Finishing Construction Work

Level V

Based on December, 2024, Curriculum Version II

Module Title: Cost Estimation and Bill of Materials Ordering

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Contents

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Acronym

MOLS	Ministry of labor and skills
TVT	Technical vocational training
CAD	Computer-Aided Design
BOM	Bill of Materials
MBOM	Manufacturing bill of materials
EBOM	Engineering bill of materials
ROI	Return on Investment
LAP	Learning activity performance

Introduction to the Module

Cost Estimation and Ordering Bill of Material help to know the understand the job cost estimation, measure quantities of work, identify and establish material, manpower, and equipment requirements and direct the resource acquisition in finishing construction field. This module cover skill, knowledge and attitude required to estimation and bill of materials ordering

This module is designed to meet the industry requirement under the finishing construction work occupational standard, particularly for the unit of competency **Estimating Job, Cost and Ordering Bill of Material**

This module covers the units:

- Job cost estimation
- Measurement quantities
- Material, manpower, and equipment requirements
- Resource acquisition process

Learning Objective of the Module

- Describe the concept of job cost estimation
- Understand the measurement quantities
- Develop estimated project costs
- List and assesse the material, manpower, and equipment requirements
- Describe resource acquisition process

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: Introductions of cost estimation

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

- Fundamental of Cost Estimation
- Components of Job Costs
  - Direct Costs
  - Indirect Costs
- Project Plans and Specifications

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

- Understand the fundamental of Job Cost Estimation
- Describe the Components of Job Costs like direct costs and indirect costs
- Explain the Project Plans and Specifications

1.1. Fundamental of Cost Estimation

Definition

Cost estimation is a process where project managers predict the amount of money they need to fund their projects. The process entails direct and indirect costs of the project. These costs may include utilities, materials, equipment, vendors, and employee compensation.

Cost estimation is the process of forecasting the total costs associated with a specific project. This involves calculating all expenses related to materials, labor, overhead, and any other direct or indirect costs necessary to complete the project. The goal is to provide a clear and accurate financial outline that helps in budgeting, resource allocation, and assessing profitability before the project begins. Effective job cost estimation is essential for informed decision-making and successful project execution.

Purpose of Cost Estimation

Job cost estimation serves several key purposes, including:

- Budgeting: Establishes a financial framework for the project, helping to allocate funds effectively.
- Profitability Analysis: Assesses the potential profitability of a project by comparing estimated costs against anticipated revenue.
- Resource Allocation: Aids in determining the necessary resources (materials, labor, and equipment) required for successful project completion.
- Risk Management: Identifies potential financial risks and allows for contingency planning to address unexpected costs.
- Performance Measurement: Provides a baseline against which actual costs can be compared, facilitating project performance tracking.

- Client Communication: Offers clients a clear understanding of project costs, enhancing transparency and trust.
- Decision Making: Informs strategic decisions regarding project feasibility, scope, and timelines based on cost implications.

1.2. Components of Cost estimation

1.2.1. Direct Costs

Direct costs are expenses that can be directly traced to a specific project, job, or activity. These costs are easily attributable to the production of goods or services and comprise expenditures for labor, materials, and equipment that are necessary to complete a specific task. Understanding direct costs is essential for accurate job cost estimation, budgeting, and financial analysis, as they significantly impact the overall cost and profitability of a project.

Direct Costs includes the following:

a) Labor costs
b) Material costs
c) Equipment costs

1) Labor Costs

Labor costs refer to the expenses associated with compensating employees or workers who are directly involved in a project or job. These costs can include various components and are crucial for job cost estimation.

Components of Labor Costs

- Wages and Salaries: The base pay for employees, which can be hourly, daily, or salary-based.
- Employee Benefits: Additional compensation provided to employees beyond their wages, including health insurance, retirement contributions, and paid leave.
- Overtime Pay: Extra pay for hours worked beyond the standard workweek (typically over 40 hours in a week).

- Payroll Taxes: Taxes those employers are required to pay on behalf of their employees, including Social Security, Medicare, and unemployment taxes.
- Training and Development Costs: Expenses related to improving employee skills and knowledge, which can include workshops, courses, and certifications.

Example1: Labor rate breakdown

Assuming the following rates and percentages for labor costs:

- **painter**: 100 Birr per day, with 13% labor taxes
- **plasterer**: 110 Birr per day, with 11% labor taxes
- **Laborers**: 58 Birr per day, with 7% labor taxes

Additional Costs

- Benefits: 8%
- Overhead: 8%
- Contingency (Risk): 8%
- Profit Markup: 12%

Labor Cost Calculation

Number of Workers

- painter: 12
- plasterer: 20
- Laborers: 100

Calculation for Each Worker Type

- Painter
  - Daily Labor Cost:

    Daily Cost=Rate× (1+Tax Rate)

    Daily Cost=100× (1+0.13) =100×1.13=113 Birr
  - Total Labor Cost for Painter:

    Total Cost=Daily Cost × Number of painter

    Total Cost=113×12=1,356 Birr

- Plasterer:
  - Daily Labor Cost:

    Daily Cost=110×(1+0.11)=110×1.11=122.1 Birr

    Daily Cost=110×(1+0.11)=110×1.11=122.1 Birr
  - Total Labor Cost for Plasterer::

    Total Cost=122.1×20=2,442 Birr

    Total Cost=122.1×20=2,442 Birr
- Laborers
  - Daily Labor Cost:

    Daily Cost=58× (1+0.07) =58×1.07=62.06 Birr

    Daily Cost=58× (1+0.07) =58×1.07=62.06 Birr
  - Total Labor Cost for Laborers:

    Total Cost=62.06×100=6,206 Birr

    Total Cost=62.06×100=6,206 Birr

Total Labor Cost Estimation

- Overall Labor Cost

  Total Labor Cost = Total Cost for Painter + Total Cost for plasterer + Total Cost for Laborers

  Total Labor Cost=1,356+2,442+6,206=10,004 Birr

Additional Labor Costs (Overhead, Benefits, Contingency, Profit)

Overhead and Benefits Calculation:

- Total Labor Cost with Benefits and Overhead:

Total Cost with Benefits and Overhead=Total Labor Cost×(1+Benefits Rate+Overhead Rate)

Total Cost with Benefits and Overhead=Total Labor Cost×(1+Benefits Rate+Overhead Rate)

Total Cost with Benefits and Overhead=10,004×(1+0.08+0.08)=10,004×1.16=11,604.64 Birr

Total Cost with Benefits and Overhead=10,004×(1+0.08+0.08)=10,004×1.16=11,604.64 Birr

- **Contingency Calculation**:
  - **Total Cost with Contingency**:

  Total Cost with Contingency=Total Cost with Benefits and Overhead×(1+Contingency R ate)

  Total Cost with Contingency=11,604.64×(1+0.08)=11,604.64×1.08=12,550.00 Birr

- **Final Selling Cost with Profit**:
  - **Final Selling Cost**:

  Final Selling Cost=Total Cost with Contingency×(1+Profit Markup)

  Final Selling Cost=12,550.00×(1+0.12)=12,550.00×1.12=14,065.60 Birr

2) Material Costs

Material costs refer to the expenses associated with purchasing the raw materials and supplies required to complete a specific project or job. These costs are a key component of direct costs and are essential for accurate job cost estimation.

Components of Material Costs

- Raw Materials: Basic materials that are processed or manufactured to create finished products.
- Supplies: Items that are used in the production process but do not become part of the finished product.
- Transportation Costs: Expenses incurred for delivering materials to the job site.
- Storage Costs: Costs associated with storing materials before they are used in the project.
- Waste and Spoilage: Costs related to materials that are wasted or spoiled during production.

Example: Material Costs for Interior Finishes

Material	Quantity	Unit Price (Birr)	Total Cost (Birr)
Gypsum Board (Drywall)	200 sheets	50	10,000
Interior Paint	30 gallons	200	6,000
Hardwood Flooring	1,200 sq m	80	96,000
Carpet (Bedrooms)	800 sq m	30	24,000
Ceramic Tile (Kitchen)	300 sq m	60	18,000
Trim and Molding	500 linear m	15	7,500

Subtotal for Interior Finishes:

- Total Material Cost = 10,000 + 6,000 + 96,000 + 24,000 + 18,000 + 7,500 = 171,500 Birr

Material Costs for Exterior Finishes

Material	Quantity	Unit Price (Birr)	Total Cost (Birr)
Vinyl Siding	1,500 sq m	50	75,000
Asphalt Shingles	2,000 sq m	30	60,000
Composite Decking	300 sq m	150	45,000

Subtotal for Exterior Finishes:

- Total Material Cost = 75,000 + 60,000 + 45,000 = 180,000 Birr

3. Overall Material Cost Estimation

Total Material Cost Calculation

- Total Interior Material Cost: 171,500 Birr
- Total Exterior Material Cost: 180,000 Birr

Grand Total Material Cost

- Total Material Cost = 171,500 + 180,000 = 351,500 Birr

4. Sales Tax and Markup Calculation

Assuming a Sales Tax of 5% and a Markup of 15% on the material costs:

1) **Sales Tax Calculation**:
   - Sales Tax = Total Material Cost × Sales Tax Rate
   - Sales Tax = 351,500 × 0.05 = **17,575 Birr**

2) **Total Cost with Sales Tax**:

- Total Cost with Sales Tax = Total Material Cost + Sales Tax
- Total Cost with Sales Tax = 351,500 + 17,575 = **369,075 Birr**

3) **Applying Markup**:

- Total Cost with Markup = Total Cost with Sales Tax × (1 + Markup Rate)
- Total Cost with Markup = 369,075 × 1.15 = **423,845.25 Birr**

4) Equipment Costs

Equipment costs refer to the expenses associated with the tools, machinery, and equipment needed to complete a specific project or job. These costs are an important component of direct costs and play a crucial role in job cost estimation.

Components of Equipment Costs

- Purchase Costs: The initial cost of buying equipment or machinery.
- Rental Costs: Fees for renting equipment instead of purchasing it, omen used for short-term needs.
- Depreciation: The reduction in value of owned equipment over time, reflecting wear and tear.
- Maintenance and Repair Costs: Expenses incurred to keep equipment in working order, including routine maintenance and unexpected repairs.
- Operating Costs: Expenses associated with the operation of equipment, such as fuel, lubricants, and operational supplies.

Example1: Interior Finishes materials cost

Material	Quantity	Unit Price (Birr)	Total Cost (Birr)
Gypsum Board (Drywall)	200 sheets	50	10,000
Paint (Interior)	30 gallons	200	6,000
Hardwood Flooring	1,200 sq m	80	96,000
Carpet (Bedrooms)	800 sq m	30	24,000

Ceramic Tile (Kitchen)	300 sq m	60	18,000
Trim and Molding	500 linear m	15	7,500

Subtotal (Interior Finishes): 171,500 Birr

2. **Labor Costs**

- Labor cost is calculated as 40% of the material cost.
- Material Cost:

  Total Material Cost = 10,000 + 6,000 + 96,000 + 24,000 + 18,000 + 7,500 = 171,500 Birr
- Labor Cost: 40% of Material Cost

Labor Cost = 171,500 * 0.40 = 68,600 Birr

3. Sales Tax and Markup

- Sales Tax: 5%

  Markup: 15%
- Calculation for Final Cost
- Material Cost with Sales Tax:
- Material Cost with Tax = Material Cost × (1 + Sales Tax)

  = 171,500 × (1 + 0.05) = 171,500 × 1.05 = 180,075 Birr
- Material Cost with Markup:

  Material Cost with Markup = Material Cost with Tax × (1 + Markup)

  = 180,075 × (1 + 0.15) = 180,075 × 1.15 = 207,086.25 Birr
- Final Cost (Selling Price):

  Final Cost = Material Cost with Markup + Labor Cost

  = 207,086.25 + 68,600 = 275,686.25 Birr

Example2: Exterior Finishes material cost

Material	Quantity	Unit Price (Birr)	Total Cost (Birr)
Vinyl Siding	1,500 sq m	50	75,000
Asphalt Shingles	2,000 sq m	30	60,000

Composite Decking	300 sq m	150	45,000

Subtotal (Exterior Finishes): $180,000 Birr

5. Overall Cost Estimation

- Total Material and Labor Cost

  Total Material Cost: 171,500 (Interior) + 180,000 (Exterior) = 351,500 Birr

  Total Labor Cost: 68,600 Birr

  Total Project Cost: 351,500 + 68,600 = 420,100 Birr

6. Tax Calculation

- Tax on Material: 351,500 × 0.05 = 17,575 Birr

  Total Tax Cost: 17,575 Birr

1.2.2. Indirect Costs

Indirect costs are expenses that cannot be directly traced to a specific project or job, yet are essential for the overall operation of a business. These costs support multiple projects and contribute to the organization's ability to function effectively. Understanding indirect costs is crucial for accurate job cost estimation and financial management.

Key Components of Indirect Costs

- Overhead costs
- Administrative expenses
- Contingencies

Overhead Costs

Overhead costs are expenses that are necessary for the overall operation of a business but cannot be directly attributed to a specific project or job. These costs provide essential support for business activities and are crucial for maintaining operations.

Key Characteristics of Overhead Costs

Indirect Nature: Overhead costs are not directly tied to any single project, making them indirect costs that support multiple functions or projects.

Fixed and Variable Components:

- Fixed Overhead: Costs that remain constant regardless of the level of production or project activity (e.g., rent, salaries of permanent staff).
- Variable Overhead: Costs that can fluctuate based on usage or production levels (e.g., utilities that vary with consumption).

Examples of Overhead Costs

- Rent and Utilities: Costs for leasing office or warehouse space and utility bills (electricity, water, heating).
- Office Supplies: Expenditures on items like paper, pens, computers, and other equipment used for administrative purposes.
- Insurance: Premiums paid for general liability, property, and other types of insurance coverage.
- Administrative Salaries: Wages for staff who support the organization but do not directly contribute to project execution (e.g., HR, finance).
- Depreciation: The allocation of costs for long-term assets (like buildings and equipment) over their useful life.

Administrative Expenses

Definition: Administrative expenses are costs associated with the management and support functions within an organization that are necessary for the overall operation but do not directly contribute to the production of goods or services.

Key Components of Administrative Expenses

- Salaries and Wages: Compensation for administrative staff, including executives, HR personnel, and office managers.
- Office Supplies: Costs for items needed for day-to-day operations, such as paper, pens, computers, and other office equipment.
- Utilities: Expenses for services that keep the office running, such as electricity, water, and internet.

- Communication Costs: Costs related to phone services, internet, and other communication tools.
- Professional Fees: Payments for services from accountants, consultants, or legal advisors.

Contingencies

Definition: Contingencies are funds set aside to cover unexpected costs or risks that may arise during a project. They provide a financial buffer to address uncertainties.

Key Characteristics of Contingencies

- Risk Management: Contingencies are a proactive approach to managing potential risks that could impact project costs, timelines, or scope.
- Percentage of Total Costs: Typically calculated as a percentage (omen 5-10%) of the total project budget, depending on the project's complexity and risk level.

Examples of Contingencies

- Unexpected Material Price Increases: Additional costs due to fluctuations in material prices that were not anticipated during initial budgeting.
- Project Delays: Costs incurred from extending timelines due to unforeseen issues, such as weather-related delays or regulatory changes.
- Scope Changes: Additional expenses resulting from changes in project scope requested by clients or stakeholders.

1.3. Plans and Specifications

Plans

Plan are the documentation prepared to convey physical information so that designers, reviewers, and the public can understand both the existing conditions and the project. Plans also allow a contractor to construct the project and define the right-of-way available or to be acquired.

Key Components of Construction Drawings

As you might imagine, a set of construction drawings is not just a random assortment of blueprints. Rather, it's a carefully crafted collection of documents that work together to tell a complete story of a construction project. This set includes several key components, each serving a unique purpose in painting a comprehensive picture of the project.

Floor Plans: Think of these as the 'Google Maps' of construction drawings. Floor plans provide a bird's-eye view of each building level, showing the arrangement of rooms, hallways, and other spaces. They also indicate the locations of doors, windows, and stairs. They're vital for understanding the flow of the building and the functional relationship between different spaces.

Elevations: These are the face of the building—literally! Elevations provide a flat view of the building's exterior from each side, illustrating the structure's design, materials, and height. They give an idea of what the finished building will look like from the outside.

Sections: These are the 'X-ray' view of the building. Sections are cutaway views that show the building from the inside, revealing elements like floor and ceiling heights, wall thickness, and the relationship between different parts of the building.

Details: Ever heard the saying, "The devil is in the details?" That's what this component is all about. Details provide a close-up view of specific parts of the building, focusing on complex or unique areas that need special attention. These could be things like custom window installations or intricate ceiling designs.

Schedules: Don't let the term 'schedules' throw you off. In construction drawings, schedules are essentially detailed lists of specific elements in the building, like windows, doors, or finishes. They provide information like quantities, sizes, materials, and locations.

Legends and Symbols: These are like the Rosetta Stone of the construction drawings world. Legends and symbols decode the specific language used in the drawings, explaining what various abbreviations and symbols mean. They ensure everyone reading the drawings is on the same page.

Specification

A specification defines the materials and methods to be used by the contractor when constructing a project and is discussed.

A specification is a general term applying to all directions, provisions, and requirements appropriating to the performance of the work and payment for the work.

Specification is defined as the designation or statement by which written instructions are given distinguishing and/or limiting and describing the particular trade of work to be executed. In short specification is a statement of particular instructions of how to execute some task. Specification is one of the contract documents.

Specifications are written based on the prepared design, drawings, general and scientific trends of workmanship, quality expected, equipment involved and materials to be used for the particular trade of work.

The specifications should clearly specify -

- Design and drawing
- Labor employment
- Materials to be used
- Construction method
- Equipment used

Specifications should be clear, concise, and brief descriptions of what is required to execute the proposed trade of work. The information that is needed for construction is usually conveyed by two basic communication lines. They are Drawings (pictorial) and Specifications (written).

In so doing the methods of communication should complement each other and neither should overlap or duplicate the other. Specifications are devices for organizing the information depicted on the drawings and they are written descriptions of the legal and technical requirements forming the contract documents.

Their difference is that the drawings should generally show the following:

- Dimensions, extents, size, shape, and location of component parts
- Location of materials, machineries, and fixtures

- Interaction of furniture, equipments and space
- Schedules of finishes, windows and doors

Specifications generally describe the following:

- Type and quality of materials, equipments, labor or workmanship
- Methods of fabrication, installation and erection
- Standards, codes and tests
- Allowance, submittals and substitutions
- Cost included, insurance and bonds
- Project records and site facilities.

Self-check (One)

Part I: Choose the best answer

1. What is the primary goal of job cost estimation?

   A. To reduce material costs

   B. To provide a clear financial outline

   C. To minimize labour costs

   D. To increase project scope

   Answer: B) To provide a clear financial outline

2. Which of the following is NOT a purpose of job cost estimation?

   A. Profitability Analysis

   B. Risk Management

   C. Marketing Strategy

   D. Performance Measurement

   Answer: C) Marketing Strategy

3. What are direct costs primarily composed of?

   A. Overhead and administrative expenses

   B. Labour, materials, and equipment

   C. Transportation and storage

   D. Contingencies and insurance

   Answer: B) Labour, materials, and equipment

4. Which of the following is an example of an indirect cost?

   A. Raw materials

   B. Labour wages

   C. Office supplies

   D. Equipment rental

   Answer: C) Office supplies

5. What is a contingency in job cost estimation?

A. A type of labour cost
B. Funds set aside for unexpected costs
C. A fixed project cost
D. An overhead expense

Answer: B) Funds set aside for unexpected costs

Part II: Write true if the statement is correct and write false if the statement is incorrect

1. Job cost estimation helps in assessing the profitability of a project. **Answer: True**
2. Indirect costs can be easily trace to a specific project. Answer: False
3. The components of labour costs include wages, benefits, and payroll taxes. **Answer: True**

Part III: Give Short Answer for the following question

1. What are the key components of direct costs?

   Answer: Labour costs, material costs, and equipment costs.
2. Explain the significance of project plans and specifications in job cost estimation.

   Answer: Project plans and specifications provide a roadmap for project execution, outlining scope, objectives, timelines, and budgets, which are essential for effective project management.
3. What role do contingencies play in job cost estimation?

   Answer: Contingencies act as a financial buffer to cover unexpected costs or risks that may arise during a project, helping to manage potential financial uncertainties.

Unit Two: Measurement quantities

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

- Take-off
- Bill of materials
- Cost estimation methods
- Profit and Income Tax

This unit will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this training module, you will be able to:

- Prepare take-off sheet
- Understand bill of materials
- Describe the cost estimation methods
- Calculate Profit and Income Tax

2.1. Take-off

Definition:

A takeoff sheet, in the realm of construction, is a fundamental document that serves as the blueprint for cost estimation and project planning. This meticulously prepared document, omen considered the backbone of construction quantity surveying, provides a comprehensive breakdown of the materials, labor, and equipment required to bring a construction project to fruition.

A takeoff sheet is an indispensable tool, offering a detailed inventory of the components that will constitute a construction project, whether it be a residential dwelling, a commercial complex, or an infrastructure project. While its primary purpose is to provide a quantitative assessment of resources, its significance extends far beyond mere number-crunching.

Types of takeoff sheet

A takeoff sheet, omen referred to as a quantity takeoff sheet, is a critical document used in construction and estimation processes to itemize and quantify materials, labor, and other resources required for a project. The type of takeoff sheet used can vary depending on the specific requirements and stage of the project. Here are some common types of takeoff sheets:

- Manual Takeoff Sheet: A manual takeoff sheet involves a physical or digital document where estimators manually calculate and record quantities based on project drawings and specifications. Estimators use scales, rulers, or digital measurement tools to determine quantities. Manual takeoff sheets are suitable for smaller or less complex projects.
- Excel Spreadsheet: Excel is a versatile tool for creating takeoff sheets. Estimators can set up customized spreadsheets to input dimensions, counts, and other data to calculate quantities. Excel sheets are adaptable and can be tailored to the specific needs of the project. They are commonly used for a wide range of project sizes and types.

- Estimating Somware Takeoff: Specialized estimating somware, such as Pro Est, Plan Swim, or Bluebeam Revue, offers advanced digital takeoff capabilities. These somware programs allow estimators to work directly with digital drawings and plans, making it easier to measure quantities, calculate costs, and generate reports. They are suitable for larger and more complex projects where precision and efficiency are essential.
- CAD (Computer-Aided Design) Takeoff: CAD somware can be used to perform takeoffs directly within the design drawings. Estimators can select and measure elements in the drawing, and the somware automatically calculates quantities. This method is especially valuable for highly detailed and technical projects.
- Building Information Modeling (BIM) Takeoff: BIM somware, such as Autodesk Revit, incorporates 3D modeling and data-rich elements to facilitate automated takeoffs. Estimators can extract quantities directly from the BIM model, ensuring high accuracy and consistency. BIM takeoffs are commonly used in complex construction and engineering projects.

A well-structured takeoff sheet encompasses a range of critical aspects:

- **Materials Breakdown:** The takeoff sheet meticulously lists the types and quantities of construction materials required. It includes items such as bricks, concrete, steel, lumber, plumbing fixtures, electrical wiring, and an extensive array of other building materials. By itemizing these materials, the takeoff sheet forms the foundation for precise procurement, cost estimation, and budgeting.
- **Labor Hours and Requirements:** In addition to materials, the takeoff sheet accounts for the workforce necessary to complete the project. It outlines the various trades, the number of workers required for each, and the estimated labor hours involved. This aspect aids in workforce management, allocation of skilled tradespeople, and labor cost forecasting.

- **Equipment and Machinery:** Construction projects omen rely on specialized machinery and equipment. The takeoff sheet identifies the specific machinery required, ranging from heavy construction equipment to tools used by skilled trades. This ensures that the right equipment is available at the right time, preventing project delays.
- **Cost Estimation:** One of the primary purposes of a takeoff sheet is to facilitate accurate cost estimation. By quantifying materials, labor, and equipment, it forms the basis for a detailed cost breakdown, aiding in budget development and financial planning for the construction project.
- **Project Planning and Scheduling:** Takeoff sheets play a pivotal role in project planning and scheduling. They help construction professionals allocate resources, set project milestones, and establish a timeline for various tasks. This ensures that the project progresses smoothly and efficiently.
- **Competitive Bidding**: Takeoff sheets are indispensable for the procurement process. They are used to create Bills of Quantity (BOQs) that are shared with contractors during the bidding phase. Contractors rely on these BOQs to submit competitive bids for the construction project.

Taking off sheet Format

The "Taking off Sheet Format" is a crucial process in quantity surveying, involving the meticulous measurement and scaling of dimensions from architectural drawings. Quantity surveyors extract quantities directly from the drawings, calculate them in a specially prepared format, and present them in a comprehensible format. These sheets, omen double-ruled and adhering to A4 paper size standards, help accurately assess costs and resources in construction bids. This document represents the format of a takeoff sheet.

- **Format for Takeoff sheet**

Project: _____

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1	2	3	Description	1	2	3	Description

Column 1: is used for stating the number of times an item occurs and is called the timising column.

Column 2: is called dimension column as it is used to enter the dimensions of the items of works. The dimensions are entered in the order indicated below: Length, Width, Height or thickness.

Column 3: is called squaring column. The stated dimensions in column 2 are multiplied to determine the quantity of the work either in m, m2, m3 or in Pcs. or No.

Column 4: is called description column and description of the work item is briefly stated.

2.2. Cost estimation methods

Cost estimation is a critical process in project management, helping to predict the total expenses associated with a project. Several methods can be used for cost estimation, each with its own advantages and applications.

Cost estimation methods

a. Unit Cost Estimation
b. Parametric Estimating
c. Historical Cost Data Analysis

A. Unit Cost Estimation

Definition: This method involves estimating costs based on the cost per unit of measure for each component of the project.

How It Works:

- Determine Unit Cost: Identify the cost for each unit of work (e.g., cost per square foot, meter, or hour).
- Calculate Total Costs: Multiply the unit cost by the quantity required.

Advantages:

- Simple and straightforward, making it easy to understand.
- Useful for projects with repetitive tasks or standard items.

Applications: Commonly used in construction and manufacturing where costs can be easily broken down by unit.

Example: For a flooring project: If the cost of installing one square meter of tile is 5birr, and the project requires 1,200 square meter:

Total Cost=Unit Cost × Quantity=5×1200=6,000 birr

B. Historical Cost Data Analysis

Definition: This method uses historical data from past projects to estimate costs for similar future projects.

How It Works:

- Analyze Costs: Review costs from previous projects that are comparable in scope and scale.
- Adjust for Variables: Modify historical data for inflation, market conditions, and specific project requirements.

Advantages:

- Provides realistic estimates based on actual past performance.
- Helps identify trends and potential cost overruns.
- Applications:

- Effective in industries where historical data is readily available, such as construction and manufacturing.

Example: If a past construction project of similar size and complexity cost 200,000birr, and inflation is estimate at 8%, the estimated cost for a new similar project would be:

Estimated Cost=Historical Cost× (1+Inflation Rate)=200,000×1.08=216,000birr

C. Parametric Estimating

Definition: This method uses statistical relationships between historical data and other variables to estimate costs.

How It Works:

- Develop Models: Create mathematical equations or models that relate project parameters (e.g., size, complexity) to costs.
- Calculate Estimates: Use these models to estimate costs for new projects based on specific variables.

Advantages:

- Can provide quick estimates for large projects with complex variables.
- Allows for adjustments based on varying project conditions.
- Applications:
- Omen used in large-scale projects where multiple variables can affect costs, such as in engineering and construction.

Example: If historical data shows that, the cost of constructing a building is 150 per square meter and the new project is estimate to be 10,000 square meter:

Estimated Cost=Cost per Square meter × Total Area=150×10,000=1,500,000birr

Types of Estimation

Estimating is a fundamental process in construction and project management. It involves predicting the future costs, resources, and schedules of a project based on available information and historical data. Various types of estimates are used throughout the project life cycle, each

serving a specific purpose and level of detail. In this article, we will delve into two primary types of estimates: the **Approximate or Rough Estimate and the Detailed Estimate.**

a. Approximate/Rough Estimate

The Approximate or Rough Estimate serves as the initial step in the estimation process. Its primary functions are to provide a quick overview of probable project expenditures and to lay the groundwork for more detailed estimates. These estimates are prepared with limited information and are omen used in the early stages of project planning and development.

- **Key Characteristics:**
  - Quick Assessment: Approximate estimates are conducted to obtain a broad idea of the potential costs of a project in a short period. They are intended to provide a rough financial outline.
  - Preliminary Planning: These estimates are especially useful for initial project planning, allowing project stakeholders to make informed decisions regarding project feasibility and securing initial funding.
  - Relies on Similar Projects: Rough estimates are typically developed by comparing the costs of the project in question to those of similar projects that have been previously completed.
- **Components of an Approximate Estimate:**
  - Project Scope: A concise description of the project's overall scope and objectives.
  - Basic Costs: A preliminary cost estimate, usually expressed as a range (e.g., -30% to +50%) to accommodate uncertainties.
  - Comparison Data: Historical data from similar projects is crucial in making rough estimates.
  - Use Cases: Preliminary financial planning and feasibility assessment. Initial discussions with stakeholders to secure funding. Assessing the viability of a project before committing to a more detailed estimate.

b. Detailed Estimate

The Detailed Estimate represents the most comprehensive and precise estimation method. It involves a thorough examination of the project's requirements, breaking down the quantities and costs of all the elements needed to complete the work. Detailed estimates are typically utilized in later stages of project development when the design and specifications are well defined.

- **Key Characteristics:**
  - Comprehensive Data: Detailed estimates include precise measurements and costs for all project components, such as materials, labor, equipment, and overhead.
  - High Accuracy: This estimation method strives to achieve a high level of accuracy, omen to within a single-digit percentage deviation from the actual costs.
  - Used for Tendering: Detailed estimates are essential for contractors when bidding on projects, as they form the basis for competitive bids.
- **Components of a Detailed Estimate:**
  - Quantities: A detailed list of all materials, labor, equipment, and other resources required for the project.
  - Unit Costs: The costs associated with each element or resource.
  - Total Costs: The culmination of quantities and unit costs for each component, providing a precise estimate of the total project cost.
  - Contingency: A provision for unforeseen expenses or risks, typically added to the estimate to mitigate potential cost overruns.

Estimating is a crucial aspect of project management and construction. The choice of the estimation method depends on the project's stage, the level of detail required, and the specific objectives of the estimate. While Approximate Estimates provide an initial overview for quick decision-making and securing funding, Detailed Estimates offer the precision necessary for bidding and executing construction projects. Both types of estimates play essential roles in the successful execution of projects, ensuring that they are completed within budget and on schedule.

2.3. Bill of materials

Definition:

A Bill of Materials (BOM) is a comprehensive list that details all the raw materials, components, assemblies, and sub-assemblies required to manufacture a product. It specifies the quantities, part numbers, and descriptions of each item necessary for production, serving as a vital document for planning, inventory management, cost estimation, and production processes. The BOM ensures that all necessary materials are identifies, tracked, and procured efficiently, facilitating smooth manufacturing operations.

A bill of materials will contain the quantity or volume of each component used but it may also include additional information such as:

- production routings
- production cycle times
- production costs
- waste factors
- Other work-center data required to produce the finished item.

It is easy to assume that small manufacturing companies may not need structured and well-cramed BOMs because with their size and smaller product portfolio, they are well aware of all the parts and raw materials required. It is also easy to assume that because a product is simple or consists of only a small number of components (or a single component), BOMs are not necessary.

However, both of these assumptions are incorrect.

BOMs are a company’s guide and recipe for building their product. Not having a bill of materials, or having an inaccurate BOM, can lead to waste, inefficiency, and errors in the manufacturing process.

It also means that rather than having systemized process data that can be passed on to future employees as the company scales or as employees leave the company, knowledge is fragmented and siloed across several employees or somware systems, leaving the company exposed to loss of repeatability.

Importance of a BOM

- Production Planning: Provides a framework for scheduling production runs and managing inventory, ensuring that all necessary materials are available.
- Cost Estimation: Assists in creating accurate pricing and budget forecasts by detailing the costs associated with materials and components.
- Inventory Management: Helps track materials and components, minimizing the risk of shortages or overstock.
- Quality Control: Ensures that the correct materials are used in production, aiding in maintaining quality standards.
- Collaboration: Serves as a reference for different departments (engineering, production, procurement, and finance), facilitating effective communication and collaboration.

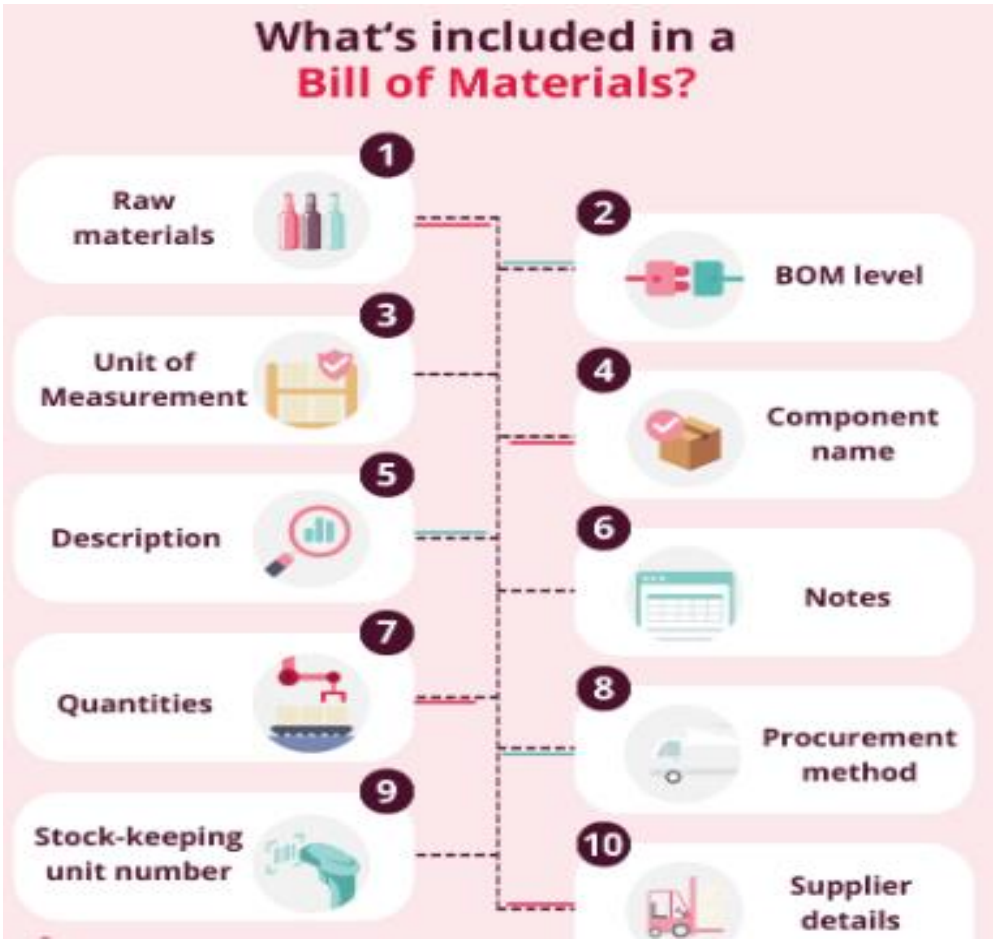


Fig 2.1. bill of matrial structutre

Types of bills of materials

There are several types of BOMs used in manufacturing. Bills of materials can be divided into types by their function or their current product lifecycle stage, by their configurability, or by their structure. Let's take a look at three different ways to categorize them:

Types of BOMs by function

a. Engineering bill of materials

b. Manufacturing bill of materials

The engineering bill of materials (EBOM) is a crucial tool for designing and engineering a new product, listing all parts, components, and materials as originally designed. It is used by planners, purchasing, and finance to trigger purchases and source new materials.

The manufacturing bill of materials (MBOM) is the most recognized form, containing all materials, assemblies, formulas, or components required for a shippable product.

Types of BOMs by configurability

a. standard bill of materials

b. Configurable bill of materials

A standard bill of materials (BOM) is a fixed list of components and materials required for a specific product, ensuring consistent features across all units produced. It is used when products are uniform and have no variations or options.

A configurable BOM, also known as a Matrix BOM or product configurator, is used to manage the production of configurable products, such as coffee tables, which can be customized in various colors and finishes. This allows for easy management of products with variations in color, size, and components.

Types of BOMs by structure

a. Single-level and
b. Multi-level.

A single-level BOM lists the materials needed for manufacturing or assembling a product, without subassemblies or other components. This is useful for simple products or those with few components or no downstream sub-processing.

Table 2.1.Single-level Bill of Materials (BOM) format

Item No.	Description	Quantity	Unit Price	Total Cost
1	Drywall Sheets	50	10.00	500.00
2	Paint (5-gallon)	10	25.00	250.00
3	Caulk	20 tubes	3.00	60.00
Total				**810.00**

A multi-level BOM contains materials and quantities for producing a finished good, but may have multiple sub-levels for complex products. This process can be repeated for subsequent levels, allowing manufacturing companies to produce their own subassemblies or formulations. This data can be tied to automation somware for operational tasks.

Table 2.2. Multi-level Bill of Materials (BOM) format

Item No.	Description	Quantity	Unit Price	Total Cost	Supplier
1	Drywall Sheets	50	10.00	500.00	ABC Supply Co.
2	Paint (5-gallon)	10	25.00	250.00	Color Paints Inc.
3	Trim Molding	200 ft	1.50	300.00	Trim Masters
4	Caulk	20 tubes	3.00	60.00	Home Supplies
5	Nails	5 lbs	4.00	20.00	Fasteners R Us
6	Flooring	100 sq. ft	5.00	500.00	Flooring World
7	Light Fixtures	15	30.00	450.00	Bright Lights Inc.
Total				**2,030.00**	

Benefits of an effective bill of materials

An effective bill of materials brings numerous advantages to product development, manufacturing, and supply chain management:

- **No missed components**: An effective BOM ensures that all individual parts and components necessary for the final product are documented, reducing the risk of missing items during assembly.
- **Effective collaboration**: Clear and detailed BOMs foster better communication and collaboration among cross-functional teams, including designers, engineers, and procurement specialists.
- **Efficient manufacturing**: BOMs provide step-by-step guidance for assembling products, enabling smoother production processes with minimal delays or errors.
- **Precise cost estimation:** A well-structured BOM aids in accurate cost estimation by outlining the quantities and costs of each component, supporting accounting and budgeting as well as finished product pricing decisions.
- **Inventory control:** BOMs assist in effective inventory management by defining required quantities and preventing overstocking or shortages of specific parts.
- **Enhanced quality control:** BOMs ensure that all components meet the required specifications, contributing to higher product quality and reducing defects.
- **Customization and variants**: For products with options or configurations, BOMs with parameters allow the easy creation of different product versions while sharing common components.
- **Smooth supply chain operations**: Supply chain managers benefit from clear BOMs that specify parts, quantities, and specifications, streamlining the procurement process and enabling supplier quality assessments.
- **Reduced rework and waste**: By accurately specifying components and their relationships, BOMs help avoid errors and rework during manufacturing. Because all

levels of components are accurately measure for quantity and volume, waste can be measured and controlled better.

- **Design iterations**: During the design phase, BOMs facilitate iterations by outlining the product structure, allowing engineers to refine prototypes efficiently. Within a manufacturing ERP system with BOM version control, product iterations can be tracked and reverted back to.
- **Planning and forecasting:** BOMs support production planning and forecasting by detailing the materials needed for upcoming orders.
- **End-to-end visibility**: From individual parts to the final product, BOMs provide end-to-end visibility into the assembly process, enabling comprehensive monitoring and control.

Key Components of a Bill of Materials (BOM)

A Bill of Materials (BOM) includes several essential components that provide detailed information about the materials and parts required for manufacturing a product. The key components:

- Item Description: A detailed description of each material or component, including specifications and characteristics.
- Quantity: The number of units needed for each item to complete the final product.
- Unit of Measure: The standard unit used to measure each item, such as pieces, kilograms, liters, or meters.
- Part Numbers: Unique identifiers assigned to each component or material, facilitating tracking and management.
- Cost Information: Estimated costs associated with each item, helping in budgeting and pricing decisions.

Ordering Bill of Materials (BOM) format

Project Information

- Project Name: _____
- Project Manager: _____
- Date: _____

Supplier Information

- Supplier Name: _____
- Contact Person: _____
- Phone Number: _____
- Email Address: _____

Bill of Materials Details

Item No.	Item Description	Quantity Required	Unit of Measure	Unit Cost	Total Cost	Supplier	Notes
1.							
2.							
3.							
4.							
5.							

Total Estimated Cost:

Total Cost: _____

Ordering Process

1. **Review BOM:** Ensure all items are listed and quantities are accurate.
2. **Supplier Selection:** Confirm the preferred supplier for each item.
3. **Place Order:** Send the order to the selected supplier(s) via email or procurement system.
4. **Order Confirmation:** Obtain confirmation of the order from the supplier.
5. **Delivery Schedule:** Confirm the expected delivery date for each item.

Inventory Check

Current Stock Levels:

- Item No. 1: _____
- Item No. 2: _____
- Item No. 3: _____

(Continue as necessary)

Notes & Comments:

_____

_____

_____

Approval

- Prepared By: _____
- Approved By: _____
- Date of Approval: _____

Instructions for Use:

1. Fill in the project and supplier information at the top.
2. List all the materials required in the BOM table, including descriptions, quantities, and costs.
3. Follow the ordering process steps to ensure everything is completed accurately.
4. Use the notes section for any additional information relevant to the order.
5. Obtain necessary approvals before placing the order.

2.4. Profit and Income Tax

Identifying Profit and Income Tax

Contractors whereby these contractors will commit to invest their capital to get maximum possible profit from the contracts to be performed execute construction projects.

A profit margin entirely depends on the market competitiveness and company strategies.

Any construction company operating a profitable business in Ethiopia shall pay 30% of its gross profit as an income tax as per the income tax proclamation No. 286/2002.

If the contractor is registered for VAT, which is usually the case, the contractor's construction cost estimate shall also include Value Added Tax which is 15% of the tender amount in accordance with the Value Added Tax proclamation No. 285/2002.

Gross Profit (M) calculation

As an illustration, if the net profit margin is assumed to be P% of the breakeven cost (direct costs + indirect costs + risk allowances), the gross profit (net profit + income tax) can be calculated as follows, which is X% of the breakeven cost

Total unit price without VAT(N)

If the contractor is registered for VAT but the contract is VAT exempted, the contractor's unit price in his tender is the sum of direct unit cost (H), indirect unit cost (K), risk allowance (L) and gross profit (M).

- **TOTAL UNIT PRICE WITHOUT VAT = H + K + L + M**

IX. Total unit price without VAT

- **TOTAL UNIT PRICE WITHOUT VAT (N) = H + K + L + M**
- **VALUE ADDED TAX (O) = 0.15 * N**
- **TOTAL UNIT PRICE WITH VAT = N + O**

- Let, **Q** be the breakeven cost
- Gross Profit = X% * Q
- Net Profit = P% * Q
- Income tax = 30% * Gross profit
- Gross Profit = Net Profit + Income tax
- X% * Q = P% * Q + 0.3 * X% * Q
- X% = P% + 0.3 * X%
  - **X% = (P/0.7)%**
  - **GROSS PROFIT = (P/0.7)% * BREAKEVEN COST**

Developing unit costs analysis for each items of work and material

ANALYSIS SHEET FOR DIRECT & INDIRECT UNIT COSTS

PROJECT: **WALLING**
WORK ITEM: (6.9) 15 cm. thick HCB Wall Both Sides Left For Plastering.
TOTAL QANTITY OF WORK ITEM: 1 m^2

LABOUR HOURLY OUTPUT: 0.75 m^2/hr.
EQUIPEMENT:
RESULT: 215.70 Birr/m^2

Material Cost (1:01)					Labour (1:02)					Equipment Cost (1:03)			
Type of Material	Unit	Qty *	Rate	Cost per Unit	Labour by Grade	No.	UF	** Indexed Hourly Cost	Hourly Cost	Type of Equipment	No.	Hourly Rental	Hourly Cost
15 cm. Thick HCB	Pcs.	13	6.92	89.96	Foreman	1	1	16.38	16.38	Tools	2	0.4	0.8
Cement	Qt.	0.08	360	28.8	Mason	1	1	7.80	7.8				
Sand	m^3	0.02	134	2.68	D/L	2	1	1.88	3.75				
Water	m^3	0.004	7	0.03									
Total (1:-01)				121.47	**Total (1:02)**				27.93	**Total (1:03)**			0.80

A= Materials Unit Cost 121.47 Birr/m^2

B= Manpower Unit Cost 37.24 Birr/m^2
Total of (1:02)
Hourly Output: _____

C=Equipment Unit Cost 1.0666667 Birr/m^2
Total of (1:03)
Hourly output: _____

Direct Cost of Work Item = A+B+C = 159.77 Birr/m^2
Over head cost : 20% 31.95 "
Profit Cost: 15% 23.97 "
Total Unit Cost : 215.70 Birr/m^2

ANALYSIS SHEET FOR DIRECT & INDIRECT UNIT COSTS

PROJECT: **FINISHING WORKS.**
WORK ITEM: (11.1) 3 Coats of cement plastering (1:3)
TOTAL QANTITY OF WORK ITEM: 1 m^2

LABOUR HOURLY OUTPUT: 0.75 m^2/hr
EQUIPEMENT:
RESULT : 107.83 Birr/m^2

Material Cost (1:01)					Labour Cost (1:02)					Equipment Cost (1:03)			
Type of Material	Unit	Qty *	Rate	Cost per Unit	Labour by Grade	No.	UF	** Indexed Hourly Cost	Hourly Cost	Type of Equipment	No.	Hourly Rental	Hourly Cost
cement	qt.	0.14	360	50.4	Foreman	1	0.2	16.38	3.28	tools	4	0.4	1.6
sand	m^3	0.036	134	4.824	Plasterer	1	1	6.83	6.825				
water	m^3	0.0065	7	0.046	Chilser	1	1	4.88	4.875				
					D/L	1	1	1.88	1.875				
Total (1:01)				55.27	**Total (1:02)**				16.85	**Total (1:03)**			1.6

A= Materials Unit Cost 55.27 Birr/m^2

B= Manpower Unit Cost 22.47 Birr/m^2
Total of (1:02)
Hourly Output: _____

C= Equipment Unit Cost 2.13 Birr/m^2
Total of (1:03)
Hourly output: _____

Direct Cost of Work Item = A+B+C = 79.87 Birr/m^2
Over head cost : 20% 15.97 "
Profit Cost: 15% 11.98 "
Total Unit Cost : 107.83 Birr/m^2

ANALYSIS SHEET FOR DIRECT & INDIRECT UNIT COSTS

PROJECT: **FINISHING WORKS.**
WORK ITEM: (11.11) 2cm marble floor
TOTAL QANTITY OF WORK ITEM: 1 m^2

LABOUR HOURLY OUTPUT: 1.2 m^2/hr
EQUIPEMENT:
RESULT : 679.04 Birr/m^2

Material Cost (1:01)					Labour Cost (1:02)					Equipment Cost (1:03)			
Type of Material	Unit	Qty *	Rate	Cost per Unit	Labour by Grade	No.	UF	** Indexed Hourly Cost	Hourly Cost	Type of Equipment	No.	Hourly Rental	Hourly Cost
cement	qt.	0.168	360	60.48	Foreman	1	0.25	16.38	4.10	tools	3	0.4	1.2
sand	m^3	0.041	134	5.494	mason ii	1	1	7.80	7.8	grinder	1	3.75	3.75
water	m^3	0.008	7	0.056	D/L	1	1	1.88	1.875				
cement grout	qt.	0.014	360	5.04	helper	1	1	2.50	2.5				
2cm thick marble floorin	m^2	1.02	390	397.8									
Total (1:01)				468.87	**Total (1:02)**				30.00	**Total (1:03)**			4.95

A= Materials Unit Cost 468.87 Birr/m^2

B= Manpower Unit Cost 30.00 Birr/m^2
Total of (1:02)
Hourly Output: _____

C= Equipment Unit Cost 4.125 Birr/m^2
Total of (1:03)
Hourly output: _____

Direct Cost of Work Item = A+B+C = 503.00 Birr/m^2
Over head cost : 20% 100.60 "
Profit Cost: 15% 75.45 "
Total Unit Cost : 679.04 Birr/m^2

Self- Check (Two)

Part 1: Choose the best answer

1. What is the primary purpose of a takeoff sheet in construction?
   A. To provide a design blueprint
   B. To estimate project timelines
   C. To break down materials, labor, and equipment needed
   D. To manage project risks

Answer: C) To break down materials, labor, and equipment needed

2. Which type of takeoff sheet is best for large and complex projects?
   A. Manual Takeoff Sheet
   B. Excel Spreadsheet
   C. Estimating Somware Takeoff
   D. CAD Takeoff

Answer: C) Estimating Somware Takeoff

3. What does a Bill of Materials (BOM) typically include?
   A) Only raw materials
   B) Raw materials, components, and assembly instructions
   C) Only finished products
   D) Only cost estimates

Answer: B) Raw materials, components, and assembly instructions

4. In which type of BOM are components listed without sub-assemblies?
   A. Multi-level BOM
   B. Configurable BOM
   C. Single-level BOM
   D. Engineering BOM

Answer: C) Single-level BOM

5. What is one advantage of using historical cost data analysis?
   A. It is always the most accurate method.
   B. It provides realistic estimates based on past performance.
   C. It requires no adjustments for inflation.
   D. It is only useful for small projects.

Answer: B) It provides realistic estimates based on past performance.

Part II: Write true if the statement is correct and write false if the statement is incorrect

1. A takeoff sheet is only used for estimating labor costs. **Answer: False**
2. A configurable BOM allows for customization of products with various options. **Answer: True**
3. Parametric estimating uses historical data to create mathematical models for cost estimation. **Answer: True**

Part III: Give Short Answer for the following question

1. What is a manual takeoff sheet, and when is it typically used?

   Answer: A manual takeoff sheet is a document where estimators manually calculate and record quantities based on project drawings. It is suitable for smaller or less complex projects.

2. Explain the importance of a Bill of Materials (BOM) in manufacturing.

   Answer: A BOM provides a comprehensive list of all materials and components required for production, aiding in planning, inventory management, cost estimation, and ensuring that all necessary items are tracked and procured efficiently.

3. What role does a detailed estimate play in the bidding process?

   Answer: A detailed estimate provides a comprehensive breakdown of all project components, allowing contractors to prepare competitive bids based on precise quantities and costs, ensuring accuracy in the bidding process.

Operation Sheet 2.1. Cost Estimation

Operation Title: Estimate cost for finishing works

Purpose: To accurately estimate the costs associated with the finishing works of the building, ensuring effective budget management and resource allocation.

Tools:

- Measuring tape
- Ladder and scaffolding
- Estimation software or spreadsheets

Instructions

- Gather all necessary project specifications and drawings from the given plan.
- Review the scope of work to ensure all finishing tasks are included.
- Identify all materials and tools required for each finishing task.

Procedures

Step 1: Review Project Specifications

Step 2: Quantity Take-Off

Step 3: Cost Estimation

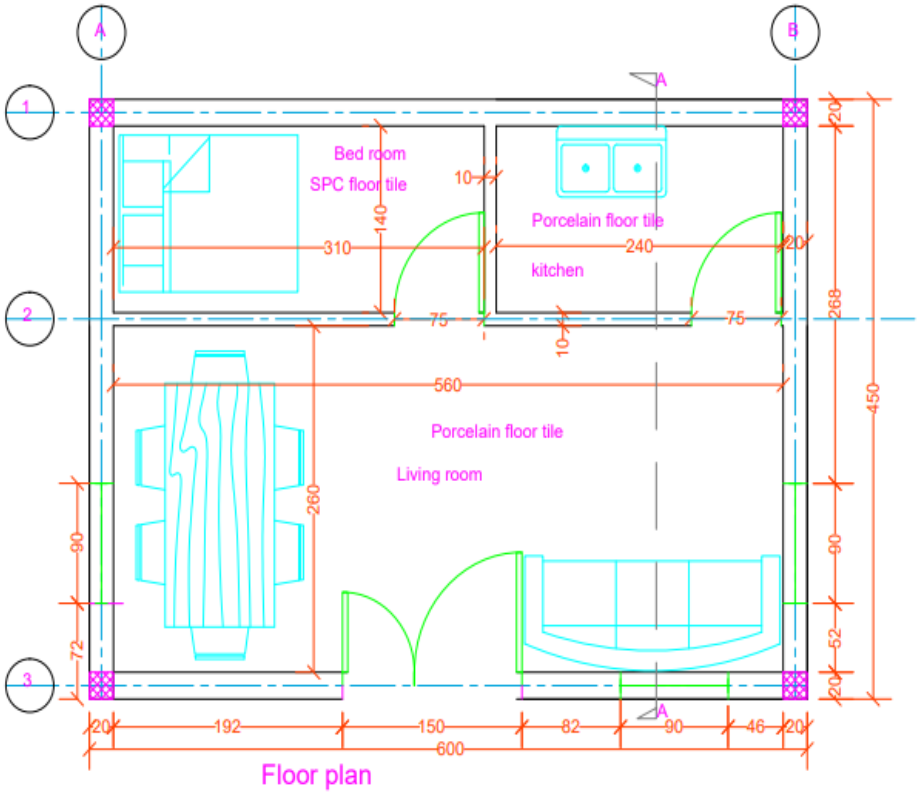
- Materials Cost
- Labor Cost
- Overhead Costs

Step 4: Compile the Cost Estimate

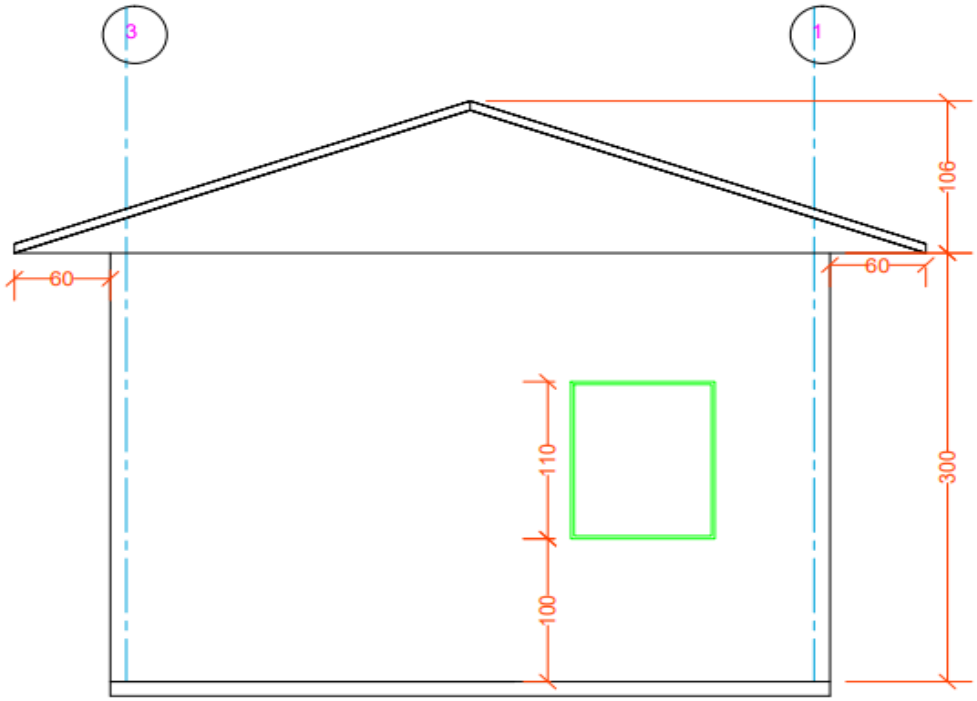
Step 5: Review and Adjust

Step 6: Summary of Estimated Costs

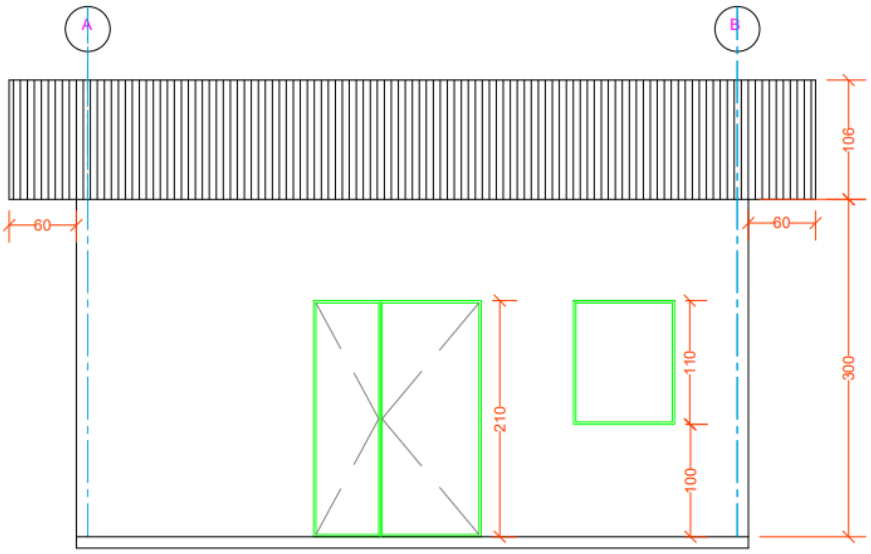
- Total Material Costs
- Total Labor Costs
- Overhead Costs
- Total Estimated Cost



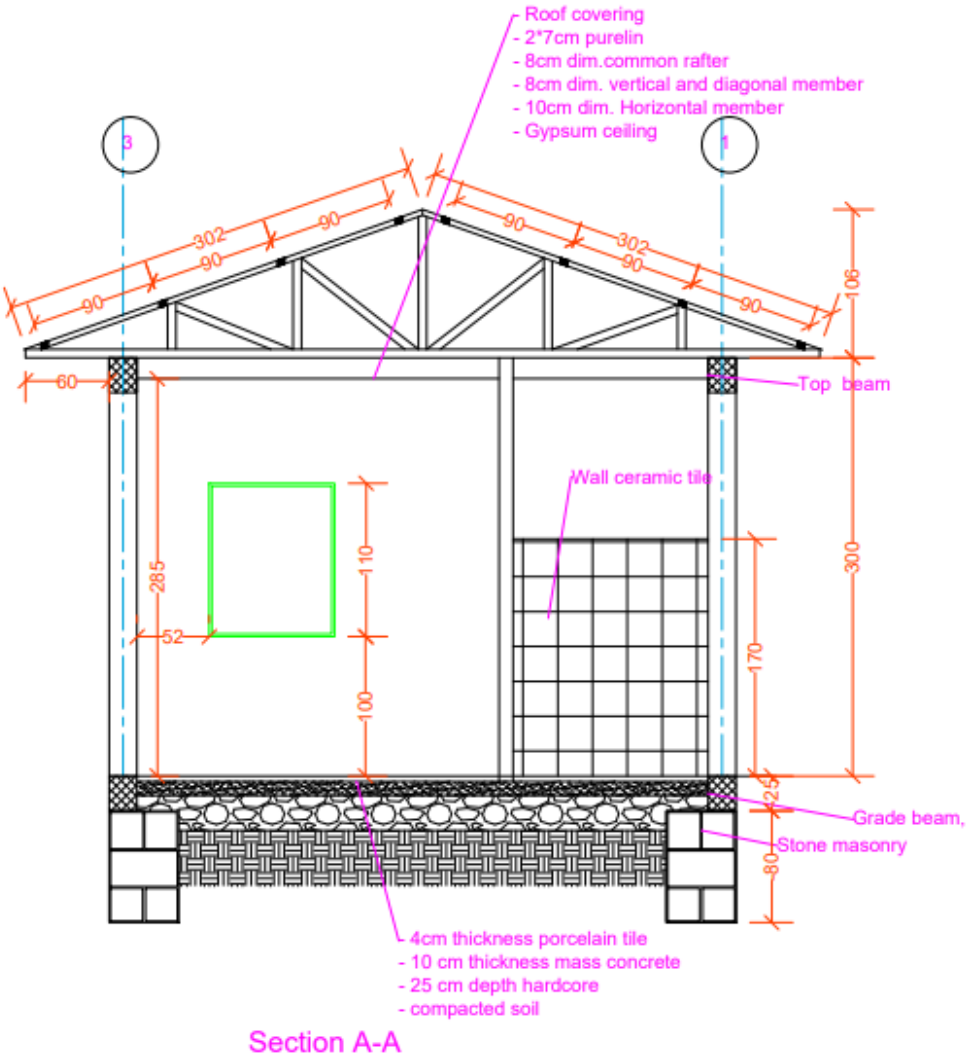
Floor plan



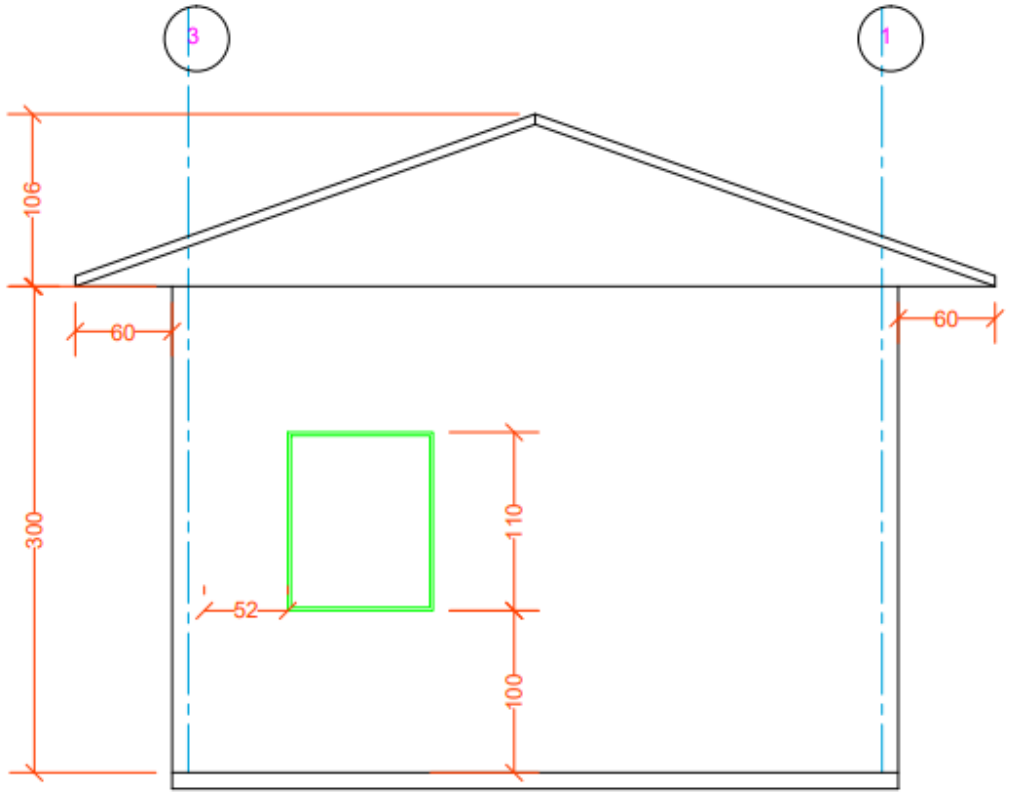
Left side elevation



Front elevation



Section A-A



Right side elevation

Unit Three: Material, Manpower, and Equipment Requirements

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

- Material requirements
- Manpower requirements
- Equipment requirements

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

- Identify material requirements
- Identify manpower requirements
- Identify equipment requirements

3.1. Material Requirements

Material Requirement refers to the specific quantities and types of materials needed to complete a project or produce a product. Accurately determining material requirements is essential for effective project management, budgeting, and scheduling.

Importance of material requirement

- Budget Control: Accurate material requirements help create a realistic budget, reducing the risk of cost overruns.
- Project Timelines: Ensuring materials are available when needed helps prevent delays in project completion.
- Quality Assurance: Proper material selection contributes to meeting quality standards and project specifications.
- Resource Optimization: Efficient management of material requirements minimizes waste and enhances resource utilization.

Key aspects of material requirement

Types of Materials:

- Raw Materials: Basic substances that undergo processing to become part of the final product (e.g., metals, plastics, wood).
- Components: Manufactured items that are assembled into the final product (e.g., screws, electrical components).
- Supplies: Items used in the production process that do not become part of the final product (e.g., adhesives, cleaning agents).

Quantities:

- Calculate the total amount of each material required based on project specifications, designs, and quantity takeoffs.
- Include allowances for waste, spoilage, and potential changes in project scope.

Quality Standards:

- Ensure that materials meet the necessary quality and regulatory standards relevant to the project.
- Specify any testing or certifications required for compliance.

Supplier Information:

- Identify reliable suppliers for each type of material.
- Assess lead times for delivery to ensure materials arrive when needed for the project.

Cost Estimation:

- Gather pricing information for materials to include in the project budget.
- Consider bulk purchasing options or long-term contracts with suppliers for cost savings.

Storage and Handling:

- Plan for adequate storage space and handling procedures for materials, especially those that are hazardous or perishable.
- Implement safety measures to protect workers and materials.

Table3.1*: Material requirements*

Material	Quantity	Unit Cost	Total Cost
Interior Paint	50 gallons	Birr 30/gallon	1,500
Primer	20 gallons	Birr 25/gallon	birr500
Laminate Flooring	12,000 sq. m.	birr3/sq. m.	birr36,000
Drywall	200 sheets	birr12/sheet	birr2,400
Finishing Compound	10 buckets	birr20/bucket	birr200
Adhesives and Sealants	Various	-	birr300
Baseboards and Moldings	1,000 linear m.	birr1.50/linear m	birr1,500

Total Material Cost: birr42,400

3.2. Manpower Requirements

Manpower Requirements refer to the specific number and types of personnel needed to execute a project effectively. Properly identifying and estimating these requirements is essential for project planning, scheduling, and cost management.

Importance of Manpower Requirements

- Project Efficiency: Properly estimating manpower needs helps to ensure that the project runs smoothly and on schedule.
- Cost Management: Accurate manpower estimates contribute to budget planning and help prevent cost overruns associated with labor.
- Quality Assurance: A well-trained and adequately staffed workforce is essential for maintaining quality standards throughout the project.
- Risk Management: Identifying manpower needs in advance allows for better planning for potential staffing challenges or shortages.

Key Aspects of Manpower Requirements

- Skill Sets:
  - Identify the specific skills and qualifications required for various roles within the project (e.g., skilled laborers, engineers, project managers).
  - Ensure that the workforce possesses the necessary certifications and training for their tasks.
- Labor Hours:
  - Estimate the total labor hours needed for each project phase based on the scope of work and productivity rates.
  - Break down labor hours by task to facilitate detailed scheduling and workload management.
- Workforce Size:
  - Calculate the number of workers required based on the project timeline, tasks, and estimated labor hours.
  - Consider the need for additional personnel during peak periods or specific project phases.
- Roles and Responsibilities:
  - Clearly define roles and responsibilities for each member of the workforce to ensure accountability and efficiency.

- Create a project organizational chart to visualize the hierarchy and reporting structure.

- Recruitment and Training:
  - Identify any gaps in skills or personnel and develop a recruitment plan to fill these gaps.
  - Plan for onboarding and training programs to ensure that all workers are prepared for their roles.
- Work Schedule:
  - Develop a work schedule that outlines shims, workdays, and hours to optimize workforce productivity.
  - Consider factors such as overtime, holidays, and labor laws when creating the schedule.
- Health and Safety Considerations:
  - Implement safety protocols and training to protect workers on site.
  - Ensure compliance with relevant health and safety regulations.

Table 3.2: *Manpower requirements*

Role	Number of Workers	Hourly Rate	Hours/Week	Total Weeks	Total Cost
Painters	5	birr25	40	4	birr20,000
Flooring Installers	3	birr30	40	3	birr10,800
Drywall Finishers	2	birr28	40	2	birr4,480
Project Supervisor	1	birr35	40	6	birr8,400

Total Manpower Cost 43, 680 birr

3.3. Equipment Requirements

Equipment Requirements refer to the specific types and quantities of machinery, tools, and equipment needed to successfully complete a project. Proper identification and estimation of these requirements are essential for effective project planning, budgeting, and execution.

Importance of equipment requirements

- Project Efficiency: Properly estimating equipment needs ensures that all necessary tools and machinery are available, helping to avoid delays.
- Cost Control: Accurate assessment of equipment requirements contributes to better budget management and cost forecasting.
- Safety: Ensuring that the right equipment is available and well-maintained enhances safety on the job site.
- Resource Optimization: Efficient management of equipment reduces waste and improves overall resource utilization.

Key Aspects of Equipment Requirements

- Types of Equipment:
  - Heavy Machinery: Includes items such as excavators, bulldozers, cranes, and forklims used for large-scale operations.
  - Tools: Hand tools and power tools essential for various tasks (e.g., drills, saws, wrenches).
  - Support Equipment: Items such as scaffolding, generators, and safety equipment (e.g., harnesses, helmets).
- Quantity and Specifications:
  - Determine how many units of each type of equipment are required based on project scope and tasks.
  - Specify the technical requirements and performance standards for each piece of equipment (e.g., capacity, size, power).
- Rental vs. Purchase:
  - Assess whether to rent or purchase equipment based on project duration, budget constraints, and usage frequency.
  - Evaluate the total cost of ownership versus rental costs, including maintenance and depreciation.
- Cost Estimation:

- Gather pricing information for purchasing or renting equipment to include in the project budget.
- Consider additional costs such as fuel, maintenance, and insurance.

- Availability and Lead Times:
  - Identify reliable suppliers and rental companies to ensure equipment availability when needed.
  - Factor in lead times for procurement and delivery in the project schedule.
- Maintenance and Operational Considerations:
  - Plan for routine maintenance and repairs to minimize downtime during the project.
  - Ensure that operators are trained on the proper use and safety protocols for each piece of equipment.
- Storage and Transportation:
  - Develop a plan for storing equipment on-site or off-site to protect it from damage and them.
  - Consider logistics for transporting equipment to and from the project site.

Table 3.3. *Equipment requirements*

Equipment	Quantity	Daily Rental Cost	Rental Duration (Days)	Total Rental Cost
Paint Sprayer	2	birr50	10	birr1,000
Floor Scraper	1	birr40	5	birr200
Trowels and Putty Knives	Various	-	-	birr100
Measuring Tape	5	-	-	birr50
Safety Gear (masks, goggles)	Various	-	-	birr200

Total Equipment Cost: 1,550birr

Self-check (Three)

Part I: Choose the correct answer

1. What is the primary purpose of determining material requirements in a project?
   A. To improve team communication
   B. To ensure accurate budgeting and scheduling
   C. To enhance marketing strategies
   D. To reduce project scope

Answer: B) To ensure accurate budgeting and scheduling

2. Which type of material is classified as a basic substance that undergoes processing?
   A. Components
   B. Supplies
   C. Raw Materials
   D. Finished Products

Answer: C) Raw Materials

3. What is a key aspect of manpower requirements?
   A. Identifying marketing strategies
   B. Calculating equipment needs
   C. Estimating total labor hours needed
   D. Developing product designs

Answer: C) Estimating total labor hours needed

4. Which of the following is NOT a type of equipment requirement?
   A. Heavy Machinery
   B. Components
   C. Tools
   D. Support Equipment

Answer: B) Components

5. Why is it important to identify reliable suppliers for materials?
   A. To increase marketing efforts
   B. To ensure materials arrive on time
   C. To reduce production time
   D. To enhance project visibility

Answer: B) To ensure materials arrive on time

Part II: Write true if the statement is correct and write false if the statement is incorrect

1. Manpower requirements relate only to the number of workers needed for a project.
   Answer: False
2. Proper management of equipment requirements can enhance safety on the job site.
   Answer: True
3. Cost estimation for equipment only includes the purchase price. **Answer:** False

Part III: Give Short Answer for the following question

1. What are the three types of materials mentioned in the document?
   Answer: Raw Materials, Components, and Supplies.
2. Explain why it is important to include allowances for waste in material requirements.
   Answer: Including allowances for waste ensures that there are sufficient materials available to account for spoilage or unexpected changes in project scope, helping to prevent delays.
3. What should be considered when deciding between renting or purchasing equipment?
   Answer: Considerations should include project duration, budget constraints, usage frequency, and the total cost of ownership versus rental costs, including maintenance and depreciation.

Unit Four: Resource Acquisition

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

- Managing resource procurement
- Communication of resource requirements
- Application of financial principles

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

- Manage resource procurement
- Communication of resource requirements
- Apply of financial principles

4.1. Managing Resource Procurement

Managing resource procurement is a crucial aspect of effective resource management, ensuring that all necessary materials, labor, and equipment are acquired efficiently and cost-effectively. Here is a structured approach to this process:

1. Assessment of Resource Needs

- **Identify Requirements:**
  - Catalog all resources needed for production, including raw materials, components, labor, and equipment.
  - Determine the specifications for each resource, such as quality standards, quantity, and timing.

2. Supplier Selection

- **Research Potential Suppliers:**
  - Evaluate suppliers based on criteria such as reliability, quality, cost, and delivery performance.
  - Consider both local and international suppliers to expand options.
- **Establish Relationships:**
  - Develop relationships with multiple suppliers to mitigate risks associated with supply chain disruptions.
  - Engage in regular communication to build trust and understanding.

3. Developing a Procurement Strategy

- **Procurement Methods:**
  - Choose appropriate procurement methods (e.g., direct purchasing, contracts, tendering) based on resource type and urgency.
  - Consider bulk purchasing for cost savings on high-volume items.
- **Just-in-Time (JIT) Procurement:**
  - Implement JIT practices to align procurement closely with production schedules, minimizing inventory holding costs.

4. Contract Negotiation

- **Negotiate Terms:**
  - Discuss pricing, delivery schedules, payment terms, and quality expectations with suppliers.

- Include clauses for quality assurance, penalties for non-compliance, and conditions for contract termination.

- **Legal Review:**
  - Ensure legal experts to protect the organization's interests review contracts.

5. Order Placement and Tracking

- **Order Management:**
  - Place orders based on calculated needs, utilizing inventory management systems to streamline the process.
  - Confirm orders with suppliers to avoid misunderstandings.
- **Tracking Deliveries:**
  - Monitor order status and delivery timelines to ensure timely receipt of resources.
  - Use tracking systems to manage and adjust orders as necessary.

6. Inventory Management

- **Inventory Control:**
  - Implement inventory management systems to track resource levels and automate reordering processes.
  - Regularly review inventory levels to prevent shortages or excess stock.
- **Stock Audits:**
  - Conduct periodic audits to verify inventory accuracy and identify discrepancies.

7. Performance Evaluation

- **Supplier Performance Monitoring:**
  - Assess supplier performance regularly based on criteria such as quality, delivery accuracy, and responsiveness.
  - Provide feedback to suppliers and address any issues promptly.
- **Continuous Improvement:**
  - Use performance data to identify areas for improvement in procurement processes.
  - Adjust strategies and practices based on feedback and changing conditions.

4.2. Communication of Resource Requirements

Effective communication of resource requirements is vital for ensuring that all stakeholders are aligned and informed throughout the procurement process. The structured approach to facilitating clear and efficient communication:

1. Establish Clear Protocols

- **Define Communication Channels:**
  - Identify the primary channels for communication (e.g., email, project management tools, meetings).
  - Ensure all stakeholders understand which channels to use for specific types of information.
- **Set Guidelines:**
  - Create guidelines for frequency and format of updates on resource requirements, ensuring consistency in communication.

2. Internal Communication

- **Cross-Department Collaboration:**
  - Facilitate regular meetings between departments (e.g., production, procurement, finance) to discuss resource needs and updates.
  - Encourage collaboration to ensure that everyone is aware of changing requirements and priorities.
- **Share Resource Requirements:**
  - Utilize shared documents or project management systems to maintain a centralized list of resource requirements.
  - Ensure that updates to resource needs are communicated promptly to all relevant teams.

3. Stakeholder Engagement

- **Regular Updates:**
  - Keep stakeholders informed about changes in resource requirements, procurement status, and any potential issues that may arise.
  - Use newsletters, bulletins, or briefings to communicate key updates.
- **Feedback Mechanism:**
  - Establish a system for stakeholders to provide feedback on resource requirements and procurement processes.

- Encourage open dialogue to address concerns and suggestions for improvement.

4. Documentation of Requirements

- **Maintain Accurate Records:**
  - Document all resource requirements clearly, including specifications, quantities, and timelines.
  - Use standardized forms or templates to ensure uniformity in documentation.
- **Version Control:**
  - Implement version control for documents to track changes and updates in resource requirements.
  - Ensure that all stakeholders have access to the most current information.

5. Training and Awareness

- **Educate Teams:**
  - Provide training for employees on the importance of effective communication and the tools used for resource management.
  - Highlight the impact of clear communication on procurement efficiency and overall operational success.

6. Crisis Communication Plan

- **Prepare for Challenges:**
  - Develop a communication plan for addressing unforeseen issues (e.g., supply chain disruptions, sudden changes in demand).
  - Ensure that all teams know how to escalate issues and communicate urgent needs quickly.

4.3. Financial Principles

Definition:

The application of financial principles refers to the systematic use of financial theories, methods, and practices to guide decision-making in resource management and procurement. This involves integrating financial analysis, budgeting, cost management, and investment evaluation into the processes of acquiring and managing resources.

Applying financial principles to resource management is essential for ensuring that procurement activities align with organizational goals and budgetary constraints. The structured approach to integrating financial principles into the resource acquisition process.

Key Components

1. Budgeting
2. Cost Management
3. Financial Analysis
4. Return on Investment (ROI)
5. Financial Forecasting

1. Budget Development

- **Create a Detailed Budget:**
  - Develop a comprehensive budget that includes all costs associated with resource procurement, such as materials, labor, overhead, and transportation.
  - Break down the budget into categories to allow for easier tracking and management.
- **Align with Organizational Goals:**
  - Ensure that the budget aligns with overall business objectives and production plans.
  - Integrate financial forecasts into the budgeting process to anticipate future resource needs.

2. Cost Management

- **Implement Cost-Control Measures:**
  - Establish processes to monitor and control spending, ensuring that procurement remains within budget.
  - Regularly compare actual expenditures against the budget to identify variances and adjust as necessary.
- **Identify Cost-Saving Opportunities:**
  - Analyze procurement processes to identify areas where costs can be reduced without compromising quality.
  - Negotiate better terms with suppliers or consider alternative sourcing options.

3. Financial Analysis

- **Conduct Cost-Benefit Analyses:**

- Evaluate the financial implications of different procurement options to make informed decisions.
- Assess both direct costs (e.g., purchase price) and indirect costs (e.g., maintenance, shipping) to determine the total cost of ownership (TCO).

- **Perform Break-Even Analysis:**
  - Calculate the break-even point for resource investments to understand the minimum sales volume needed to cover costs.
  - Use this analysis to guide pricing strategies and production planning.

4. Return on Investment (ROI) Assessment

- **Evaluate ROI on Major Investments:**
  - Assess the ROI for significant resource investments, such as new machinery or technology.
  - Calculate ROI using the formula:

  ROI=Net Profit Cost of Investment×100\text{ROI} = \frac{\text{Net Profit}}{\text{Cost of Investment}} \times 100ROI=Cost of Investment Net Profit ×100

- **Monitor Performance Metrics:**
  - Establish key performance indicators (KPIs) to measure the effectiveness of resource investments and procurement strategies.
  - Regularly review these metrics to identify areas for improvement.

5. Financial Forecasting

- **Use Historical Data:**
  - Analyze historical procurement data and market trends to forecast future resource needs and associated costs.
  - Adjust forecasts based on anticipated changes in production levels or market conditions.

- **Scenario Planning:**
  - Develop financial scenarios to prepare for potential changes in demand, costs, or economic conditions.
  - Use these scenarios to create flexible procurement strategies that can adapt to changing circumstances.

Self-check (four)

Part I: Choose the best answer

1. What is the first step in managing resource procurement?
   A. Supplier Selection
   B. Order Placement
   C. Assessment of Resource Needs
   D. Performance Evaluation

Answer: C) Assessment of Resource Needs

2. Which procurement method is characterized by aligning orders with production schedules?
   A. Direct Purchasing
   B. Just-in-Time (JIT) Procurement
   C. Tendering
   D. Bulk Purchasing

Answer: B) Just-in-Time (JIT) Procurement

3. What should be established to evaluate supplier performance?
   A. Financial Forecasting
   B. Cost Management
   C. Supplier Performance Monitoring
   D. Crisis Communication Plan

Answer: C) Supplier Performance Monitoring

4. Which principle involves creating a detailed budget for resource procurement?
   A. Cost Management
   B. Financial Analysis
   C. Budget Development
   D. Return on Investment (ROI)

Answer: C) Budget Development

5. What is a key benefit of maintaining accurate records of resource requirements?
   A. Reduces supplier options
   B. Enhances procurement negotiations
   C. Ensures uniformity in documentation
   D. Increases inventory costs

Answer: C) Ensures uniformity in documentation

Part II: Write true if the statement is correct and write false if the statement is incorrect

1. Establishing relationships with multiple suppliers can mitigate risks associated with supply chain disruptions. **Answer:** True
2. Version control is not necessary for documenting resource requirements. **Answer:** False
3. Financial forecasting relies solely on current market conditions and does not consider historical data. **Answer:** False

Part III: Give Short Answer for the following question

1. What is the purpose of conducting cost-benefit analyses in resource procurement?

   Answer: Cost-benefit analyses evaluate the financial implications of different procurement options to make informed decisions, assessing both direct and indirect costs.

2. Explain the importance of establishing clear communication protocols during resource procurement.

   Answer: Clear communication protocols ensure that all stakeholders are aligned and informed about resource needs, updates, and potential issues, facilitating efficient collaboration and decision-making.

3. What role does Just-in-Time (JIT) procurement play in resource management?

   Answer: JIT procurement aligns resource acquisition closely with production schedules, minimizing inventory holding costs and ensuring that materials are available when needed without excess stock.

LAP Test

Practical Demonstration

Name: _____ **Date: _____**

Time started: _____ **Time finished: _____**

Instruction: Perform the following tasks

Task 1: Estimate cost for finishing works

Reference

- "Project Estimating and Cost Management" by Parviz F. Rad
- "Estimating Construction Costs" by Robert L. Peurifoy and Garold D. Oberlender
- "Cost Estimation: Methods and Tools" by Gregory K. Mislick and Daniel A. Nussbaum
- "Somware Cost Estimation with COCOMO II" by Barry W. Boehm
- "Cost Engineering" by Douglas D. Gransberg and Calin M. Popescu
- "Production and Inventory Management" by Edward A. Silver, David F. Pyke, and Rein Peterson
- Materials Management with SAP S/4HANA" by Jawad Akhtar
- "Manufacturing Planning and Control for Supply Chain Management" by F. Robert Jacobs and William L. Berry
- "Bill of Materials in Excel & ERP" by Daniel Smith
- "Procurement and Supply Chain Management" by Kenneth Lysons and Brian Farrington

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