OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

05888

Distr.
LIMITED

ID/WG.191/12
20 August 1974

ORIGINAL: ENGLISH

United Nations Industrial Development Organization

Expert group meeting on the selection of
equipment for the sugar processing industry
Vienna, Austria, 25 - 28 November 1974

INDUSTRIAL FEASIBILITY CALCULATIONS IN THE SUGAR INDUSTRY 1/

by

Frank H.C. Kelly *

* Sugar Technologist, Nambour, Queensland, Australia.

1/ The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

SUMMARY

The objects of an investment need clear definition.

Five distinct stages of a feasibility study can be identified involving increasing amounts of information, increasing precision of predictions and increasing cost of evaluation. It is not essential to perform each stage separately and there may be merging.

Checking of estimates involves relating to known existing installations. Scaling for size and factors for new site location need evaluation.

Means for improving the reliability of estimates are mentioned.

Auxiliary equipment especially in terms of service facilities requires separate evaluation.

The time-value of money in terms of cash-flow concept is mentioned.

Sources of information for estimating and use of check lists need to be identified.

Items of concern in manufacturing cost estimates are listed.

The place of insurance requires understanding of factors involved.

By-product and waste-product costing has special seasonal features in the sugar industry.

Profitability may or may not be the main criterion of success since business systems vary widely with differences in political and economic philosophy as well as cultural background.

A. Introduction

A feasibility study may be defined as an investigation of all phases of a proposal for investment in as much detail as is necessary to decide whether to drop it or continue the expenses through the next stage of development.

Such a study may apply to an entirely new plant or to the replacement of some major section of an existing plant. To a lesser degree of course it applies to any new expenditure of money no matter how small it may be.

There may be one of three main reasons for establishing a new sugar factory viz:-

1. As a financial investment
2. As a service to the community
3. To develop a new area of country

In fact there may often be motivation towards two or even all three of these reasons. It is wise however first of all to itemise the reasons for the proposal and to define as far as possible the objectives with some kind of time factor stages of achievement. This can later be used for checking the progress and perhaps modifying the schedule or even the objectives.

This discussion will be essentially in terms of a financial investment for which the object may be defined as the maximisation of profit in relation to investment employed.

There are undoubtedly other measures which can be used to judge the profitable growth of an enterprise, such as return on sales but ultimately maximising the profit gives the best measure of profitability as far as the initial providors of capital are concerned.

Capital investment proposals require a sequence of decisions which

must be made with great care and step by step study of the effects of these decisions.

To study effects of a decision involves also a consideration of alternatives which may be summarised in three simple words:- (a) Yes, (b) No, (c) Perhaps. The third alternative would involve considering real issues in alternative directions and when all possible alternatives are set out it becomes a matter of Yes-No decision for each in turn.

B. Stages of Feasibility Studies

Five stages in an ordered series of feasibility studies can be recognised each successive stage increasing in cost but also giving a more reliable estimate of the magnitude of investment that will ultimately be required. Sometimes one or two of these steps may be omitted or merged.

A matter of substantial difficulty in all cost estimations is to predict the rate of inflation which may be moderate, medium or high with different numbers fitting these categories. The best economists in the world are unable to give satisfactory predictions in this field, nevertheless it must be included in the time factor scale. The longer the time between the initial survey and the purchase of equipment the greater the effect of inflation. Deflation is always a possibility but not a current phenomenon.

C. Feasibility Study Stage I

An order of magnitude estimate to prescribe the scope of operations. This involves specifiying the nature of the raw material and product, the purpose of the investment, capacity, location and site requirements. Utility and service requirements together with building and auxiliary requirements should be itemised. The handling of raw material and product as well as storage requirements should be specified.

The precision of the most probable cost is very low at this stage and lies anywhere within a range of ±30% or even wider of the ultimate

mark.

The cost of such a study estimate is relatively modest varying perhaps over the range US$1000 to $5000 depending on the magnitude of the ultimate investment and the accessibility of reliable information.

D. Feasibility Study Stage II

A more detailed study estimate would involve a closer study of costs with respect to location, some rough sketch plans with preliminary sizing and material specifications. The approximate sizes and type of construction of buildings and rough estimates of quantities of utilities of which water supply is probably the most important for a sugar factory.

A preliminary flow sheet should be drawn up including forecasts of such items as piping, insulation, electric motors and wiring and sundry auxiliary equipment as well as the main items of plant units.

An estimate of engineering services and drafting requirements should be made at this stage.

It should reasonably be expected that at this stage the most probable final cost would be within ±30% of the estimated cost.

The cost of producing this estimate would probably lie between $3000 and $25000 depending on the amount of detail included. The greater the detail the more accurate should be the forecast. This type of study merges into the next.

E. Feasibility Study Stage III

At this stage a budget for development is authorized and study proceeds to areas additional to those itemized for Stage II. These include a general description of the site with soil bearing information. The location and dimensions of railroads, roads, impounds, fences and preliminary

cost of development.

The process flow sheet now becomes more specific with more detailed information on sizing and arrangement.

Building sketches can now include foundations sketches, architectural and construction information as well as preliminary structural design.

Utility requirements should be prescribed in terms of a preliminary heat and materials balance for the flow sheet.

A preliminary list of instrumentation should be prepared.

On the electrical side the number of substations, their size and general specifications should be set out together with the preliminary lighting specifications.

A better estimate of the engineering services and drafting requirements should be possible at this stage.

The resuults of estimates at this stage should be reliable to within ±20% of the ultimate cost.

The cost of producing stage III information can be expected to lie between $20000 and $50000 again with provision for a higher cost if more detail is included, but with the expectation of a more reliable forecast.

F. Feasibility Study Stage IV

Before proceeding with this stage a real decision must be made as to whether stage IV should or should not be undertaken as it involves heavy financial cost and related commitment. It is almost the point of no return as far as the project is concerned and may be referred to as the project control estimate.

Information would be more detailed for the items listed under stage III.

Additionally there would be required a well developed site plan and topographical map.

The process flow sheet would now have to include engineering details.

Equipment would need preliminary engineering specifications.

Buildings require general arrangements to be set out and elevations specified.

The heat and materials balance related to the flow sheet would need to be calculated in greater detail in engineering terms. Piping lay-outs and schedules require to be specified. The equipment and piping to be insulated need to be itemised and the insulation itself to be specified and scheduled.

Instrumentation must be specified in more detail with respect to engineering specifications together with their functions in the detailed flow sheet.

Electrical equipment should be listed in detail with correct engineering specifications with greater detail than included at stage III. Technically prepared line diagrams for power and lighting distribution.

Engineering and drafting will be in greater detail and require more investment.

The reliability of the forecast at this stage should be expected to be within ±10% of the ultimate cost and the cost of preparing the information would probably lie within the range of $100000 to $200000 for complete factories and $25000 to $100000 for major items of equipment such as a complete milling train or steam generator facility.

G. Feasibility Study Stage V

This stage involves drawing up detailed specifications of all items of plant, buildings and transport and service facilities for the purpose of obtaining firm estimates.

This is generally a distinct stage fromm that of calling tenders but there may be a merging.

Costs can be expected to become as reliable as is possible with respect to general market conditions and a reliability approaching ±5% is to be expected.

H. General Observations

Unfortunately the influence of inflation, political decisions, disasters (floods, earthquakes etc.) and other unforseen factors of major consequence are almost impossible to predict. Even a world industrial depression is not impossible. Such factors introduce significant hazards into the reliability of forecasting. Inflation indexes covering 50 years of industrial activity are obtainable for American and British conditions and no doubt also from other developed countries. Forecasting nevertheless is still hazardous.

Nevertheless investment will continue and the elements of good business accumen of imponduable value must be part and parcel of all new ventures.

Costing of preparing later stage feasibility studies is frequen'ly done on a percentage basis by consultants with minimum basic costs for small parcels of work. On the other hand there may be fixed fee agreements such as for example to an expert or group of consultants for an opinion on information already gathered.

Care must always be exercised to examine the influence of vested interests in preparing feasibility studies and cost estimates. It is impossible to completely avoid vested interest of some type or another.

The important thing is to recognise it and as far as possible evaluate its effect.

I. Checking or Estimates

An independent opinion on each stage of a feasibility study is always worth obtaining. The cost is usually marginal with respect to the final investment and the information can be of substantial value in the decision making processes.

Too often endeavours are made to get such information at no-cost. This can reasonably be expected to be of no-value.

Cost estimates are almost invariably related to some previous installation. There will always be a first installation especially in developing countries which involves some prescience.

Often it is desired to estimate the effect of changes in the scale of operation. An empirical relationships has been observed between the cost and size of a facility which is known as the "six-tenths factor". According to this relationship, as facility size increases, its cost increases thus:-

$$\frac{\text{cost}_1}{\text{cost}_2} = \left(\frac{\text{size}_1}{\text{size}_2}\right)^n$$

where exponent n = 0.6

An exponent of 0.7 is often equally applicable and other exponents are also used. Its use in this form is chiefly of value for stage I or stage II studies where the order-of-magnitude is being estimated.

Sometimes such a mathematical technique is employed for individual unit size-costing. Exponents are rather more variable and uncertain when it is broken down to smaller units.

For example the exponent may vary between 0.7 and 0.98 for pumps, whereas it may be as low as 0.4 for tanks. A figure of 0.5 for evaporators and moderate sized heat exchangers.

For piping if we take cost vs diameter squared then an exponent of the order of 0.7 may be satisfactory for small sizes and 0.9 for large sizes. On the other hand a simple cost-diameter relationship may require an exponent exceeding unity and perhaps as high as 1.2.

As for other technical cost problems skill and experience are important ingredients.

Endeavours have been made to increase the reliability of size-cost predictions, one such formula being:-

$$C_n = f\, c^{0.6}\, D + I$$

where C_n is the cost of the new plant
f is a lumped cost index relative to the original plant
D is total direct cost
I is total indirect cost

The factor f is estimated to consist of such items as labour cost (e.g. 0.7), a labour efficiency index (e.g. 0.6) and a material and equipment cost index (e.g. 1.5).

The value of f would then be:-

$$f = 0.7 \times 0.6 \times 1.5 = 0.63$$

Different weightings may be given to the influence of labour and material costs. Such decisions are rather subjective and dependent upon the skill and experience of the estimator.

The size-cost exponential relationships are useful but can be hazardous, on the other hand they are probably the best way we have for handling this type of problem. The technique actually used for the calculations and the magnitude of exponents used should be clearly recorded in the feasibility studies.

J. New Locality Costs

It is common experience to require the cost of a new plant of

the same capacity but at a new location. This introduces additional financial hazards but one technique for this type of calculation is phrased in the following mathematical formula:-

$$C_n = [f_E\ E + f_M + f_L\ e_L\ (E_L + M_L)]f_I\ \frac{C}{C-I}$$

where C = original plant cost

f_E = current equipment cost index relative to cost to equipment E

f_M = current material cost index relative to cost of material M

f_L = current labour cost index in new area relative to cost of equipment labour E_L and material labour M_L

e_L = labour efficiency index in new area relative to efficiency of E_L and M_L

f_I = factor for indirect expenses which adjusts for variation in engineering and field expense (varies between 0.9 and 1.05)

Because the respective cost indexes are frequently not the same, equipment and material costs are treated separately.

K. Improving Reliability of Estimates

The reliability of estimates may be improved by breaking down the size of the costed plant to individual units and components as far as is practicable.

Standardisation of a code of accounts and feedback of cost data from actual construction projects permits accumulation of usable unit cost data for authorization estimates. This relates also to such construction data as concrete installations, structural steel erection, lighting, insulation, piling and so on.

Costing may then be broken down to individual functions as with the case of piping for example where one technique is to operate on a factor of "cost per joint". Components of total installed piping may be

subdivided into (1) material - pipe, valves, fittings, buts, bolts, gaskets and hangers; (2) labour - cut, erect, align, fit, bolt, thread and weld, and test; and (3) indirect costs - handle and haul, store, scaffold, lost time, tools and rentals, contractor's overhead and profit.

Factors which are attributed to labour include man-hours, craft rate, productivity, height and competency.

The crafts involved in the erection of piping include pipe-fitters, labourers, carpenters, warehousemen, teamsters, and operating engineers.

More simple factoring techniques may be used where neither flow sheet nor detailed piping drawings are available. These involve a factor by per cent of equipment value and the per cent of total plant installed. These methods are based strictly on experience gained from piping costs from similar installations previously made and costed.

L. Auxiliary Equipment

This term is commonly used to refer to all structures equipment and services which do not enter directly into the process and fall into two broad categories:- utilities and service facilities. The steam generating facilities may or may not be included as auxiliary equipment for a sugar factory depending upon personal preferences. Electricity, water, storage facilities and air-conditioning would be auxiliary equipment and services.

M. Cash Flow Concept

Present day cost estimates take into account the time value of money. Money can be put to work as soon as it is available to earn interest. The longer cash must be invested before it starts to earn interest the less beneficial it is to the owner.

Time value of money has been integrated into investment evaluation

systems by means of compound interest relationships.

This is a specialised and somewhat complex aspect of financing of investments and it is not intended here to do more than mention a few leading points.

Key cash flow-items are depreciation according to the financial technique preferred, taxes, working capital, raw material stock values, labour, utilities, finished product values, freights and accounts receivable.

The liquid investment working capital is the net sum of five items - inventories, accounts receivable, accounts payable, taxes payable and cash.

N. Information for Estimating

Tables, charts, indexes, cost codes and other relevant data are available to provide information for estimating. These may be obtained from handbooks, local authorities, national institutes or related sources.

Information should be reduced to terms of a common cost code used for the particular installation and understandable to both customer and vendor each of whom would have his own specialists handling this area of operations.

Check lists of items for fixed capital cost estimating are available from handbooks or may be prepared especially for sugar industry installations. A great deal of information of this character is available for the chemical industry especially in U.S.A. but there would seem to be scope for documentation and specialised treatment for the sugar industry.

O. Manufacturing Cost Estimation

A complete cost analysis must cover a great many items and whereas check lists of a general character for the chemical industry are also available for preparing these estimates a comparable one of more specific

application to the sugar industry would be of value.

Generally these items are summarised under the following group headings:-

Materials
Labour
Plant overhead
Distribution costs
Marketing costs
Administration expenses

When an investment proposal is to be justified, manufacturing cost estimates may be necessary for both a proposed new installation and a comparison with an existing operating installation. This enables target figures for the new installation to be specified and degree of achievement defined.

Costing utilities is extremely difficult in the sugar industry and more so in the case of a cane sugar mill than with a beet sugar factory or a separate refinery. The reason for this is the self-sufficiency of a sugar factory and the substantial amount of recycling which is or can be practiced.

P. Insurance and Property Taxes

These must both be considered in a manufacturing cost estimate for a new installation. They are usually relatively minor cost items but vary widely from one place to another and experts should be consulted if precise estimates are required.

Q. By-Products

Just as a cost must be added if there is a waste-disposal problem from a given process, so a credit can be allowed if a saleable by-product is produced. By-products in the sugar industry are usually related to the amount of major product being processed which increases problems in balancing production with sales.

At the estimating stage, analysis is made around the complete processing unit and individual costs need not be allocated to the major product or to the by-product which minimises problems of accounting allocation of costs.

R. Profitability

Profit is the ultimate objective of investment under capitilistic systems of economic evaluation. Even within this system there are variations in the technique employed for measuring profitability.

It is not intended to discuss these in this paper but merely to draw attention to the fact and also note that there are alternativ objectives of investment which have their own systems of evaluation.

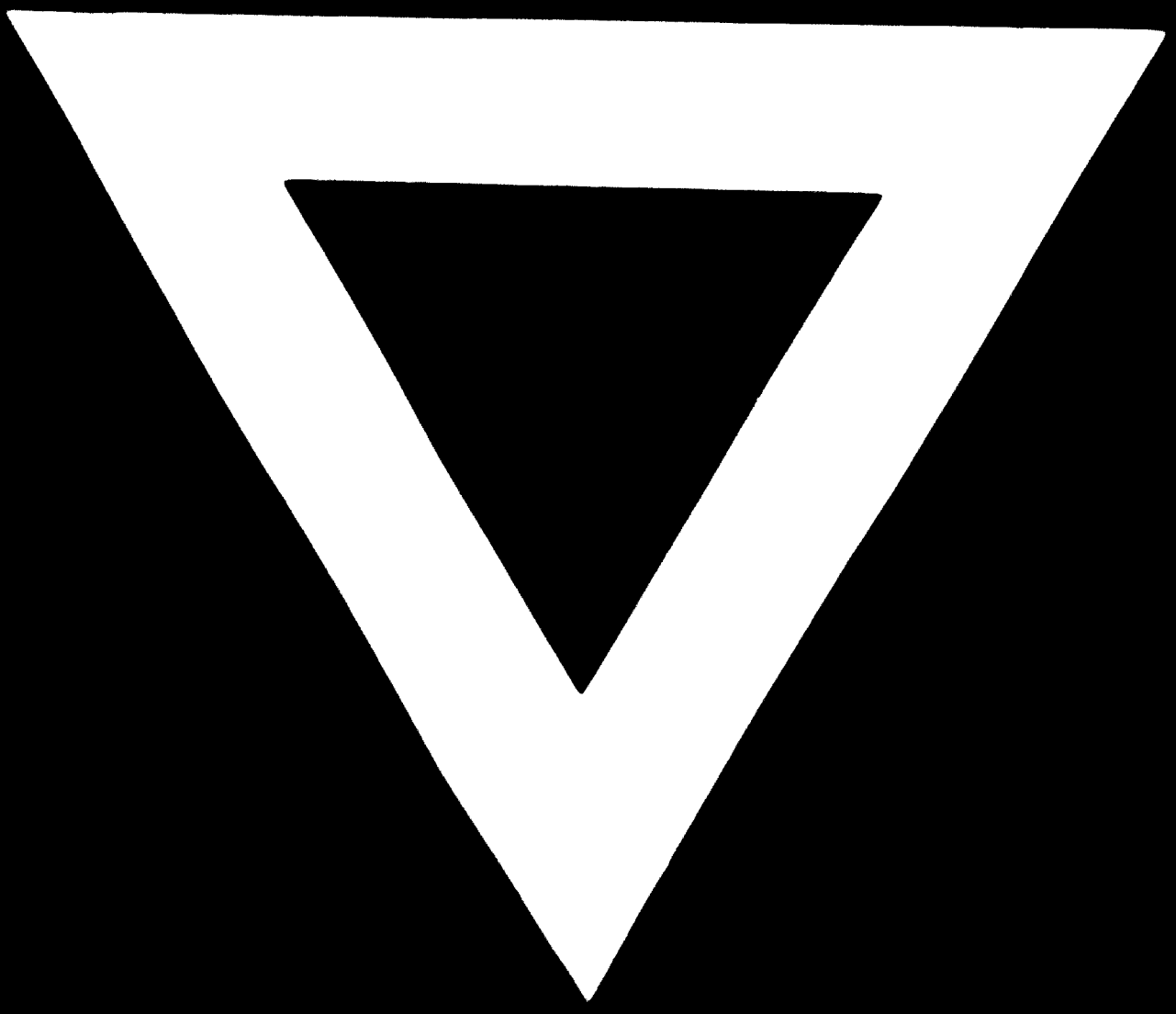
S. Business Systems

Business systems themselves vary from one part of the world to another. Sometimes they are related to the political philosophy of the country concerned, at other times they are related to the historical background of industrial activity in that country.

When international relationships are concerned, as is very often the case with the sugar industry it is necessary to obtain an understanding between the parties concerned and lay down carefully the terms of reference. This is not always straightforward even when language barriers can be reasonably surmounted. It is not unusual for complete incompatibility to be experienced requiring a great deal of understanding on both sides for each others point of view and for the exercise of good will and mutual trust.

Questions:

1. What is involved in a feasibility study for the installation of a new sugar factory.
2. How would we go about effecting same?
3. To what extent can land-tenure practices influence the feasibility study of a new sugar an factory in a developing country?



75.06.06