# CHAPTER 3

# THE CEMENT INDUSTRY IN THAILAND

## I. Introduction

This chapter will look initially at how the cement industry in Thailand was founded, financed, and developed. The aim is to cite on example of the features involved in location theory. Thailand, like many other developing countries, has during the past few decades had a programme of construction development which has recessitated the use of large quantities of cement. Countries in such a position have a choice between producing the material themselves, if the raw materials and financing for cement producing plants are available, or importing the material. However in same countries the cement industry has had a retarded development because of either a lack of capital available for investment or a shortage of foreign exchange.

Thailand did not suffer from either of the above mentioned factors. In following a policy of rapid industrialization and public utilities investment, the country needed vast quantities of cement for such projects as dam building, road and bridge construction, and factory creation.

The Siam Cement Company was founded in 1913 and was one of the first major manufacturing enterprises in the country. The plant, partially financed by the private investment, was located near the source of raw materials. During the past 40 years, then has been a rapid increase in production. The cement was used for both private and government construction. The rise in demand, the availability of raw materials and the high cost of importing cement from abroad all meant that the company was able to develop successfully. The main factory today is at Bangsue, north of Bangkok. This site is near the railway yard and main street traffic arteries. Now a pipeline brings clay pumped from clay fields 13 kilometers away, at Don Muang.

In Saraburi, the Tha Luang factory is producing at full capacity of 1.2 million metric tons a year. Here also, a pipeline connects the factory with the Ban Moh marl quarry, 7 kilometer away. The plant can also transport its products along the Pasak river, a tributary of the Chao Phraya.

Also in Saraburi, a new 350 million baht plant was opened in 1972, with a capacity of 600,000 tons a year. The money for this was provided by a loan from the Siam Cement Company and other members of the Siam Cement Group. Financing the Siam Cement Company has been accomplished mainly though issuance of authorized capital in the form of shares.

Other companies include the Jalaprathan Cement Co. Ltd., formed in 1956. It was originally formed to provide material for irrigation and dam projects. The Government owns 7.5% of the shares through the Royal Irrigation Department. The main plant is located at Takli. A total of 50% of production is used on Government projects.

## II. Cement Demand and Market

Mainly because of the U.S. Army construction projects and the Government's first National Development Plan, there has been rapid expansion of cement consumption in Thailand during the past 12 years. In the period 1964 - 1968 this increase rate was 21% during four years. It is expected, however, that during the next few year the demand with expand at about 12% per anum.

Accompanying the increase in demand, the supply has also increased space. The Jalaprathan Cement Company was formed to help meet the Government's need for the cement, while the Siam Cement Company supplied private and Government demand for Central Thailand. Since the Siam Cement Company produced 80% of the total amount of cement consumed the market can be classed as dominant firm oligopoly. Despite the shortage in supply, the Government help maintain stable prices through low tariffs on imported cement.

## III. Cement Factors of Production

(i) Raw materials: Raw material for cement products can be obtained by quarrying, mining, dredging on by purchasing; and the different plants in Thailand use a variety of these methods.

(ii) Labour: The cement industry has been classified as a capital intensive industry, and labour, employed by this type of industry is mainly skilled rather than unskilled. Jobs are stratified according to levels of responsibility in the work, and different rates of pay accompany the different levels. There seems to be a uniform schedule of payment rates for workers from plant to plant of the various companies.

(iii) Fuel: Solid liquid or gaseous fuels are usually purchased; and since the cost is higher than for other purchased materials, it is bought on the open market. Fuel can easily be transported by road from Bangkok, or by boat from various depots. All the cement plants in Thailand use two types of fuel-fuel oil and motor fuel, both of which are prefered and easily available.

(iv) Power: Power use can be divided roughly into thirds; one third for grinding raw materials, one third for grinding the clinker and one third for all other purposes. On the average, one barrel of cement requires 20 kilowatt hours of power.



IV. Cement Input-Output Analysis

One aim in this study is to apply the traditional Weberian framework to the analysis of the cement industry's location in Thailand. To do this the input-output structure of the Jalaprathan company at Takli has been investigated.

The figures in Tables 3-1, 3-2 and 3-3 show the growth and the trend of cement products, including the resources used by one cement plant. Most of these resources are available locally, and there is also a local market for consumption of the finished product; 80% to Bangkok, the rest to the North and Northeast.

(i) Labour

The view that the cement industry will certainly not be obstructed by a shortage of labour is given strong confirming support

Table 3-1

Input and Output Table for Cement Factory 1961 - 1971

Jalaprathan Cement, Takli, Nakornsawan

| Year | 1961 | | 1962 | | 1963 | | 1964 | |
|---|---|---|---|---|---|---|---|---|
| Input and Output | Unit | Value | Unit | Value | Unit | Value | Unit | Value |
| Input | | | | | | | | |
| Cement Rock | 11,771,000 | 117,710 | 114,804.986 | 148,040 | 94,932.070 | 1,949,320 | 75,508.650 | 1,755,080 |
| Gypsum | 2,514.000 | 377,100 | 6,553.647 | 982,950 | 9,789.940 | 1,468,350 | 13,570.459 | 2,035,500 |
| Lime-stone | 173,661.000 | 1,562,949 | 201,585.000 | 1,814,265 | 190,546.000 | 1,905,460 | 195,789.000 | 1,762,101 |
| Sand-stone | 7,031.000 | 26,717,800 | 10,060.600 | 38,230,280 | 8,807.100 | 33,466,980 | 9,006.500 | 34,224,700 |
| Clay and Shale | 19,900.000 | 139,300 | 26,986.000 | 188,902 | 27,653.000 | 193,571 | 27,571.000 | 192,997 |
| Motor Fuel | 5,199.610 | 4,159,688 | 5,297.631 | 4,233,304 | 5,186.693 | 4,149,354 | 5,207.586 | 4,166,068 |
| Fuel Oil | 15,190.669 | 6,881,070 | 18,670.284 | 8,457,510 | 16,982.594 | 7,692,846 | 17,242.903 | 7,810,626 |
| Electric Power | 9,549.080 | 2,387,270 | 12,547.458 | 3,136,864 | 23,005.484 | 5,751,371 | 22,485.207 | 5,621,301 |
| Labour Cost | 236 | 4,848,450 | 317 | 5,087,250 | 359 | 5,656,300 | 422 | 7,091,900 |
| Output | | | | | | | | |
| Cement | 195.877 | 48,969,250 | 200,988 | 50,247,000 | 273.727 | 68,431,750 | 274,150 | 68,537,500 |

Source: Cement Factory

Table 3-2

Input and Output Table for Cement Factory 1961 - 1971

Jalaprathan Cement, Takli, Nakornsawan

| Year | 1965 | | 1966 | | 1967 | | 1968 | |
|---|---|---|---|---|---|---|---|---|
| Input and Output | Unit | Value | Unit | Value | Unit | Value | Unit | Value |
| Input | | | | | | | | |
| Cement Rock | 86,598.720 | 1,865,980 | 179,200.956 | 1,792,000 | 185,100.000 | 1,851,000 | 195,455.270 | 1,954,550 |
| Gypsum | 14,128.976 | 2,119,200 | 14,392.110 | 12,158,816 | 12,496.660 | 12,496,660 | 12,500.195 | 12,500,190 |
| Lime-stone | 198,672.000 | 1,788,048 | 99,716.635 | 8,974,497 | 95,729.817 | 8,615,688 | 96,100.785 | 8,649,070 |
| Sand-stone | 8,970.200 | 34,086,760 | 7,553.986 | 28,705,146 | 8,564.226 | 32,544,000 | 8,972.750 | 34,096,450 |
| Clay and Shale | 27,910.000 | 195,370 | 27,195.110 | 190,365 | 20,346.297 | 142,422 | 27,139.124 | 189,970 |
| Motor Fuel | 5,345.125 | 4,276,100 | 5,972.467 | 4,777,973 | 5,772.995 | 4,378,396 | 7,645.850 | 6,116,680 |
| Fuel Oil | 17,690.473 | 8,013,570 | 30,889.161 | 13,992,717 | 30,217.158 | 13,688,301 | 31,172.462 | 14,124,080 |
| Electric Power | 33,202.495 | 8,300,623 | 30,278.651 | 7,569,662 | 30,526.714 | 7,631,678 | 38,500.261 | 9,625,060 |
| Labour Cost | 353 | 9,215,400 | 410 | 11,384,200 | 531 | 14,004,720 | 554 | 15,311,900 |
| Output | | | | | | | | |
| Cement | 289.506 | 72,376,500 | 290.174 | 72,543,500 | 284.969 | 71,242,250 | 298.877 | 74,719,250 |

Source: Cement Factory

Table 3-3

Input and Output Table for Cement Factory 1961 - 1971

Jalaprathan Cement, Takli, Nakornsawan

| Year | 1969 | | 1970 | | 1971 | |
|---|---|---|---|---|---|---|
| Input and Output | Unit | Value | Unit | Value | Unit | Value |
| Input | | | | | | |
| Cement Rock | 215,456.150 | 2,154,561 | 292,573.691 | 2,925,738 | 200,595.447 | 2,005,954 |
| Gypsum | 13,000.000 | 19,500,000 | 12,769.133 | 12,769,133 | 13,297.030 | 13,329,000 |
| Lime-stone | 98,736.500 | 8,886,285 | 123,700.000 | 11,133,000 | 87,876.478 | 7,908,883 |
| Sand-stone | 10,134.169 | 38,509,815 | 9,796.000 | 37,224,800 | 11,682.418 | 44,393,188 |
| Clay and Shale | 19,264.000 | 134,848 | 16,334.309 | 114,338 | 13,148.278 | 92,036 |
| Motor Fuel | 7,520.100 | 6,016,080 | 7,260.105 | 5,808,084 | 8,154.205 | 6,523,364 |
| Fuel Oil | 30,135.600 | 13,651,155 | 32,842.568 | 14,877,426 | 28,011.071 | 12,688,983 |
| Electric Power | 38,766.149 | 9,691,537 | 39,964.213 | 9,991,053 | 38,578.203 | 9,644,550 |
| Labour Cost | 576 | 16,326,200 | 590 | 16,481,400 | 500 | 16,622,920 |
| Output | | | | | | |
| Cement | 296.579 | 74,144,750 | 274.425 | 68,606,250 | 294,372 | 3,593,000 |

Source: Cement Factory

by the labour output ratio illustrated in Table 3-4 below. This table indicates that the labour contributes only a very small portion to the production of cement product, relative to the highly significant role played by capital. That is to say, the cement industry is definitely a capital intensive industry, as shown in Tables 3-4 and 3-5.

Table 3-4 Labour output ratio of cement factory

| Years | Labour (unit = person) | Output | $\frac{L}{O}$ |
|---|---|---|---|
| 1961 | 236 | 195,899 | .0012 |
| 1962 | 317 | 200,988 | .0016 |
| 1963 | 356 | 273,727 | .0013 |
| 1964 | 422 | 294,150 | .0015 |
| 1965 | 353 | 289,506 | .0012 |
| 1966 | 410 | 290,174 | .0014 |
| 1967 | 531 | 284,969 | .0019 |
| 1968 | 554 | 298,877 | .0019 |
| 1969 | 576 | 296,579 | .0019 |
| 1970 | 590 | 274,425 | .0021 |
| 1971 | 500 | 294,372 | .0017 |

Source: Derive from Input-Output Table 3-1, 3-2, 3-3.

Table 3-5 Capital out-put ratio of the cement factory

| Years | Capital (฿)[1] | Value-added (฿)[2] | $\frac{C}{O}$ |
|---|---|---|---|
| 1963 | 77,620,537 | 81,381,774.3900 | .9538 |
| 1964 | 79,851,161 | 80,602,841.5000 | .9907 |
| 1965 | 80,494,695 | 84,107,283.1200 | .9570 |
| 1966 | 93,737,832 | 58,220,511.3600 | 1.6100 |
| 1967 | 128,200,914 | 52,588,179.2600 | 2.4378 |
| 1968 | 132,167,993 | 47,237,509.8500 | 2.7979 |
| 1969 | 106,561,831 | 34,916,245.6700 | 3.0519 |
| 1970 | 84,626,574 | 44,563,875.7500 | 1.8990 |
| 1971 | 71,990,796 | 52,954,579.0800 | 1.3557 |

Source: 1. Thai Investment Review 1969

2. Derive from Input-Output (Table 3-1, 3-2, 3-3)

3. Value-added = Annual value of the total cement product minus total value of material cost.

Further consideration must be given, to the absolute amount of labour cost per ton of product which is compressed into an actual percentage of total cost of output. In another word, the actual percentage of labour compression refers the fraction of total cost of a ton of cement accounted for by labour. Friedrich gave the following explanation regarding Weber's index of the labour cost of the industry.

"This absolute amount of labour cost per ton of product on which the compression is based (and which is in a certain sense the object of this compression) evidently pertains to every given industry of a country in a given stage of development in the form of average costs of labour which must be applied to the ton of the product. And called this as the index of the labour cost of the industry. He added that as a condition of labour orientation the labour cost accruing per ton of product therefore belongs to the characteristic of the particular industries."[1]

The figures in Table 3-6 show that the index of the labour cost of the cement industry is a very low one, particularly, when we compare this index with the index of material cost. During 1961 - 1971, the index of the labour cost was nine to seven times smaller than the index of material cost.

This finding yields a result which is consistent with Weber's theoretical solution concerning the significance of the index of labour cost in determining the orientation of an individual plant. Weber further stated on his theoretical measurement as follows:

"With a high index of labour costs," he stated, "a large quantity of labour cost will be available for compression, with correspondingly large potential indices of economy of the labour locations and correspondingly high critical isodapanes; therefore we shall find a high attracting power of the labour locations. And vice versa: low

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[1] Afled Weber, Theory of the Location of Industries, trans. by Carl J. Friedrich (Chicago: The University of Chicago Press, 1965), pp. 106 - 107.

Table 3-6

Index of Material Cost and Index of Labour Cost of the Cement Factory

1961 - 1971

| Years | Index of Material Cost per ton | Index of Labour cost per ton |
|---|---|---|
| 1961 | 216.1708 | 24.7525 |
| 1962 | 284.5549 | 25.3112 |
| 1963 | 206.6927 | 20.6640 |
| 1964 | 209.9886 | 25.8687 |
| 1965 | 209.4798 | 31.8315 |
| 1966 | 269.3597 | 39.2323 |
| 1967 | 285.4631 | 49.1447 |
| 1968 | 291.9464 | 51.2314 |
| 1969 | 332.2699 | 55.0484 |
| 1970 | 345.6084 | 60.0579 |
| 1971 | 328.1085 | 86.4691 |

Value: ฿

Source: Derive from Input-Output Table 3-1, 3-2, 3-3

$$\text{Index of Material Cost} = \frac{\text{Total Value of Material Cost}}{\text{Total Cement Output}}$$

$$\text{Index of Labour Cost} = \frac{\text{Total Value of Labour Cost}}{\text{Total Cement Output}}$$

index of labour costs, small quantity of labour cost available for compression, etc.

That is to say, the potential attracting power of the labour locations runs, for the different individual industries, parallel to the indices of the labour costs of the industries. The index of labour costs is the provisional standard of measuring the extent to which the industries may be deviated. For many industries it alone decides definitely how they will be oriented, this is true for all those in which the labour cost are so low that they are insufficient to cause effective indices of economy. The other industries are grouped by this index according to the amount of labour they require per ton of product, which primarily indicates to what extent they may be deviated."[2]

We have come to a stage where it seems logical to say that the labour factor can be regarded as a locational factor of very low significance, and one which will certainly not be dominant in determining the location of a cement plant. The locational factor which is most significant in its effect on the location of cement industry is the transportation cost.

(iii) Transportation Cost

With Weberian assumptions and the law of transport orientation, the cement industry's locational pattern can be determined. The outcome of this analysis depends on the relative attractive force exerted by the consumption point and by the source of raw material; in other words, our objective is to find out which will be the locational point at which lowest transportation cost occurs. To analyse this,

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2 <u>Ibid.</u>, pp. 107 - 108.

we use empirical figures for the weights and quantities of raw materials and other inputs and the geographic points to which specified outputs are designated to go; and we obtain a solution for the optimal the geographical position of any plant, which is determined by the minimum transport cost for that plant, as indicated by the Weberian mathematical solution. The results of the "material index" and "locational weight" are illustrated in Table 3-7 below.

Table 3-7

Material Index and Location Weight of the Cement Factory

| Years | Material Index per ton[1] | Locational Weight per ton[2] |
|---|---|---|
| 1961 | 1.2490 | 2.2490 |
| 1962 | 1.4752 | 2.4752 |
| 1963 | 1.3769 | 2.3769 |
| 1964 | 1.3364 | 2.3364 |
| 1965 | 1.3559 | 2.3559 |
| 1966 | 1.3619 | 2.3619 |
| 1967 | 1.3631 | 2.3631 |
| 1968 | 1.3969 | 2.3969 |
| 1969 | 1.4600 | 2.4600 |
| 1970 | 1.4504 | 2.4504 |
| 1971 | 1.3633 | 2.3633 |

Source: Derive from Input-Output (Table 3-1, 3-2, 3-3)

Table 3-7 (continued)

1. Material Index (M.I.) = $\frac{\text{Localize Materials + Ubiquity}}{\text{Finished Product}}$

2. Locational Weight (L.W.) = $\frac{\text{Localize Material + Finished Product}}{\text{Finished Product}}$

3. Value of Ubiquity of cement industry equal to zero.. See Edgar M. Hoover, The Location of Economic Activity (New York: Mcgraw-hill Book Co., 1963), p. 35.

4. The formulations of Material Index and Locational Weight have been already explained in Chapter I. The original concept was given by Alfred Weber, Theory of the Location of Industries, trans. by J.C. Friedrich (Chicago: University of Chicago Press, 1965), p. 60.

The figures for the Material Index and Locational Weight in Table 3-7 indicate that from 1961 - 1971 the value of the material index has always been greater than 1; and during the same period, the locational weight was always greater than two. This finding is relevant to the Weberian thecretical conclusion, as quoted below:

"We now can state the following conclusion regarding the struggle with respect to location between the place of consumption and the material deposits.

First, generally speaking, industries having a high locational weight are attracted towards material; those having low locational weight are attracted towards comsumption; for the former have a high, the latter have a low, material index. In view of our mathematical conclusion, then, all industries whose material index is not greater than one and whose locational weight therefore is not greater than two lie at the place of consumption.

Second, with respect to the composition of the material index we can deduce the following: Pure materials can never bind production to their deposits. For since they enter without loss of weight into the product, the sum of the component weights of their deposits is always at most equal to the weight of product, and therefore the material index which they create never is more than one. We shall see the detail below. Weight-losing materials, on the other hand, may pull production to their deposits, for this to happen, however, it is necessary that the material index which they codetermine be greater than one, and that their portion of the material index be equal to that of the remainder plus the weight of the product. Stated more simply their weight must be equal to or greater than the weight of the product plus the weight of the rest of the localized materials"[3]

The Weberian framework analysis which has been applied to the empirical conditions of cement production, leads in the end to the conclusion of our study that cement production is of a type which is bound to the source of materials deposit. This study is consistent with the Report of the Interregional Seminar on the Cement Industry of The United Nations held in Denmark 2-16 May 1964.

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[3] Ibid., p. 61.

"The report had drawn the general conclusion that cement plants were, by and large, resource tied, and their location near basic raw material can be regarded as ideal when markets were also at hand. The location of plants was in fact determined by a compromise among a number of factors, of which the most important are, proximity to limestone and clay, cement market, transport facilities, fuel, and power resources, and water supply."[4]

A contrary view has been expressed by a Portland cement specialist, J.C. Witt, who states the following, "Formerly, it was customary to give first consideration to the sources of raw materials and fuels, shipping the cement relatively long distances, if necessary, to the market. The tendency now is to locate a plant as close as practicable to the principal market, even if this requires bringing raw materials and fuels relatively long distances to the plant. Frequently, the principal limiting factor is the cost of transportation."[5] Even though Witt finds a present preference for establishing cement plants proximate to the market his remarks do not negate our conclusion; since he accepts the fact that transportation cost is frequently a disadvantage in locating cement plants at the place of principal markets. Witt's assertion seems not to be relevant to the theoretical characteristic we have assumed for the cement industry; since our finding and analysis

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[4]United Nations, Report of the International Seminar on the Cement Industry (New York: 1965), p. 2.

[5]J.C. Witt, Portland Cement Technology (New York: Chemical Publish Co., 1966), p.140.

is based on the hypothesis that the point at which cement plants should be located is the place at which transportation costs are minimized. And by our analysis the minimal transport cost point for the cement industry is at the source of raw materials.

One factor which may distort our results is the leakage of cement dust. It is estimated that the cement industry loses as much as 8% of its output as dust in the South-east Asian countries.[6] The possible distortion can be dismissed because of the following finding:

Even if the weight of the finished cement product per ton is smaller than the weight of raw material consumed per ton of product, because of the loss of cement dust during packing and storage rather than by the waste of material, it will not change the outcome of our analysis. This is true since the loss of cement dust during production is still smaller than the total losses of materials, which means that the sum of the weights of the finished product and the cement dust lost is still smaller than the Material Index. In the extreme case, though, even if the sum of the weights of the finished product and the cement dust lost is equal to Material Index, the cement industry will still be oriented to material; since its procurement costs per ton mile are greater than the distribution cost.[7]

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[6]NEDB, Article concerning Cement Rush Calls for Caution, (Bangkok, Thailand, 1971).

[7]Edgar M. Hoover, The Location of Economic Activity, (New York: Mcgraw-Hill Co., 1963), p.32.

(iii) Other Findings on the Input-Output Relationship

In the previous section, we used various indicators which were derived from Input-Output Tables 3-1, 3-2 and 3-3 to analyse location in the cement industry by use of the traditional Weberian framework. In this section, other indicators which are also derived from Input-Output Tables 3-1, 3-2, and 3-3 will be incorporated in our analysis along with the indicators already developed in the last section. Our main objective in this section is to investigate the interrelated influences on location of the factors of production of **which combined** by a certain cement factory. The findings from this part of our study will provide a second confirmation of the influence of costs of related factors of production in determination of location of factories in the cement industry.

To simplify our investigation, we will initially decompose a ton of cement into the proportions contributed by each factor of production.

(1) Material Component

Table 3-7 in the previous section, demonstrates the evident rigidity of the material composition of a ton of cement during the years 1961 - 1970 (see column headed material index per ton in Table 3-7) This characteristic is in accordance with the specifications of the American Standard for Testing and Material (ASTM).

"Portland cement is the product obtained by finely pulverising clinker produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials, with no additions subsequent to calcination excepting water and calcined or uncalcined gypsum."[8]

(2) Labour Component

The figures in Table 3-4 in the column indicating the labour out-put ratio, and which we call here the "labour component" tend to increase year by year during the 1961 - 1970 period. It will be shown below that this was due to the fact that labour productivity gradually decreased over the decade. (See the figures on labour productivity in Table 3-8 below).

Table 3-8 Annual Labour Productivity of the Cement Factory

| Years | Quantity of labour: person | Product: ton | $\frac{O}{L}$ = ton |
|---|---|---|---|
| 1961 | 236 | 195,977 | 829.9873 |
| 1962 | 317 | 200,988 | 634.0315 |
| 1963 | 356 | 273,727 | 762.4708 |
| 1964 | 422 | 274,150 | 649.6445 |
| 1965 | 353 | 289,506 | 820.1303 |
| 1966 | 410 | 290,174 | 707.7415 |
| 1967 | 531 | 284,969 | 536.6648 |
| 1968 | 554 | 298,877 | 539.4892 |
| 1969 | 576 | 296,579 | 514.8941 |
| 1970 | 590 | 274,425 | 465.1271 |
| 1971 | 500 | 294,372 | 588.7440 |

8 Loc.cit., Witt, p. 181.

(3) Capital

It must be realized from the start that this factor includes new investment for plant modification and replacement which resulted in an increased amount of capital during 1967 - 1969, while the quantity of output did not change much. This caused the figure for capital to be more uneven than it would otherwise have been over the whole period 1963 - 1971. But when we compare the figures of the early years, 1963 - 1965 and the two lastest years 1970 - 1971, the difference is very small; this implies that the capital required to produce a ton of cement has not varied. This empirical evidence is consistent with the capital-output ratios calculated for the cement industri's current production. The illustration of this is given in Table 3-9 below.

Table 3-9 Capital Output Ratio of the Cement Factory and Capital Output Ratio of the Cement Industry

| years | $\frac{C}{U}$ of Cement Factory A[1] | $\frac{C}{U}$ of Cement Industry[2] |
|---|---|---|
| 1963 | .9538 | 1.45 |
| 1964 | .9907 | 1.45 |
| 1965 | .9570 | 1.66 |
| 1966 | 1.6100 | 1.67 |
| 1967 | 2.4378 | 1.52 |
| 1968 | 2.7979 | 1.35 |
| 1969 | 3.0519 | n.a. |
| 1970 | 1.8990 | n.a. |
| 1971 | 1.3557 | n.a. |

Table 3-9 (continued)

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1. The figure of capital used to calculate $\frac{C}{U}$ obtained from Thai Investment Review, Report of Quoted Companies (Bangkok: Siam Publication, 1969), p. 71; for the output figure obtained from the Input-Output Table 3-1, 3-2, 3-3.
2. Chaliaw Ngarmwong, Economic Evaluation of Promoted Industries (Bangkok: Thammasart University, 1971), p. 68.

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Since the capital output ratio indicates the capital requirement for increasing value-added by output, it follows that the capital required for one ton of a cement product is quite a constant component, employed in fixed proportion to a rigid material component and accompanied by an increase in the labour input needed for producing a ton of cement. The constancy of the capital and material components underlies the view expressed earlier that labour productivity must have fallen over the decade. Indeed, the increase in labour used per ton of cement is not consistent with any alternative hypothesis, under these circumstances.

(iv) <u>Share of Material Cost and Labour Cost as Percentages of Value-added of a Cement Factory During 1961 - 1971.</u>

If our finidings ragarding the factor combination for a ton of cement are precise, given the technical specification and chemical composition of cement, then, the analysis below follows logically.

The finding in section (ii) suggests that the capital requirement and material components needed to produce one ton of cement can be taken as constant, and any change in value-added of cement may be attributed to changes in material or labour costs. Differences in labour cost can arise in 2 ways: they can be caused by differences in labour productivity and in the labour wage rate. In our empirical case, both labour productivity and labour wage rates caused a change in value-added of the cement product. Since labour contributes a very small proportion to the product, its result is not as great as that of material cost. In another words, we can say that material cost plays a very significant, indeed dominant, role in determining the value-added of the cement product, Table 3-6 illustrates the proportionate importance of material cost and labour cost, and we count it as evidence to support the foregoing statement.

Table 3-10 Share of Material Cost and Labour Cost as a percentage of Value-added of the Cement Factory 1961 -1971

| Years | Value-added*/ton | Material Cost as a percentage of Value-added | Labour Cost as a percentage of Value-added |
|---|---|---|---|
| 1961 | 287.83 | 75.10 | 8.59 |
| 1962 | 219.45 | 129.66 | 11.53 |
| 1963 | 297.31 | 69.52 | 6.94 |
| 1964 | 294.01 | 71.42 | 8.79 |
| 1965 | 290.52 | 72.10 | 10.95 |
| 1966 | 200.64 | 134.25 | 19.55 |
| 1967 | 184.54 | 154.68 | 26.62 |
| 1968 | 158.05 | 184.72 | 32.41 |
| 1969 | 117.73 | 282.23 | 46.75 |
| 1970 | 162.39 | 212.82 | 36.98 |
| 1971 | 179.89 | 182.39 | 31.39 |

Source: Derive from input-Output Table 3-1, 3-2, 3-3

*Value-added/ton = Factory Price/ton (obtained from Table 3-1, 3-2, 3-3) minus Material Cost/ton

Factory Price = $\frac{\text{Total Value of Output}}{\text{Output}}$ (Figures obtainable from Table 3-1, 3-2, 3-3)

Thus, our final conclusions are first, that to explain location in the cement industry, initial consideration should be given to material deposits; and second that, the lower the material cost the higher the value-added as well as the production accounted for by labour cost, although this latter factor is of minor significance in our own Thai situation. Finally, the advantage of one plant over another plant should stem from a difference in material costs rather than the amount of material consumed for a ton of cement, or rather than from a difference in the capital output ratios of the two plants.