

COST ESTIMATION AND ECONOMIC ANALYSIS

A preliminary economic analysis is performed for the overall plan. Due to lack of recent data, different cost estimates are done based on cost indices and capacity. However, the present analysis will give a fair idea about the profitability of the plant.

Since the exact cost of the plant is not found, the calculations are done based on the purchased equipment cost.

Marshall & Swift Equipment cost Index:

| <i>Year</i> | 1993 | 2002 |
|-------------------|------|--------|
| Cost Index | 1000 | 1105.3 |

Cost of the equipment is given by;(3)

$$C_2 = C_1 \left(\frac{Q_2}{Q_1} \right)^n \left(\frac{C.I_2}{C.I_1} \right)$$

Where C_1, C_2 – Equipment costs.

Q_1, Q_2 – Capacity of the equipment

N – exponent.

8.1 Estimation of Capital Investment Cost:

I. **Direct Costs:** material and labour involved in actual installation of complete facility (70-85% of fixed-capital investment)

A. Equipment + installation + instrumentation + piping + electrical + insulation + painting (50-60% of Fixed-capital investment)

1. Purchased equipment cost (PEC): (15-40% of Fixed-capital investment)

| EQUIPMENT | No.s | COST IN Rs. |
|----------------------------|-------------|--------------------|
| Distillation Column | 2 | 40,00,000 |
| Condenser | 4 | 46,12,000 |
| Gas-Liquid Separators | 4 | 14,55,000 |
| Reboiler | 1 | 4,26,000 |
| Extractor | 1 | 14,55,000 |
| Solvent Stripper | 1 | 19,40,000 |
| Pumps | 5 | 10,10,000 |
| Clay Treator | 1 | 3,05,000 |
| Liquid-Liquid Seperator | 1 | 1,50,000 |

Total Purchased Equipment Cost(P.E.C): \approx **Rs. 1,50,00,000**

2. Installation, including insulation and painting: (25-

55% of purchased equipment cost(PEC).)

Consider the Installation cost = 45% of Purchased equipment cost

= 45% of Rs. 1,50,00,000

= $0.45 \times 1,50,00,000 = \text{Rs. } \underline{67,50,000}$.

3. Instrumentation and controls, installed: (6-30% of

Purchased equipment cost.)

Consider the installation cost = 20% of Purchased equipment cost

= 20% of 1,50,00,000 = $0.20 \times 1,50,00,000 = \text{Rs. } \underline{30,00,000}$

2. Piping installed: (10-80% of Purchased equipment cost)

Consider the piping cost = 60% Purchased equipment cost

= 60% of Purchased equipment cost = $0.60 \times 1,50,00,000$

= Rs. 90,00,000

4. Electrical, installed: (10-40% of Purchased equipment cost)

$$\begin{aligned}\text{Consider Electrical cost} &= 20\% \text{ of Purchased equipment cost} \\ &= 20\% \text{ of } 1,50,00,000 \\ &= 0.20 \times 1,50,00,000 \\ &= \text{Rs. } \underline{30,00,000}\end{aligned}$$

B. Buildings, process and Auxiliary: (10-70% of Purchased equipment cost)

$$\begin{aligned}\text{Consider Buildings, process and auxiliary cost} &= 40\% \text{ of PEC} \\ &= 40\% \text{ of } 1,50,00,000 = 0.40 \times 1,50,00,000 \\ &= \text{Rs. } \underline{60,00,000}\end{aligned}$$

C. Service facilities and yard improvements:

(40-100% of Purchased equipment cost)

$$\begin{aligned}\text{Consider the cost of service facilities and yard improvement} &= 70\% \text{ of PEC} \\ &= 70\% \text{ of } 1,50,00,000 \\ &= \text{Rs. } \underline{1,05,00,000}\end{aligned}$$

D. Land: (1-2% of fixed capital investment or 4-8% of Purchased equipment cost)

$$\begin{aligned}&= 6\% \text{ PEC} = 6\% \text{ of } 1,50,00,000 \\ &= \text{Rs. } \underline{9,00,000}\end{aligned}$$

Thus, **Direct cost** = A + B + C + D

$$= \text{Rs. } \underline{5,41,50,000}$$

II. **Indirect costs:** expenses which are not directly involved with material and labour of actual installation of complete facility (15-30% of Fixed-capital investment)

A. Engineering and Supervision: (5-30% of direct costs)

Consider the cost of engineering and supervision = 10% of Direct costs
i.e., cost of engineering and supervision = 10% of 5,41,50,000

$$= \text{Rs. } \underline{54,15,000}$$

B. Construction Expense and Contractor's fee: (6-30% of direct costs)

Consider the construction expense and contractor's fee = 15% of Direct costs

i.e., construction expense and contractor's fee = 15% of 5,41,50,000

$$= \text{Rs. } \underline{81,22,500}$$

C. Contingency: (5-15% of Fixed-capital investment or 20% to 40% of PEC)

Consider the contingency cost = 30% PEC

i.e., Contingency cost = 30% of 1,50,00,000

$$= \text{Rs. } \underline{45,00,000}$$

Thus, Indirect Costs = Rs. 1,35,37,500

III. Fixed Capital Investment:

Fixed capital investment = Direct costs + Indirect costs

$$= 5,41,50,000 + 1,35,37,500$$

i.e., Fixed capital investment = Rs. 6,76,87,500

IV. Working Capital: (10-20% of Fixed-capital investment)(FCI)

Consider the Working Capital = 15% of Fixed-capital investment

i.e., Working capital = 15% of FCI

$$= \text{Rs. } \underline{1,01,53,125}$$

V. Total Capital Investment (TCI):

Total capital investment = Fixed capital investment + Working capital

$$6,76,87,500 + 1,01,53,125$$

i.e., Total capital investment = Rs. 7,78,40,625

8.2 Estimation of Total Product cost:

Note that all the percentages are expressed on an annual basis.

I. Manufacturing Cost = Direct production cost + Fixed charges + Plant overhead cost.

A. Fixed Charges: (10-20% total product cost)

i. Depreciation: (depends on life period, salvage value and method of calculation-about 10% of FCI for machinery and equipment and 2-3% for Building Value for Buildings)

Consider depreciation = 10% of FCI for machinery and equipment and 2% Building Value for Buildings)

$$\begin{aligned} \text{i.e., Depreciation} &= (0.10 \times 6,76,87,500) + (0.02 \times 60,00,000) \\ &= \text{Rs. } \underline{68,88,750} \end{aligned}$$

ii. Local Taxes: (1-4% of fixed capital investment)

Consider the local taxes = 3% of fixed capital investment

$$\text{i.e. Local Taxes} = 0.03 \times \text{FCI} = \text{Rs. } \underline{2,03,062}$$

iii. Insurances: (0.4-1% of fixed capital investment)

Consider the Insurance = 1.0% of fixed capital investment

$$\text{i.e. Insurance} = 0.01 \times \text{FCI} = \text{Rs. } \underline{67,687}$$

iv. Rent: (8-12% of value of rented land and buildings)

Consider rent = 10% of value of rented land and buildings

$$= 10\% \text{ of } 9,00,000$$

$$= 0.10 \times 9,00,000$$

$$\text{Rent} = \text{Rs. } \underline{90,000}$$

Thus, Fixed Charges = Rs. 72,49,499

B. Direct Production Cost: (about 60% of total product cost)

⇒ Let Rs. X be the total product cost.

i. Raw Materials: (10-50% of total product cost)

Consider the cost of raw materials = 30% of total product cost

⇒ Raw material cost = 30% of X

⇒ Raw material cost = Rs. $0.3X$

ii. Operating Labour (OL): (10-20% of total product cost)

Consider the cost of operating labour = 15% of total product cost

⇒ operating labour cost = 15% of X

⇒ Operating labour cost = Rs. $0.15X$

iii. Direct Supervisory and Clerical Labour (DS & CL): (10-25% of OL)

Consider the cost for Direct supervisory and clerical labour = 20% of OL

⇒ Direct supervisory and clerical labour cost = 20% of $0.15X$
 $= 0.2 \times 0.15X$

⇒ Direct supervisory and clerical labour cost = Rs. $0.03X$

iv. Utilities: (10-20% of total product cost)

Consider the cost of Utilities = 15% of total product cost

⇒ Utilities cost = 15% of X =

⇒ Utilities cost = Rs. $0.15X$

v. Maintenance and repairs (M & R): (2-10% of fixed capital investment)

Consider the maintenance and repair cost = 5% of fixed capital investment

i.e. Maintenance and repair cost = $0.05 \times 6,76,87,500 = \text{Rs. } \underline{20,30,625}$

vi. Operating Supplies: (10-20% of M & R or 0.5-1% of FCI)

Consider the cost of Operating supplies = 10% of M & R

Operating supplies cost = 10% of $20,30,625 = 0.10 \times 20,30,625$

Operating supplies cost = Rs. $2,03,625$

vii. Laboratory Charges: (10-20% of OL)

Consider the Laboratory charges = 15% of OL

Laboratory charges = 15% of 2,03,062 = $0.15 \times 2,03,062$

⇒ Laboratory charges = Rs. 30,460

viii. Patent and Royalties: (0-6% of total product cost)

Consider the cost of Patent and royalties = 5% of total product cost

⇒ Patent and Royalties = 5% of X

⇒ Patent and Royalties cost = Rs. 0.05X

Thus, Direct Production Cost = Rs. 0.68X + 22,64,147

C. Plant overhead Costs (50-70% of Operating labour, supervision, and maintenance or 5-15% of total product cost); includes for the following: general plant upkeep and overhead, payroll overhead, packaging, medical services, safety and protection, restaurants, recreation, salvage, laboratories, and storage facilities.

Consider the plant overhead cost = 10% of total product cost.

Plant overhead cost = Rs. 0.1X

Thus, Manufacture cost = Direct production cost + Fixed charges + Plant overhead costs.

Manufacture cost = $72,49,499 + 0.68X + 22,64,147 + 0.1X$

Manufacture cost = Rs. $95,13,646 + 0.78X$

II. General Expenses = Administrative costs + distribution and selling costs + research and development costs

A. Administrative costs: (about 15% of costs for operating labour, supervision, and maintenance or 2-6% of total product cost); includes costs for executive salaries, clerical wages, legal fees, office supplies, and communications.

Consider the Administrative costs = 4% TPC

Administrative costs = $0.04X$

Administrative costs = Rs. 0.04X

B. Distribution and Selling costs: (2-20% of total product cost); includes costs for sales offices, salesmen, shipping, and advertising.

Consider the Distribution and selling costs = 10% of total product cost

Distribution and selling costs = 10% of TPC

⇒ Distribution and selling costs = 0.1X

C. Research and Development costs: (about 5% of total product cost)

Consider the Research and development costs = 5% of total product cost

Research and Development costs = 5% of X

⇒ Research and development costs = $0.05 \times X$

⇒ Research and Development costs = Rs. 0.05X

Thus, General Expenses = Rs. 0.19X

IV. Total Product cost = Manufacture cost + General Expenses

$$X = 95,13,646 + 0.78X + 0.19X$$

$$X = 31,71,21,533$$

Total product cost = 31,71,21,533

V. Gross Earnings/Income:

= total income – total product cost

estimation of total income:

Wholesale Selling Price of toluene per kg. = Rs. 75 /Kg

Annual working days = 330 days

Therefore annual toluene production = 250 x 300

=75,000 tons/year

Total Income = Selling price × Quantity of product manufactured

$$= (75 /\text{kg}) \times (250 \text{ T/day}) \times (1000 \text{ kg/T}) \times (330 \text{ days/year})$$

Total Income = Rs. 5.625×10^9

$$\begin{aligned}\text{Gross income} &= \text{Total Income} - \text{Total Product Cost} \\ &= (5.625 \times 10^9) - (317,12,133)\end{aligned}$$

$$\text{Gross Income} = \text{Rs. } \underline{530,78,78,476}$$

Let the Tax rate be 40% (common)

$$\begin{aligned}\text{Taxes} &= 40\% \text{ of Gross income} \\ &= 40\% \text{ of } 530,78,78,476\end{aligned}$$

$$\text{Taxes} = \text{Rs. } \underline{212,31,51,387}$$

$$\text{Net Profit} = \text{Gross income} - \text{Taxes} = \text{Gross income} \times (1 - \text{Tax rate})$$

$$\text{Net profit} = \text{Rs. } \underline{318,47,27,080}$$

(a) Rate of Return:

$$\text{Rate of return} = \text{Net profit} \times 100 / \text{Total Capital Investment}$$

$$\text{Rate of Return} = 318,47,27,080 \times 100 / (7,78,40,625)$$

$$\text{Rate of Return} = \underline{40.91\%}$$

(b) Break even Analysis:

Data available:

$$\text{Annual Direct Production Cost} = \text{Rs. } 31,71,21,533$$

$$\text{Annual Fixed charges, overhead and general expenses} = \text{Rs } 9,92,14,743$$

$$\text{Total Annual sales} = \text{Rs. } 5.625 \times 10^9$$

$$\text{Wholesale Selling Price of toluene per kg.} = \text{Rs. } 75.00$$

$$\begin{aligned}\text{Direct production cost per kg. of touene} &= (31,71,21,533) / (5.625 \times 10^9 / 75) \\ &= \text{Rs. } \underline{4.228} \text{ per kg.}\end{aligned}$$

Let 'n' TPA be the break even production rate.

Number of kg. needed for a break-even point is given by

$$\text{Fixed charges} + \text{direct charges} = \text{selling cost}$$

$$(9,92,14,743) + (4.228 \times n) = (75 \times n)$$

$$n = \underline{1401892.56} \text{ kg/year}$$

$$n = 1401.89 \text{ tons/year}$$

$$n = \underline{4.5} \text{ tons/day} = \underline{5} \text{ TPD}$$

Hence, the break even production rate is 5 TPD or 2% of the considered plant capacity.