Estimation Levels - Introduction

Different types of estimates are required as a project evolves

- Conceptual and Preliminary Estimates
  - Prior to engineering design completion
- Definitive Estimates
  - forecast the project cost within allowable limits from a combination of conceptual and detailed information often including partial contract and other procurement awards
- Detailed Estimates (Engineer's and bidding)
  - Prepared from completed plans and specifications

Conceptual/Preliminary Estimates

Help decide feasibility

Very useful for rapid iteration of design plans

Great variability according to type

Categories:

Time-referenced cost indices

Cost-capacity factors

Component ratios

Parameter costs

Cost Indices

Show changes of costs over time

Changes in:

- Technology
- Methods
- Productivity
- Inflation

Both *input* and *output* cost indices available

Published periodically by Engineering News-Record and other publications

Input Cost Indices

Reflect price changes for a certain "basket" of goods

- Like Consumer price index

Very general

Problems

- May not reflect particular inputs of project
- Ignore productivity changes
- Ignore technology changes
- Competiveness of contractors (lowered overhead)

Cost Indices Component Calculations

ENR's Building Cost Index is computed as follows:

Components:

1,088 board feet of lumber (2x4, 20-city average)
2500 pounds of structural-steel shapes (20-city average, base mill price before 1996, fabricated after 1996
1.128 tons of Portland cement (bulk, 20 city average)
66.38 hours of skilled labor (20-city average of Bricklayers, Carpenters, and Structural Ironworkers)

Cost Indices Time Conversion

We convert from one base period to another

- "current cost" = 3802 (February 2019)
- Base cost (1913) = 100
- Index on 1913 base = 3802%

Example 1:

Warehouse estimate: Assume you have an estimate to a similar warehouse completed in 1978 for a cost of $4,200.000. We are planning to build the new one in 2019. The ENR index for 1978, relative to the base date of 1913, was 1654%

3802%/1654% x 4,200,000 = $9,654,413.54 ~ $ 9,650,000

Cost Indices Use and Accuracy

20% to 30% Accuracy
Negligible time and effort
Valuable for Preliminary Planning

Cost-Capacity Factor

Apply to changes in size, scope, or capacity of projects of similar types

Reflect the nonlinear increase in cost with size (economies of scale, learning curves)

$$C_2 = C_1 (Q_2/Q_1)^x$$

Where

C_2 = estimated cost of the new facility with capacity Q_2

C_1 = known cost of facility of capacity Q_1

x = the cost-capacity factor for this type of work

Cost-Capacity Factor II

X is empirically derived factors based on well-documented historical records for different kinds of projects

Q are parameters that reasonably reflects the size of the facility (barrels per day produced by a refinery, tons of steel per day produced by a steel mill, gross floor area for a warehouse, etc)

Cost-Capacity Factor Example

Consider the cost-capacity factor x = 0.8 for a warehouse.

We have available an estimate for a similar warehouse located nearby with a usable area of 120,000 square meter (from Example 1), cost $4.200.000 in 1978.

The prospective owner for the new warehouse wants a structure with a usable area of 150,000 square meter

An old process plant has a capacity to produce 10,000 gallons per day of a particular chemical. The cost today to build the plant would be $1M. The appropriate cost-capacity factor for this type of project is X = 0.6. What would be an estimate for a similar plant with a capacity of 30,000 gallons per day?

$$C_2 = C_1 (Q_2/Q_1)^X$$

$$C_2 = 1{,}000{,}000 * (30{,}000/10{,}000)^{0.6} \approx \$\ 1{,}930{,}000$$

Component Ratios

Focus on Major Equipment

- Compressors
- Pumps
- Furnaces
- Refrigeration Units
- Belt Conveyors
- Turbine Generators

“Equipment-Installation-Cost-Ratios”

“Plant-Cost-Ratios”

Cost-Capacity Factor Calculations

$$C_2 = C_1 (Q_2/Q_1)^x$$

Solution:

$C_2 = 4{,}200{,}000 \times (3802/1654) \times (150{,}000/120{,}000)^{0.8} = \$11{,}541{,}278$

Cost-capacity factor can be accurate to within 15 to 20% of actual costs

Component Ratios: Installation Cost

Multiply the Purchase Cost by Installation Cost Factor
+/- 10 to 20% Accuracy

Component Ratios Factors

Typical Equipment Installation Factors*

ITEM	INSTALLATION COST, %
Belt conveyors	20 - 25
Bucket elevators	25 - 40
Centrifugals, disk or bowl	5 -6
Top suspended	30 - 40
Continuous	10 - 25
Crystallizers	30 - 50
Dryers, continuous drum	100†
Vacuum rotary	150 - 200†
Rotary	50 - 100†
Dust collectors, wet	220 - 450†
Dry	10 - 200†
Electrostatic precipitators	33 - 100†
Electric motors plus controls	60
Filters	25 - 45
Gas producers	45 - 250
Instruments	6 - 300
Ion exchangers	30 - 275†
Towers	25 - 50
Turbine generators	10 - 30

* Adapted from F. C. Jelen (ed.), *Cost and Optimization Engineering*, McGraw-Hill Book Company, New York, 1970, p. 316.

† Includes accessories.

Component Ratios Plant Cost

Plant-cost-ratios use equipment-vendor-price-quotations

ITEM	COST		FACTOR	PLANT COST
Blowers and Fans	$ 10,000	×	2.5	$ 25,000
Compressors	50,000	×	2.3	115,000
Furnaces	100,000	×	2.0	200,000
Heat Exchangers	80,000	×	4.8	384,000
Instruments	50,000	×	4.1	205,000
Motors, Electric	60,000	×	8.5	510,000
Pumps	20,000	×	7.0	140,000
Tanks	125,000	×	2.4	260,000
Towers	200,000	×	4.0	800,000
Total	$ 685,000			$ 2,639,000

Parameter Costs Characteristics

Relates all costs of a project to jut a few physical measures, or "parameters", that reflect the size or scope of the project

Warehouse - the "parameter" would be "gross enclosed floor area"

With good historical records on comparable structures, parameter costing can give reasonable levels of accuracy for preliminary estimates

Parameter Costs Source Data

Commonly used in building construction

ENR "Quarterly Cost Roundup"

R.S.Means "Means Square Foot Costs"

NB: Different from *RS Means Building Construction Cost Data!*

Detailed Estimate

1. Break Project into Cost Centers
2. Estimate Quantities
3. Price out Quantities
4. Calculate Total Price