# Automotive Electricity and Electronics

# Level –V

## Based on December 2024, Curriculum Version II


**Module Title: Technical Specifications and project/Service cost Standard**

**Module Code: EIS AEE5 M06 1224**

**Nominal Duration: 60 Hours**

**Prepared by: Ministry of Labor and Skill**

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## Table of Contents

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# Acronyms

| | |
|---|---|
| VAT | Value Add Tax |
| IRS | Internal Revenue Service |
| LAP | Learning Activity Performance |
| TM | Training Module |

## Introduction to Module

This section to read and interpret exploded and sectioned views of automotive component parts and to monitor project costing systems. It requires interpretations of standard machine drawings by using symbols, dimensional tolerances and conventional representation of materials, machine elements, and sizes of drawing sheets and determines, manage, and prepare maintenance of cost control, the production of expenditure and schedules. This module is designed to meet the industry requirement of standard machine drawings by using symbols, dimensional tolerances and conventional representation of materials, machine elements, sizes of drawing sheets level V occupational standard, particularly for the unit of competency: Developing Technical Specifications and project/Service cost Estimation

**This module covers the units**:

- Introduction to specification
- Prepare and Develop Specifications
- project/service costs standard

**Learning Objective of the Module**

- Understand to specification
- Prepare and Develop Specifications
- Understand and prepare project/service costs standard

**Module Instruction**

For effective use these modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

# Unit one: Introduction to specification

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Purpose of Specifications
- Types of Specifications
- Manufacturer's specification manual
- Interpreting and applying manual data

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Define the Purpose of Specifications
- Identify Types of Specifications
- Understand Manufacturer's specification manual
- Understand Interpreting and applying manual data

### 1.1 Purpose of Specifications

Automotive Technical Specification, also a technical spec or tech spec, is a comprehensive document that outlines the precise engineering and design details of a vehicle or automotive component. These specifications serve as a vital reference for manufacturers, engineers, designers, and quality control personnel involved in the production and maintenance of vehicles.

The word "**specifications"** means identifying the goods, works and services required by the procuring entity.

However, in the context of this guideline, a specification document is one of three documents that can be defined as a statement of needs as it defines what the procuring entity wants to buy and consequently, what the supplier/contractor is required to provide.

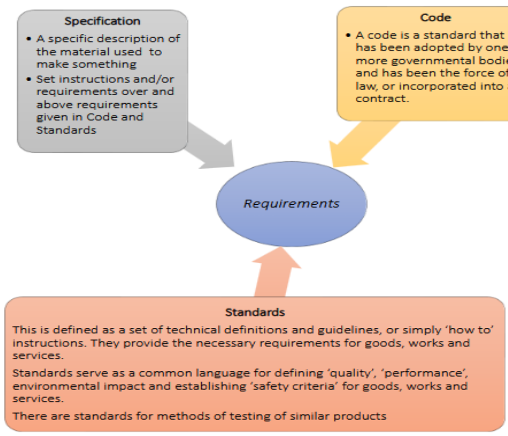
A specification is a term that is applied generally to goods and is the technical description of the Product to be procured covering the requirements and much more - e.g. cost, technicalities, problems, etc.

The term 'requirement' refers to the users' description of what the finished product, in their eyes, should do. This involves collecting information, identifying appropriate solutions and avoiding over and under specification and time for delivery. Given that specifications

include the requirements, it is advisable that the requirements are determined before the specifications..

**Specification vs Codes vs Standards**

Understanding the difference between specification, codes and standards is very important, since this ensures the procuring entity's documents clearly identifies the needs



**Key components of automotive technical specs include:**

**Design and Dimensions:** This section provides detailed drawings, diagrams, and measurements of the vehicle's structure, including the chassis, body, and major components. It outlines the vehicle's overall dimensions, weight distribution, and key design parameters.

**Materials and Construction:** These specifications specify the materials used in the vehicle's construction, such as types of metals, plastics, or composites. It details welding techniques, fasteners, and other joining methods.

**Engine and Powertrain:** Information about the engine, transmission, drivetrain, and associated components is included. This covers engine type, displacement, power output, torque, and emission standards compliance.

**Electrical and Electronics:** Technical specs detail the vehicle's electrical system, including the wiring, sensors, control units, and communication protocols. It also outlines safety features like airbags and electronic stability control systems.

**Fuel System:** For vehicles with internal combustion engines, specifications describe the fuel delivery system, fuel tank capacity, and efficiency standards.

**Suspension and Steering:** This section provides information on the vehicle's suspension setup, including the type of suspension, shock absorbers, and steering system.

**Safety Features:** Specifications cover safety components such as seat belts, airbags, antilock braking systems (ABS), and electronic stability control (ESC) systems.

**Performance Parameters:** Technical specifications include performance data like acceleration, top speed, fuel economy, and emissions levels.

## 1.2 Types of Specifications

Classification of automobile. Vehicle specifications of two/three wheeler, light motor vehicles, trucks, buses and multi-axle vehicles. Engine components (Introduction) .

Study of engine specifications, comparison of specifications of vehicles. Introduction of Electric and Hybrid Vehicles. Cost analysis of the Vehicle.

Specifications are technical data, numbers, clearances and measurements used to diagnose and adjust automobile components. Specifications can be referring to as specs. They are usually consider precise measurements under standard conditions. Examples of specifications include. valve clearances, spark plug gaps, Ignition timing and size of engine and etc

**General Engine Specification**–This specification identify the size and style of the engine.

They are include :- Cubic ,inch displacement, Engine codes, Fuel system settings, Bore and stroke, Horsepower, torque, compression ratio and Normal oil pressure.

**Tune-Up specifications** – This specification helps identify adjustments necessary for tune-up on the vehicle. This includes. Spark plug gap, Firing order, Degrees of ignition timings, Fuel system settings and fuel pump pressure.

**Capacity Specifications** –This specification include identifying the capacity of different fluids on the vehicle. This includes : Cooling capacity, Number of quarts of oil , Fuel tank size, Transmission transaxle capacity, Rear axle capacity

**Maintenance Specifications -** This specification used to aid technician in servicing the vehicle. This include distributor advance at different speeds,

This specification help the technician determine how much wear has occurred. The mechanic is then able to decide whether to replace the component in question. Usually maximum or minimum clearances given for this purpose.

**Operational Specification** – This specification tell how the vehicle is to operate, what type of oil to use, and so on. Some of them found in the owner's manual. Other specification includes Tire inflation, Tire size and general information for the operator of the vehicle.

**Torque Specification** – It is important to torque each bolt or nut correctly when replacing or installing a component on the automobile. Torque specifications used for this purpose. This torque specification used in place of any standard bolt and nut torque specification.

## 1.3 Manufacturer's specification manual

A **Vehicle Manufacturer's Specification Manual** (often referred to as a **Service Manual** or **Owner's Manual**) is a comprehensive document provided by the vehicle manufacturer that contains detailed information about a specific vehicle model. This manual serves multiple purposes for both vehicle owners and automotive professionals. Here are the key components typically included:

**General Information**: Overview of the vehicle model, Specifications for different trims and options

**Technical Specifications**: Engine details (type, displacement, power output), Transmission and drivetrain information Chassis dimensions and weight specifications

**Maintenance Guidelines**: Recommended service intervals Maintenance schedules for oil changes, filter replacements, etc. Fluid types and capacities (engine oil, coolant, brake fluid)

**Repair Procedures**: Step-by-step instructions for common repairs, Diagrams and illustrations for easier understanding Torque specifications for bolts and fasteners

**Troubleshooting Information**: Common issues and their solutions, Diagnostic trouble codes (DTCs) and their meanings Electrical system troubleshooting

**Safety Information**: Safety features and how they operate, Emergency procedures and guidelines Information on airbags and child safety seats

**Emissions and Environmental Compliance**: Information on emissions standards and compliance Maintenance procedures for emission control systems

The specification manual is crucial for vehicle owners, mechanics, and dealerships as it provides essential information for proper vehicle operation, maintenance, and repair. It helps ensure that vehicles are serviced correctly, promoting safety and longevity.

### 1.3.1 Types of manual

**Owner's manual**

Owner's manual an owner is manual or an operator's manual is a booklet that comes with a new car. This manual usually explains how to operate the automobile's control and accessories. In addition, the owner's manual provides a great deal of technical information that can be useful to the technician.


Fig 1.3 Cover and a table of contents of a typical owner's manual

**Repair Manual**

The technician at independent repair shops most often uses a repair manual. This manual called an aftermarket because it published by independent publisher and not by the car manufacturer. Like the shop manual.

This contains information on troubleshooting,

Specifications and step- by- step repair procedures.

The main difference is that they cover many different car models and years instead of just one. Because they are covering more models and years, they typically cover topics in less detail.

**Service manuals**

Service manuals**: -** are also published by independent companies rather than the manufacturers. However, they pay for and get most of their information from the carmakers. The manuals contain component information, diagnostic steps, repair procedures, and specifications for several makes of automobiles in one book. Information is usually condensed and is more general than the manufacturers' manuals. The condensed format allows for more coverage in less space and, therefore, is not always specific. They may also contain several years of models as well as several makes in one book.

### 1.4 Interpreting and applying manual data

There are different types of specifications, which generally are mostly types of documents, forms or orders or relates to information in databases. The word specification is defined as "to state explicitly or in detail" or "to be specific". A specification may refer to a type of technical standard (the main topic of this page).

Using a word "specification" without additional information to what kind of specification you refer to is confusing and considered bad practice within systems engineering.

A requirement specification is a set of documented requirements to be satisfied by a material, design, product, or service.

**A functional specification** is closely related to the requirement specification and may show functional block diagrams.

**A design or product specification** describes the features of the solutions for the Requirement Specification, referring to the designed solution or final produced solution. Sometimes the term specification is here used in connection with a data sheet (or spec sheet). This may be confusing.

**A data sheet describes** the technical characteristics of an item or product as designed and/or produced. It can be published by a manufacturer to help people choose products or to help use the products. A data sheet is not a technical specification as described in this article.

**"In-service" or "maintained** as" specification, specifies the conditions of a system or object after years of operation, including the effects of wear and maintenance (configuration changes).Specifications may also refer to technical standards, which may be developed by any of various kinds of organizations, both public and private.

**Understanding and using Manuals**

The manual uses the conventions described below.

**Bold text** is used for emphasis and to high light selectable the manual contains instructions for maintain, servicing, and repair and replacing and also testing the vehicle. Some of the illustrations shown in the manual may contain modules and optional equipment that are included on operating systems. **Conventions;**

Example: Select OK to items such as buttons and menu options continue.

**Terminology**; certain terms are used to command specific actions throughout the manual. Those terms are described below.

**Select:-**The term “select” means to highlight a menu item or other option, then pressing the Y/a, OK, Accept, or similar button to activate it. Example:  Select Functional Tests.

**Scroll:** - The term “scroll” means moving the cursor or changing data by using the directional arrow buttons, scroll bars, or other means. Example: Scroll to see any other codes and the data list.

**Using the Manual Notes and Important Messages**

**Scan Tool; -** The term “scan tool” is used to refer to any tool that communicates directly with the vehicle data stream. When necessary, the term “Scanner” is used to distinguish Snap-on equipment from another diagnostic device, such as any vehicle factory scan tool.

**Notes and Important Messages**

The following messages appear throughout the manual.

**A NOTE:** provides help full information such as explanations, tips, and comments.

Example: - NOTE: for additional information refer to...

**IMPORTANT**: Indicates a situation which, if not avoided, may result in damage to the test equipment or vehicle.

Example:-IMPORTANT: To avoid incorrect TPS adjustment or component damage, be sure to follow the on-screen instructions. Refer to a vehicle service manual for complete test or adjustment procedures.

**The manual is intended to assist:**

New operators in the highway transportation industry, including but not limited to, trucks that have a registered gross weight or actual weight of over 4,500 kilograms, and buses that can carry 10 or more passengers (excluding the driver)

New operators preparing to complete the Commercial Vehicle Operators' Registration (CVOR) written test.

Existing operators who need to have a clear understanding of their responsibilities, relevant acts, regulations and requirements.

Truck and bus operators who transport dangerous goods or have a specific requirement covered in this guide.

Maintenance staff who repair, maintain and test-drive commercial vehicles.

Safety officers responsible for ensuring the safe operation of commercial vehicles and driver safety .

Company management seeking to comply with legislative requirements

| | |
|---|---|
| VEHICLE MAKE ...................... | Fuel Filter CHAMPION Type........... |
| MODEL ........................... | CLUTCH Type.................. |
| GENERAL DATA ...................... | Adjustment .................. |
| ENGINE................................ | SUSPENSION Front wheel Alignment |
| Cylinder arrangement............... | TYRES _____ |
| Bore .................. | Type .................. |
| Stroke.................. | Pressures cold Front.................. |
| Compression ratio............Natural aspirated/Turbocharger | Rear .................. |
| | ELECTRICAL------- |
| Oil filter CHAMPION type.................. | Battery type.................. |
| Air filter CHAMPION type .................. | Cold crank .................. |

**Interpret manuals according to job requirement**

Diagnosing or Troubleshooting Information One type of troubleshooting guide is the diagnosis chart. The first part lists the possible problem, then sit i divided into three areas: condition, cause and the Correction.

| FUEL SYSTEM DIAGNOSIS | | |
|---|---|---|
| The following diagnostic procedures are for fuel system problems and their effect on vehicle performance. Other systems of the vehicle can also cause similar problems and should be checked when listed on the chart. The problem areas described are:<br>1. Engines cranks normally. Will not start<br>2. Engines starts and stalls.<br>3. Engine starts hard.<br>4. Engine idles abnormally and/ or stalls<br>5. Inconsistent engine idle speeds<br>6. Engine diesels (after run) when shut off.<br>7. Engines hesitates on acceleration<br>8. Engine less than normal power at low speeds<br>9. Engine has less than normal power on heavy acceleration or at high speed.<br>10. Engine surges<br>11. Poor gas mileage | | |
| CONDITION | POSSIBLE CAUSE | CORRECTION |
| | | |

**Working Steps or correct sequencing and Adjustment**

Procedure information gives the correct step by step to follow in doing a repair job. The procedures are usually numbered in a step-by-step order. Below is an example of stepby-step procedure to follow in replacing a cylinder head.

**Cylinder Head Replace**

1. Raise and support front of vehicle, then drain cooling system and disconnect exhaust pipe from manifold.
2. Lower vehicle and remove oil dipstick tube and air cleaner.
3. Disconnect wire connectors and vacuum hoses from carburetor or TBI unit.
4. Remove EGR valve base plate from intake manifold, if applicable.
5. Disconnect heater hose from intake manifold, then remove AIR system discharge tube attaching bolt from intake manifold.
6. Remove ignition coil lower attaching bolt, then disconnect wiring from coil.
7. Disconnect all wiring from cylinder head and intake manifold, then remove engine upper support attaching bolt from engine strut.
8. Remove A/C compressor and position aside with refrigerant lines attached.
9. Remove alternator drive belt, then remove AIR pump bracket bolt from engine block, if equipped.
10. Disconnect throttle and throttle valve cables from throttle lever and intake manifold.
11. Disconnect upper radiator hose from cylinder head then disconnect AIR hose from tube assembly, if equipped.
12. Remove rocker arm cover, and then remove rocker arms and push rod.
13. Remove cylinder head attaching bolts then lift cylinder head and intake and exhaust manifold as an assembly from cylinder block.

**Procedures for Finding Specification**

The following are the general procedure when locating information:

1. Identify the type, model and year.

2. Locate the VIN on the vehicle for reference.

3. Select the appropriate year of the service manual

4. Refer to the first table of contents in the manual on the inside cover and page number that covers the type of vehicle.

5. Turn to that page and read the index of service operation

6. Look for the engine rebuilding specifications page number and turn to that page.

7. Engine rebuilding specifications are shown in various tables.

8. Often these specifications will be listed according to the size and configuration of the engine. If you are unsure of this information, use the VIN to identify the size and configuration. VIN information can be found by referring to the first table of contents.

9. Also pay close attention to the footnotes identified by the numbers such as 1, 2,3,4,5. These footnotes give valuable information to the service technician concerning specific engine styles.

**How to use and interpret a Shop Manual**

1. Select he appropriate manual for the vehicle being serviced.
2. Use the table of contents to locate the section that applies to the work being done.
3. Use the index at the front of that section to locate the required information.
4. Carefully read the information and study the applicable illustrations and diagrams.
5. Follow all the required steps and procedures give for that service information.
6. Adhere to all the given specifications and perform all measurements and adjustment procedure with accuracy and precision.

**Self-check 1.1**

**Part-I: Choose the correct answer from the given alternatives**

1. What is the primary purpose of specifications in a project?
   a. A) To outline the project timeline
   b. B) To define the requirements and expectations for the project
   c. C) To manage team dynamics
   d. D) To allocate budget resources
2. Specifications serve as a legal document that can be used to:
   a. A) Justify project delays
   b. B) Resolve disputes between stakeholders
   c. C) Increase project scope
   d. D) Change team members
3. Which of the following is a key purpose of technical specifications?
   a. A) To provide marketing information
   b. B) To ensure compliance with industry standards
   c. C) To define project risks
   d. D) To assign tasks to team members
4. How do specifications contribute to project quality?
   a. A) By limiting communication among team members
   b. B) By providing clear guidelines for performance and acceptance criteria
   c. C) By increasing project costs
   d. D) By reducing the need for testing
5. Specifications help in managing stakeholder expectations by:
   a. A) Offering vague descriptions of project outcomes
   b. B) Providing detailed descriptions of project deliverables
   c. C) Excluding stakeholders from the development process
   d. D) Focusing solely on budget constraints

**Directions: Answer all the questions listed below.**

**Part II: Fill in the blank space**

1) A Manufacturer's Specification Manual serves as a comprehensive __________ for the products produced by the manufacturer.
2) The manual typically includes detailed __________ regarding the materials, dimensions, and performance characteristics of the product.
3) One key section of the manual is the __________ section, which outlines the safety and regulatory compliance requirements.
4) The __________ section of the manual provides guidelines for installation, operation, and maintenance of the product.
5) Manufacturer's specifications often include __________ diagrams to help users understand the product's design and function.
6) A well-structured specification manual helps ensure __________ among different teams involved in product development and production.
7) Specifications in the manual should be clear and __________ to avoid any misunderstandings during the manufacturing process.

## Unit two. Prepare and Develop Specifications

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Technical specification
- Develop technical Specifications procedures
- Methods of organizing Technical specification

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify Technical specification
- Develop technical Specifications procedures
- Identify the Methods of organizing Technical specification

## 2.1 Technical specification

**Automotive Technical Specifications** refer to detailed descriptions and parameters that define the performance, design, and functionality of a vehicle. These specifications serve as a guideline for manufacturers, engineers, and consumers, providing essential information about a vehicle's capabilities and features.

The purpose of developing a specification is to help procuring entities promote the broadest possible competition among suppliers/contractors, while assuring the critical performance or other requirements for the goods, works and services.

**Depending on the need, specifications can be simple or complex.**

Nevertheless, the success of effectively communicating the specification to suppliers resides with ensuring that they are coherent, accurate and logical, without repetition or unnecessary/extraneous detail, expressed in unambiguous language and in terms that are readily understood by participants in the relevant supply market.

Specifications, once developed, must coincide with other related project documents (drawings, schedules/programme, other consultant's documents, statutory regulations, standards and codes of practices, building codes), and serve the following:

Standard technical specifications for a vehicle typically include a range of categories. Here's a breakdown of common specifications you might find:

**Clear definition**

As a supporting document, the specification is an opportunity to make your requirements on a project clear. A good specification should give a clear indication of the levels of quality you expect, the types of materials you want to be used on the job and how they should be installed, finished or tested.

**Support for your drawings (where applicable)**

Drawings alone cannot convey all your requirements. Supporting drawings (whether hand-drawn or developed as computer-aided drawings) with a comprehensive and detailed specification will save you time and effort in the long run.

**Information to ensure accurate pricing**

A well-structured specification with suitably detailed information should make it easy for a supplier/contractor to submit a price quickly and accurately. Ensuring you provide detailed information about project requirements, perhaps even specific products, but certainly expectations on performance and minimum operating standards that need to be achieved will result in more accurate pricing down the line

**The ability to minimize risk**

Classifying requirements in a specification eliminates any uncertainty on what is to be provided as well as any potential disputes. A specification that draws on relevant and up-to-date standards and accurately references the drawings should therefore help minimise risks of dispute on a project

**Clear instructions for those delivering your project**

A good specification acts as the main performance indicator of the project and thereby as a guide for 'on-site' instruction. It represents the standards for workmanship to be completed and effectively provides instruction for those working on the job to follow.

It is important to remember that your specification should not be excessively prescriptive when it comes to delivery, that is, the focus should clearly be on outcomes rather than the process by which the outcomes are achieved; for example, a water-tight roof would be an outcome while vacuuming the floor is a stipulation on how the outcome should be achieved, which would not be detailed in the specification.

**The ability to improve compliance**

This ensures the specification adheres to specific standards, sustainability benchmarks and health and safety requirements. Timely and efficient statutory compliance helps you avoid legal implications and penalties on a project and reduces the risk of prosecution.

**The security that comes from being legally binding**

Simply put, the specification forms part of the contract documentation and therefore becomes legally binding in the event of any dispute or litigation.

**An assurance of client satisfaction**

The specification is an interpretation of the initial brief. The clarity and completeness of requirements, delivery terms and any particular conditions governing the supply to the destination ensures that the supplier meets the performance criteria, thereby maximising client satisfaction.

**A resource for facilities management**

In the context of a facilities management team, specifications develop and evolve across the project timeline and eventually leads to an "as built" version that represents a complete specification of the final asset. Specification will prove invaluable for facilities managers and maintenance teams to provide vital information about the building or asset when it transitions into use, re-use and even through to demolition.

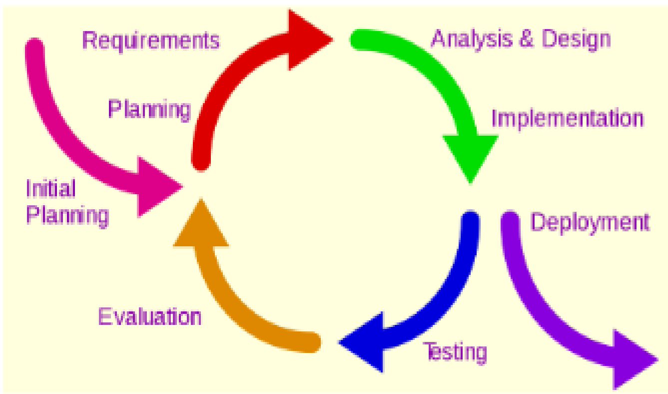
**Cost effective-saves time and money**

Taking the time to collate accurate information, clear instruction and minimal repetition will allow the supplier/contractor to proceed with little disruption, with a reduced need for questioning and clarification, all of which would add time and reduce costs to a project.

**Developing specification in stages**

When the requirements are complex and there are many potential solutions, consider refining the requirement and developing the specification in stages. This approach allows requirements to be refined in response to a narrowing range of solutions

Specification Development Process Flow




A typical process flow for planning and managing the development of specification


Figure 2.1: Typical Specification Process Flow4

**1. Engine Specifications**

- **Type**: Inline, V-type, rotary, etc.
- **Displacement**: Measured in liters (L) or cubic centimeters (cc).
- **Power Output**: Horsepower (hp) or kilowatts (kW).
- **Torque**: Measured in pound-feet (lb-ft) or Newton-meters (Nm).
- **Fuel System**: Carbureted, fuel injection, turbocharged, etc.
- **Fuel Type**: Gasoline, diesel, electric, hybrid.

**2. Transmission**

- **Type**: Manual, automatic, continuously variable transmission (CVT).
- **Number of Gears**: Typically ranges from 4 to 10.
- **Drive Configuration**: Front-wheel drive (FWD), rear-wheel drive (RWD), all-wheel drive (AWD), or four-wheel drive (4WD).

**3. Chassis and Dimensions**

- **Body Style**: Sedan, coupe, SUV, truck, etc.
- **Wheelbase**: Distance between the front and rear axles.
- **Length, Width, Height**: Overall dimensions of the vehicle.
- **Curb Weight**: Weight of the vehicle without passengers or cargo.
- **Payload Capacity**: Maximum weight the vehicle can carry.

**4. Suspension System**

- **Front Suspension**: Type (e.g., MacPherson strut, double wishbone).
- **Rear Suspension**: Type and configuration.
- **Ground Clearance**: Distance between the ground and the lowest point of the vehicle.

**5. Braking System**

- **Type of Brakes**: Disc, drum, or regenerative (for electric vehicles).
- **Anti-lock Braking System (ABS)**: Whether equipped or not.

- **Brake Dimensions**: Size of rotors and drums.

**6. Tires and Wheels**

- **Tire Size**: Specifications usually include width, aspect ratio, and diameter (e.g., 225/45R17).
- **Wheel Type**: Material (steel, alloy) and size.

**7. Electrical System**

- **Battery Capacity**: Measured in amp-hours (Ah).
- **Alternator Output**: Measured in amps.
- **Lighting System**: Types of headlights (halogen, LED).

**8. Performance Metrics**

- **Acceleration**: Time to reach 0-60 mph or 0-100 km/h.
- **Top Speed**: Maximum speed of the vehicle.
- **Fuel Economy**: Miles per gallon (mpg) or liters per 100 kilometers (L/100km).

**9. Safety Features**

- **Airbags**: Number and type (front, side, curtain).
- **Stability Control**: Presence of electronic stability control (ESC).
- **Crash Test Ratings**: Ratings from organizations like NHTSA or IIHS.

**10. Interior and Features**

- **Seating Capacity**: Number of passengers.
- **Infotainment System**: Type and features (Bluetooth, navigation).
- **Climate Control**: Air conditioning, heating, etc

## 2.2 Develop technical Specifications procedures

Developing technical specifications for a vehicle involves a systematic approach to ensure accuracy and comprehensiveness. Here’s a step-by-step procedure:

### 1. Define Objectives

- Determine the purpose of the specification (e.g., new vehicle design, compliance, marketing).
- Identify the target audience (engineers, manufacturers, consumers).

### 2. Gather Preliminary Information

- Research existing vehicle specifications and industry standards.
- Review regulatory requirements (safety, emissions) relevant to the vehicle type.

### 3. Establish a Specification Framework

- Create a standardized template, including sections for each category (engine, transmission, etc.).
- Ensure the template allows for detailed descriptions and technical data.

### 4. Collect Data

- **Engine Specifications**: Gather data on engine type, displacement, power, and torque.
- **Transmission**: Specify the type, number of gears, and drive configuration.
- **Chassis and Dimensions**: Measure or obtain dimensions such as wheelbase, curb weight, and payload capacity.
- **Suspension and Brakes**: Detail the types of suspension systems and brake configurations.
- **Tires and Wheels**: List tire sizes and wheel specifications.
- **Electrical Systems**: Document battery capacity and lighting systems.
- **Safety Features**: Include information on airbags, stability control, and crash test ratings.
- **Interior Features**: Describe seating capacity, infotainment systems, and climate control.

**5. Analyze Performance Metrics**

- Conduct tests or simulations to determine acceleration, top speed, and fuel economy.
- Document results and link them to the vehicle specifications.

**6. Review and Validate Data**

- Cross-check collected data with industry standards and benchmarks.
- Engage relevant stakeholders (engineers, designers) to validate specifications.

**7. Draft the Technical Specifications Document**

- Use clear and concise language to describe each specification.
- Include diagrams and charts where necessary for clarification.
- Ensure that all units of measurement are standardized.

**8. Implement Revision Procedures**

- Establish a process for updating specifications based on new data, technology, or regulatory changes.
- Create a version control system to track changes.

**9. Approval and Finalization**

- Submit the draft document for review to stakeholders and management.
- Incorporate feedback and finalize the specifications document.

**10. Dissemination and Training**

- Share the finalized specifications with relevant teams (production, sales, marketing).
- Provide training sessions to ensure understanding and correct application of the specifications.

**11. Monitor and Evaluate**

- After implementation, monitor vehicle performance against the specifications.
- Gather feedback from users and stakeholders to identify areas for improvement.

### 2.3 Methods of organizing Technical specification

Organizing technical specifications effectively is crucial for clarity and usability. Here are several methods to structure and organize technical specifications:

1. **Categorical Organization**

**Sections by Systems**: Divide specifications into major vehicle systems such as:

Engine**,** Transmission Chassis**,** Suspension**,** Braking System**,** Electrical System**,** Interior Features

**Pros**: Easy to navigate; users can quickly find specific information.

2. **Hierarchical Structure**

**Main Categories and Subcategories**: Use a hierarchy to break down complex information.

**Engine**

- Type
- Displacement
- Power Output

**Transmission**

- Type
- Number of Gears

**Pros**: Provides depth and detail; ideal for comprehensive documents.

3. **Tabular Format**

**Tables for Quick Reference**: Present data in tables for easy comparison.

Example:

| Specification | Value |
|---|---|
| Engine Type | V6 |
| Horsepower | 300 hp |
| Torque | 400 Nm |

**Pros**: Facilitates quick understanding and comparison of specifications.

4. **Flowcharts and Diagrams**

**Visual Representation**: Use flowcharts or diagrams to illustrate relationships between components.

**Pros**: Enhances comprehension, especially for complex systems.

5. **Chronological Order**

**Development Timeline**: Organize specifications based on the development process or vehicle lifecycle stages (concept, design, production).

**Pros**: Useful for tracking changes and understanding the evolution of specifications.

6. **Alphabetical Order**

**A-Z Listing**: List specifications alphabetically for quick lookup.

**Pros**: Simple and straightforward; useful for shorter documents.

7. **Modular Approach**

**Separate Modules**: Create self-contained modules for each specification area, allowing users to access only the information they need.

**Pros**: Reduces information overload; easy to update individual modules.

**8. Digital Formats**

**Interactive Documents**: Use digital tools (like PDFs with hyperlinks) to allow quick navigation between sections.

**Pros**: Enhances user experience; makes it easier to find information.

9. **Checklist Format**

**Checklists for Compliance**: Organize specifications as checklists for compliance or quality assurance.

**Pros**: Useful for ensuring all specifications are met during production or inspection.

10. **Use of Standards and Guidelines**

**Industry Standards**: Align specifications with recognized industry standards (e.g., SAE, ISO) for consistency and credibility.

**Pros**: Ensures clarity and compliance with industry norms.

**Prepare specifications**

First Year Engineering (DIT)

| Vehicle Specification Parameters | |
|---|---|
| Engine | Fuel Type: Petrol/ Diesel |
| | Engine Type |
| | Method of cooling |
| | Displacement |
| | No of cylinders |
| | Max. Power |
| | Max. Torque |
| | Valves per cylinder |
| | Fuel delivery: Carburetor/ Fuel pump/ injectors |
| | Compression Ratio |
| | Bore/ Stroke |
| | Compression Ratio |
| | Top Speed |
| Fuel Consumption | Fuel Tank Capacity (Liters) |
| | Reserve fuel capacity ( Liters) |
| | Mileage (kmpl) |
| | Overall riding Range |
| Transmission | Gear box: 4 Speed/ 5 Speed etc |
| | Clutch: Centrifugal clutch / wet multi plate clutch / single plate clutch |
| | Manual / Automatic/ Semi automatic |
| Braking | Front brake type : Drum/ Disc |
| | Rear brake type : Drum/ Disc |
| Suspension | Front Suspension: Telescopic Hydraulic Shock absorber |
| | Rear Suspension: Spring Loaded Hydraulic Damper |
| Wheels & Tyres | Wheel Type & Size: Spoke or Alloy wheel |
| | Tyre: Tubeless |
| | Tyre Size |
| Battery | Voltage: 12 V/ 18 V/ 24 V |
| Body Dimensions | Wheel Base |
| | Length (mm) |
| | Width (mm) |
| | Height (mm) |
| | Wheel Base (mm) |
| | Ground Clearance (mm) |
| | Kerb weight (kg) |
| | Gross weight (kg) |
| | Front Track |

**Vehicle Specification of Two Wheeler:**

| Specification | Honda Shine<br> |
|---|---|
| Engine Type | Single Cylinder, 4-Stroke, SI Engine |
| Displacement | 124.73 cc |
| Max Power | 10.30 PS @ 7500 rpm |
| Cooling System | Air Cooled |
| Drive Type | Chain Drive |
| Fuel Supply | Carburetor |
| Clutch | Wet, Multi Plate |
| Transmission | Manual |
| Gear Box | 5 Speed |
| Bore (Dia.) | 52.4 mm |
| Stroke | 57.8 mm |
| Compression Ratio | 9.2:1 |
| Front Suspension | Telescopic Fork |
| Speedometer | Analogue |
| Length | 2007 mm |
| Width | 762 mm |
| Height | 1085 mm |
| Fuel Capacity | 10.5 L |
| Ground Clearance | 160 mm |
| Weight | 120 Kg |
| Tyre Size (Dia.) | Front :-18, |
| Tyre Type | Tubeless |
| Front Brake | Disc brake |
| Rear Brake | Drum brake |



**Vehicle Specification of Light Motor Car:**

| Specification | Maruti Baleno Zeta<br> |
|---|---|
| Fuel Type | Petrol |
| Fuel Tank Capacity (Lit.) | 37 |
| Engine Displacement (cc) | 1197 |
| Body Type | Hatchback |
| Max Power (bhp@rpm) | 83.1bhp@6000rpm |
| Engine Type | Petrol Engine |
| Displacement (cc) | 1197 |
| Max Torque (nm@rpm) | 115Nm@4000rpm |
| No of Cylinder | 4 |
| Valves Per Cylinder | 4 |
| Valve Configuration | DOHC (dual overhead cam) |
| Fuel Supply System | MPFI (Multi Point Fuel Injection) |
| Transmission Type | Manual |
| Gear Box | 5 Speed |
| Drive Type | FWD |
| Ground Clearance (mm) | 170 |
| Length (mm) | 3995 |
| Width (mm) | 1745 |
| Height (mm) | 1510 |
| Wheel Base (mm) | 2520 |
| Total Weight (kg) | 880 |
| Front Suspension | Mac Pherson Strut |
| Rear Suspension | Torsion Beam |
| Steering Type | Power |
| Steering Column | Tilt & Telescopic |
| Steering Gear Type | Rack & Pinion |
| Front Brake Type | Disc |
| Rear Brake Type | Drum |
| Tyre Size / Type | 16 / Tubeless, Radial |

**Self-check 2.1**

**Part-I: Choose the correct answer from the given alternatives**

1. **What is the primary purpose of developing technical specifications?**
   A) To outline project timelines
   B) To communicate project requirements clearly
   C) To assign tasks to team members
   D) To manage stakeholder expectations
2. **Which of the following is NOT a key component of technical specifications?**
   A) Performance requirements
   B) Budget estimates
   C) Design details
   D) Testing procedures
3. **In developing specifications, what is the significance of stakeholder involvement?**
   A) It increases project costs
   B) It ensures all requirements are considered
   C) It slows down the development process
   D) It creates unnecessary complexity
4. **Which type of specification focuses on how a product or system operates?**
   A) Functional specification
   B) Technical specification
   C) Regulatory specification
   D) Performance specification
5. **What is a "requirements traceability matrix"?**
   A) A tool for estimating costs
   B) A document that links requirements to their source
   C) A list of project stakeholders
   D) A timeline for project deliverables
6. **What should be included in the introduction section of a technical specification document?**

A) Detailed design drawings
B) The purpose and scope of the specifications
C) A list of project team members
D) Cost estimates for the project

7. **Which method is commonly used to validate technical specifications?**
   A) Market research
   B) Peer review
   C) Random sampling
   D) Cost-benefit analysis
8. **What role do diagrams play in technical specifications?**
   A) They complicate the document
   B) They provide visual clarity and context
   C) They are unnecessary and should be avoided
   D) They only serve as decoration
9. **Which of the following is a common challenge in developing technical specifications?**
   A) Overly detailed documentation
   B) Lack of user involvement
   C) Clear communication of requirements
   D) Consistent formatting
10. **After developing technical specifications, what is the next crucial step?**
    A) Distribution to stakeholders
    B) Finalizing the project budget
    C) Conducting market analysis
    D) Initiating project execution

**Directions: Answer all the questions listed below.**

**Part II: Fill in the blank space**

1. The first step in preparing specifications is to clearly define the __________ of the project.
2. Specifications should be organized in a __________ format to ensure clarity and ease of use.
3. When developing specifications, it is important to gather input from __________ to ensure all requirements are met.
4. __________ specifications detail the performance characteristics and quality standards required for the project.
5. A well-written specification document should include measurable __________ to assess compliance.
6. It is essential to review and validate the specifications with __________ to ensure accuracy and feasibility.
7. The use of __________ can help visualize complex systems and relationships within the specifications.
8. Specifications should be kept up to date to reflect any changes in project __________ or requirements.
9. In the specification document, each section should include a clear __________ to guide the reader.
10. Conducting a __________ analysis can help identify potential risks and challenges associated with the specifications.

## Unit three: project/service costs Standard

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Introduction project cost estimation
- Identify project costs
- Preparation Of Project Expenditure Schedule
- Prepare Projected Cash Flow And Payments
- Maintain Checks On Expenditure And Evaluate Outcomes
- Recording And Reporting Project Cost Estimates

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Understand project cost estimation
- Identify project costs
- Preparation Of Project Expenditure Schedule
- Prepare Projected Cash Flow And Payments
- Maintain Checks On Expenditure And Evaluate Outcomes
- Record And Report Project Cost Estimates

### 3.1 Introduction project cost Estimation

Estimates are central to establishing the basis for key project decisions, for establishing the metrics against which project success will be measured and for communicating the status of a project at any given point in time. Logical and reasonable cost estimates are necessary in maintaining public confidence and trust throughout the life of a major project. The total program cost estimate includes construction, engineering, and acquisition of right-of-way, and related costs, which will be identified by this guidance. Although this guidance is for major projects, it may also be applied to other projects.

Major projects by nature are usually more complex and contain more risk elements than other projects. Careful attention must be provided when preparing cost estimates for major projects. Traditional estimating methods may not be appropriate in all cases.

Cost estimation should be prepared for all capital and rehabilitation projects, regardless of size, complexity, schedule, or stage of project development. It should be prepared by qualified and experienced people. The preparer of any cost estimate should be able to provide the basis for their decisions and to defend the specific elements of the cost estimate, if asked. Cost estimates are a key element in the business cases in which they are the basis for establishing and amending project budgets and are one of the most important factors against which the success of a project is measured.

Therefore philosophy of project cost estimating is to produce the best cost estimates to the level of project development, inclusive of contingencies reflective of the project risks and the project phase, using the most accurate and complete project and pricing information available at the time the estimate is prepared.

**What is a Project Cost Estimate?**

A “project cost estimate” is a prediction of the most likely total cost of the identified scope of work for a project. Cost estimates should reflect an overall accuracy indicative of the level of information available at the time the estimate is prepared.

Project cost estimates are based on identifying, quantifying and estimating the cost of consuming all the resources (e.g. people, machines, materials, services, property) required to complete all activities (e.g. planning, engineering, property acquisition, construction, etc.) including appropriate allowances for associated risks and uncertainty (contingency), using prices prevailing at the time the estimate is prepared.

Each project is unique. To accurately develop an estimate of costs for a project an estimator must be capable of mentally constructing the project, accounting for all the activities necessary to complete it, and then estimating the costs using prices prevailing at the time the estimate is prepared. Many of the best cost estimators are knowledgeable in both in design and construction.

**Cost Centres**

Parts of the business to which particular costs can be attributed In large businesses this can be a particular location, section of the business, capital asset or human resource/s Enable a business to identify where costs are arising and to manage those costs more effectively.

### 3.1.1 Purpose of a Cost Estimate

The primary purpose of a project cost estimate is to provide a basis for developing, amending, or reviewing a project budget. A cost estimate is a key component of the project business cases, as it is the foremost document to justify/support the funding allocation. Cost estimates are also used in value analysis/value engineering, and program planning in organizations investment plans.

### 3.1.2 Estimating Methods and Tools

The appropriateness of a particular estimating method depends upon the extent of the project information available, the stage of project development, the intended use of the estimate, the timeframe in which it is required to be prepared, and the estimator's preferences.

The commonly used methods are described below.

**Project Cost Estimates through the Project Lifecycle**

Over the years a general consensus has arisen: estimates which take into account the various risks that a project may face during its development and construction tend to be more accurate than those estimates which do not adequately consider such risks. As knowledge increases, risk typically decreases. Cost estimates originate during early planning stages of project development, and are updated and refined at strategic points throughout the project's life cycle as information becomes known.

Each updated estimate should reflect prevailing pricing for the entire scope of work to be performed based on the knowledge available at the time the estimate is prepared, and an appropriate assessment of the risks at that time. The result is a series of successive estimates, each indicating a greater level of confidence than the preceding estimate. While the total amount of the estimate may remain relatively consistent throughout this progression (i.e. no significant increase or decrease); the expected range of accuracy will have improved. Each successive estimate should fall within the range of accuracy of the previous estimate.

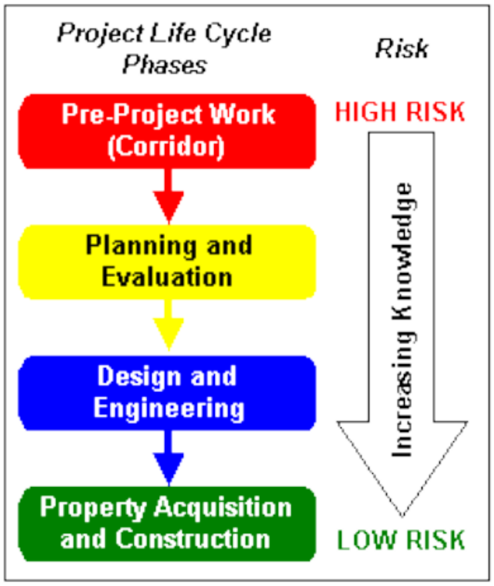



Fig-3.1 : Project Cost Estimates through the Project Lifecycle

### 3.1.3 Parametric Estimating Method

The parametric method produces a high level estimate using various factors (parameters) developed from historical databases, engineering practices and technologies that define the cost of typical transportation infrastructure or facility segments, such as cost per lane kilometer of roadway, cost per interchange, cost per square meter of a bridge structure, and cost per intersection. The historical costs used to develop these estimates come from previous relevant projects and from relevant historical percentages. The appropriateness of this method depends largely on the extent of the project definition available, and the similarity between the new project and historical models. This approach is beneficial when little or no design information is available. This method can be refined somewhat if selection of relevant projects and assessment of the data is more tailored to the specifics of the project being estimated. Costs from similar projects in the past provide an excellent source of information, but analysis of the data requires good judgment, both to select the most appropriate past project as a source, and to assess the accuracy of the historical data.

The parametric method is primarily intended to be used at the very early stages of project development prior to any detailed project planning. It can also be used as part of a quality assurance check on a more detailed cost estimate prepared during project planning or preliminary design. It should not be used as the basis for approving a project budget.

### 3.1.4 Detailed Cost Estimating Method

Detailed cost estimating is the most accurate estimating method, as each cost item is quantified and priced. This method can only be used when design definition has advanced to the point where quantification of units of work is possible (or can reasonably be assumed). It is used to develop pre-tender estimates.

Two approaches are generally used in detailed cost estimating: the historical bid-based approach and the cost-based approach (not often used).

**Cost-based approach:** This approach does not rely on historical cost data, rather it is based on determining the contractor's cost for labor, equipment, materials, and any specialty subcontractor effort, for each item needed to complete the work (also known as "bottom up" estimating). The cost-based approach is not often used, but Contractors generally utilize it to prepare bids. Cost based estimates require significant effort, time, and estimator experience to prepare. They may be preferable on unique projects where geographical influences, market factors or material prices may cause the use of historical unit prices to be unreliable and can be a good way to check a few large items of work in a historical bid based estimate to ensure that the historical prices are still valid. One effective way to develop detailed cost estimates is to use the cost-based approach on those work items that comprise the largest money value (typically that 20% of items that may account for 80% of cost) and then cost the remainder of estimate line items using the historical bid -based approach. Doing so provides for an efficient use of estimating resources and reduces the total time in preparing the estimate.

**Historical bid-based approach:** This approach applies historical unit cost data (i.e. recent average unit prices) to quantities or measures of individual work items to determine a total cost for each item.

Risk and Uncertainty

Costs should be determined for uncertainties within an estimate.

All elements of the project must be reduced to a cost that can be accounted and budgeted. There should be a disciplined and comprehensive method of assessing and reassessing project risk and uncertainty. Costs that are unknown and costs associated with potential risks can be included in the form of a contingency amount. Major projects require special consideration of project risk and complexity in order to produce accurate contingencies.

Contingency estimates should be defined and quantified throughout the project's development as specific risk elements, which then may then be used to create a risk management plan for the project. As the project is refined, the contingency should reflect the shift of contingencies into actual cost categories. Contingencies should be expressed in terms that can be easily presented to and understood by the public. The appearance of false precision must be avoided. Unsupported early optimism (i.e. low contingency amounts) will only cause problems as the project progresses.

Early cost estimates usually contain a larger degree of uncertainty. To account for this uncertainty, a project cost estimate can be expressed as a range or can be expressed with an indication of the confidence level.

**Team of Experts**

A skilled, interdisciplinary team should produce estimates. Estimates should be developed using a clearly identified scope of work. Estimates should be based on consultation and input from agency experts and not be developed in a vacuum.

The estimating team should be composed of experienced personnel, with the requisite technical, managerial, leadership, and communication cost estimating skills. The team should also have a thorough understanding of the project's scope, including the ability to determine and evaluate critical issues and risks. If resources are available, others experienced in estimating who have not been extensively exposed to the project should also provide input. This can bring a new independent analysis regarding items that may have a major impact on the cost estimate. Core competencies for cost estimating and a formalized training program to meet these competencies should be established. In addition, an estimating process manual should be in place. Some projects already have comprehensive cost estimating manuals and procedures. An experienced person who is well trained in major project estimating should lead the process.

**Validation of Estimates**

A competent unbiased team should validate the cost estimates. Estimates on very large projects are very complex and subject to perceptions of being inappropriately manipulated. A second independent set of eyes to review the estimate will afford managers and decision makers an opportunity to capture a different perspective or at least a second opinion.

**Revalidation of Estimates**

Periodic reviews of estimates are important for several reasons. First, conditions and underlying assumptions for original and subsequent estimates often change, thus estimates need to be refreshed to account for these changes.

Second, throughout project development phases there are key decisions in the public interest that must be made based upon the most current and accurate estimates possible.

Finally, management must have a means of minimizing the potential for surprises concerning the financial condition of the project.

**Program Cost Estimate Elements**

The following cost elements should be included when preparing a program cost estimate for a major project:

**Preliminary Engineering**

This is the cost to prepare the construction documents. It includes any field investigation, testing and administration of the design work. It also includes the cost of other environmental documentation. The cost of a Consultant for this work would be included here.

**External Third Party**

Perhaps the most difficult costs to estimate are those that are associated with third parties, such as utilities and railroads. Third party requirements have a high potential for risk and change. For example, major projects often are located in urban areas with a high concentration of existing utilities. While it is best to locate and avoid as many utilities as possible during the design phase, appropriate contingencies for utility adjustments need to be included.

**Project Contingencies**

To allow for the likelihood that additional project work will be identified after the design has been completed and the project awarded, a contingency for cost growth during construction should be included. This is normally around 5% to 10%. However, some projects where the potential for scope creep and changes during construction is high have used a contingency factor approaching 15%.

The following may also have an impact on this percentage:

**Design-Build Contracts**

Design-Build contracting on major projects has thus far shown very little increase from the negotiated contract amount to the final project completion and therefore may require a smaller project contingency since the number of project claims due to design errors is substantially reduced.

**Number of Concurrent Contracts and Contract Interfaces**

On projects where multiple project contracts are underway at the same time, close coordination of project activities and schedules may be required. The potential for one contractor to impact another contractor's activities is higher and may result in additional delay or coordination costs during construction.

**Contractor Proposed Project Changes.**

Project contracts should include specifications to allow the contractor to propose project changes that result in benefits to the contractor and the owner. These are sometimes referred to as Value Engineering Change Proposals. Contracts that restrict the opportunity for contractors to make changes may limit the ability to contain costs once project starts. An increased project contingency may be appropriate in these situations.

**Project Time**

For longer duration projects, there is a greater risk for impacts to the project schedule and therefore, the contingency amount should be higher. Project scheduled in winter or rainy seasons should be accounted for appropriately in the contingency amount, since there may be a higher risk in meeting project schedules due to unforeseen weather delays. When a major project consists of two phases by different Contractors that are interdependent, a higher than normal contingency may be necessary. Also, compressed or accelerated project schedules could potentially increase costs.

**Environmental Impacts**

Due to the size and complexity of most major projects, there is often greater public and resource agency scrutiny during construction. This attention results in a greater likelihood that additional environmental mitigations may be required once project begins.

**Project Administration**

This includes project engineering, inspection, and administrative oversight during construction. The cost of a General Engineering Consultant for this work would be included here.

**Management Reserve**

A management reserve may be appropriate for high risk projects and projects that are sensitive to changing politics and management. A management reserve is beneficial if significant consequences could result from the project being underestimated.

### 3.2 Components of an Estimate

**Materials:** The estimator makes a take-off of all the different materials required on the project from the plans and specifications

**Labor:** The estimator estimates the hours needed to do the required work and then multiply by the appropriate wage

**Equipment:** The cost of equipment includes ownership or rental (kefeya) fees, moving to the job site, erecting, dismantling and operating.

**Overhead:** There are two types of overheads:

- General overhead: includes all costs that cannot be directly charged to any particular, such as the cost of office supplies, rent, travel expenses and salaries.
- Job overhead: includes all costs which apply indirectly to the service and cannot be charged to materials, labor, or equipment.

**Profit:** Most estimators show the profit expected from a job as a percentage of the total estimated cost of the service. The profit varies from 6-15%

Approximate profits usually expected are:

- Small service 6-8%
- Medium service 10%
- Large service 12%
- Very large service 15-20%

**Sources of Errors in Estimates**

- Mistakes in replace instead repair take-off (Which one 1st).
- Mistakes in estimating the labor time required for certain items of work.
- Errors in estimating hourly wages of labor.

- Failure to allow for rising costs of materials.
- Failure to allow for delays due to breakdown of machines and acts of technician.
- Making no provisions (carless)to have estimates checked.
- Insufficient allowance for overhead.
- mission of profit

**Consideration of Cost Estimate**

Every estimate, whether it is generated in the conceptual phase of a service or at bidding time, must be consider a number of issues.

The price of the service is affected by a number of factors:

- The size of the collision.
- The quality of the body.
- The location of collision.
- The service starts and duration.
- Market conditions**.**

**Stages of Estimate**

1. Conceptual phase.
2. Schematic phase.
3. Design development phase.
4. Procurement phase

   1. Conceptual phase

The description of a project may be a sketch or a brief written description. Top management are involved in cost Estimation and damage identification.

e.g., chief executive officer, vice chairman, general manger

The size of the maintenance is known, although it may be described in terms of capacity like:

- The degree of damage body.
- The number of replaced parts

The time needed to prepare this type of estimate is short in the range of a half day or less. The presentation of the estimate is generally informal for the purpose of a providing a target budget. The estimates are often prepared for many different options the best alternative(s) can be selected

   2. Schematic Phase Estimate

In this Phase, the technician & operational manager have become involved in the accident analysis (problem identification) & estimating of the project

A schematic estimate will be based on a design that is approximately 30% designed and include the following information:

- Damaged parts.
- Impact direction for collision
- Body parts repair mechanism manual.

This estimate includes some area take-off, & calculation of the major collide elements. Such as:

- The gross area of collision.
- The repaired paint part area.
- The gross cubic meters of paint to be removed

This estimate will take one to two weeks & will carry a 10% contingency for unknown design. and engineering details in the next design stage. At the end of the schematic design stage the presentation of the design to the owner is accompanied by an estimate of the cost of the project Before the service team moves on to the next phase of design, the owner will decide on the basic design parameters and on the service budget Any cost reduction ideas will be presented and priced by the estimators. Some of these ideas may be accepted or rejected at this stage, and may be carried forward to be better defined in the next phase.

3. Design Development Phase Estimate

The design development estimate is based on much more defined information. B/C of this the time taken to prepare this type of estimates is longer but the accuracy is greater

The estimate in this stage will be based on a design that is 60% complete and includes the following information:

- Detailed on the degree of collision parts.
- Parts to be replaced even if they work well.
- All relevant specification sections.
- Well defined mechanical and electrical systems

Most of the major servicing items will be quantifiable, and the more important unit prices should be known at this point

The preparation of this estimate should take two to three weeks and the accuracy is within 5 to 10% of the final cost. The costs of the materials and methods will beknown and should be compared to past similar service. Major assumptions should be noted and compared to what was assumed at the schematic design stage. The estimate at this stage is a tool used to verify that the design service operation is within the owner's budget, and to identify any good cost saving ideas

4. Procurement Phase Estimate

In this stage, an estimate would be prepared by all the service provider who are bidding for the service of the given engine, as well as the technical team. The service provider prepares the estimate to identify a price to bid (for bidding). The owner team prepares an estimate to be in a position to negotiate a fair price and to verify the accuracy of the servicers price.

The estimate is prepared based on a complete set of servicing documents Estimates done for bidding require a complete understanding of material quantities, which are taken from the problem identification & collision analysis. Estimates also require accurate unit prices, which usually involves input from local material suppliers. An exact schedule will be prepared. This will be used to identify the duration of the project


Figure3.2 Cost Estimate

Depending on the size of the project, a bid estimate can take three weeks or longer to prepar

### 3.3 Preparation of Project Expenditure Schedule

**Definitions**

**Task Designate**

Tasks are called "activities."

- Estimated completion times (and sometimes costs) are associated with each activity.
- Activity completion time is related to the amount of resources committed to it.
- The degree of activity details depends on the application and the level of specificity of data.

**Project**

- A project is a collection of tasks that must be completed in minimum time or at minimal cost.
- A project is a temporary endeavor undertaken to create a "unique" product or service
- A project is composed of a number of related activities that are directed to the accomplishment of a desired objective
- A project starts when at least one of its activities is ready to start
- A project is completed when all of its activities have been completed.

**Project plan**

_ A project plan is a schedule of activities indicating the start and stop for each activity. The start and stop of each activity should be visible and easy to measure

– When a resource is required

– Amount of required project resources

During Project Planning, Managers should consider:

– Resource availability

– Resource allocation

– Staff responsibility

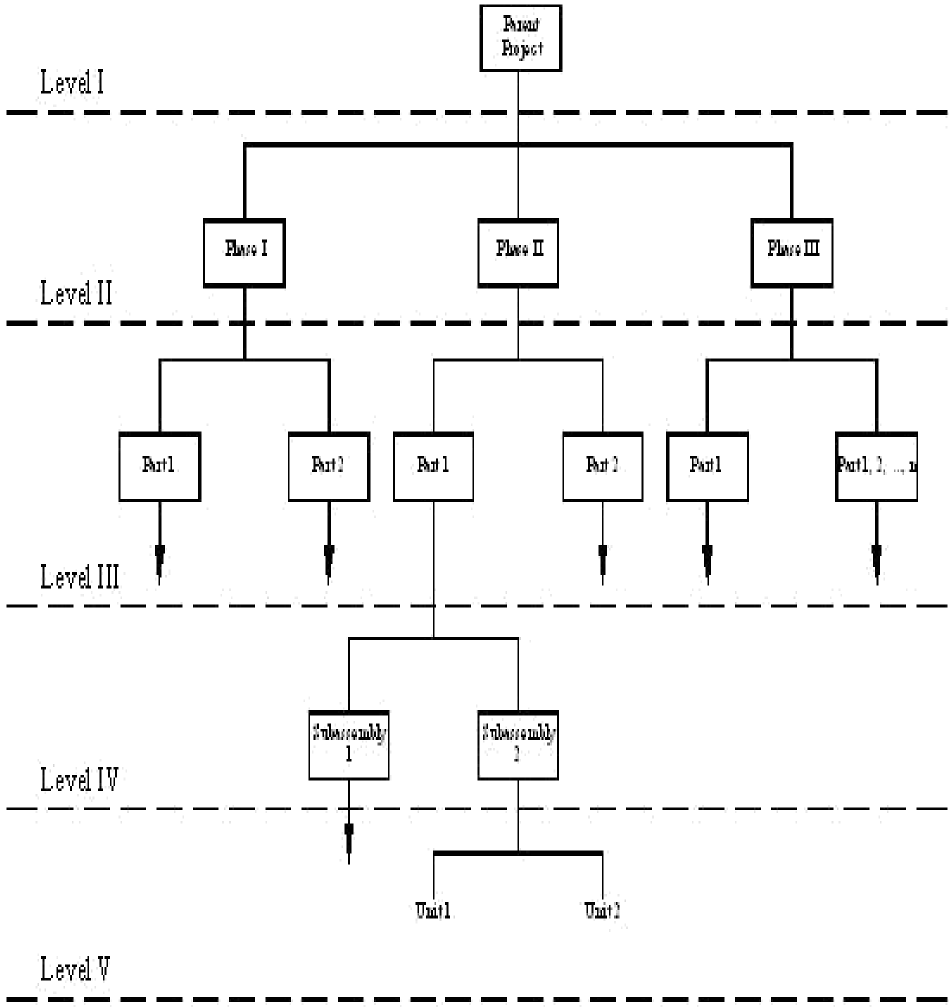
– Cash flow forecasting

Mangers need to monitor and re-plan as the project progresses towards its predefined goal

**Work Breakdown Structure (WBS)**

- A breakdown of the total project (organization) task into components to coordinate the work and to integrate resources; i.e
  - How the work will be done?
  - How people will be organized?
  - How resources will be allocated?
  - How progress will be monitored?

- WBS is a methodology for converting a large-scale project into activities for planning, scheduling, and control purposes;
- Helps to "rollup" costs of individual elements to get total costs;
- Helps to identify commonalities & eliminate unnecessary duplication;
- Thus, by applying the WBS approach, the overall project planning and control can be improved.




- Individual components in a WBS are referred to as elements and the hierarchy of each is designated by a level identifier.
- Each WBS element is assigned a code;
- Alphanumeric codes may be used;

**WBS helps in**

– identifying the main activities

– break each main activity down into sub-activities which can further be broken down into lower level sub-activities

**Project Scheduling**

**Steps**

– Define activities

– Sequence activities

– Estimate time

**Techniques**

– Gantt chart

– CPM

– PERT

– Microsoft Project

**Gantt Chart**

_ Developed in 1918 by H.L. Gantt

_ Graph or bar chart with a bar for each project activity that shows passage of time

_ Provides visual display of project schedule

**Advantages**

Easily understood

Easily created and maintained

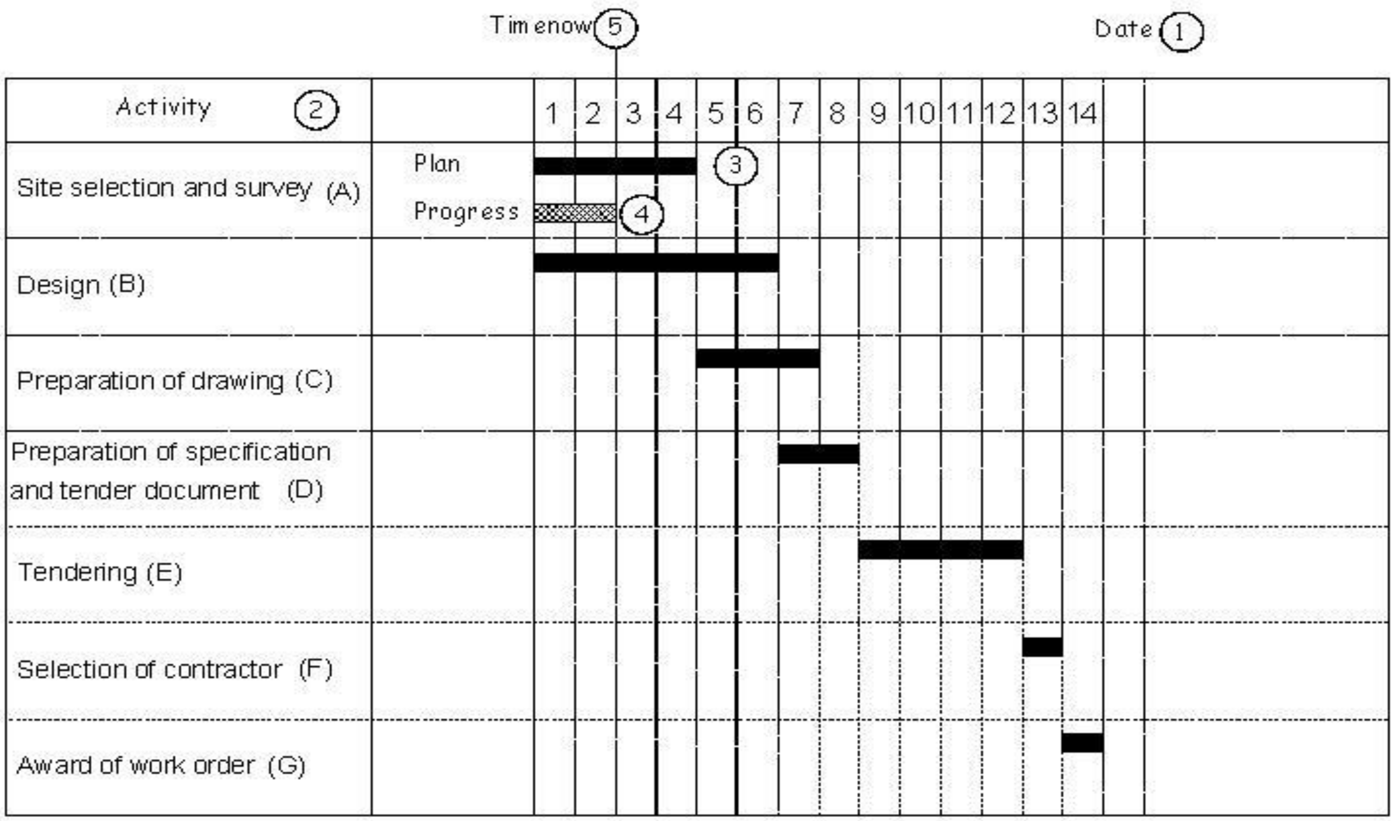
**Limitations**

– Does not clearly indicate details regarding the progress of activities

– Does not give a clear indication of interrelation between the activities

- – Does not show interdependencies well
- – Does not uncertainty of a given activity (as does PERT)

*Example of Gantt chart*




**Bar chart for a building project**

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

Two widely used project control methods are Program Evaluation and Review Technique (PERT) and Critical Path Method (CPM). The development of PERT is associated with the U.S. Polaris project to monitor the effort of 250 prime contractors and 9000 subcontractors. PERT was the result of efforts of a team formed by the U.S. Navy's Special Project Office in 1958. Team members included the consulting firm of Booz, Allen, and Hamilton and the Lockheed Missile System Division.

The history of CPM can be traced to 1956 when E.I. duPont de Nemours and Co. used a network model to schedule design and construction activities. The following year, CPM was used in the construction of a $10 million chemical plant in Louisville, Kentucky.

In projects three important factors of concern are time, cost, and resource availability. CPM and PERT deal with these factors individually and in combination. PERT and CPM are similar. The major difference between the two is that when the completion times of activities of the project are uncertain, PERT is used and with the certainty of completion times, CPM is employed.

The following steps are involved with PERT and CPM:

- Break a project into individual jobs or tasks.
- Arrange these jobs/tasks into a logical network.
- Determine duration time of each job/task.
- Develop a schedule.
- Identify jobs/tasks that control the completion of project.
- Redistribute resources or funds to improve schedule.

The following sections present a formula to estimate activity expected duration times and CPM in detail.

**Activity Expected Duration Time Estimation**

The PERT scheme calls for three estimates of activity duration time using the following formula to calculate the final time:

$$T_a = \frac{OT + 4\,(MT) + PT}{6} \quad \text{.....................................................(2.1)}$$

Where

$T_a$ = activity expected duration time,

OT = optimistic or minimum time an activity will require for completion,

PT = pessimistic or maximum time an activity will require for completion,

MT = most likely time an activity will require for completion. This is the time used for

**CPM activities.**

Equation (2.1) is based on Beta distribution.

**Example 2.1**

Assume that we have the following time estimates to accomplish an activity:

OT = 55 days

PT = 80 days

MT = 60 days

Calculate the activity expected duration time.

Substituting the given data into Eq. (2.1), we get:

$$T_a = \frac{55 + 4\,(60) + 80}{6} = 62.5 \text{ days}$$

The expected duration time for the activity is 62.5 days.

**Critical Path Method (CPM)**

Four symbols used to construct a CPM network are shown in figure 2.1. The circle denotes an event. Specifically, it represents an unambiguous point in the life of a project. An event could be the start or completion of an activity or activities, and usually the events are labeled by number. A circle shown with three divisions in figure 2.1(b) is also denotes an event. Its top half labels the event with a number, and the bottom portions indicate latest event time (LET) and earliest event time (EET). LET may be described as the latest time in which an event can be reached without delaying project completion. EET is the earliest time in which an activity can be accomplished or an event could be reached.

The continuous arrow represents an activity that consumes time, money, and manpower. This arrow always starts at a circle and ends at a circle. The dotted arrow denotes a dummy activity or a restraint. Specifically, this is an imaginary activity that does not consume time, money, or manpower. Figure 2.2 depicts an application of a dummy activity. It shows that activities L and M must be accomplished before activity N can start. However, only activity M must be completed prior to starting activity O.

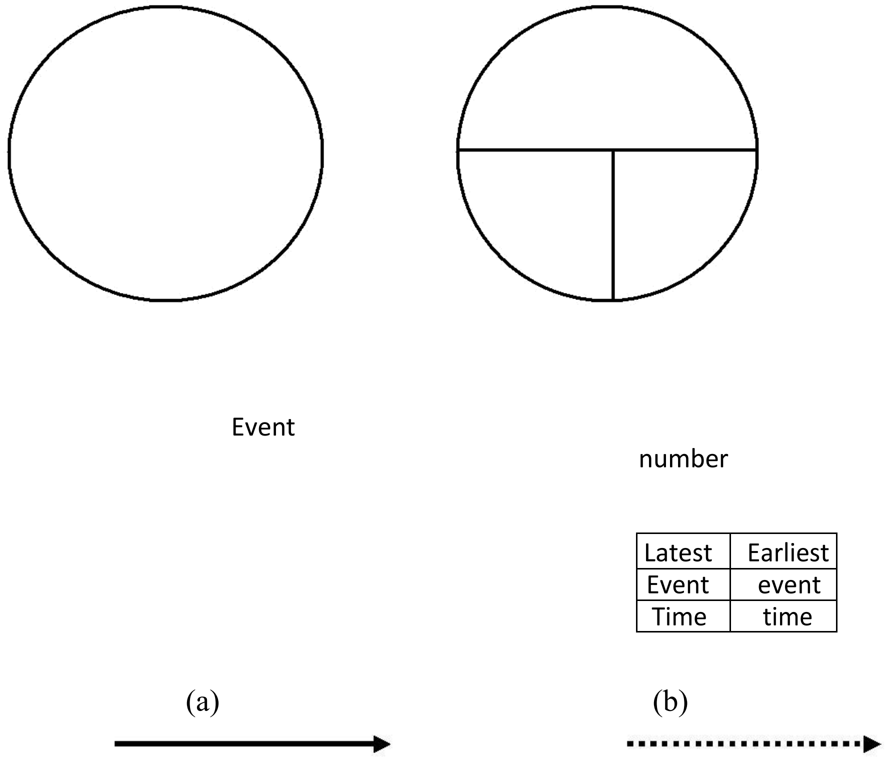



Figure 2.1 CPM symbols:
a) Circle b) circle with divisions c) continuous arrow d) dotted arrow

Table 2.2 Project Activities' Associated Data

| **Activity Identification** | **Immediate Predecessor Activity or Activities** | **Expected Duration ( Days)** |
|---|---|---|
| L | - | 12 |
| M | - | 2 |
| N | L, M | 2 |
| O | M | 6 |
| P | O | 3 |
| S | N, P | 9 |
| T | S | 15 |

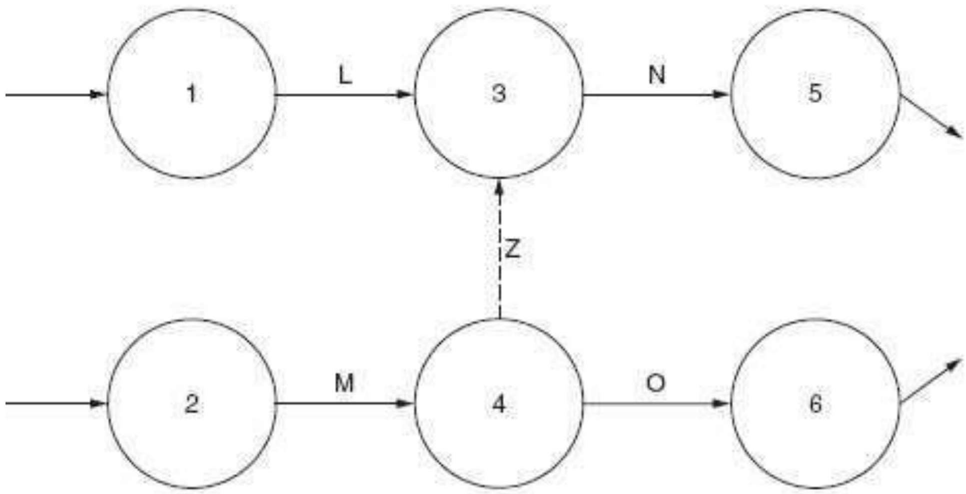



**Figure 2.2** A portion of a CPM network with a dummy activity.

**Example 2.2**

A project was broken down into a set of seven activities, after which table 2.2 was prepared. Prepare a CPM network using figure 2.1 symbols and table 2.2 data, and determine the critical path associated with the network. A CPM network for given data in table 2.2 is presented in figure 2.3.

In this figure, the following paths originate and terminate at events 1 and 7, respectively:

M–N–S–T (2 + 2 + 9 + 15 = 28 days)

L–X–N–S–T (12 + 0 + 2 + 9 + 15 = 38 days )

L–O–P–S–T (12 + 6 + 3 + 9 + 15 = 45 days )

The quantities in parentheses above show the total time in days for each path. The dummy activity consumes zero time. By definition, the longest path through the network is the critical path. Inspection of the above three values shows that 45 days is the largest time. Specifically, it will take 45 days from event 1 to reach event 7. Thus, this is the critical path. The word "critical" is used because any delay in the complete ion of activities along the critical path will result in delay of completion of the maintenance project.

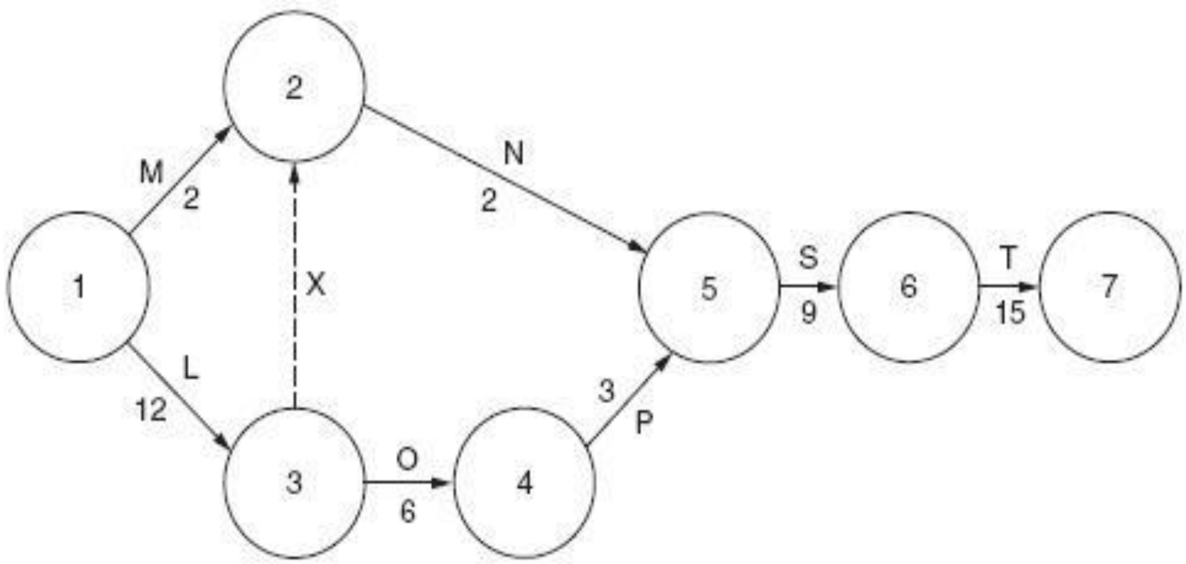



**Figure 2.3** A CPM network for table 2.2 data.

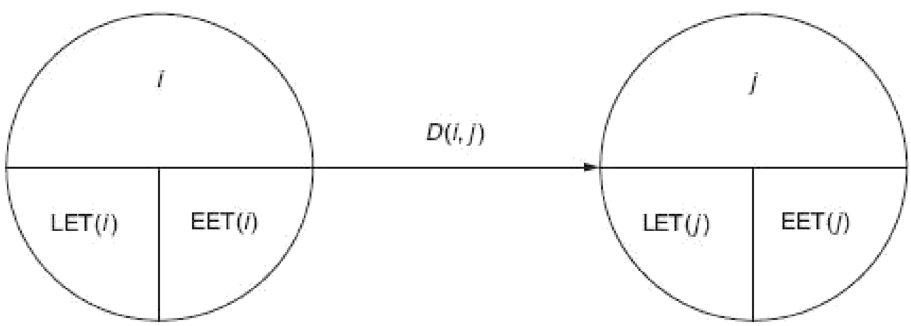



**Figure 2.4** A single activity CPM network.

**Critical Path Determination Approach**

For simple and straightforward CPM networks, the critical path can easily be identified in a manner discussed above. For complex networks a more systematic approach is required. This section presents one such approach with the aid of figure 2.4. The symbols used in the figure are defined below.

EET (*i*) = earliest event time of event *i*

EET (*j*) = earliest event time of event *j*

LET (*i*) = latest event time of event *i*

LET ( *j*) = latest event time of event *j*

*D* (*i*, *j*) = expected duration time of the activity between events *i* and *j*

The following steps are associated with the approach:

1. Construct CPM network.
2. Calculate EET of each event by making a forward pass of the network and using: For any event *j*,

EET (j) = Maximum for all preceding

| | |
|---|---|
| i of [EET (i) + D(i,j)] ---------------------------------------------- | 2.2 |
| Also | |
| EET (first event) = 0 ---------------------------------------------------- | 2.3 |

3. Calculate LET of each event by making a backward pass of the network and using: For any event *i*,

| | |
|---|---|
| LET (i) = Minimum for all succeeding | |
| j of [LET(j) + D (i,j)] ---------------------------------------------------------- | 2.4 |
| Also | |
| LET (last event) = EET (last event) ------------------------------------ | 2.5 |

If LET of all events of the network in question was calculated correctly, we should get

| LET (first event) = 0 ------------------------------------------------------------- | 2.6 |
|---|---|

4. Select network events with equal EET and LET. If the network results in only one path, i.e., from the first event to the last event, with EET = LET, this path is critical. Otherwise, go to next step.
5. Calculate the total float for each activity on each of the paths with EET = LET. The critical path is the path that results in the least sum of the total floats. The total float for any activity (*i, j*) can be calculated using the following equation:

| Total float = LET (j) – EET (i) – D (i,j) ------------------------- | 2.7 |
|---|---|

**Example 3.3**

Determine the critical path by calculating EET and LET of each event of the network shown in figure 2.3.

Using Eq. (2.2) we obtain EET of events 1, 2, 3, 4, 5, 6, and 7 as 0, 12, 12, 18, 21, 30, and 45, respectively. Similarly, with the aid of Eq. (2.4) the LET of events 1, 2, 3, 4, 5, 6, and 7 are 0, 19, 12, 18, 21, 30, and 45, respectively. Figure 2.5 shows a redrawn figure 2.3 CPM network with these EETs and LETs. The lower left quarter of each circle in figure 2.5 shows LET and the right right quarter the EET. The activities marked CP in figure 2.5 indicate the critical path as all the events that fall on this path have EET = LET, and it is the only path whose events have equal EETs and LETs. In other two paths the EET and LET of all events encountered are not equal.

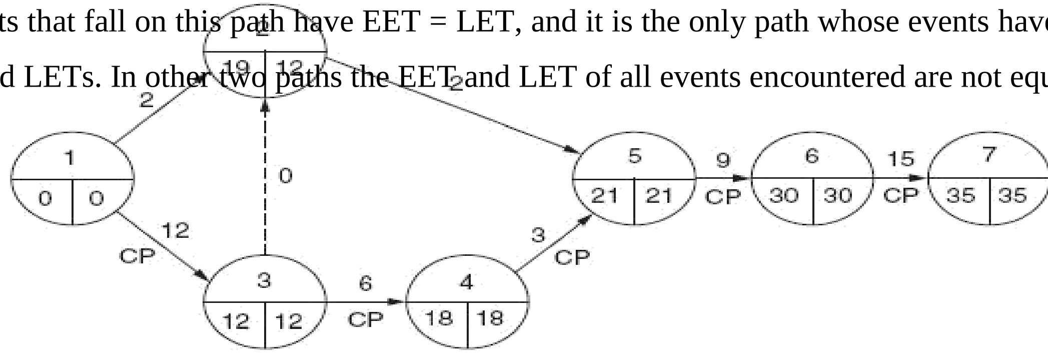


Figure 2.5 Network diagram with EETs and LETs

## CPM Advantages and Disadvantages

As with other methods, CPM has its advantages and disadvantages. Some of the CPM advantages are as follows:

- It is an effective tool for monitoring project progress.
- It helps improve project understanding and communication among involved personnel.
- It highlights activities important to complete the project on time. These activities must be completed on time to accomplish the entire project on predicted time.
- It shows interrelationships in workflow and is useful in determining labor and resources needs in advance.
- It is an effective tool for controlling costs and can easily be computerized.
- It helps avoiding duplications and omissions and determining project duration systematically.

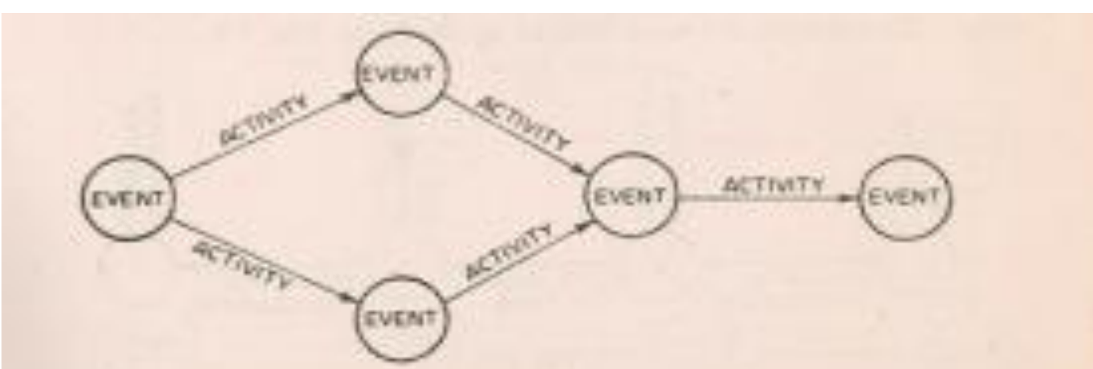
**Some of the disadvantages of the CPM are as follows:**

- Costly
- Time-consuming
- Poor estimates of activity times
- Inclination to use pessimistic estimates for activity times

### Network Diagrams in CPM

A ND is a flow diagram consisting of activities and events, connected logically and sequentially.

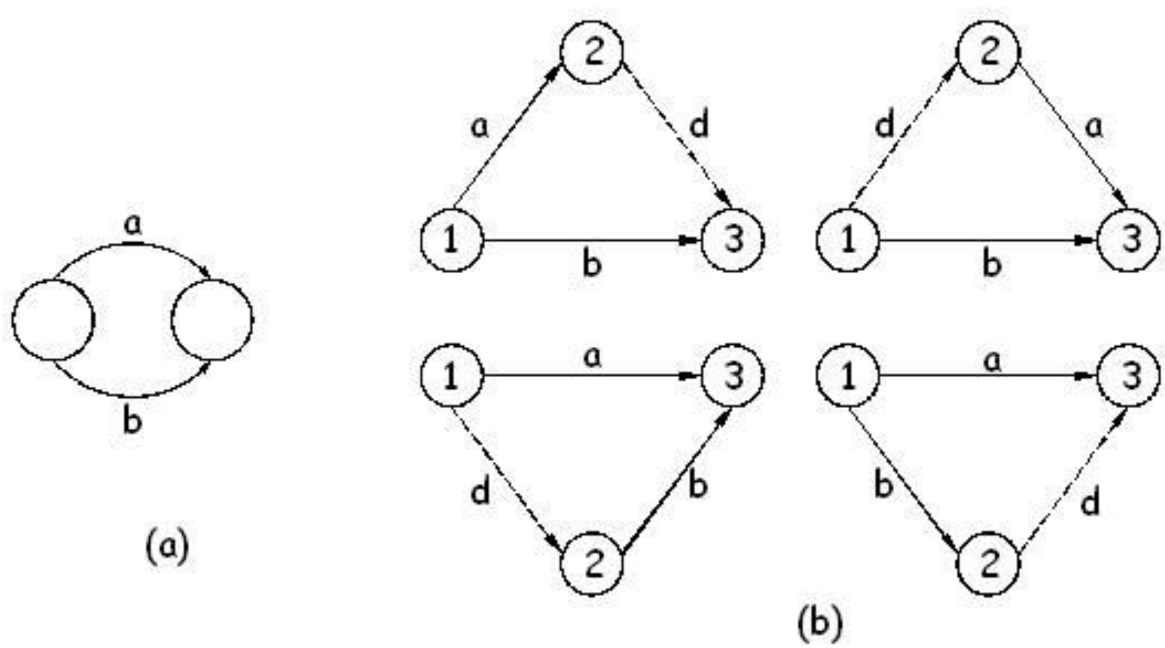
In ND, usually an activity is represented by arrow while an event is represented by circle.



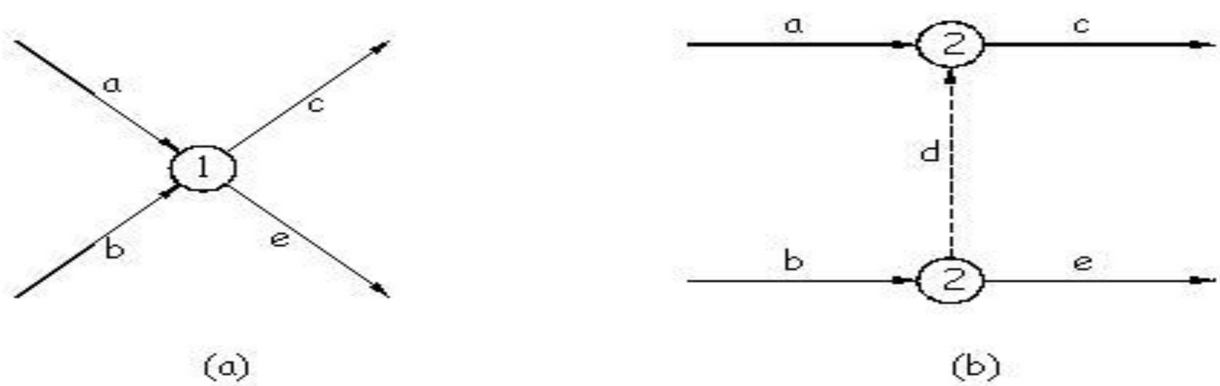
## Rules for Drawing ND

1. Each activity should be represented only by one arrow; i.e., no single activity can be represented twice in the network;

2. No two activities can be identified by the same events;




Suppose jobs **a** and **b** in a certain project must precede the job c, on the other hand, job e is preceded by job b only…




3. **Check the precedence relationship:** whenever any activity is added to the network

- What activity must be completed immediately before this activity can start?
- What activities must follow this activity?
- Which activities must occur simultaneously?

4. Other rules:
   - Try to avoid arrows which cross each other.
   - Use straight arrows.
   - Do not represent duration of activity by arrow length.
   - Avoid mixing two directions of arrows
   - Only one entry-end points (1 start & 1 end events)

**Two Types of ND**

**•CPM - deterministic approach**

–Used in cases when there are enough info. About each job or operation;

–A single estimate of the job's duration is accurate to give reasonable results;

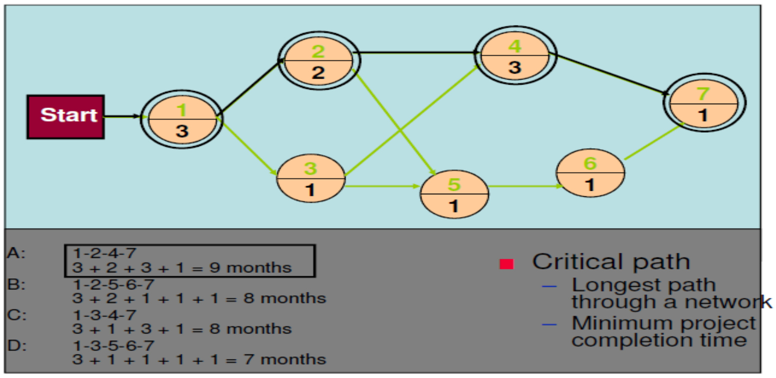
**•PERT –probabilistic approach**

– Probability of executing the activity can only be stated within a range of time duration

• Both methods are used as dynamic control tools in the management of large projects;

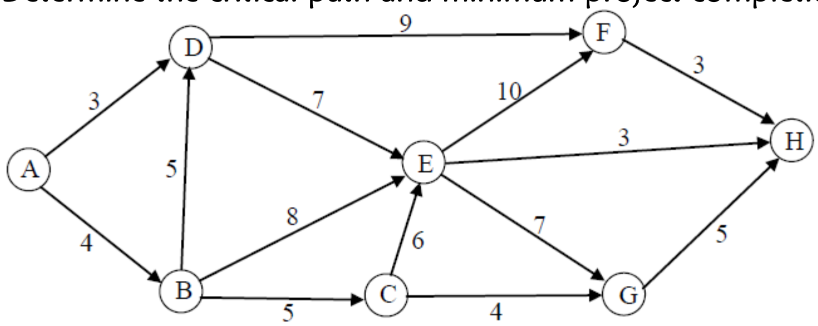
•These give the project manager a comprehensive picture of the project status at any time.

**Critical path**




**Exercise**

Determine the critical path and minimum project completion time




**Summary**

## PERT/CPM

- – Developed for industrial projects where activity times are generally known
- CPM and PERT have been used to plan, schedule, and control a wide variety of projects:
- – R&D of new products and processes
- – Project of buildings and highways
- – Maintenance of large and complex equipment
- – Design and installation of new systems

### CPM vs. PERT

- Both use Network Diagrams
- CPM: deterministic

- PERT: probabilistic
- CPM: one estimate, PERT, three estimates
- PERT is infrequently used

## 3.4 Prepare Projected Cash Flow and Payments

### 3.4.1 Cost concepts and Classifications

- Cost refers the amount of expenses spent to generate product or services.
- Anything incurred during the production of the good or service to get the output into the hands of the customer.
- Cost refers expenditure that may be actual or nominal expenses incurred to generate output.

As a manager we use cost information for taking decisions and making plans, programs and policies and strategies.

### 3.4.2 Classifications of Project Cost

**Manufacturing Vs Non-manufacturing Costs**

All costs incurred by the firm must be accounted for in its financial statements

**Manufacturing Costs**

- Direct Labor (DL)
- Direct Materials (DM)
- Manufacturing overhead (OH)

**Non-Manufacturing Costs**

- Marketing or Selling Costs
- Administrative Costs

**Manufacturing Costs**

- Manufacturing costs involves the cost of raw material, labour and use of equipment to finished goods

## Elements of Manufacturing Costs

### 1. Direct Materials (DM)

Materials that are consumed in the manufacturing process and physically incorporated in the finished product

Materials whose cost is sufficiently large to justify the record keeping expenses necessary to trace the costs to individual products

### 2. Direct Labor (DL)

- Labor time that is physically traceable to the products being manufactured
- Labor time whose cost is sufficiently large to justify the record keeping expenses necessary to trace the costs to individual products

*Example:*

Direct labor for manufacturing Honda Accords

- Line workers, robot operators, painters, assembly workers

Any labor probably not included in direct labor?

- Factory janitors, factory supervisors, factory secretaries

### 3. Manufacturing Overhead (OH)

All of costs of manufacturing excluding direct materials and direct labor

**a. Indirect Materials (IM)** – Materials, used in the manufacturing of products, which are difficult to trace to particular products in an economical way

- Glue, nails, cleaning supplies

**b. Indirect Labor (IL)** – Labor, used in the manufacturing of products, which is difficult to trace to particular products in an economical way

Wages for maintenance workers, factory supervisor's salary, idle time

**c. All other types of manufacturing overhead**

Depreciation on machinery, depreciation on factory building, factory insurance, utilities for factory

**Non-Manufacturing Costs**

Non-manufacturing costs are:

- Cost other than manufacturing cost that are incurred for sale
- Selling expenses /marketing expenses
- Marketing or Selling Costs – Costs incurred in securing orders from customers and providing customers with the finished product
- Sales commissions, costs of shipping products to customers, storage of finished goods, depreciation of selling equipment (cash register)
- Administrative Costs – Executive, organizational, and clerical costs that are not related to manufacturing or marketing
- CEO's salary, cost of controller's office, depreciation on administrative building.
- Promotion, or Advertisement costs,

**Cost According to Behavior**

- Fixed cost
- Variable cost

**a. Fixed Cost**

- Fixed cost is also called period cost or capacity cost.
- It does not change in short term period or within a relevant range.
- Fixed costs are caused by holding of assets and other factors of production in a state of readiness to produce.

**Characteristics of fixed cost**

- Unit cost increase as activities/outputs decrease.
- Costs that remain constant even activities are decreased or increased
- Total costs that remain constant.

**b. Variable costs**

- Variable costs are based on activity.
- The variable costs should be zero at zero activity.
- They change directly with changes in activity level in a responsibility center.
- If output is doubled, variable expenses is to be doubled,
- If output increases by 15% the variable expenses also increase by 15%, if output is zero, the variable cost also zero.

**Variable costs are usually characterized by:**

- Unit cost remains constant.
- Total costs that increase as activity increases.
- Total costs that decrease as activity decreases.
- Total costs changes proportionality with changes in output.

### 3.4.3 Calculating the Break-even Point

The break-even point in your business is the point at which your sales revenue equals your total expenses. At that point you neither make money, nor do you lose any. The break-even lets you know what it is going to take in sales just to survive. It provides a good indication of the viability of a business project.

The break-even can also be used to evaluate a business expansion or any other business expenditure. You are simply asking how much additional revenue will be required to cover the additional cost.

Break-even analysis considers two functions of Q

– Total cost – sum of fixed and variable cost

Total cost = F + (VC)*Q, VC=unit variable cost

– Revenue – amount of money brought in from sales

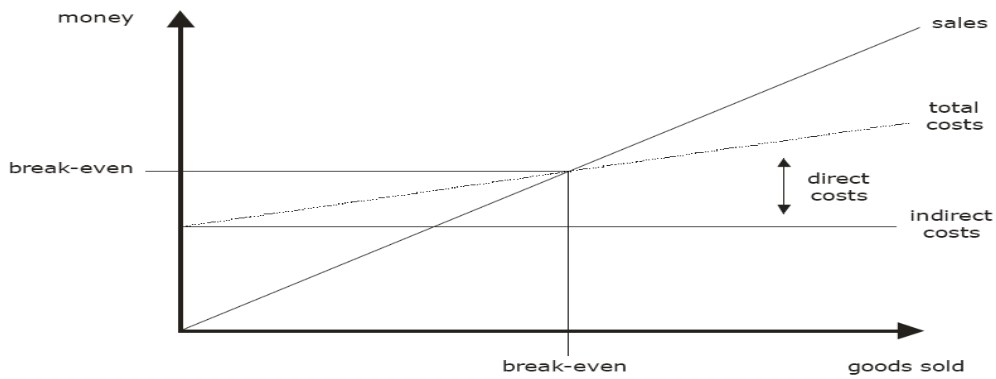
Revenue = (SP) * Q, SP= unit selling price

Q = number of units sold

Break-even point: @Total Cost=Revenue

Q=F/SP-VC, F=Fixed cost

The following graph shows the relationship between sales, direct costs and indirect costs.




The graph indicates, how much turnover the business has to generate, or how many goods have to be sold before the business makes a profit. The earlier the business reaches the break-even point the better for the business.

## 3.5 Maintain Checks on Expenditure and Evaluate Outcomes

### 3.5.1 Budgets

- Estimates of the income and expenditure of a business or a part of a business over a time period
- Used extensively in planning
- Helps establish efficient use of resources
- Help monitor cash flow and identify departures from plans
- Maintains a focus and discipline for those involved

**Flexible Budgets** – budgets that take account of changing business conditions

**Operating Budgets** – based on the daily operations of a business

**Objectives Based Budgets** - Budgets driven by objectives set by the firm

**Capital Budgets** – Plans of the relationship between capital spending and liquidity (cash) in the business **Variance** – the difference between planned values and actual values

- **Positive variance** – actual figures less than planned
- **Negative variance** – actual figures above planned

### 3.5.2 Budgeting and Cost Estimation

- The budget serves as a standard for comparison
- It is a baseline from which to measure the difference between the actual and planned use of resources
- Budgeting procedures must associate resource use with the achievement of organizational goals or the planning/control process becomes useless
- The budget is simply the project plan in another form.

### 3.5.3 Estimating Project Budgets

In order to develop a budget, we must:

- Forecast what resources the project will require
- Determine the required quantity of each
- Decide when they will be needed
- Understand how much they will cost - including the effects of potential price inflation

There are two fundamentally different strategies for data gathering:

- Top-down
- Bottom-up

### 3.5.3 Top-Down Budgeting

- This strategy is based on collecting the judgment and experiences of top and middle managers

- These cost estimates are then given to lower level managers, who are expected to continue the breakdown into budget estimates
- This process continues to the lowest level

**Advantages:**

- Aggregate budgets can often be developed quite accurately
- Budgets are stable as a percent of total allocation
- The statistical distribution is also stable, making for high predictability

### 3.5.4 Bottom-Up Budgeting

In this method, elemental tasks, their schedules, and their individual budgets are constructed following the WBS or project action plan

- The people doing the work are consulted regarding times and budgets for the tasks to ensure the best level of accuracy
- Initially, estimates are made in terms of resources, such as labor hours and materials
- Bottom-up budgets should be and usually are, more accurate in the detailed tasks, but it is critical that all elements be included
- Advantages:
  - ➢ Individuals closer to the work are apt to have a more accurate idea of resource requirements
  - ➢ The direct involvement of low-level managers in budget preparation increases the likelihood that they will accept the result with a minimum of aversion
  - ➢ Involvement is a good managerial training technique, giving junior managers valuable experience

### 3.5.5 Project Cash Flow

The Need

– Cash flows can be estimated by attempting to assess flows from

1. Project in progress.
2. Projects under contract but not yet begun.
3. Potential projects which will start during the coming financial accounting period.

### 3.5.6 Profit and Loss Statement

A profit and loss statement helps to determine whether a business is operating at a profit or a loss for a given time period of one month to one year. The more frequently you calculate your profits and losses, the sooner you will know the financial position of the business.

There are five specific steps to calculating the profit and loss statements:

**1. Sales:** including sales for cash and credit,

**2. Cost of Goods Sold:** this is the price paid by the business for merchandise sold; it can be computed by adding the value of the goods purchased during the period to the initial stock ( the initial stock figure can be obtained from the previous income statement), and then subtracting the value of the stock on hand at the end of the period.

**3. Gross Profit:** calculated by subtracting the cost of goods sold from sales

**4. Expenses:** this includes labour costs and other costs of operating the business

**5. Net Profit:** this is the amount remaining when the expenses are deducted from the gross profit. This figure will indicate whether you are operating at a profit or a loss.

*Example: ABC Flower Shop, Profit and Loss Statement For Month Ending July 31, 20*

| | | | |
|---|---|---|---|
| **Sales** | | | |
| Cash sales | 60,000 | | |
| Credit sales | 20,000 | | |
| Total sales | | 80,000 | |
| **Cost of goods sold** | | | |
| Beginning inventory | 18,000 | | |
| Purchases | 50,000 | | |
| Cost of goods for sale | 68,000 | | |
| Less ending inventory | 8,000 | | |
| **Cost of goods sold** | | 60,000 | |
| **Gross profit** | | | 20,000 |
| **Expenses** | | | |
| Salaries/wages | 10,000 | | |
| Electricity | 1,500 | | |
| Advertising | 700 | | |
| Other expenses | 800 | | |
| **Total Expenses** | | | 13,000 |
| **Net profit before taxes** | | | 7,000 |
| **Estimated tax** | | | 2,000 |
| **Estimated net profit after taxes** | | | 5,000 |

### 3.5.7 The Balance Sheet

The balance sheet is a financial statement which indicates what you own and what you owe on any given day in the life of a business. The financial figures on the balance sheet change from day to day because money is always coming in and going out of the business. A primary reason for preparing a balance sheet is to determine if the business is making a profit or a loss.

The formula used to prepare a balance sheet is:

***Assets* = *Liabilities* + *Net Worth***

**Assets:**

These include everything a business owns, such as cash, equipment, buildings and inventory.

• **Current assets** include cash and anything that can be converted into cash within twelve months. Current assets include cash, bank accounts, accounts receivable (what people owe you), and inventory.

• **Fixed assets** are things that cannot be changed into cash easily (within twelve months). They are items that the business acquired for long-term use. Fixed assets include land, buildings, machinery, equipment, and vehicles.

**Liabilities:**

These include anything that the business owes. Liabilities might include loans, credit notes, taxes and mortgages.

• **Current liabilities:** a current liability is anything you owe that has to be paid by using a current asset. Current liabilities are usually items to be paid within twelve months, including taxes, loans and bills due to creditors.

• **Long-term liabilities:** any debt that cannot be paid within twelve months, such as a mortgage.

**Net Worth:**

This is what is actually owned by the business after subtracting liabilities.

It represents the initial investment of the owners and retained earnings.

ABC Flower Shop Balance Sheet June 8 2010,

| | | |
|---|---|---|
| **ASSETS** | | |
| **Fixed Assets** | | |
| | Land and building | 18,000 |
| | Equipment | 3,800 |
| | **Total Fixed Assets** | 21,800 |
| **Current Assets** | | |
| | Cash | 8,000 |
| | Accounts receivable | 2,000 |
| | Inventory | 1,700 |
| | **Total Current Assets** | 11,700 |
| **TOTAL ASSETS** | | **33,500** |
| **LIABILITIES AND NET WORTH** | | |
| **Long-Term Liabilities** | | |
| | Mortgage | 8,500 |
| | **Total Long-Term Liabilities** | 8,500 |
| **Current Liabilities** | | |
| | Accounts payable | 1,000 |
| | Taxes payable | 2,000 |
| | **Total Current Liabilities** | 3,000 |
| **TOTAL LIABILITIES** | | 11,500 |
| **NET WORTH**<br>(Total Assets – Total Liabilities) | | 22,000 |
| **TOTAL LIABILITIES AND NET WORTH** | | **33,500** |

**Summary**

- ❖ A cash-flow projection shows whether you can pay bills and when you will need a cash infusion to keep going
- ❖ An income statement demonstrates on paper when you are going to make a profit
- ❖ Income statements track revenues and expenses but do not tell the whole story
- ❖ Projections include more than just sales
- ❖ Cash-flow projections are a tool used to help you control money

## 3.6 Recording and Reporting Project Cost Estimates

### Introduction

The project cost estimate is an important document for any project. Each estimate should be recorded and maintained with care as a key support to the budget development and cost management process.

The full and complete project cost estimate consists of project information (scope etc.), the assumptions, and the estimate of costs for each cost element. An estimate submitted with just a total money amount is of limited value without a record of the context, basis, and assumptions used to develop it. A copy of the entire project cost estimate should be retained in the project records, and all cost estimates should also be retained electronically. Although estimators usually retain a copy of any estimate they've prepared, it is staff who are ultimately responsible for retaining copies of the cost estimates for projects.

Cost estimates are prepared throughout the project life cycle. Early conceptual and planning level estimates are prepared prior to the assignment of a Project Manager, often in support of a business case for approving project funding. These estimates should be retained by the program area responsible for developing and submitting the business case. Individuals such as Regional Planners, Regional Planning and Program staff, and Project Sponsors are responsible for maintaining a record of these estimates.

Once the project is assigned to a Project Manager, the Project Manager becomes responsible for retaining the project cost estimate.

The Project Manager should seek out copies of all relevant previous cost estimates to ensure they are retained in the project file. The cost estimate used to support the project budgets should be included in the project's 'Cost Plan' (as part of the overall Project Plan). Subsequent estimates, produced throughout the project life cycle, should be retained in the project file to track the evolution of the project costs.

Project cost estimates are often requested during project reviews or audits, and they should be readily retrievable in response to such requests. Copies of the project cost estimates may also be requested by the Planning and Programming Branch for use in benchmarking and project cost analysis.

### 3.6.1 Performance Measures and Feedback

The intention is to undertake analysis, review and feedback of project cost estimates on a periodic basis as a means to measure the Project success in preparing accurate cost estimates in accordance with these Guidelines, and to provide a basis for improvement in estimating processes and improvements with these Guidelines.

This analysis and feedback is intended to be undertaken in a couple of ways:

### 3.6.2 Audits of Project Cost Estimates

Conduct audits of project cost estimates on a sampling of projects each year. The selection of projects will depend upon several factors such as: the value of the project; the complexity of the project; actual costs significantly varying from budgets; and other issues that may warrant a review of the estimate. These audits may or may not be conducted in conjunction with an overall project quality review/audit. The estimates will be audited for compliance with the Project Cost Estimating Guidelines, and for accuracy and completeness of the estimate.

### 3.6.3 Comparing Expected Cost Estimates against Actual Project Costs

Undertake annual review of a large sample of projects to analyze the cost estimates at varies stages of the project life cycle. For example: comparing the conceptual cost estimate against the initial project budget, against the project forecast at pre-tender, and against the final project actual cost.

Such analysis is intended to measure the projects actual estimating accuracy against the expected accuracy ranges set out in the " Level of Estimates" and the overall success of the Project in estimating the final cost of the project.

It will also serve as direct feedback to Project Manager's and Cost Estimators to assist in the development of future estimates; and provide insight into how this Guidelines can be updated, revised and improved going forward.

### 3.6.4 Improving the Process of Cost Estimation

- There are two fundamentally different ways to manage the risks associated with the chance events that occur on every project:
- The most common is to make an allowance for contingencies - usually 5 or 10 percent
- Another is when the forecaster selects "most likely, optimistic, and pessimistic" estimates.

### 3.6.5 Key Principles of Project Cost Estimating

In general, there are key principles that should be adhered to when preparing a program cost estimate at any stage of a major project. All project cost estimates of an organization should be developed with the following guiding principles.

**Quality**

Project cost estimates should be prepared by individuals with knowledge, skill and experience in estimating costs infrastructure projects using industry recognized, repeatable, and defendable practices.

Cost estimators should:

- apply expert judgment to the estimate and the assumptions made in developing it
- incorporate appropriate quality control processes into the estimating process
- appropriately consider and quantify the risks and uncertainties of the project
- present the estimate in an easily understood format
- be able to defend the estimate and the basis for the decisions and assumptions therein, if asked

**Integrity**

Project cost estimates should be prepared using a high standard of professional and ethical integrity. They should not be prepared by anyone who may be, or may be perceived to be, in conflict of interest. Developing estimation through an open and transparent process, and presenting it in a manner that is easily understood, helps to maintain the public and other stakeholder's trust, support and confidence to an organization.

**Interdisciplinary Experts**

Project cost estimates are ideally developed in consultation with skilled, interdisciplinary experts, and not in isolation. Working with such expertise is particularly important when the project scope is least defined. Where possible project cost estimates should be prepared using a team approach, employing expertise from appropriate disciplines for the major project components (e.g. engineers for design parameters; property acquisition experts for property costs and related risks; construction personnel for constructability and scheduling; and environmental experts to determine potential impacts and mitigation).

Interdisciplinary experts should also review the project scope, objectives and risks to ensure the project is well defined and understood. Where practical, fields review should be conducted with the team of experts, prior to the preparation of the estimate. After an estimate is initially developed it should be shared with the entire project team to capture items or issues that may have been previously overlooked or unknown.

**Self-check 3.1**

**Part-I: Choose the correct answer from the given alternatives**

1. What is the primary purpose of project cost estimation?

A) To determine project timelines

B) To forecast the financial resources required for a project

C) To assign tasks to team members

D) To evaluate project risks

2. Which of the following is NOT a common method for estimating project costs?

A) Analogous estimating

B) Parametric estimating

C) Bottom-up estimating

D) Random sampling

3. What does the term "contingency reserve" refer to in cost estimation?

A) A fixed amount set aside for unexpected expenses

B) The total cost of all project activities

C) The budget allocated for project management

D) The cost of labor only

4. Which factor can significantly impact project cost estimates?

A) Project scope

B) Team morale

C) Weather conditions

D) Stakeholder opinions

5. In bottom-up estimating, how are costs determined?

A) By using historical data from similar projects

B) By estimating costs for individual activities and summing them up

C) By applying a percentage increase to the total budget

D) By consulting with external experts only

6. What is the role of a project manager in cost estimation?

A) To create the project timeline

B) To oversee the technical execution of the project

C) To ensure costs are estimated accurately and managed throughout the project

D) To perform quality assurance testing

7. Which of the following is a common risk associated with project cost estimation?

A) Over-optimism in resource availability

B) Lack of stakeholder engagement

C) Changes in project scope

D) All of the above

8. What is the function of a cost management plan?

A) To outline the project's quality standards

B) To define the procedures for monitoring and controlling project costs

C) To establish the project's communication strategy

D) To identify project stakeholders

**Directions: Answer all the questions listed below.**

**Part II: Fill in the blank space**

1. The primary objective of project cost estimation is to determine the ___________ required for completing the project.
2. In project management, ___________ estimating involves using historical data from similar projects to forecast costs.
3. A ___________ reserve is an additional amount of money set aside to cover unforeseen expenses during a project.
4. The ___________ method involves estimating costs for individual project activities and then summing them to get the total project cost.
5. ___________ estimating uses statistical relationships between historical data and other variables to estimate costs.

6. One common risk in project cost estimation is __________, which can lead to underestimating project costs.
7. A __________ management plan outlines the processes for monitoring and controlling project costs.
8. It is important to update cost estimates throughout the project lifecycle to reflect changes in project __________ and resource availability.
9. A project manager must ensure that costs are estimated accurately and managed throughout the project to avoid __________.
10. The total project cost is often broken down into direct costs, indirect costs, and __________ costs.

## Developers Profile

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