AGRICULTURAL TVET COLLEGE

# SMALL SCALE IRRIGATION DEVELOPMENT LEVEL-III

# MODEL TTLM

## Learning Guide- 09

**Unit of competency:** Estimate of costing irrigation work

**Module Title:** Estimating of costing irrigation work

**LG code:** AGR SSI1M 09 LO1-LO4

**TTLM Code:** AGR SSI3 TTLM 1218V1

**Nominal Duration:** 50Hr

| Instruction sheet | Learning guide- 09 |
|---|---|

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

- Gather information
- Estimate materials, labor and time.
- Calculate costs
- Document and verify details.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Obtain details of customer requirements
- Access plan and specifications and inspect sites
- Develop details of products and services
- Determine delivery point and methods of transportations
- Record details
- Plan and sequence work
- Estimate types and quantities of materials required
- Estimate labor requirement
- Estimate time requirement
- Calculate total materials, labor and overhead costs
- Calculate total work costs and mark-up percentages
- Calculate final cost of work
- Document details of costs and charges
- Verify costs, calculations and other details
- Prepare customer quotation and tender
- Document details for future reference

**Learning Activities**

1. Read the specific objectives of this Learning Guide.
2. Read the information written in the "Information Sheets.
3. Accomplish the "Self-check" at the end of each learning outcomes.
4. IfyouearnedasatisfactoryevaluationproceedtothenextInformationSheet".However, if you acting is unsatisfactory, see your teacher for further instructions or go back to the Learning Activity.
5. Submit your accomplished Self-check. This will form part of your training portfolio

| **Information Sheet-1** | **Gather information** |
|---|---|

**Introduction**

Cost estimates are prepared at concept stage, refined throughout the project-preparation process, and updated during implementation. The cost estimate should identify those principal cost components needed to support effective project management (including monitoring of costs and physical progress during implementation). Once you've gathered information on market trends and your strategic objectives, the next step is to analyze the segment or segments that the product is geared toward and predict future buying habits as much as possible.

**1.1 Obtaining details of customer requirements**

Preparing a cost estimate for a job is an important part of owning and operating a business. A job estimate should cover all expected costs of completing a project and should take into consideration the complexity and size of the project.

- ✓ **Procedure for preparing a job Estimate**

**Step 1:** Communicate with your potential customer about the project and ask any questions that you feel are pertinent to have a better idea of what they expect. Making sure you understand what they want is necessary to preparing an accurate job estimate.

**Step 2:** Consider all of the phases of the project and break it down into steps as necessary.

**Step 3:** Write a list of essential material you will need. For instance, if you are a writer, include costs such as Internet, access to a database or specific software. If you are renovating, write out the list of supplies that you will need. Be sure to consider applicable travel costs or telephone

expenses to meet with a client. Research any costs that may change to make sure that you are providing an accurate estimate and that you will not lose money.

**Step 4:** Detail the expenses that you will incur from the job and use this budget to help with your plans for deciding on a job estimate. Prepare a spreadsheet to document these projected expenses.

**Step 5:**Plan for possible delays and contingencies when preparing ajob estimate. This will help you come up with an accurate delivery date and estimate for a job. If you help someone develop a website, take revisions and modifications into consideration and be sure to outline that you have put aside x amount of hours for revisions. Anything above that would thenbe added later.

**Step 6:** Estimate the number of hours that you and any other employees might spend on the project. Find the average rate charged for your area of expertise or go with your regular per hour charges. Multiply these figures to get the cost of labor for the project.

**Step 7:** Add these numbers together and outline each figureunder a heading, such as"Labor" or"Parts" to ensure thatyou maintain the integrity of your business practice. This will also help when explaining your job estimate so that you are sure you have the figures right.

**Step 8:** Prepare a final budget using a template or software and make sure that it looks professional before you deliver the job estimate to a potential client.

**Step 9:** Outline any potential clauses, such as the bid is only good for 10days or that a deposit is required within 10 days to hold the estimate. Make sure that you write the seclauses or conditions out clearly to ensure that you communicate effectively with your customer.

**Step 10:** Deliver the job estimate to the client as promised. Time is important when preparing a job estimate. If you say that you will have an estimate prepared within 24 hours, be sure to follow that deadline. Taking longer may cost you work.

**Step 11:** Follow-up with your client to answer any questions they may have about your job estimate.

### 1.2 Accessing plan & specifications, & inspecting sites

#### 1.2.1. Accessing plan

Site layout plans are prepared by contractors as part of their mobilization activities before work on site commences.

They are a crucial part of construction management, as sites can be very complex places involving the co-ordination and movement of large quantities of materials as well as high-value products, plant and people. Effectively and accurately laying out a site can help ensure that the works are undertaken efficiently and safely.

Careful sizing and positioning of temporary facilities can help reduce travel times, congestion, waiting times, and so on, and help to make the site a more effective workplace with better worker morale.

Site layout planning involves four basic processes:

- ✓ Identifying the site facilities that will be required.
- ✓ Determining the sizes, and other constraints of those facilities.
- ✓ Establishing the inter-relationships between the facilities.
- ✓ Optimizing the layout of the facilities on the site.

Site layout plans might include locations for and sizes of:

- ✓ Zones for particular activities.
- ✓ Cranes (including radii and capacities).
- ✓ Site offices.
- ✓ Welfare facilities.
- ✓ Off-loading, temporary storage and storage areas (laydown area)
- ✓ Sub-contractor facilities.
- ✓ Car parking.
- ✓ Emergency routes and muster points.
- ✓ Access, entrances, security and access controls, temporary roads and separate pedestrian routes.
- ✓ Vehicle wheel washing facilities.
- ✓ Waste management and recycling areas.
- ✓ Site hoardings and existing boundaries.
- ✓ Protection for trees, existing buildings, neighboring buildings, and so on.
- ✓ Signage.
- ✓ Temporary services (including electrical power, lighting, water distribution, drainage, information and communications technology, site security systems, and so on)
- ✓ Temporary works (such as propping solutions to retained structures, sheet piling details, and so on).
- ✓ Areas for the construction of mock-ups for testing.

- ✓ Fabrication facilities.

Problems caused by poor site layout planning can include:

- ✓ Inappropriate storage which can result in damage to products and materials.
- ✓ Poor siting of plant.
- ✓ Poor siting of welfare facilities.
- ✓ Inadequate space provision.
- ✓ Unsatisfactory access.
- ✓ Security and safety issues.
- ✓ Poor way finding (due to complex layouts or inadequate signage).
- ✓ Demoralized workers, delays and increased costs.

As sites will change in nature during the course of the works, there may be a number of different site layout plans for different phases, and there may be more detailed plans showing particularly complex areas or sequences or describing specific functions.

### 1.2.2 Specification

1. Specifications are the written requirements for a material, product, or service for a proposed project, like a dam, weir, or canal.
   - ✓ For architectural projects, the specifications are art of the Contract Documents included with the bidding and construction requirements and the drawings.
2. Purpose of Specifications
   - ✓ Specifications should describe the type and quality of every product required for the project.
   - ✓ The specifications should describe the requirements for fabrication, erection, application, installation and finishing.
   - ✓ Specifications should describe the quality of workmanship necessary for the project. This includes – All phases of creation and installation starting with
     - o manufacturing,
     - o fabrication,
     - o application,
     - o installation,
     - o Finishing and adjustment.
3. Specifications should include any necessary codes and standards applicable to the project.

- ✓ The specifications should also include descriptions and procedures for alternate materials, products or services if necessary.
- ✓ The specification and project manual.
- ✓ Contract Documents contain the bidding and construction requirements, drawings and specifications.
- ✓ The project manual is the bound written portion of the Contract Documents.
- ✓ The project manual is typically organized according to Master Format.

4. Types of Specifications • There are four methods of specifying. There is no defined rule for using one method over another or about combining methods, but care should be taken to avoid redundancy or contradictions. • The four methods are: –
   A. Descriptive
   B. Performance
   C. Reference Standard
   D. Proprietary

A. Descriptive Specifications

- ✓ Under this method of specifying the exact properties of the materials and methods of installation are described in detail without using proprietary or manufacturer's names.
- ✓ Descriptive specifications are commonly used for products for which no standards exist, on projects where using proprietary names is restricted, and in situations where the Architect/Engineer want to exercise tight control over the specified work.
- ➢ Advantages to using descriptive specifications
  - Descriptive specifications specify exactly what the design intends.
  - They are applicable to all conditions, methods or situations of a project.
  - They are applicable to all sizes and types of projects.
  - They permit free competition because they do not restrict the use of specific products or manufacturers.
  - Disadvantages of descriptive specifications: – They require the specifier to take special care in describing the design intent in order to achieve the desired results.

B. Performance Specifications

- Under this method the required end results are specified along with the criteria by which the performance will be judged and the method by which it can be verified.
- The contractor is free to choose the materials and methods that comply with the performance specification.
- They are generally used to encourage the use of new and innovative techniques that may lead to more economical construction.
- They are also used to supplement other specification methods.
- Advantages to using performance specifications: –
  - ✓ Only the end result or design intent is specified, this gives the Contractor flexibility in selecting and applying products.
  - ✓ They permit free competition.
  - ✓ They can be applicable in all types and sizes of projects.
  - ✓ Performance specifications delegate the technical responsibilities to the construction industry, where the Contractor instead of the Architecture/Engineering firm is responsible for the results.
- Disadvantages to using performance specifications: –
  - ✓ They can be time consuming to produce and may result in long, detailed specifications.
  - ✓ They are more difficult to enforce than other methods of specifying.
  - ✓ They may be too elaborate for simple or minor projects.

C. Reference Standard Specifications – Under this method reference is made to an established standard defined by associations very knowledgeable about a certain part or phase of construction. – Reference standard specifications are used for "commodity" products in the marketplace, where brand names are not important.

- Steps for preparing reference standard specifications are:
  1. The standard must be recognized as authoritative by the industry.
  2. The standard must be available to all parties involved in the project.
  3. The specifier must know the standard. Assure that the standard relates to the current project and does not present duplicate or conflicting information.

4. Establish a date of the standard.
5. Incorporate the standard correctly into the specifications.
6. Enforce the requirements of the standard

D. Proprietary Specifications – Under this method the actual brand names, model numbers and other proprietary information is specified. – They are primarily used for private commercial projects where the Owner knows what products they want. – There are two types of proprietary specifications, closed and open.

### 1.2.3. Inspecting site

The inspection process is separate from the contractor's own supervision of the works. Inspection is carried out purely to give an independent view of the works either for the client or a third party, the term supervision might imply taking some responsibility for the works, when in fact contractual responsibility lies with the contractor. Inspection of the construction works will be carried out as they proceed to verify compliance with the requirements of the contract documents.

Site inspectors (or clerks of works) may be provided as an additional service by the existing consultant team, or could be new appointments. They may be based on site permanently or may make regular visits. On large projects it may be appropriate to have separate site inspectors for mechanical and electrical services, structural works andarchitectural works. Specialist inspections may also be necessary for specific aspects of the project such as; the client's environmental policy, site waste management plan, accessibility, and so on.

Site inspectors provide an independent assessment of the works and will generally report to the contract administrator. They are likely to keep a site diary, attend construction progress meetings and to produce regular written reports.

Specific inspections may also be carried out during the construction phase as part of the general contract administration process:

- ✓ Condition surveys of neighboring structures prior to commencement of the works.

- ✓ Regular valuation inspections to assess progress of the works in order to value interim payments.
- ✓ Inspecting mock ups and samples and witnessing tests.
- ✓ Witnessing commissioning.
- ✓ Inspection prior to certification of practical completion.
- ✓ Inspection after handover of the site to the client on certification of practical completion.
- ✓ Inspection at the end of the defects liability period to prepare a schedule of defects.
- ✓ Inspection on completion of the rectification of defects set out on the schedule of defects.

Design consultants generally have a responsibility to provide periodic inspection under the terms of their conditions of engagement. However, the fact that it is periodic, and inspection not supervision, can relieve them of liability for specific workmanship defects that result in court action.

**1.3 Developing details of products and services**

Product and service management includes a wide range of management activities, ranging from the time that there's a new idea for a product to eventually providing ongoing support to customers who have purchased the new product. Every organization conducts product development, whether it's done intentionally or unintentionally.

This module provides a wide overview of considerations in developing and managing a product. How a product is developed or managed is depends very much on the nature of the organization and its products, for example, retail, manufacturing, wholesale, etc. Note that different people might even have different categorizations for the activities described below.

Product development tools (such as the Kano model) can help identify needs and group them by established criteria.

1. **Develop the Concept**

In this phase, the new product idea is refined to best serve the needs of potential clients and stand out from the competition.

How can this be achieved? Get opinions from leading users who may foresee future needs in the market. Also, rely on a team with expertise in various disciplines: design and production people for the technical requirements, marketing experts for reaching customers, and finance and management departments for determining what funds are available.

The three golden aims in this phase are to satisfy the client, stand out from the competition, and show the greatest potential for turning a profit.

**2. Testing**

Now you need to create your prototype and, essentially, assess how well it performs. Does your product:

- Offer a series of features that satisfy customer needs?
- Arrive on the market at an opportune time?
- Perform efficiently with regards to development and manufacturing costs?
- Maintain a healthy equilibrium between the launch cost and the product's capacity to turn a profit?

It's also good to keep in mind that investing in cost reduction early can increase profitability. Cutting product prices can increase market share, which in turn trims distribution costs and discourages the competition.

**3. Position and Launch**

With the product designed and studied thoroughly, the next step is to decide on its strategic positioning. How do you want potential customers to perceive the product? This stage needs to take into account economic, but also functional and emotional factors.

Traditionally, functional innovations were emphasized in new products. But this has become less sustainable in the current climate, as technology advances allow competitors to respond and new innovations to enter the market quickly. When price and features of rival products are similar, differentiation is largely due to the emotional factor. This is at the heart of the relevance of brand image, communication and the so-called intangible attributes of a service or product.

It's a competitive world out there. Planning carefully and remembering the human factor can pay dividends when launching new products.

### 1.4 Determining delivery point and methods of transportations

- ✓ **Transportation and Delivery Scheduling**

During order entry, each schedule line for an item can contain a requested delivery deadline. The goods should arrive at the customer on this date. At the order processing stage, the system can automatically schedule when the essential shipping activities such as picking, loading and transporting must be started so that the requested delivery date can be kept.

The terms used in scheduling are defined below. You must distinguish between

- Times (time duration) needed to carry out certain activities
- Dates that are calculated on the basis of these times

**Times**

- Values based on past experience of the shipping department are entered in the system in the form of transit times, loading times, pick/pack times, and transportation lead times:
- The transit time is the time in days that is required to deliver goods from your premises to the customer location. It is defined for a route.
- The loading time is the time in days that is required for loading a delivery item. It is determined from the shipping point, the route, and the loading group of the material.
- The pick/pack time is the time in days that is required for allocating goods to a delivery as well as the time in days that is required for picking and packing. It is calculated using the shipping point, the route, and the weight group of the order item.
- The transportation lead-time is the time in days that is needed to organize the shipping of the goods. This might include booking a ship and reserving a truck from a forwarding agent. It is defined for a route.

If you have not maintained any working times in the shipping point, the unit for the time specification is the day (workday = 24 hours) with two decimal places

If you have maintained the working times in the shipping point, the unit for the time specification is hours, minutes, and seconds.

You can also enter the factory calendar of the forwarding agent for the route when you define the transit time. This factory calendar can be different from your company's calendar. For example, the forwarding agent might operate a 6-day-week.

You may only enter the transit time in days with two decimal places, even if you have maintained the working times in the shipping point.

**1.5 Recording details**

During the construction of irrigation schemes we are expected to make the recording of details of our system. The recording details may include:

**Cost Accounting Records**

- Keep them accurate and keep them current.
- Accurately code entries and use the same cost codes throughout job.
- The contract may require you to maintain certain cost accounting records and make them available to the consultant or owner.

**Equipment Records**

- On some projects it will be important to maintain detailed equipment records being used.

Include: used by whom, when, where, how long, doing what, and sometimes the operator.

- Downtime - Reasons for and duration.
- Major equipment moves.
    - Distance and time taken, as well as method used.
    - At whose direction was move made.
    - Problems encountered.
    - Effect on schedule/productivity, not only of the contractor moving the equipment but also on yours and that of other trades.

| **Self-Check-1** | **Written Test** |
|---|---|

Name: _____ Date: _____

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

1. What is the importance of estimating cost of irrigation works? explain(5 pt )
2. How can we obtain details of customer requirements? List and explain the steps(8 pt )
3. List and explain the ways of assessing plan and specifications and inspecting sites?( 6 pt )
4. What is the objective of recording details in irrigation work(5pt)

**Note: satisfactory Rating-12 and above pts. Unsatisfactory Rating-below 12 pts.**

You can ask your teacher for the copy of the correct answers

| Information sheet -2 | Estimate materials, labor and time. |
|---|---|

**There are several kinds of estimating techniques; these can be grouped into two main categories:**

**1. Approximate Estimates**

an approximate estimate is an approximate or rough estimate prepared to obtain an approximate cost in a short time. For certain purposes the use of such methods is justified.

**2. Detailed Estimate**

A detailed estimate of the cost of a project is prepared by determining the quantities and costs of every thing that a contractor is required to provide and do for the satisfactory completion of the work. It is the best and most reliable form of estimate. A detailed estimate may be prepared in the following two ways

**(a) Unit Quantity Method**

In the unit quantity method, the work is divided into as many operations or items as are required. A unit of measurement is decided. The total quantity of work under each item is taken out in the proper unit of measurement. The total cost per unit quantity of each item is analyzed and worked out. Then the total cost for the item is found by multiplying the cost per unit quantity by the number of units.

For example, while estimating the cost of a building work, the quantity of brickwork in the building would be measured in cubic meters. The total cost (which includes cost of materials. labor, plant, overheads and profit) per cubic meter of brickwork would be found and then this unit cost multiplied by the number of cubic meters of brickwork in the building would give the estimated cost of brickwork. This method has the advantage that the unit costs on various jobs can be readily compared and that the total estimate can easily be corrected for variations in quantities.

**(b) Total Quantity Method**

In the total quantity method, an item of work is divided into the following five subdivisions

(I) Materials

(II) Labor

(III) Plant

(IV) Overheads

(V) Profit

The total quantities of each kind or class of material or labor are found and multiplied by their individual unit cost. Similarly, the cost of plant, overhead expenses and profit are determine

**2.1 Planning & sequencing work**

Clear definition of the products required for a project is mandatory and should be clearly understood in the initial stages of project planning and cost development. The costs and overall time required are dependent upon the delivery item requirements. Products may be divided into two groups: intermediate and final. Work-planning is the process of determining what an office intends to carry out for the term of a work cycle (i.e. annual or biennial budget calendar). Work-plans should be constructed within the guidance and focus of a strategic plan and should contain the operational details that illustrate exactly what services will be delivered and to what level of quality.

**Work-plan objectives**

A work-plan should outline the primary objectives of the team. Where there is an overall strategic plan for the office level, the overall objectives should be directly derived from the source – but only those that apply to the work-planning time period. Objectives that apply to a future time period should be omitted. The work-plan should clearly articulate what areas of focus are most important for the upcoming work year or budgetary cycle.

**Planning**

Work activity planning: construction work is analyzed into parts which are then arranged in Logical sequence.

Work activity scheduling: estimated times for activities are included in a schedule for the Project Labor, materials, and equipment scheduling: amounts of resources required at different times throughout a project are estimated and scheduled Budgeting and Cash flow needs: these are calculated and scheduled to find out the amount of financing required throughout the project.

**2.2 Estimating types & quantities of materials required**

## Introduction

You use the quantity of work to be done based on the dimensions of the proposed work. However, at the time of execution of the work, material requirement need to be identified to procure the materials in the required quantities in advance before you start work

### Theoretical Consumption:

Based on actual observation of material required for certain activities, the department fixed per unit requirements, they are called theoretical consumption of material. For example, to prepare 1 cubic metre of concrete with proportion of 1:2:4 (cement, sand, aggregate) the following quantities are required for each of the material we use in cement concrete. Cement 6.37 bags, 2) sand = 0.43 cubic metres, 3) stone = 0.85 cubic metres

The quantity of the material required depends on the dimensions and specifications of the work. Theoretical consumption statement will help to estimate the quantities of the material required. There is certain relationship between the specifications of the work to be done and the material required for that particular work. For example, while preparing cement concrete mixture of 1:5:10 ratio, for constructing foundation of a structure of 1 cubic metre, the quantities of cement, sand and gravel required would be different if the proportion is 1:4:8. Mathematical form of such relationship is used for estimating the material quantities with the help of quantity of the work mentioned in the Bill of Quantities. Few examples are given below which will help you to understand the calculations for estimating the quantity of material.

**Quantity Take Off**

It is a tedious process in determining the required construction quantities

Can be broken down into:

- ✓ Determination of the quantities of work
- ✓ Computation of the prices associated with those Quantities

**Quantity Take Off Procedures**

- ✓ Identification of work item
- ✓ Calculation of quantity – linear, area, volume and unit
- ✓ Upon measuring the material take-off,estimator should understand the actual field procedure
- ✓ Usually quantity take-off is facilitated by the use of forms. The purpose of the forms is to standardize the worksheets by providing properly assigned areas where specific information is to be written to allow follow-up so that checking can be easily performed

**Material waste factors**

Waste factor is used to increase material quantity to ensure that enough material is procured to realistically complete the work and allow bulk discount purchase.

Nature of Waste Factors Refers to spoilage of materials that result as parts of the construction process. It usually derived from 2 main factors:

Industrial standards

Materials handling and installation

**Properties of basic construction materials**

**Aggregates**

Use fine aggregates or sands and coarse aggregates (gravel) that comply with the standards approved and in addition they should be chemically inert

- ✓ Use coarse aggregates or gravels not rounded in shape
- ✓ Ensure that the nature and grading of aggregates remain reasonably constant to ensure that the overall grading remains constant for each section of the work
- ✓ Don't allow dust during mixing
- ✓ Use clean gravel and sand aggregates of various sizes separately
- ✓ Deliver aggregates to the site in clean and suitable vehicles, and
- ✓ Store it in appropriate site for ease of use during construction

**Gravel**

Gravel is a coarse aggregate (natural or crushed) used in concrete making, Use the following gravel sizes for the specified purpose:

- ✓ 10mm maximum size, graded, for all "fine" concrete for foundation spreading.

- ✓ 20mm maximum size, graded, for all reinforced concrete for weirs, walls and slabs.
- ✓ 36mm maximum size graded for all mass concrete walls and slabs( 1, 2, 3 in road construction)

**Sand**

Sand is a fine aggregate to be used in concrete making for common mixes, natural sand aggregate is used

- ✓ Sand size range between 0.075mm to 4.75mm
- ✓ Using sieve analysis when we sieve the sand with 4mm diameter sieve the sand will pass and the remaining is the gravel
- ✓ Then when we sieve the sand with a sieve of diameter 200 micro mm all clay and silt will pass and the sand will remain
- ✓ Good sand is that which contains equal proportions of fines and courses free from silt and clay
- ✓ In any case the percentage of silt plus clay in usable sand should not be greater than 5% If the sand is too dirty washing with water is strongly recommended

**Cement**

- ➢ Use ordinary Portland cement of an approved type in the permanent works complying with approved standards
- ➢ Cement should be free flowing and free of lumps and must be supplied in sealed bags
- ➢ Use protected cement from weather effect
- ➢ Cement in bags should be stored in a suitable weatherproof, dry and well ventilated store house, the floor must be raised above the surrounding ground level
- ➢ Cement from unfasten bags should not be used in the permanent works
- ➢ Remove cement, which has become hardened or lumpy
- ➢ Cement which is stored more than six months should not be used

**Mortar**

- Mortar is the mixture of cement and sand with water the mix cement: sand proportions must be as in the ratio of 1:2, 1:3 or 1:4 parts by weight
- Small quantities of mortar may be hand mixed, for over 0.5 m3 mechanical mixer is needed

- Use appropriate water content for the mortar so as to make it consistent with the use for which it is required but in any case the water/cement ratio shall not be more than 0.58 by weight

**2.3 Estimating labor requirement**

The construction industry, to which these craftsmen belong, is one of the most labor-intensive industries in the world. The labor cost component of a building project often ranges from 30 to 50%, and can be as high as 60% of the overall project cost. Therefore, it is clear that construction labor is a vital component of a construction project. These work packages can then be assigned to and completed by an individual worker or a crew. A crew is a team of workers, which can be of the same trade or a composite of many different trades. Due to the diverse nature of the different tasks associated with all the building systems, many types of craftsmen from many different trades are required in a building construction project.

**Labor s production rates (Productivity)**

A production rate is defined as the number of units of work produced by a person in a Cost Estimating specified time. Production rates may also specify the time in man-hours or man-days required to produce a specified number of units of work. The time that a labor will consume in performing a unit of work varies between labors and between projects and with climatic conditions, job supervision, complexities of the operation and other factors. It requires more time for erect shutters for stairs than for foundations. Sometimes, the production rate is replaced by the term productivity. In the most general sense, productivity is the ratio of input versus the respective output. In construction, the input is often the work hours of a worker or a crew, such as the 8 hours of a bricklayer. The output is the amount of work produced, such as laying 500 bricks. Thus construction productivity is defined as the quantity of work produced in a given amount of time by a worker or a specific crew, that is, the quantity of construction output units produced in a given amount of time or a unit time. The formula for productivity is presented in Eq. 2.1. Construction productivity = quantity of work produced / time duration (2.1)

**Example 2.1**

If a bricklayer can lay 500 bricks in 8 hours, then, the associated construction productivity is 500 bricks divided by 8 hours, which is 62 bricks per bricklayer hour.

Although most items associated with the monetary factor remain relatively constant over a short period of time, such as during the construction phase, productivity, on the other hand, can fluctuate wildly.

**Man-Hour Estimates**

Estimates of total man-hour requirements are a combination of data derived by two different procedures. For the on-site activities, where labor input can be identified as relating to a specific project, direct primary data are available. For all other activities, however, such as the manufacture of construction equipment and materials, which are in their nature diffuse and non-specific with respect to a particular project, an estimating procedure was used. These two methods are described below.

**On-Site Man-Hours**

To check compliance with this law, an administrative regulation requires that each contractor on Federal construction file a copy of his weekly project payroll with the supervising agency. These payrolls are thus a primary source of data on production man-hours worked and wages paid on a project. Although these payrolls were the basic source of production worker data, non-production workers (e.g., general supervisors, engineers, and clerks) and certain classes of production workers (such as self-employed subcontractors) are not required to be reported on the project payrolls. Moreover, the processing of the payrolls, and of the material described in the following section, developed an occasional question as to completeness or meaning.

These estimates, the most common of which is termed ''Reasonable Contract Estimate," show not only the estimated quantities and prices of materials and supplies to be used and the wages to be paid, but also judgments as to the type of equipment likely to be used, and estimates of its ''rental" cost (the cost of owning and maintaining) and its operating cost (the cost of fuel, lubricants, and minor repairs). When required by changes in the scope of the work, these estimated costs were adjusted to approximate final costs by use of the ratio of the contractors' original bid to final payment to him for each bid item.

The labor data for plant ''mobilization and demobilization" were also based on information in these government estimates. Although this category represents the work of the contractor's own employees in mobilizing heavy construction equipment to the construction site, the work is not required to be reported on the payrolls, and had to be separately estimated. The information available was fragmentary in some cases, and the relative accuracy of the resulting estimates is unknown.

**Off-Site Man-Hours**

The government estimate used as a standard is prepared in considerable detail for each bid item (major subfeature) of the job by an engineer in the District office of the Corps who is familiar

with local conditions and practices. In most cases, he has access to a considerable body of experience on similar jobs, since work of the same type tends to recur in a given area.

These estimates, the most common of which is termed ''Reasonable Contract Estimate, '' show not only the estimated quantities and prices of materials and supplies to be used and the wages to be paid, but also judgments as to the type of equipment likely to be used, and estimates of its ''rental'' cost (the cost of owning and maintaining) and its operating cost (the cost of fuel, lubricants, and minor repairs). These data on materials, supplies, and equipment costs were tabulated for each sample project from the detailed estimates made available by the District offices of the Engineers, and were the basis of the breakdown for all elements of cost with the exception of the on-site labor costs which were derived from the actual construction payrolls as described above. When required by changes in the scope of the work, these estimated costs were adjusted to approximate final costs by use of the ratio of the contractors original bid to final payment to him for each bid item.

**2.4 Estimating time requirement**

Determining the total work duration for a task involves knowledge of the quantity of work required for the task and the production rate for the specific crew that will be performing the work. A straight forward approach to the estimation of activity durations is to keep historical records of particular activities and rely on the average durations from this experience in making new duration estimates. Since the scope of activities is unlikely to be identical between different projects, unit production rates are typically employed for this purpose the duration of an activity may be estimated as given in Eq. 4.2.

Work duration = quantity of work / number of crews × production rate (4.2)

**Example 4.3**

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

**Solution**

Interior painting duration = 440 / 11 = 40 hours

Exterior painting duration = 378 / 14 = 27 hours

Total work hours = 67 hours

Typically, the quantity of work is determined from engineering drawings of a specific project. The number of crews working is decided by the planner. In many cases, the number or amount of resources

applied to particular activities may be modified in light of the resulting project plan and schedule. Some estimate of the expected work productivity must be provided. Historical records in a firm can also provide data for estimation of productivities.

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

| **Self-Check 2** | **Written Test** |
|---|---|

**Name:** _____ **Date:** _____

***Directions:*** **Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers**

1. How to estimate labor in construction activities?(**5pt**)
2. List the Quantity Take Off Procedures?(**5pts** )
3. Define Labor s production rates (Productivity)? (**5pts**)
4. Write about Planning & sequencing workand the objective of planning?**(5pt)**
5. What are the two common estimation methods in work/project place?(**5pt**)

***Note:*** **Satisfactory rating –12.5 points and above Unsatisfactory - below 12.5 points**

You can ask your teacher for the copy of the correct answer.

| **Information sheet -3** | **Calculate costs** |
|---|---|

### 3.1. Calculating total labor, material, and overhead cost

- ***Basic principle for estimating labor costs***

Labor costs in construction are determined by two factors: ***monetary*** and ***productivity***. The monetary factor is related to hourly wage rates, wage premiums, insurance and taxes. Estimating the components of the monetary factor is more difficult in construction than in other industries. This is due to the variety of

work involved in construction, as well as the many types of trades involved. The problem is further complicated by the presence of the unions with their craft structures and collective bargaining processes. Although the computational process of this component seems complex and tedious, it is only a matter of accounting as the needed numbers (such as wage rates, fringe benefits, and insurance) are readily available.

The formula for computing the total cost of labor is quite simple. It requires the knowledge of the total work hours or labor hours needed to perform all the tasks and then applying the corresponding wage rates. The formula for calculating the total cost of labor is shown as

***Total cost of labor = total work hour × wage rate***

### Estimating Material cost

Construction materials for irrigation projects are listed below depending on current price multiply the amount of material needed:-

- Soil of different types- sandy soil, clay, silt clay
- Stone - basaltic, sand stone
- Sand - of different size
- Iron bars- deformed reinforcement iron bars of different diameter (6 mm, 8mm, 10mm, 12mm, 14mm etc…)
- Nails /pegs – of different sizes
- Corrugated iron sheets- of different thickness ( G28, G32, G35)
- Clay tiles/ /
- Hollow concrete blocks
- Cement
- Gravel – of different sizes
- Stirrups
- Black wire 1.5 mm diameter
- Timber( formwork)
- Woods
- Water
- Steel pipes
- PVC pipes

- Sheet metals of different thickness (1 mm, 2mm, 3 mm, 4 mm, etc..)

Before we are proceeding to calculate the total material cost we should have to calculate the volume of material required. Depending on the current price of the material multiply it by volume it gives the cost of material.

E.g for masonry work approximately 30% mortar and 70% stone. You can use 1:4ratio

- ✓ Mortar is mix of cement and sand
- ✓ Total volume of work*70% is volume of stone
- ✓ Total volume * 30% is equals to mortar volume.

$$\text{(a) Cement} = \frac{1}{5} * \text{w m3} * 1400\ \text{kg/m3} * 1.3\ \text{Shrinkage} * 1.05\ \text{wastage}$$

$$= 368 * \text{w (kg)}$$

$$\text{(b) Sand} = \frac{4}{5} * \text{wm3} * 1.3\ \text{Shrinkage} * 1.15\ \text{wastage}$$

$$= 1.2 * \text{w (m3)}$$

C. Stone = volume of work*70%*1.25 bulking factor

D. You can use $0.4m^3$ of water for masonry work of $1m^3$

1. Then the material cost of cement is $368*Wm^3$ (kg)* current price of cement and material cost of sand is $1.2*Wm^3$ * current price of sand in $m^3$.
2. Cost of mortar = sand cost +cement cost +cost of water
3. Cost of masonry (material) = sand cost +cement cost + cost of stone + cost of water
4. You can use Cost of equipment is 5% of labor cost
5. Direct cost =labor cost +equipment cost +material cost
6. Add 35% indirect cost

- **Overhead cost**

- ✓ **Overhead cost can be direct overhead cost or indirect overhead cost**

**Direct overhead cost is =** labor cost +equipment cost +material cost

**Indirect overhead cost is =** office expense + staff salary +miscellaneous (vehicles, oil…) +depreciation cost

### 3.2 Calculating total work cost and final cost of work

- ✓ In terms of accounting total cost of work in process is the cost of the beginning work in process plus total manufacturing costs for the current period.
- ✓ Total cost of work = **labor cost +material cost+ equipment cost+ staff salary**
- ✓ **Mark-Up % =** Percentage of money added to direct job costs to cover **overhead.**

| **Self-Check 3** | **Written Test** |
|---|---|

**Name:** _____ **Date:** _____

***Directions:*** **Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers**

For the construction of 1 m3 of masonry work, the rate analysis is as follows:

- ✓ Let the mix proportion of cement and sand is 1:4, and daily output of one mason crew is 0.75 $m^3$
- ✓ Crew composition of one mason consists of 1 main mason + 4 daily laborers
- ✓ Daily payment for the main mason is assumed to be 80 birr and daily payment for the laborers is 35 birr each = 220 birr per day

**Then calculate**

1. Labor cost?(5pt)
2. Equipment cost?(5pt)
3. Cost of cement, sand, stone depending on current price? (15pt)

***Note:*** **Satisfactory rating –12.5points and above Unsatisfactory - below 12.5 points**

You can ask your teacher for the copy of the correct answer.

| **Information Sheet-4** | **Document and verify details**. |
|---|---|

### 4.1 Documenting details of costs & charges

Cost and charges can be defined as the total money, time, and resources associated with a purchase or activity. Costs can be classified into different categories for different purposes. Costs may be categorized according to their:

- Management function
- Ease of traceability
- Timing of charge against revenue
- Behavior in accordance with activity and
- Relevance to decision making.

**According to Management Function**

1. Manufacturing costs - incurred in the factory to convert raw materials into finished goods. It includes cost of raw materials used (direct materials), direct labor, and factory overhead.
2. Nonmanufacturing costs - not incurred in transforming materials to finished goods. These include selling expenses (such as advertising costs, delivery expense, salaries and commission of salesmen) and administrative expenses (such as salaries of executives and legal expenses).

**According to Ease of Traceability**

1. Direct costs - those that can be traced directly to a particular object of costing such as a particular product, department, or branch. Examples include materials and direct labor. Some operating expenses can also be classified as direct costs, such as advertising cost for a particular product.
2. Indirect costs - those that cannot be traced to a particular object of costing. They are also called common costs or joint costs. Indirect costs include factory overhead and operating costs that benefit more than one product, department, or branch.

**According to Timing of Charge against Revenue**

1. Product costs - are inventorial costs. They form part of inventory and are charged against revenue, i.e. cost of sales, only when sold. All manufacturing costs (direct materials, direct labor, and factory overhead) are product costs.

2. Period costs - are not inventorial and are charged against revenue immediately. Period costs include non-manufacturing costs, i.e. selling expenses and administrative expenses.

**According to Behavior in Accordance with Activity**

1. Variable costs - vary in total in proportion to changes in activity. Examples include direct materials, direct labor, and sales commission based on sales.

2. Fixed costs - costs that remains constant regardless of the level of activity. Examples include rent, insurance, and depreciation using the straight line method.

3. Mixed costs - costs that varies in total but not in proportion to changes in activity. It basically includes a fixed cost potion plus additional variable costs. An example would be electricity expense that consists of a fixed amount plus variable charges based on usage.

**According to Relevance to Decision Making**

1. Relevant cost - cost that will differ under alternative courses of action. In other words, these costs refer to those that will affect a decision.

2. Standard cost - predetermined cost based on some reasonable basis such as past experiences, budgeted amounts, industry standards, etc. The actual costs incurred are compared to standard costs.

3. Opportunity cost - benefit forgone or given up when an alternative is chosen over the other/s. Example: If a business chooses to use its building for production rather than rent it out to tenants, the opportunity cost would be the rent income that would be earned had the business chose to rent out.

4. Sunk costs - historical costs that will not make any difference in making a decision. Unlike relevant costs, they do not have an impact on the matter at hand.

5. Controllable costs - refer to costs that can be influenced or controlled by the manager. Segment managers should be evaluated based on costs that they can control.

After completion of our work we are expected to record and document details of all the costs and charge that are related with our irrigation work. Documents are a power full tools that can aids

our memory, minimizes miss understanding, stimulates thoughtfulness, helps us from repetition of mistakes so that we are expected to document all costs and charges that are relate with our job from the star up to ending.

### 4.2 Calculating cost according to workplace procedure

Workplace procedures are a series of specific steps that guide a worker through a task from start to finish in a chronological order. Safe job procedures are designed to reduce the risk by minimizing potential exposure.

- ✓ On calculating cost refer 3.1, 3.2,

### 4.3 Preparing customer quotation & tender

A **quotation** is a fixed price offer that can't be changed once accepted by the customer. This holds true even if you have to carry out much more work than you expected. If you think this is likely to happen, it makes more sense to give an estimate. You can also specify in the quotation precisely what it covers, and that variations outside of this will be subject to additional charges. An **estimate** is an educated guess at what a job may cost - but it isn't binding. To take account of possible unforeseen developments, you should provide several estimates based on various circumstances, including the worst-case scenario. This will prevent your customer from being surprised by the costs. To work out a quote or estimate you need to know your **fixed and variable costs**. These include the cost-per-hour of manual labor and the cost of the materials you'll require.

**Prepare a written estimate**

When you prepare an estimate it's good practice to give the customer a **written copy**, including a full **breakdown** of costs.

- ✓ Overall price
- ✓ Breakdown, listing the components of the price
- ✓ Schedule, detailing when work will be done or products delivered
- ✓ Terms and conditions
- ✓ Time period the estimate is valid for

- ✓ Payment terms or schedule

**Prepare a written quotation**

- ✓ The work you're quoting for has clear requirements - in terms of time, labour, materials, etc.
- ✓ Your costs are stable
- ✓ You're confident the work won't turn out to be more complicated than expected
- ✓ It's good practice to give your customers a **written quotation**. This should include the:
- ✓ Overall price
- ✓ Breakdown of the components of the price, indicating what is covered and what is not
- ✓ Period the quotation is valid for
- ✓ Schedule for when the work will be done or products delivered
- ✓ Full contact details of your business
- ✓ Payment terms or schedule

**Prepare a price for a tender**

- ✓ A breakdown of component costs at each stage of the project (e.g. Weekly or monthly)
- ✓ Staff time and costs
- ✓ Management time and costs
- ✓ Administration time and costs
- ✓ Estimates of reimbursable expenses

**4.4 Documenting details for future reference**

The terms of reference document defines all aspects of how a consultant or a team will conduct an evaluation. It defines the objectives and the scope of the evaluation, outlines the responsibilities of the consultant or team, and provides a clear description of the resources available to conduct the study. Developing an accurate and well specific dereference document is a critical step in managing a high-quality evaluation. The evaluation reference document serves as the basis for a contractual arrangement with one or more evaluators and sets the parameters against which the success of the assignment can be measured. The specific content and format for a reference document will vary to some degree based on organizational requirements, local

practices, and the type of assignment. However, a few basic principles and guidelines inform the development of any evaluation reference document.

The document then serves as the basis for a contractual arrangement between the commissioner of an evaluation and the external consultant(s) or in-house staff carrying out the work.

Reference document provides clearly detailed parameter about:

- Why and for whom the evaluation is being done
- What it intends to accomplish
- How it will be accomplished
- Who will be in involved in the evaluation?
- When milestones will be reached and when the evaluation will be completed
- What resources are available to conduct the evaluation?

| **Self-Check-4** | **Written Test** |
|---|---|

Name: _____ Date: _____

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

1. What is quotation and tender? How can we prepare customer quotation and tender?(8 pt )
2. How can we document details of future references? what is reference document?(8 pt )
3. How can we document details of costs and charges?(6pts)
4. List and explain ways of verifying costs, calculations and other details(6pt)

**Note: satisfactory Rating-14 and above pts. Unsatisfactory Rating-below 14 pts.**

You can ask your teacher for the copy of the correct answers

## REFERENCE


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- ✓ Lee, S. Trench, W. and Willis, A. (2005) Willis's Elements of Quantity Surveying Blackwell Publishing, Oxford.