RQF LEVEL 5

TRADE: ROAD CONSTRUCTION

MODULE CODE: RCTCE501

TEACHER'S GUIDE

Module name: Cost Estimation

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Acronyms

- RCT: Road Construction
- CE: Cost Estimation
- BOQ: Bills Of Quantity
- CAD: Computer Aided Design
- PPEs: Personal Protective Equipment

Introduction

This module describes the skills and knowledge required to prepare a small budget. They can keep basic business financial records.

For all engineering work, it is required to know beforehand the probable cost of construction known as “Estimated cost”. If the estimated cost is greater than the money available, then attempts are made to reduce the cost by reducing the work or by changing the specifications.

In preparing an estimate, the quantities of different items of work are calculated by simple measurement methods and from these quantities the cost is calculated.

This course is designed to provide the basics of estimating and costing of various construction projects such as buildings, roads, water supply systems, dams, airports and other related civil engineering structures. It covers determination of unit rates for labour, construction materials, construction plant & equipment and possible forecasting of future construction rates. It consists of determining the cost of various items in the structure and calculate the overall cost of the structure.

Estimation and costing are two terms that are used in civil engineering. Estimation is the process of predicting the cost of construction projects by comparing the project to a similar one that has already been completed

Costing is the process of calculating the overall cost of a construction project considering all aspects such as labor, materials, equipment costs, and taxes.

This is usually done before purchase or construction begins or during preliminary planning stages. Estimating is usually more accurate, but there are a few limitations – namely that if your estimate relies on labor costs, you’ll need to know how many man-hours will take to complete the project.

Estimates are developed from observations and knowledge of past experience. The accuracy of an estimate often depends on the level of detail available and the amount of time for which data are available for analysis.

The purpose of cost estimation is **to give project stakeholders accurate information concerning the related project costs**. It is easier to make lasting decisions if there is information to back them up. Cost estimation also gives clients value-aided options and helps clients minimize expenses

Module Code and Title : RCTCE 501 Cost estimation

Learning Units:

1. Examine the work
2. Determine required resources
3. Calculate the cost estimation

Learning Unit 1: Examine the work

STRUCTURE OF LEARNING UNIT

Learning outcomes:

1.1 Determine the work extent
1.2 Analyse the complexity of the work
1.3 Localize the working place
1.4 Determine the work duration

Learning outcome 1.1 Determine the work extent

Duration: 2 hrs

Learning outcome 1.1 objectives:

By the end of the learning outcome, the Trainees will be able to:

1.Determine the work extent with respect to the duration,

2.Determine the work extent with respect to the cost and location

3.Determine the dimension respecting ally types of dimensions

Resources

Equipment	Tools	Materials

Computer Projector	Tape measure Pen Pencil Books Measuring tools Calculator Note book Handout Writing device	Paper Internet

Advance preparation:

- ✓ Required drawings are prepared and available before the session starts
- ✓ Required measuring tools are available before the session starts

Content 1.1.1.: Determination of work extent

During the process of determining the work to be carried out in any construction project you must first access some of the following key points :

a. Working place

working place is the location where someone works/project of his/her employer, place of performing the project proposed. So it is better to know well the environment of the project location.

b. Duration

The project duration is the basic project management characteristic that is usually expressed in terms of working time units (hours, days, weeks, months, years).

c. Outdoor location (External

If something happens outdoors, it happens outside in the fresh air rather than in a building. ... You refer to the outdoors when talking about work or leisure activities which take place outside away from buildings.

d. Indoor location (internal)

If something happens indoors, it happens inside in closed area rather than out a building. ... You refer to the indoors when talking about work activities which take place inside closed area.

e. Complexity

Once a position has been associated with a benchmark job, its level of complexity is assessed. The level of complexity refers to the duties, the degree of autonomy and the scope of responsibilities. The assessment of the level of complexity is based on the position and not on the incumbent.

f. Maintenance cost

In order the work in proper condition annual repair must be carried out for that reason the maintenance cost must be considered before work began. In cost estimation the respect of dimension as required by the clients is also an important issue that the estimator must follow as it is required in tender

Theoretical learning Activity

- ✓ Trainees are asked to brainstorm about factors considered when determining work extent

Practical learning Activity

NA

Points to Remember (Take home message)

Determination of work extent

- Working place
- Duration
- Outdoor location (External)
- Indoor location (internal)
- Complexity
- Maintenance cost

Content 1.1.2.: Determination of dimensions

In cost estimation the respect of dimension as required by the clients is also an important issue that the estimator must follow as it is required in tender

These dimensions to be followed are the following :

- ✓ **Length** : the measurement or extent of something from end to end ; the greater of two or the greatest of three dimensions of an object
- ✓ **Width** : the measurement or extent of something from side to side ; the lesser of two or the least of three dimensions of a body
- ✓ **Height** : the measurement of someone or something from head to foot or from base to top

- ✓ **Thickness** : the distance through an object, as distinct from width or height
- ✓ **Accuracy** : the quality or state of being correct or precise
- ✓ **Clearness** : easy to perceive, understand, or interpret
- ✓ **Completeness** : the state or condition of having all the necessary or appropriate parts

Theoretical learning Activity

- ✓ Trainees are asked to brainstorm about the types of dimensions
- ✓ Trainees are asked to brainstorm the meaning of accuracy, clearness and completeness

Practical learning Activity

NA

Points to Remember (Take home message)

Determination of dimension:

- Length
- Width
- Height
- Thickness
- Accuracy
- Clearness
- Completeness

Learning outcome 1.1. Formative assessment

Written assessment: Open ended questions, multiple choice and true or false type questions

Question 1. what are the points you must follow During the process of determining the work to be carried out in any construction project.

Answer: The key element are:

- ✓ Working place
- ✓ Duration
- ✓ Outdoor location (External factor)

- ✓ Indoor location (internal factor)
- ✓ Complexity
- ✓ Maintenance cost

Question 2. Respond by true or false the following statement "Dimensions of an object to be estimated are "Length, Width, Height and Thickness"

Answer: true

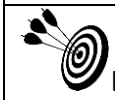
Question 3. Select the right answer. "the measurement or extent of something from end to end; the greater of two or the greatest of three dimensions of an object is?"

a) Height
b) width
c) length
d) thickness

Answer: C) length

Learning outcome 1.2 Analyze the complexity of the work

 **Duration: 2 hrs**

 **Learning outcome 1.2 objectives:**

By the end of the learning outcome, the Trainees will be able to:

1. Determine the quantity of materials according to the type of work
2. Determine the quality of materials according to the type of work
3. Know the human resources required according to their competence related to the work

 **Resources**

Equipment	Tools	Materials
Computer Projector	Pen Pencil Books Handout Measuring tools Note book Writing device	Paper Internet Sand Stones Bricks Cement

Advance preparation:

- ✓ Sample of Materials such as sand, bricks, stones, cement have to be prepared to confirm their availability before the session starts

Content 1.2.1: Analysis of complexity of the work

The estimator to ensure the success of the project he/she must understand clearly the complexity that may influence the performance of the project.

Some of these complexities are the following :

1.2.1.1. Quantity of materials

- ✓ **Shape (size…) :** The shape and size of material must be respected as required by the owner of the work
- ✓ **Specification :** For the work to be done as desired by the customer, specification must be clearly shown. The two type of specification are general specification and detailed specification

1.2.1.2. **Quality of material used** : Material is anything made of matter, constituted of one or more substances. Cement, Steel, Nails, Aggregates and Water are all examples of materials. Sometimes the term "material" is used more narrowly to refer to substances or components with certain physical properties that are used as inputs to production or manufacturing.

- ✓ **Materials**

A material management system has been described as having the aim of ensuring that all materials are delivered to the site to enable incorporated in the work at the right time in the correct quantity at the best cost and of the correct quantity. After the breaking down the job into activities and after making plan and schedule you are able to estimate or calculate the quantities of materials required. Using the bill of quantity or specification and drawing, the procurement offices will take and schedule all the materials requirement for the project, the quantity of material depends on the importance of the project.

To meet these aims good management of materials and tools should therefore follow the following steps:

- Planning and scheduling of materials
- Requesting those materials
- Ordering
- Receiving and handling
- Storage and security
- Issuing
- Incorporating

❖ **The most type of materials used in construction are:**

The following are the 5 different types of constructions materials:

- **Metals**: chemical element, such as iron, gold, or a mixture of such elements, such as steel, which electricity and heat can travel through and which is generally hard and strong. **ex:** tubes
- **Mineralogical materials**: valuable or useful substances which are formed naturally in the ground. **ex:** sto
- **Organically materials**: are those materials coming from living plants and animals.

Ex: timber

- **Synthetically materials**: products that are made from artificial substances, often copying a natural product.

Ex: paints

- **Water**: is a clear liquid, without color or taste that can be found underground or on the su

The Principe of construction site related the materials is that 'materials should be possessed a ht quantities, right quality and right time.

❖ **General qualities of materials of construction materials are** :

- ✓ They should be durable
- ✓ They should be strong
- ✓ They should be free from impurities and organic matter
- ✓ They should have standard sizes

1.2.1.3. **Human resources, materials**

- ✓ **Labour availability**

The labor force required on any project need to be planned at an early stage. The aim of labour force planning is to establish not only what is to be done out but also who is to do it.
From the overall project programme together with the methods statement it is possible to forecast the amount, the type and flow of labour. The amount of labour on site should be planned to avoid unnecessary wastage of money. This can be achieved for example by moving no critical activities on the programme to attain more balanced labour pattern. Correct forecasting on early stage avoids problems and prevents delays occurring later.

The availability of labour will depend up on the following factors:

- National economy
- Activity in the construction industry
- Training and education
- Technology to be used
- Complexity of the project
- Location of the project

- ✓ **Availability of funds**

They are money planned for a specific project. The client must analyse if the money available is sufficient for the project before it is being implemented
Finance is one of the resources available, to contract control of finance is important as it is affected by everything that the company does. It is also affected by the management of other resources, such as plant, materials and labour. In order for the company to survive it must at least break even to preferably make profit. At project level there are a number of importance steps which can be taken to enable that cost of materials, plants and labour is controlled there

by maximizing return on the finance used. Cost control at project level is concerned with making sure that the costs do not exceed the budgeted costs.

Theoretical learning Activity

- ✓ Trainees are asked to brainstorm the difference between tools , materials and equipment
- ✓ Trainees are asked to brainstorm their understanding about human resources

Practical learning Activity

- ✓ Group presentation on Human Resources materials

Points to Remember (Take home message)

Analysis of complexity of the work:

1. Quantity of materials:
   - Shape (Size….)
   - specification
2. Quality of materials Used
   - Type of materials used
3. Human Resources materials
   - Labor availability
   - Availability of funds

Learning outcome 1.2. formative assessment

Written assessment: Open ended questions, true or false question and multiple choice question

Question 1. List the five (5) different types of constructions materials you know

Answer:

- ✓ Metals
- ✓ Mineralogical materials
- ✓ Organically materials
- ✓ Synthetically materials

- ✓ Water

Question 2. Select the correct answer**,** The availability of labour will depend up on the following factors:

a) Technology to be used
b) Availability of facilities
c) Complexity of the project
d) Time of each task
e) All above are correct
f) a and c are correct

Answer : F) a and c are correct

Question 3. Respond by **true** if the following statement is correct or **false** if the statement is wrong.

a) the estimator to ensure the success of the project he/she must understand clearly the complexity that may influence the performance of the project.

b) cost control at project level is concerned with making sure that the costs do not exceed the budgeted costs.

c) finance is one of the resources available, to contract control of finance is important as it is affected by everything that the company does.

d) the aim of labour force planning is to establish not only what is to be done out but also who is to do it.

answer:

a) true

b) true

c) true

d) true

Learning outcome 1.3 Localize the working place

Duration: 2 hrs

Learning outcome 1.3 objectives:

By the end of the learning outcome, the Trainees will be able to:

1. Distinguish between indoor and outdoor location according to the location of workplace
2. Define out-country location according to the location of workplace
3. Define clearly the term site investigation as used in construction

Resources

Equipment	Tools	Materials
PPEs	Pen Pencil Handout Places Note book Writing device	Paper

Advance preparation:

- ✓ the trainer should have chosen the site where students will visit
- ✓ means of transport should be available to transport students to the site

Content 1.3.1.: working location

Working location: One of the essential for a construction project is the land that becomes the building site. Site selection and financing would be the responsibility of the owner of the project. Site means a workplace at which construction work is done and includes any adjoining area where plant or other materials used or to be used in connection with that work are located or kept and over which the main contractor has control for the purpose of doing the construction work.

Before the design works begin, you need to learn as much about the proposed building site as possible.

This may be done by:
1. Considering the suitability of the site for its intended purpose

2. Investigating the site in persons
3. Surveying the site
4. Digging trial holes

1.3.1.1. Investigating the site:
When the client identifies a site, then the building surveyor investigates it to find out the:

- ✓ The strength of the soil, because this affects the design of the foundations
- ✓ Type of the soil which will be excavated
- ✓ Amount of the water in the ground because this affects the design of the foundations and working procedures.
- ✓ Amount of clean or contaminated ground
- ✓ Amount that the ground slopes
- ✓ Access to services such as mains water, electricity and drainage
- ✓ Best position for the building in terms of the local climate
- ✓ Position of natural features such as trees, rocks, and streams.
- ✓ Position of other buildings near the site
- ✓ Location of site boundaries and access road.

1.3.1.2. Factors to be considered when selecting a building site

- ✓ Elevation of site, elevated sites are generally preferable to low lying ones, being drier and easier to drain.
- ✓ Availability of facilities e.g. hospital, transport etc.
- ✓ Availability of services e.g. water, electricity, sewage, etc.
- ✓ Types and conditions of subsoil e.g. gravel, sand, clay etc.
- ✓ Before any building work can commence, the area must be levelled i.e. reducing levels

After all those factors governing the selection of site (work location) the work location can be one the following:

- ✓ Indoor location
- ✓ Outdoor location
- ✓ Out-country location

1.3.1.3. Before preparing the estimate, the estimator should visit the site and make a study of conditions:

1) Note location of the proposed building
2) Get all data available regarding the soil
3) a sketch of the site showing all important details.
4) Obtain information concerning light, power, and water
5) Secure information concerning banking facilities.
6) Note conditions of streets leading to railway yards and to material dealers,
7) Investigate general efficiency of local workman.

Theoretical learning Activity

- ✓ Trainees are asked to brainstorm purpose of site investigation

- ✓ Trainees are asked to brainstorm their understanding about indoor location, outdoor location and out country location

Practical learning Activity

- ✓ Site visit on type of working location

Points to Remember (Take home message)

Working location

- Indoor location
- Outdoor location
- Out-country location

Learning outcome 1.3. formative assessment

Written assessment: Open ended questions and multiple choice type questions

Question1. What are the purposes of building site investigation?

Answer: site investigation is done to know :

- ✓ The strength of the soil, because this affects the design of the foundations
- ✓ Type of the soil which will be excavated
- ✓ Amount of the water in the ground because this affects the design of the foundations and working procedures.
- ✓ Amount of clean or contaminated ground
- ✓ Amount that the ground slopes
- ✓ Access to services such as mains water, electricity and drainage
- ✓ Best position for the building in terms of the local climate
- ✓ Position of natural features such as trees, rocks, and streams.
- ✓ Position of other buildings near the site
- ✓ Location of site boundaries and access road.

Question 2. Give at least three factors to be considered when selecting a building site

Answer: Factors to be considered when selecting a building site

- ✓ Elevation of site, elevated sites are generally preferable to low lying ones, being drier and easier to drain.
- ✓ Availability of facilities e.g. hospital, transport etc.

- ✓ Availability of services e.g. water, electricity, sewage, etc.
- ✓ Types and conditions of subsoil e.g. gravel, sand, clay etc.
- ✓ Before any building work can commence, the area must be levelled i.e. reducing levels

Question3. Select the correct answer, the work location can be one the following:

a) Indoor location, Site excavation, Site clearance

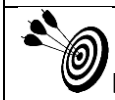
b) Indoor location, outdoor location, out-country location

c) Outdoor location, Universe location, Out-country location

Answer: B) indoor location , outdoor location , out-country

Learning outcome 1.4 Determine the work duration

 **Duration: 2 hrs**

 Learning outcome 1.4 objectives:

By the end of the learning outcome, the Trainees will be able to:

1. State the importance of determining work duration of a project as used in construction

2.State the steps of work duration determination according to their order

3. Estimate work duration according to the productivity of man per hour

 **Resources**

Equipment	Tools	Materials
NA	Pen Pencil	Paper

 **Advance preparation:**

- ✓ Trainer should be aware of the productivity hours of a worker per day

Content 1.4.1: Steps of work duration determination

1.4.1.1. Definition

Determining work duration is the technique for evaluating the number of work periods required to finish individual activities with estimated resources. The key advantage of this procedure is that it **projects the amount of time that every task will take to complete**, which is a significant input to the development schedule process.

1.4.1.2. Importance of work duration determination

- ✓ To provide amount of time each activity will take to complete.
- ✓ It is used to construct project schedule
- ✓ It helps to be aware of the extent of the work and its complexity

1.4.1.3. The steps of work duration determination are :

1. Time of each task
2. Determination of concurrent tasks
3. Total time

1.4.1.4.The three elements of an activity/work

1. duration,
2. cost,
3. resources.

Theoretical learning Activity

- ✓ Trainees are asked to brainstorm the steps of work duration determination

Practical learning Activity

- ✓ Group work about calculation of total work duration

Points to Remember (Take home message)

The steps of work duration determination are :

- Time of each task
- Determination of concurrent tasks
- Total time

Content 1.4.2: Estimate work duration

1.4.2.1. Estimate the work duration

To estimate the work duration needed to complete a given activity you must have successful information on:

- Productivity hour per day
- How many resources on each activity
- Available work days
- Delays-lag time(effort hours)
- Resources constraints (activity done sequentially or parallel)
- Maintenance days

1.4.2.2. Methods for the Estimation of Activity Duration in Project Management

When you create project plans, you need to assess the time required to complete individual activities. Use duration estimates to get an idea of this time and determine the schedule you need to adhere to in order to complete projects.

You can use various methods to estimate

1. **PERT Method**

The Program Evaluation and Review Technique, or PERT, estimation method is a weighted average of three scenarios. First, compute the averages for optimistic, pessimistic and most likely time scenarios. PERT gives more weight to the most likely scenario, so multiply that average by four. Combine this result with the optimistic and pessimistic averages, and divide the result by six to come up with a final estimate. The optimistic scenario presumes all goes well, and you can complete the activity without issues. Conversely, with the pessimistic scenario, you imagine everything will go wrong and it'll take longer to complete the activity. The most likely scenario assumes you can complete the activity without surprises. The PERT estimation method is a good

1.4.2.3.Below are 3-point estimate or PERT

- ✓ Uses 3 estimates (optimistic (O), most likely (M), pessimistic (P))
- ✓ Triangular distribution = (O + M + P) / 3 – used infrequently
- ✓ Beta Distribution = (O + 4M + P) / 6 – use most often

1.4.2.4.How to estimate activity duration?

- Involve the team, project managers and work package owners.
- Examine historical information and previous practice
- Decide how you want to quantify the work
- Don't forget resource requirements and capabilities

- Determine which estimation method to use
- Modify constraints and assumptions from other planning processes
- Verify accuracy of estimates
- Consider the need for time reserve

PERT Three Point Estimating

PERT technique (Project Evaluation & Review Technique) Uses three estimates, to define an approximate range for an activity's duration
Σ = Expected Time or Expected Duration
O = Optimistic P = Pessimistic M = Most Likely

Sigma σ
The standard deviation of an activity
- Degree of variation from the average - (mean)
- Indicates the standard error in the estimate and provides an idea of its accuracy
- the larger the standard deviation (spread between the optimistic and pessimistic estimates), the larger the risk in the estimate

± 1 standard deviation = 68.26%
± 2 standard deviations = 95.46%
± 3 standard deviations = 99.73%
± 6 standard deviations = 99.999998% - also known as Six Sigma

Statistical Concepts
Normal distribution curve
- Standard Deviation = σ
- How close the data points (measurements) are to the mean (m) when plotted on a graph

Variance and Standard Deviation
Variance of the activity = square of the standard deviation = Sigma squared
Variance and the standard deviation measure variability, and are measures of how spread out a distribution is (from the mean)

Another term – heuristics (simple rule of thumb) – six sigma is an example

exercise:
Your project has a critical path equal to 30 days and a standard deviation of 2½ days. What will be the earliest finish and latest finish estimates for this project within a 95% confidence level?

Answer
The question gives you:
- a standard deviation of 2½,
- your confidence level is 95% which is two standard deviations,
- therefore, you multiply the 2½ by 2 to get 5.

You add the resulting 5 to the project duration to give you the upper end of the variance range = 35
You subtract that 5 from the project duration to give you the lower end of the variance range = 25

Your answer:

- will be the option which states Earliest finish estimate of 25 and latest finish estimate of 35.

Exercise

Calculate The PERT Duration of the Critical Path Activities, Standard Deviation (σ), Variance (σ^2), Projects PERT Duration, and Standard Deviation (σ Project =√ Σ variances)) If all the activities above are on the Critical Path, what is the project's mean duration and σ?

Answer:

Project's mean duration = 170.99 days and σ=10.1 days

2. **Analogous Estimation**

The analogous, or top-down, estimation relies on information from similar projects to determine the activity duration for a current project. You'll need historical data and a degree of expertise about the similar projects, because the reliability of your estimation depends on how closely the activities match the projects you're using as comparisons. Use this method at the beginning of a project when you don't have all the details. Adjust the estimates as you learn more about the tasks and how long they can be expected to take with the resources available.

3. **Parametric Estimation**

The parametric estimation is similar, but more accurate, than the analogous estimation. To use it, multiply the number of units you need by the time it takes to produce the units. You'll need historical information about similar activities to complete your estimate. The method is scalable. This means if your historical data tells you that it takes one person an hour to produce one unit, you can reasonably estimate that you can complete three units within one hour if you allocate three workers to the task. When you use this method, it's important to account for all tasks that impact the activity. For example, if the workers spend part of the time preparing materials, account for that time in your estimates.

4. **Expert Judgement**

If your project is complicated and a number of factors can influence the duration of your activities, you might want to use expert judgment to estimate activity duration. Experts knowledgeable in a particular area can judge the time and resources you'll need to complete activities in that area. Be careful when choosing experts or using their estimates, because they may have certain biases that might influence their estimates. You also can gather estimates from external experts. If you can get external estimates at reasonable cost, it might be prudent to rely on them instead of generating estimates internally.

5. **The Delphi Technique**

The Delphi technique makes use of group intelligence to determine activity duration. The technique involves gathering opinions from several experts and then sending the responses back to the experts for their review. They can change their opinions after reviewing the responses. The process might involve several rounds, as you want to investigate differences of opinion and get to a consensus. To reduce bias and prevent individual experts from overly influencing results, experts submit their opinion anonymously. You can use a third party to gather the opinions.

6. **Work Breakdown Structure**

Certain activities might be too large or complex for a reliable duration estimate. If an activity takes up more than 10 percent of the project schedule, you might want to break it into several different

tasks. You can use a work breakdown structure to reduce these activities into smaller, more manageable tasks. Doing this enables you to set priorities and estimate the duration of tasks more accurately. A work breakdown structure also is useful for building accountability, because you can assign specific tasks to designated project participants.

N.B : in daily life the useful methods is Parametric
Activity Duration =(Quantity of work)/(Number of Crews*Resource Output)
Activities Cost =Activity Duration* Cost of the Crew per Unit Time

Example:
1.If the daily production rate for a crew that works in an activity is 175units/day and the total crew cost per day is 1800 F. The material needed for daily work is 4.5units at 100F/unit.
a. Calculate the time and cost it takes the crew to finish 1400 units
b. Calculate the total unit cost. Consider an eight hours work day.

ANS1.
a) Duration (units of time) =Quantity/Production per unit of time x number of crews = 1400/175x1=8days
Cost (labor cost) =Duration (units of time) x crew cost per unit of time =8daysx1800 F/ day=14400 F
Total direct cost=14400 F+4.5 units of materialx100 F/dayx8days =18000 F/2marks
Unit cost=total cost/quantity =18000 F/1400=12.86 F/unit

2. What is the duration in days to install 6000 square feet of walls shuttering if:
a. Crew of 2 carpenters is used with output of 200 square feet/day
b. Productivity is measured as 0.008man-hour/square feet. Number of carpenters=3,and number of working hours/day=8hours

ANS2.
a. Duration=6000/ 200=3days
b. Total man-hours needed=6000x 0.008=48man-hours (if one man used)
Duration=48/8=6 days (if one man used)
Duration using 3 men=6/3=2days

Theoretical learning Activity

- ✓ Trainees are asked to brainstorm the definition of variance and standard deviation as used in statistics
- ✓ Trainees are asked to brainstorm the formulas of variance and standard deviation as used in statistics

Practical learning Activity

- ✓ Group works on calculation of time and cost of works

 Points to Remember (Take home message)

To estimate the work duration needed to complete a given activity you must have successful information on: - Productivity hour per day - How many resources on each activity - Available work days - Delays-lag time(effort hours) - Resources constraints (activity done sequentially or parallel) - Maintenance days

Learning outcome 1.4. formative assessment

Written assessment: Open ended questions and multiple choice question

Question1. Choose the two (2) wrong answers from the following

Those are the elements of an activity/work except:

A. Labours
B. duration
C. resources.
D. Drawing
E. cost

answer:

A. Labours
B. duration
C. resources.
D. Drawing
E. cost

Question2. State at least 2 Importance of work duration determination?

Answer: Importance of work duration determination are:

- ✓ To provide amount of time each activity will take to complete.
- ✓ It is used to construct project schedule
- ✓ It helps to be aware of the extent of the work and its complexity

Question 3. What are the steps of work duration determination?

answer:

- ✓ Time of each task
- ✓ Determination of concurrent tasks
- ✓ Total time

Practical assessment

Question 1 . If the daily production rate for a crew that works in an activity is 100 units/day and the total crew cost per day is 3000F. The material needed for daily work is 4.5 units at 240F/Unit.

a) Calculate the time and cost it takes the crew to finish 1200 units

b) Calculate the total unit cost.

Answer:

a) Duration (units of time) =Quantity/Production per unit of time x Number of crews=1200/100x1= 12 days

Cost (labor cost) =Duration (units of time) x Crew cost per unit of time

=12 days x 3000 Rwf/day=36000Rwf.

Cost of material= 4.5unit x 240F/unit**=** 1080F

b) Total cost= 36000Rwf + 1080F**= 37080F**

TotalUnit Cost=Total cost/quantity=37080 Rwf/1200=30.9Rwf/Unit

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Learning Unit 2: Determine required resources

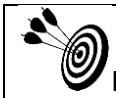
STRUCTURE OF LEARNING UNIT

Learning outcomes:

2. 1. Quantify materials
2. 2. Identify the quality of materials
2. 3. Determine human resources

Learning outcome 2.1 Quantify materials

Duration: 30 hrs



Learning outcome 2.1 objectives:

By the end of the learning outcome, the Trainees will be able to:

1. Identify types of materials as used in construction activities

2. Calculate the Quantities of materials in terms of size and shape

3. State the Method of calculating quantities of materials according to their respective procedures

Resources

Equipment	Tools	Materials
Computer Projector	Tape measure Pen Pencil Calculator Rulers Note book Proforma invoice Plan view	Paper Bricks Sand Aggregate Cement Water Internet

Advance preparation:

- ✓ The sample of the materials such as sand, gravel, cement, stones have to be prepared and available before the session starts
- ✓ Tools to be used in calculation have to be availed before the session starts eg: calculator, drawings

Content 2.1.1: Identification of materials

2.1.1.1.Types of materials

Material is anything made of matter, constituted of one or more substances. Cement, Steel, Nails, Aggregates and Water are all examples of materials. Sometimes the term "material" is used more narrowly to refer to substances or components with certain physical properties that are used as inputs to production or manufacturing.

a)Type of materials used used in construction

1) **Cement**: Used as binding material
2) **Lime:** Used as binding material and also for painting
3) **Building units:** burnt bricks, mud blocks and cement blocks for walling and paving

4) **Water:** used for mixing of concrete, watering and curing.
5) **Boards or timbers**: Used for formwork, scaffolding and also for the construction of foundation, floors, walls, roofs, pillars, and frames.
6) **Nails:** Are available in different sizes and are used to joint boards, timber, ceilings and profiles.
7) **Steel:** Is used for reinforcement of concrete. E.g: column, beam and slab.
8) **Binding wire:** used for binding of steel bars
9) **Aggregates:** Fine aggregates and coarse aggregates

    a) **Fine aggregates** : are those which pass a standard 5mm sieve. They are generally called sand.
    b) **Coarse aggregates**: are those which are retained on a standard 5mm sieve, crushed stone or gravels to 60mm grains.

10) **Stones**: these are pieces of all classified of natural rocks which are finished as small building units for masonry construction, used in foundation bases, filling up on the floors as hardcore, and for fencing works.

Theoretical learning Activity

- ✓ Trainees are asked to brainstorm the possible types of materials used in construction industry

Practical learning Activity

- ✓ Individual selection of different construction materials

Points to Remember (Take home message)

Type of materials used

1) Cement
2) Lime
3) Building units
4) Water
5) Boards or timbers
6) Nails
7) Steel
8) Binding wire
9) Aggregates
10) Stones

Content 2.1.2: Quantities of materials in terms of size and shape

2.1.2.1.Definition of quantity survey

- **Quantity survey** means estimating of quantities of different items of work.
- **A quantity surveyor** is a professional working within the construction industry concerned with building cost. The main role of quantity surveyor is to estimate the cost of civil engineering work. Each building can be divided into different parts, costs of each part can be estimated and adding to cost of all parts of building together will give contractors an estimated cost for the whole work.

Every good quantity surveyor must have a good knowledge of building materials and construction (should provide correct calculation) and be able to visualize drawings and details. A quantity surveyor is a descriptive title in which despites the role provided by a profession in producing a bill of quantity.

- **Quantity surveying is important in**:

1. Determination of quantities of items of civil engineering works
2. Preparation of estimate of civil engineering works
3. Preparation of tender documents for civil engineering works
4. Determination of labor requirement for civil engineering items

2.1.2.2.UNITS OF MEASUREMENTS

The units of measurements are mainly categorized for their nature, shape and size for making payments to the contractor. The principle of units of measurements normally consists the following:

- Single units work like doors, windows, trusses etc, is expressed in numbers.
- Works consists linear measurements involve length like cornice, fencing, handrail, bands of specified width are expressed in running meters (RM)
- Works consists a real surface measurements involve area like plastering, white washing, partitions of specified thickness etc.
- Works consist of cubical Contents which involve volume like earthwork, cement concrete; Masonry etc are expressed in Cubic meters.

Units of measurement for various items of works and materials

Item No.	Particulars of items	Unit of measurement	Unit of payment
1	Earthwork in excavation	m^3(cum)	Per m^3
2	Stone masonry	m3	perm^3

3	Damp proof course(DPC)	m^2(sqm)	per m^2
4	Brickwork	m3	Per m^3
5	Cement concrete (C.C)	m3	Per m^3
6	Flooring	m2	per m^2
7	Roof	m2	per m^2
8	Door and window fitting	number	per number
9	Plastering, pointing ,and painting	m^2	per m^2
10	Rainwater pipe	m	per m

2.1.2.3.Principles of deciding unit of measurement

The most important principles of selection of unit of measurement:

- The unit of measurement should be simple and convenient to measure, record and understand
- It should be one, which provides for fair payment for the work involved
- In the result it should be yield quantities which are neither too minute nor too large
- The price per unit should not be a very small figure or a very large one, that is generally costlier items will be measured in small units, cheaper ones in larger units
- The unit of measurement may sometimes depend upon the unit for the raw material and / or labour and important dimensions.

2.1.2.4.Rules for measurement

The rules for measurement of each item are invariably described in IS 1200.However some of the general rules are listed below.

1. Measurement shall be made for finished item of work and description of each item shall include materials, transport, labour, fabrication tools and plant and all types of overheads for finishing the work in required shape, size and specification.
2. In booking, the order shall be in sequence of length, breadth and height or thickness.
3. All works shall be measured subject to the following tolerances.
   - ✓ Linear measurement shall be measured to the nearest 0.01 meter
   - ✓ Area shall be measured to the nearest 0.01 square meter
   - ✓ Cubic Contents shall be worked-out to the nearest 0.01 cubic meter
4. Same type of work under different conditions and nature shall be measured separately u separate items.
5. The bill of quantities shall fully describe the materials, proportions, workmanships and a represent the work to be executed.
6. In case of masonry (stone or brick) or structural concrete, the categories shall be measur and the heights shall be described: a) From foundation to plinth level

b) From plinth level to first floor level

c) From First floor to second floor level and soon.

2.1.2.5.Purpose of estimating idea of the cost to help him decide whether the work can be undertaken as proposed or need to be curtailed or abandoned, depending upon the availability funds and prospective direct and indirect benefits

- Estimating in construction is to ensure that work is carried out according to correct plan specification
- Estimator must be in a position to know exactly how much expenditure is going to incur estimating of materials, labour, plant and time
- The estimator comes up with approximate cost. The actual cost of a project will be deter after completion of the project.

2.1.2.6.Qualifications of an estimator

A good estimator should possess the following qualifications:

1. A thorough understanding of architecture drawings
2. A sound knowledge of building materials, constructions methods and customs prevailed in the trade
3. A fund of information collected or gained through experience in construction work, relating to materials required hourly, output of labour and plant, overhead expenses and cost of all things
4. An understanding of a good method of preparing an estimate
5. A systematic and orderly mind
6. Ability to do careful and accurate calculations
7. Ability to collect, classify and evaluate data that would be useful in estimating.

2.1.2.7.Steps in preparation of a detailed estimate

There are three clearly defined steps in preparation of a detailed estimate:

1. Taking out quantities

In the first step of taking out quantities, the measurements are taken off from the drawing and entered on measuring sheet. The measurement to be taken out would depend upon the unit of measurement.

For example, in the case of stone masonry in foundation; length, thickness, and height of the tr would be taken from the drawing and entered on the measurement sheet; the unit of measurer is cubic meter (m^3); whereas, in the case of plastering**,** only the length and height of the wall wo be entered on the measurement sheet; the unit of measurement is square meter(m^2).

2. Squaring out

The second step consists of working out volumes, areas, etc., and costing up to their total in recognized units.

3.Abstracting

In the third step, all the items along with the net results obtained in the second step are transfe from measurement sheets to specially ruled sheets having rate column ready for pricing.
The second and third steps above are known as working up.

All calculations in these stages and every entry transferred should be checked by another perso ensure that no mathematical or copying error occurs.

Example1: estimate the quantities of brickwork and plastering in a wall 4m long,3m height and 30cm thick. Calculate also the cost if the rate of brickwork is Rs.320per $m^3$and of plastering is Rs.8.50 per m^2.

Answer:

Quantity of brick work: L x B x H =4mx3mx0.30m = 3.6 m^3
Quantity of plastering (2faces): 2 x L x H =2 x4m x3m= 24 m^2
Cost of brickwork: 3.6 m^3 x320 Rs/ m^3 =Rs.1152.0
Cost of plastering: 24 m^2x8.50 Rs /m^2=Rs.204.0
Total cost =Rs.1152.0 +Rs.204.0=Rs.1356.0

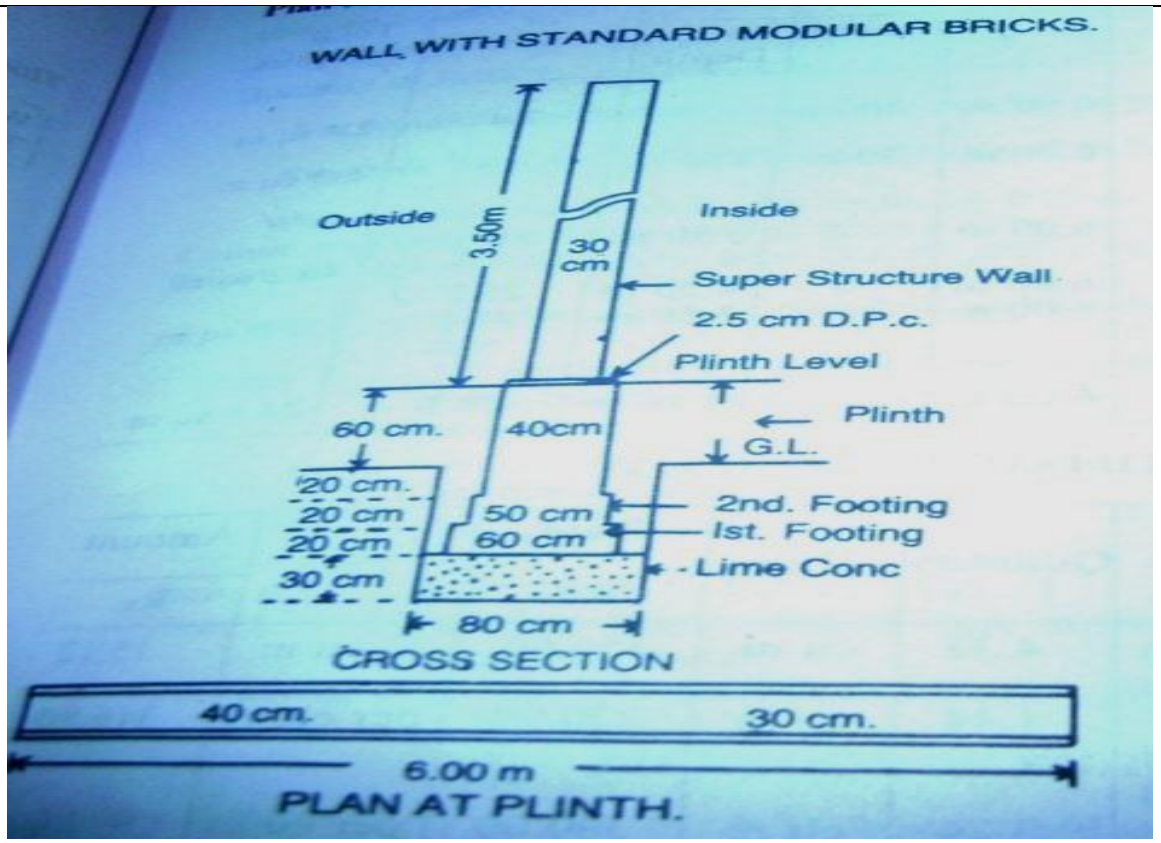
Example 2 : Prepare a detailed estimate of part a wall of building from the given plan and section and general specification.

General specifications

- ✓ Foundation concrete shall be of lime concrete
- ✓ Foundation and plinth shall be of 1^{st}class brickwork in lime mortar.
- ✓ Damp proof course-2.5 mm c.c1:$1^{1/2}$: 3with water proofing compound.
- ✓ Superstructure 1^{st} class brickwork in lime mortar.
- ✓ Wall finishing–inside wall 12mm cement plastered 1:6 and whitewashed 3 coats.

Outside wall 12mm cement plastered 1:6 including 10 cm below ground level and finished with two coats of color over one coat of white washing. Assume local current rates.

Plan and section of the building are shown below.



SOLUTION

Detailed estimate of measurement and calculation of quantities

S/N	Description of items	No	Dimensions			Quantities
			Length	Breadth	Height	
1	Earthwork in excavation in foundation	1	6m	0.8m	0.9m	4.32 cu.m
2	Lime concrete in foundation	1	6m	0.8m	0.3m	1.44 cu.m
3	1st class brickwork in lime mortar in foundation and plinth					
	1st footing	1	6m	0.6m	0.20m	0.72

	2^{nd} footing	1	6m	0.5m	0.2m	0.60
	Plinth wall up to GL	1	6m	0.4m	0.2m	0.48
	Plinth wall above GL	1	6m	0.4m	o.6m	1.44
	Total					3.24 cu.m
4	2.5 cm damp proof course c.c $1:1^{1/2}:3$	1	6m	0.40m	-	2.4 sq.m
5	First class brickwork in lime mortar for superstructure	1	6m	0.3m	3.5m	6.3cu.m
6	12mm plaster of cement sand 1:6 Inside Outside including 10cm below GL	1 1	6m 6m	- -	3.5m 4.2m	21sq.m 25.0sq.m
7	White washing 3coats (inside)	1	6m	-	3.5m	21sq.m
8	Colour washing 2coats over one coat of white washing (outside above GL)	1	6m	-	4.1m	24.6

2.1.2.8.METHODS OF TAKING OUT QUANTITIES

The calculation of quantity of materials can be done using various methods of estimates.

The application of an individual method depends upon the design and shape of the building.

The different methods are as under:

a) Long wall-short wall method (out to out & in to in)

b) Centre line method.

c) Crossing method.

d) Bay method

e) Service unit method

a) Long wall-short wall method

In this method, the wall along the length of room is considered to be long wall while the wall perpendicular to long wall is said to be short wall. To get the length of long wall or short wall, calculate first the centre line lengths of individual walls. Then the length of long wall, (out to out) may be calculated after adding half breadth at each end to its centre Line length. Thus the

length of short wall measured into in and maybe found by deducting half breadth from its centre line length at each end. The length of long wall usually decreases from earth work to brickwork in superstructure while the short wall increases. These lengths are multiplied by breadth and depth to get quantities.

b) Centre line method

This method is suitable for walls of similar cross sections. Here the total center line length is multiplied by breadth and depth of respective item to get the total quantity at a time. When cross walls or partitions or verandah walls join with main all, the center line length gets reduced by half of breadth for each junction .Such junction or joints are studied carefully while calculating total center line length. The estimates prepared by this method are most accurate and quick. This method is suitable only if the offset are symmetrical and the building is more or less rectangular in shape. The center line of the building is determined carefully after doing deductions for repeated measurements. This center line acts as length for the complete calculations of the estimate. If the deduction is not cared for the results of estimates may be wrong. All the walls should have the same section

c) Crossing method (Partly centre line and partly cross wall method)

This method is adopted when external (i.e., all-round the building) wall is of one thickness and the internal walls having different thicknesses. In such cases, centreline method is applied to external walls and long wall-short wall method is used to internal walls. This method suits for different thicknesses walls and different level of foundations. In this method, lengths and breadths of the masonry walls at plinth level are taken (internal dimension of the room + thickness of the walls) for calculating quantities.

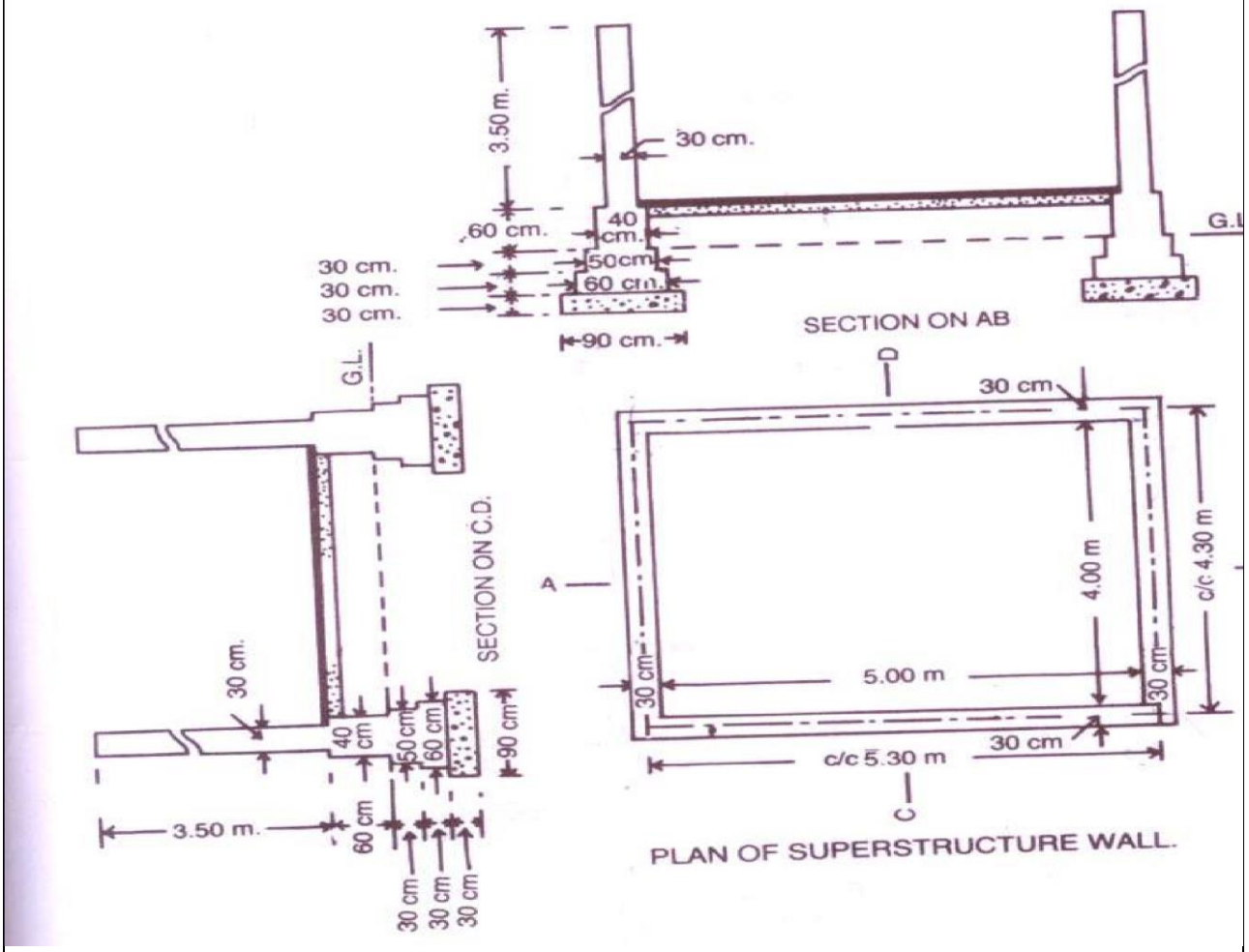
e) Bay method This method is useful and is generally followed in case of building having several bays. The cost of one bay is worked out and then multiplied by the number of bays in that building. The extra cost of the end walls and difference in framing. If there is any, should be made, so as to arrive at the correct cost

f) Service unit method

This method is followed in cases such as school building where there are so many classrooms. The cost of one classroom is worked out and then multiplied by the number of classrooms to

be constructed. In case of hospitals, the service unit is a bed ,in case of water tank ,it is a litre ,in case of cinema hall ,the service unit is a seat.

The length of long wall centre to centre = 5.00 + ½ × .30 + ½ × .30 = 5.30 m. The lengt
all centre to centre = 4.00 + ½ × .30 + ½ × .30 = 4.30 m.



Example1: The plan presents the plan of superstructure wall of single room building of 5mx4m, and sections represent the cross-sections of the walls with foundation. Estimate by using long and short wall method and center line method the quantities of:

1) Earthwork in excavation in foundation,
2) Concrete in foundation
3) Brickwork in foundation and plinth,
4) Brick work in superstructure

SOLUTION

1. Long and short wall method

Details of measurement and calculation of quantities

Item No.	Description of item	No.	Length	Breadth	Height	quantity	Explanatory notes
1	Earthwork in excavation						
	Long wall	2	6.20m	0.90m	0.90m	10.04	L=5.3+0.90
	Short wall	2	3.20m	0.90m	0.90m	5.51	B=4.3-0.90
2	Concrete in foundation						
	Long wall	2	6.20m	0.90m	0.30m	3.35	L=same as above
	Short wall	2	3.40m	0.90m	0.30m	1.83	
3	Brickwork in foundation and plinth						
	Long walls						
	1st footing	2	5.90m	0.60m	0.30m	2.13	L=5.3+0.6
	2nd footing	2	5.80m	0.50m	0.30m	1.74	L=5.3+0.5
	Plinth walls						
	Short walls	2	5.70m	0.40m	0.60m	2.74	L=5.3+0.40
4	Brickwork in superstructure						
	Long Walls	2	5.60m	0.30m	3.50m	11.76	L=5.3+0.30
	Short walls	2	4.0m	0.30m	3.50m	8.40	L=4.3-0.30
					Total	$20.16m^3$	

2. Centre line method

Long wall centre to centre length = 5m+0.15m +0.15m= 5.3m Short wall centre to centre length = 4m+0.15m +0.15m= 4.3m

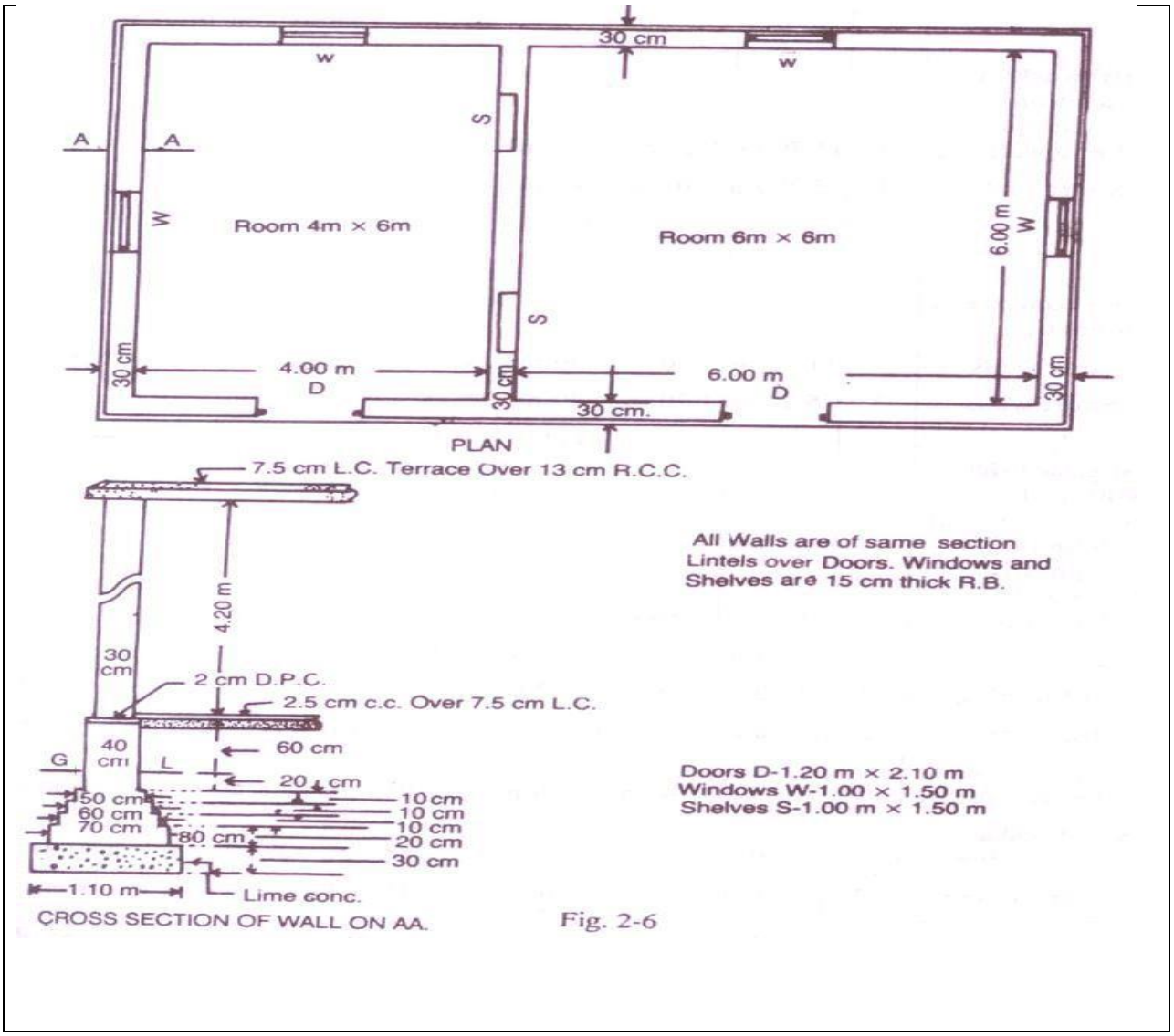
Total centre line length=2(5.3m+4.3m) =19.2m

Details of measurement and calculation of quantities

Item No.	Description of item	No.	Dimension			Quantity	unit	Explanatory notes
			L	B	H			
1	Earthwork in Excavation	1	19.2	0.9	0.9	15.552	cu.m	Total centreline length= 19.2m
2	Lime concrete in Foundation	1	19.2	0.9	0.3	5.184	cu.m	
3	Brickwork in foundation and plinth							
	1st footing	1	19.2	0.6	0.3	3.456	cu.m	
	2nd footing	1	19.2	0.5	0.3	2.88	cu.m	
	plinth wall	1	19.2	0.4	0.6	4.608	cu.m	
4	Brickwork in superstructure	1	19.2	0.3	3.5	20.16	cu.m	

Example 2: Estimate the quantities of the following items of two roomed building from the given plan and section by using long and short wall method, and centre line method:

1. Earthwork in excavation in foundation,
2. Lime concrete in foundation,
3. 1stclass brickwork in cement mortar 1:6 in foundation and plinth,
4. 2.5 cm c. c damp proof course, and
5. 1stclass brickwork in lime mortar in superstructure.



SOLUTION

1. Long and short wall method

Long wall centre to centre length = 4m+6m+ 0.3m+ 0.15m +0.1m = 10.6m

Short wall centre to centre length= 6m +0.15m + 0.15m =6.3m

Details of measurement and calculation of quantities

Item No.	Description	No.	Dimension			Quantity	unit	Explanatory notes
			L	B	H			
1	Earthwork in excavation in foundation							
	Long Wall	2	11.7	1.1	1	25.74	cu.m	L=10.6+1.1=11.7

	Short Wall	3	5.2	1.1	1	17.16		L=6.3-1.1=5.2
2	Lime concrete in foundation							
	Long Wall	2	11.7	1.1	0.3	7.722	cu.m	same as above
	Short Wall	3	5.2	1.1	0.3	5.148	cu.m	same as above
3	1st class brickwork in 1:6 cement mortar in foundation and plinth							
	Long Wall							
	1st footing	2	11.4	0.8	0.2	3.648	cu.m	L=10.6+0.8=11.4
	2nd footing	2	11.3	0.7	0.1	1.582	cu.m	L=10.6+0.7=11.3
	3rd footing	2	11.2	0.6	0.1	1.344	cu.m	L=10.6+0.6=11.2
	4th footing	2	11.1	0.5	0.1	1.11	cu.m	L=10.6+0.5=11.1
	Plinth wall above footing	2	11	0.4	0.8	7.04	cu.m	L=10.6+0.4=11
	Short Wall							
	1st footing	3	5.5	0.8	0.2	2.64	cu.m	L=6.3-0.8=5.5
	2nd footing	3	5.6	0.7	0.1	1.176	cu.m	L=6.3-0.7=5.6
	3rd footing	3	5.7	0.6	0.1	1.026	cu.m	L=6.3-0.6=5.7
	4th footing	3	5.8	0.5	0.1	0.87	cu.m	L=6.3-0.5=5.8
	Plinth wall above footing	3	5.9	0.4	0.8	5.664	cu.m	L=6.3-04=5.9
4	Damp proof course2.5 cm c.c							
	Long Wall	2	11	0.4		8.8	sq.m	same as plinth
	Short Wall	3	5.9	0.4		7.08	sq.m	same as plinth
	Deduct door sills	2	1.2	0.4		0.96	sq.m	
	Net Total					15.88	sq.m	
5	1st class brickwork in 1:6 cement mortar in superstructure							
	Long Wall	2	10.9	0.3	4.2	27.468	cu.m	L=10.6+0.3=10.9
	Short Wall	3	6	0.3	4.2	22.68	cu.m	L=6.3-0.3=6
	Deduct							
	Door opening	2	1.2	0.3	2.1	1.512	cu.m	
	Window	4	1	0.3	1.5	1.8	cu.m	
								10cm back of
	Lintel over doors	2	1.5	0.3	0.15	0.135	cu.m	15cm bearing
	Lintel over window	4	1.3	0.3	0.23	0.3588	cu.m	15cm bearing
	Lintel over Shelves	2	1.3	0.3	0.15	0.117	cu.m	15cm bearing
	Total deduction					4.5228	cu.m	
	Net Total					45.625	cu.m	

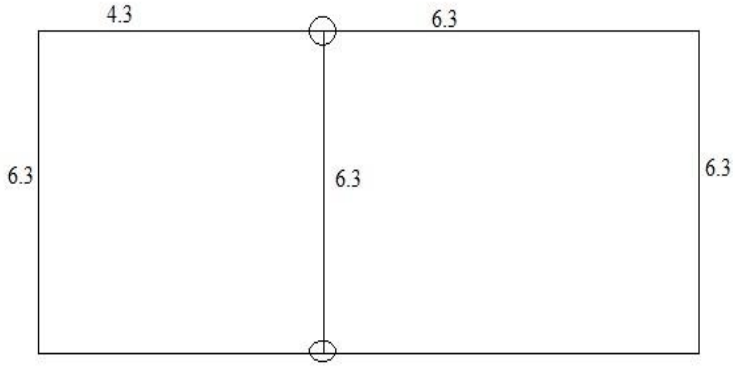
2. Centre line method

Centre line length for long wall=4m+2(0.15m)+6m+2(0.15m)=10.6m

Centre line length for short wall=6m+ 0.15m+0.15m = 6.3m

Total Centre line length of wall=2x10.6+3x6.3=40.1m Number of T-junction=2

Centre line diagram



Details of measurement and calculation of quantities

Item No.	Description of item	No.	Dimension			Quantity	Unit	Explanatory note
			L	B	H			
1	Earthwork in Excavation	1	39	1.1	1	42.9	cu.m	L=40.1-2*1.1/2=39
2	Lime concrete	1	39	1.1	0.3	12.87	cu.m	same as above
3	1st class brickwork in 1:6 cement mortar in foundation and plinth							
	1st footing	1	39.3	0.8	0.2	6.288	cu.m	L=40.1-2*0.8/2=39.3
	2nd footing	1	39.4	0.7	0.1	2.758	cu.m	L=40.1-2*0.7/2=39.4
	3rd footing	1	39.5	0.6	0.1	2.37	cu.m	L=40.1-2*0.6/2=39.5
	4th footing	1	39.6	0.5	0.1	1.98	cu.m	L=40.1-2* 0.5/2=39.6
	plinth wall above footing	1	39.7	0.4	0.8	12.704	cu.m	L=40.1-2*0.4/2=39.7
4	Damp proof course	1	39.7	0.4		15.88	sq.m	same as plinth wall
	Deduct sill	1	1.2	0.4		0.96	sq.m	
	Net total					14.92	sq.m	
5	1st class brickwork in 1:6 cement mortar in superstructure							
		1	39.8	0.3	4.2	50.148	cu.m	L=40.1-2*0.3/2=39.8
	Deduct							
	Door opening	2	1.2	0.3	2.1	1.512	cu.m	
	Window	4	1	0.3	1.5	1.8	cu.m	
	Shelves	2	1	0.2	1.5	0.6	cu.m	10cmback of shelve

	Lintel over doors	2	1.5	0.3	0.15	0.135	cu.m	15cm bearing
	Lintel over window	4	1.3	0.3	0.23	0.3588	cu.m	15cm bearing
	Lintel over Shelves	2	1.3	0.3	0.15	0.117	cu.m	15cm bearing
	Total deduction					4.5228	cu.m	
	Net total					45.625	cu.m	

2.1.2.9.Calculation of quantities of materials for brickwork

Example 1:- Calculate the Quantity of material for the following items.
a) R.C.C. (1:2:4) for 20m^3 of work
b) R.C.C. (1:3:6) for 15m^3 of work

Example 2:- Calculate the quantity of materials for the following items.
a) C.M. (1:4) for 1m^3 of work
b) CM (1:6) for 1m^3 of work

Note: For 1m3 dry concrete = 1.52m^3 wet concrete approximately
Specific weight of cement= 1440 kg/m^3 (or) 1.44 t/m^3
1 bag of cement = 50 Kg
Volume of wet concrete= 1.52*Volume of dry concrete

`ANSWERS

1. a) 1m3 of dry concrete =1.52 m3 of wet concre

sum of ratio=1+2+4=7

$$\text{cement}=\frac{1*1.52*20*1440}{7}=6253.714\ \text{kg}$$

number of bags=6253.714kg/50 kg=125 bags

$$\text{sand}=\frac{2*1.52*20}{7}=8.686\ \text{m3}$$

$$\text{gravel}=\frac{4*1.52*20}{7}=17.37\ \text{m3}$$

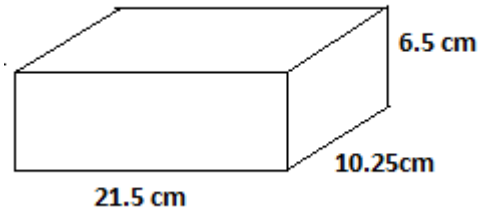
2. a) cement $=\frac{1*1*1440}{4*50}=7.2$ **bags**

$$\text{sand}=\frac{4*1}{4}=1\ \text{m3}$$

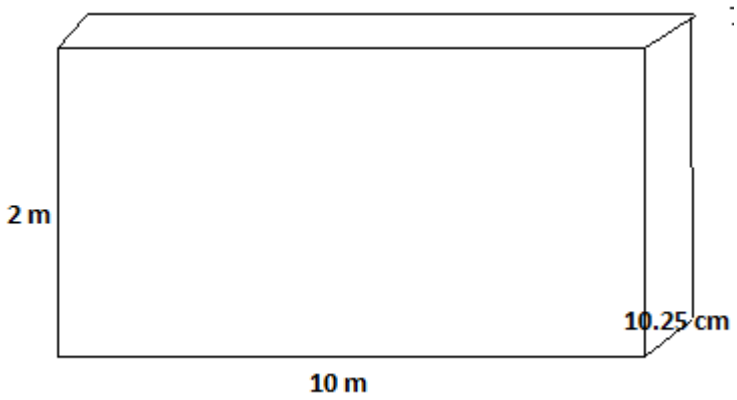
Two methods can be used in calculation of quantities of brickwork

A/ wall volume method
B/area wall method

B/ area wall method
Let take a standard measurement of a brick



Example
take a wall of 2000mm of height and 10000mm length. Calculate the quantities of materials in a below wall



Solution

area of wall=10m *2= 20 sqm
horizontal joints= are equal to number of layers
horizontal joints= $\frac{\text{heigth of wall}}{\text{height of brick+joint}} = \frac{2000mm}{75mm}$ =27 joints

area of horizontal joint=10*0.01(joint)*27=2.7 sqm
number of vetical joint=$\frac{10000mm}{215+10}$ =44 joints

total number of vertical joints=44*27=1188 joints
area of 1 vertical joint=10mm*65mm=650 sqmm=0.00065sqm
total area of vertical joint=0.00065*1188=0.7722 sqm
area of total joints=2.7 sqm+0.7722 sqm=3.4722 sqm
area occupied by bricks=20 sqm-3.4722 sqm=16.5278sqm
number of bricks per 1/2 brick wall=$\frac{16.5278}{0.215*0.065}$ =1183 bricks

number of bricks of a full brick wall=1183*2=2366 bricks
addition of 2 to 5% of wastage

B/ volume method.

solution

volume of wall=10*0.1025*2m=2.05 cum
volume of a brick=0.1025*0.065*0.215= 0.0014324375 cum
number of bricks horizontally =10/0.215+0.01=44.44444444 bricks
number of bricks vertically=2/0.065+0.01=26.66666666 bricks
total number of bricks =26.666666*44.44444444=1185.185 bricks
total volume occupied with bricks=1185.185*0.0014324375=1.6977037037 cum
volume occupied with mortor=2.05 -1.6977037037=0.352 cum

Theoretical learning Activity

- ✓ Trainees are asked to brainstorm about the method of estimation
- ✓ Trainees are asked to brainstorm about the units of measurements of works

Practical learning Activity

- ✓ Group works on calculation of quantities in bill of quantity

Points to Remember (Take home message)

Method of calculating quantities of materials:

- Centre line method
- Crossing method
- Long wall-short wall method
- Bay method
- Service unit method

Learning outcome 1.1. formative assessment

Written assessment: Open ended questions, table completion

Question1. Provide The measurement unit for the following activities

Number	Activities	Unit
1	Earth work	
2	Concrete and Reinforced Concrete	
3	Plastering	
4	Painting	
5	Stone work	
6	Ceiling	
7	Tiling	
8	Flooring	
9	Windows	
10	Doors	

Answer:

Number	Activities	Unit
1	Earth work	M^3
2	Concrete and Reinforced Concrete	M^3
3	Plastering	M^2
4	Painting	M^2
5	Stone work	M^3
6	Ceiling	M^2
7	Tiling	M^2
8	Flooring	M^2
9	Windows	number
10	Doors	number

Question 2. define the following terms;

a) Quantity surveyor:

b) bill of quantity

c) An estimate

d) Estimating

e) Actual cost

answer:

a) **Quantity surveyor**: is a professional working within the construction industry concerned with building cost

b) **bill of quantity**: is a document which quantifies in details the scope of construction project using a standard method of measurement and is typically used in the tender process for pricing and analysis purpose

c) **An estimate:** is an approximate calculation of the cost of works to be done

d) **Estimating:** is the technique of calculating or computing the various quantities and the expected expenditure to be incurred on a particular work or project

e) **Actual cost:** the cost of a project used for completing all construction works

Practical assessment

Question 1: estimate the quantities of brickwork and plastering in a wall 6m long,3m height and 30cm thick. Calculate also the cost if the rate of brickwork is Rs.2500per $m^3$and of plastering is Rs.300 per m^2.

Answer:

Quantity of brick work: L x B x H =6mx3mx0.30m = 5.4 m^3

Quantity of plastering (2faces): 2 x L x H =2 x6m x3m= 36 m^2

Cost of brickwork: 5.4 m^3 x2500 Rs/ m^3 =Rs.13500

Cost of plastering: 36m^2x300 Rs /m^2=Rs.10800

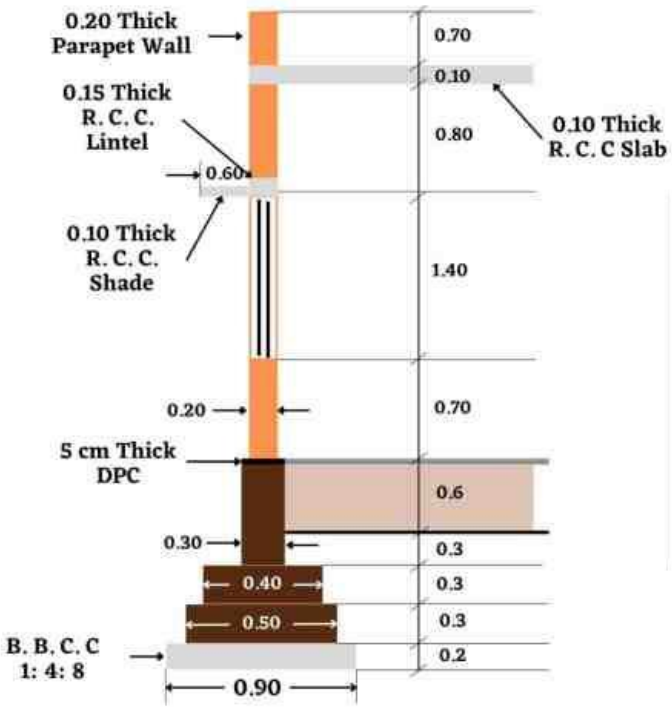
Total cost =Rs.13500 +Rs.10800=Rs.24300

Question 2. Estimate by long wall short wall method the quantities of the following items of the following building

1. Earthwork in excavation in foundation,
2. Lime concrete in foundation,
3. 1st class brickwork in cement mortar 1:6 in foundation and plinth,
4. 2.5 cm c.c damp proof course and
5. 1st class brickwork in lime mortar in superstructure.

Plan view

Building Section



Door - Window Schedule

D1 = 1.10 x 2.10
D2 = 0.90 x 2.10
G1 = 1.20 x 2.10
W1 = 1.80 x 1.40
W2 = 1.20 x 1.40
W3 = 1.50 x 1.40
V = 0.60 x 0.60

Answer:

Item No.	Item Description (Work Details)	No	Length (L)	Breadth (B)	Height (H)	Quantity	Explanation
1.	**Earthwork in excavation for the foundation**						
	For Long Wall:	3	8.3	0.9	1.1	24.65	L = (4+3+2×0.2) + 2×0.45 = 8.3 m H = 0.3 + 0.3 + 0.3 + 0.2 = 1.1 m
	Short Wall:	3	3.3	0.9	1.1	9.80	L = 4.2 – 2 x 0.45 = 3.3 m
	Short Wall:	4	2.3	0.9	1.1	9.11	L = 3.2 – 2 x 0.45 = 2.3 m
	Wall in front of W. C	1	0.4	0.9	1.1	0.40	L = (1.1 + 0.2) – 2 x 0.45 = 0.4 m
						43.96 m^3	
or	**Brickbat cement Concrete (1:4:8) for foundation**						

	For Long Wall:	3	8.3	0.9	0.2	4.48	
	For Short Wall:	3	3.3	0.9	0.2	1.78	
	For Short Wall:	4	2.3	0.9	0.2	1.66	
	wall in front of W.C	1	0.4	0.9	0.2	0.07	
						7.99 m³	
2.	**Brick masonry up to plinth in c.m.1:6**						
	For Long Wall:						
	First Step: L= 8.3 – 2 x 0.2 = 7.9m	3	7.9	0.5	0.3	3.56	
	Second Step: L = 7.9 – 2 x 0.05 = 7.8m	3	7.8	0.4	0.3	2.81	
	Third Step: L = 7.8 – 2 X 0.05 = 7.7M	3	7.7	0.3	0.85	5.89	
	For Short Wall:						
	First Step: L = 3.3 +2 x0.2 =m3.7m	3	3.7	0.5	0.3	1.67	
	Second Step: L= 3.7+2×0.2=3.8	3	3.8	0.4	0.3	1.37	
	Third Step: L=3.8+2X0.05=3.9M	3	3.9	0.3	0.85	2.98	
	For Short Wall:						
	First Step:L=2.3+2×0.2=2.7m	4	2.7	0.5	0.3		
	Second Step: L=2.7+2×0.05=2.8m	4	2.8	0.4	0.3		
	Third Step: L=2.8+2×0.05=2.9m	4	2.9	0.3	0.85		
	Wall in front of W.C.:						
	First Step: L =0.4+2×0.2=0.8m	1	0.8	0.5	0.3	0.12	

	Second Step: L= 0.8+2X0.2=0.9m	1	0.9	0.4	0.3	0.11	
	Third Step: L=0.9+2X0.05=1m	1	1.0	0.3	0.85	0.26	
	Steps:						
	First Step:	1	1.1	0.9	0.15	0.15	
	Second Step:	1	1.1	0.6	0.15	0.10	
	Third Step:	1	1.1	0.3	0.15	0.05	
	For step L= D1=1.1m						
						24.99 m³	
3.	**Brick masonry above plinth up to slab level in c.m. 1:6**						
	For Long Wall:	3	7.6	0.2	3.0	13.68	
	L=7.7-2×0.05=7.6m						
	H=0.7+1.4+0.9=3.0m						
	For Short Wall:	3	4.0	0.2	3.0	7.2	
	L=3.9=2×0.05=4.0m						
	For Short Wall:	4	3.0	0.2	3.0	7.2	
	Wall in front of W.C.						
	L-1+2×0.05=1.1.m	1	1.1	0.2	3.0	0.66	
					Total Quantity=	28.74 **m³**	
	Deduction For Doors & Windows						
	D1	3	1.1	0.2	2.1	2	
	D2	2	0.9	0.2	2.1	0.76	
	G1	1	1.2	0.2	2.1	0.50	
	W1	4	1.8	0.2	1.4	2.02	

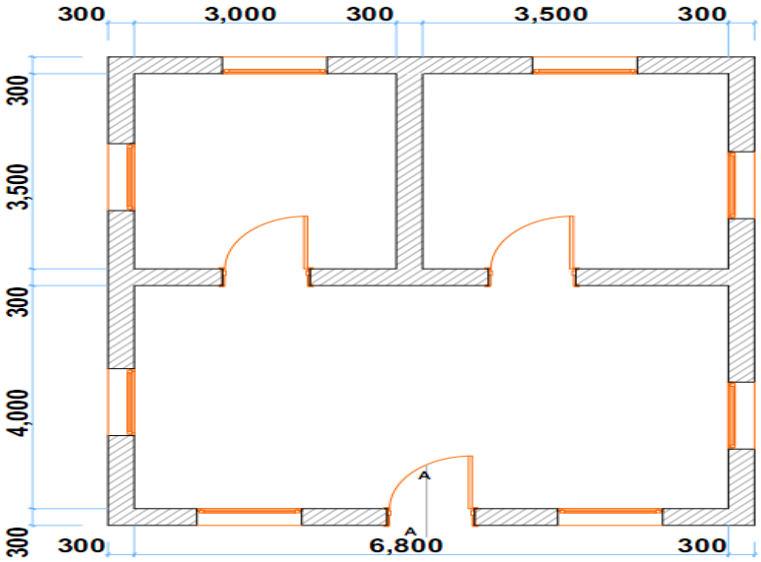
	W2	1	1.2	0.2	1.4	0.34	
	W3	1	1.5	0.2	1.4	0.42	
	V	2	0.6	0.2	0.6	0.14	
					Deduction=	**(-)5.57 m^3**	
	Deduction for lintels above door and windows with 15cm bearing at each end.	3	1.4	0.2	0.15	0.126	
		2	1.2	0.2	0.15	0.072	
		1	1.5	0.2	0.15	0.045	
		4	2.1	0.2	0.15	0.25	
		1	1.5	0.2	0.15	0.045	
		1	1.8	0.2	0.15	0.054	
		2	0.9	0.2	0.15	0.054	
					Deduction=	**(-)0.646 m^3**	
	Net qunantity=28.74-5.57-0.646= 22.54m^3						
4.	**Smooth plaster inside the rooms and ceilings in c.m.1:3**						
	Plaster for walls:						
	Drg. Room	4	4.0		3.0	48.0	
	Bed Room	2	4.0		3.0	24.0	
		2	3.0		3.0	18.0	
	Kitchen	2	4.0		3.0	24.0	
		2	3.0		3.0	18.0	
	Bath	2	3.0		3.0	18.0	
		2	1.7		3.0	10.2	

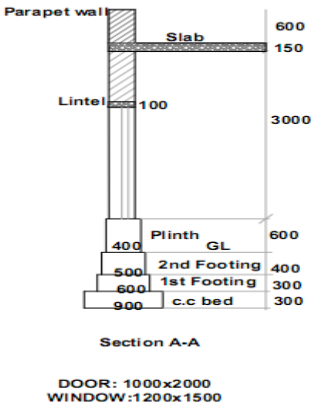
	w.c.	2	1.3		3.0	7.8	
		2	1.1		3.0	6.6	
	in front of W.C	2	1.5		3.0	9.0	
			1.1		3.0	6.6	
	ceiling plaster						
	Drg. Room	1	4.0	4.0		16.0	
	Bed Room	1	4.0	3.0		12.0	
	Kitchen	1	3.0	4.0		12.0	
	Bath	1	4.0	1.7		5.1	
	w.c.	1	1.3	1.1		1.43	
	in front of W.C	1	1.5	1.1		1.65	
					Total Quantity=	**238.38 m^2**	
	Deduction for Door/ Window						
	D1	5/2	1.1		2.1	5.78	
	D2	4/2	0.9		2.1	3.78	
	G1	2/2	1.2		2.1	2.52	
	W1	4/2	1.8		1.4	5.04	
	W2	1/2	1.2		1.4	0.84	
		1/2	1.5		1.4	1.05	
					Total Deduction=	**(-)19.01 m^2**	
	The area of a ventilator is less than 0.5m2 therefore no deduction is made						

	For Door, half the number of faces is deducted.				**Net Quantity=**	**219.37 m^2**	

Question 3. From the given single storied residential building below , by using center line method, estimate the quantities

1) Earthwork in excavation in foundation
2) Concrete in foundation
3) Brickwork in foundation and plinth
4) Brickwork in superstructure





ANSWER:

Estimation of quantities

Total center line length_(3.3+3.8)3+(3.8x3)+(4.3x2)=41.3m

No of T-junction= 4

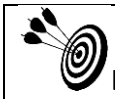
Item No	Description of item	No	Dimension			Quantity	Unit	Explanatory notes
			L	B	H			
1	Earthwork in excavation	1	39.5	0.9	1	35.55	Cum	L= 41.3-(4x0.9/2) =39.5
2	Concrete for foundation	1	39.5	0.9	0.3	10.665	Cum	

3	Brickwork in foundation and Plinth 1st footing 2nd footing Plinth Total	 1 1 1	 40.1 40.3 40.5	 0.6 0.5 0.4	 0.3 0.4 0.6	 7.218 8.06 9.72	 Cum	L=41.3-(04x0.6/2) = 40.1m L=41.3-(4x0.5/2) = 40.3m L=41.3-(4x0.4/2) =40.5
						25.00	Cum	
4	Brickwork in superstructure Parapet wall Total	1 1	40.7 30.4	0.3 0.3	3 0.6	36.63 5.472	Cum	L= 41.3-(4x0.3/2) =40.7m L= 2(7.1+8.1)=30.4m
						42.102	Cum	
	<u>Deduct:</u> Door Window Lintel over door Lintel over window	 3 8 3 8	 1 1.2 1.2 1.4	 0.3 0.3 0.3 0.3	 2 1.5 0.1 0.1	 1.8 4.32 1.108 0.336	cum	
						6.564		
	Net quantity		35.538					

NA

Learning outcome 2.2 Identify the quality of materials

Duration: 5 hrs



Learning outcome 2.2 objectives:

By the end of the learning outcome, the Trainees will be able to:

1. determine the Quality of material needed according to their Specification
2. determine the Quality of material needed according to their Description
3. determine the Quality of material needed according to Material testing

Resources

Equipment	Tools	Materials
Computer Projector	Tape measure Pen Pencil	Paper Bricks Sand Aggregate Cement Water

Advance preparation:

- ✓ Trainer should have prepared materials such as sand, cement, water, stones, bricks and others…. Before the session starts

Content 2.2.1: determine Quality of material needed

1. Quality of material needed according the Specification of material

a) Definition of specification

is a detailed explanation of expected workmanship and quality of materials to be used by the contractor in executing a given piece of work. They are used to supplement the working drawings. Specification is a precise description of all the essential information and the job requirements that will affect the price of the work butt can not be shown on tendering

b) Types of specification

- **General Specifications:** This gives the nature, quality, class and work and materials in general terms to be used in various parts of wok. It helps no form a general idea of building.
- **Detailed Specifications**: These gives the detailed description of the various items of work laying down the Quantities and qualities of materials, their proportions, the method of preparation workmanship and execution of work.

Example of specification : the below figure shows the wall to be constructed.

Plan and Section

Fig. 2-1

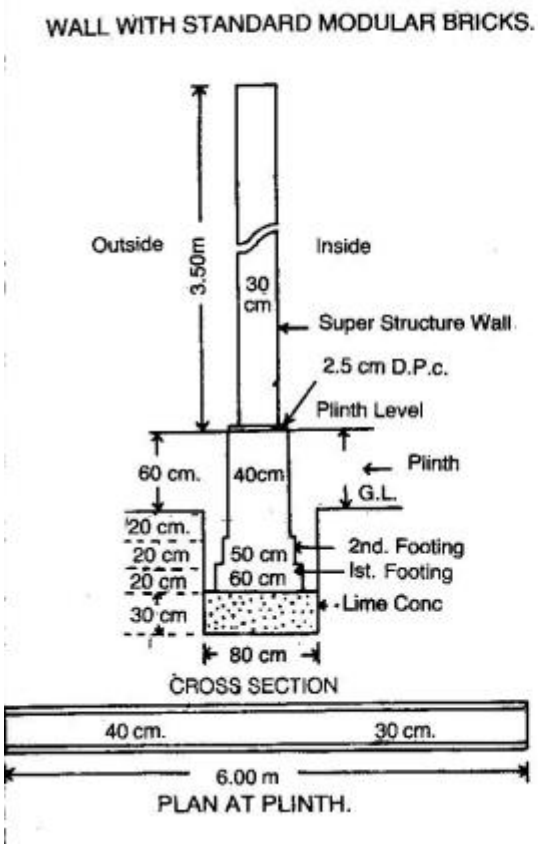
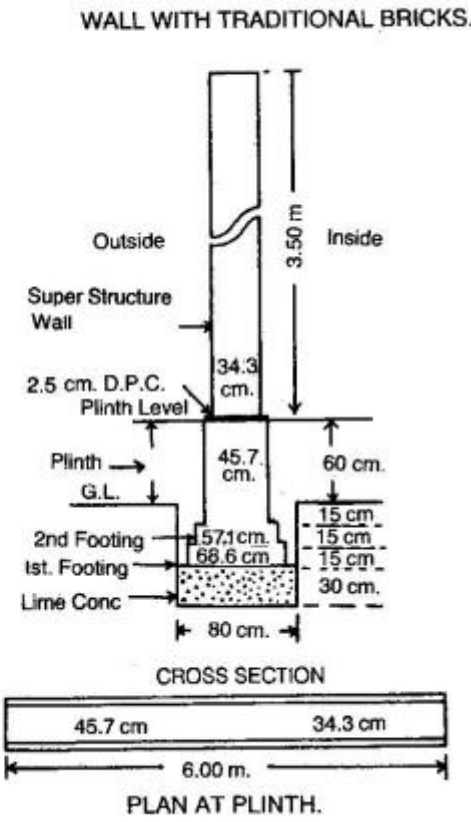


Fig. 2-2



Consider the following specification

- Foundation concrete shall be of lime concrete
- Foundation and plinth shall be of 1st class brickwork in lime mortar.
- Damp proof course-2.5 mm c.c1:$1^{1/2}$: 3with water proofing compound.
- Superstructure1 st class brickwork in lime mortar.
- Wall finishing–inside wall 12mm cement plastered1:6andwhitewashed3coats.
- Outside wall 12mm cement plastered 1:6 including 10 cm below ground level and finished with two coats of color over one coat of white washing

2. Quality of material needed according the Description of material

Type of materials used

1. Cement: Used as binding material
2. Lime: Used as binding material and also for painting

3. Building units: burnt bricks, mud blocks and cement blocks for walling and paving 4. Water: used for mixing of concrete, watering and curing.
5. Boards or timbers: Used for formwork, scaffolding and also for the construction of foundation, floors, walls, roofs, pillars, and frames.
6. Nails: Are available in different sizes and are used to joint boards, timber, ceilings and profiles.
7. Steel: Is used for reinforcement of concrete. E.g: column, beam and slab.
8. Binding wire: used for binding of steel bars
9. Aggregates: Fine aggregates and coarse aggregates

A. Fine aggregates are those which pass a standard 5mm sieve. They are generally called sand. B. Coarse aggregates: are those which are retained on a standard 5mm sieve, crushed stone or gravels to 60mm grains.

10. Stones: these are pieces of all classified of natural rocks which are finished as small building units for masonry construction, used in foundation bases, filling up on the floors as hard-core, and for fencing works.

3. Quality of material needed according the Material testing

Materials testing

Construction Materials testing (CMT) is a vital process that help builders and sites owners identify potential problems before committing resources to the project.

Importance of materials testing

A building structure is much more than floors walls and a foundation. virtually all building rely on a variety of support materials, including layers of soil and cement, to maintain long-term stability

- Materials testing ensure that the structural materials used during construction meet all necessary quality benchmarks.
- It is essential for keeping the structure in line with applicable legal requirements including occupational safety and environmental regulation.
- Material testing helps avoid expensive repair
- It include field examinations and laboratory test.

(stewart, 1991)

- ✓ Trainees are asked to brainstorm the types of specification
- ✓ Trainees are asked to brainstorm about the importance of conducting test on construction materials

Practical learning Activity

- ✓ Observation of the construction materials

Points to Remember (Take home message)

Quality of material needed:

- Specification of material
- Description of material
- Material testing

Learning outcome 2.2. formative assessment

Written assessment: Open ended questions

Question 1. Define the term "specification" as used in cost estimation

Answer: is a detailed explanation of expected workmanship and quality of materials to be used by the contractor in executing a given piece of work. They are used to supplement the working drawings. Specification is a precise description of all the essential information and the job requirements that will affect the price of the work butt can not be shown on tendering

Question 2. Differenciate two types of specification

Answer: **General Specifications:** This gives the nature, quality, class and work and materials in general terms to be used in various parts of wok. It helps no form a general idea of building. While **Detailed Specifications**: These gives the detailed description of the various items of work laying down the Quantities and qualities of materials, their proportions, the method of preparation workmanship and execution of work.

Question 3. State the importance of conducting test on construction materials before being used

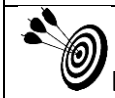
Answer:

- ✓ Materials testing ensure that the structural materials used during construction meet all necessary quality benchmarks.
- ✓ It is essential for keeping the structure in line with applicable legal requirements including occupational safety and environmental regulation.
- ✓ Material testing helps avoid expensive repair
- ✓ It include field examinations and laboratory test.

NA

Learning outcome 2.3 Determine human resources

Duration: 5 hrs



Learning outcome 2.3 objectives:

By the end of the learning outcome, the Trainees will be able to:

1. Know the Factors for human resource determination
2. Know the Labor classification according to their skills

Resources

Equipment	Tools	Materials
Computer	Tape measure Pen Pencil	Paper

Advance preparation:

NA

Content 2.3.1: Factors for human resource determination:

The following are the factors to be considered when determining the quantity of labour:

- **Variety of task**: It means the degree to which the job requires that the employee perform a wide range of tasks
- **Extent of work: The** size of work affect primarily the quantity of labour to perform it. The higher size of the work, the higher quantity of labour
- **Duration of task:** it refers to the time required to complete a specific task or activity
- **Emergency work:** It may happen that the site needs the labour for emergency and unexpected works which is not planned during planning of work
- **Working place:** The site may affect the performance of labour according to its conditions. Normally in hot area the productivity is higher than cold area

Theoretical learning Activity

- ✓ Trainees are asked to brainstorm the definition of term "human resources "
- ✓ Trainees are asked to brainstorm the factors for human resources determination

Practical learning Activity

NA

Points to Remember (Take home message)

Factors for human resource determination:

- Variety of tasks
- Extent of work
- Duration of work
- Emergency work
- Working place

Content 2.3.2: Labor classification

Labour classification

Labour are classified into the following class

- **Skilled labour first class**: They have special skills training, knowledge and ability in their work. They are trained, educated and experienced segment of workforce that can complete more complex mental or physical tasks on the job. They are characterized by advanced education ex: Engineer
- **Skilled labour second class:** They are having or requiring less training than skilled labour and more than unskilled labour. Semi-skilled career requires some level of judgement, which exceeds the little no judgement required in unskilled jobs. Examples of them are tradesmen, technician
- **Unskilled labour:** They are employed for carrying out such jobs which don't requires any specialized professional skills

Theoretical learning Activity

- ✓ Trainees are asked to brainstorm the definition of term "labor "
- ✓ Trainees are asked to brainstorm the classes of labor

Practical learning Activity

- ✓ Group presentation about labour classification

Points to Remember (Take home message)

Labor classification:

- Skilled 1st class
- Skilled 2nd class
- Unskilled

Learning outcome 2.3. formative assessment

Written assessment: Open ended questions

Question 1. Define the term “human resources” as used in cost estimation

Answer: Human resource refers to a person within a company's workforce who lends their skills and talents to the organization to help it succeed. It can also refer to the department responsible for managing all matters related to employees

Question 2. State the factors for human resources determination

Answer: Factors for human resource determination

- Variety of tasks
- Extent of work
- Duration of work
- Emergency work
- Working place

Question 3. Explain the classes of Labor according to their skills

Answer: Labour are classified into the following class

- **Skilled labour first class**: They have special skills training, knowledge and ability in their work. They are trained, educated and experienced segment of workforce that can complete more complex mental or physical tasks on the job. They are characterized by advanced education ex: Engineer
- **Skilled labour second class:** They are having or requiring less training than skilled labour and more than unskilled labour. Semi-skilled career requires some level of judgement, which exceeds the little no judgement required in unskilled jobs. Examples of them are tradesmen, technician
- **Unskilled labour:** They are employed for carrying out such jobs which don’t requires any specialized professional skills

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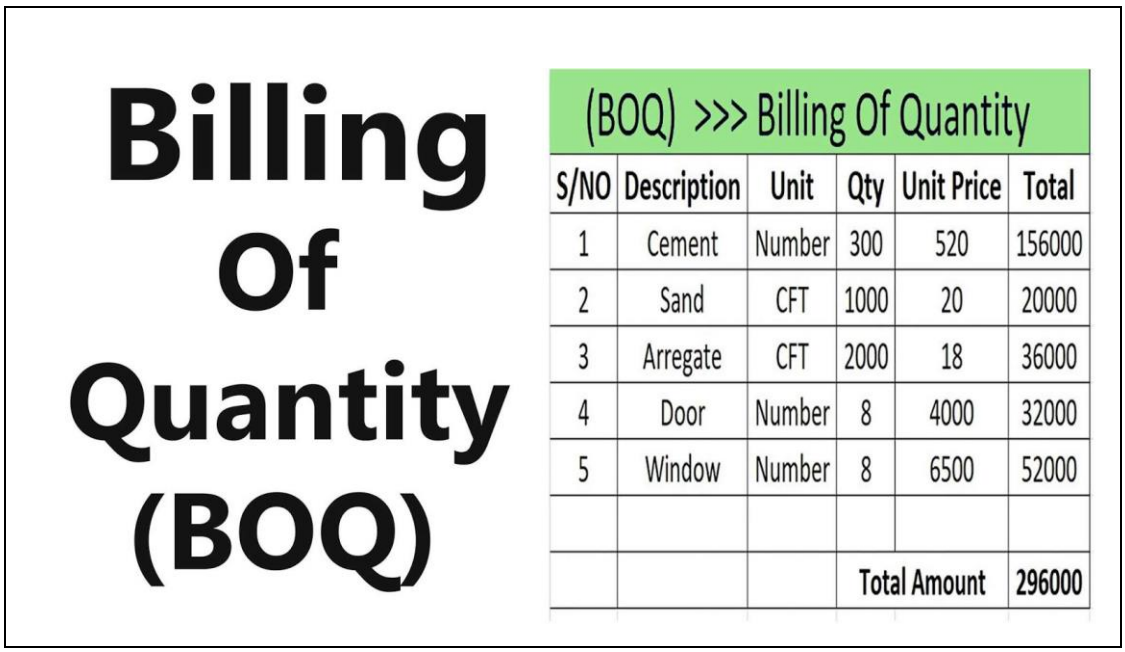
Learning Unit 3: Calculate the cost estimation



(BOQ) >>> Billing Of Quantity

S/NO	Description	Unit	Qty	Unit Price	Total
1	Cement	Number	300	520	156000
2	Sand	CFT	1000	20	20000
3	Arregate	CFT	2000	18	36000
4	Door	Number	8	4000	32000
5	Window	Number	8	6500	52000
			Total Amount		296000

STRUCTURE OF LEARNING UNIT

Learning outcomes:

3.1. Actualize the prices

3.2. Determine the units and total costs of materials

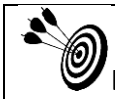
3.3. Perform calculation of charges and benefits

3.4. Fill in bill of Quantities

3.5. Prepare invoice

Learning outcome 3.1 Actualize the prices

Duration: 10 hrs



Learning outcome 3.1 objectives:

By the end of the learning outcome, the Trainees will be able to:

1. Determine the cost survey price as used in cost estimation
2. Determine the price survey methodology as used in cost estimation

Resources

Equipment	Tools	Materials
NA	Tape measure Pen Pencil	Paper Pro forma invoice Internet Drawing

Advance preparation:

- ✓ Trainer should have brought a sample of proforma invoice to show the students

Content 3.1.1: Cost Survey Prices

Before deciding any price for any item, it is recommended to perform survey on current prices on the market,

3.1.1.1. some of the surveys conducted are the following:

- ✓ Material survey prices
  - **Window shopping (comparison):** the activity of looking at goods displayed in shop windows, especially without intending to buy anything
  - **Proforma invoice** : proforma invoice is a preliminary bill or estimated invoice which is used to request payment from the committed buyer for goods or services before they are supplied. A proforma invoice includes a description of the goods, the total payable amount and other details about the transaction.
- ✓ Human resources survey price (Window shopping (comparison))
- ✓ Equipment survey price (Window shopping (comparison))

- ✓ Transport survey price (Window shopping (comparison))

Theoretical learning Activity

- ✓ Trainees are asked to brainstorm the definition of term “window shoping”

Practical learning Activity

- ✓ Individual window shopping to survey the price

Points to Remember (Take home message)

Cost Survey Prices:

- Materials survey prices
  - ✓ Window shopping (comparison)
  - ✓ Proforma invoice
- Human Resources survey prices (Window shopping (comparison))
- Equipment survey prices (Window shopping (comparison))
- Transport Survey prices (Window shopping (comparison))

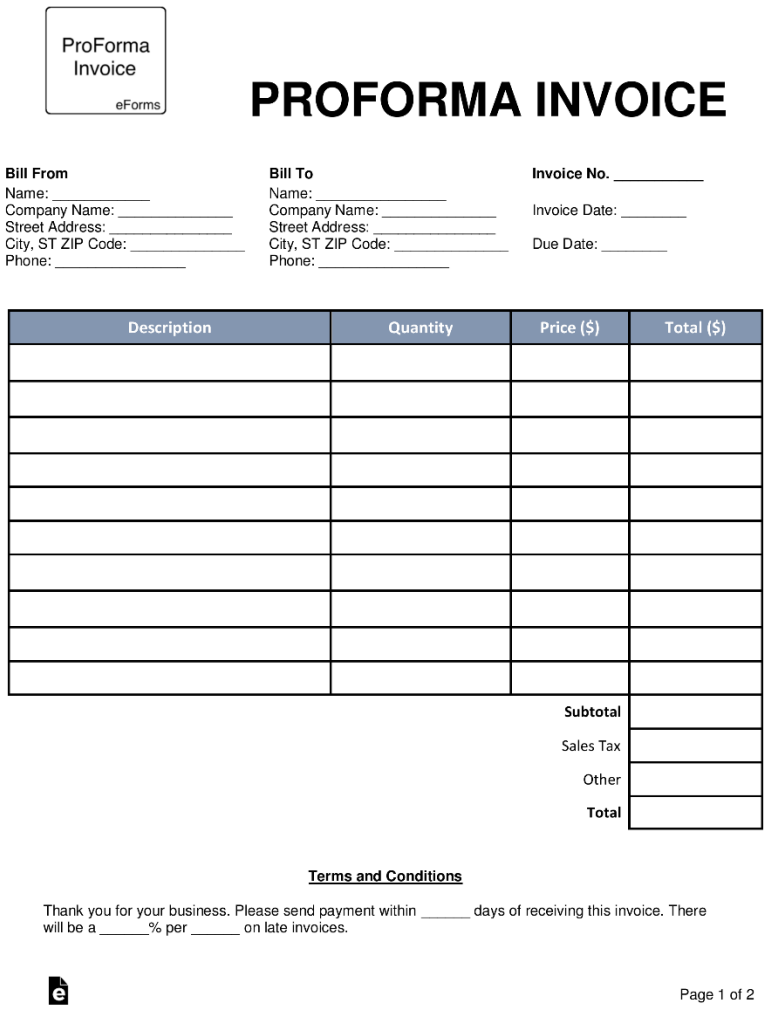
Content 3.1.2: Price survey methodology

A pricing survey is a research method used to determine optimal pricing for products or services. Pricing surveys ask questions directly to your target market to gain insights into how much they are willing to pay, what features have the highest impact on sales, the perceived value of your product/brand, etc.

The method used are:

- ✓ **Performa format**: The proforma invoice shows the customer how much to pay you once you deliver a product or perform a service

Figure: https://www.google.com/url?sa=i&url=https%3A%2F%2Feforms.com%2Finvoice-template%2Fproforma%2F&psig=AOvVaw1mKoeCaTKzoAFeqPxqcfPB&ust=1681909007223000&source=images&cd=vfe&ved=0CBEQjRxqFwoTCPiLxbm9s_4CFQAAAAAdAAAAABAE



ProForma Invoice

eForms

PROFORMA INVOICE

Bill From
Name: _____
Company Name: _____
Street Address: _____
City, ST ZIP Code: _____
Phone: _____

Bill To
Name: _____
Company Name: _____
Street Address: _____
City, ST ZIP Code: _____
Phone: _____

Invoice No. _____

Invoice Date: _____

Due Date: _____

Description	Quantity	Price ($)	Total ($)
		Subtotal	
		Sales Tax	
		Other	
		Total	

Terms and Conditions

Thank you for your business. Please send payment within _____ days of receiving this invoice. There will be a _____% per _____ on late invoices.

Page 1 of 2

- ✓ **Surveys templates**: it is a questionnaire developed to be answered by different individuals to know the information about product/service . the following is a sample of cost survey template

Figure:https://www.google.com/url?sa=i&url=https%3A%2F%2Fedit.org%2Fsurveys&psig=AOvVaw2wThpVriXEzJWOEVYHNWb8&ust=1681908818302000&source=images&cd=vfe&ved=0CBEQjRxqFwoTCKCGnOC8s_4CFQAAAAAdAAAAABAE

SURVEY TEMPLATE

Customize this survey template

Question 1. Type here your question. Which is your question?

Write your answer here.

Question 2. Type here your question. Which is your question?

Write your answer here.

Question 3. Type here your question. Which is your question?

Write your answer here.

Question 4. Type here your question. Which is your question?

Write your answer here.

PLEASE, RATE YOUR EXPERIENCE

1 **2** **3** **4** **5**

Edit and download this free printable online editable survey template.
Find more quizzes to edit in the graphic editor EDIT.org

YOUR LOGO

Theoretical learning Activity

- ✓ Trainees are asked to brainstorm about the use of proforma invoice and its format

Practical learning Activity

- ✓ Group work on developing a proforma invoice

Points to Remember (Take home message)

Price Survey methodology:

- Proforma format
- Survey templates

Learning outcome 1.1. formative assessment

Written assessment: Open ended questions, true or false question

Question 1. Define the term "window shopping" as used in price survey

Answer: window shopping is the activity of looking at goods displayed in shop windows, especially without intending to buy anything

Question 2. What is the role of proforma invoice?

Answer: Proforma invoices provide an estimate or quotation for goods or services before they are shipped or provided

Question 3. Before deciding any price for any items it is recommended to perform survey on current prices on the market, then list down some of the surveys that should be conducted

Answer:

1. Material survey prices

2. Human resources survey price
3. Equipment survey price
4. Transport survey price

Question 4. Answer by True or False the following statement."Price survey methodology are Performa format and Human resources survey price "

Answer: False

Practical assessment

Question 1. The price of door is 45,000 Rwf excluding VAT. If VAT is charged at 15%, find the price of the door inclusive VAT.

Answer:

- ✓ VAT = 15% of 45,000 Rwf = 6750Rwf
- ✓ Total price of door: 45,000Rwf + 6,750Rwf= 51,750Rwf

Question 2. NYANZA TSS want to construct a simple storing house in NYANZA District. The following are same rates for construction.

Elements of the house

No	Elements	Rates(rwf)	Net pricing
1	Drainage	3256	**488.4**
2	Gardening	1151	**172.65**
3	Provisional sum	1560	**234**
4	Roofing	1577	**236.55**
5	Sub-structure	4505	**675.75**
6	Super-structure	4574	**686.1.**

Answer: If 15% is to be added to cover profit and overhead cost calculate the tender price using

a) Net pricing is 488.4+172.65+234+236.55+675.75+686.1=2493.4510

b) Gross pricing. (3256+1151+1560+1577+4505+ 4574) *15%=2493.45

Learning outcome 3.2 Determine the units and total costs of materials

Duration: 10 hrs

Learning outcome 3.2 objectives:

By the end of the learning outcome, the Trainees will be able to:

1. Determine the Cost per unit measures as Per Cubic meter or square meter
2. Determine the total cost with respect to the formula

Resources

Equipment	Tools	Materials
NA	Tape measure Pen Pencil	Paper

Advance preparation:

. trainer should have done research about current prices of products and works

Content 3.2.1: Determination of units and total prices of each item

Definition of estimate and its different types

- **An estimate** is an approximate calculation of the cost of works to be done. For all engineering work, it is required to know beforehand the probable cost of construction work known as" **Estimated cost**". If the estimated cost is greater than the money available, then attempts are made to reduce the cost by reducing the work or by changing the specifications.

In preparing an estimate, the quantities of different items of work are calculated by simple measurement methods and from these quantities the cost is calculated.

- **Estimating** is the technique of calculating or computing the various quantities and the expected expenditure to be incurred on a particular work or project.

The following requirements are necessary for preparing an estimate.

a) Drawings like plan, elevation and sections of important points.
b) Detailed specifications about workmanship & properties of materials etc.
c) Standard schedule of rates of the current year.

1. **Need for estimation and Costing**
   - ✓ Estimate gives an idea of the cost of the work and hence its feasibility can be determined i.e whether the project could be taken up within the funds available or not.
   - ✓ Estimate gives an idea of time required for the completion of the work.
   - ✓ Estimate is required to invite the tenders and Quotations and to arrange contract.
   - ✓ estimate is also required to control the expenditure during the execution of work
   - ✓ Estimate decides whether the proposed plan matches the funds available or not.

Estimating involves the following operations:

- Preparing detailed Estimate.
- Calculating the rate of each unit of work

Preparing abstract of estimate

2. **Data required in preparation of an estimate**

a) Drawings (plans, elevations, sections etc): If the drawings are not clear and without complete dimensions the preparation of estimation become very difficult .So, it is very essential before preparing an estimate.

b) Specifications:
- ✓ General Specifications: This gives the nature, quality ,class ,work and materials in general terms to be used in various parts of wok. It helps to form a general idea of building.
- ✓ Detailed Specifications: These gives the detailed description of the various items of work laying down the Quantities and qualities of materials ,their proportions, the method of preparation workmanship and execution of work.

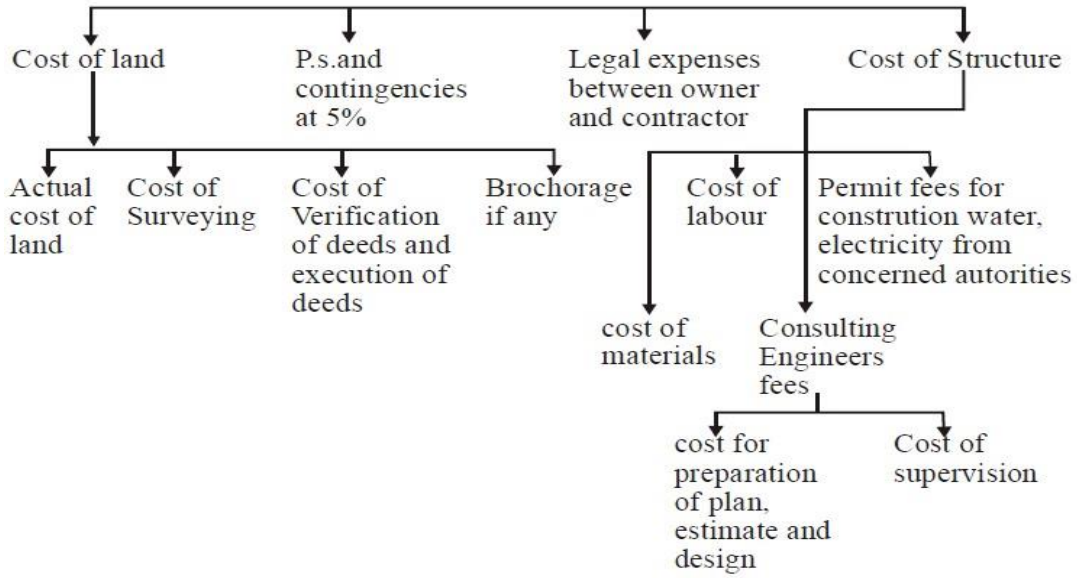
c) Rates: For preparing the estimate the unit rates of each item of work are required:

1. for arriving at the unit rates of each item.
2. The rates of various materials to be used in the construction.
3. The cost of transport materials.
4. The wages of labour, skilled or unskilled of masons , carpenters , etc.

3. **Complete estimate**

Most of people think that the estimate of a structure includes cost of land ;cost of materials and

Labour ,but many other direct and indirect costs included and are shown below



The complete estimate of a projector building structure should include all items of expenditure from the beginning up to the end.

4. **LUMPSUM:**

While preparing an estimate,it is not possible to work out in detail in case of petty items. Items other than civil engineering such items are called lump sum items or simply L.S. Items.

The following are some of L.S. Items in the estimate.

- Water supply and sanitary arrangements.
- Electrical installations like meter, motor, etc.,

- Architectural features.
- Contingencies and unforeseen items.

In general, certain percentage on the cost of estimation is allotted for the above L.S. Items Even if sub estimates prepared or at the end of execution of work, the actual cost should not exceed the L.S. amounts provided in the main estimate.
Contingencies indicates incidental expenses of miscellaneous character which cannot be classified under any distinct item sub-head, yet pertain to work as whole. Provision for contingencies 3%to 5% of estimated cost, is made in the estimate to cover the miscellaneous petty expenditures which do not come under any item of work

5. **WORKCHARGED ESTABLISHMENT**

During the construction of a project considerable number of skilled supervisors, work assistance, watchmen etc, are employed on temporary basis. The salaries of these persons are drawn from the L.S. amount allotted towards the work charged establishment.

That is, establishment which is charged directly to work. A L.S. amount of 1½ to 2% of the estimated cost is provided towards the work charged establishment.

Meaning of technical words

- ✓ **Profit:** Amount of money which can be gotten after work completion and payment of labour.
- ✓ **Overhead:** Amount of money given on site so that the work continue more quickly
- ✓ **Contingency:** Amount of money used on the site like money of telephone
  - ✓ **Bid cost** (estimated cost):the cost obtained by adding on the cost; Profit, overhead, and contingency.
- ✓ **Approximate cost:** the cost of a project which you need before works begin.
- ✓ **Actual cost:** the cost of a project used for completing all construction works.

Types of estimate

Before undertaking the construction of a project it is necessary to know the probable cost which is work out by estimating. The primary object of the estimate is to enable

one to know beforehand, the cost of the work .The estimate is the probable cost of a work and is determined theoretically by mathematical calculations based on the plans, drawings and current rates. Approximate estimate may be calculated by various methods but accurate estimate is prepared by detailed estimate method.

Normally, there are two types of estimate:

- Detailed estimate and
- Approximate estimate.

1. Approximate estimate/rough cost estimate/Preliminary estimate

Preliminary or approximate estimate is required for studies of various aspects of work of project and for its administrative approval. It can decide, in case of commercial projects, whether the net income earned justifies the amount invested or not. The approximate estimate is prepared from the practical knowledge and cost of similar works .The estimate is accompanied by a report explaining necessity and utility of the project and with a site or layout plan. A percentage of 5 to 10% is allowed for contingencies.

The following are the methods used for preparation of approximate estimates.

a) Plinth area method
b) Cubical Contents methods

a. Plinth area method

Plinth area is the built up covered area of a building measured at floor level of any storey. The plinth area is calculated by taking the external dimensions of a building at the floor level excluding plinth offsets if any. Court-yard, open areas, balconies and cantilever projections are not included in the plinth area .Supported porches(other than cantilever)are Included in the plinth area .The cost of construction is determined by multiplying plinth area with plinth area rate .The area is obtained by multiplying length and breadth(outer dimensions of building).In Fixing the plinth area rate ,careful observation and necessary enquiries are made in respect of quality and quantity aspect of materials and labour ,type of foundation ,height of building ,roof, wood work, fixtures, number of stories etc.,

The following areas include while calculating the plinth area of building:

- Area of walls at floor level.
- Internal shafts of sanitary installations not exceeding2.0m2, lifts, air-conditioning ducts etc.,
- Area of barsati at terrace level: Barsati means any covered space open on one side constructed on one side on terraced roof which is used as shelter during rainy season.
- Porches of non-cantilever type.

Areas which are not to include:

- Area of lofts.
- Un enclosed balconies.
- Architectural bands, cornices etc.,
- Domes, towers projecting above terrace level.
- Box louvers and vertical sun breakers.

Examples:

Example1: Prepare an approximate estimate of building project with total plinth area of all building is 800 sqm, and from following data:

1. Plinth area rate Rwf. 45000 per sqm.
2. Cost of watersupply@7½%of cost of building.
3. Cost of Sanitary and Electrical installations each @ 7½%ofcost of building.
4. Cost of architectural features @1%of building cost.
5. Cost of roads and lawns @5%of building cost.
6. Cost of Petty Supervision (P.S) and contingencies @4%of building cost. Determine the total cost of building project.

ANSWER

Given data

Plinth area= 800 m2

Plinth area rate= Rwf 45,000 per sqm

- ✓ Cost of building= 800*4500=**Rwf 36,000,000**
- ✓ Add the cost of the water supply charges @ 7.5%= $\frac{36,000,0000*7.5}{100} = \mathbf{2,700,000}$
- ✓ Add the cost of sanitary and electrical installation @ 15%=$\frac{36,000,000*15}{100}$=**5,400,000**

- ✓ Add the cost of architectural features @ 1%= $\frac{36,0000,000*1}{100} = \mathbf{360,000}$
- ✓ Add the cost of roads lawns @ $= \frac{36,000,000*5}{100} = \mathbf{1,800,000}$
- ✓ Add the cost of P.S and contingencies @ 4%= $\frac{36,0000,000*4}{100}$=**1,440,000**

Total cost of the project
=36,000,000+2,700,000+5,400,000+360,000+1,800,000+1,440,000 =**47,700,000 Frw**

Example2: The plinth area of an apartment is 500sqm.Determine the total cost of building from the following data:

- Rate of construction =Rwf. 24,600/per m^3.
- The height of apartment = 16.25 m
- Water Supply, Sanitary and Electrical installations each at 6%of building cost.
- Architectural appearance@ 1%ofbuildingcost.
- Unforeseen item @2%of Building cost.
- P.S. and contingencies@4%of building.

Solution:

- ✓ The cost of build=cubic Content*cubic rate=500*16.25*24,600=202950000
- ✓ Provision for water supply, sanitary and Electrical installation water supply and sanitation each @6%= $\frac{202,950,000*18}{100}$ =36,531,000
  i.e. total percent=3*6=18%
- ✓ Architectural appearance@1%= $\frac{202,950,000*1}{100}$ =2,029,500
- ✓ Unforeseen item@2%=$\frac{202,950,000*2}{100}$=4,059,000
- ✓ P.S. and contingencies@4%=$\frac{202,950,000*4}{100} = 8,118,000$

Total cost =36,531,000+2,029,500+4,059,000+8,118,000=253,687,500

Example3: The plinth area and plinth area rate of a residential building are 100 sqm and 500,000/sqm respectively. Determine the total cost of building assuming suitable provisions.

Solution:

- ✓ Cost of building = 100x500,000 = 50,000,000
- ✓ Cost of water supply and sanitary fitting @ 15%= $\frac{50,000,000*15}{100}$ = 7,500,000
- ✓ Cost of Electrification @ 71/2 % = $\frac{50,000,000*7.5}{100}$ = 3,750,000
- ✓ Cost of loads & Lawns @ 5% = $\frac{50,000,000*5}{100}$ =2,500,000
- ✓ Cost of P.S & Contingencies @ 4% = $\frac{50,000,000*4}{100}$ = 2,000,000

Total cost = 50,000,000 + 7,500,000 + 3,750,000 + 2,500,000 + 2,000,000
=**65,750,000**

Example 4: Prepare an approximate estimate of a proposed building from the following:

- ✓ Plinth area of the building = 226 sqm
- ✓ Cost of the structure = Rwf. 25,000 per sqm
- ✓ Water supply and sanitary arrangement = 12 ½ %
- ✓ Electrification = 7%
- ✓ Fluctuation of rates = 5%
- ✓ Petty supervision charges 3%

Sol:

- ✓ Cost of the structure = 226 x 25,000 = 5,650,000
- ✓ Water supply and sanitary arrangement @12 ½ % = $\frac{5,650,000*12.5}{100}$ = 706,250
- ✓ Electrification @7% = $\frac{5,650,000*7}{100}$ = 395,500
- ✓ Fluctuation of rates @5% =$\frac{5,650,000*5}{100}$ = 282,500
- ✓ Petty supervision charges @3% =$\frac{5,650,000*3}{100}$ = 169,500

Total cost of the proposed building = 5,650,000 +706,250 +395,000 +282,500 + 169,500 =7,203,750 Rwf

b. Cubical Content method

This method is generally used for multi storied buildings. It is more accurate than the other two methods like plinth area method and unit base method. The cost of a structure is calculated approximately as the total cubical Contents (Volume of buildings) multiplied by Local Cubic Rate. The volume of building is obtained by Length x breadth x depth or height. The length and breadth are measured out of walls excluding the plinth offset.

The cost of building= volume of buildings x rate/ unit volume.

Examples: prepare the rough estimate for a proposed commercial complex for a municipal corporation for the following data.

Plinth Area=500m^2 /floor
Height of each storey=3.5m
No. of storeys=G+2
Cubical Content rate=167,234/m^3
Provided for a following as percentage of structure cost
A) Water supply &sanitary arrangement-8%
B) Electrifucation-6%
C) Fluctuation of rate-5%

D) Contractors profit-10%
E) Petty supervision & contingencies-3%

Solution :
Cubical Content = no. Of storeys (PLINTH AREA * HEIGHT OF EACH STOREY) = 3(500*3.5)=5250 M^3
Structural cost = cubical Content * cubical Content cost = 5250*167,234=877,978,500
Other provisions:

- water supply and sanitation = 877,978,500*8/100=70,238,280
- electrification = 877,978,500*6/100=52678,710
- fluctuation of rates= 877,978,500*5/100=43,898,925
- P.S./& contingencies=877,978,500*3/100=26,339,355
- contractors profit = 877,978,500*10/100=87,797,850

Total cost = **1,158,931,620 frw**

c. Unit base method

According to this method the cost of structure is determined by multiplying the total number of units with unit rate of each item .In case of schools and colleges ,the unit is considered to be as 'one student' and in case of hospital ,the unit is' one bed' .The unit rate is calculated by dividing the actual expenditure incurred or cost of similar building in the nearby locality by the number of units .

Examples :
Example 1. Prepare an approximate estimate or rough cost estimate of a hostpiatal building for 50 beds. The cost of construction altogether for each bed is rwf. 50,648,230. Determine the total cost of hospital building
Solution
No.of beds=50
Cost of construction=50,648,230*50=2,824,115,000frw
Total cost of building : 2,824,115,000frw

Example 2. To prepare the rough cost estimate of a hostel building that accommodates 150 students. The cost of construction including all provisional is 1,500,000/per student Determine the total cost of building
Solution :
No .of student=150
Cost of construction all lumpsum provisions=1,500,000
Total cost of hostel building = 150*1,500,000=225,000,000frw

2. DETAILED ESTIMATE

The preparation of detailed estimate consists of working out quantities of various items of work and then determines the cost of each item. This is prepared in two stages:

a) Details of measurements and calculation of quantities

The complete work is divided into various items of work such as earthwork concreting, brick work ,R.C.C. Plastering etc ,The details of measurements are taken from drawings and entered in respective columns of prescribed preformat .The quantities are calculated by multiplying the values that are in numbers column to Depth column as shown below:

Details of measurements form

S.No	Description of Item	No	Length (L) m	Breadth (B) m	Depth/ Height (D/H)m	Quantity	Explanatory Notes

b) Abstract of Estimated Cost

The cost of each item of work is worked out from the quantities that already computed in the details measurement format workable rate. But the total cost is worked out in the prescribed form is known as **abstract of estimated form**.

ABSTRACT OF ESTIMATED FORM

Item No.	Description of item	Quantity	Unit	Rate	Amount

Rate analysis

In order to determine the rate of a particular item, the factors affecting the rate of that item are studied carefully and then finally a rate is decided for that item. This process of determining the rates of an item is termed as analysis of rates or rate analysis.

The rates of particular item of work depend on the following:

- Specifications of works and material about their quality, proportion and constructional Operation method.
- Quantity of materials and their rates

- Number and Cost of labours;
- Location of site of work and the distances from source and conveyance Charges.
- Overhead and establishment charges
- Profit

Overhead costs: Overhead costs include general office expenses, rents, taxes, supervision and other costs which are indirect expenses and not productive expenses on the job.

The miscellaneous expenses on overheads may be under the following heads:

A) General overheads-

- Establishment (office staff),
- Stationary, printing, postages, etc…
- Travelling expenses, Telephone
- Rent and taxes

B) Job Overheads-

- Supervision (salary of engineers, supervision…)
- Handling of materials,
- Repairs,
- Amenities of labours
- Workman's compensation, insurance, etc…
- Interest on investment

The contactor may be allowed a net profit of 6 to 8%, and the miscellaneous overhead expenses may come to about 5 to 10%. For overhead expenses and contractor's profit 15% of the actual cost may be reasonable amount but it is usually practice to add 10% for all these under the head profit. For small works overhead cost may be very little .A provision for water charges @1.5% of the total cost is made in the rate.4% of estimated Cost is allowed for Petty Supervision, contingencies and Unforeseen items .A percentage of 1.5% to 2% is also added to meet the expenditure of work charged establishment .The grand total thus obtained is **estimated cost** of the work.

The detailed estimate should be accompanied with:

- Report,
- specification,
- Drawings (plans, elevations, sections),
- designs charts and calculations,
- Standards schedules of rates.

Factors to be considered During Preparation of Detailed Estimate

- **Quantity and transportation of materials: For** bigger project, the requirement of materials is more .Such bulk volume of materials will be purchased and transported definitely at cheaper rate.
- **Location of site*:*** The site of work is selected, such that it should reduce damage or in transit during loading, unloading, stocking of materials.
- **Local labour charges:** The skills, suitability and wages of local labours are considered while preparing the detailed estimate.

Units of dimensions for materials and works and mode of measurement for different items of works and materials

To find out the quantities of any items in construction it is recommended to have the international unit to express that quantity, and then deduce the cost per unit of measurements

- Per cubic meter
- Per linear meter
- Per square meter
- Per unit of mass
- Per pieces
- Lump sum

Total cost

The total cost is usually equal to unit price x quantity of each item

Example: Calculate the cost of brickwork having 4.5cu.m and plastering having 25m^2 if the rate of brickwork is Rs.320per $m^3$and of plastering is Rs.8.50 per m^2.

Answer:

Cost of brickwork: 4.5 m^3 x320 Rs/ m^3 =Rs.1440

Cost of plastering: 25 m^2x8.50 Rs /m^2=Rs.212.5

Total cost =Rs.1440.0 +Rs.212.5=Rs.1652.5

Theoretical learning Activity

- ✓ Trainees are asked to brainstorm the types of estimates
- ✓ Trainees are asked to brainstorm the requirements which are necessary for preparing an estimate.

Practical learning Activity

- ✓ Group works in making approximate estimate

Points to Remember (Take home message)

Determination of units and total prices of each item:

1. Cost per unit measures
   - Per Cubic meter
   - Per square meter
   - Per linear meter
   - Per unit of mass
   - Per pieces
   - Lump sum
2. Total cost
   - Unit price x quantity of each item

Learning outcome 3.2. formative assessment

Written assessment: Open ended questions

Question 1. describe the Data required in preparation of an estimate

Answer: Data required in preparation of an estimate:

- ✓ Drawings (plans, elevations, sections etc.): If the drawings are not clear and without complete dimensions the preparation of estimation, become very difficult. So, it is very essential before preparing an estimate.

- ✓ Specifications:
  a) General Specifications: This gives the nature, quality, class, work, and materials in general terms to be used in various parts of wok. It helps no form a general idea of building.
  b) Detailed Specifications: These gives the detailed description of the various items of work laying down the Quantities and qualities of materials, their proportions, the method of preparation workmanship and execution of work

- ✓ Rates: For preparing the estimate, the unit rates of each item of work are required for arriving at the unit rates of each item, The rates of various materials to be used in the construction, The cost of transport materials and The wages of labour, skilled or unskilled of masons, carpenters

Question 2. Define following terms

a. Profit
b. Overhead
c. Bid cost
d. d. Approximate cost
e. Actual cost

Answer:

a. **Profit:** Amount of money which can be gotten after work completion and payment of labour.
b. **Overhead:** Amount of money given on site so that the work continues more quickly
c. **Bid cost** (estimated cost): the cost obtained by adding on the cost Profit, overhead, and contingency.
d. **Approximate cost:** the cost of a project which you need before works begin.
e. **Actual cost:** the cost of a project used for completing all construction works.

Practical assessment

Question 1. Prepare the rough estimate for a proposed commercial complex for a municipal corporation for the following data.

Plinth area **400 sqm/floor**

Height of each storey=**3.3m**

No.of Stories=**G+1**

Cubical Content rate=**155,234 Rwf/m^3**

Provided for a following as a percentage of structured cost.

a) Water supply and sanitary arrangement **8%.**
b) Electrification **6%.**
c) Fluctuation of rates **5%.**
d) Contractors profit **10%.**
e) Petty supervision & contingencies **3%.**

Answer:

Given Data.

Plinth area **400 sqm/floor**

Height of each storey=**3.3m**

No.of Stories=**G+1**

Cubical Content rate=**155,450 Rwf/m^3**

Volume=400m^2*3.3m=**1320m^3**

Cost of building=Plinth area*Plinth area rate*Number of floors

400*3.3*155,450*2=**410,388,000 Rwf**.

Water supply and sanitary arrangement=$= \frac{410,388,000*8}{100} = \mathbf{32,831,040\ Rwf}$

Electrification = $= \frac{410,388,000*6}{100} = \mathbf{24,623,280 Rwf}$

Fluctuation of rates $= \frac{410,388,000*5}{100} = \mathbf{20,519,400 Rwf}$

Contractors profit $= \frac{410,388,000*10}{100} = \mathbf{41,038,800\ Rwf}$

Petty supervision & contingencies $= \frac{410,388,000*3}{100} = \mathbf{12,311,640\ Rwf}$

Total Cost=410,388,000+ 328310400+ 24623280+20519400 +

41038800+ 12311640 =**837,191,520 Rwf.**

Learning outcome 3.3 Perform calculation of charges and benefits

Duration: 10 hrs

Learning outcome 3.3 objectives:

By the end of the learning outcome, the Trainees will be able to:

1. Calculate the charges and benefits/Price unit breakdown according the data available
2. calculate the grand total cost according the data available

Resources		
Equipment	**Tools**	**Materials**
Computer Projector	Tape measure Pen Pencil Calculator	Paper

Advance preparation:

- ✓ Trainer should have searched the current rates of products and works

Content 3.3.1: Calculation of charges and benefits/Price unit breakdown

To establish the grand total for any project you must first calculate the total cost and associate to its other cost that will not be classified among material cost and some of these costs are:

- ✓ Labour cost
- ✓ Maintenance cost
- ✓ Taxes
- ✓ Equipment
- ✓ Benefits
- ✓ Transport
- ✓ Other unforeseen charges

Hence the grand total cost of the project is the sum of these listed above items plus the total cost of materials

Example: Calculate the grand total cost of the following work given in the table below

Abstract of estimated cost

Items No	Description	quantity	unit	Rate Rs.	Amount Rs.
1	Earth work in excavation in foundation	4.32	Cu.m	350.0	1512.0
2	Lime concrete in foundation	1.44	Cu.m	220.0	316.80
3	1st class brickwork in lime mortar in	3.24	Cu.m	300.0	972.0
4	2.5cmdampproofcoursec.c1:1 1/2:3	2.4	Sq.m	20.0	48.0
5	First class brickwork in lime mortar for Superstructure	6.3	Cu.m	320.0	2016.0
6	12mm plaster of cement sand 1:6	46.0	Sq.m	8.50	392.70
7	Whitewashing 3 coats(inside)	21.0	Sq.m	0.75	15.75
8	Colour washing 2 coats over one coat Of whitewashing	24.6	Sq.m	0.82	20.17
Total cost=					Rs 5293.42
Add for contingencies 3% of total cost=					Rs 158.80
Add for work charged establishment 2% of total cost=					Rs 105.86
Add for labour cost 30% of total cost=					Rs 1588.02
Add for benefits and taxes 10% of total cost=					Rs 529.34
Add for Equipment and transport 5% of total cost =					Rs 264.67
Grand total=					**Rs 86547.1**

Theoretical learning Activity

- ✓ Trainees are asked to brainstorm the definition of term “profit”

Practical learning Activity

NA

Points to Remember (Take home message)

1. **Calculation of charges and benefits/Price unit breakdown:**
   - The Labor Cost
   - Material cost
   - Maintenance cost
   - Taxes
   - Equipment
   - Benefits
   - Transport
   - Other Charges

Content 3.3.2: Layout of bills of quantity

Bill of quantities

In order to represent clear how you find out the cost of each items it is necessary to represent it in table form and that table is known as bill of quantities or simple **(B O Q**).

A bill of quantity is a document which quantifies in details the scope of construction project using a standard method of measurement and is typically used in the tender process for pricing and analysis purpose

Layout of bills of quantity

This is simple form of bill of quantity

S/N	Description of items	No	Length	Breadth	Height	Quantity (LXBXH)	Rate/unit	Total cost	Explanatory notes

Theoretical learning Activity

- ✓ Trainees are asked to brainstorm the definition of bills of quantity
- ✓ Trainees are asked to brainstorm the elements of a bill of quantity

Practical learning Activity

NA

Points to Remember (Take home message)

Layout of bills of quantity

S/N	Description of items	No	Length	Breadth	Height	Quantity (LXBXH)	Rate/unit	Total cost	Exp no

Learning outcome 3.3. formative assessment

Written assessment: Open ended questions

Question 1. What do you understand the bill of quantity?

Answer: A bill of quantity is a document which quantifies in details the scope of construction project using a standard method of measurement and is typically used in the tender process for pricing and analysis purpose

Question2. Draw the form of :
a) Details of measurements and calculation of quantities(bill of quantities**)**
b) Abstract of Estimated Cost **(** priced bill of quantities**)**

Answer:

a) Layout of bills of quantity

S/N	Description of items	No	Length	Breadth	Height	Quantity (LXBXH)	Rate/unit	Explanatory notes

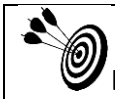
b) Abstract estimated cost

Items No	Description of items	quantity	unit	Rate Rs.	Amount Rs.

Draw a detailed estimated and label its elements

Learning outcome 3.4 Fill in bill of Quantities

Duration: 10 hrs



Learning outcome 3.4 objectives:

By the end of the learning outcome, the Trainees will be able to:

1. know the Types of Bill of quantities as used in cost estimation

2. state the elements of a Bill of quantities as used in cost estimation

Resources

Equipment	Tools	Materials
NA	**Tape measure** **Pen** **Pencil**	**Paper**

Advance preparation:

- ✓ Sample of bill of quantity should be prepared

Content 3.4.1: Types of Bill of quantities and its Content

Types of bills of quantities

- ✓ Firm bill of quantities: used to obtain lump sum price of a project
- ✓ Approximate bill of quantities: contain provisional quantities
- ✓ Specified bill of quantities: contain items and its specification

Bill of quantity Contents

- ✓ Item number
- ✓ Item description
- ✓ Unit of measures on each item
- ✓ Quantity of each item
- ✓ Rate per unit
- ✓ Total cost (Amount)
- ✓ Observation (explanatory notes)

Main purpose of bills of quantity

- Enable all contractors tendering for contract to price on exactly the same information with minimum effort.
- Allow for better comparison
- Ordering of materials
- Cost analysis for use in future
- Reference particularly on site during construction
- Planning and progressing by the contractors' site planer.
- Final accounting
  - Quality by reference to the technical specifications

Layout of bills of quantity

This is simple form of bill of quantity

S/N	Description of items	No	Length	Breadth	Height	Quantity (LXBXH)	Rate/unit	Total cost	Explanatory notes

Theoretical learning Activity

- ✓ Trainees are asked to brainstorm the types of bills of quantity
- ✓ Trainees are asked to brainstorm the elements of a bill of quantity

Practical learning Activity

- ✓ Presentation of the elements of a bill of quantity

Points to Remember (Take home message)

Types of bills of quantities

- ✓ Firm bill of quantities: used to obtain lump sum price of a project
- ✓ Approximate bill of quantities: contain provisional quantities
- ✓ Specified bill of quantities: contain items and its specification

Bill of quantity Contents

- ✓ Item number
- ✓ Item description
- ✓ Unit of measures on each item
- ✓ Quantity of each item
- ✓ Rate per unit
- ✓ Total cost (Amount)
- ✓ Observation (explanatory notes)

Learning outcome 3.4. formative assessment

Written assessment: Open ended questions

Question 1. List out Six (6) Bill of quantity Contents?

Answer:

- Item number
- Item description
- Unit of measures on each item
- Quantity of each item
- Rate per unit
- Total cost (Amount)
- Observation(explanatory notes)

Question 2. Respond by True or False the following statement "One of the main purposes of bill of quantity is a Reference particularly on site during construction."

Answer: TRUE

Practical assessment

Question 1. Read carefully the following bill of quantity and Replace letters in parentheses from (a) to (t) by their corresponding values or words.

Item N°	Description of items	Quantity	unit	Unit price in Rwf/unit	Total amount in Rwf
1	Earthwork in excavation in foundation	11.42	m^3	2,000	**….(a)….**
2	Earthwork in filling	42.15	**(b)..**	2740.21352	115,500
3	Cement concrete in Foundation	**…(c)…**	m^3	80,000	717,200
4	Stone masonry in foundation and plinth	21.42	..(d)..	50,000	642,600
5	12 mm sand plastering (1:6)	21.56	**(e)..**	1,500.00	32,340
6	2.5 cm damp proof Course	8.18	m^2	**..(f)..**	14,688
7	Single metal door (90*240)	2	**..(g).**	100,000	200,000
8	First class brickwork 1:6	31.85	m^3	60,000	**..(h)..**

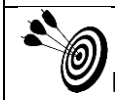
Answer

a) 22,840
b) m^3
c) 8.965
d) m^3
e) m^2
f) 1,795.599

g) Number
h) 1,911,000

Learning outcome 3.5. Prepare invoice

 **Duration: 10 hrs**

 Learning outcome 3.5 objectives:

By the end of the learning outcome, the Trainees will be able to:

1. know the elements of an invoice as used in purchasing goods and services

2. prepare an invoice containing all information as used in purchasing goods and services

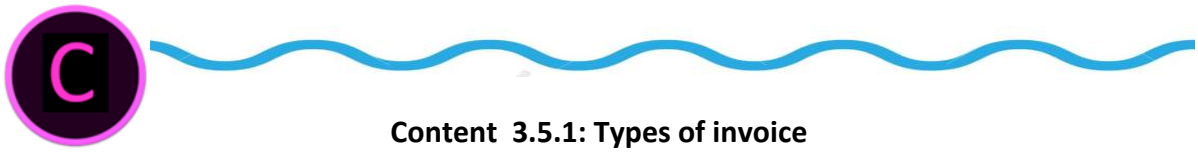
 **Resources**

Equipment	Tools	Materials
NA	Tape measure Pen Pencil Proforma invoice Interim invoice Recurring /Service invoice Past due invoice Final Invoice Advance invoice Miscellaneous invoice	Paper

 **Advance preparation:**

Different types of invoice have to be prepared such as:

- ✓ Proforma invoice
- ✓ Interim invoice
- ✓ Recurring /Service invoice
- ✓ Past due invoice
- ✓ Final Invoice
- ✓ Advance invoice
- ✓ Miscellaneous invoice



Content 3.5.1: Types of invoice

Types of invoices

There are many different types of invoices you can send to customers. Each type of invoice has a specific purpose. The following are six types of invoices in accounting that you might send to customers.

1.Performa invoice

A pro forma invoice is not a demand for payment. You can think of this document like a preinvoice. You send a pro forma invoice before completing work for a customer.

The pro forma invoice shows the customer how much to pay you once you deliver a product or perform a service. You can also use a pro forma invoice to show the value of items you give away, such as a gift.

Usually, a pro forma invoice estimates the work you will do and how much items will cost. The pro forma invoice represents a commitment to provide something. The terms in a pro forma invoice can change as the project proceeds.

2. Interim invoice

An interim invoice breaks down the value of a large project into multiple payments. You send interim invoices as you complete the large project.

The larger the project, the more you spend on labour, materials, and other operating costs. Interim invoices help you manage your small business cash flow for large jobs. You don't have to wait until the end of the project to receive payments. Instead, you can use money from interim invoices to cover some of the costs.

3. Final invoice

As the name implies, you send a final invoice after you complete a project. The final invoice lets the customer know the work is done. Unlike a pro forma invoice, the final invoice is a demand for payment.

Your final invoice should include an itemized list of the products and services you provided. You should also note the total cost, due date, and payment methods.

Be sure to send final invoices immediately via mail or online after completing work. That way, you can keep cash flowing into your business at a healthy rate and avoid collections problems.

4. Past due invoice

Sometimes, your customers don't pay you by the due date on the final invoice. When this occurs, you need to send a past due invoice. Send past due invoices immediately after an invoice becomes late.

A past due invoice reminds customers that their payment due dates have passed. Include all the information from the final invoice on the past due invoice. Also, include any late fees or interest penalizing the customer for paying late.

If past due invoices don't work, you might have to take a different approach for customers who won't pay. Consider changing your payment terms, setting up a payment plan, or hiring a collections agency.

5. Recurring invoice

Use recurring invoices to bill customers for on-going services. You charge the same amount periodically, similar to some utility bills.

Using a recurring invoicing system works well for subscription-based businesses. And, you could use recurring invoices if your customers have memberships to your company. For example, if you own a gym and members pay a monthly fee, recurring invoices might be the best billing option.

6. Credit memo

Instead of charging a customer, you use a credit memo to acknowledge that you owe them money. The credit memo will be equal to or less than the amount of the customer's original invoice.

You might send a credit memo because your customer returned goods, products you sent were damaged, or you sent the wrong item. With a credit memo, you can refund the amount the customer originally paid or offer credit to your customer on a future purchase.

7.miscellaneous invoice: A miscellaneous invoice is an invoice created by the supplier for items other than time sheets or expense sheets

8. advance invoice: An advance invoice is one that is sent to the customer or client prior to the work commencing. The company can outline clear terms for payment, and thus glean a better understanding of when they will receive the revenue from the job

Theoretical learning Activity

- ✓ Trainees are asked to brainstorm the types of invoice

Practical learning Activity

- ✓ Preparation of different types of invoices in groups

Points to Remember (Take home message)

Types of invoice:

- Proforma invoice
- Interim invoice
- Recurring /Service invoice
- Past due invoice
- Final Invoice
- Advance invoice
- Miscellaneous invoice

Content 3.5.2: Elements of invoice:

Elements of an invoice

- ✓ Standout Header
- ✓ Invoice number
- ✓ Company's information
- ✓ Date
- ✓ Goods or service sold
  - Item name or title of service
  - Price of the item/service
  - Amount or quantity of product or service

- ✓ Fees
- ✓ Total amount due
- ✓ Terms of transaction
- ✓ A unique message
- ✓ Due date

Creating an invoice will all elements

Each type of invoice has its own unique purpose. But, usually, invoices contain the same key information. Make sure your invoices include the following items:

Date of the invoice: Let customers know which day you created the invoice.

Customer contact information: Customers want to be sure the invoice is intended for them. State the customer's name, business, address, and phone number.

Your business's information: Customers need to be able to reach you. Include your name, business, address, email address, and phone number on the invoice.

Items purchased: Create an itemized list of each product and service you provided. Next to each item, write the individual cost.

Total amount due: State the total payment amount you expect to receive from the customer.

Payment terms: Note the date you expect to be paid by. Also, detail how you want the customer to pay you. For example, do you accept checks, credit cards, or cash? Is there a specific address where customers should send payments? Clear invoice payment terms make it easy for customers to pay.

Invoice number: Number each invoice for your records. Make a note of the invoice number so that you can match it to payments in the future.

Theoretical learning Activity

- ✓ Trainees are asked to brainstorm the elements of invoice

Practical learning Activity

NA

Points to Remember (Take home message)

Elements of an invoice

- Standout Header
- Invoice number
- Company's information
- Date
- Goods or service sold
  - Item name or title of service
  - Price of the item/service
  - Amount or quantity of product or service
- Fees
- Total amount due
- Terms of transaction
- A unique message
- Due date

Content 3.5.3: Functions of invoice

Functions of invoices

Companies need to deliver invoices in order to demand payments. An invoice is a legally binding agreement showing both parties' consent to the quoted price and payment conditions. However, there are other benefits to using invoices.

- **Maintaining records**

The most important benefit of an invoice is the ability to keep a legal record of the sale. This makes it possible to find out when a good was sold, who bought it, and who sold it.

- **Payment tracking**

An invoice is an invaluable tool for accounting. It helps both the seller and the buyer to keep track of their payments and amounts owed.

- **Legal protection**

A proper invoice is legal proof of an agreement between the buyer and seller on a set price. It protects the merchant from fraudulent lawsuits.

- **Easy tax filing**

Recording and maintaining all sale invoices helps the company report its income and ensure that it's paid the proper amount of taxes.

- **Business analytics**

Analyzing invoices can help businesses gather information from their customers' buying patterns and identify trends, popular products, peak buying times, and more. This helps to develop effective marketing strategies.

Theoretical learning Activity

✓ Trainees are asked to brainstorm the functions of invoice

Practical learning Activity

✓ Presentation of functions of invoice

Points to Remember (Take home message)

Functions of invoice:

- Maintaining records
- Payment tracking
- Legal protection
- Easy tax filling
- Business analytics

Content 3.5.4: Layout of invoice preparation

Example of an invoice

Figure: https://www.google.com/url?sa=i&url=https%3A%2F%2Finvoicer.ai%2Fproforma-invoice-template%3F_qss%3D&psig=AOvVaw24cnzECcmo4YU1uYp1Fjb9&ust=1681908145545000&source=images&cd=vfe&ved=0CBEQjRxqFwoTCPixzp-6s_4CFQAAAAAdAAAAABAY

East Repair Inc.

INVOICE

1912 Harvest Lane
New York, NY 12210

Bill To
John Smith
2 Court Square
New York, NY 12210

Ship To
John Smith
3787 Pineview Drive
Cambridge, MA 12210

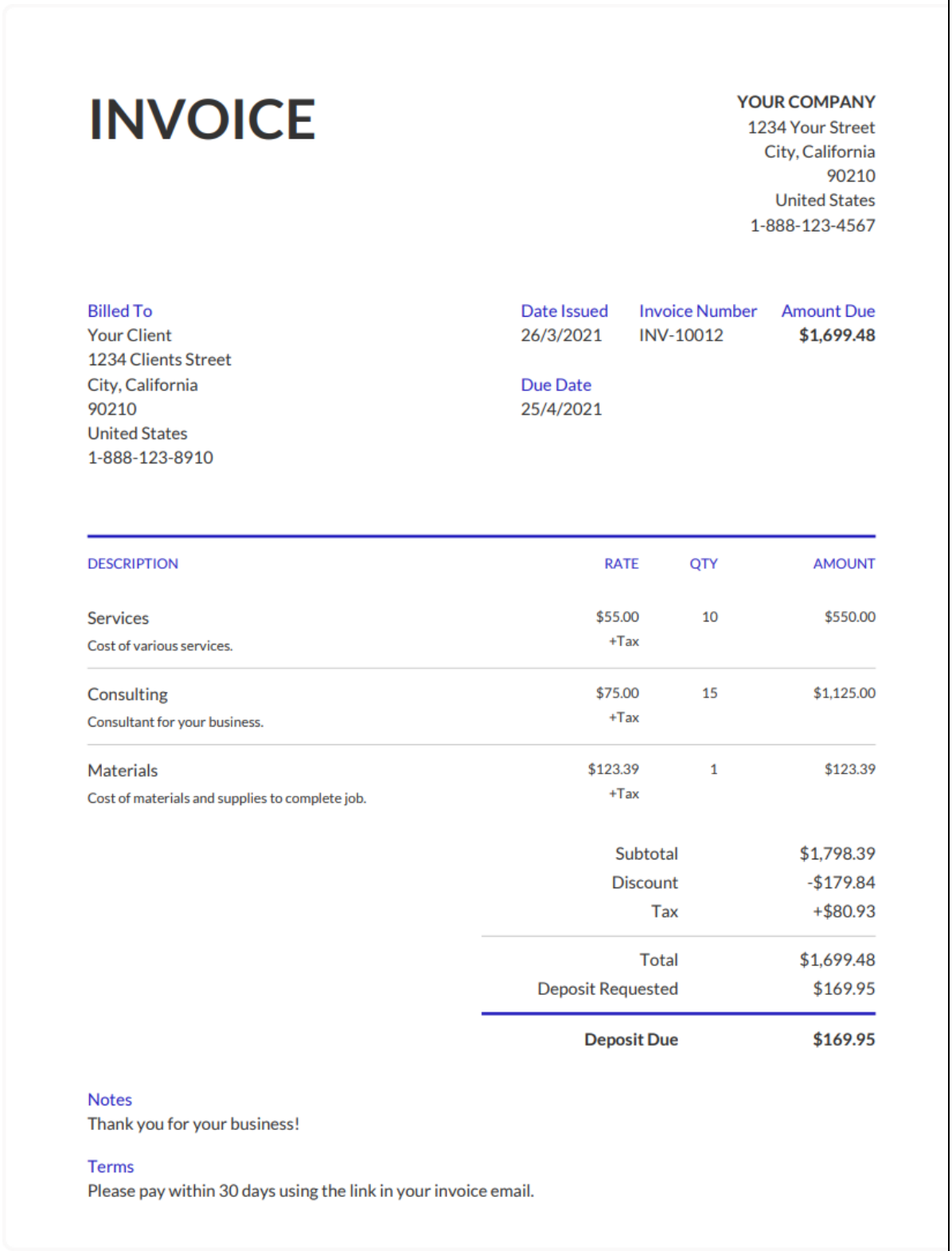
Invoice #	US-001
Invoice Date	11/02/2019
P.O.#	2312/2019
Due Date	26/02/2019

QTY	DESCRIPTION	UNIT PRICE	AMOUNT
1	Front and rear brake cables	100.00	100.00
2	New set of pedal arms	15.00	30.00
3	Labor 3hrs	5.00	15.00
		Subtotal	145.00
		Sales Tax 6.25%	9.06
		TOTAL	**$154.06**

Terms & Conditions
Payment is due within 15 days

Please make checks payable to: East Repair Inc.

Figure: https://www.google.com/url?sa=i&url=https%3A%2F%2Finvoicehome.com%2F&psig=AOvVaw24cnzECcmo4YU1uYp1Fjb9&ust=1681908145545000&source=images&cd=vfe&ved=0CBEQjRxqFwoTCPixzp-6s_4CFQAAAAAdAAAAABAo



INVOICE

YOUR COMPANY
1234 Your Street
City, California
90210
United States
1-888-123-4567

Billed To
Your Client
1234 Clients Street
City, California
90210
United States
1-888-123-8910

Date Issued	Invoice Number	Amount Due
26/3/2021	INV-10012	**$1,699.48**

Due Date
25/4/2021

DESCRIPTION	RATE	QTY	AMOUNT
Services Cost of various services.	$55.00 +Tax	10	$550.00
Consulting Consultant for your business.	$75.00 +Tax	15	$1,125.00
Materials Cost of materials and supplies to complete job.	$123.39 +Tax	1	$123.39

Subtotal	$1,798.39
Discount	-$179.84
Tax	+$80.93
Total	$1,699.48
Deposit Requested	$169.95
Deposit Due	**$169.95**

Notes
Thank you for your business!

Terms
Please pay within 30 days using the link in your invoice email.

Theoretical learning Activity

- ✓ Trainees are asked to brainstorm the layout of invoice

Practical learning Activity

NA

Points to Remember (Take home message)

INVOICE

ABC Supply
4883 Dressler Rd NW
Canton, OH 44718
(877) 968-7147

John's Tree Service
John Doe
100 Main Street NW
Cleveland, OH 44115

Invoice #: 1
Date: 7/20/2017
Due Date: 7/20/2017

DESCRIPTION	QUANTITY	PRICE	SALES TAX	AMOUNT
Grass Seed	10.00	$5.00	Yes	$50.00

SUBTOTAL:	$50.00
SALES TAX:	$0.00
TOTAL:	$50.00
BALANCE DUE:	$50.00

Learning outcome 3.5. formative assessment

Written assessment: Open ended questions

Question 1. Explain the item include on invoice

Answer: Make sure your invoices include the following items:

- ✓ **Date of the invoice**: Let customers know which day you created the invoice.
- ✓ **Customer contact information**: Customers want to be sure the invoice is intended for them, State the customer's name, business, address, and phone number. Your business's information: Customers need to be able to reach you. Include your name, business, address, email address, and phone number on the invoice.
- ✓ **Items purchased**: Create an itemized list of each product and service you provided. Next to each item, write the individual cost.

- ✓ **Total amount due**: State the total payment amount you expect to receive from the customer.
- ✓ **Payment terms**: Note the date you expect to be paid by. Also, detail how you want the customer to pay you. For example, do you accept checks, credit cards, or cash? Is there a specific address? where customers should send payments? Clear invoice payment terms make it easy for customers to pay.
- ✓ **Invoice number**: Number each invoice for your records. Make a note of the invoice number so that you can match it to payments in the future.

Question2. Illustrate the function of invoice

Answer: Function of an invoice

- ✓ Maintaining records
- ✓ Payment tracking
- ✓ Legal protection
- ✓ Easy tax filling
- ✓ Business analytic
- ✓ Facilitation of inspection
- ✓ Easy preparation of sold account

References

Dutta, B. (2002). *Estimating and Costing in Civil Engineering: Theory and Practice Including Specifications and Valuation.* kindle edition.

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Mislick. (2015). *Cost Estimation: Methods and Tools.* Wiley Series in Operations Research and Management Science .

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Summative Assessment

Integrated situation	Resources
NYAMATA TVET School in Bugesera district needs a joinery Carpentry Workshop (60x30x7)m In 6 months for new course: joinery carpentry at school , the workshop will be constructed by Real constructors ,Deco ltd (supervision company) has provided its drawings(plan view, elevation view, structural details and trusses details and other details for the workshop). Mandela TVET School needs Whole cost estimation for the joinery carpentry workshop for budget preparation. As a mason supervisor NYAMATA TVET School ask you to carry out the following tasks: 1) Examine the work 2) Determine resources 3) Prepare the bill of quantities 4) Calculate the cost estimation 5) Prepare an invoice to Mandela TVET school.	- Books - Measurements tools - Drawings - Calculator - Note books - Pens& pencils - Internet - Computer - Proforma invoice - Office and its accessories

Assignment duration: 7 hours

Assesment Criterion 1: Quality of Process

Checklist	Score	
	Yes	No
Indicator:Materials, tools and equipment are selected		
✓ Materials		
✓ Tools		
✓ Equipment		
Indicator: Determination of the work extent is done		
✓ **Working place is identified**		
✓ Work duration is determined		
✓ Outdoor location		
✓ Indoor location		
✓ Complexity of the work		
Indicator: Dimensions are determined		
✓ **Length**		
✓ Height		
✓ Width		
✓ Thickness		
✓ Accuracy		
✓ Clearness		
Indicator: Working location is defined		
✓ **Outdoor location**		
✓ Outdoor location		
✓ Indoor location		
✓ Out-country location		
Indicator:Human resource is identified		
✓ **Availability of labor**		
✓ Availability of funds		
Indicator: Steps of work duration are identified		
✓ **Time of each task**		
✓ Concurrent task determination		
✓ Total time		
Indicator: Estimate work duration is estimated		
✓ **Productivity hours per day**		
✓ How many resources on each activity		
✓ Available work days		
✓ Delays		
Indicator: quantity of materials in term of size and shape are measured		
✓ **Linear measurement**		
✓ Area		

✓ Cubic Content		
Indicator: Methods of quantities calculation are applied		
✓ **Centre line method**		
✓ Crossing method		
✓ Bay method		
Indicator: Quality of materials is identified		
✓ **Specification of material**		
✓ Description of material		
✓ Material testing		
Indicator: Human Resources are determined		
✓ **Variety of task**		
✓ Extent of work		
✓ Duration of work		
✓ Emergency work		
✓ Working place		
Indicator: Price survey methodologies are used		
✓ **Proforma invoice**		
✓ Survey templates		
Indicator: Prices survey is done		
✓ **Materials**		
✓ Equipment		
✓ Human resources		
✓ Transportation		
Indicator: Charges, benefits are calculated		
✓ **Labor cost**		
✓ Taxes and fees		
✓ **Transport**		
✓ Equipment		
✓ Benefits		
✓ Maintenance cost		
✓ Other charges		
Indicator: Cost is calculated		
✓ **Cost per unit measurement**		
✓ Total cost		
Indicator : type of bill of quantities is selected		
✓ **Firm bill of quantity**		
✓ **Approximate bill of quantity**		
✓ Specified Bill of quantity		
Indicator: BOQ Contents are respected		
✓ **Item number**		
✓ Item description		
✓ Unit of measures		
✓ Quantity of each item		

<u>Indicator</u>: Type of invoice is selected		
✓ **Proforma Invoice**		
✓ Interim Invoice		
✓ Recurring/Service invoice		
✓ Past due invoice		
✓ Final invoice		
✓ Advance Invoice		
✓ Miscellaneous invoice		
<u>Indicator</u>: Invoice elements are respected		
✓ **Standout header**		
✓ Invoice number		
✓ Company's information		
✓ Date		
✓ Goods/services sold		
✓ Fees and taxes		
✓ **Amount due**		
✓ Terms of transaction		
✓ Unique message		
✓ Date due		
Indicator: invoice functions are respected		
✓ **Maintaining records**		
✓ Payment tracking		
✓ Legal protection		
✓ Easy tax filing		
✓ Business analytic		

Assesment Criterion 2: Quality of product

Checklist	**Score**	
	Yes	**No**
<u>Indicator</u>: Cost Estimation is well done		
✓ BOQ is well prepared		
✓ Cost estimation on each item is well calculated		
✓ Invoice is well prepared		

Assesment Criterion 3: relevance

Checklist	**Score**

	Yes	No
<u>Indicator</u>: Materials are well used		
✓ No waste materials		
<u>Indicator</u>: Time is respected		
✓ Time required: 7 hrs		