

REPRINT

BM/207

1983 1168

45

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Published in :

'INDIAN PLANNER & BUILDER'
Vol. 2, No. 11—January 1983

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ABSTRACT

The paper proposes a simple way of estimating the predesign or pre-construction cost involving capital investment and cost of production. Cost estimates and the limits of profitability are basic to every manufacturer before taking up a process for establishing an industry. A procedure has been suggested for finding out investment on plant on basis of cost of purchased equipment particularly for small scale building material industries. The method of computation of working capital, manufacturing cost and expected profitability are also presented.

Though the main works of a researcher is to do the bench scale experiments and that of an engineer is to design the plant for production of a new product a very important aspect is the economic evaluation by means of which both can visualize their technical efforts in terms of cost and profit and direct their work towards greater productivity at lesser cost.

Cost estimating is a form of predicting something that has not yet happened, it is peculiarly subject to wishful thinking. Estimates are useful principally as evaluation tools. Generally two types of estimates are in practice. First is preliminary estimate known as predesign cost estimate^(1,2,3). The second is manufacturing cost estimate or construction cost estimate. In this paper a simple technique for cost estimation has been discussed as for a predesign or preconstruction cost estimate is concerned along with some examples regarding building material production processes. The main aim of a predesign estimate is assessment of capital required and expected profitability from particular process before it being taken up in practice finally. These estimates may also be used in size optimization⁽⁷⁾.

A predesign cost estimate is defined as cost estimate not based on firm design information and made prior to submission on quotations of equipment. Calculations are usually based on flow schemes⁽⁸⁾. The cost of equipment may be found out using 0.6 scaling up or scaling down factor^(1,13,15,16).

After assessing the cost of equipments to be purchased the cost of plant is determined by the use of indices differ for different types of industries^(1,5). By means of case studies of several processes the values of indices for building material industries were found which are different from those for chemical industries mentioned in some books^(11,13,16) and have been given in

Table 1. Table 2 indicates values of indices for building material industries. For the sake of clarity one example is given in Table 2A knowing the type and the size of plant and equipment, requirement of land, building and shed is found out and thereafter knowing the prevailing rates at a particular place the fixed capital on land and building is calculated. The sum of the fixed capital on land and building and the fixed capital on plant is known as fixed capital investment⁽¹⁴⁾.

For economic evaluation of proposed investments working capital⁽¹⁰⁾ must be defined as the funds, in addition to fixed investment, which a company must contribute to the project. These must be adequate to get the plant operating and to meet subsequent obligations as they come due. Current assets to be considered in this head are made up chiefly of cash, accounts receivable inventories and negotiable securities. For simple projects like building material production about 20-25% of annual sales may be kept reserved to be used as working capital⁽¹⁷⁾.

The evaluation of a new process plant must include not only an estimation of capital expenditure but also determination of operating or manufacturing cost with an ultimate indication of profit^(6,12).

All the operating expenses may be quantitatively related to raw materials, utilities, labour and equipment. Factors which may be used for estimating purposes have been discussed in the following lines. These are of two types (i) Direct and (ii) Indirect.

Raw Materials :

The first direct expenditure incurred in chemical production is the purchase of raw material. About one third to one half of operating expenses is material costs. Raw material costs may be computed by having suppliers quotations or the prices published in Journals like Chemical Times, Economic Times, Builder's Friend

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etc. As raw material the naturally occurring material or waste material should be taken, as far as possible as it is seen in some cases that economy is achieved by doing so. For example, if lime is purchased from the market for production of lime products the cost of production is expected to be higher than if limestone is purchased and calcined in lime kiln by the manufacturer of lime product. Similarly in production of Gypsum plaster boards the cost of production is higher when calcined Gypsum is purchased as raw material and it is calcined by the manufacturer of gypsum plaster boards in a kettle or open pans.

Utilities :

This is the second major direct cost which consists of electric power, water, fuel, bagging etc. utility costs are highly variable being dependent not only on the consumption but also on plant location. The services may be supplied through any one of the following methods :

- (i) the utility may be purchased at established rates and the cost for actual requirement is to be considered. This is applicable only in case of industries, established in factory area or industrial township. Manufacturing units of paints, pigments, mortars etc. come under this category.
- (ii) the services may be produced within the company and then utilized in production the cost of installation may be included in the capital cost of plant and the appropriate operating charges in cost of production. For example a tubewell is installed for supply of water by a brick manufacturer. Although it is desirable to make the estimates based on more accurate service rates, which differ from place to place, for predesign estimates rates given in Table 5 may be used for present Indian conditions.

Labour and Supervision :

This is a major expense involved in the manufacturing costs and is roughly 1/6th of total operating cost or cost of production. One Supervisor-cum-Manager is needed in every industrial unit how-so-ever small it may be. His duty is to look after every section including administrative and sales aspects. The second category under this head is operators for various equipments. Thirdly skilled labour is necessary because personnels are trained for a particular job and then employed on monthly basis. The fourth and last category is daily wage mazdoors for miscellaneous jobs. In small scale industries it has been observed that expenditure on supervision is 8-10% of labour.

Maintenance and Repair :

A considerable portion of direct expense is incurred by direct maintenance which includes cost of all the materials, labour and supervision employed, the inci-

idental repairs of equipment and building are also included in it. Although these expenditures are difficult to anticipate these vary between 2-10% and may be taken 6% of plant cost for predesign estimates and 2% of building and shed cost as maintenance and repair charges.

Operating Supplies :

This item is often confused with maintenance and repair but it actually denotes expenses incurred due to obsolescence and normal wear such as gaskets, valves, lubricants, charts etc. This is considered to be a separate expenditure and is about 10-15% of maintenance and repair cost.

Indirect Expenses :

Plant overhead cost (8-14) : such expenses involve technical and analytical services, hospital facilities, transportation, wastage, maintenance of roads and yards, general engineering, safety services, janitor and similar services, lighting and inter plant communications, shops and ware houses, shipping and receiving facilities. These expenses are closely related to the labour cost directly connected with production operation. The plant overhead cost is about 20-50% of total expenses on labour and supervisor involved in operation or maintenance and repair. It is a sort of indirect expenditure and cannot be neglected.

Fixed Costs :

This is the second type of indirect expenses. This is independent of the production. In other words, the expenditure must be paid whether or not the plant operates. Such costs are based entirely on the magnitude of investment.

Depreciation :

Depreciation is an attempt to write off cost of equipment, buildings and other material possessions. Though there are several methods of calculating depreciation of equipment and building, as their values go on decreasing with time, for preliminary cost estimation 10 % of plant cost and 2.5 % of building cost may be taken as depreciation.

Administrative Costs :

Salaries of executives, clerical staff, cost of stationery and general administration to keep records, future planning etc. are considered under this head. Some amount out of annual sales should be allotted for this purpose. For building material industry it is taken about 2% of annual sales and may be applicable to other similar small scale industries.

Distribution and Selling Costs :

For every product specially for a new one, proper advertisement and publicity is a must. In some cases proper agents are to be contacted. As a principle it is

necessary to sell all the products as soon as possible to maintain the profitability and economy. The amount to be spent under this head depends on type of product and nature of selling. For predesign estimation it may be taken as 2% of annual sales.

Interest on investment :

When the capital investment is supplied directly from entrepreneurs pocket, interest on owned money cannot be charged as a cost. However in predesign estimates the interest may be included as cost. Interest on capital investment e.g. long term loan may be taken 11% per annum and on working capital 15% per annum because this loan is taken for one year only. These rates are based on Industrial development financiers and are some what less than that of loans taken from banks.

Taxes and Insurance :

Local property taxes are dependent on the locality in which the plant is situated and may be taken 1-2% of fixed capital. Similarly insurance fees vary from plant to plant and may be taken 1-2% of fixed capital. For predesign cost estimates both combined together may be taken as 2% of fixed capital.

Profit :

The sum of direct, indirect and fixed expenditures in production cost indicates the total annual cost of production. When this is subtracted from gross annual income or annual sales the value of annual return is obtained. Thereafter on the basis of total capital investment the percentage return is obtained. Thus we get the profitability before income tax or sales tax.

Discussion :

From Table No. 3 containing the data about cost economics of various projects the following conclusion are drawn :

1. The fixed capital on plant is in the range of 15-40% of total capital investment because cost of purchased equipment as well as ancillaries is much lower than that in chemical production.
2. The highest turn over ratio is in the case of products, the price of which may be fixed on higher side and fixed investment is lower, as in the case of plastic masonry paint (Table 3).
3. For cement and clay products the turn over ratio is less reported in American and British literature. The turn over ratio is higher than this as it is obvious from the Table 3.
4. An idea of investment at a glance may be given to an entrepreneur, knowing approximate cost of purchased equipment as from table 3 we see than the ratio of total investment to purchased equipment varies between 4-10 (Table 3).

5. Sometimes cost of purchased equipment is confused with fixed capital on plant but from Tables 2 and 3 it is obvious that fixed capital as plant is more than twice the cost of purchased equipment.

After calculations of cost of production direct, indirect and fixed expenses one can verify the various expenditures from Table 4, though sufficient experience is required to get the true worth of the answer, because the estimate discussed is based on many assumptions requiring a close scrutiny. Every possible way should be followed to check the preliminary estimate to avoid serious errors in budgeting. Usual practice is to start with plant calculations because most of the fixed expenditure in manufacturing cost depends upon the investment. The return on investment, which is percentage ratio of annual return to total capital investment, should be kept about 20%.

Conclusion :

The preliminary cost estimation may be done on the basis of the cost of purchased equipment using the percentages as given in Table 2 for small scale building material industries. The cost of production can be worked out taking direct, indirect and fixed expenditures separately and then adding them together. An idea of percentage return on investment may also be obtained fixing the selling price of the material as per present demand in the market. This method of predesign estimates would also give an idea about selection of the site, procurement of raw materials and sale prospects in the market.

Acknowledgement

The author is thankful to Dr. Mohan Rai for suggestions and guidance. The paper is being published with kind permission of Director, Central Building Research Institute, Roorkee.

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TABLE-1

Ratio factors for estimating fixed capital on plant based on delivered equipment cost (for chemical plants).

	Average small scale plant	Full Chemical plant
1. Purchased equipment	100	100
2. Equipment erection	30	39
3. Electrical installation	15	10
4. Process piping	15	30
5. Insulation	8	—
6. Instruments and controls	10	28
7. Water services and drainage	10	10
8. Laboratory and workshop	10	35
9. Engineering and supervision	10	32
10. Premium	—	—
11. Contingency 15% of fixed capital on plant.	35	37
	<u>243</u>	<u>322</u>

TABLE-2

Ratio factors for estimating plant cost based on delivered equipment cost (for Building material plants).

1. Purchased equipment	100
2. Equipment erection	10
3. Process piping	5
4. Insulation	Not required
5. Electrical installation	10
6. Instruments and controls	5
7. Water services and drainage	5
8. Laboratory and workshop	5
9. Engineering and Supervision	10
10. Premium	—
11. Contingency 10% of item 1 to 10	15
	<u>165</u>

TABLE-2(A)

Case Study of Semi-mechanized Brick Plant at Ahmedabad

Content	Pre-design Estimates	Actual Expenditure (Data Obtained from owner of industry)
A. Fixed capital on land & Building :		
i) Land	On lease	On lease
ii) a) Building	150 sq.m. @ Rs. 400/m ² =60,000	Machine shed 99.85 sq.m. =24,000
b) Shed	200 sq.m. @ Rs. 300/m ² =60,000	Clay shed 99.85 sq.m. =22,000
iii) Central Shed	200 sq.m. @ Rs. 100/m ² =20,000	Central shed 2675 sq.m. =19,000
iv) Yard Improvement (L.S.)	4000	Building 161 sq.m. =67,500
	<u>A=1,44,000</u>	<u>A=1,34,500</u>
B. Fixed capital on plant :		
Brick Kiln	40,000	40,000
Drying & Kiln Shed	7,00,000	5,60,000
1) Purchase Equipment		
Brick Machine	1,20,000	1,20,000
Kiln Accessories	35,000	35,000
Material handling equipment	14,000	14,000
I.D. Fan and Motor	25,000	25,000
Tube Well	25,000	65,000
∴ P.E.	= <u>2,19,000</u>	<u>2,59,000</u>

2) Erection cost	20,000	10,000
3) Electrical Installation	20,000 (10% of P.E.)	20,000
4) Instruments & Control	10,000 (5% of P.E.)	3,500
5) Water services & Drainage	10,000 (5% of P.E.)	6,000
6) Laboratory & W/s	10,000 (5% of P.E.)	10,000
7) Engg. & Supervision	10,000 (5% of P.E.)	—
8) Contingency 10% of item 1 to 7	29,400	30,000
∴ Fixed capital on plant B.	10,68,400	9,38,500 (12% less pre estimated expenditure)

TABLE—4

Break up of cost of production

Raw material	25-50% of cost of production
Labour	20-35% of cost of production
Maintenance and repair	6% of plant cost (item 1,3,4,5,6,7,8 in Table 2)
Operating supplies	2% of building and shed cost 10% of Maintenance and repair
Taxes and Insurance	2% of fixed capital
Overheads	20-50% of labour and supervision and maintenance and repair.
Depreciation	10% of plant cost (1,3,4,5,6,7,8 in Table 2) 2.5% of building and shed cost.
Administrative expenses and selling expenses	2% of Annual sales distribution and selling expenses 2% per annum on fixed capital 15% per annum on working capital.

TABLE—5

Average cost of utilities in India.

Electric power	Rs. 0.30/- KWH
Water	Re. 1/- KL
Coal	Rs. 500/- tonne
Jute bags	Rs. 30/- tonne or Rs. 1.50 per bag when purchased lump sum.

TABLE—3
Economic Data of some building material production processes :

Sl. No.	Project	Fixed capital on land & building (A)	Purchased equipment	Fixed capital on plant (B)	Working capital (C)	Total capital investment (A+B+C)	P.E. as %age of (I)	Ratio of P.E. to (I)	Annual Sales	Turn over ratio
1.	Plastic Masonry Paint	2,00,000	1,34,000	2,22,000	9,31,000	11,73,500	19%	8.7	37,26,000	3.1
2.	Corrosion Inhibiting Pigment	86,250	25,000	52,940	1,02,750	2,41,940	22%	9.6	4,11,000	1.7
3.	Wood Wool Boards	1,52,600	87,000	1,32,000	2,81,250	5,65,850	23%	6.5	11,25,000	1.98
4.	Improved bricks from black soils	30,000	75,000	1,10,000	3,09,000	4,49,000	24.5%	5.9	10,46,100	2.3
5.	Gypsum Plaster Boards	7,26,700	1,34,000	2,04,000	4,46,000	13,77,000	15%	10.1	17,85,600	1.3
6.	Clay Flyash Bricks	15,000	60,000	87,000	2,73,600	3,75,600	23%	6.26	10,94,400	2.9
7.	Activated Lime Pozzolana Mixture	1,60,000	2,84,000	4,49,500	6,09,500	14,46,500	30%	5.0	33,48,000	2.3
8.	Hydrated Lime	2,10,000	3,69,000	5,84,000	7,94,000	14,60,000	40%	4.0	26,94,000	1.8