

COSTING AND PROJECT EVALUATION USING NODOC



Three types of Capital cost estimates

- 1- Preliminary (approximate) estimates
- 2- Authorization (Budgeting) estimates
- 3- Detailed (Quotation) estimates



1- Preliminary (approximate) estimates

- Accuracy typically ± 30 per cent
- Used in initial feasibility studies and to make coarse choices between design alternatives.



2- Authorization (Budgeting) estimates

- accuracy typically $\pm 10 - 15$ per cent
- used for the authorization of funds



3- Detailed (Quotation) estimates

- accuracy ± 5 -10 per cent
- used for project cost control and estimates for fixed price contracts
- These are based on the completed (or near complete) process design, firm quotations for equipment, and a detailed breakdown and estimation of the construction cost.



Fixed capital

- The total cost of the plant ready for start-up. It is the cost paid to the contractors.

It includes the cost of:

- 1. Design, and other engineering and construction supervision.
- 2. All items of equipment and their installation.
- 3. All piping, instrumentation and control systems.
- 4. Buildings and structures.
- 5. Auxiliary facilities, such as utilities, land and civil engineering work.



Working capital

the additional investment needed, over and above the fixed capital, to start the plant up and operate it to the point when income is earned.

It includes the cost of:

- 1. Start-up.
- 2. Initial catalyst charges.
- 3. Raw materials and intermediates in the process.
- 4. Finished product inventories.
- 5. Funds to cover outstanding accounts from customers.



- Working capital can vary from
- as low as 5 per cent of the fixed capital for a simple, single-product, process, with little or no finished product storage;
- to as high as 30 per cent for a process producing a diverse range of product grades for a sophisticated market.
- A typical figure for petrochemical plants is 15 per cent of the fixed capital.



- Fixed capital is a once-only cost that is not recovered at the end of the project life, other than the scrap value.
- Most of the working capital is recovered at the end of the project. The total investment needed for a project is the sum of the fixed and working capital.



COST ESCALATION (INFLATION)

- used to update historical cost data makes use of published cost indices.
- $\text{Cost in year A} = \text{Cost in year B} \left(\frac{\text{Cost index in year A}}{\text{Cost index in year B}} \right)$



- To get the best estimate, each job should be broken down into its components and separate indices used for labor and materials.



Example:

$$C = 0.45E_q + 0.1C_i + 0.19C_n + 0.26D_i$$

where

- C = the composite index
- C_i = civil engineering index
- C_n = site engineering index
- D_i = design index



Caution

- All cost indices do not necessarily relate the true make-up of costs for any particular piece of equipment or plant; nor the effect of supply and demand on prices



RAPID CAPITAL COST ESTIMATING METHODS

- 1-Historical costs
- 2-Step counting methods



1- Historical costs

- An approximate estimate of the capital cost of a project can be obtained from a knowledge of the cost of earlier projects using the same manufacturing process.



- C_2 = capital cost of the project with capacity S_2 ,
- C_1 = capital cost of the project with capacity S_1 .
- The value of the index n is traditionally taken as 0.6; the well-known six-tenths rule.

$$C_2 = C_1 \left(\frac{S_1}{S_2} \right)^n$$



Caution

- Where UK, or other local, indexes and historical exchange rates are available, it is probably better to convert costs to the local currency using the rate of exchange ruling at the date of the costs and update using the local index:



2- Step counting methods

- Step counting estimating methods provide a way of making a quick, *order of magnitude*, estimate of the capital cost of a proposed project.
- The technique is based on the premise that the capital cost is determined by a number of significant processing steps in the overall process. Factors are usually included to allow for the capacity, and complexity of the process: material of construction, yield, operating pressure and temperature.



THE FACTORIAL METHOD OF COST ESTIMATION

- 1- Lang factors
- 2- Detailed factorial estimates



- Capital cost estimates for chemical process plants are often based on an estimate of the purchase cost of the major equipment items required for the process
- The other costs being estimated as factors of the equipment cost.



1- Lang factors

- The fixed capital cost of the project is given as a function of the total purchase equipment cost by the equation

- C_f = fixed capital cost

- C_e = the total delivered cost of all the major equipment items: storage tanks, reaction vessels, columns, heat exchangers, etc.,

$$C_f = f_L C_e$$

- f_L = 3.1 for predominantly solids processing plant
- = 4.7 for predominantly fluids processing plant
- = 3.6 for a mixed fluids-solids processing plant



2- Detailed factorial estimates

- To make a more accurate estimate, the cost factors that are compounded into the “Lang factor” are considered individually



Direct-cost items

- 1. Equipment erection, including foundations and minor structural work.
- 2. Piping, including insulation and painting.
- 3. Electrical, power and lighting.
- 4. Instruments, local and control room.
- 5. Process buildings and structures.
- 6. Ancillary buildings, offices, laboratory buildings, workshops.
- 7. Storages, raw materials and finished product.
- 8. Utilities (Services), provision of plant for steam, water, air, firefighting services (if not costed separately).
- 9. Site, and site preparation.



- The contribution of each of these items to the total capital cost is calculated by multiplying the total purchased equipment by an appropriate factor.



Note

- The accuracy and reliability of an estimate can be improved by dividing the process into sub-units and using factors that depend on the function of the sub-units



Indirect costs

- 1. Design and engineering costs, which cover the cost of design and the cost of “engineering” the plant: purchasing, procurement and construction supervision. Typically 20 per cent to 30 per cent of the direct capital costs.
- 2. Contractor’s fees, if a contractor is employed his fees (profit) would be added to the total capital cost and would range from 5 per cent to 10 per cent of the direct costs.
- 3. Contingency allowance, this is an allowance built into the capital cost estimate to cover for *unforeseen circumstances (labor disputes, design errors, adverse weather)*. Typically 5 per cent to 10 per cent of the direct



- The capital cost required for the provision of utilities and other plant services will depend on whether a new (green field) site is being developed, or if the plant is to be built on an existing site and will make use of some of the existing facilities.

