked to draw the arrow network for the project given on table below we can have the respective AoA & AoN:

Activity	Immediately Preceding Activity (IPA)
A	-
B	A
C	A
D	B

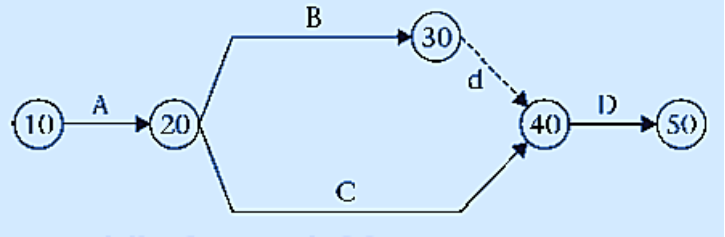


Figure 2a: AOA logic network

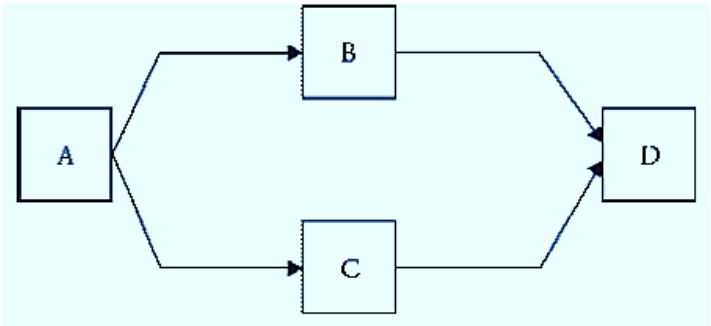


Figure 2b: AON logic network

Example 6: Exercise drawing the arrow network for the project given next.

Activity	Immediately Preceding Activity (IPA)
A	-
B	A
C	A
D	B
E	B,C

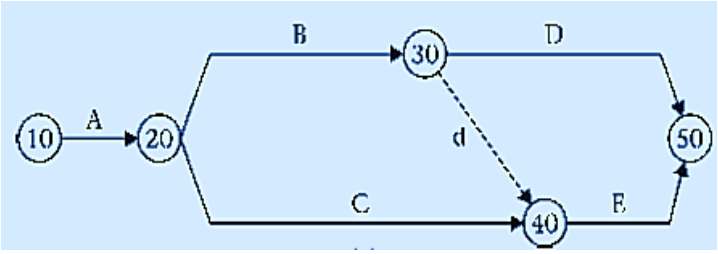


Figure 3a: AOA logic network

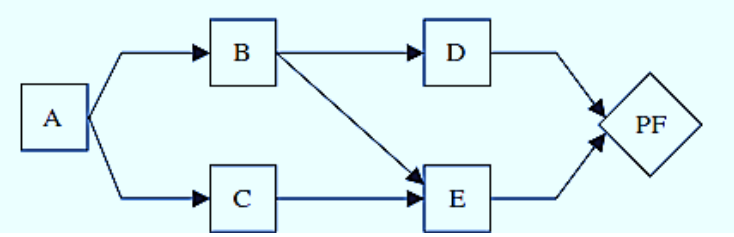


Figure 3b: AON logic network

5.2.3 Network Logic

Identifying the preceding activity (**PA**) and immediately preceding activity (**IPA**) is the easiest method to develop the network logic and draw the network diagram.

Types of Network Schedules

The two common types of network schedules used in the construction industry are:

- Critical Path Method (**CPM**); and
- Program Review and Evaluation Technique (**PERT**).

A. Critical Path Method, CPM

The most widely used scheduling technique is the critical path method (CPM) for scheduling, often referred to as critical path scheduling. This method calculates the minimum completion time for a project along with the possible start and finish times for the project activities.

Computer programs and algorithms for critical path scheduling are widely available and can efficiently handle projects with thousands of activities.

i) Duration

An activity's "duration" is the amount of time estimated to complete that activity. An activity's duration can be expressed in any unit: minutes, hours, work days, calendar days, weeks, or months. Duration of activities depends on the quantity of work, the type of work, the type and quantity of available resources that may be used to conduct the activity.

Activity durations are **estimated** based on **historical data** and **experience** considering the following factors:

- Construction method;
- Project time limits;
- Weather and site effects on production;
- Quality of supervision;
- Labor productivity; and
- Complexity of the task.

The duration is calculated by **dividing** the **quantity of work by daily production rate**.

- For instance, assume a daily production rate of $50m^2$ in preparing a flat slab formwork for an $800m^2$ to complete the task:

Duration=$800m^2$ /($50m^2$ /day) = 16 working days.

After the activities and durations are determined, the next step in preparing a CPM schedule is to **arrange activities** in **order** in which the activities will be **performed**.

ii) Calculation of Critical Path

Assuming an activity on branch project network and all precedence are of finish-to-start nature, so that the succeeding activity can not start until the completion of preceding activity.

Earliest start(ES): is earliest time at which an activity can be started.

Earliest finish(EF): is earliest time at which an activity can be finished.

EF=ES + Duration

Latest start (LS): is latest time at which an activity can be started without delaying the completion of project.

LS=LF – Duration

Latest finish (LF): is latest time at which an activity can be finished without delaying the completion of project.

LF=LS + Duration

Float (F): is difference between the time available to do a job and the time required to do a job.

iii) Critical Path Scheduling Algorithms

1. Event Numbering Algorithm:

Step 1: Give the starting event number 0.

Step 2: give the next number to any unnumbered event whose predecessor events are each already numbered.

Step 3: Repeat step 2 until all events are numbered.

2. Earliest Event Time Algorithm

Step 1: Let E(0)=0.

Step 2: For j= 1, 2, 3, …n (where n is the last event)

Let **$E(j)= \text{maximum}\{E(i)+D_{ij}\}$**

Where: the maximum is computed over all activities (i,j) that have j as the ending event.

3. Latest Event Time Algorithm

Step 1: Let L(n)=the required time of project completion.

Note: L(n) must equal or exceed E(n).

Step 2: For i= n-1, n-2, …0 (where n is the last event)

Let, **$L(i) = \text{minimum}\{L(j) - D_{ij}\}$**

where: the minimum is computed over all activities (i,j)

that have i as the starting event.

iv) Earliest Time Calculations

The earliest event time algorithm computes the earliest possible time, E(i), at which each event, i, in the network can occur. Earliest event times are computed as the maximum of the earliest start times plus activity durations of each of the activities immediately preceding an event.

The earliest start time of each activity (**i,j**) is equal to the earliest possible time for the preceding event **E(i)**:

$$\mathbf{ES(i,j) = E(i)}$$

The earliest finish time of each activity (i,j) is calculated as:

$$\mathbf{EF(i,j) = E(i) + D_{ij}}$$

v) Latest Time Calculations

The latest event time algorithm computes the latest possible time, L(j), at which each event, j, in the network can occur, given the desired completion time of the project, L(n) for the last event n.

The latest finish time consistent with completion of the project in the desired time frame of **L(n)** for each activity **(i,j)** is equal to the latest possible time **L(j)** for the succeeding event:

$$\mathbf{LF(i,j) = L(j)}$$

The latest start time of each activity (i,j) can be calculated as:

$$\mathbf{LS(i,j) = L(j) - D_{ij}}$$

vi) Critical Path

The critical path itself represents the set or sequence of predecessor/successor activities which will take the longest time to complete. The duration of the critical path represents the minimum time required to complete a project. Any delays along the critical path would imply that additional time would be required to complete the project. CPM assumes deterministic durations. CPM does not consider resource constraints.

Requirements for Critical Activity

The earliest start and latest finish times of each event are useful pieces of information for developing a project schedule. Events which have equal earliest and latest times, E(i)=L(i), lie on the critical path(s).

An activity is a critical activity if it satisfies all of the following conditions:

$$\mathbf{E(i)=L(i)}$$

$$\mathbf{E(j)=L(j)}$$

$$\mathbf{E(i) + D_{ij} =L(j)}$$

vii) Activity float and schedules

The concept of float is to use part or all of allowable range to schedule an activity without delaying the completion of the project. An activity that has the earliest time for its predecessor and successor nodes differing by more than its duration possesses a window in which it can be scheduled late.

Float is a very valuable concept since it represents the scheduling flexibility or "maneuvering room" available to complete particular tasks. Activities on the critical path do not provide any flexibility for scheduling nor leeway in case of problems.

For activities with some float, the actual starting time might be chosen to: balance workloads over time, correspond with material deliveries, and improve the project's cash flow.

There are three types of activity floats:

- Free float,
- Independent float, and
- Total float

Free float is the amount of delay which can be assigned to any one activity without delaying subsequent activities.

$$FF(i,j) = E(j) - E(i) - D_{ij}$$

Independent float is the amount of delay which can be assigned to any one activity without delaying subsequent activities or restricting the scheduling of preceding activities.

$$IF(i,j) = \begin{cases} 0 \\ E(j) - L(i) - D_{ij} \end{cases}$$

Total float is the maximum amount of delay which can be assigned to any activity without delaying the entire project.

$$TF(i,j) = L(j) - E(i) - D_{ij}$$

➔ Forward pass calculations

In mathematical terms, the ES for activity j is as follows :

ESi= max (EFi)

Where, (EFi) represents the EF for all preceding activities.

Likewise, the EF time for activity j is as follows:

EFj= ESj+ Dj

Where, Dj is the duration of activity j.

Forward pass: The process of navigating through a network from start to end and calculating the completion date for the each activity.

➔ **Backward pass calculations**

In mathematical terms, the late finish LF for activity j is as follows :

$$LFj=\min (LSk)$$

Where (LSk) represents the late start date for all succeeding activities.

Likewise, the LS time for activity j is as follows

$$LSj= LFj-D$$

Where Dj is the duration of activity j

Backward pass: The process of navigating through a network from end to start and calculating the late dates for each activity end to start and calculating the late dates for each activity.

The late dates (along with the early dates) determine the critical activities, the critical path, and t he amount of float each activity has.

B. Program Evaluation and Review Technique, PERT

Construction works are uploaded with uncertainties ranging from adverse weather, machinery breakdown and material shortage etc. which affect the activity progress and schedule. However; the probability of an activity being completed as planned can be assessed.

PERT is one of the most widely used project management tools which entertains uncertainty in planning. PERT is developed in 1958 for the POLARIS missile program by the Program Evaluation branch of the Special Projects office of the U.S. Navy along with the lockheed Missile systems and Booz-Allen & Hamilton.

Even though the rules for network manipulation of PERT are similar to CPM, it was developed independently. Basically the only difference between the two is that CPM uses deterministic/fixed duration for each activity while PERT uses probabilistic duration.

The probability distribution appropriate for most projects is Beta distribution. Beta distribution is chosen for the following reasons:

- There is only a small probability of completing the project in the most optimistic time;
- Probability of completing the project in the most pessimistic time is small; and
- There is only one most likely time.

i) PERT Activity Durations

PERT differs from CPM in that it bases the duration of an activity on three estimates:

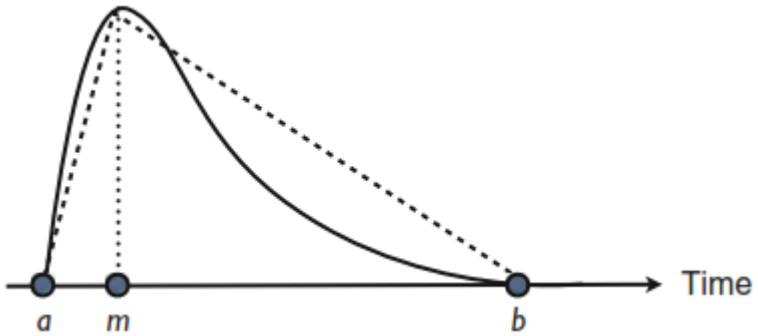
- **Optimistic time**, **a**, which occurs when execution goes extremely well.
- **Most likely time**, **m**, which occurs when execution is done under normal conditions.
- **Pessimistic time**, **b**, which occurs when execution goes extremely poorly.

The **range** (a, b) **encloses** all **possible estimates** of the **duration** of an activity. The estimate m lies somewhere in the range (a, b). Based on the estimates, the **average duration time**, $\mathbf{t_e}$, **standard deviation**, **σ**, and **variance**, **υ**, are approximated as:

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

$$\sigma_{te} = \frac{b - a}{6}$$

$$v = (\sigma_{te})^2$$



ii) Sequence of events in PERT

PERT plans activities and logic as in CPM and assign three duration estimates unlike the single duration in CPM. Translate the three estimates in to continuous distribution and calculate the average duration time, $\mathbf{t_e}$, standard deviation, $\boldsymbol{\sigma}$, and variance, $\boldsymbol{\upsilon}$. Use each activity's $\mathbf{t_e}$ as its duration and determine the critical path. Combine the activities in the critical path to compute its probability distribution. It makes inferences about the likely hood of the project being completed on or after any given day using the distribution of the critical path.

iii) Calculations in PERT

Once the activity duration is plotted on the normal distribution, and standard deviation, $\boldsymbol{\sigma}$, and variance, $\boldsymbol{\upsilon}$ can be determined. The value of the most likely time, m, does not affect the calculation of standard deviation. It is only affected by the range from optimistic to pessimistic estimates.

The **earliest expected time** of **completion**, $\mathbf{T_E}$, is the summation of expected elapsed time for each activities.

$$T_E = \sum_{i=1}^{n} t_{e,i}$$

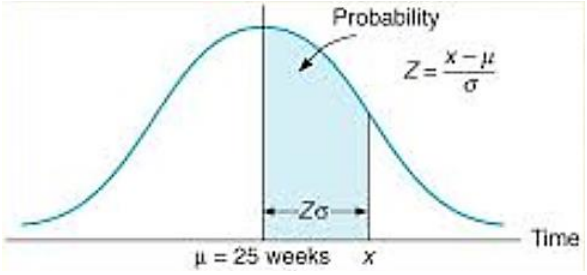
The **standard deviation**, $\boldsymbol{\sigma_{te}}$, is computed to calculate the probability to determine the chance of finishing the project on time.

$$\sigma_{te} = \sqrt{\left(\sigma_a^2 + \sigma_b^2 + \sigma_c^2 + \ldots\right)}$$

The earliest expected time of completion, $\mathbf{T_E}$, and standard deviation, $\boldsymbol{\sigma_{te}}$, of an activity form a probability curve. If $\boldsymbol{\sigma_{te}}$, is large compared to $\mathbf{T_E}$, the variance, $\boldsymbol{\upsilon}$, is wide where as if $\boldsymbol{\sigma_{te}}$, is small compared to its $\mathbf{T_E}$, then the estimates are confident that the actual time will not be far from the $\mathbf{T_E}$. To calculate the probability of completing a project by a certain allowable date $\mathbf{T_i}$, **requires** the use of **probability curve** or **Z-table**, $\mathbf{T_E}$, and $\boldsymbol{\sigma_{te}}$.

The value of Z i.e. number of standard deviation from mean is calculated by:

$$Z = \frac{T_i - T_E}{\sigma_{te}}$$



Where:

$\mathbf{T_i}$ = any date chosen (allowable completion date);

$\mathbf{T_E}$ = critical path earliest expected completion date; and

$\boldsymbol{\sigma_{te}}$ = critical path standard deviation.

iv) Normal Distribution

The normal distribution is pattern for the distribution of a set of data which follows a bell shaped curve known as a normal curve, or normal distribution. This distribution is sometimes called the Gaussian distribution in honor of Carl Friedrich Gauss, a famous mathematician.

The bell shaped curve has several properties:

- Curve concentrated in the center (mean) of the data and decreases on either side. This means that the data has less of a tendency to produce unusually extreme values, compared to some other distributions.
- The bell shaped curve is symmetric. This indicates that the probability of deviations from the mean is comparable in either direction. Fifty percent of the distribution lies to the left of the mean and fifty percent lies to the right of the mean.
- The spread of a normal distribution is controlled by the standard deviation. The smaller the standard deviation the more concentrated the data is.

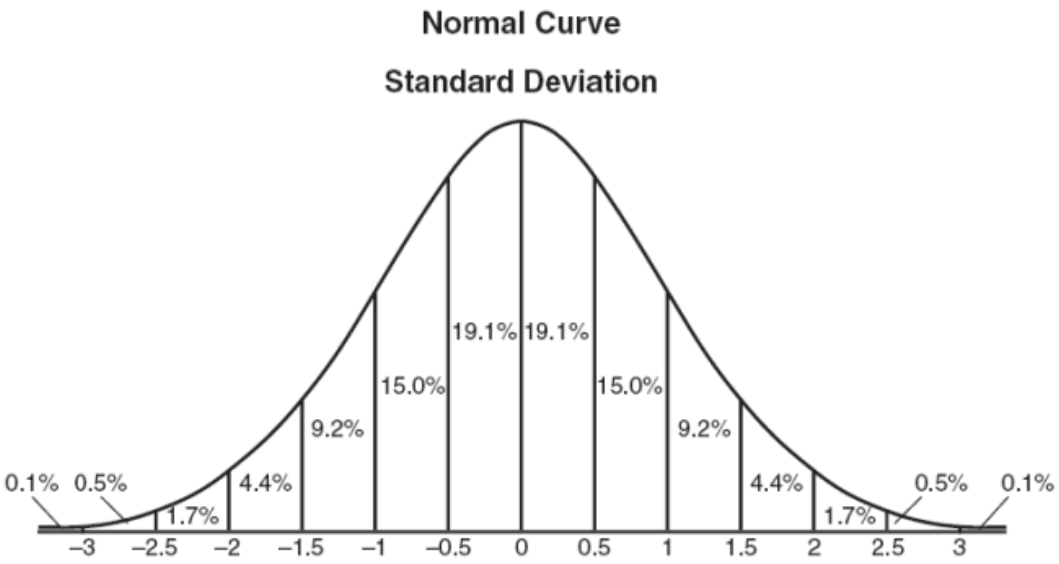


Figure:

v) Z-Table

Table 5: Z- Table

Z	P, Probability of completing by T_E	Z	P, Probability of completing by T_E
-3.0	0.00	0.1	0.54
-2.5	0.01	0.2	0.58
-2.0	0.02	0.3	0.62
-1.5	0.07	0.4	0.66
-1.4	0.08	0.5	0.69
-1.3	0.10	0.6	0.73
-1.2	0.12	0.7	0.76
-1.1	0.14	0.8	0.79
-1.0	0.16	0.9	0.82
-0.9	0.18	1.0	0.84
-0.8	0.21	1.1	0.86
-0.7	0.24	1.2	0.88

-0.6	0.27	1.3	0.90
-0.5	0.31	1.4	0.92
-0.4	0.34	1.5	0.93
-0.3	-0.38	2.0	0.98
-0.2	0.42	2.5	0.99
-0.1	0.46	3.0	1.00
0.0	0.50		

REFERENCE

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[3]. Mubarak, S., Construction Project Scheduling and Control, 3rd Edition, John Wiley & Sons, Inc., UK 2015.

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CHAPTER SIX: CONSTRUCTION PROJECT MANAGEMENT

6.1 Mobilization

Mobilization encompasses activities that take place between the award of the construction contract and the beginning of construction work in the field. Some of this work may have begun prior to, and in anticipation of, the award, and much of it will continue into the days and weeks during which fieldwork is beginning. The contractor may be required to make a number of arrangements for various kinds of 'paper work' as part of the pre-construction mobilization. Requirements vary from project to project and especially from country to country.

6.2 Programming and Scheduling

With the contract in hand and the project mobilization phase underway, the contractor will undertake to develop a more detailed plan and schedule for the project's time dimensions. The result will be a document that will assist with deploying personnel and equipment, procuring materials and supplies and planning cash flows. Equally as important, it will provide the basis for monitoring and controlling project progress as the project proceeds.

6.3 Organizing the Work Site

An important activity as the contractor begins work in the field is to **set up the site** in a manner that will allow the work to proceed efficiently and effectively. It encompasses the following issues:

- Temporary services and facilities;
- Site layout plan; and
- Buying out the job.

6.3.1 Temporary Services and Facilities

The following are among the various **temporary services** and **facilities** that will likely be needed. Such as:

- Offices,
- Workshops and indoor storage,
- Temporary housing and food service,
- Temporary utilities,

- Sanitary facilities,
- Medical and first aid facilities,
- Access and delivery,
- Storage/lay down areas, and
- Quarries and borrow areas.

6.3.2 Site Layout Plan

All of the worksite organization considerations discussed above will converge in a plan that will be described in writing and shown on a drawing or series of drawings. The jobsite layout plan includes:

- Jobsite space allocation,
- Jobsite access,
- Material handling,
- Worker transportation,
- Temporary facilities,
- Jobsite security etc.

Helpful references for establishing the plan include: the construction documents, the program, technical data on lifting and conveyance equipment, local codes, safety standards, size and weights of the large anticipated lifting loads, and information from subcontractors and their storage needs.

6.3.3 Buying out the Job

The term buyout, in the context of construction project mobilization, refers to procuring the materials and equipment that will be installed in the project and arranging subcontracts. It includes both selecting suppliers and subcontractors and finalizing their purchase orders or subcontracts.

6.3.4 Project Staffing

To carry out the work in the field requires people and those people must be organized in an effective relationship/structure. This section considers the organization structure at the worksite and the sources of the laborers

6.4 Monitoring and Control

Monitoring and Controlling Process Group: Regularly measures and monitors progress to identify variances from the project management plan so that corrective action can be taken when necessary to meet project objectives.

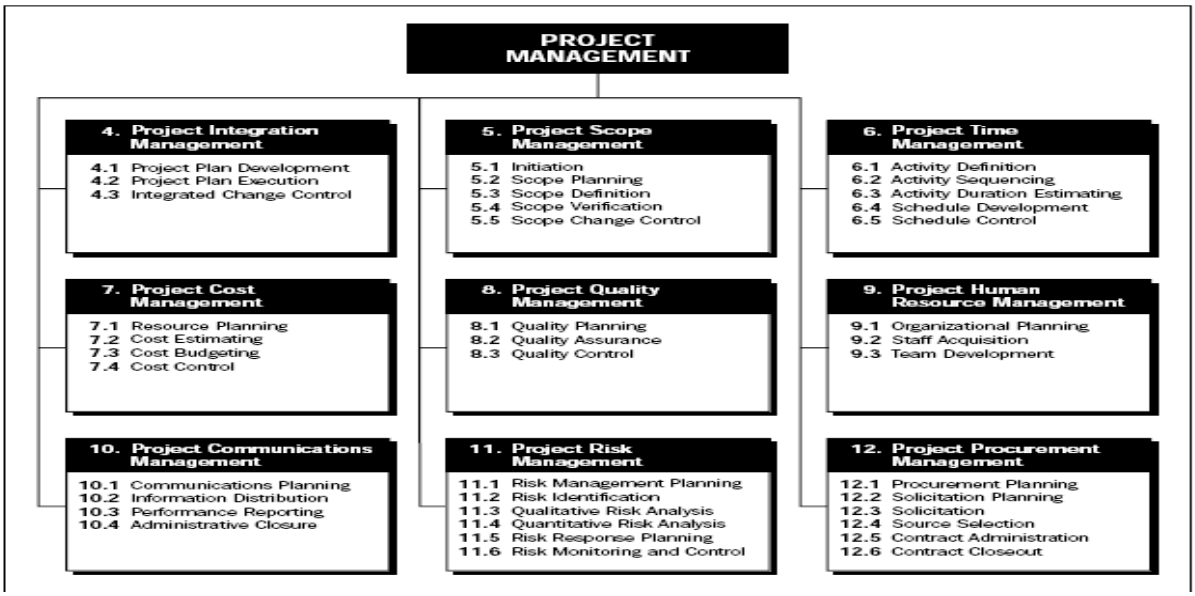


Figure 8.1 Project management Knowledge areas

Knowledge area	**Controlling : Process Group**
Project Integration Management	Integration change control
Project Scope Management	Scope change control
Project Time Management	Schedule change control and progress monitoring
Project Cost Management	Cost control
Project Quality Management	Quality control
Project Human Resource management	
Project Communication Management	Performance reporting
Project Risk Management	Risk Monitoring and Control
Project Procurement Management	
Project Safety Management	
Project Environmental Management	Environmental control
Project Financial Management	Financial control
Project Claim Management	Claim Prevention

6.4.1 Cost Control

Cost control is concerned with influencing factors that create change to the cost baseline, to determining that the cost baseline has changed and managing the actual changes if they occur. Cost control includes:

- Monitoring cost performance to detect and understand variance from plan
- Ensuring that all appropriate changes are recorded accurately
- Preventing incorrect and inappropriate changes from being included in the cost baseline
- Informing appropriate stakeholders of authorized changes
- Acting to bring expected costs within acceptable limits

The purposes of construction cost systems enables to provide a means for comparing actual with budgeted expenses and thus draw attention and to develop a database of productivity and cost performance data for use in estimating the costs of subsequent projects; and generate data for valuing variations and changes to the contract and potential claims for additional payments.

Two related outcomes are expected from the periodic monitoring of costs:

- Identification of any work items whose actual costs are exceeding their budgeted costs, with subsequent actions to try to bring those costs into conformance with the budget; and
- Estimating the total cost of the project at completion, based on the cost record so far and expectations of the cost to complete unfinished items.

For cost control on a project, the construction plan and the associated cash flow estimates can provide the baseline reference for subsequent project monitoring and control. The final or detailed cost estimate provides a baseline for the assessment of financial performance during the project. To the extent that costs are within the detailed cost estimate, then the project is thought to be under financial control. For control and monitoring purposes, the original detailed cost estimate is typically converted to a project budget, and the project budget is used subsequently as a guide for management. Specific items in the detailed cost estimate become job cost elements.

Table 8.2 An Example of a Project Budget

	Material Cost	Subcontract Work	Temporary Work	Machinery Cost	Total Cost
Steel Piling	$292,172	$129,178	$16,389	$0	$437,739
Tie-rod	88,233	29,254	0	0	117,487
Anchor-Wall	130,281	60,873	0	0	191,154
Backfill	242,230	27,919	0	0	300,149
Coping	42,880	22,307	13,171	0	78,358
Dredging	0	111,650	0	0	111,650
Fender	48,996	10,344	0	1,750	61,090
Other	5,000	32,250	0	0	37,250
Sub-total	$849,800	$423,775	$29,560	$1,750	$1,304,885

Summary	
Total of direct cost	$1,304,885
Indirect Cost	
Common Temporary Work	19,320
Common Machinery	80,934
Transportation	15,550
Office Operating Costs	294,458
Total of Indirect Cost	410,262.
Total Project Cost	$1,715,147

6.4.1.1 Project S-Curve

Owner requires contractor to provide an S-curve of estimated progress and costs. it shows a Cumulative costs across the duration of the project; and it can be a graphical representation of the outflow of money (both direct & indirect).

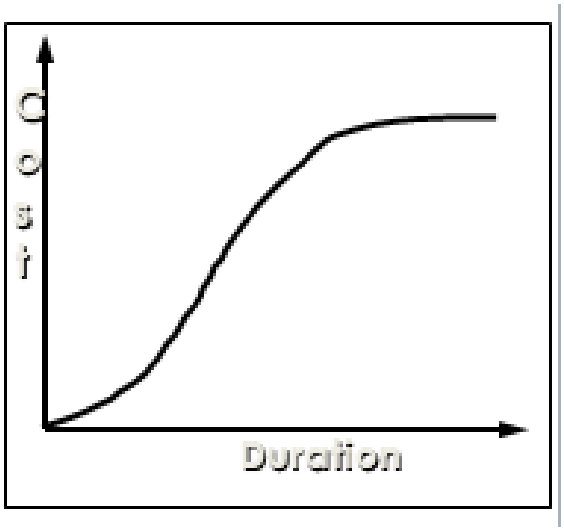
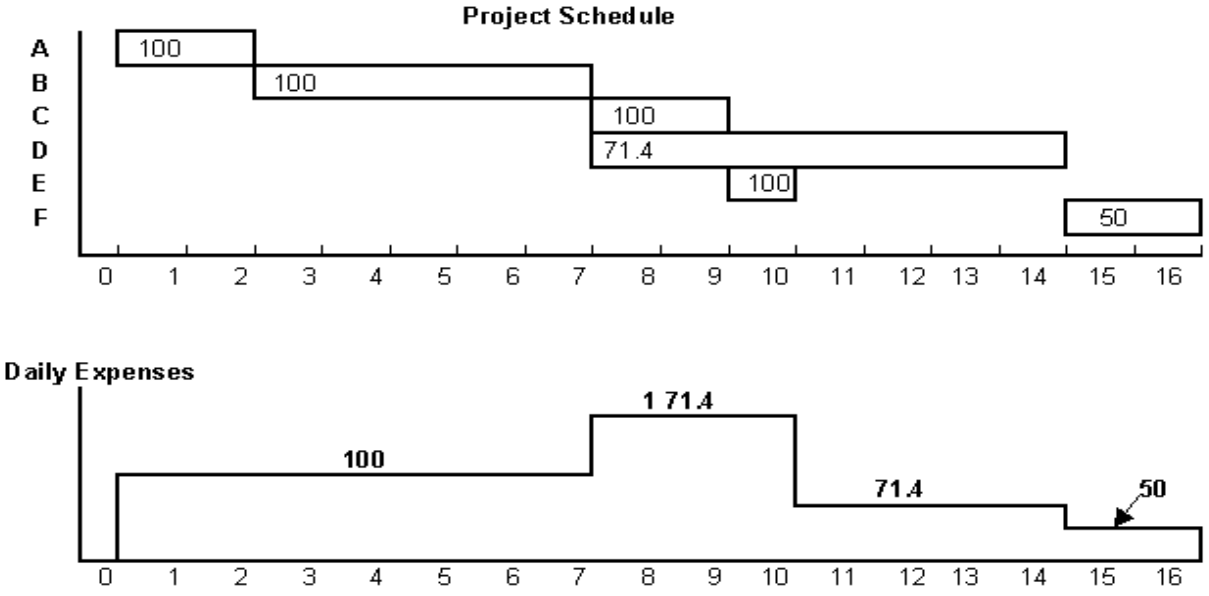


Figure 8.2 S-Curves

Example

Activity	Days	Cost($)	Cost/day
A	2	200	100
B	5	500	100
C	2	200	100
D	7	500	71.4
E	1	100	100
F	2	100	50



6.4.1.2 Earned Value Management (EVM)

Several tools and techniques assist in project cost control. Expert judgment, data analysis, project management information systems, and the to-complete performance index are some of the methods. There are many general accounting approaches for measuring cost performance but earned value management is a tool unique to project management.

Earned value management (EVM) is a project performance measurement technique that integrates scope, time, and cost data. This method measures project performance by comparing the amount of work planned with actually accomplished, in order to determine if cost and schedule performance as planned. Given a baseline (original plan plus approved changes), you can determine how well the project is meeting its goals

You must ***enter actual information periodically*** to use EVM such as :

- Was a WBS item completed or approximately how much of the work was completed
- Actual start and end dates
- Actual cost

6.4.1.3 Earned Value Management Terms

The planned value (PV), formerly called the budgeted cost of work scheduled (BCWS), also called the budget, is that portion of the approved total cost estimate planned to be spent on an activity during a given period

- Estimated value of the planned work

Actual cost (AC), formerly called actual cost of work performed (ACWP), is the total of direct and indirect costs incurred in accomplishing work on an activity during a given period

- What you paid

The **earned value (EV)**, formerly called the budgeted cost of work performed (BCWP), is an estimate of the value of the physical work actually completed

- Estimated value of work done

Table 8.3: EVM

NAME	FORMULA	NOTES
Cost Variance (CV)	EV-AC	Negative = Over budget Positive = Under budget
Schedule Variance (SV)	EV-PV	Negative = Behind Schedule Positive = Ahead of Schedule
Cost Performance Index (CPI)	EV/AC	How much are we getting for every dollar we spend?
Schedule Perform Index (SPI)	EV/PV	Progress as % against plan
Estimate to Complete (ETC)	EAC-AC	How much more do we have to spend?
Variance at Completion (VAC)	BAC-EAC	At the end of the day, how close will we be to plan?
Estimate at Completion (EAC)	BAC/CPI	

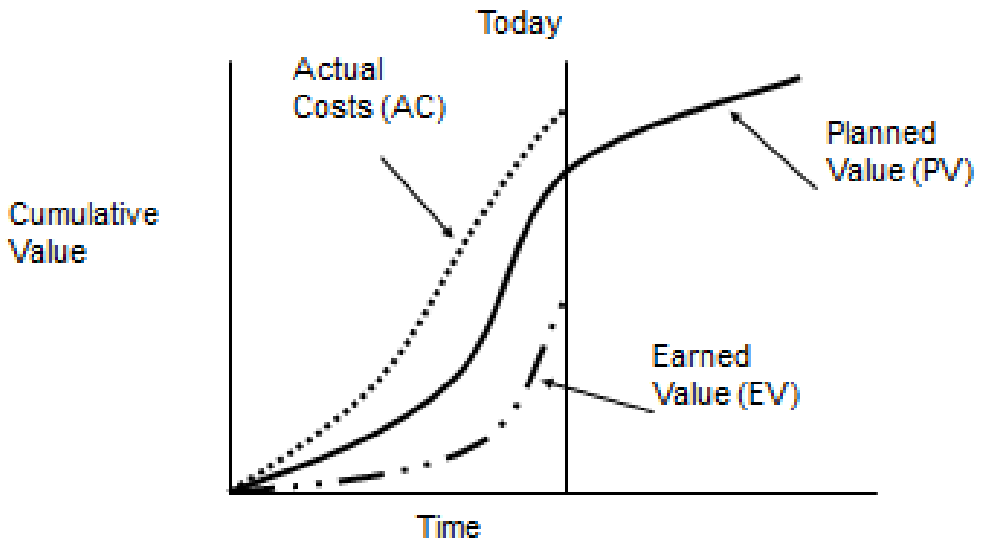


Figure 8.3 Project management Knowledge areas

6.4.1.4 Rules of Thumb for Earned Value Numbers

Negative numbers for cost and schedule variance indicate problems in those areas.

- ✓ If CV is negative it means that performing the work cost more than planned
- ✓ A negative SV means that it took longer than planned to perform the work

CPI =1:the planned and actual costs are the same; <1: over budget; >1: under budget

SPI=1: on schedule; <1 behind schedule; >1 ahead of schedule

6.5 Resource Management

6.5.1 General

If the construction manager's job during project operation is about monitoring and control, it is also about the management of resources. Halpin and Woodhead (1998), in their introduction to construction management, state that 'construction management addresses how the resources available to the manager can best be applied'. They suggest that the four primary resources to be managed are the 'four Ms' of Manpower, Machines, Materials and Money. As cited in network scheduling, the basic inputs to critical-path analysis are the individual project activities, their durations, and dependency relationships. Accordingly, the forward-path and backward-path calculations determine the start and finish times of activities.

The CPM algorithm, therefore, is duration-driven. Activities' durations here are function of the resources that are required (rather than available) to complete each activity. The CPM formulation, therefore, assumes that all the resources needed for the schedule are available. This assumption, however, is not always true for construction projects. Under resource constraints, the schedule becomes impractical, cost and time are not accurate, and resources may not be available when needed. In order to deal with such issue, a proper management of available resources is required to adjust the schedule accordingly.

6.5.2 Resources: Definition

The first step in resource management is to decide exactly what resources are considered important enough to be managed. The most important resources that project managers have to plan and manage on day-to-day basis are people, machines, materials, and money. Obviously, if these resources are available in abundance then the project could be accelerated to achieve shorter project duration. On the other hand, if these resources are severely limited, then the result most likely will be a delay in the project completion time.

6.5.3 Resource Allocation

Resource allocation, also called resource loading, is concerned with assigning the required number of resources identified for each activity in the plan. More than one type of resource may be assigned to a specific activity. For example, fixing steel plates on a certain foundation may require different types of resources such as: welders, laborers and a certain type of welding machine. From a practical view, resource allocation does not have to follow a constant pattern; some activities may initially require fewer resources but may require more of the same resources during the later stages of the project.

6.5.4 Resource Aggregation

After each activity has been assigned its resources, the next step is to aggregate the resources used by all activities. Resource aggregation is simply the summation, on a period-by-period basis, of the resources required to complete all activities based on the resource allocation carried out previously. The results are usually shown graphically as a histogram as shown on Figure 8.4. Such aggregation may be done on an hourly, daily, or weekly basis, depending on the time unit used to allocate resources. When a bar chart is used, the resource aggregation is fairly simple and

straightforward. For a given bar chart, a resource aggregation chart can be drawn underneath the bar chart.

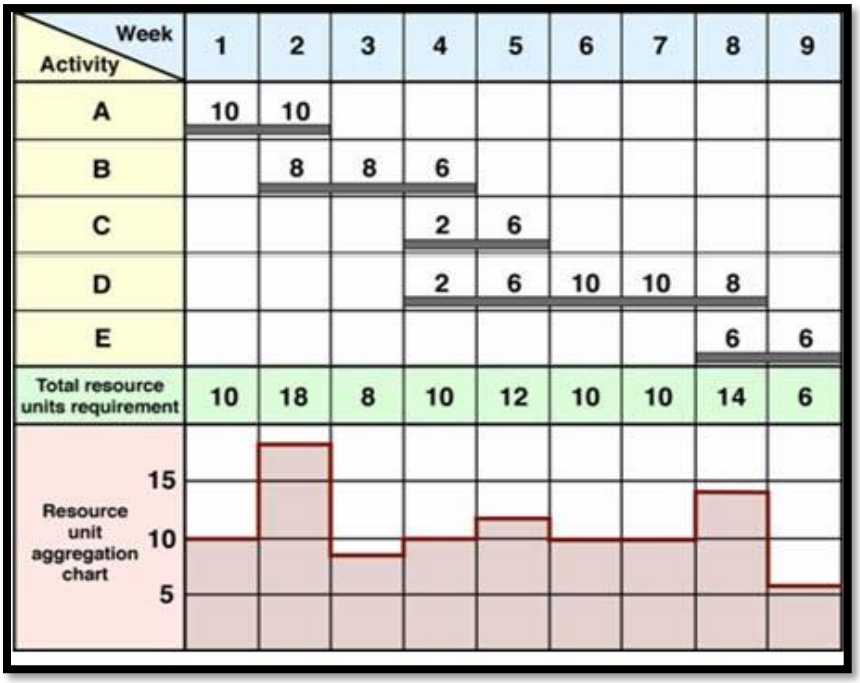


Figure 8.4: Resource aggregation

An example is shown in the figure, where, for a particular resource, the required resource units for each time period are written on the bar chart. The total number of resource units for each time period can then be summed and a resource aggregation or load chart can be produced as presented underneath the bar chart. Thus, having a project scheduling is necessary to facilitate the bar chart drawing

6.5.5 Resource Leveling

The primary focus, for purposes of scheduling, in time constrained projects is to improve resource utilization. This process is called resource leveling or smoothing. It applies when it is desired to reduce the hiring and firing of resources and to smooth the fluctuation in the daily demand of a resource, as shown in Figure 8.5. In this case, resources are not limited and project duration is not allowed to be delayed. The objective in this case is to shift non-critical activities of the original schedule, within their float times so that a better resource profile is achieved.

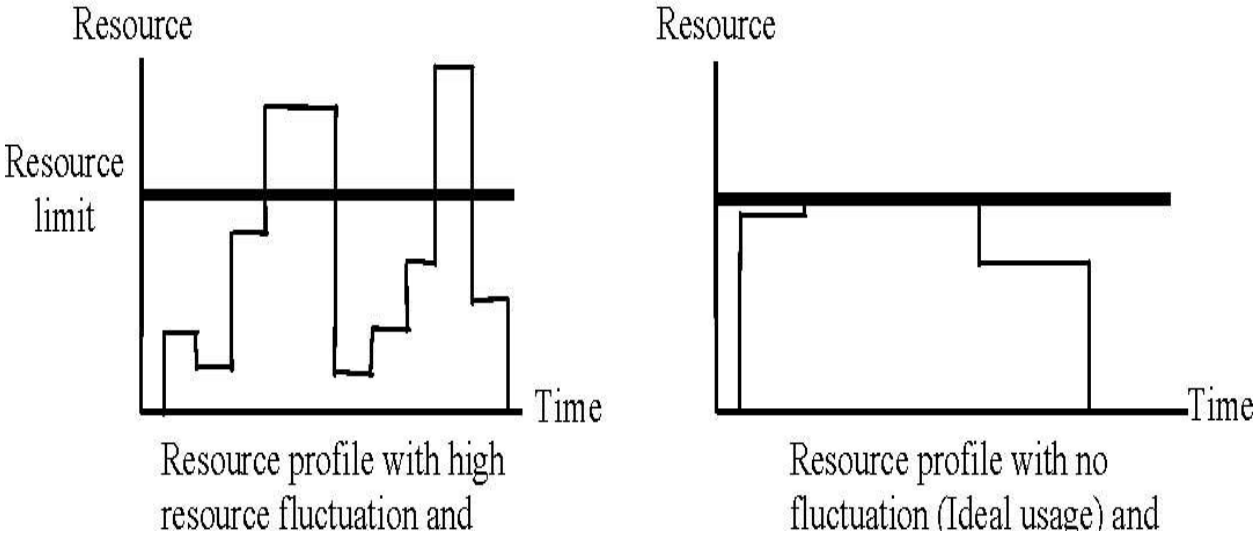


Figure 8.5: Resource Leveling

Resource Leveling is a process used to examine a project for an unbalanced use of resources (usually people) over time, and for resolving over-allocations or conflicts. Resource leveling ensures that resource demand does not exceed resource availability. The peaks and valleys in the resource profile indicate high day-to-day variation in the resource demand.

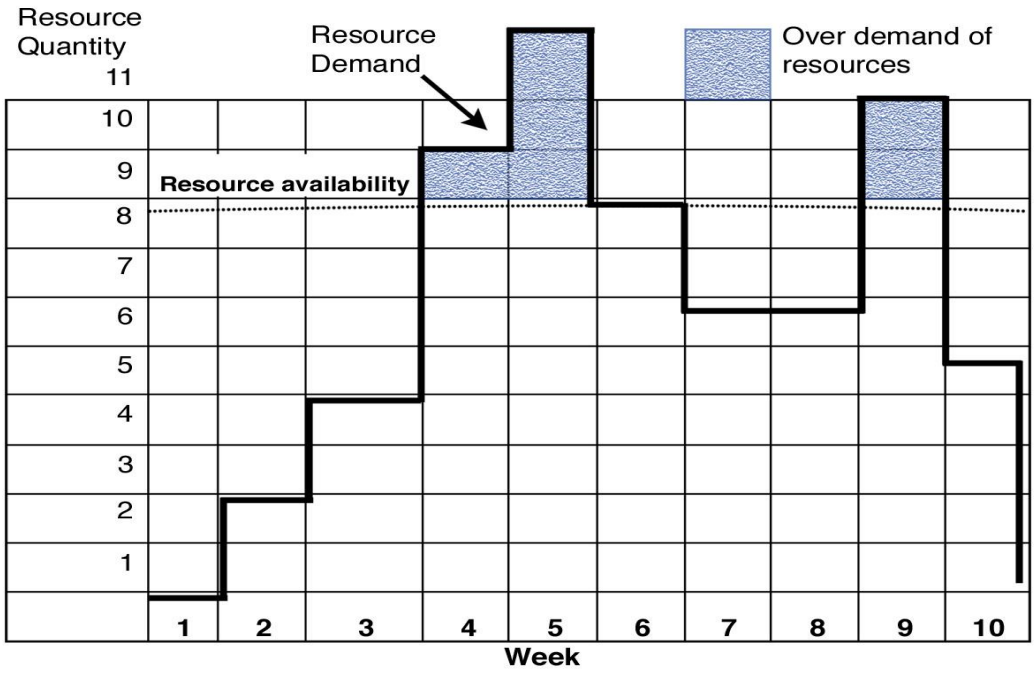


Figure 8.6: Resource Leveling Example

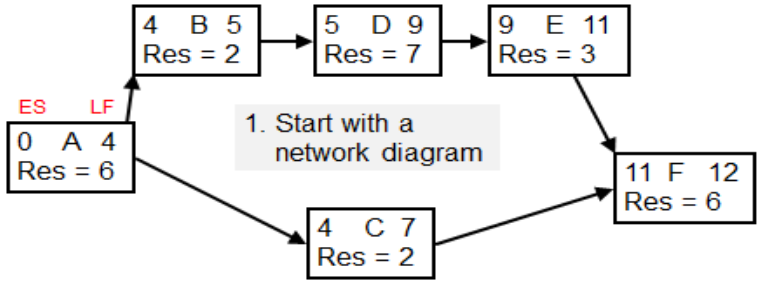
6.5.5.1 General Procedure for Leveling

Resource leveling shift non-critical activities within their float times so as to move resources from the peak periods (high usage) to the valley periods (low usage), without delaying the project.

1. Create a project activity precedence table and network diagram,
2. Develop resource loading tables and a resource profile
3. Determine activity late finish times
4. Identify resource over allocation
5. Level the resource loading table
6. Recalculate net activity slacks and project delay

Creating Resource Loading Charts (1/4)

Display the amount of resources required as a function of time.



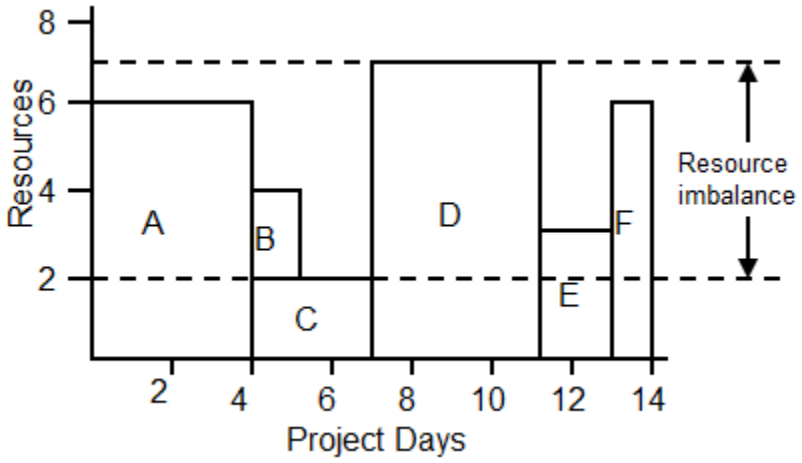
Creating Resource Loading Charts 2/4

Produce a table that shows the duration, early start, late finish, slack, and resource(s) required for each activity.

Activity	Resource	Duration	ES	Slack	LF
A	6	4	0	0	4
B	2	1	4	0	5
C	2	3	4	4	11
D	7	4	5	0	9
E	3	2	9	0	11
F	6	1	11	0	12

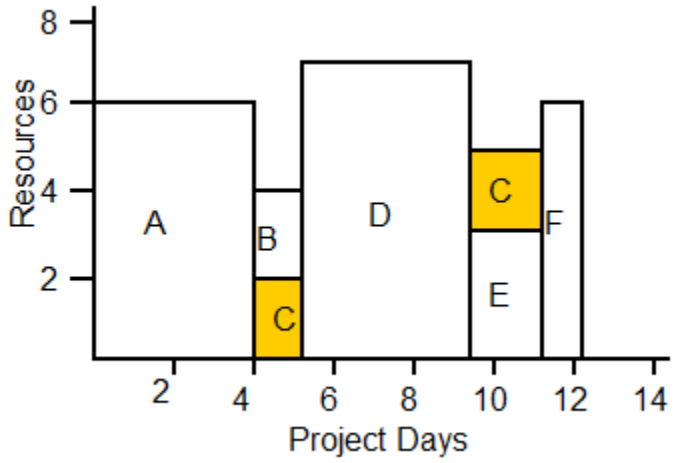
Creating Resource Loading Charts 3/4

Draw an initial loading chart with each activity scheduled at its ES.



Creating Resource Loading Charts 4/4

Rearrange activities within their slack to create a more level profile. Splitting C creates a more level project.



6.6 Materials Management

Materials management is an important element in project planning and control. Materials represent a major expense in construction, so minimizing procurement or purchase costs presents important opportunities for reducing costs. First, if materials are purchased early, capital may be tied up and interest charges incurred on the excess inventory of materials. Even worse, materials may deteriorate during storage or be stolen unless special care is taken. Second, delays and extra expenses may be incurred if materials required for particular activities are not available.

Accordingly, insuring a timely flow of material is an important concern of project managers. Materials management is not just a concern during the monitoring stage in which construction is taking place. Decisions about material procurement may also be required during the initial planning and scheduling stages. Sufficient time for obtaining the necessary materials must be allowed. In some cases, more expensive suppliers or shippers may be employed to save time.

Materials management is also a problem at the organization level if central purchasing and inventory control is used for standard items. In this case, the various projects undertaken by the organization would present requests to the central purchasing group. In turn, this group would maintain inventories of standard items to reduce the delay in providing material or to obtain lower costs due to bulk purchasing. This organizational materials management problem is analogous to inventory control in any organization facing continuing demand for particular items.

6.6.1 Material Procurement and Delivery

The main sources of information for feedback and control of material procurement are requisitions, bids and quotations, purchase orders and subcontracts, shipping and receiving documents, and invoices. For projects involving the large scale use of critical resources, the owner may initiate the procurement procedure even before the selection of a constructor in order to avoid shortages and delays. Under ordinary circumstances, the constructor will handle the procurement to shop for materials with the best price/performance characteristics specified by the designer.

Some overlapping and re-handling in the procurement process is unavoidable, but it should be minimized to insure timely delivery of the materials in good condition. The materials for delivery to and from a construction site may be broadly classified as:

- Bulk materials,
- Standard off-the-shelf materials, and
- Fabricated members or units.

Bulk materials refer to materials in their natural or semi-processed state, such as earthwork to be excavated, wet concrete mix, etc. which are usually encountered in large quantities in construction.

Standard piping and valves are typical examples of standard off-the-shelf materials which are used extensively in construction projects. Since standard off-the-shelf materials can easily be stockpiled, the delivery process is relatively simple.

Fabricated members such as steel beams and columns for buildings are pre-processed in a shop to simplify the field erection procedures.

6.6.2 *Inventory Control*

The general objective of inventory control is to minimize the total cost of keeping the inventory while making tradeoffs among the major categories of costs which include:

- Purchase costs,
- Order costs,
- Holding costs, and
- Unavailable costs.

These cost categories are interrelated since reducing cost in one category may increase cost in others.

A. ***Purchase Costs***

The purchase cost of an item is the unit purchase price from an external source including transportation and freight costs. For construction materials, it is common to receive discounts for bulk purchases, so the unit purchase cost declines as quantity increases. Because of this, organizations may consolidate small orders from a number of different projects to capture such bulk discounts, in some cases; this is a basic saving to be derived from a central purchasing office.

B. ***Order Costs***

The order cost reflects the administrative expense of issuing a purchase order to an outside supplier. Order costs are usually only a small portion of total costs for material management in construction projects, although ordering may require substantial time.

C. ***Holding Costs***

The holding costs or carrying costs are primarily the result of capital costs, handling, storage, obsolescence, shrinkage and deterioration. Capital cost results from the opportunity cost or financial expense of capital tied up in inventory.

- Handling and storage represent the movement and protection charges incurred for materials.
- Storage costs also include the disruption caused to other project activities by large inventories of materials that get in the way.
- Obsolescence is the risk that an item will lose value because of changes in specifications.
- Shrinkage is the decrease in inventory over time due to theft or loss.
- Deterioration reflects a change in material quality due to age or environmental degradation.

D. ***Unavailability cost***

The unavailability cost is incurred when a desired material is not available at the desired time. In manufacturing industries, this cost is often called the stock out or depletion cost. Shortages may delay work, thereby wasting labor resources or delaying the completion of the entire project.

6.6.3 *Cost Tradeoff in Material Management*

To illustrate the type of trade-offs encountered in materials management, suppose that a particular item is to be ordered for a project. The amount of time required for processing the order and shipping the item is uncertain. Consequently, the project manager must decide how much lead time to provide in ordering the item. Ordering early and thereby providing a long lead time will increase the chance that the item is available when needed but it increases the cost of inventory and chance of spoilage on site.

6.7 Personnel Supervision and Labor Productivity

A qualified workforce is essential to successful construction management. To achieve this it is vital to understand and practice the human resources function both at organization and project level. Other important knowledge the construction manager must know about on-site personnel management includes the methods by which craftspeople are hired and maintained.

6.7.1 HRM Functions

Human resources functions can be broadly classified into managerial and operative function. The managerial functions include planning, organizing, directing and controlling the human resources. Operative functions on the other hand include operational/routine activities in which the human resources department will be doing as day today activities such as human resources planning, job analysis, employee motivation, performance management and training and development etc.

Operative HRM functions include:

- Human resources planning;
- Job analysis design;
- Recruitment and selection;
- Training and development;
- Performance appraisal;
- Compensation and remuneration;
- Motivation, welfare, health and safety; and
- Industrial relations.

6.8 Equipment/Machinery Management

Construction of various facilities requires the utilization of construction equipment. Because of this learning the fundamental concepts and analyses of the planning, selection, and utilization of construction equipment is essential. It requires understanding the following key issues:

- The total construction process, from inception of the idea through construction and startup this will enable someone to know the nature of the work for which the equipment is being used, and

- How construction equipment should be selected and used to produce the intended quality in the most cost-effective manner.

Factors considered in construction equipment selection.

- Use of available equipment;
- Suitability of job conditions;
- Uniformity in types;
- Size of equipment;
- Use of standard equipment;
- Unit cost of production;
- Country of origin;
- Availability of spare parts;
- Selection of manufacturer;
- Suitability of local labor; and
- Adaptability for future use.

6.9 **Documentation** and Communication

6.9.1 General

The on-site management of a construction project involves great amounts of paperwork, even for relatively small projects. The purpose, of course, is to communicate directions, questions, answers, approvals, general information and other material with appropriate members of the project team, so that the project can proceed maintaining the intended quality in a timely and cost-effective manner. Some of the documents necessary for the execution of the contract, primarily from the contractor's point of view are dealt with hereunder.

In any case, the following sample classification can be used:

- General documents;
- Contract documentation;
- Communication records;

- Project status documentation;
- Correspondence;
- Material management; and
- Financial management.

6.9.2 General Documents

Contacts: a list of all persons and organizations with whom the contractor corresponds during the life of the project, with relevant contact information.

Program/schedule: the master project schedule, including the original baseline and all updates, together with any supplementary related information such as detailed sub networks, resource studies and analyses of schedule trends.

Accident reports: a report for each accident, plus summary data and related analyses.

Punch lists and other project closeout documents: lists of deficiencies identified during inspections as the project nears completion; certificates, warranties and record drawings.

Drawings: design drawings from the design professional, as revised throughout the project, with any supplementary sketches that may be issued.

Specifications: Technical specifications, plus general and special conditions and other parts of the project documents manual.

Subcontracts: copies of agreements with all subcontractors.

Insurance: certificates of all insurance carried by the contractor, as well as certificates for insurance required to be carried by all subcontractors.

Bonds: similar to insurance; contractor's copies of its performance and payment bonds, plus proof that subcontractors have furnished surety bonds, if so required.

6.9.3 Communication Records

Meeting minutes: records of all meetings held at the jobsite or elsewhere if pertaining to the project; regularly scheduled general and safety meetings; other special meetings of any kind.

Telephone records: brief records of all telephone calls placed or received at the jobsite.

Conversation records: often simply a memorandum to the file to record an understanding resulting from a conversation that was less formal than a meeting.

6.9.4 Project Status Documentation

Daily reports: a standard report that includes weather conditions, work in progress, number of direct employees and subcontractor personnel on site, visitors, equipment on site, material deliveries and special issues.

Weekly and/or Monthly reports: summary of accomplishments for the period, comparison of actual with planned schedule progress, cost status, change orders and special issues.

Progress photography: periodic still and video photography that records project progress.

6.9.5 Correspondence

Letters: all letters written by the contractor, as well as those received at the jobsite office; should include a record of correspondence conducted at the home office if related to the project.

Field memoranda: various types of correspondence, less formal than letters, issued at the jobsite to subcontractors, forepersons and other individuals; job directives, safety issues and disciplinary matters.

Transmittals: accompany submittals to owner's representative, subcontractors and material suppliers, accompany requests for payment and accompany certificates and other documentation at project closeout.

Requests for information (RFIs): issued from contractor to design professional or owner for clarification of design information or to present any other questions; includes summary log containing the status of each request.

6.9.6 Materials Management

Purchase orders: issued to material suppliers, as explained in an earlier section.

Submittals: shop drawings, product information and samples, plus status information on their review and approval.

Expediting and delivery information: status of manufacturing, shipping and delivery of each material item, with comparisons against project schedule.

Material inventory status: inventory of all stored materials, with quantities and dates when items were added and withdrawn.

Quality control reports: concrete test reports, soil laboratory results, off-site testing of steel components and so on.

Invoices: also part of cost system. All requests for payment of materials, with summary log of status of each.

6.9.7 Financial Management

Requests for payment: Prepared by contractor to request periodic payments as the project progresses, as explained earlier; based on measurements and progress to date.

Cost and budget tracking reports: Comparisons of actual costs to date against planned costs, for individual work items and the project as a whole; analysis of cost trends.

Variation requests: requests from the owner for proposals for changes in the work; summary log of status of each.

Variation proposals: prepared by the contractor for the owner, in response to variation requests; summary log of status of each.

Variations: orders from the owner authorizing changes in the work; summary log of status of each. Note that one log may suffice for variation requests, variation proposals and variations.

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CHAPTER SEVEN: PROJECT CLOSEOUT

7.1 Project Completion

The period of completion and handover of a project is the transition from its construction to its occupation by the end user (the client).For simple projects; this may consist of only a formal handover. For projects, which include other operating systems, this phase may include commissioning activities. On completion, however, the construction contract does not finally come to an end until the consultant issues his completion certificate.

As the project nears completion, a number of special activities must take place before the contractor's responsibilities can be considered complete. There are various testing and startup tasks, the final cleanup, various inspections and remedial work that may result from them and the process of closing the construction office and terminating the staff's employment. In addition, a myriad of special paperwork is required, including approvals and certification.

Approvals and certifications that allow the contractor to receive final payment, a set of as-built drawings that include all changes made to the original design, operating manuals, warranties and a final report.

The contractor will also be responsible for transferring and archiving project records and will conduct some sort of project critique and evaluation; operator training may also be part of the contractor's contractual responsibilities.

7.2 Project Acceptance

Project acceptance and handover is a stage at which the project owner accepts and enter into facility usage and operation.

Project acceptance has two stages:

- Provisional acceptance, and
- Final acceptance.

7.2.1 Provisional Acceptance

When the works has been substantially completed and have passed any final test that may be prescribed by the contract, the contractor may give notice to the Engineer to effect the

provisional acceptance. It usually covers the defects liability (maintenance) period which spans 12 months.

If the Engineer rejects the request, he shall prepare a checklist of all defective works and give it to the contractor for correction. Whenever the Engineer confirms that the work is substantially completed he shall conduct the acceptance in the presence of the Employer. During the defects liability period any defects, shrinkage or other faults which are due to materials or workmanship not in accordance with the contract are to be specified by the Engineer in a schedule of defects. The contractor has to rectify the items in the schedule of defects within a reasonable time

7.2.2 Final Acceptance

When the Engineer is satisfied that all-defective work has been made good, the Contract requires that the certificate for completion must be issued within 28 days of whichever of the following is the latest:

- The end of defects liability period, or
- The completion of the making-good of defects.

Procedures of Final Acceptance

Final acceptance may be requested by the contractor and confirmed by the Engineer. If the Engineer rejects the request, he shall prepare a checklist of all defective works and give it to the contractor for correction.

Whenever the Engineer confirms that the defective works has been made good he asks in writing to the stakeholders to send their representative to conduct the acceptance jointly. The representatives inspecting the site and the work should confirm, that defective works has been made good. Following the confirmation of all representatives, the engineer should prepare the standard format prepared for this purpose for signing by the committee.

7.2.3 Contract Closeout

It is a transition from design and construction to the actual use of the constructed facility. The management team must provide documentation, shop drawings, as built drawings, and operation manuals to the owner organization. Assessment of the project team’s performance is crucial in

this stage for avoiding mistakes in the future. Actual activity costs and durations should be recorded and compared with that was planned.

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CHAPTER EIGHT: INSURANCE IN CONSTRUCTION INDUSTRY

8.1 Risk and Insurance in Construction

Construction project is involved with a very wide environment even wider than the scope and concept of the project itself. Construction projects undergo various stages including conceptual design, preliminary design, detailed design, construction, and commissioning. At these stages in construction project life cycle decisions are made based on uncertain information, potential risk events and other various variables. Risk is "an uncertain event or condition that if it occurs has a positive or negative impact on at least one project objective that could include scope, schedule, cost, and quality" [1].

The mere fact that construction projects are unavoidably unique, works with nature and in a changing environment makes them come across uncertainty. Hence, risk cannot be avoided but it is recommended to recognize, assess and manage it. This reason brings about the essence of risk management to ensure successful project delivery. Risk management is an important project management planning and control tool which plays a vital role in improving decision-making that is active throughout the life of a project. It enables proper management of the inevitably unique and consistently changing projects [1, 2].

Though the terms might seem to be similar or are most of the times used interchangeably risk and uncertainty are different things. In distinguishing risk from uncertainty, risk can be viewed as measurable uncertainty; and uncertainty as immeasurable risk. Uncertainty is a mere intellectual curiosity and only becomes a risk when it matters. This clarifies the fact that not all uncertainty is a risk, though risk is always uncertain. Risk becomes a subset of uncertain, filtered on whether or not it matters. The definition of risk as the "subset of uncertainty that matter" tightly couples risk management to achievement of objectives, since the goal is to identify and manage any uncertainty that could affect our desired outcome [3].

According to the PMBOK project risk management has an objective of either increasing or decreasing the probability and impact of positive and negative events respectively. This guide expresses the processes, included in Annex B, involved in project risk management. The

processes involved are planning, identification, analysis, response planning, monitoring, and control as presented by Figure 8.1 below.

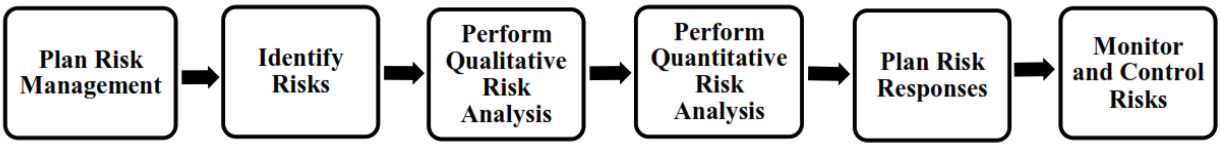

Figure 8.1: Process of project risk management [5]

- **Plan risk management**:
- **Identify risk**:
- **Qualitative risk analysis**:
- **Quantitative risk analysis**:
- **Risk response**:
- **Monitor and control risk**:

As the risk response step in risk management is concerned with topic of our discussion, insurance, the following section will focus on it.

Risk Response Planning

This process involves the development of actions that will reduce threats and enhance opportunities of project objectives. It includes the identification and assignment of a responsibility of each agreed-to and funded risk response.

High and moderate risks are addressed using agreed upon and detail appropriate responses. A watch list is developed for low priority risks to assist periodic monitoring and insure that their status has not changed. Appropriate risk treatment strategies are formulated after evaluating the risks based on their *financial impact* or as a response to *the effects of risk on project objectives*. Some of the risk treatment strategies within the framework of risk management, risk avoiding, transferring, reduction, and accepting, are discussed below.

a. Risk avoidance: involves changing the project management plan to eliminate the treat entirely if the *risk is intolerable* and no other means can be undertaken to mitigate its damages. The project management may also isolate the project objectives from the risk's impact, change the objective that is in jeopardy, changing the project scope, doing the project in a different way

or even shut down the project entirely. Risk which results due to lack of knowledge can be eliminated by obtaining information, improving communication, and acquiring expertise [4].

b. Risk Transfer: requires shifting some or all of the negative impact of a threat, along with ownership of the response, to a third party. Transferring the risk does not eliminate it at all but simply gives the responsibility of its management to another party. Transferring liability of risk is most effective in dealing with financial risk exposure. Transference tools are quite diverse and include the use of insurance, performance bonds, warranties, guarantees, etc. Risk transferring through insurance always involves payment of a risk premium to the insurance provider. Insurance may be seen as a means of response against adverse impacts by spreading the financial loss of the insured over the whole of the insuring community [5].

However, insurance only shifts the potential financial consequence of the risk event to a third party. But transferring risk can turn out to be expensive if the risks are managed by those who are inexperienced, or who do not have the influence to reduce its impact or probability [6].

Contract may also be used to share or transfer liability for specified risks to another party. Risk transfer through the use of contract can be looked at in different ways. That is in relation to the use of the contract clauses and provision, using different project delivery mechanism, and contact types. Risks cannot be eliminated through procurement but contractual arrangement can greatly influence how risks are managed [6, 7].

c. Risk Reduction: is expressed as "a reduction in the probability and/or impact of an adverse risk event to be within acceptable threshold limits" by taking actions such as obtaining more information [1]. Taking preventive mitigation strategies to reduce the probability and/or impact of a risk are often *more effective* than reactive mitigation strategies. The reactive mitigation strategies try to repair the damage after the risk has occurred [1, 4].

Risk mitigation is the most commonly employed response strategy to deal with project risks. However, this type of strategy handles particular causes of the risk and it is almost impossible to come up with exhaustive list of mitigation alternatives [4].

d. Risk Acceptance: This strategy is adopted because it is seldom possible to eliminate all threats from a project. This strategy adapted:

i) when the project team has *decided not to change the project management plan to deal with a risk*,
ii) when is *not possible to identify any other suitable response strategy*,
iii) to *handle risks that remain* after avoidance, transfer, or mitigation responses have been taken,
iv) to handle risks whose probability of occurrence and/or impact are *lower than the acceptable level*.

This strategy can be either passive or active. Passive acceptance requires no action and the risks will be dealt with when they occur. Estimating a contingency reserve, which is like establishing fallback plans, is the most common active acceptance strategy. The strategy that will be used as a reaction to a risk that has occurred includes reserves as amounts of time, money, or resources to handle the risks [4].

Construction insurance, addressed under the risk transferring response tool, is a practice of exchanging a contingent claim for a fixed payment to protect the interests of parties involved in a construction project. It is a method of managing risks in the construction industry. It has a function of transferring certain risks from clients, contractors, subcontractors and other parties involved in the construction project to insurers, to provide contingent funding in time of difficulty. Construction insurance plays an increasingly important role in guaranteeing the success of projects, with insurers sharing losses resulting from natural disasters and other contingencies.

8.2 Historical Background of Insurance

Throughout human history, unexpected economic loses have occurred. Such losses would occur even if the insurance transaction had never been developed. Through the operation of an insurance system, however, combined losses can be predicted. The Predictability of losses is basic to an insurance system`s operations. Basic to an insurance allows a groups (but not an individual`s) losses to be predicted accurately, it allows the cost of losses to be financed and redistributed in advance [8].

The origin of insurance was that a group of merchants agreed to pay money out to the merchant, who was unlucky and did not have his ship return full of treasure. He would then be able to buy

a new ship to replace the loss. This was arranged at a local coffee shop in London where the merchants used to meet. From this grew Insurance Companies and London remains the world center of insurance [9].

The origins of engineering insurance go back to the 18th century in the period, which became known as the industrial Revolution in Great Britain. At that time, steam became the main source of power and energy. By the 19th century, the safe working of steam boilers and steam pressure plant was marred by inadequate engineering and metallurgical skills with a result that there were frequent explosions of disastrous proportion as well as steam plant failures.

Quality of material, safe working pressure limits, adequacy of design and manufactures specification became of real concern which led to the formation of a private association in 1850 called "The Manchester Steam Users Association", in inspection and reporting upon steam boilers initially, followed by steam engines piping, valves etc., and subsequently all types of electrical and mechanical machinery. Once established and contributing to the safe working conditions within industry, financial support was given to clients who conformed to the standards laid down by the engineers, should such inspected plant break down, hence the establishment of specialist engineering insurers.

Engineering insurance can be divided into two main groups. The first group comprises of insurances, which provide purely material damage cover such as Machinery Breakdown, Boiler, Electronic Equipment insurance, Contractors' All Risks and Erection All Risks insurances. The second Group is made up of insurances, which cover the material damage or the economic loss that results from damage indemnifiable under a branch of insurance named in the first group. Such insurances are deterioration of stock and Machinery Loss of profits Insurances. The various branches together constitute a comprehensive system. The insurance cover available extends from the construction of a plant or from the erection of a machine up to the continuous use of plant or machinery. The perils, which prevail during the different periods, determine the extent of cover provided by the different policies [10].

8.3 Insurance Defined

Financial Definition

Insurance is a financial arrangement that redistributes the cost of unexpected losses. Insurance involves the transfer of potential losses to an insurance pool. The pool combines all the potential losses and then transfers the cost of the predicted losses back to those exposed. Thus, insurance involves the transfer of loss exposures to an insurance pool and the redistribution of losses among the members of the pool. Certainty of financial payment from a pool with adequate predictability of losses is the hallmarks of the insurance transaction [8].

An insurance system redistributes the cost of losses by collecting a premium payment from every participant (insured) in the system. In exchange for the premium payment, the insurer promises to pay the insured`s claims in the event of covered loss. Generally, only a small percentage of insured is suffer losses. Thus, an insurance system redistributes the costs of losses from the unfortunate few members experiencing them to all the member of the insurance system who pay premium [8].

Legal definition

Insurance is a contractual arrangement whereby one party agrees to compensate another party for losses. Let's define some o4important terms:

- **Insurer**: the party agreeing to pay for the losses the.
- We call the party whose loss causes the **insurer** to make a claims payment to the insured.
- Premium: the initial payment the insurer receives.
- **Insurance policy**: is the insurance contract.
- We call the insured`s possibility of losses the **insured`s exposure to loss**. We say the insured transfers the exposure to loss to the insurer by purchasing an insurance policy.

Insurance is a branch of contract law. The insurance policy, like all contracts, is an arrangement creating rights and corresponding duties for those who are parties to it. The insurance contract *creates* the insured`s right to collect payment from the insurer from the insurer, if a covered loss

occurs. The insurer has corresponding duty to *pay for such losses*. The insurance contract also creates other right and duties. The insurer has the right:

- To c*ollect premiums*, and those wanting their coverage to continue have the corresponding duty to pay for such losses.
- To specify the rules and conditions for participating in the insurance pool, and insured has the corresponding duty to obey them if he/she expects to collect for losses. In analyzing an insurance contract, you should remember that a right created for one party represents a duty for the other party.

Perhaps the word duty is too strong a term to describe the obligations of an insured to an insurer. Generally, an insurer *legally cannot force* an insured to pay premiums but it may *cancel the insurance or deny claims* if premiums are unpaid. Likewise, an insurer generally cannot force an insured to meet the conditions set forth in the contract, but if the insured does not meet the conditions, *losses will not be paid*. Thus, it seems fair to note that an insurance contract creates rights and corresponding obligations for the insurer and insured.

Loss

The word loss, as it is commonly used, means being without something previously possessed. We speak of "loss of memory" and "loss of time." when the word used in insurance, however, it takes on a more limited meaning. A typical insurable loss is an undesired, unplanned reduction of economic value. We call planned losses such as burning of fuel or wear and tear, expenses.

Insurable losses are categorized as direct or indirect losses. This distinction is important. Direct losses are the immediate, or first, result of an insured peril. Indirect losses, also called consequential losses, or loss of use, are a secondary result of an insured peril. For example, if fire destroys a home, the loss of the home is the direct loss. If a tornado destroys a restaurant, the property damage is the direct loss; the loss of income during the period when the business is being re-established is the direct loss. There must be a direct loss before there can be an indirect loss. Property insurance policies are specific when providing coverage for direct or indirect losses, or for both [8].

Risk

Risk could be define as a condition of the real world in which there is an exposure to adversity. More specifically, Risk is a condition in which there is a possibility of an adverse deviation from a desired outcome that is expected or hoped for [11].

Reinsurance

Reinsurance is a device whereby an insurance company may avoid catastrophic hazard in the operation of the insurance mechanism. Shortly, it is *an insurance for insurers*. It is based on the same principles of sharing and transfer as insurance as itself. Insurance companies developed the concept of reinsurance for the purpose of protecting themselves from the catastrophe of a comparatively large single loss or a large number of small losses caused by a single occurrence. The act of transferring a part of risk to the reinsurance company is called ceding, and that portion of the risk passed on to the reinsurer is called the cession [11].

Types of Insurance

The insurance policy is divided into three broad categories, namely,

- Life Insurance;
- Property Insurance; and
- Liability Insurance;

8.4 Insurance Contracts

A contract is an agreement whereby two or more persons as between themselves create, vary or extinguish obligations of a proprietary nature according to Art. 1675 of the Civil Code. It is a legally binding agreement creating rights and duties for those who are parties to it. If one party fails to perform its duties without a legal excuse, attorneys say the contract is breached. A contract is enforceable by courts, this means it is considered as a low that binds contracting parties.

In general, insurance services are governed by

- The Commercial Code of Ethiopia ;(Article 654-Article 712);
- The Civil Code of Ethiopia; (by the General Contract);

- Other Proclamations issued to regulate the financial sector of the country;
- By the Insurance Policy(including the endorsement thereof) agreed between the Insured & the Underwriter (the Insurance Company);

Special Legal Characteristics of Insurance Contracts [11]

- Principle of indemnity
- Doctrine of adhesion
- Personal contract
- Conditional contract
- Unilateral contract
- Contract of utmost good faith
- Aleatory contract

Principle of Indemnity

In many forms of insurance, particularly in property and liability, the contract is one of indemnity. This means that the insured is entitled to payment from the insurance company only if he or she has suffered a loss and only to the extent of the financial loss sustained. The principle of indemnity maintains that an individual should not be permitted to profit from the existence of an insurance contract but should be restored to the same financial condition that existed prior to the occurrence of the loss. This principle is enforced through legal doctrines and policy provisions designed to limit the amount the insured can collect to the amount of the loss.

The most important legal doctrine giving substance and support to the principle of indemnity is that of **insurable interest.** An insurance contract is legally binding only if the insured has an interest in the subject matter of the insurance and this interest is insurable if the insured would suffer a financial loss in the event of damage to, or destruction of, the subject matter of the insurance. Another contractual provision designed to prevent the insured from making a profit is the **subrogation clause**. Here if the insured collects indemnity under the policy and the loss has been caused by the negligence of some third party, the right to collect damages from the negligent party must be relinquished to the insurance carrier. The right of subrogation is based on

the principle that if it did not exist, the insured would be permitted to collect twice for the loss, once from the insurance company and once from the negligent party.

Personal Contract

Though insurance coverage may apply to property, the risk is transferred to the company from an individual. If an insured wants to sell the insured property, the protection is not binding in favor of the new owner of the property. Since the company has a right to decide with whom it will and will not do business, the insured cannot transfer the contract to someone else without the written consent of the insurer except in case of insurance and in case where the assignment doesn't change the contracting parties or the nature of the risk.

Unilateral Contract

Only one party to the contract is legally bound to do anything. The insured makes no promises that can be legally enforced. If an insured violates certain conditions of the contract, he or she may be prevented from collecting in the event of loss.

Conditional Contract

When insurance contract is said to be a conditional contract, it means conditions of contract are considered a part of the consideration by the insured. The insurer is obligated to fulfill its promises only if the insured has fulfilled his or her promises. Since an insurance contract is a unilateral contract, the insured cannot be legally required to meet policy conditions. At the same time, if conditions are not met, the insured may be prevented from collecting in the event of loss.

Contract of Adhesion

An adhesion contract is a type of contract prepared by one of the parties (insurer) and accepted or rejected by the other party (insured). It is not drawn up through negotiation. Because the insurance company has the right to draw up the contact, the contract have held that any ambiguity in the contract should be interpreted in favor of the insured.

The fact that the insurance policy is a contract of adhesion and insured must accept or reject the terms as they are written makes the doctrine of "presumption of intent "rather important in the area of that a person is bound by the terms of a written contract that he or she signs or accepts,

whether he or she reads the contract or not. The court assumes that the insured reads the contract and agrees with the terms thereof.

Aleatory Contract

The term aleatory means that the outcome is affected by chance and that the number of Birr/Dollars given up by the contracting parties will be unequal. The insured pays the required premium, and in no loss occurs, the insurance company pays nothing. If a loss does occur, the insured's premium is small in relation to the amount the insurer will be required to pay. This makes insurance contracts like a gambling contract.

Contract of Utmost Good Faith

Partly due to the fact that the contract is aleatory, the insurer and the insured enter into an agreement in which mutual faith is of paramount importance. The practical effect of the principle of utmostgood faith lies in the requirement that the applicant for insurance must make full and fair disclosure of the risk to the agent and the company. The risk that the company thinks it is assuming must be the same risk that the insured transfers. Any information about the risk that is known to one part should be known for the other. If the insured intentionally fails to inform the insurer of any facts that would influence the issue of the policy or the rate at which it would be issued, the insurer may have grounds for avoiding coverage.

8.5 Basic Parts of Insurance Policy

According to Article 654 of the Commercial Code, an insurance policy is a contract whereby a person, called the insurer, undertakes against payment of one or more premiums to pay to a person, called the beneficiary, a sum of money where a specified risk materializes.

Insurance policies are composed of four basic parts: [8]

a) Declarations

b) Insuring agreement

c) Deductibles

d) Exclusions

e) Conditions

f) Endorsements

a) Declarations

Usually it is the first element of the property and liability insurance. The declarations present the important facts about the coverage provided and personalize the coverage to a particular insured. Information about the following is also included.

- Location of the property insured
- The name of the policy holder
- Other matters relating to the identification of the person or property insured

b) Insuring Agreements

The insuring agreement is specific language creating the contract. It describes the insurer's and the insured's rights and duties. Often, sub agreements are used to identify specific perils covered by the policy or to indicate coverage is provided on an open-perils basis. In this section, the company promises to pay for loss if it should result from perils covered.

c) Deductibles

Property insurance policies require the insured to pay the first dollars of an insured loss. Insurers call this amount the deductible. These provisions serve two purposes. First, they reduce the morale hazard because the insured must pay a small part of every loss. Second, deductibles eliminate the expenses and payments for small claims. The savings from reduced expenses and payments for losses are reflected in lower premiums. Therefore, the larger the deductible an insured chooses, the lower the insurance premium.

d) Exclusions

Exclusions identify losses not covered. If an insurer denies s claim based on an exclusion and the insured then contests the denial, the insurer has the legal burden of proving it applied the exclusion correctly. Property insurance exclusions serve to eliminate:

- Losses arising from catastrophic event
- Losses associated with the moral or morale hazard

- Coverage not needed by the typical insured
- Coverage where another policy is specifically designed to provide coverage
- To exclude non-insured partied from benefiting from coverage
- To control costs and keep premium premiums affordable

e) Conditions

Conditions provide a framework for the insurance policy explaining many of the important relationships, rights, and duties of the insurer and insured.

f) Endorsement

Endorsements are used to modify standard insurance contracts. They can add coverage directly or they can add coverage by deleting exclusion in the standard policy. Sometimes an endorsement can eliminate coverage for a reduction in premium for instance or exclude an insured (for example, a teenage driver).

8.6. Major Types of Construction Insurance Policies [5]

Contractor's All Risk Policy: The basic concept is to offer comprehensive and adequate protection against loss or damage in respect of the contract works which could be any building or civil engineering project under construction plant and equipment and/or construction machinery. CAR insurance provides "all risk" cover. This policy provides cover to hazard that is not specifically excluded. It is effective during the performance of the contract and the period of maintenance.

Professional Indemnity Insurance: The legal liability incurred in the course of a professional's work is covered under this policy. Legal liabilities are incurred as a result of negligence and lack of care. When the PI insurance is provided and is adequate the client will be reimbursed for the designer's negligence and all the resulting damages if negligence could be proven.

Contractors Third Party Liability Policy: This policy covers loss or damage to third party persons or property arising out of the construction or maintenance of the works. As the name indicates, third party means anyone who is not a part of the insurance contract.

Contractors Employers Liability Policy: Covers damages in respect of injuries to workmen in their employment, or employment of any sub-contractor.

The following are some of the relevant insurance policies available locally [12].

➔ Engineering Insurance

- Boiler Insurance;
- Contractor All Risk Insurance;
- Contractors Plant & Machinery;
- Erection All Risk;
- Electronic Equipment Insurance;
- Machinery Breakdown;
- Machinery Loss of Profit;
- Workmen's Compensation;

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CHAPTER NINE: SAFETY AND HEALTH PROVISIONS IN CONSTRUCTION ACTIVITIES

Health and Safety in the context of construction industry is the discipline of preserving the health of those who build, operate, maintain and demolish engineering works, and others affected by those works. Health and safety should be designed into constructions before, during and after the building phase. It is cheaper and easier to control the risks to workers in construction before work starts on site.

Health at work and healthy work environments are among the most valuable assets of individuals, communities and countries. Occupational health is an important strategy not only to ensure the health of workers, but also to contribute positively to productivity, quality of products, work motivation, job satisfaction and thereby to the overall quality of life of individuals and society [1].

Health, safety and working environment are the promotion and maintenance of the higher degree of physical mental and social well-being of workers in all occupations. At the construction workplaces the workers are exposed to hazards of occupational risks and injuries. These scenarios relate to the type of hazard that may arise during construction activities as a result of equipment failure, inadequate procedures, inexperienced or poorly trained staff, etc. The typical safeguards for these general incidents are the controlled safe work procedures for the type of construction work undertaken. Hence, the key to control safety and health is to predict the hazards and thus be in a position to eliminate them [2].

9.1 Definition

Health: refers to the freedom from the immediate and long term effects of exposure to unhealthy working condition. Occupational Health can be defined as the ongoing maintenance and promotion of physical, mental and social well-being for all workers, minimizing all occupational health risks and the adaptation of work to people. It also involves the education of people to adapt safely to their work. Health is about preventing people from being harmed at work or becoming ill. Health service should be concerning with the preventive measures laid down to guide the employers the workers and their representatives on the requirements for a safe healthy working environment [3].

Safety: applies to the freedom from risk of injury and from avoidable accidents [4].

According to World Health Organization (1995), occupational safety and health can be defined as a multidisciplinary activity aiming at:

- Protection and promotion of the health of workers by eliminating occupational factors and conditions hazardous to health and safety at work;
- Enhancement of physical, mental and social well-being of workers and support for the development and maintenance of their working capacity, as well as professional and social development at work;
- Development and promotion of sustainable work environments and work organizations.

9.2 The Role and Nature of the Construction Industry

The construction sector plays an important role in the economies of countries throughout the world as well as in our country. The state of the construction industry in a country is indicative of the state of its national economy meaning the fate of any national economy cannot be separated from that of the construction industry. This is a consequence of; inter spectral relationship, the forward and backward linkages the construction sector forges with the rest of the economy. The backward linkages refer, for instance, to the construction materials and services sectors of the economy. The forward linkages refer to the economic activities that result from the use of constructed buildings and facilities [5].

The construction industry is characteristically one in which most of its products are unique for substance, form, size and purpose. Each building or facility may, therefore, be described as being custom - made. Buildings cannot be isolated from the environment in which they are situated. The products of construction differ widely in terms of location, materials and production techniques, and the standards of the finished product regarding space, quality, durability, and aesthetic consideration. It is less well recognized that they vary from each other, even when built to identical plans and specifications. The completed products are generally not mobile in that they are permanently fixed in specific locations. This consideration implies that even if components are prefabricated and/or pre- assembled elsewhere, the final assembly process remains site- specific.

The physical working environment in construction varies with seasons and job site conditions. Site conditions conceivably vary between work done below natural ground level, at ground level, at elevated heights, and sometimes even over and under water. This changing working environment results in potentially hazardous situations. Construction workers are required, therefore, to familiarize themselves constantly with these new situations. Unlike manufacturing, continuity of production is not always possible, since each product of construction is usually unique.

Construction sites are subject to local conditions. The availability of materials and plant equipment may vary, requiring substitution with materials and plant with which the labor force might be unfamiliar. Moreover, each building site represents in effect the creation of a production site where new workplaces are set up.

The construction industry is characterized by fragmentation due to the number of stakeholders and participants in the construction process from project inception through project completion and beyond each with divergent roles, goals, expertise and skills. This fragmentation has resulted in the increased construction costs, low productivity, and poor communication between all participants, confusing and contradictory documentation, ineffective and inefficient project management, unnecessary delays, unsatisfactory quality performance, reworks, poor safety performance and costly disputes.

The construction industry is subject to economic cycles and is dependent on changing governmental priorities and policies producing ‘stop-go’ approaches in the sector. In most economies in the world, the intensity of construction activity fluctuates according to variations in investor confidence, availability and cost of finance and consumer demand, or even a combination of these. These variations are typical investor and consumer reactions to changing governmental priorities and policies.

Consequently, the construction industry does not enjoy continuous demand for its products and services. This scenario implies that the demand for people with the appropriate construction skills also fluctuates. Qualified and trained workers, needing employment of some kind, leave the industry when demand for their services disappears. The impact of this occurrence is evident

in the lack of investment in, and lack of commitment to worker training that is an important component of any plan to improve safety performance.

Frequently, workers are expected to acquire totally new skills ‘on the job’ but without any structured instruction or training program. Usually a proper induction program that has been shown to be effective in safety and health programs is not conducted for these new employees. These workers constitute the group most likely to experience accidents.

The procurement systems used within the industry are frequently based on competitive tendering. This tendering practice results in contractors undertaking ‘On the job’ refers to training that occurs on the actual job site where the worker is employed and it implies that this skill acquirement is a consequence of performing the work.

Construction projects on a ‘one- off’ basis. By implication each project is, therefore, treated as being unique, without the prospect of either the physical structure being reproduced, or the project team working together again on the next project. Since this practice is the predominant means of obtaining work in many countries, it is difficult for contractors to determine their future workload, plan or invest for the future. The risks associated with this uncertainty lead to limited investment in fixed capital, minimum employment of permanent staff, and the increased use of subcontractors and casual labor.

For a long time, the construction industry has been labeled as one with a poor health and safety culture. Efforts to improve health and safety performance will not be effective until the health and safety culture is improved. That is, there is a need for a major paradigm shift regarding attitudes toward safety and health on construction sites [5].

9.3 Construction Safety Management

9.3.1 Safety Performance of the Construction Industry

Construction work also exposes workers to a wide range of health problems: from asbestosis to back pain; hand/arm vibration syndromes to cement burns. Internationally, construction workers are two to three times more likely to die on the job than workers in other industries while the risk of serious injuries almost three times higher [6].

Apart from the actual costs incurred regarding injuries and fatalities, the national economy of any country suffers enormous cost and loss of productivity due to the number of workdays lost as a consequence of occupational injuries and deaths.

In a high-hazard industry like construction, safety is an investment that provides real benefits. A safe work environment helps to keep skilled employees on the job and projects on track by reducing accidents that result in injuries and schedule delays, while also reducing the risks of litigation and regulatory action. A strong safety record enhances a company's reputation, makes it more competitive and helps to manage insurance costs over time.

Nurturing a successful safety culture, however, requires commitment and participation all the way from top to bottom including the chief executive to project managers, superintendents, foremen and individual workers on the job site. That commitment should extend to the selection of subcontractors who also embrace a strong safety ethic [7].

9.3.2 Safety organization

The organization of safety on the construction site will be determined by the size of the work site, the system of employment and the way in which the project is being organized. Safety and health records should be kept which facilitate the identification and resolution of safety and health problems on the site.

In construction projects where subcontractors are used, the contract should set out the responsibilities, duties and safety measures that are expected of the subcontractor's workforce.

These measures may include the provision and use of specific safety equipment, methods of carrying out specific tasks safely, and the inspection and appropriate use of tools. The person in charge of the site should also assure that materials, equipment and tools brought on to the site meet minimum safety standards.

Training should be conducted at all levels, including managers, supervisors and workers. Subcontractors and their workers may also need to be trained in site safety procedures, because teams of specialist workers may mutually affect each other's safety. There should also be a system so that site management has information quickly about unsafe practices and defective equipment.

Safety and health duties should be specifically assigned to certain persons. Some examples of duties which should be listed are:

- provision, construction and maintenance of safety facilities such as access roadways, pedestrian routes, barricades and overhead protection;
- construction and installation of safety signs;
- safety provisions peculiar to each trade;
- testing of lifting machinery such as cranes and goods hoists, and lifting gear such as ropes and shackles;
- inspection and rectification of access facilities such as scaffolds and ladders;
- inspection and cleaning of welfare facilities such as toilets, clothing accommodation and canteens;
- transmission of the relevant parts of the safety plan to each workgroup;
- Emergency and evacuation plans [8].

9.3.3 Consideration during design, construction and post construction processes

As any builder knows, projects start well before ground work is started. Safety should be part of the process right from the very beginning. In working toward establishing a safer workplace, construction companies can tap the extensive knowledge of risk management experts who are well experienced and competent.

Formal consideration of construction worker safety is not a traditional aspect of design. Design professionals traditionally focus on the safety of the "end-user", such as the building occupant, motorist, or facility operator [9]. But incorporating safety through all the processes involved in construction is cheaper and easier to control the risks to workers in construction before work starts on site, for example by:

- putting in place a purchasing policy for machinery and work equipment (for example, buying tools with low noise and vibration emissions);
- setting health and safety requirements in tender specifications (meeting national legislation as a minimum);

- planning the work process to minimize the number of workers who could be harmed (for example, schedule noisy work when the least number of workers are likely to be exposed);
- starting your control activities before getting to site (for example, by planning, training, site induction and maintenance activities);
- setting down the procedures for effective consultation and participation of workers on OSH issues;
- ensuring all persons, including managers, are trained and able to carry out their work without risk to the safety or health of themselves or other worker [6].

Project planners should also work with their insurers to determine the most effective risk management strategies before a project begins and while it's being built. Health and safety should be designed into constructions, before, during and after the building phase. Once a project starts, safety should be a part of every employee's job, every day [7].

During construction, the site should be well organized that workers are able to safely move through with minimum obstacle. Precaution signs should be placed at required locations insuring their visibility for everyone working in the site. We also need to make sure that the signs are understood by everyone. Personal protective equipment must be used to avoid or reduce the amount of damage resulting from the work in progress. While using equipment it is best to follow the recommendation forwarded by the manufacturer to avoid accidents. Generally checklists should be prepared and followed.

During construction of the structure, there were considerable risks of health damage due to contaminated land, especially risks related to the release of gases in large quantities during the foundation earthworks. Significant measures were taken to counter pollution during both the construction and operation of the structure.

Workers could face various health and safety problems during carrying out maintenance works. Such as facing dust of many kind and at times problem of contaminated land. Implementing effective control of such health and pollution risks could be achieved if accurate information reaches all those involved in the work.

Working out a safety and coordination plan is very important and involving health and safety coordinator during the work will also make the project fruitful. Defining safety measures which could be useful for future maintenance work will keep the workers involved safe.

The demolition of buildings entails specific risks from hazardous substances (such as asbestos), in addition to the usual risks involved in demolition work, such as falls from heights, being struck by falling objects, and slips or trips[10].

When the demolition of any building or structure might present danger to workers or to the public:

(a) appropriate precautions, methods and procedures should be adopted, including those for the disposal of waste or residues, in accordance with national laws or regulations;

(b) the work should be planned and undertaken only under the supervision of a competent person. It is best for all involved if the concept of life time safety, which was developed from the lessons learned brought forward by design firms and owner from prior projects, is implemented.

9.3.4 Safety related construction risk and its allocations

The improvement of safety, health and working conditions depends ultimately upon people working together, whether governments, employers or workers. Safety management involves the functions of planning, identifying problem areas, coordinating, controlling and directing the safety activities at the work site, all aimed at the prevention of accidents and ill health. Accident prevention is often misunderstood, for most people believe wrongly that the word “accident” is synonymous with “injury”. This assumes that no accident is of importance unless it results in an injury.

Construction managers should be concern with the dangerous conditions that produced the injury but rather they direct their focus towards the injuries to the workers. They should be concerned with the “incident” rather than the “injury”.

On a construction site there are many more “incidents” than injuries. A dangerous act can be performed hundreds of times before it results in an injury, and it is to eliminate these potential dangers that managers’ efforts must be directed. They cannot afford to wait for human or

material damage before doing anything. So safety management means applying safety measures before accidents happens. Effective safety management has three main objectives [8]:

- to make the environment safe;
- to make the job safe,
- to make workers safety conscious.

Employers, with project supervisors, must cooperate and protect workers' health and safety. This can be achieved by [6]:

- avoiding risks to all workers;
- evaluating risks that cannot be avoided;
- combating risks at source;
- using collective measures to protect workers;
- using individual measures where there are no other alternatives;
- establishing emergency procedures;
- informing workers of the risks present and the necessary control measures;
- ensuring the appropriate training is given.

Health and safety management works to eliminate or reduce accidents from happening. Risk assessment, which is the process of evaluating risks that cannot be avoided, should identify:

- potential dangers (hazards);
- who might be harmed and how seriously;
- how likely this harm might happen;
- the actions required to eliminate or reduce the risk to workers;
- which actions should be taken first.

The control measures should be put in place and checks made to ensure that they are working and are meeting legal requirements.

Of the inherent characteristics of the construction contract which are peculiar to it and distinguishes it from other types of contract, the concept of construction insurance stems from

complex matrix of hazards and risks. There is a complex matrix of hazards and risks that could lead to personal injury and/or physical damage during the construction period and beyond. Difficulties generally arise in construction projects due to their inherent characteristics. However, when hazards eventuate and risks materialize through events that could result in costly losses, which must be absorbed by the contractor while carrying out his legal obligation to complete the works [11].

The control measures should be put in place and checks made to ensure that they are working and are meeting legal requirements.

9.4 Causes of Construction Site Accidents

There are several factors that cause accidents on construction sites. The main factors affecting safety performance are poor safety awareness, lack of training, reluctance to commit resources to safety, reckless operations, lack of necessary personal protection equipment for workers and no documentation of safety management system or safety manuals. Table 9.1 shows the classification of the causes of construction accidents, which are the most influential factors, as job site conditions, equipment's and materials, human and management factors [12].

Table 9.1: Classification of causes of construction accidents [12]

Human	Management	Job Site Condition	Material & Equipment
• Lack of certain abilities • Lack of certain attitudes such as stubbornness or recklessness • Physical and emotional stress • Excessive overtime work for labor • Reluctance to input tools for safety • Misplacing objects • Overexertion or strenuous movement • Struck by falling objects, materials and tools • Loss of balance • Stepping on or striking against objects • Inappropriate use of ladders and hoists • Improper cleaning and unusable materials • Lack of teamwork spirits • Transient workforce • Dangerous demolition work	• Lack of certain knowledge • Lack of awareness of safety regulations • Inadequate safety performance • Supervisory fault • Lack of experienced project managers • Poor inspection program • Poor safety awareness of project managers • Lack of innovative technology	• Excessive noise • Slippery and muddy work surface • Poor ventilation • Lack brightness • Lack of edge protection • Hole and edge • Limitation of working area • Collapse of temporary structures	• Operating equipment without authority • Using defective tools/equipment • Mechanical failure of machinery • Unsafe facilities and equipment • Low maintenance of tools • Lack of protection when transporting materials • Lack of material storage protection • Failure to ensure tight position during hauling/lifting • Lack of proper caution signals

9.5 Health Hazards and Occupation Health Services

In addition to hazards associated with accidents, there are also health problem associated with construction work that may be categorized into: 1. Chemical Hazards – those due to liquids, dust, gas and fires 2. Physical Hazards – those due to cold, heat, noise vibration, radiation and compressed air 3. Biological infection from works in sewers and contaminated sites and

Appropriate preventive measures should be taken to avoid any danger to the safety and health of workers whose work exposes them to hazards arising from the use or presence of chemical, physical or biological agents and climatic conditions.

The employer should make arrangements for the identification and assessment by competent persons of health hazards presented by the use of different operations, plant, machinery, equipment, substances and radiations at the construction site and takes appropriate preventive or control measures against the identified health risks in conformity with the national laws and regulations [10].

In the use of materials that contain hazardous substances and in the removal and disposal of waste, the health of workers and of the public and the preservation of the environment should be safeguarded [13].

Exposure to some materials will not only affect the workers working with it but also their families. Families of workers involved with LBP activities may be exposed to lead brought home from the workplace. This could happen due to number of reasons one of which is workers' vehicles being contaminated and a significant amount of lead being transported to their home. Lead has been used since ancient times as a paint pigment. Two major chemical forms, white and read lead, of lead are used as colors. Both types of lead provide a thick tough coating; one that does not crack through wear or temperature variation because it can expand and contract. The chemical nature of lead causes it to provide corrosion resistance as well [13].

Another well recognized building material causing health hazard is asbestos. Although asbestos is no longer used as an insulation material; workers may still be exposed to asbestos during demolition or remodelling jobs [14].

The employer should be responsible for ensuring that first aid, including the provision of trained personnel, is available. First-aid kits or boxes, as appropriate, should be provided at the workplaces, including isolated locations such as maintenance gangs, and on motor vehicles, locomotives, boats and floating equipment, and be protected against contamination by dust, moisture, etc.

The occupational health discipline covers the following key components [4]:

1. The availability of occupational health and safety regulations at workplace.
2. The availability of active and functional occupational health and safety committee at workplace
3. Monitoring and control of factory hazards to health
4. Supervision and monitoring of hygiene and sanitary facilities for health and welfare of the workers
5. Inspection of health safety of protective devices
6. pre-employment, periodical and special health examination.
7. Performance of adaptation of work to man
8. Provision of First Aid
9. Health education and safety training to the worker
10. Advice to employers on the above mentioned items
11. Reporting of occupational deaths, diseases, injuries, disabilities, hazards and their related preventive measures at working

9.6 Local Context

9.6.1 Constitution

The parent legislative frame work of the land is the constitution of the Federal Democratic Republic of Ethiopia Proclamation No. 1/1995 (21st August, 1995). This grand legislation has several articles pertaining to matters of decent work in general and of safety, health and working in particular.

- **Article 9** states the supremacy of the constitution in the hierarchy of the laws of the land and all international agreements ratified by Ethiopia are an integral part of the law of the land. This includes all the ILO's conventions ratified by Ethiopia.

- **Article 10** about the human and democratic rights states that human rights and freedoms, emanating from the nature of mankind, are inviolable and inalienable. Human and democratic rights of citizens and people shall be respected.
- **Sub article 2 of article 13** stipulates that the fundamental rights and freedoms shall be interpreted in a manner conforming to the principle of the Universal Declaration of Human Rights and international instruments adopted by Ethiopia.
- **Sub article 3 of article 89** states that the government shall take measures to avert any natural and man-made disasters and in the event of disaster to provide timely assistance to the victims.
- **Under sub article 8 article 89** requires the government to endeavor to protect and promote the health, welfare and living standards of the working population of the country.
- **Sub article 1 of article 44** "Environmental Rights" states that all persons have the right to a clean and healthy environment [15].

9.6.2 Specific OSH Related Rules and Regulations

a) Labor Proclamation No. 377/2003

Section three of the Labor Proclamation No. 377/2003 presents the obligation of the parties. Provision 12 states obligations of an Employer among which is taking all the necessary occupational safety and health measures [16].

SECTION THREE
Obligation of the Parties

12. *Obligations of an Employer*

to take all the necessary occupational safety and health measures and to abide by the standards and directives to be given by the appropriate authorities in respect of these measures;

This same section also puts forward the obligations expected from the workers.

- to handle with due care all instruments and tools entrusted to him for work;
- to report for work always in fit mental and physical conditions;
- to give all proper aid when an accident occurs or an imminent danger threatens life or property in his place of work without endangering his safety and health;
- to inform immediately the employer any act which endangers himself or his fellow workers or which prejudice the interests of the undertakings;

Article 179: Power and Duties of Labor Inspectors

- The Labor inspectors shall have the power to enter, during any working hours without prior notice, any work place which they may think necessary to inspect in order to examine, test or enquire to ascertain observation.

Article 178: Measures to be taken by Labor Inspection

1. When the labor inspector observes any conditions which constitute a threat to the health, safety or welfare of the workers of such undertaking he shall instruct the employer to correct such condition within a given period of time.
2. And if the employer fails to take stapes within the given time, the inspector shall issue order to require the employer alteration in existing conditions which may be necessary to remove the threat to the health, safety or well-being of the workers. And an order requiring the employer any measures that may be necessary to prevent imminent danger to the safety or health of the workers to be taken immediately. In cases of having doubt about the technical or legal danger of any particular case, the Labor Inspector shall report thereon to the minister requesting that appropriate decision be given and orders given accordingly.

- **Strengths Advantages and Gaps on the Labor proclamation 377/2003**

The law as part of its implementation strategies has stipulated about the penalty which will be lodged upon the non-compliers of the law including those offenders due to violating of the provisions of the law pertaining to safety, health, working environment and fundamental rights at work places (Article 183-186). The penalty laid down in for all violations except for those violating the procedure set (Article 130 (2&4)) for collective bargaining is up to Birr 1200 . In the case of not showing good faith or not appearing for bargaining the penalty is up to Birr 10,000 (Amendment of the Labor Proclamation No.494/2006, Article 4(1)). On Article 183 as a general provision, it is also stated that unless the penal code provide more severe penalties, the penalties described above shall be applied.

Ethiopia has been a member state of the ILO since 1923 and has ratified 19 conventions until 2006 one of which is the occupational safety and health and working environment convention No 155/1981which was ratified on September 1991 [9].

Next some of the other laws and regulations related to occupational safety, health and working environment we came across are discussed.

b) The Public Health Proclamation 200/2000

The objective of the law is to legally determine the mechanism and steps to be taken for the promotion of the health of the society and creation of healthy environment the law covers also the obligation of putting in place of minimum requirement of health and hygiene to be maintained in each enterprise. The competent authority to oversee the implementation of the law is the Ministry of Public Health and its regional counterparts. It is also clearly indicated that the competent authority shall appoint qualified and capable inspectors to implement the provisions of the proclamation. The law has clearly spell out that subsequent laws related with public health shall be issued. The inspectors who do have powers without prior notice can enter into premises to inspect matters that endanger the public health including those that affects the health of workers. The matters which directly related to occupational safety and health that are provided by the law are those that deal with occupational health control and use of machines, and the waste handling and disposal as a part of the obligation of the employer through the same law in its Articles 12 and 13 [17].

c) Proclamation on Radiation Protection No. 79/1993

This is the law which has enabled the authority to control and supervises activities involving all sources of radiation and to lay down laws governing such activities in order to minimize any associated hazards. while allowing such activities to be carried out for the benefit of the public in general and working population in particular the authority which is the custodian for the implementation of the law has a mandate to recruit inspectors that have authority to inspect and identify radiation exposure and sources including those of occupational origin for putting in place of appropriate mitigating methods including taking prosecuting measures up on noncompliance by proponents [18].

Radiation protection proclamation No. 571/2008 is applicable to radiation sources, accessories of radiation devices and related practices and should not extend to radiations and radiation sources found in nature without any human interventions and sources and practices which are exempted from regulatory control. Any person who engages in a practice or is in possession radiation sources needs to apply for authorization.

- A person who applies shall make safety assessment on the likelihood and magnitudes of exposure attributed to the source depending on the nature of the practice and submit the report and take all necessary steps for radiation protection and safety (Article 18/3/c).
- Article 22 discusses about the duties and responsibilities of licensees and other concerned parties. Sub article 1 among other things states that any licensee shall appoint a qualified and experienced person in radiation health and safety measures as radiation safety officer.
- The licensee and the radiation safety officer shall ensure that radiation workers are supplied with monitoring device commensurate with the level of the potential risk expected from the authorized source or practice and other accessories necessary to carry out radiation work with the lowest reasonably achievable risk. And also that the workers are given proper instructions on radiation safety measures and as appropriate receive medical checkup every six months.
- Engagement in radiation work and medical examination is raised under article 24. Any person shall not engage in radiation work if he does not have proper training, is under the age of eighteen years or is not found, by medical examination, to be free from disease or

weakness which could be considered to make him particularly vulnerable to the health hazards involved in the work. If a person engaged in radiation work or any person who, because of his work, may have been exposed to ionization radiation shows signs of injury which may be suspected of having been caused by such radiation, the licensee shall have the responsibility to immediately make arrangements for medical examination of the person.

- In order to insure the implementation of the proclamation and make the society give it proper attention, this proclamation also places penalties (Article 28) for not practicing the stated rules which will be implemented unless severe penalties are prescribed in the criminal law.

d) The Pollution Control Proclamation No. 300/2002

The law deals with any pollution in whatever forms be it in gases, mists, liquid and solid to be controlled if possible prevented the source. It is provides that enterprises and work places are responsible for controlling any type of pollutant generated in due course of their production services. The law designated the Environmental Protection Authority, to ensure the implementation of the law. The competent authority undertake both the inspection of the premises where such pollutant is believed to exist and undertake various measures including the monitory, evaluation of the hazard and propose measures to control.

In some cases also to take the case to courts if there the case to courts if there is non-complacence and proponents are not in position to implement the subsequent recommendation given by the authority. The authority shall assign inspectors who have the authority to inter in to premises or enterprises and activities to ensure the ideas of the law implemented.

e) Environmental Impact Assessment Proclamation No.299/2002

The law deals with setting legal basis in order to manage and control the environmental effects which are caused by development activity before resuming operational level at design, construction, operation or an or going one as a result of its modification or termination through impact assessment in order to put in place mitigating intervention. The law has set all the mechanism and steps to be taken in order to determine the project, or the would be production system can entail as a harmful effect on the entire environment in general and of the working

environment in particular. The issue identifying occupational safety and health impacts is also a central theme of the environmental Impact assessment proclamation and the subsidiary regulation, standards set for the effective implementation of the ideals of the law there in. The law clearly stipulated that any owner of project for which environment impact assessment, should be done in order to identify the likely adverse impacts the project can bring to the environment [15].

f) The Investment Proclamation of the Federal Democratic Republic of Ethiopia, No 37/1996

The legislation which is proclaimed for the encouragement and promotion of investment in order to accelerate economic development of the country has also clearly stipulated that upon the application for investment permit new projects required that the investment authority in collaboration with concerned bodies to ascertain that the investment complies with the conditions stipulated in other necessary laws such as environmental, public health, labor law (Safety, Health and Foreign work Permit) to mention a few, within 10 days after receiving application, shall issue an invest permit. If the investment could not fulfill all the conditions set by the relevant laws as per deemed necessary advise is given to incorporate the advice to fulfill the conditions. If that cannot be accepted accordingly, the license can be suspended or evocated (Article 14 and 16) [15].

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