محاضرات الدكتور/ عادل الشبراوى

" تصميم المشروعات وتحليل عناصر تكاليفها الاولية "

Case Study

CEMENT WORKS

This case study should be examined in two sessions.

The first part should be given to students before the first session.

The second part should be handed out during the first session.

The third part and conclusion should be distributed at the final session.

CASE STUDY

This case study, which is to be carried out in two stages, is intended to illustrate first the methods of forecasting demand, and then the calculation of discounted prospective yields, from the enterprise point of view, for a number of possible alternative solutions, which differ either in the technique used (vertical or rotatory kilns) or in the location in which they are set up.

A number of methods of estimating future demand will be tried out, each based on a variety of statistical data about the market for the product. The solution proposed involves using two of these methods. The results they give may seem to be on the low side. The production target finally decided on may also seem to be on the low side, but it must be remembered that the problem is being looked at from the point of view of a private enterprise which is embarking on what is, for it, a new line of production. Prudence is, therefore, essential, even though it may prove costly at a future date.

Once the production target is defined, the various acceptable technical solutions will be compared by means of the discounted returns method, the calculations being made from the point of view of the enterprise, irrespective of methods of financing.

PLAN OF CASE STUDY

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INTRODUCTION

A civil engineering firm in a developing country uses large quantities of cement, much of which it has to import since indigenous supplies are insufficient. To eliminate, or at least reduce, its dependence on imports it is considering building one or more cement works for itself.

The firm, which we shall call Company S, has been prospecting for two years and has located two limestone deposits with what are estimated to be very considerable reserves. There are clay seams in the vicinity of both of these sites, so that it is technically possible to exploit them with a view to cement production.

To find out whether the project was worth considering, Company S began by bringing together certain statistical information about the local cement market, which enabled it to make a survey of that market, forecast its future trend and there by fix its own production targets. Taking these targets as a basis, Company S worked out a certain number of possible technical alternatives for the purposes of comparison.

The present case study follows the procedure adopted by Company S, and is, therefore, divided into three parts :

— The first part gives the information collected by Company S about the local cement market, which will enable the reader to analyse the existing market and forecast the future demand for cement in the country concerned.

— The second part sets out the findings of the market survey carried out by Company S, and describes the technical alternatives envisaged by the latter in the light of the production targets envisaged after the survey.

— The third part compares these alternatives from Company S's point of view. We shall also consider the possible effects these alternatives could have on the economy as a whole, and, more particularly, on public finance and the balance of payments, with a view to justifying the Company's projected request for finance from a foreign development assistance body.

This case study can therefore be used for training purposes in three stages : the first part can be given to the students to study ; a first discussion period is held on the market survey findings, and the technical information (second part) is handed out to the students to study ; a second discussion period is held covering the material given in the third part.

1. INFORMATION ABOUT THE LOCAL CEMENT MARKET

1.1. General economic position

The country in question has an area of some 100,000 square kilometres. (A sketch map is provided at the end of Chapter 1.) It is administratively divided into nine provinces (numbered from 1 to 9) of varying economic importance.

The population is increasing steadily at something like 2.5 per cent per annum. Its trend over the last few years is shown in Table 2.1 :

Table 2.1. POPULATION (THOUSANDS)

At 1st January

YEAR	POPULATION	YEAR	POPULATION
1959	16,400	1962	17,600
1960	16,800	1963	18,000
1961	17,150	1964	18,500

Assuming that the population increases at the same rate (3 %) over subsequent years, it should number 20,000,000 by the beginning of 1967.

The country's economic growth rate is about 4.5 per cent per annum. During the period 1959-1964, the trend of gross domestic product (GDP), expressed in constant 1962 prices, was as shown in Table 2.2 below.

Table 2.2. GDP (MILLION 1962 DOLLARS)

YEAR	GDP	YEAR	GDP
1959	2,040	1962	2,280
1960	2,120	1963	2,410
1961	2,180	1964	2,510

For 1965 (final figures not yet published), GDP should be about $2,580 million in 1962 prices.

It is thought that, allowing for the projected development plans, the economic growth rate observed over the last few years should be maintained at more or less the same level during the years to come.

1.2. Information about the cement market

1.2.1. *Demand conditions*

In 1965, total consumption of cement was in the region of 660,000 tons, or 35 kg per capita, which is very much below the figures for developed countries.

Table 2.3 below shows the trend of total cement consumption during the period 1959-1964. The rate of growth during the period was 25 per cent per annum.

Table 2.3. CEMENT CONSUMPTION (THOUSAND TONS)

YEAR	CONSUMPTION	YEAR	CONSUMPTION
1959	200	1962	354
1960	229	1963	571
1961	320	1964	602

It should be noted that these statistics are based on two different sources : a breakdown of consumption by sector (the main headings being the private sector, the public sector and usage for military purposes) and statistics of local production and imports.

Finally, there is an interesting series of annual figures on housebuilding (published in a recent Ministry of Construction report), as shown in Table 2.4 below .

Table 2.4. NUMBER OF DWELLINGS BUILT PER ANNUM

YEAR	NUMBER OF DWELLINGS	YEAR	NUMBER OF DWELLINGS
1959	21,000	1962	70,000
1960	26,000	1963	86,000
1961	56,000	1964	95,000

In spite of the progress made since 1961, there are still on average 8 people per dwelling. The Development Plan coming into operation in 1966 therefore provides for a special housing drive, the target for 1968 being 160,000 houses.

1.2.2. *Supply conditions*

In 1964, there was only one cement works in operation in the country. It belongs to Company A, is located in province 9 (site a' on the attached map) and in 1964 produced 91,000 tons of cement.

In 1965, Company B opened a cement works in province 4 (site b' on the attached map) with a production capacity in the neighbourhood of 200,000 tons of cement per annum.

It is intended to enlarge these two works during 1966 and 1967, which will raise local production capacity to 650,000 tons of cement per annum from 1968, 290,000 tons for Works a' and 360,000 tons for Works b'.

The gap between local production and consumption is filled by imports. The price of imported cement is relatively steady at around $23 per ton CIF, on which the central Government levies 15 per cent import duty.

For local production, the selling price to consumers is fixed by the public authorities at $23 per ton, the cost of transport being paid by the producer.

1.3. Conclusion

Company S intends to forecast the future demand for cement on the basis of the above data and, by comparing it with local supply, work out its own production target for 1968.

Total cement consumption in 1968 may be forecast by proceeding as follows :

- Estimate GDP in 1968 based on the trend as shown by available data for the period 1959-1964.
- Establish a correlation between cement consumption and GDP. On the basis of this correlation and the projected value of GDP in 1968, estimate provisionally cement consumption in 1968.
- Find a correlation between cement consumption and the number of dwellings built during the year, and use it to make a second estimate of cement consumption in 1968 for comparison with the one obtained above.
- Look for supporting information by making comparisons with per capita cement consumption in other low-income countries.

2. RESULTS OF THE MARKET SURVEY AND DESCRIPTION OF THE TECHNICAL ALTERNATIVES CHOSEN FOR CONSIDERATION

2.1. Results of the market survey

2.1.1. *Forecast of total cement consumption in 1968*

2.1.1.1. *Estimate of GDP in 1968*

Plotted on a graph over time (Graph 2.1), the values of the GDP show a rising, substantially linear trend for the period 1959-1964.

The following regression equation is obtained by the least squares method :

$$P = 94.86\,t + 1{,}924.66$$

P being the GDP expressed in $ million at 1962 prices and t the number of the year (taking t = 1 for 1959).

The corresponding coefficient of correlation is 0.994, which shows that the degree of correlation is very high[1].

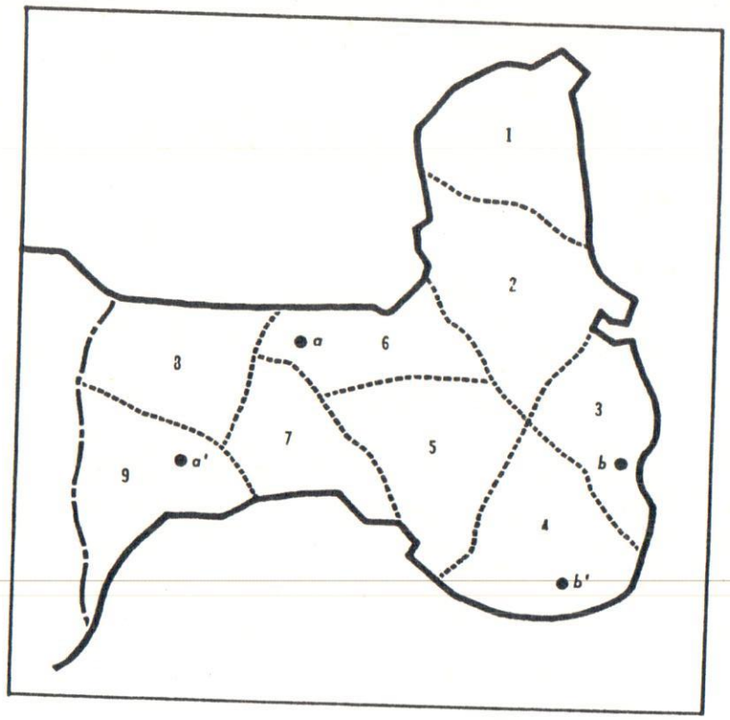
In 1968 (i.e. for t = 10), GDP would therefore amount to $2,873 million (at 1962 prices).

2.1.1.2. *Estimate of cement consumption on the basis of GDP*

Graph 2.2 compares cement consumption each year with the corresponding GDP. The graph shows that the trend of the annual consumption of cement as a function of the corresponding GDP is substantially linear.

1. The method used here is a first approximation. It should be remembered that the association of an economic phenomenon (in this case the GDP) with time implies the basic assumption that all the factors which have contributed towards the past evolution of the GDP will continue to do so in future. This must be a simplification of reality.

SKETCH MAP OF THE COUNTRY UNDER STUDY



KEY :

a, b } Sites of the limestone deposits located by Company S

a' Site of Company A's cement works

b' Site of Company B's cement works

The corresponding regression equation is :

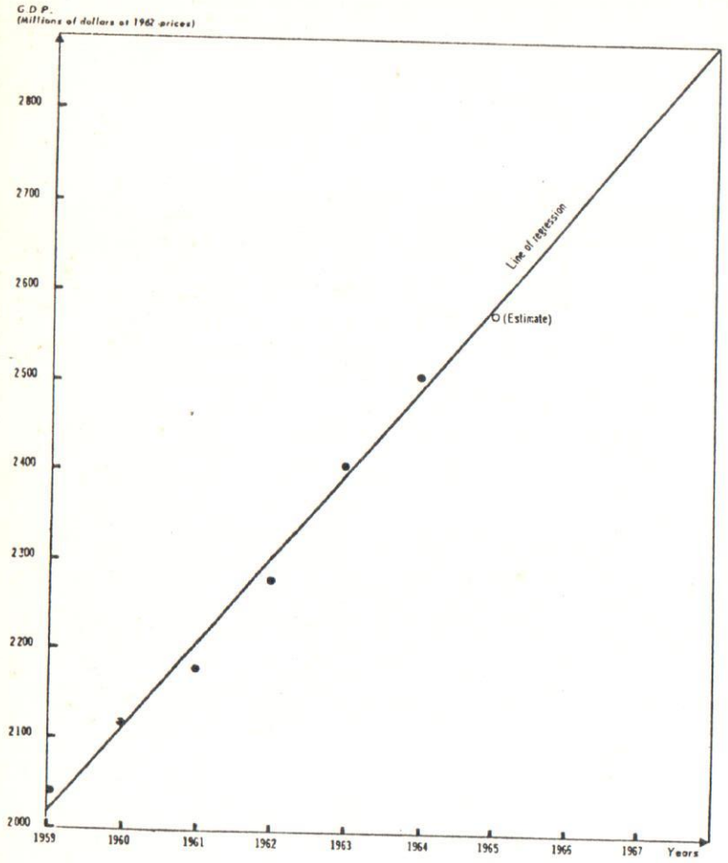
$$C = 0.934\,P - 1{,}728.4$$

C being cement consumption in thousand tons and P being GDP in millions of dollars at 1962 prices.

The coefficient of correlation is 0.979, which means that the correlation is significant.

Using the figure of $2,873 million for the GDP in 1968, we arrive at a total of 954,982 tons as a preliminary estimate of cement consumption in 1968.

Graph 2.1. TREND OF GDP



2.1.1.3. *Estimate of cement consumption on the basis of the number of dwellings to be built in the year*

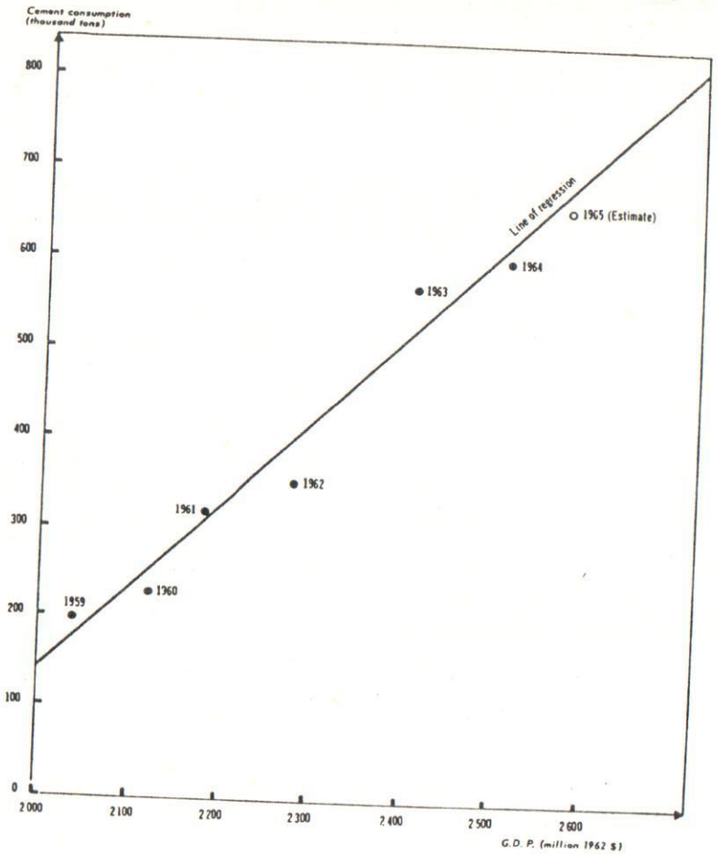
The linear correlation of cement consumption with the number of dwellings built each year (see Graph 2.3) is indicated by a regression line giving the following equation :

$$C = 5.304.x + 67.04$$

C being cement consumption in thousand tons and x the thousands of dwellings built in the year. The coefficient of correlation is 0.953.

On the basis of a programme for 160,000 dwellings to be built in 1968, we arrive at a second estimate of cement consumption in 1968, i.e. 915,037 tons.

Graph 2.2. CEMENT CONSUMPTION AS A FUNCTION OF GDP



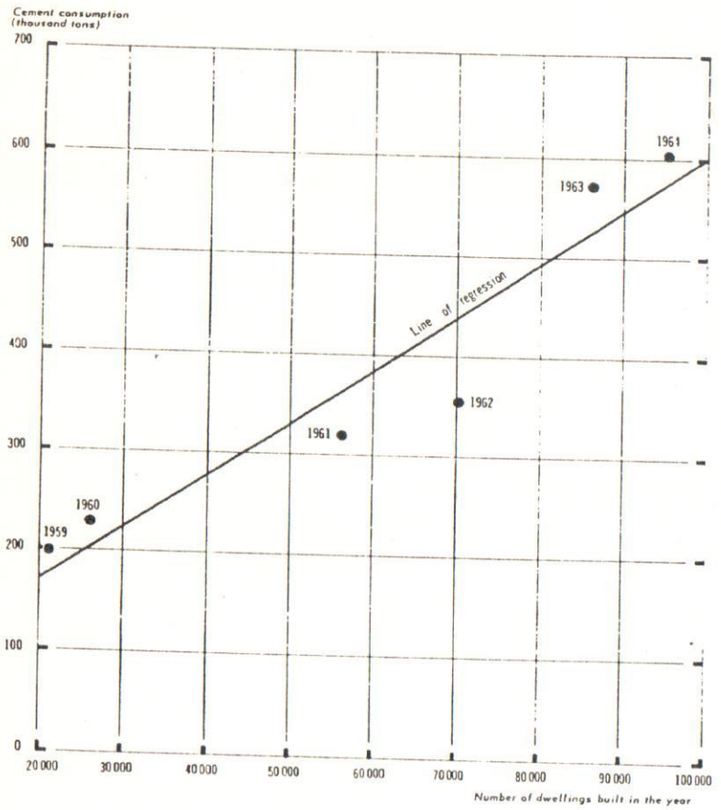
2.1.1.4. *Conclusion*

The two estimates of cement consumption in 1968 obtained above are fairly consistent, since they only differ by 4.18 % (if the calculation is made for 954,982 tons), or by 4.36 % (if the ratio is established with 915,037 tons). The estimate obtained on the basis of GDP is no doubt optimistic as it implicitly supposes that GDP will continue to grow during the next few years at the same rate as in the last few years, itself an optimistic assumption.

In short, it may very reasonably be estimated that *cement consumption will be at least 900,000 tons in 1968*, and this is the figure which will be used in what follows. Other methods could be used to project the future consumption of cement.

For example, one could try to establish correlations by using exponential formulae that relate consumption of cement to the national product, that

Graph 2.3. CEMENT CONSUMPTION AS A FUNCTION OF THE NUMBER OF DWELLINGS BUILT



is to say formulae which assume that the growth of the national product is not a linear but an exponential function of time. If the use of exponential formulae can be justified as a result of an inspection of the correlation coefficients which they give between the dependent and independent variables, it will result in more optimistic estimates of the consumption of cement. Thus, since we have decided to be cautious, we have used linear formulae.

The likelihood of achieving this figure can be checked by comparing it performance in other countries. Graph 2.4 shows per capita cement consumption in the light of per capita GDP for a number of countries. The figures used in Table 2.5 below refer unless otherwise stated to 1962 and are taken from the 1963 Statistical Year Book and the 1963 Yearbook of

National Accounts Statistics published by the Statistical Office of the United Nations Organisation. In the case of the country examined here, the figures refer to 1968 and result from the above estimates, i.e. per capita GDP of $138.5 at 1962 prices and per capita cement consumption of 43.5 kg.

Graph 2.4 confirms that the consumption envisaged is comparable with that recorded in countries with an equivalent standard of living.

TABLE 2.5. PER CAPITA CEMENT CONSUMPTION AND INCOME FOR VARIOUS COUNTRIES IN 1962

COUNTRY	PER CAPITA G.D.P. (DOLLARS)	PER CAPITA CEMENT CONSUMPTION (KG)
Argentina	462	137.5
Brazil	179[1]	67
Gabon	203[1]	79.5
India	73	19
Indonesia	73[1]	6.5
Mexico	361	90
Paraguay	86[1]	9
Portugal	352	126.5
South Korea	110	37
South Vietnam	95	27
Turkey	272	80
UAR	156[1]	65.5
Upper Volta	43[1]	6

1. Estimate for 1961.

2.1.2. *Breakdown of total demand by sector and by province*

a) *For 1968*

The breakdown of total demand for cement in 1968 by sector and by province can be forecast on the basis of the national and provincial development plans, and on the actual figures achieved in recent years.

The irrigation, housebuilding and road-building programmes give the following breakdown of total demand :

— Housebuilding	215,000 tons
— Irrigation	45,000 tons
— Dams	100,000 tons
— Roads	20,000 tons
— Military purposes	200,000 tons
— Other uses[1]	320,000 tons
Total	900,000 tons

Consumption under the first four headings may be broken down by province on the basis of the regional plans, but consumption for military purposes, which is secret, cannot be broken down in this way. This item can therefore only be added to « Other uses » and the corresponding consumption by province broken down on the basis of consumption observed in 1964. Table 2.6 below shows the final breakdown.

1. This is a residual figure.

Graph 2.4. PER CAPITA CEMENT CONSUMPTION AS A FUNCTION OF PER CAPITA GDP

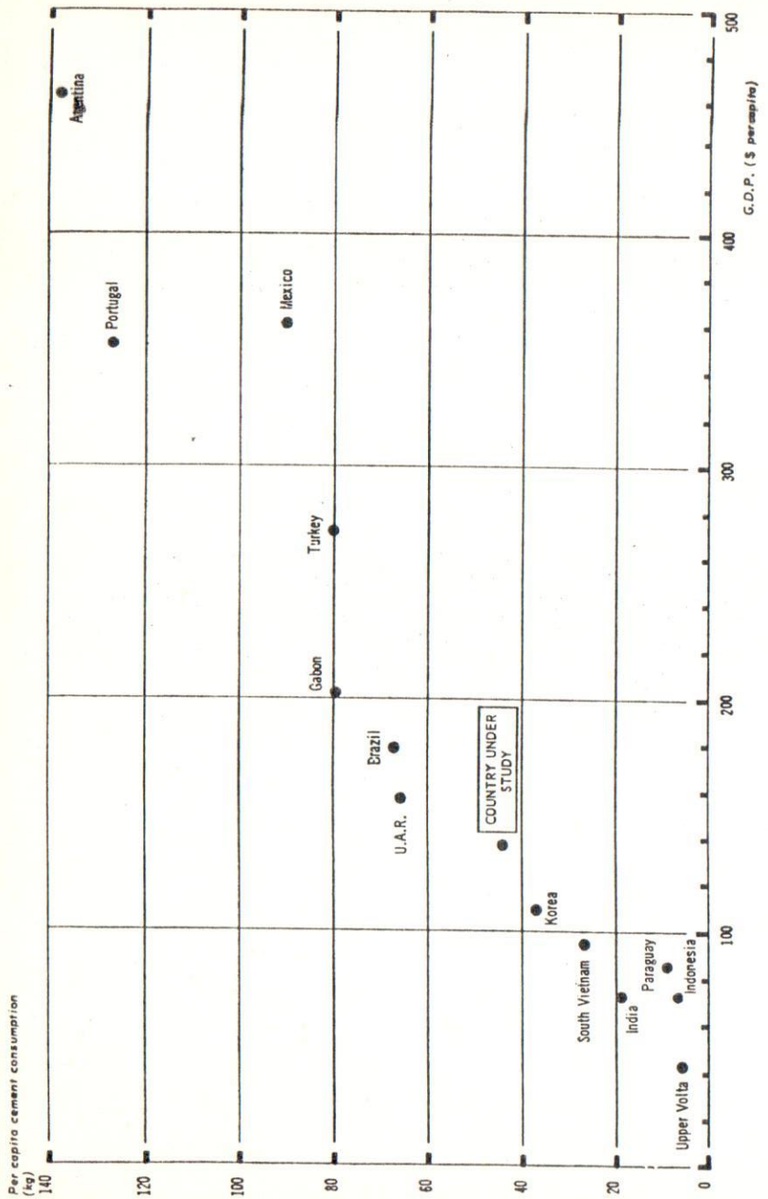


TABLE 2.6. CEMENT CONSUMPTION IN 1968 BY PROVINCE ACCORDING TO END-USE

Tons.

PROVINCE \ USE	HOUSE BUILDING	IRRIGATION	DAMS	ROADS	OTHER	TOTAL
1	31,000	—	—	—	142,000	173,000
2	23,000	3,000	—	—	40,000	66,000
3	16,000	2,000	100,000	1,000	46,000	165,000
4	28,000	4,000	—	—	53,000	85,000
5	31,000	3,000	—	10,000	47,000	91,000
6	30,000	24,000	—	—	33,000	87,000
7	25,000	3,500	—	—	44,000	72,500
8	15,000	1,000	—	—	82,000	98,000
9	16,000	4,500	—	9,000	33,000	62,500
Total	215,000	45,000	100,000	20,000	520,000	900,000

b) *After 1968*

The building of the dam in province 3 is due to begin in 1968 and will be spread over three years. The corresponding consumption of cement is again estimated to be 100,000 tons in 1969 and 1970.

For all other uses combined, it is estimated that demand for cement will rise after 1968 at appreciably the same rate in each province, 10,000 tons per annum per province.

2.1.3. *Choice of targets by Company S*

Company S believes that total demand for cement in 1968 will very probably be at least 900,000 tons. Since local productive capacity will then be 650,000 tons per annum, there will be a gap of 250,000 tons between local production and consumption.

To be on the safe side, *Company S selects a target for its own production of 200,000 tons in 1968.*

The composition of supply in 1968 would then be as follows :

— Works a'	290,000 tons
— Works b'	360,000 tons
— Company S	200,000 tons
— Imports	50,000 tons
Total	900,000 tons

2.2. DESCRIPTION OF ALTERNATIVES

There are five alternatives which differ the ones from the others either by the technique of cement production or by the location of the works.

2.2.1. *Technical alternatives*

Without going into a detailed description of the various methods of making cement, the general process is briefly as follows :

— quarrying and grinding the raw materials in order to obtain the raw mix ;

— « burning » the raw mix in the kiln at 1,450°C in order to obtain the « clinker » ;
— grinding the clinker mixed with gypsum or other materials (e.g. blast-furnace slag) ;
— bagging and distribution.

Two types of kiln are at present in use :

— the vertical kiln, and
— the horizontal (rotary) kiln.

The advantages of the vertical kiln are its lower investment cost and lower fuel consumption. On the other hand, the raw materials used must meet very precise specifications. Rotary kilns, however, have a larger, more regular output.

In the particular case we are studying, technical studies indicated that the characteristics of the raw materials available locally were such that either type of kiln could be used.

Chemical engineering studies showed that the optimum capacity of a vertical kiln would be such as to produce about 50,000 tons per annum.

Company S finally decided to consider three technical alternatives for producing the desired output of 200,000 tons per annum.

Alternative 1 : a 200,000-ton works equipped with one rotary kiln ;
Alternative 2 : a 200,000-ton works equipped with four vertical kilns each producing 50,000 tons a year ;
Alternative 3 : two 100,000-ton works, each equipped with two vertical kilns producing annually 50,000 tons a piece.

The following paragraphs set out the cost data for each of these alternatives.

2.2.2. *Choice of location*

As mentioned in the Introduction, Company S has found two limestone deposits at a in province 6 and b in province 3 (see map annexed to Chapter 1). It is possible to build a cement works with a production capacity of 200,000 tons of cement per annum on each of these sites.

2.2.3. *Alternatives to be compared*

By combining technical alternatives with those resulting from location, Company S has *five possible alternatives for comparison*, i.e. :

Alternative I : a 200,000-ton works equipped with rotary kiln at a ;
Alternative II : a 200,000-ton works equipped with rotary kiln at b ;
Alternative III : a 200,000-ton works equipped with four vertical kilns producing 50,000 tons at a ;
Alternative IV : a 200,000-ton works equipped with four vertical kilns producing 50,000 tons at b ;
Alternative V : two 100,000-ton works equipped with two vertical kilns producing 50,000 tons, one at a and one at b.

In order to compare these alternatives, Company S will calculate for each of them the present (discounted) value of the prospective yield for the period of operation envisaged (20 years).

Company S has chosen to discount profits at 8 per cent per annum, but an additional calculation will be made at 10 per cent per annum in order to see how this factor affects the results.

2.3. Investment costs

In all three cases, the period of construction will extend over the two years 1966 and 1967, production beginning early in 1968.

Table 2.7 below shows the total investment costs for each of the three technical alternatives. It is assumed that this expenditure will be divided equally between the two years 1966 and 1967.

Table 2.7. INVESTMENT COSTS

Millions of dollars.

	ALTERNATIVE I & II	ALTERNATIVE III & IV	ALTERNATIVE V[1]
Purchase of equipment and technical services	4.35	3.40	3.80
Infrastructure and installation work	2.10	1.80	2.00
Total	6.45	5.20	5.80

1. In this case, the corresponding expenditure has also to be divided between the two works.

Investment expenditure must also include the following estimates of requirements for working capital :

$300,000 for alternative I and II
$200,000 for alternative III and IV
$300,000 for alternative V

Half of this working capital will be employed in 1967 and the other half in 1968.

Some of these costs must be paid in dollars, the rest in local currency.

2.3.1. *Investment costs to be paid in dollars*

This type of expenditure corresponds to the first item in Table 2.7 above, i.e. purchase of equipment and foreign technical assistance. Dates for the renewal of equipment are known approximately.

Table 2.8 gives a breakdown of costs to be paid in dollars.

Table 2.8. INVESTMENT COSTS TO BE PAID IN DOLLARS

Millions of dollars.

	ALTERNATIVE I & II	ALTERNATIVE III &IV	ALTERNATIVE V
Renewable equipment :			
— every 20 years	1.35	0.90	1.00
— every 10 years	2.00	1.40	1.60
— every 5 years	0.50	0.60	0.70
Technical assistance (not renewable but repayable in 5 years)	0.50	0.50	0.50
Total	4.35	3.40	3.80

For tax purposes, depreciation on expensive equipment is calculated according to the life of such equipment.

2.3.2. *Investment costs to be paid in local currency*

This type of expenditure corresponds to the second heading in Table 2.7 above, i.e. infrastructure and installation costs, to which the working capital is added, as it is also disbursed in local currency.

Infrastructure and installation costs include :

— the purchase of land (no allowance for depreciation) ;
— the construction of buildings (to be depreciated for tax purposes over 20 years) ;
— civil engineering works (to be depreciated for tax purposes over 10 years) ;
— expenditure on technical research and training for supervisory staff and specialised workers (to be depreciated for tax purposes over five years) ;
— working capital (no allowance for depreciation), which is recovered when the factory is finally closed down.

None of these costs are renewable during the period concerned. The figures are given in Table 2.9.

TABLE 2.9. INVESTMENT COSTS TO BE PAID IN LOCAL CURRENCY

Millions of dollars.

	ALTERNATIVE I & II	ALTERNATIVE III & IV	ALTERNATIVE V
Land	0.25	0.25	0.25
Buildings	0.50	0.50	0.60
Civil engineering	1.20	0.90	1.00
Technical research and training	0.15	0.15	0.15
Total	2.10	1.80	2.00

2.4. OPERATING COSTS

Operating costs may be divided into fixed and variable costs.

2.4.1. *Fixed costs*

These costs are mainly overheads, and are estimated as follows :

— $300,000 per annum for Alternative I and II ;
— $350,000 per annum for Alternative III and IV ;
— $400,000 per annum for Alternative V.

2.4.2. *Variable costs*

Variable costs may be classified under six main headings : raw materials, power, productive manpower, maintenance, bagging and transport.

a) *Raw materials*

Extraction of the clay and limestone costs $1.38 per ton of cement produced (mainly for manpower).

Gypsum is imported at the CIF price of $10 per ton, to which must be added 15 per cent State import duty, and about 5 per cent for the cost of transport, the production of 1 ton of cement requiring about 30 kg of gypsum.

The above figures are the same for all the technical alternatives.

b) *Power*

The cost of electric power is $1.2 per ton of cement produced in all cases. This corresponds to a consumption of about 110 kWh per ton of cement.

The kilns burn anthracite mined locally. In the case of a vertical kiln producing 50,000 tons a year, the consumption of anthracite is 209 kg per ton of cement produced[1]. In the case of a rotary kiln, the anthracite has to be mixed with bituminous coal and 80 kg of this coal and 120 kg of anthracite are then needed per ton of cement produced.

Bituminous coal is imported at the CIF price of $20 per ton, to which must be added 15 per cent State import duty and about 5 per cent for the cost of transport.

The anthracite comes from a mine situated in province 3 near one of the two limestone deposits found by Company S. This deposit is located at *b*, the other being at *a* on the map at the end of Chapter 1), so that the anthracite costs $7 per ton delivered to *b* and $11 per ton delivered to *a*.

c) *Production workers*

The cost of production manpower is $0.8 per ton of cement produced in the case of Alternative 1 and $1.2 per ton of cement produced in the case of Alternative 2.

d) *Maintenance*

The cost of maintenance is $0.6 per ton of cement produced in the case of Alternative 1 and $0.5 per ton of cement produced in the case of Alternatives 2 or 3. The cost of major maintenance, which can be estimated at $150,000 in the case of Alternative 1 and $100,000 in the case of Alternatives 2 or 3, should be added.

e) *Bagging*

The cost of bagging is $1.4 per ton of cement produced, whatever alternative is chosen.

f) *Transport*

Transport costs depend on the site selected (see paragraph 2.2.2). Company S has concluded agreements with Companies A and B, which own cement works a' and b'. Under these agreements orders for cement will be divided between the various producing works so as to reduce total transport costs to a minimum, any import being in any case consumed in province 1 (it is in this province, which is a heavy consumer of cement and also the furthest from the production centres, that the delivery port for cement is situated).

1. The high consumption of anthracite is explained by the high ash content of the coal used.

Company S has made estimates (Table 2.10 below) of the cost of rail transport in 1968 for the cement produced. It is assumed that these estimates will still apply after 1968.

TABLE 2.10. COST OF CEMENT TRANSPORT

$ per ton.

FROM WORKS \ TO PROVINCE	1	2	3	4	5	6	7	8	9
a	7.0	6.4	5.6	6.8	5.1	3.0	5.2	5.3	6.6
b	6.2	6.0	4.0	6.1	6.1	6.3	6.5	6.8	6.9
a'	7.2	7.0	6.9	6.8	6.7	6.6	5.8	5.7	5.5
b'	6.9	6.5	5.6	5.4	5.6	6.5	6.5	6.6	6.8

2.5. TAXATION OF PROFITS

Company S will be setting up a subsidiary company to operate the cement works, which will qualify for a reduced rate of taxation, i.e. 20 per cent of net profits (after provision for depreciation).

Any losses during one financial year can be carried forward to succeeding years.

3. COMPARISON OF POSSIBLE ALTERNATIVES

3.1. COMPARISON FROM THE POINT OF VIEW OF COMPANY S

The main criterion behind Company S's choice is maximum present value of prospective yield.

The prospective yield for a period of T years discounted at i per cent per annum is given by the equation :

$$B_a = -(I_a + R_a) + \sum_{p=1}^{T} \frac{R_p - D_p}{(1+i)^p}$$

I_a is the present (discounted) cost of initial investment, R_a the present (discounted) cost of renewals, R_p earnings in the year p, and D_p the operating expenditure for year P (including taxation of profits, excluding depreciation).

In the present case, the operational life to be discounted is 20 years, assuming that the residual value of the works at the end of those 20 years is nil. The calculations are made using two different discount rates. 8 per cent and 10 per cent.

In the following paragraphs we examine each of the factors involved in the calculation of the present (discounted) value of the prospective yield, i.e. :

— initial investment and renewals
— operating expenditure (other than cement transport costs)
— cement transport costs
— taxation of profits
— earnings.

3.1.1. *Schedule of investment and renewal expenditure*

Table 2.11 is based on the figures in section 2.3, and shows the schedule of investment and renewal expenditure for the period concerned for each of the alternatives considered.

TABLE 2.11. SCHEDULE OF INVESTMENT AND RENEWAL EXPENDITURE

Millions of dollars.

YEAR	ALTERNATIVE I OR II	ALTERNATIVE III OR IV	ALTERNATIVE V
1966	3.25	2.60	2.90
1967	3.35	2.70	3.05
1968	0.15	0.10	0.15
1973	0.50	0.60	0.70
1978	2.50	2.00	2.30
1983	0.50	0.60	0.70

3.1.2. *Operating expenditure (excluding cement transport)*

Table 2.12 is based on the figures in section 2.4 and shows the annual operating expenditure (other than cement transport) for a 200,000-ton output for each of the alternatives considered.

TABLE 2.12. ANNUAL OPERATING EXPENDITURE (OTHER THAN TRANSPORT)

Thousands of dollars.

	ALTERNATIVE I	ALTERNATIVE II	ALTERNATIVE III	ALTERNATIVE IV	ALTERNATIVE V
Overheads	300	300	350	350	400
Clay and limestone	276	276	276	276	276
Gypsum	72	72	72	72	72
Electric power	240	240	240	240	240
Anthracite	264	168	460	293	376
Bituminous coal	384	384	—	—	—
Production manpower	160	160	240	240	240
Maintenance	120	120	100	100	100
Bagging	280	280	280	280	280
Major maintenance	150	150	100	100	100
Total	2,246	2,150	2,118	1,951	2,084

3.1.3. *Schedule of cement transport costs*

In order to work out these schedules, optimum distribution of local cement production has to be calculated for each year and each alternative, i.e. the distribution whereby total transport costs are lowest (see section 2.4.2, sub-section f). As an example, Table 2.13 shows the optimum distribution of cement availabilities in 1968 for Alternatives I or III (a 200,000-ton cement works at a).

TABLE 2.13. BREAKDOWN OF CEMENT SUPPLIES IN 1968 FOR ALTERNATIVES I OR III

Thousands of tons.

FROM \ TO	IMPORTS	WORKS a	WORKS a'	WORKS b'	TOTAL
1					
2	50		79	44	173
3				66	66
4				165	165
5				85	85
6		91			91
7		87			87
8		22	50.5		72.5
9			98		98
			62.5		62.5
Total	50	200	290	360	900

Using the cost data set out in Table 2.10, this breakdown gives a total transport cost for Works a of:

$$(91 \times 5.1) + (87 \times 3.0) + (22 \times 5.2) = \$839{,}500.$$

Table 2.14 on the following page shows for all the alternatives considered the schedules of cement transport costs over the period concerned. Transport costs given in this table have been calculated by supposing that the 1968 tariff of Table 2.10, will remain valid for the following years, and on the basis of demand estimates from each of the Provinces (see paragraph 2.1.2).

3.1.4. *Schedule of depreciation*

Table 2.15 below is based on the figures in section 2.3 and shows the schedule of depreciation for all the alternatives considered.

It should be noted that the calculation of depreciation is necessary solely for taxation purposes. Strictly speaking, it is not required when calculating the present value of the prospective yield.

3.1.5. *Earnings*

The selling price fixed by the public authorities (see section 1.2.2) is \$23 per ton, so that annual earnings in each case are \$4.6 million.

3.1.6. *Operating accounts*

Tables 2.16, 2.17, 2.18, 2.19 and 2.20 show for each alternative the annual operating accounts of the Company running the cement works. The following terms are used in the tables:

— Gross trading profit, for the difference between earnings and operating costs (operating expenditure other than transport and transport costs).
— Net trading profit, for the gross trading profit less depreciation.
— Profit after tax, for the *gross* trading profit less tax.

Liquidity problems have not been analysed here. A quick check will show that there should not be any.

TABLE 2.14. SCHEDULE OF CEMENT TRANSPORT COSTS[1]

Thousands of dollars.

YEAR	ALTERNATIVE I OR III	ALTERNATIVE II OR IV	ALTERNATIVE V
1968	839.5	870	727.3
1969	816.5	850	706.3
1970	795.3	830	700
1971	774.3	1,011.8[2]	710
1972	753.3	990	700
1973	732.3	970	700
1974	711.3	950	700
1975	690.3	930	700
1976	669.3	910	700
1977	648.3	890	700
1978	627.3	870	700
1979	606.3	850	700
1980	600	830	700
1981	600	810	700
1982 and beyond	600	800	700

1. No allowance is made for the building of new factories which might alter the distribution of deliveries and consequently transport costs. The effects of such new buildings would be small, as new cement works undoubtedly be built in provinces that so far do not have any. In any case, changes in supply areas will only take place in the distant future, and the discounting process used minimises the increase in costs that they might entail.
2. This rise in transport costs is due to the fall in demand in province 3 (end of dam-building work), where Works b is located.

TABLE 2.15. SCHEDULE OF DEPRECIATION

Thousands of dollars.

YEAR	ALTERNATIVE I OR II	ALTERNATIVE III OR IV	ALTERNATIVE V
1968 - 1972	642.5	550	610
1973 - 1977	512.5	420	480
1978 - 1987	392.5	330	380

3.1.7. *Calculation of present (discounted) value of prospective yield. Effect of forecasting errors and conclusions*

By discounting back to 1966 the schedule of investment and renewal expenditure (Table 2.11) and the schedule of operating profits (Tables 2.16, 2.17, 2.18, 2.19 and 2.20), the difference between the two gives the value in 1966 of the prospective yield for each of the alternatives considered. Table 2.21 shows the results discounted respectively at 8 per cent and 10 per cent.

This table shows that, whether the discount rate is 8 or 10 per cent, the alternatives can be classified in decreasing order of present value of prospective yield as follows: III, IV, V, I, II.

In theory, *Company S should therefore choose Alternative III*, i.e. build a 200,000-ton cement works equipped with four vertical kilns on the deposit found in province 6 (site a). However, it will be noted that the margin is relatively small between this alternative and Alternative IV, which only differs from the former in the choice of site for the cement works

TABLE 2.16. ANNUAL OPERATING ACCOUNTS FOR ALTERNATIVE I

Thousands of dollars.

YEAR	EARNINGS	OPERATING EXPENDITURE*	TRANSPORT	1 GROSS TRADING PROFIT	DEPRECIATION	2 NET TRADING PROFIT	3 TAX	4 PROFIT AFTER TAX
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*
1968	4,600	2,246	839.5	1,514.5	642.5	872	174.4	1,340.1
1969	4,600	2,246	816.5	1,537.5	642.5	895	179	1,358.5
1970	4,600	2,246	795.3	1,558.7	642.5	916.2	183.2	1,375.5
1971	4,600	2,246	774.3	1,579.7	642.5	937.2	187.4	1,392.3
1972	4,600	2,246	753.3	1,600.7	642.5	958.2	191.6	1,409.1
1973	4,600	2,246	732.3	1,621.7	512.5	1,109.2	221.8	1,399.9
1974	4,600	2,246	711.3	1,642.7	512.5	1,130.2	226	1,416.7
1975	4,600	2,246	690.3	1,663.7	512.5	1,151.2	230.2	1,433.5
1976	4,600	2,246	669.3	1,684.7	512.5	1,172.2	234.4	1,450.3
1977	4,600	2,246	648.3	1,705.7	512.5	1,193.2	238.6	1,467.1
1978	4,600	2,246	627.3	1,726.7	392.5	1,334.2	266.8	1,459.9
1979	4,600	2,246	606.3	1,747.7	392.5	1,355.2	271	1,476.7
1980 to 1987	4,600	2,246	600	1,754.0	392.5	1,361.5	272.3	1,481.7

* Other than cement transport.

1. $d = a - (b + c)$
2. $f = d - e$
3. $g = 20/100\ f$
4. $h = d - g$

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TABLE 2.17. ANNUAL OPERATING ACCOUNTS FOR ALTERNATIVE II

Thousands of dollars.

YEAR	EARNINGS	OPERATING EXPENDITURE*	TRANSPORT	1 GROSS TRADING PROFIT	DEPRECIATION	2 NET TRADING PROFIT	3 TAX	4 PROFIT AFTER TAX
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*
1968	4,600	2,150	870	1,580	642.5	937.5	187.5	1,392.5
1969	4,600	2,150	850	1,600	642.5	957.5	191.5	1,408.5
1970	4,600	2,150	830	1,620	642.5	977.5	195.5	1,424.5
1971	4,600	2,150	1,011.8	1,438.2	642.5	795.7	159.1	1,279.1
1972	4,600	2,150	990	1,460	642.5	817.5	163.5	1,296.5
1973	4,600	2,150	970	1,480	512.5	967.5	193.5	1,286.5
1974	4,600	2,150	950	1,500	512.5	987.5	197.5	1,302.5
1975	4,600	2,150	930	1,520	512.5	1,007.5	201.5	1,318.5
1976	4,600	2,150	910	1,540	512.5	1,027.5	205.5	1,334.5
1977	4,600	2,150	890	1,560	512.5	1,047.5	209.5	1,350.5
1978	4,600	2,150	870	1,580	392.5	1,187.5	237.5	1,342.5
1979	4,600	2,150	850	1,600	392.5	1,207.5	241.5	1,358.5
1980	4,600	2,150	830	1,620	392.5	1,227.5	245.5	1,374.5
1981	4,600	2,150	810	1,640	392.5	1,247.5	249.5	1,390.5
1982 to 1987	4,600	2,150	800	1,650	392.5	1,257.5	251.5	1,398.5

* Other than cement transport.

1. $d = a - (b + c)$
2. $f = d - e$
3. $g = 20/100\ f$
4. $h = d - g$

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TABLE 2.18. ANNUAL OPERATING ACCOUNTS FOR ALTERNATIVE III

Thousands of dollars.

YEAR	EARNINGS	OPERATING EXPENDITURE*	TRANSPORT	1 GROSS TRADING PROFIT	DEPRECIATION	2 NET TRADING PROFIT	3 TAX	4 PROFIT AFTER TAX
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*
1968	4,600	2.118	839.5	1,642.5	550	1,092.5	218.5	1,424.0
1969	4,600	2.118	816.5	1,665.5	550	1,115.5	223.1	1,442.4
1970	4,600	2.118	795.3	1,686.7	550	1,136.7	227.3	1,459.4
1971	4,600	2.118	774.3	1,707.7	550	1,157.7	231.5	1,476.2
1972	4,600	2.118	753.3	1,728.7	550	1,178.7	235.7	1,493.0
1973	4,600	2.118	732.3	1,749.7	420	1,329.7	265.9	1,483.8
1974	4.600	2.118	711.3	1,770.7	420	1,350.7	270.1	1,500.6
1975	4,600	2.118	690.3	1,791.7	420	1,371.7	274.3	1,517.4
1976	4,600	2.118	669.3	1,812.7	420	1,392.7	278.5	1,534.2
1977	4,600	2.118	648.3	1,833.7	420	1,413.7	282.7	1,551.0
1978	4,600	2.118	627.3	1,854.7	330	1,524.7	304.9	1,549.8
1979	4,600	2.118	606.3	1,875	330	1,545.7	309.1	1,566.6
1980 to 1987	4,600	2.118	600	1,882.0	330	1,552	310.4	1,571.5

* Other than cement transport.
1. $d = a - (b + c)$
2. $f = d - e$
3. $g = 20/100\ f$
4. $h = d - g$

TABLE 2.19. ANNUAL OPERATING ACCOUNTS FOR ALTERNATIVE IV

Thousands of dollars.

YEAR	EARNINGS	OPERATING EXPENDITURE*	TRANSPORT	1 GROSS TRADING PROFIT	DEPRECIATION	2 NET TRADING PROFIT	3 TAX	4 PROFIT AFTER TAX
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*
1968	4,600	1,951	870	1,779	550	1,229	245.8	1,533.2
1969	4,600	1,951	850	1,799	550	1,249	249.8	1,549.2
1970	4,600	1,951	830	1,819	550	1,269	253.8	1,565.2
1971	4,600	1,951	1,011.8	1,637.2	550	1,087.2	217.4	1,419.8
1972	4.600	1,951	990	1,659	550	1,109	221.8	1,437.2
1973	4,600	1,951	970	1,679	420	1,259	251.8	1,427.2
1974	4,600	1,951	950	1,699	420	1,279	255.8	1,443.2
1975	4,600	1,951	930	1,719	420	1,299	259.8	1,459.2
1976	4,600	1,951	910	1,739	420	1,319	263.8	1,475.2
1977	4,600	1,951	890	1,759	420	1,339	267.8	1,491.2
1978	4,600	1,951	870	1,779	330	1,449	289.8	1,489.2
1979	4,600	1,951	850	1,799	330	1,469	293.8	1,505.2
1980	4,600	1,951	830	1,819	330	1,489	297.8	1,521.2
1981	4,600	1,951	810	1,839	330	1,509	301.8	1,537.2
1982 to 1987	4,600	1,951	800	1,849	330	1,519	303.8	1,545.2

* Other than cement transport.
1. $d = a - (b + c)$
2. $f = d - e$
3. $g = 20/100\ f$
4. $h = d - g$

TABLE 2.20. ANNUAL OPERATING ACCOUNTS FOR ALTERNATIVE V

Thousands of dollars.

YEAR	EARNINGS	OPERATING EXPENDITURE*	TRANSPORT	1 GROSS TRADING PROFIT	DEPRECIATION	2 NET TRADING PROFIT	3 TAX	4 PROFIT AFTER TAX
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*
1968	4,600	2,084	727.3	1,788.7	610	1,178.7	235.7	1,553.0
1969	4,600	2,084	706.3	1,809.7	610	1,199.7	239.9	1,569.8
1970	4,600	2,084	700	1,816.0	610	1,206	241.2	1,574.8
1971	4,600	2,084	710	1,806.0	610	1,196	239.2	1,566.8
1972	4,600	2,084	700	1,816.0	610	1,206	241.2	1,574.8
1973	4,600	2,084	700	1,816.0	480	1,336	267.2	1,548.8
1974	4,600	2,084	700	1,816.0	480	1,336	267.2	1,548.8
1975	4,600	2,084	700	1,816.0	480	1,336	267.2	1,548.8
1976	4,600	2,084	700	1,816.0	480	1,336	267.2	1,548.8
1977	4,600	2,084	700	1,816.0	480	1,336	267.2	1,548.8
1978 to 1987	4,600	2,084	700	1,816.0	380	1,436	287.2	1,528.8

* Other than cement transport.

1. $d = a - (b + c)$
2. $f = d - e$
3. $g = 20/100\ f$
4. $h = d - g$

TABLE 2.21. PRESENT (DISCOUNTED) VALUES OF PROSPECTIVE YIELDS FOR THE ALTERNATIVES CONSIDERED

Thousands of dollars.

	ALTERNATIVE I	ALTERNATIVE II	ALTERNATIVE III	ALTERNATIVE IV	ALTERNATIVE V
At 8 %					
Discounted investment and renewal expenditure	7,900	7,900	6,492	6,492	7,364
Discounted operating profits	12,928	12,334	13,710	13,631	14,089
Present value of prospective yield	5,028	4,434	7,218	7,139	6,725
At 10 %					
Discounted investment and renewal expenditure	7,572	7,572	6,201	6,201	7,027
Discounted operating profits	10,971	10,496	11,634	11,598	12,006
Present value of prospective yield	3,399	2,924	5,433	5,397	4,979

(site b in province 3 instead of site a). This margin is due almost entirely to cement transport costs and is only $79,000 at 8 per cent and $36,000 at 10 per cent, i.e. 1.1 per cent and 0.7 per cent respectively less in present value than the prospective yield on Alternative III.

On the other hand, the differences between the yields on Alternative III (or Alternative IV) and those of Alternative I and II are such that the ordering of these alternatives could not possibly be changed when errors in calculation are taken into account. Thus for Alternative I (200,000-ton cement works with one rotary kiln sited at a) to have a higher prospective yield than Alternative III (200,000-ton cement works with vertical kilns sited at "a"), investment and renewal expenditure for Alternative III would have had to be underestimated by 28 per cent, or its operating expenditure would have had to be underestimated by 15 per cent. It seems unlikely that such errors could have been made on well specified technical projects in an industry with which experts are very familiar.

It will be noted that Alternative V, like Alternatives III and IV, assumes the use of vertical kilns capable of producing 50,000 tons a year, the only notable difference being that production in the former case is divided between two works. It is thus probable that if an error has been made in estimating cost items for Alternative V, a similar error has also been made in estimating cost items for Alternatives III and IV.

At the discount rate of 8 per cent, the (discounted) prospective yield on Alternative V is at least 7 per cent less than those on Alternatives III and IV. Although the prospective yield on it is slightly lower than on the other two, there might be certain advantages in adopting Alternative V. For this Alternative, the profit is not distributed equally between the two works a and b. The overall advantage is in favour of b, since even though a has lower transport costs, b has even lower anthracite costs.

In the first stage, the construction of a 100,000-ton works might be envisaged at b. The demand for cement for the dam being built in province 3 would minimise the significance of not having a sales network in the first few years.

A few years later, the second works might be erected at a, if the demand forecast for province 6 comes up to expectations.

Finally, a calculation covering an Alternative V' that differs from V by the timing of investments will reveal a slightly lower prospective yield than Alternatives III and IV. But this is more or less offset by other advantages, not all of which are quantifiable :

— flexibility of operation due to production by two works ;
— limitation of risks caused by fluctuations in demand ;
— step-by-step establishment of the sales network ;
— lower transport costs ;
— position as an established supplier of the cement market will make it easier to deal with potential competitors who may set up later on.

Although there is no doubt as to which is the best technical solution (Alternative 2 — four vertical kilns each with a capacity of 50,000 tons), it is much harder to decide which is the best site, in view of the inevitable unreliability of forecasts of demand for cement in each of the provinces beyond 1968. We assumed (see section 2.1.3) that after 1968 the demand for cement would increase at the same rate in each province by 10,000 tons a year. At this stage in the study we must take a closer look at this assumption. It is possible, for example, that the construction of a dam in province 3 will induce some businessmen to settle in that province. If this happened, the demand for cement in province 3 would be greater than what was forecast, which would favour the adoption of Alternative IV.

Furthermore, to be scrupulously fair in comparing Alternatives III and IV, other factors such as the availability of labour would have to be considered.

Finally, it should be noted that the profitability of the enterprise is more or less assured, irrespective of whether Alternative III or Alternative IV is chosen, and notwithstanding possible errors in forecasting prices and costs. A reduction in net earnings of $1 per ton due to unfavourable selling conditions or increased operating costs would lead, after payment of taxes, to a fall of $160,000 in profits. And then the present value of the prospective yield would be $1,347,000 when discounted at a rate of 10 per cent, whatever alternative is considered.

On the assumption that Alternative III, which seems the best one, is adopted, the cement works will still be profitable if the selling price does not fall below $17.80 per ton at a discount rate of 8 per cent, and $19.10 per ton at a discount rate of 10 per cent.

At the same time, this reasoning shows that an average error of $5.20 or $3.90 per ton (depending on the discount rate used) on operating and transport costs would be necessary before the profitability of the investment becomes doubtful. This would be a high percentage of error in the costs forecast, which proves that the risks of the operation envisaged are limited.

In short, *Company S can be practically certain that the present value of the prospective yield on the project will be positive. The final choice between Alternatives III and IV involves :*

— *a more detailed study of the regional cement market ;*
— *a more precise study of conditions for working* the two deposits and *locating* the two works, so that cost estimates may be made making better allowance for the local characteristics of the two sites.

It should further be noted that Alternatives III and IV are those which require least capital.

CONCLUSION

The market analysis showed that a works producing 200,000 tons of cement per annum has every chance of being able to sell its production over the coming years, since according to the forecasts made at least 50,000 tons of cement would still have to be imported, probably at a higher price, after the new works is built and the extensions at present planned by competing firms are carried out.

The plan to build a dam in province 3 would moreover help the new works to get started, and would tide it over the first few years when the new works' distribution network might be defective.

The technical survey showed that the two deposits under consideration could be used for cement production by two possible methods : vertical kiln or rotary kiln using the dry process. The necessary clay, water, electric power and fuel could be provided at both sites on satisfactory terms. The unskilled manpower needed could be recruited easily in both cases.

The economic survey showed that :

— A rotary kiln would be more expensive to use than vertical kilns.
— The simultaneous construction and operation of two works with a production capacity of 100,000 tons per annum would be more expensive than the construction and operation of a single works, in spite of the saving in transport costs.
— The present value of the prospective yield from a works comprising four vertical kilns each with a production capacity of 50,000 tons per annum would be practically independent of location under the assumptions made of the overall and regional trend of the market.
— The margin available would be sufficient to absorb any reasonable errors regarding investment or operating costs and prices or total demand. (Discounted at 10 per cent, the reduction in the average annual gross profit after tax would have to be $685,000 — for the project to result in a prospective yield with a present value of zero — or, for example, a fall in the selling price of about 15 per cent over the whole life of the works).

Of the various solutions considered the choice should be a single works with vertical kilns, whose location would have to be examined in greater detail :

— if possible, by improving regional forecasts of demand ;
— by more precise study of the costs of installation and of operating the two deposits concerned.

The vertical kiln solution is moreover better than the rotary kiln solution in that it provides a certain flexibility :

— in the early stage of operations, by allowing the construction of the four kilns to be spread out over a period of time ;
— in later operations, by making it possible to avoid sudden stoppages in the whole production process at certain times for commercial

reasons (e.g. seasonal drop in demand) or technical reasons (kiln maintenance).

There are confirmed reserves for a period of 20 years at the two deposits, assuming a production level of 200,000 tons of cement per annum. In fact, there is a good chance that the reserves are higher, and will permit exploitation over a longer period or at a faster pace.

Taking all this into account, Company S decides to build the cement works and therefore :

— Commissions a firm of specialists to carry out an additional survey of the two deposits, and asks for a contract to be drawn up for the design work in respect of the future plant.
— Undertakes an additional survey of the regional market and the commercial network to be set up in order to dispose of any quantities not absorbed by Company S itself, which is a public works enterprise.
— Makes plans for the recruitment and possible training abroad of future supervisory staff for the works.
— Applies to the Government for approval and tax exemption.
— Contacts its bank to discuss means of financing the works, and particularly regarding payments in foreign exchange. Foreign assistance is envisaged, and the examination of the estimated operating accounts (see Tables 2.16 to 2.20) together with the tables of cash reserves deduced from them shows that amortization of a foreign loan could easily be provided for.