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Acronym

BOQ	-----	bill of quantity
UF	-----	utilization factor
DC	-----	direct cost
MC	-----	material cost
LC	-----	labor cost
EC	-----	equipment cost
IC	-----	indirect cost
TC	-----	total cost
GMP	-----	guaranteed maximum price
CMR	-----	Construction Management at Risk
CMR	-----	Construction Management at Risk
DBB	-----	Design-Bid-Build
DB	-----	Design-Build
MP	-----	Multi-Prime

Introduction to the Module

The prepare bill of quantities helps to know the Gather information estimate materials, labor and time calculate costs, document and verify detail in plumbing installation work filed.

This module is designed to meet the industry requirement under the plumbing installation work occupational standard, particularly for the unit of competency: prepare bill of quantities

This module covers the units:

- Information
- Estimation materials, labor, time and costs
- Documentation and verify detail

Learning Objective of the Module

- Gather Information
- Estimating materials, labor, time and costs
- Documenting and verify detail

Module Instruction

For effective use this 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: Gathering information

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

- Customer requirements
- Plans/specifications
- Products and/or services
- Delivery point and methods
- Record

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:

- Obtain customer requirements
- Access plans/specifications
- Develop products and/or services
- Determine delivery point and transportation methods
- Record details

1.1. Customer requirements

The Bill of Quantities (BoQ) is a document commonly used in construction projects to provide a detailed breakdown of the quantities and types of materials, equipment, and labor required to complete the project. It serves as a basis for tendering, cost estimation, and contract administration.

The BoQ is typically prepared by a quantity surveyor or an estimator and is based on the project's design documents, such as architectural and engineering drawings, specifications, and schedules. It organizes the project into measurable and quantifiable items, referred to as bill items or work items, which are categorized according to trades or disciplines.

Each bill item in the BoQ includes a description of the work to be done, the unit of measurement (e.g., cubic meters, square meters, pieces), the quantity required, and the unit rate or price. The unit rate represents the cost per unit of measurement for each item and is used to calculate the total cost for that item by multiplying it with the quantity.

- **The BoQ helps various stakeholders in the construction project in several ways:**
 - **Tendering:** Contractors use the BoQ to prepare accurate and competitive bids for the project. The detailed breakdown of quantities and rates enables them to estimate their costs more precisely.
 - **Cost Estimation:** The BoQ serves as a basis for cost estimation and budgeting. By summing up the costs of individual bill items, the total project cost can be determined. It also helps in identifying cost-saving opportunities and making value engineering decisions.
 - **Contract Administration:** During the execution of the project, the BoQ acts as a reference document for measuring and valuing the work completed. It helps in assessing progress payments, variations, and claims. The BoQ can also be used for cost control and monitoring purposes.

- **Material Procurement:** The BoQ provides a detailed list of materials required for the project, enabling efficient procurement planning and coordination with suppliers.

The BoQ plays a crucial role in ensuring clarity, transparency, and accuracy in the financial aspects of construction projects. It helps in minimizing disputes, facilitating effective project management, and achieving cost control objectives.

- **Some key details to consider:**

- 1) **Date:** Start by noting the date the plumbing work is performed or the date the bill is issued.
- 2) **Contact Information:** Include the contact information of both the plumber or plumbing company and the customer. This usually includes names, addresses, phone numbers, and email addresses.
- 3) **Description of Work:** Provide a detailed description of the plumbing services performed. Include information such as the type of work (e.g., installation, repair, maintenance), the specific fixtures or systems involved (e.g., toilets, sinks, water heaters), and any additional details that are relevant to the job.
- 4) **Quantity:** Specify the quantity of each item or service provided. For example, if the plumber replaced three faucets, you would note "3" in the quantity column next to "faucets."
- 5) **Unit Price:** Indicate the unit price or rate for each item or service. This is the cost per unit or the hourly rate charged by the plumber.
- 6) **Total Price:** Multiply the quantity by the unit price for each item or service to calculate the total price for that line item. Sum up all the line items to get the subtotal.
- 7) **Taxes and Fees:** If applicable, include any taxes, surcharges, or fees that need to be added to the subtotal.
- 8) **Grand Total:** Add the subtotal and any applicable taxes or fees to get the final amount owed by the customer.
- 9) **Payment Terms:** Specify the payment terms, such as the due date and acceptable payment methods (e.g., cash, check, credit card).

- 10) **Terms and Conditions:** Include any relevant terms and conditions, such as warranty information, liability disclaimers, or refund policies.

Remember to consult with a professional plumber or an accountant to ensure your plumbing bill accurately reflects the services provided and complies with any local regulations or requirements.

The **customer requirement** for a bill of quantities (BOQ) is centered around understanding and documenting the specific needs and preferences of the customer or client regarding a construction project. The BOQ is a detailed document that provides a comprehensive list of items, quantities, and costs required for the construction or renovation of a building.

Bill of Quantities (BOQ) creating for a construction project, there are different requirements to consider depending on whether you are working from the perspective of a customer or an owner.

- **Key considerations about customer requirements and owner requirements:**

- **Customer Requirements:**

- Scope of Work:** Clearly define the scope of the project, including the desired outcomes, specifications, and any particular requirements.
- Detailed Specifications:** Provide detailed specifications for materials, equipment, and workmanship standards to ensure the desired quality and performance.
- Cost Control:** Specify any budget constraints or cost limitations that the BOQ should adhere to.
- Compliance:** Specify any relevant codes, regulations, or standards that need to be followed during construction.
- Timeframe:** Clearly communicate the desired project duration and any specific milestones or deadlines.
- Value Engineering:** Request suggestions or proposals for cost-saving measures or alternative materials without compromising quality.

➤ **Owner Requirements:**

- a) **Design Intent:** Clearly communicate the design intent, architectural drawings, and engineering plans to ensure accurate quantification of materials and resources.
- b) **Cost Estimation:** Request detailed cost estimates for each item, including labor, materials, equipment, and any associated costs (such as permits or testing).
- c) **Transparency:** Request a breakdown of quantities and rates for each item to facilitate cost analysis, comparisons, and potential negotiation.
- d) **Change Management:** Specify the process for handling any changes or variations to the BOQ during the construction phase, including documentation and approval procedures.
- e) **Quality Assurance:** Specify any quality control or quality assurance requirements to ensure compliance with specified standards.
- f) **Reporting:** Request regular progress reports and updates on the quantities used, work completed, and any deviations from the original BOQ.

It's important to note that these requirements may vary depending on the specific project, industry, and contractual agreements. It's always recommended to consult with relevant professionals, such as architects, engineers, or quantity surveyors, to ensure that the BOQ meets the specific requirements of the construction project.

1.2. Plans and specifications

A bill of quantities (BOQ) is a document used in construction projects to itemize the materials, labor, equipment, and other costs required to complete the project. For a sanitary installation project, the BOQ would typically include the following components:

- a) **Plumbing Fixtures:** This section will list all the plumbing fixtures required for the project, such as toilets, sinks, faucets, showers, bathtubs, and urinals. It will specify the quantity and type of each fixture.
- b) **Pipes and Fittings:** The BOQ will include a detailed list of pipes and fittings needed for the plumbing system. This can include pipes made of various materials (PVC, copper, etc.) and fittings like elbows, tees, valves, and connectors.

- c) **Drainage System:** This section will outline the drainage system components, including pipes, traps, gullies, manholes, and other related items.
- d) **Water Supply System:** The BOQ will specify the materials required for the water supply system, such as pipes, valves, water meters, pumps, pressure regulators, and storage tanks.
- e) **Hot Water System:** If a hot water system is part of the project, the BOQ will include items like water heaters, circulation pumps, pipes, and fittings specific to the hot water supply.
- f) **Sanitary Accessories:** This section will list additional accessories like soap dispensers, hand dryers, mirrors, towel holders, and other fixtures necessary for the sanitary facilities
- g) **Labor and Installation:** The BOQ will allocate the necessary labor costs for the installation of the sanitary system. This can include skilled plumbers, technicians, and general laborers.
- h) **Miscellaneous:** The BOQ may also include additional items such as adhesives, sealants, insulation, hangers, brackets, and any other materials required for the proper installation of the sanitary system.

It's important to note that the level of detail in a BOQ may vary depending on the project's requirements. It's advisable to consult with a professional quantity surveyor or a building services engineer to prepare an accurate and comprehensive bill of quantities for your specific sanitary installation project. Keep in mind that this is a general template, and you may need to tailor it to your specific project requirements.

Example: Project overview and objectives

a) Introduction

- Scope of work for the sanitary installation project
- Relevant codes and standards to be followed

b) General Requirements

- Description of the building or facility

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- Design considerations and constraints
- Project schedule and milestones

c) Plumbing Plans

- Floor plans indicating the location of fixtures, drains, vents, and pipes
- Isometric diagrams to illustrate the routing of pipes
- Schedules for fixtures, such as sinks, toilets, showers, and urinals
- Details of special plumbing systems, such as grease traps or backflow prevention devices

d) Drainage and Waste Systems

- Layout of the sanitary drainage system, including main stacks, branch lines, and cleanouts
- Sizing of pipes based on fixture units and anticipated flow rates
- Specifications for materials, such as PVC or cast iron pipes, fittings, and supports
- Details of venting systems to ensure proper drainage and prevent sewer gas buildup

e) Drainage and Waste Systems

- Layout of the sanitary drainage system, including main stacks, branch lines, and cleanouts
- Sizing of pipes based on fixture units and anticipated flow rates
- Specifications for materials, such as PVC or cast iron pipes, fittings, and supports
- Details of venting systems to ensure proper drainage and prevent sewer gas buildup

f) Water Supply Systems

- Layout of the domestic water supply system, including distribution lines and branch connections
- Sizing of pipes based on anticipated demand and pressure requirements
- Specifications for water supply fixtures, valves, and controls
- Backflow prevention measures and devices

g) Special Systems

- Description and layout of any special systems, such as rainwater harvesting or gray water recycling
- Specifications for equipment and components related to the special systems

Schematic diagrams and calculations, if applicable

h) Specifications

- Detailed specifications for materials, equipment, and installation methods
- Quality standards and testing requirements
- Compliance with relevant plumbing codes and regulations
- Coordination with other trades, such as electrical or HVAC systems

1.3. Products/services

To develop details of products/services for plumbing installation bill quantity, need to consider various factors and components involved in a plumbing installation project.

• **Some key details to consider:**

- Material Quantities:** Plumbing installations require various materials, such as pipes, fittings, valves, connectors, fixtures, and accessories. Determine the quantities of each material required based on the project specifications, including pipe lengths, pipe diameters, and the number of fixtures.
- Labor Costs:** Plumbing installation involves skilled labor to perform tasks such as cutting and fitting pipes, connecting fixtures, and testing the system. Consider the number of hours required for each task and multiply it by the labor rate to calculate the labor costs.
- Pipe Sizing and Routing:** Analyze the plumbing layout and determine the required pipe sizes and routing. The length and diameter of the pipes will affect the material quantities and costs.
- Fixtures and Accessories:** Consider the types and quantities of fixtures and accessories needed for the plumbing installation. This includes sinks, toilets, showers, faucets, water heaters, and other components. Each fixture has its own cost, which should be factored into the bill quantity.

- e) **Additional Components:** Plumbing installations may require additional components such as water pumps, pressure regulators, water filters, and drainage systems. Include these components and their quantities in the bill quantity calculations.
- f) **Contingencies:** It's important to include a contingency factor to account for any unforeseen circumstances or changes during the installation process. This ensures that the bill quantity covers unexpected expenses.
- g) **Markup and Profit:** Consider the markup and profit margin to be included in the bill quantity. This is typically a percentage added to the total costs to cover overhead expenses and generate profit for the plumbing contractor.
- h) **Calculation and Documentation:** Once you have determined the quantities and costs of the materials, labor, fixtures, and additional components, perform calculations to arrive at the bill quantity. Document all the details, including itemized costs, material specifications, and any assumptions made during the estimation process.

- **Bill of quantities**

A bill of quantities or schedule of quantities consists of a complete list of all various items of works for a project, giving the item number and description of items with unit and quantity of work against each, thus enabling an estimated calculation of price of work. Describe the expected amount of work (measured) in works; it sets out the units of measurement, the units of work, the unit price and the total cost of the works.

The bill of quantities is prepared from drawings and specifications and is arranged in a tabular form without completing columns of rate and amount.

The work of a project is usually divided into separate elements for payment purposes with respect to the kind of work involved, each element as a separate bill designated as a payment item. The total price of a bid is obtained by summation of the amounts for all items scheduled in the tender, arrived at by multiplying the estimated number of units for each item by the corresponding unit-price bid. The general format of BOQ is expressed as follows:

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Table 1: general format of BOQ Unit cost /Units of Measurement

The following units of measurement and abbreviations are recommended for use in different types works in preparation of BOQ.

Type	Unit	Abbreviation
Volume	cubic meter	m ³ or cu m
Area	Meter square	M ²
Time	Hour	h
Mass	Kilogram / Metric ton/	Kg /MT/
Items	Number	No
Length	Meter /Liner meter	M /ML/

Item no.	Description	Unit	Quantity	Rate/unit price	Amount
1.	Sanitary work	m			

There are four clearly defined steps in preparation of Bill of Quantities:

- a. Taking off
- b. Squaring
- c. Abstracting
- d. Writing the final Bill of Quantity

1) Taking Off

This is a process of measuring or scaling dimensions from drawings and recording all dimensions in an easily understood format. This is coupled with the descriptions in the drawings and specification.

In this task the quantity surveyor “takes off” the quantities from the drawings and determines the volume of work to be done for the various components. These quantities are calculated in a specially prepared format, as to aid accurate preparation and enable checking/rechecking or adjusting of amounts

and correcting errors if any. These special formats are called “Take off sheets” or “Dimension Paper”.
The dimension paper used for taking off is usually double-ruled as shown (A4 size)

2) Taking Off

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 ml, m², m³ or in Pcs. or No.

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

The following tasks are part of the Taking Off:

- Describing the item,
- Timising,
- Dotting on (adding to the timising factor),
- ditto
- Deduction of items,
- Correction of dimensions (nullifying).



XYZ Construction PLC

Project Residential Building

Takeoff Sheet

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LX\Y\ZH			LX\Y\ZH		
		A. SUB STRUCTURE	1.5 Back fill around foundation with selected borrowed materials		
		1. Excavation and Earthwork			
		1.1 Site Clearing	103.16	303.16	m ³ total Volume of Pit Excavation excavation.
10.00			2	1.3	
15.50				1.30	
	155			0.40	
	325.00	m ² total area of site cleared.			-1.35
		1.2 PIT excavation giving work space 20 cm in both sides .	5	1.5	
4	1.70			1.50	
	1.70			0.40	
	2.20				-4.50
	25.432		3	2	
5	1.90			2	
	1.90			0.40	
	2.20				-4.8
	39.71		2	1.30	
3	2.40			1.3	
	2.40			0.30	
	2.20				-1.014
	38.02				-11.03 m ³ total Volume of concrete pad
	303.16	m ³ total Volume of Pit excavation.			
		1.3 Strap excavation giving work space 10 cm in both sides .	12	1.80	
2	1.60			0.30	
	0.50			0.30	
	1.80				-1.04 m ³ total Volume of concrete for foundation column
	2.88				80.50 m ³ total Volume of back fill around foundation.
2	1.85				
	0.50				
	1.80				
	3.33		1	16.75	
1	3.25			0.40	
	0.50			1.00	
	1.80				6.70
	2.93		1	2.95	
	0.14	m ³ total Volume of Strap Beam excavation.		0.75	
			1.6 Ditto but 1.5 around stone masonry		

1) Squaring

The dimensions entered in Column 2 are squared or cubed as the case may be, multiplied by the timing factor, and the result entered in Column 3. This task is called squaring. All squared dimensions should

be carefully checked by another person before abstracting, and if correct the item should be ticked with red. Use two decimal places.

2) Abstracting

The squared dimensions are transferred to abstract sheets and all similar dimensions are collected in the same category to obtain the total quantity of each item.

3) Writing the final bill

After the abstract sheets have been completed and checked, the final bill of quantity is written. The dimensions are copied from the abstracts, and as each item is transferred it should be ticked by a vertical line from the abstract sheets. The description of each item in the final BoQ should be short, precise and descriptive as per the specification..

- **Specification**

Specification is a specific description of a particular subject. Engineering Specification contains detailed description of all workmanship and materials (required to complete a project) in accordance with its drawings and details. Drawings with the Specification will completely define the structure. Drawings and Specifications are complementary. Specification should be written in an orderly and logical manner. Engineering Specification are organized into divisions and sections. Proper organization of the specifications facilitates cost estimating and aids in preparation of bids. It is not practical to include sufficient notes on the drawings. Detailed descriptions should be incorporated in specifications.

- **Contractors study specifications to determine:**

- Details of materials required
- Sequence of work,
- Quality of workmanship, and
- appearance of the end product,
- Estimate costs.

Good specifications expand or clarify drawing notes, define quality of materials and workmanship, establish the scope of the work, and describe the responsibilities of the contractor.

It's important to note that the specific items and quantities required for a bill of quantities will depend on the project's scope, specifications, and design. A professional quantity surveyor or

construction estimator can help in accurately preparing the bill of quantities based on the project requirements.

1.4. Delivery points and methods

Project Delivery is a comprehensive process including planning, design and construction required to execute and complete a building facility or other type of project. Choosing a project delivery method is one of the fundamental decisions’ owners make while developing their acquisition strategy.

Choosing the best method for any project must start with a good understanding of choices available. Owners must also have a firm grasp of the impact of each choice, because the delivery method establishes when parties become engaged; it influences the choices of contractual relationships; and it influences ownership and impact of changes and modification of project costs. In all delivery systems, there is always a minimum of three parties involved: owner, designer and contractor. It is important to choose a delivery method that best meets the unique needs of each owner and their project.

Project considerations have fundamental impacts on the delivery method selected. These considerations include a realistic budget, a schedule that includes a reasonable performance period, a responsive and quality design process, a risk assessment with allocation of risks to the appropriate parties and recognition of the level of expertise within the owner’s organization.

- **Commonly Used Project Delivery Methods:**
 - Construction Management at Risk (CMR)
 - Design-Bid-Build (DBB) or traditional
 - Design-Build (DB)
 - Multi-Prime (MP)
- **Construction Management at Risk (CMR) (also called CM at-Risk or CM/GC)** – This delivery method entails a commitment by the CMR for construction performance to deliver the project within a defined schedule and price, either a fixed lump sum or a guaranteed maximum price (GMP). The CMR provides construction input to the owner during the design phases and becomes the general contractor during the construction phase.
- **Design-Bid-Build (DBB)** –The design phase, which requires the services of a designer who will be the “designer of record” for the project; the bid phase, when a contractor is selected;

and a build or construction phase, when the project is built by the selected (typically low bid) contractor. This sequence usually leads to a sealed bid, fixed-price contract.

- **Design-Build (DB)** – This method of project delivery includes **one** entity (design-builder) and a **single** contract with the owner to provide both architectural/engineering design services and construction.
- **Multi-Prime (MP)** – Although similar to design-bid-build relative to the three sequential project phases, with MP the owner contracts directly with separate specialty contractors for specific and designated elements of the work, rather than with a single general or prime contractor.

The delivery point and methods for a bill of quantities (BOQ) can vary depending on the specific project and the contractual arrangements between the parties.

- **Delivery Point:**

The delivery point refers to the physical location where the bill of quantities is provided or submitted. It can be one of the following:

- **Online Platform:** In today's digital age, it is common for project stakeholders to use online platforms or project management systems to exchange documents, including the bill of quantities. In this case, the delivery point would be the specific online platform designated for document sharing.
- **Project Office:** The project office or site office can also serve as the delivery point. Contractors or suppliers may be required to submit their bill of quantities physically to the designated office.
- **Client's Office:** Sometimes, the client's office is designated as the delivery point. Contractors or suppliers may need to submit the bill of quantities directly to the client's office, either physically or electronically.

- **Methods of Delivery:**

The methods of delivery for a bill of quantities can include the following:

- **Physical Delivery:** Contractors or suppliers may be required to print and physically deliver the bill of quantities to the specified delivery point. This can be done by courier or by hand, depending on the project requirements.

- **Electronic Delivery:** In many cases, the bill of quantities is submitted electronically. This can be done via email, file-sharing platforms, or online project management systems. The electronic document should be properly formatted and adequately protected to ensure its integrity during transmission.
- **Registered Mail:** For official or legal purposes, registered mail can be used to send the bill of quantities. This method provides proof of delivery and adds an extra layer of security and accountability.
- **Contract-specific Methods:** In some cases, the contract or tender documents may specify specific methods of delivery for the bill of quantities. These could include using a specific software or online portal, submitting in a particular file format, or following a specific delivery procedure. It is crucial to carefully review the contract or tender documents to understand any specific requirements.

Delivery point and methods for the bill of quantities may be subject to the specific project's requirements and contractual arrangements. It is important to refer to the contract documents and communicate with the relevant parties involved to ensure compliance with the specified procedures.

1.5. Recording details

When creating a plumbing bill of quantity, it's important to record accurate and comprehensive details to ensure clarity and transparency.

Key elements:

- **Project Information:**
 - Project name
 - Project location
 - Client name
 - Date of preparation
 - Bill of Quantity reference number
- **Itemized List:** Provide a detailed list of all plumbing items required for the project. This should include materials, fixtures, fittings, and equipment. Each item should have a unique identifier or code, description, quantity, unit of measurement, and unit price. Group similar items together (e.g., pipes, valves, faucets) to enhance readability.

- **Specifications:** Include specifications for each plumbing item, such as material type, size, grade, and any specific requirements. Specify the standards or codes that should be followed for installation and quality assurance.
- **Quantities:** Accurately quantify the required amounts of each item based on project drawings, specifications, or any other relevant documentation. Include allowances for waste, additional fittings, or any other contingencies.
- **Pricing:** Calculate the total cost for each item by multiplying the quantity by the unit price. Ensure that the unit prices are up to date and reflect the current market rates for the specified materials and labor.
- **Summary:** Provide a summary section that includes subtotals for different categories or sections of the bill of quantity, such as materials, labor, and overheads. Calculate the grand total for the entire plumbing bill of quantity.
- **Terms and Conditions:** Include any applicable terms and conditions, such as payment terms, delivery requirements, and any disclaimers or limitations of liability.
- **Attachments:** If necessary, attach relevant drawings, specifications, or other supporting documents that provide additional information or clarify specific requirement

Review and proofread the bill of quantity for accuracy and completeness before finalizing it. It's also advisable to consult with a qualified plumbing professional or estimator to ensure the accuracy of the quantities and pricing.

2.1. SELF CHECK- 1

PART – I choose the correct answer

- Which of the following documents is typically used to gather information for the preparation of a Bill of Quantities?
 - Architectural drawings
 - Environmental impact assessment
 - Marketing brochure
 - Project schedule
- What is the primary purpose of gathering information for a Bill of Quantities?
 - To estimate the project's duration
 - To identify potential risks and hazards
 - To determine the project's budget
 - To evaluate the project's environmental impact
- How information about materials is typically gathered for a Bill of Quantities?
 - By conducting site surveys
 - By consulting with subcontractors
 - By reviewing historical cost data
 - By analyzing competitors' pricing
- What is the purpose of gathering information about labor requirements for a Bill of Quantities?
 - To estimate the project's timeline
 - To calculate the project's net present value
 - To evaluate the project's legal compliance
 - To determine the project's staffing needs

PART – 2 give short answer

- What is the scope of the project for which the Bill of Quantities is being prepared?
- Can you provide a detailed description of the project, including its purpose, location, and any specific requirements?
- Are there any existing structures or utilities on the site that need to be considered during the project?
- Are there any site-specific conditions or constraints that may affect the construction process or material quantities?

5. Are there any specific quality standards or regulations that need to be adhered to during construction?

Unit Two: Estimating and calculating materials, labor time and cost

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

- Plan and sequence of work
- Tools and equipment for product work
- Labor and time requirements
- Total work cost Calculation

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

- Planning and sequencing work
- Estimating tools and equipment for product work
- Estimating labor and time
- Calculation Total work cost

2.1. Planning and sequencing work tasks

Planning and sequencing the work for plumbing bill of quantity preparation involves several steps to ensure an organized and efficient process.

- a) **Review the project documentation:** Carefully examine the project specifications, architectural drawings, and any other relevant documents. Understand the scope of work, project requirements, and any specific details related to the plumbing system.
- b) **Break down the tasks:** Identify all the necessary plumbing tasks required for the project. This may include water supply, drainage, venting, fixture installation, and any other plumbing components. Create a comprehensive list of all the tasks that need to be completed.
- c) **Determine task dependencies:** Analyze the interdependencies between the plumbing tasks. Some tasks may need to be completed before others can begin. Identify any critical paths or tasks that could affect the overall progress of the project.
- d) **Establish a logical sequence:** Based on the task dependencies, establish a logical sequence for the plumbing work. Start with tasks that have no dependencies or can be done concurrently. Then, identify tasks that depend on the completion of previous tasks and organize them accordingly.
- e) **Consider resource availability:** Take into account the availability of resources, such as materials, equipment, and skilled labor. Ensure that the sequence of work aligns with the availability of these resources to avoid delays or inefficiencies.
- f) **Allocate timeframes:** Estimate the time required for each plumbing task. Consider factors like the complexity of the task, the number of workers involved, and any external factors that may impact the

timeline. Set realistic timeframes for each task and allocate sufficient time for completion.

- g) Create a schedule:** Once you have determined the sequence and timeframes, create a detailed schedule for the plumbing work. Use project management tools or software to help you visualize and manage the schedule effectively. Consider including milestones or checkpoints to track progress.

H. communicates and coordinates: Share the planned sequence of work with the relevant stakeholders, such as the project manager, contractors, and suppliers. Ensure that everyone involved understands the schedule and their roles in the plumbing work. Regularly communicate and coordinate with the team to address any issues or changes that may arise.

I. Monitor and adjust: Continuously monitor the progress of the plumbing work and compare it against the planned schedule. Identify any deviations or delays and take corrective actions as necessary. Regularly update the schedule to reflect any changes or adjustments made during the project.

Before approving a project, the cost of work required must be thoroughly investigated. It is necessary to prepare the cost estimate, for the intended work from the plans and specifications. Thus, an estimate for construction work can be defined as the process of calculating the quantities and costs of the various items needed in connection with the work.

2.2. Estimation of materials tools and equipment.

To provide an estimation of materials, tools, and equipment, I'll need more specific information about the project you're referring to. Please provide details about the nature of the project, such as construction, woodworking, gardening, or any other relevant context. Additionally, let me know the scope and scale of the project, including the desired outcome or deliverable. With these details, I'll be able to assist you better in estimating the required materials, tools, and equipment.

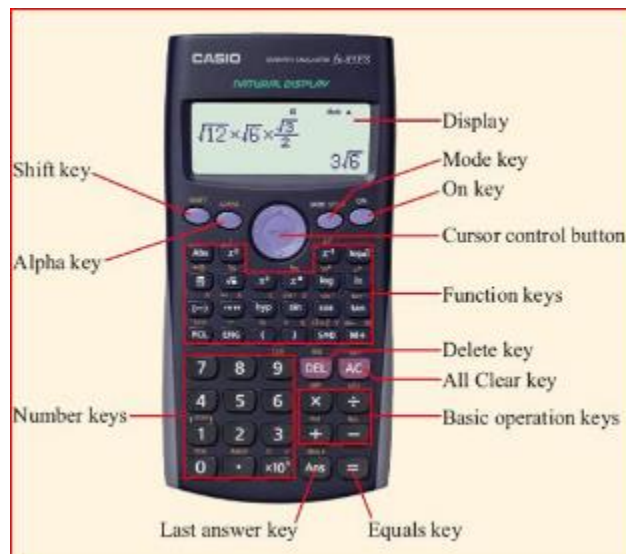
Preparing a plumbing bill of quantities requires a thorough understanding of the project requirements and the specific plumbing systems involved. While the exact tools and equipment may vary depending on the project scope, here are some common tools and resources that can assist you in preparing a plumbing bill of quantities:

- **Measuring Tools:** These tools are essential for accurately measuring distances, angles, and dimensions. Examples include measuring tapes, rulers, calipers, and laser measuring devices.



1.1 Diagram- tapes rule

- **Calculators:** Calculators are electronic devices designed to perform mathematical calculations. They come in various forms, ranging from simple handheld calculators to sophisticated scientific or graphing calculators. Calculators are commonly used in academic, professional, and personal settings to perform calculations quickly and accurately.



1.2 Diagram- scientific Calculators

- **Quantity Takeoff Software:** Specialized software can streamline the process of quantifying plumbing components and materials. These tools allow you to create digital takeoffs, generate reports, and perform calculations efficiently. Examples include On-Screen Takeoff, Blue beam Revue, or Plan Swift.
- **Plumbing Codes and Standards:** Familiarize yourself with the plumbing codes and standards applicable to your project. These include local building codes, plumbing regulations, and industry standards such as the International Plumbing Code (IPC) or the Uniform Plumbing Code (UPC).
- **Plumbing System Design Software:** Depending on the complexity of the project, you may need software tools to design plumbing systems. These tools assist in creating detailed plumbing layouts, pipe sizing, and hydraulic calculations. Examples include AutoCAD, Revit MEP, or Plumbing CAD.
- **Catalogs and Product Literature:** Plumbing manufacturers provide catalogs and product literature that contain detailed information about their products, including specifications, dimensions, and installation requirements. These resources can help you accurately identify and quantify the required plumbing components.
- **Estimating Software:** Estimating software can be useful for calculating material quantities, labor costs, and overall project costs.
- **Spreadsheet Software:** Utilize spreadsheet software like Microsoft Excel or Google Sheets to organize and calculate quantities, unit costs, and total costs for each plumbing item. These programs offer powerful formula capabilities and allow for easy customization and data analysis.
- **Reference Guides and Manuals:** Plumbing reference guides and manuals can provide valuable information about installation methods, material requirements, and industry best practices. Examples include the Plumbing Engineering Design Handbook, the Pipefitters Handbook, or manufacturer-specific installation guides.
- **Supplier and Contractor Quotes:** Reach out to suppliers and contractors to obtain quotes for plumbing materials and labor. These quotes can help you accurately determine unit costs and factor them into your bill of quantities.

- **Knowledge and Experience:** Finally, rely on your own expertise and experience in plumbing systems and construction. A solid understanding of plumbing principles, materials, and installation methods is crucial for accurately quantifying plumbing items.

Remember that the tools and equipment listed above serve as aids in preparing a plumbing bill of quantities. The specific tools you'll need may vary based on the project requirements, complexity, and your preferred work methods.

2.3. Estimation of labor and time requirements.

Estimating labor and time requirements for plumbing bill quantity preparation can vary depending on several factors such as the complexity of the project, the scope of work, and the experience level of the plumber. However, I can provide you with a general outline of the process and some factors to consider when estimating labor and time requirements for plumbing bill quantity preparation.

- **Scope of Work:** Firstly, you need to determine the scope of work for the plumbing project. This includes identifying the specific tasks and materials required for the job, such as installing pipes, fixtures, or repairing existing plumbing systems.
- **Quantity Takeoff:** Perform a quantity takeoff to determine the materials and quantities needed for each task. This involves reviewing the project plans and specifications and measuring the lengths of pipes, fittings, and fixtures required. You can use estimating software or manual methods to calculate the quantities accurately.
- **Construction Labor**

Construction labors influence every part of a project. They operate equipment and fabricate and install materials. Detailed estimate requires the breakdown of project costs into the labor, material and equipment costs. Thus, type of estimate needs to have a design available to get such required details. This chapter introduces the details of estimating labor, equipment and material costs as the basis for detailed cost estimate of construction projects.

In today's fast-paced industrialized age, where many of the products we see are increasingly being mass produced in factories by machines, a building still remains as one of the few handcrafted products put together piece by piece by craftsmen. The construction industry, to which these craftsmen belong, is one of the most labor-intensive industries in the world. The

labor cost component of a building project often ranges from 30 to 50%, and can be as high as 60% of the overall project cost. Therefore, it is clear that construction labor is a vital component of a construction project.

A building is a very complex product, made up of many different systems, such as the structural system, exterior enclosure system, and HVAC system. These systems can be broken down into many more subsystems and sub-subsystems. In this way, a building construction project is divided into numerous work packages. These work packages can then be assigned to and completed by an individual worker or a crew. A crew is a team of workers, which can be of the same trade or a composite of many different trades. Due to the diverse nature of the different tasks associated with all the building systems, many types of craftsmen from many different trades are required in a building construction project.

- **Labor Requirements:** Once you have determined the quantities, you can estimate the labor requirements. Consider the following factors:
 - **Task Complexity:** Different tasks may require varying levels of skill and time. For example, installing a basic sink faucet may be less time-consuming compared to installing a complex shower system.
 - **Experience Level:** The experience and expertise of the plumber can significantly affect the time required for the job. Experienced plumbers may be more efficient and complete tasks faster.
 - **Site Conditions:** Consider the site conditions and any challenges that may impact labor requirements. Factors such as accessibility, existing plumbing conditions, and working in confined spaces can affect the time needed to complete the project.
- **Labor's production rates (productivity)**

A production rate is defined as the number of units of work produced by a person in a specified time. Production rates may also specify the time in man-hours or man-days required to produce a specified number of units of work. The time that a labor will consume in performing a unit of work varies between labors and between projects and with climatic conditions, job supervision, complexities of the operation and other factors. It requires more time for erect shutters for stairs than for foundations.

Sometimes, the production rate is replaced by the term productivity. In the most general sense, productivity is the ratio of input versus the respective output. In construction, the input is often the work hours of a worker or a crew, such as the 8 hours of a plumber. The output is the amount of work produced, such as installing 300 m. Thus, construction productivity is defined as the quantity of work produced in a given amount of time by a worker or a specific crew, that is, the quantity of construction output units produced in a given amount of time or a unit time. The formula for productivity is:

Construction productivity = quantity of work produced / time duration

Labor productivity rates are characterized by their tendency to vary from;

- Individuals
- Day to day
- Project to project

As a result, it becomes one of the most inaccurate aspects of estimating.

Example: If a installation work can install 300 m pipe in 8 hours, then, the associated construction productivity is 300 m length of pipe divided by 8 hours, which is 37.5m pipe install per hour.

Although most items associated with the monetary factor remain relatively constant over a short period of time, such as during the construction phase, productivity, on the other hand, can fluctuate wildly. To accurately estimate productivity, an estimator not only needs a good historical record, but a lot of experience. Productivity rates can be determined from published sources such as Means' Building Construction Cost Data and Walker's Building Estimator's Reference Book.

- **Basic principles for Labor Estimating**

The formula for computing the total cost of labor is quite simple. It requires knowledge of the total hour or labors needed to perform all the tasks and apply it to the corresponding wage rates.

Total cost of labor = Σ total work hour x wage rate

Determining the total work hours for a task involves knowledge of the quantity of work required for the task and the productivity rate for the specific crew that will be performing the work.

The quantity of work associated with the material quantity is determined by the quantity take off discussed in previous lecture.

- **Estimating time**

Determining the total work duration for a task involves knowledge of the quantity of work required for the task and the production rate for the specific crew that will be performing the work. The quantity of work associated with the material quantity is determined by the quantity take off discussed in unit 1. A straight forward approach to the estimation of activity durations is

to keep historical records of particular activities and rely on the average durations from this experience in making new duration estimates. Since the scope of activities is unlikely to be identical between different projects, unit production rates are typically employed for this purpose. The duration of an activity may be estimated as:

Work duration = quantity of work / number of crews × production rate

Example: Find the duration of an interior and exterior painting activities with quantities of 440 m² and 378 m² respectively, using crews of 11 m²/hours and 14 m²/hours for the interior and exterior painting activities respectively.

Solution

Interior painting duration = 440 / 11 = 40 hours

Exterior painting duration = 378 / 14 = 27 hours

Total work hours = 67 hours

Typically, the quantity of work is determined from engineering drawings of a specific project. The number of crews working is decided by the planner. In many cases, the number or amount of resources applied to particular activities may be modified in light of the resulting project plan and schedule. Some estimate of the expected work productivity must be provided. Historical records in a firm can also provide data for estimation of productivities.

Having defined a duration of a given work, it means that the planner has already defined the number of resources that will be employed in a particular work. Knowing duration and resources employed, it is simple to estimate the activity direct cost. Then, the three elements of an activity: duration, cost, and resources form what is called construction method. Some activities can be performed using different construction methods. Where, its method will have its own resources, cost and duration.

- **Estimating Time:** Once you have estimated the labor required for each task, you can assign time durations based on your experience or industry standards. Some tasks may have fixed time estimates, while others may require adjustments based on the specific project requirements.
- **Contingencies:** It's essential to include contingencies in your estimates to account for unforeseen circumstances, such as unexpected repairs or delays due to weather conditions. Adding a buffer to your estimates helps accommodate such situations.

- **Review and Refinement:** After preparing the initial labor and time estimates, review them carefully and consider seeking input from experienced plumbers or colleagues to ensure accuracy. Refine your estimates based on their feedback and make adjustments as necessary.

2.4. Total work cost Calculation

Based on the methods used for the preparation of detailed estimates in different countries, in general the principal parts of the detailed estimates consist of the following:

- **General abstract of cost**

This includes the name of the project, the date of preparation and the cost of different main sub-headings, including engineering cost of civil works, cost of equipment and land, etc. as well as contingencies. The detailed cost of each sub-heading is not shown in the general abstract of cost.

- **Abstract of cost**

The estimated cost of each and every individual item of work is calculated by multiplying the quantity by the specified rate in tabular form known as 'Abstract form', then adding multiplied values all together to get the actual estimated cost of work. A percentage (1.5 to 2.5 percent) of the above estimate is usually added for a work charge and an amount (usually 0.5 percent) for tools and plant, to calculate the grand total of the estimated cost.

In order to ensure that the detailed estimates can be easily surveyed, sub-headings are usually required. In this case, each sub-heading of the estimate is grouped for similar items of work. For a building project, the sub-headings should be as follows:

- a) Site clearing and preparation
- b) Earthwork - this includes excavation, filling, dressing, dewatering, etc.
- c) Concrete work - this includes plain and reinforced concrete works, prefabricated concrete works, formwork for concrete structures, etc.
- d) Brickwork - this includes brickwork in foundation and plinth, brickwork in superstructures, etc.
- e) Sanitary installation work
- f) Electrical installation work
- g) Woodwork

h) Roofing

Basically, the cost of any construction project comprises:

- a) **Direct costs**, which include the direct cost of materials, labor as well as equipment's and
- b) **Indirect costs**, which include but not limited to head office and site overhead costs.

1) Direct Construction Cost

Direct construction costs are all costs that can be specifically booked with an activity in a project. The current trend is to assign as much as possible costs to direct costs as these costs can be budgeted, monitored and controlled far more effectively than the indirect costs.

The direct costs mainly include material, labor, equipment and sub contract costs as described below.

- **Direct Material costs:** These costs referring to the cost of materials, consumables and components used for executing an activity including the allowances for scrap and wastages.
- **Direct Labor costs:** All costs related to the workers working on a specific activity such as carpenters, masons, erectors, painters, plumbers and soon.
- **Direct Equipment costs:** These costs referring to the costs of machineries and plants used in executing a specific activity.
- **Sub contract costs:** In case some specific activities are sub contracted, the sub contract price will be considered as the direct cost of the activities to be executed by the subcontractor

2) Indirect Construction Cost

Indirect construction costs are all costs, which cannot be directly booked under a specific activity in a construction project but required to keep the whole project operational. These costs are also called overhead costs, which mainly include the head office and site overhead costs.

- **Head office overhead costs:** Head office overhead costs are all costs required to run the whole operation of the construction company, which usually administers different projects at a time. These costs are not usually associated with

specific project but rather shared proportionally by all projects under the company. Some of the check lists for head office overhead costs are given below with further clarifications.

- **Senior management costs:** These refer to costs related with salaries and benefit packages of the senior management in the head office.
- **Indirect labor costs:** Staffs other than the senior management members working at the head office such as the technical, administrative, marketing, finance and supply staffs.
- **Head office building costs:** In both cases, costs are incurred in such a way either rental costs will be paid, if the building is rented and building depreciation will be considered, if the building is owned.
- **Bidding Expenses:** These costs are usually associated with bid document purchases, site visit expenses, bid bonds and soon. These costs are sometimes called sunk costs.
- **Expertise service costs:** These costs will be incurred when professional services are required such as the services of external auditors, lawyers, management consultants and external trainings.
- **Office furniture and equipment's:** Different office furniture and equipment's are required depending on the size and standard of the company.
- **Office running expenses:** The head office operation requires lots of miscellaneous expenses such as telephones, fax, internet services, stationery, mail services and so many others.
- **Risk Allowance (three major risks)**
 - **Contractual risks:** are usually stemming from the contract agreements with the project owner, subcontractors and suppliers.
 - **Technical risks:** are associated usually with the clarification of the technical specifications, working drawings, construction technology and difficulties in understanding new method of constructions.
 - **Political and economic risks:** reflect the impact of political situations, stability of economic policies, inflation and price escalation on the execution of the intended construction project.

3) Profit and Income Tax

PM depends on the market competitiveness and company strategies.

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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, Tax which is 15%** of the tender amount in accordance with the VAT proclamation No. 285/2002.

- **Unit Rate Analysis**

Rate Analysis is the process of **fixing cost per unit of measurement** for the different item of works.

Total cost per unit of work (TC): Direct cost (DC) + Indirect cost (IC)

Direct Cost (DC) includes cost due to material (MC), cost due to labor (LC), cost due to equipment (EC)

Indirect Cost (IC) covers overhead costs, and contractor's profit.



Table 1: Direct material Unit cost (E)

PROJECT NAME	
BOQ REFERENCE	
ACTIVITY CODE	
UNIT OF MEASURE	

ACTIVITY DESCRIPTION

DIRECT MATERIAL COST					DIRECT LABOR HOURLY COST					DIRECT EQUIPMENT HOURLY COST					
Material Description	Unit	Quantity	Unit cost	Total cost	Labor by trade	No of labor	Basic salary	Labor index	UF	Total cost	Equipment description	No of equipments	Hourly cost	UF	Total cost
A - TOTAL DIRECT MATERIAL COST					B - TOTAL DIRECT LABOR HOURLY COST					C - TOTAL EQUIPMENT HOURLY COST					

D - Hourly crew productivity	Data
E - Direct material cost	A
F - Direct labor cost	B/D
G - Direct equipment cost	C/D
H - DIRECT UNIT COST	E + F + G
I - Site overhead costs	K1 * H
J - Head office overhead costs	K2 * H
K - INDIRECT UNIT COST	I + J

L - RISK ALLOWANCE	$R1 * E + R2 * F + R3 * G + R4 * I + R5 * J$
M - GROSS PROFIT	$P\% / 0.7 * (H + K + L)$
N - TOTAL UNIT PRICE WITHOUT VAT	$H + K + L + M$
O - VALUE ADDED TAX (VAT)	$0.15 * N$
P - TOTAL UNIT PRICE WITH VAT	$N + O$
REMARK	

Direct material cost is the total cost of construction materials required to execute a unit of specific activity in a project. In estimating the direct material cost, the contractor shall obtain the quantity and quality of materials required to produce the specific unit of an activity.

$\text{Direct material cost} = \sum (\text{material quantity} * \text{material unit cost})$

In order to have a **better material cost estimation**, contractors shall develop the following information:

- Material price at place of delivery
- Supplier's address such as telephone, fax and mail address
- Supplier's contact person
- Supplier's email address and web site
- Supplier's credit facility
- Country of origin
- Material delivery time
- Place of delivery (i.e. at the supplier's shop, project site, Addis Ababa air port or Djibouti port)
- Transportation charges usually per ton-km as well as transporters

The contractor shall add the following costs to the material supplier's price to get the material unit cost at the project site:

- Loading expenses at the supplier's place of delivery;
- Transportation costs to the project site;
- Insurance charges during transportation to the project site; and
- Unloading expenses at the project site.

❖ **Coarse Aggregate (20mm):**

A. Material source.....	Legehar
B. Material price at Legehar.....	140.00 Birr/m ³
C. Loading cost.....	8.00 Birr/ m ³
D. Transportation cost with dump truck.....	50.00 Birr/ m ³

⇒ Coarse aggregate unit cost = B + C + D

⇒ Coarse aggregate unit cost = 140 + 8 + 50

⇒ **Coarse aggregate unit cost = 198.00 Birr/m³**

Example 1: Materials required for water supply and sanitary installation

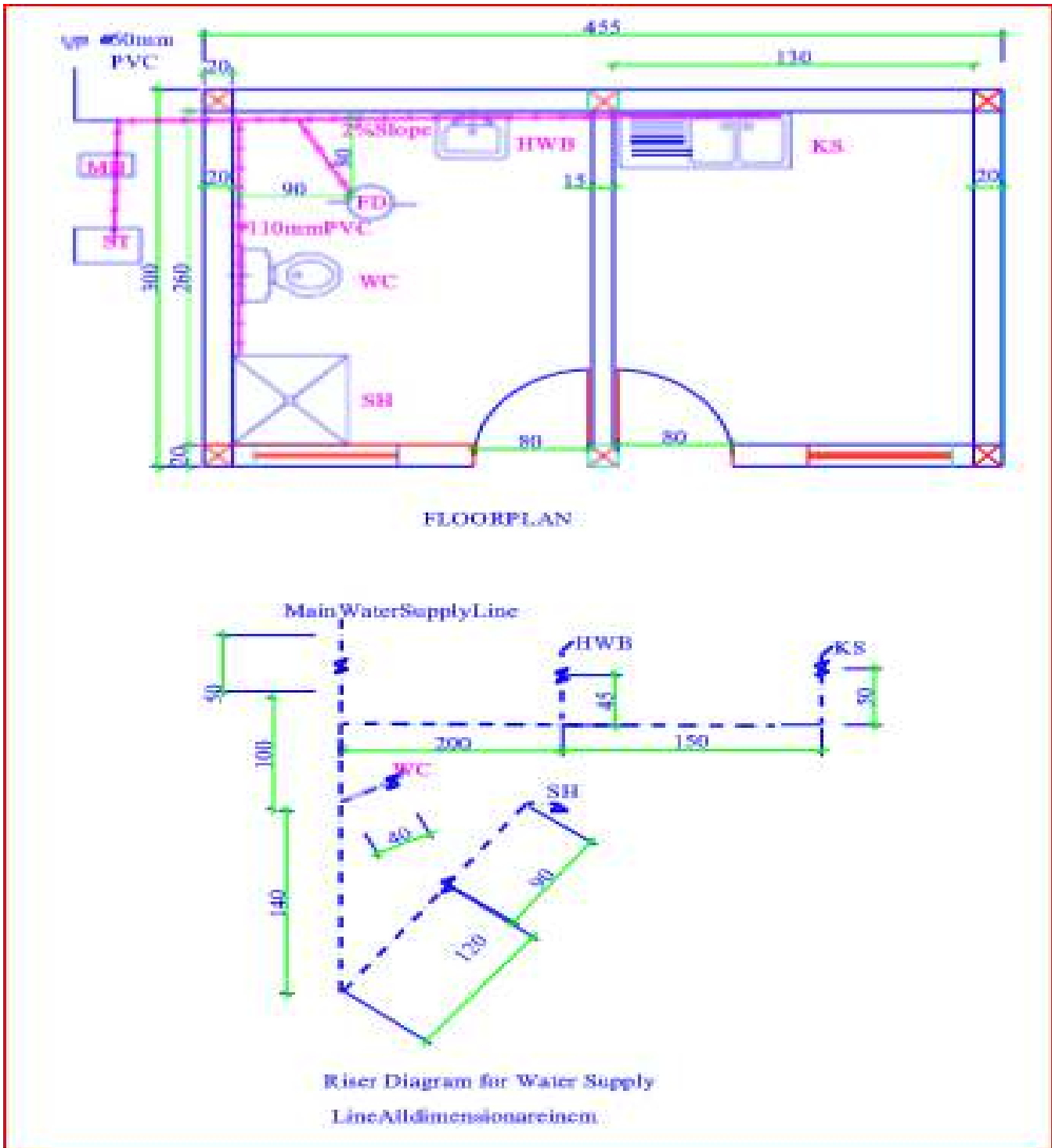


Figure.0.1 Materials required for water supply and sanitary installation

**Table 2 Direct material
cost**



No.	Items	Unit	Qty	Specification	Unit cost	Total cost
1	Ppr pipe ¾ inch	Pc	3	4 kg and above	200 birr	600birr
2	PPR gate Valve ¾ inch	Pc	3	5kg and above	200 birr	600 birr
3	PPR union ¾ inch	Pc	1	Germany	50 birr	50 birr
4	PPR Female Elbow 1/2 inch	Pc	4	Standard	50 birr	200 birr
5	PPR Tee ¾ inch	pc	5	Standard	10 birr	50 birr
6	PPR Normal Elbow ¾ inch	Pc	5	standard	10 birr	50birr
7	Chrome gate valve ¾ inch	Pc	1	standard	25 birr	100 birr
11	PPR Female Elbow 1/2 inch	Pc	4	Standard	25 birr	50 birr
12	Flexible pipe ¾ inch / internal thread/	pc	3	plastic	170 birr	510 birr
13	Poly venilechloride / pvc pipe/ 50mmø/	pc	1	Standard	200 birr	200 birr
14	Poly venilechloride / pvc pipe/ 110mmø/	pc	1	Standard	280 birr	280 birr
15	Pvc elbow 50mmø	pc	6	Standard	45 birr	270 birr
16	Pvc tee 50mmø	pc	1	Standard	50birr	50 birr
17	Pvc reducer 110 – 50mmø	pc	4	Standard	50birr	200 birr
18	Pvc tee 110 mmø	pc	2	Standard	55birr	110 birr
29	Pvc elbow 110mmø	pc	1	Standard	55 birr	55 birr
20	Pvc y- branch 110mmø	pc	1	Standard	55 birr	55 birr
21	Shower treey 70*70cm	pc	1	Standard	1200 birr	1200 birr
22	Pedestal hand wash basin	pc	1	Standard	3000 birr	3000 birr
23	Water closet / wall mounted/	pc	1	Standard	4000 birr	4000 birr
24	Kitchen sink /one boll/	pc	1		2000 birr	2000 birr
25	Bottle trap 50mmø flexible	pc	2		200 birr	400 birr
26	Single tap / faucet/ ¾ inch		2		250 birr	500 birr
27	Pvc mastics	litter	1	Weld on 717 Tm	550 birr	550 birr
Total material cost						<u>15800.00</u>

- **Direct Labor Unit Cost**

In calculating the direct labor cost, contractors need to calculate the direct labor hourly cost which is the total hourly cost of labor crew required to execute a specific activity in the project.

In estimating the direct labor hourly cost, the contractor shall obtain the following inputs:

Number of labors,

Skill and labor utilization factor (UF),

Labor basic salary, and labor index from his previous records and the labor market.

$$\Rightarrow \text{Direct labor hourly cost} = \sum (\text{No of labor} * \text{Basic salary} * \text{Labor index} * \text{UF})$$

$$\Rightarrow \text{Direct labor cost} = \text{Direct labor hourly cost} / \text{Hourly crew productivity}$$

- **Labor Index** is a multiplying factor of the basic salary which represents the additional benefits whereby a worker gets from the contractor such as: Severance pay; Annual leave, Occupational accident expenses, Occupational disease expenses, Overtime pay, Occupational safety, health and working environment and Benefits resulting from collective agreements.

Labor cost (LC) assuming consists of a site engineer, foreman, plumber, and four daily laborers and a productivity of 0.50 m³ per hr:

- Crew a group, which is directly involved in a similar job
- Utilization Factor (UF) = 1/ the # of crew or people under 1G
- A crew for brick masonry work consists of a mason, an assistant mason and two labors (4)
- Foreman, to guide/control masonry work, UF = ¼,
- Site Engineer/Manager, UF = 1/10 (assumed to control 10 foremen)

Table 3 labor cost

	Salary per hr	Utilization Factor (UF)	C per hr
Site Engineer	= 8,000 Birr/ Month / (22 days * 8 hrs/day) = 45.45 Birr/hr	= 1/10 = 0.1	4.54
Foreman	= 150 Birr/Day * 1/8 Day/ hr = 18.75 Birr/ hr	= 1/4 = 0.25	4.69
Plumber	= 135 Birr/Day * 1/8 Day/ hr = 16.88 Birr/ hr	= 1	16.88
Daily laborers (4)	= 4 * 50 Birr/Day * 1/8 Day/ hr = 25.00 Birr/ hr	= 1	25.00
Mixer Operator	= 50 Birr/Day * 1/8 Day/ hr = 6.25 Birr/ hr	= 1	6.25
	Total LC (Birr/ hr) (i.e. for 0.5 m ³ of concrete)		= 57.36



Table 4 bill of quantities

BILLOFQUANTITIES(BOQ)					
NAMEOFTHEWORK:CONSTRUCTIONOFNEWBUILDINGOFTHE					
DNIT					
			ESTIMATEDCOST		
			EARNESTmoney		
			TIMELIMIT		
ISSUED TO :					
SCHEDULEOF WORK/ITEM(S)					
No	Description of Work/Item(S)	No.ofQt	Unit	DNITAMOUNT	
	WATERSUPPLY&SANITARYITEMS			Rate	Amount
1	Providing and fixing stainless steel kitchen sink of approved standard ISI make with drain board and C.P. waste with C.I. or M.S. Brackets painted white including cutting holes and making good the same but				
1.2	610x460mmwithbowldepth200mm	1	no	500	500
2	Providing and fixing vitreous China wash basin with single hole for pillar tap with C.I. or M.S. brackets painted white including cutting holes and				
2,1	(i)600mmx480mm	1	NO	500	500
3	Providing and fixing C.P.brassanglevalve15mm	3	NO	300	900
4	P/FCP brass Bibcock single liver ofapprovedquality: 15mm nominal bore.				
4,1	15mmdia	2	NO	200	400
5	Providing and fixing P.V.C. waste pipe for sink Or wash basin including P.V.C. waste fittings complete Semi rigid pipe				

5.1	50mmdia	4	ML	50	250
5.2	110 mm dia	4	ML	100	400
7	Providing and fixing chromium plated brass soap dish with C.P. Brass brackets fixed to wooden cleats with	1	NO	150	150
8	Providing and fixing C.P. Brass Towel rail complete with C.P. Brass				
8.1	750mmx 20mm	1	NO	200	200
9	Providing and fixing recessed Roll type toilet paper holder(Vitreous China)	1	NO	150	150

10	Providing and fixing stone ware gully trap grade 'A' complete with C.I. grating,brickmasonrychamberincementmortar1:5andwatertight C.I.coverwithframeof300mmx300mm size(inside)the weight of covertobenotlessthan4.53kgandframetobenotlessthan2.				
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Square Mouth Traps

10.1	(i)100mmx100mmsizePtype	1	NO	200	200
10	ProvidingandfixingPVCwaterstorage tankofISI:12701 marked, G.I.in let and outlet connection, 15mmnominalboreballvalveand mosquito proof PVC cover with locking				
	Arrangement including hoisting up to all heights above ground level:-				
10.1	1000litresnetcapacitytank	1	NO	1500	1500
11	Providing and fixing ball valve (brass)of approved quality, High or low pressure,withplasticfloatscomplete:20mmnominal				



11.1	20mm nominal bore	1	NO	100	100
12	Chrome shower valve of standard design 15 mm nominal bore	2	no	150	350
14	Install and fixing PPR Union in PPR pipe including cutting and threading the pipe and making long screw setc. complete (New work) :15 mm nominal bore	1 1	ML	50	550

Sewage & External Water Supply

17	Excavation in foundation, trenches etc. in earth work in all classification of soil such as pick work, jumper work, pick jumper work, blasting work, jumper blasting work, soft and hard blasting and saturated soil, de-watering, including wedging out rocks where blasting work is prohibited, chiseling or any other mixed variety of soil, de- watering and/or removal of slush and incidentals, lift up to any heights,				
17.1	15cm(Fifteen centimeter)layers, when required into plinths, sides of foundation etc; consolidating each deposited layer by ramming, watering and then disposing go fall excavated earth as directed by the Engineer-in-Charge, with in all leads, lifts of materials and other incidentals as per approved drawing, design and as directed by the Engineer-in-Charge.				
19	Providing and fixing PPR gate valve with C.I. wheel of approved quality(screwed end)				
19.1	15mm dia. nominal bore	1	NO	300	300

20	Providing and laying in trenches, galvanized mild steel tubes (light grade), tube fittings (earth work in trenches to be measured and paid separately)				
20.1	25mmdia.nominal bore				
21.2	20mmdia.nominal bore				
TOTAL OF WATER SUPPLY AND SANITARY INSTALLATIONS					5900

A) Equipment Cost

	Salary per hr	EC/ hr
Mixer	= 30 Birr/hr * 1/0.5 m ³ /hr	= 60.00 Birr / m ³
	Total EC (Birr/m ³)	= 60.00 Birr / m ³

- **Total Cost calculation**

- DC = MC + LC + EC
- DC = 15800 + 5900 + 60 = **21760 Birr**
- IC = 35/100 * 21760 = **7616 Birr**
- TC = (21760 + 7616) = **29376.00 birr**

Self-check -2

Part –I choose the correct answer

- When estimating materials for a construction project, which of the following factors should be considered?
 - Project location
 - Material availability
 - Project timeline
 - All of the above
- What is the purpose of calculating labor costs in the preparation of a Bill of Quantities?
 - To determine the number of workers required for the project
 - To estimate the wages and salaries of the workers
 - To assess the productivity of the labor force
 - To allocate costs to different project activities
- Which of the following is a direct cost associated with labor in the preparation of a Bill of Quantities?
 - Equipment rental
 - Administrative overhead
 - Overtime wages
 - General contractor's fee
- When estimating the time cost for the preparation of a Bill of Quantities, which of the following factors should be considered?
 - Project complexity
 - Availability of skilled labor
 - Project scope
 - d) All of the above
- Which of the following methods can be used to estimate the cost of materials in a Bill of Quantities?
 - Price per unit
 - Market research and supplier quotations
 - Historical cost data
 - d) All of the above
- What is the purpose of preparing a Bill of Quantities?
 - To estimate the total cost of a construction project
 - To provide a detailed breakdown of materials and labor required for the project
 - To facilitate tendering and contract administration
 - All of the above

PART – 2 give short answer

1. What are the key steps involved in estimating and calculating materials, labor, and time cost for the preparation of a Bill of Quantities?
2. What factors do you consider when estimating the labor cost for a construction project?
3. How do you calculate the cost of materials for a project based on current market rates and quantities specified in the Bill of Quantities?
4. What methods or formulas can be used to estimate the time required for completing different tasks in a construction project?
5. How do you account for overhead costs and contingencies when calculating the total cost of a project in the Bill of Quantities?

Operation sheet 2.1

Operation Title: Total work cost calculation

Purpose: To know the performance of cost calculation

Conditions or situations for the operations:

- Safe working area
- Properly operated tools and equipment

Equipment Tools and Materials:

- Calculator
- Measuring tool
- Catalogs and Product Literature
- Reference Guides and Manuals

Steps in doing the task

1. Project Information:
2. Itemized List
3. Specifications
4. Quantities
5. Pricing
6. Summary

Quality Criteria:

Assured performing of all the activities according to the procedures

Precautions:

- Detailed Scope of Work
- Accurate Measurements
- Standard Pricing
- Clear Assumptions and Exclusions

Lap Tests

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks accordingly.

Task 1: Review project documents

Task 2: Breakdown of work items

Task 3: calculations Measurements and take-offs

Task 4: Material quantities

Task 5: Labor and equipment requirements

Task 6: Pricing and cost analysis

Task 7: Contingencies and allowances

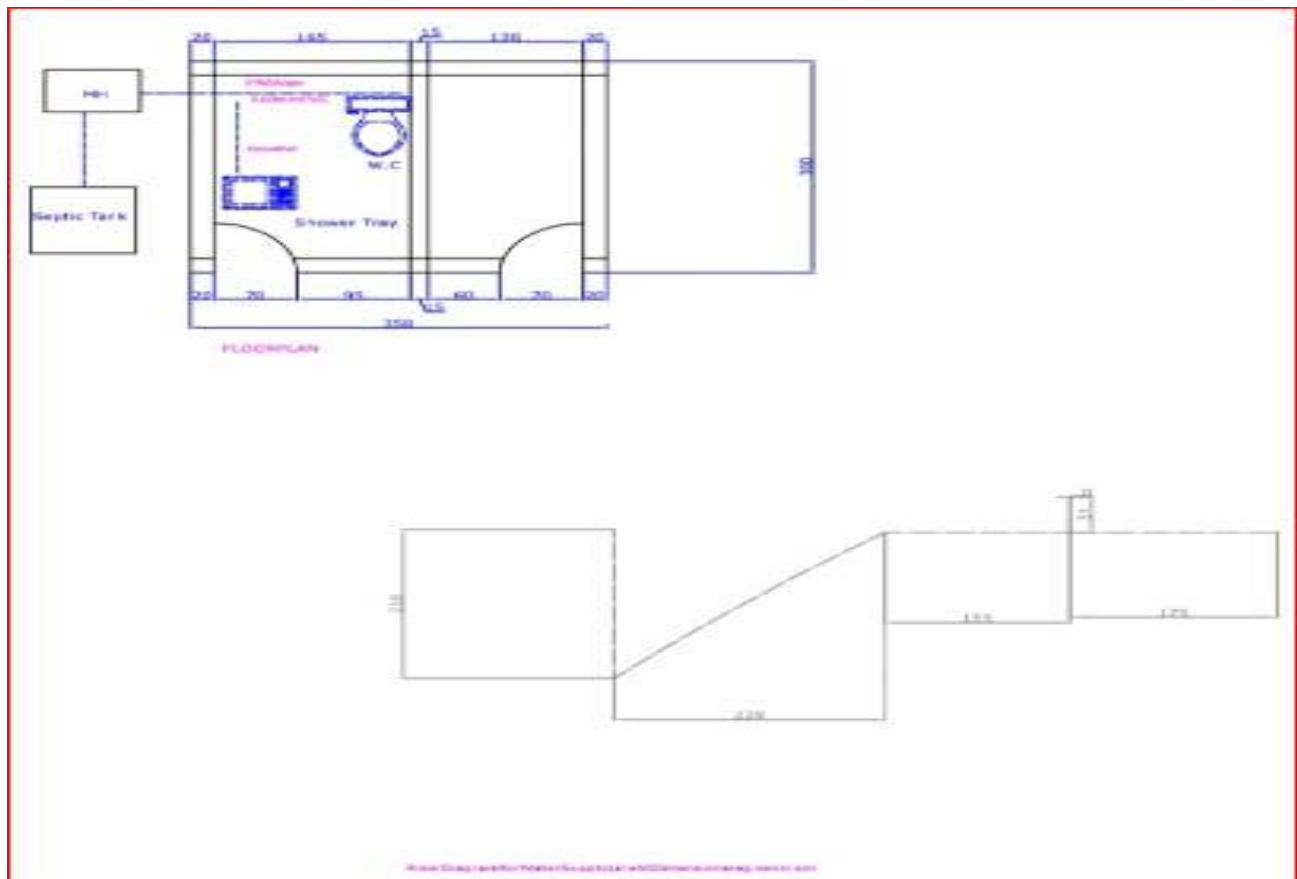


Figure 2:

Unit Three: Documentation and verify details
<p>This unit is developed to provide you the necessary information regarding the following content coverage and topics:</p> <ul style="list-style-type: none"> • Documentation details costs and charges. • Verification of costs, calculations and other details. • Preparation of customer quotation and tender. • Documentation of details. <p>This guide will also assist you to attain the unit stated in the cover age. Specifically, upon completion of this learning guide, you will be able to:</p> <ul style="list-style-type: none"> • Documenting details costs and charges. • Verifying of costs, calculations and other details. • Prepare of customer quotation and tender. • Documenting of details.

3.1. Documentation details costs and charges.

A bill of quantities (BOQ) is a document that provides a detailed breakdown of the quantities, Measurements, and costs of the materials, labor, equipment, and other items required to complete a Construction project. While the specific format and content of a bill of quantities may vary

- **Depending on the project and the organization.**
 - a) **Item Description:** Each item or work element is described in detail, specifying the materials, specifications, and scope of work.
 - b) **Quantities:** The bill of quantities provides accurate and detailed measurements of each item or work element. This could include quantities in terms of units, lengths, areas, volumes, or other relevant measurements.
 - c) **Rates:** For each item or work element, the bill of quantities specifies the rates or prices per unit of measurement. These rates may be obtained from previous projects, market rates, or as per agreed-upon contractual terms.
 - d) **Extensions:** The bill of quantities calculates the extended cost for each item by multiplying the quantity with the corresponding rate. This provides the subtotal cost for each item.
 - e) **Summary:** The bill of quantities includes a summary section that consolidates the extended costs of all items. This summary helps in providing an overall cost estimate for the project.
 - f) **Contingencies and Overheads:** Some bills of quantities may include allowances for contingencies and overheads. Contingencies account for unforeseen circumstances or changes in the project scope, while overheads cover general project expenses such as administration, insurance, and supervision.

It's important to note that the bill of quantities typically provides the cost information but may not include taxes, profit margins, or other additional charges. These elements are often included in the final contract or agreement between the parties involved.

To obtain the specific costs and charges for a bill of quantities, it's advisable to refer to the documentation provided by the project owner, contractor, or quantity surveyor. They would typically outline the rates, calculations, and any additional charges applicable to the project. It's important to review this documentation carefully and seek clarification from the relevant parties if any details are unclear or require further explanation.

3.2. Verification of costs, calculations and other details.

- **To verify costs, calculations, and other details for a bill of quantity, follow these steps:**
 - A) **Review the Bill of Quantities (BOQ):** Carefully go through the BOQ document to understand the scope of work, item descriptions, and units of measurement, quantities, rates, and total costs.
 - B) **Cross-check quantities:** Verify that the quantities mentioned in the BOQ are accurate and match the project requirements. This can be done by comparing the BOQ with the project plans, drawings, and specifications.
 - C) **Check rates and calculations:** Ensure that the rates for each item in the BOQ are correct and accurately calculated. Double-check any calculations to avoid errors.
 - D) **Verify labor costs:** If the BOQ includes labor costs, make sure that the labor hours and rates are accurate. Cross-reference the labor costs with industry standards or consult with experts to ensure they are reasonable.
 - E) **Validate material costs:** Check the prices of materials mentioned in the BOQ against current market rates. You can obtain quotes from suppliers or refer to industry databases to verify the material costs.
 - F) **Consider contingencies:** Account for contingencies such as waste, bad weather, or delays in material delivery. Add a percentage (typically 15-20%) to the cost of materials to cover these contingencies.
 - G) **Seek expert advice:** If you are unsure about any aspect of the BOQ, consider consulting with a quantity surveyor or a construction cost consultant. They can provide professional guidance and help verify the costs, calculations, and other details.

H)

3.3. Preparation of customer quotation and tender.

Preparing a customer quotation and tender for a bill of quantity involves several steps.

- **General Outline Of The Process:**

- A) **Review the Bill of Quantity (BOQ):** Carefully study the BOQ provided by the customer. The BOQ contains a detailed list of materials, quantities, and specifications required for the project.
- B) **Identify Cost Components:** Break down the project into various cost components such as labor, materials, equipment, subcontractors, and overheads. This will help you estimate the costs accurately.
- C) **Obtain Supplier Quotations:** Reach out to suppliers and subcontractors to obtain quotations for the materials and services required for the project. Ensure that the quotations align with the specifications mentioned in the BOQ.
- D) **Estimate Labor Costs:** Calculate the labor costs based on the project scope, timeline, and required manpower. Consider factors such as wages, benefits, and productivity rates. You may consult with your team or use historical data to estimate labor costs accurately.
- E) **Calculate Equipment Costs:** If equipment is needed for the project, determine the rental or purchase costs. Consider the duration of equipment usage, fuel, maintenance, and any other associated expenses.
- F) **Factor in Overheads:** Include overhead costs such as administrative expenses, insurance, permits, and any other indirect costs that are necessary to complete the project.
- G) **Prepare the Quotation:** Once you have gathered all the cost components, compile them into a comprehensive quotation. Ensure that the quotation is clear, accurate, and includes all the necessary details such as project scope, deliverables, timelines, terms, and conditions.
- H) **Review and Proofread:** Double-check the quotation for any errors or omissions. Ensure that all the calculations are accurate and that the quotation is aligned with the customer's requirements.

- I) **Submit the Quotation:** Send the completed quotation to the customer within the specified deadline. Depending on the customer's requirements, you may need to submit the quotation physically or electronically.
- J) **Follow Up:** After submitting the quotation, follow up with the customer to address any questions or concerns they may have. This demonstrates your commitment and willingness to work with them.

Remember, the specific requirements for preparing a customer quotation and tender for a bill of quantity may vary depending on the industry and project. It is essential to tailor your approach based on the customer's needs and any specific guidelines provided.

3.4. Documentation of details.

A bill of quantities (BOQ) is a document commonly used in construction projects to provide a detailed breakdown of the quantities, measurements, and descriptions of the materials, labor, and other resources required to complete the project. It serves as a basis for tendering, cost estimation, and contract administration. Here are the typical details included in a bill of quantities:

- **Project Information:**
 - Project title and location
 - Client information
 - Contractor information
 - Date of preparation
 - Preliminaries:
- **General project requirements and conditions**
 - Site preparation and clearance
 - Temporary works (if applicable)
 - Safety and health provisions
 - Quality control measures
- **Measurements:**
 - Description and unit of measurement for each item
 - Quantities required for each item
 - Rates per unit (if known)

- **Civil Works:**
 - Excavation and earthworks
 - Concrete works (footings, slabs, beams, columns, etc.)
 - Masonry works (brickwork, block work, etc.)
 - Structural steelwork
 - Waterproofing and insulation
 - Roofing and cladding
 - Carpentry and joinery
 - Finishes (plastering, painting, tiling, etc.)
 - Flooring
 - External works (paving, landscaping, fencing, etc.)
 - Drainage and utilities
- **Mechanical and Electrical Works:**
 - Plumbing and sanitary works
 - Heating, ventilation, and air conditioning (HVAC)
 - Electrical wiring and fittings
 - Fire protection systems
 - Security systems
 - Lifts and escalators (if applicable)
- **Specialized Works:**
 - Specialized equipment or systems (e.g., solar panels, generators)
 - Specialist subcontractor works (e.g., specialized finishes, installations)
 - Contingencies and Provisional Sums:
 - Allowances for unforeseen works or variations
 - Provisional sums for items that are not fully defined or specified
- **Summary:**
 - Subtotals for each section (e.g., civil works, mechanical works)
 - Totals for each category (material, labor, plant and equipment, etc.)
- **Grand total**

- It's important to note that the specific details and format of a bill of quantities may vary depending on the project's requirements, contractual arrangements, and local standards. It is often prepared by quantity surveyors or estimators with expertise in construction cost management.

SELF CHECK- 1

PART – I choose the correct answer

- Which of the following documents provides a detailed breakdown of the quantities, specifications, and estimated costs of materials and labor for a construction project?
 - Project schedule
 - Construction contract
 - Preparation Bill of Quantities
 - Scope of work
- When reviewing a Preparation Bill of Quantities, which of the following details should be verified?
 - Quantities of materials
 - Specifications of materials
 - Estimated costs of labor
 - All of the above
- Which of the following stakeholders is primarily responsible for preparing the Bill of Quantities?
 - Architect
 - Contractor
 - Owner/client
 - Quantity surveyor
- What is the typical format of a Preparation Bill of Quantities?
 - Spreadsheet
 - Narrative document
 - Flowchart
 - Gantt chart
- Which of the following is NOT a common method for verifying the details of a Preparation Bill of Quantities?
 - Cross-referencing with project drawings
 - Requesting clarifications from the contractor
 - Conducting on-site inspections
 - Comparing with competitor bids

PART – 2 give short answer

- What are the key documents typically included in a construction project's documentation package?
- What steps can be taken to verify the accuracy and completeness of a Bill of Quantities?
- How can one identify and resolve discrepancies between the Preparation Bill of Quantities and other project documents?

4. How can digital tools and software assist in the verification and management of documentation in construction projects?
5. How can the verification process of the Bill of Quantities be streamlined to minimize errors and ensure efficiency?

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