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PLANT SIZE AND ECONOMIES OF SCALE

Prepared by

Research and Evaluation Division

Centre for Industrial Development

Department of Economic and Social Affairs

United Nations, New York

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I. Introduction

One of the problems which has been widely and frequently discussed in the recent literature on economic development, both at the macro economic level and the micro economic level, is the question of economies of scale and the size of plants. The question relates to techniques and forms of production organization which can be utilized in a plant or industry.[1/] In developed countries the problem has been mostly discussed as relating to monopoly and strategy under oligopoly, whereas in newly industrializing countries it has been the problem of selection of industry or establishment and operation of new plants. This paper will be confined mainly to discussion of size of plants as related to developing countries.

As is well known, the cost of industrial product is generally lower in a large-scale plant than in a small-scale plant, the main reason being that the costs of equipment and construction and land, the amount of labour required and sometimes the amount of raw materials do not vary in proportion to changes in the size of production. A large scale production may also require less overhead cost per unit of output.

However, the economies of scale may not always be entirely relevant for the choice of industry especially in under-developed countries when one takes into account local conditions in their factor proportions, the prices of competitive goods, the size of market, the location of plant, the technology involved, etc.

This paper deals briefly with (I) the cost of production in relation to the scale of production, and (II) the effect of such factors as market, transportation, management and technology on the scale of production.

1/ The term "economies (or diseconomies) of scale" has been vaguely used. One of the distinctions is between external and internal economies, the other between pecuniary and technological. Internal economies are those within the firm, external economies are external to the firm but available to all firms in the industry. Pecuniary economies arise from the change in the price of a factor or intermediate good, or a cost of marketing, while technological economies are realized when a larger scale of output permits a lesser input per unit of output to be realized in physical terms.

II. Cost-size relationship

A decrease in unit production cost with increase in size of plant is a well known characteristic of many industries.

This relationship can be expressed for various components of production cost including investment or capital charges, labour, raw materials, maintenance, and other inputs by formulation of appropriate equations. The relationship between investment and scale of production for example has been presented in the following formula.

$$\left(\frac{K_1}{K_2}\right) = \left(\frac{X_1}{X_2}\right)^{\beta}$$

where K_1 and K_2 stand for capital requirements of plants 1 and 2, and X_1 and X_2 are the corresponding output levels. β is an empirical exponential coefficient which varies from one industry to another and which would hold true only within a certain range beyond which it would also tend to vary.

Each component of production cost shows a different variation in relation to the scale of capacity and output. In general, the amounts of raw materials consumed vary in about the same proportion to output, whereas labour and equipment requirements increase less rapidly than the rise in production. Those costs for sales and distribution, although they are not included in the direct cost, also increase less proportionately.

A few studies on the subject of economies of scale have been hitherto undertaken by the Industrial Development Division of the United Nations Headquarters and the United Nations Economic Commission for Latin America. For example, the study on this subject, which analyzes changes in costs and in investment outlays in relation to capacity of output in two industries, ammonia fertilizers and glass containers appeared in the Bulletin of Industrialization and Productivity.2/ The Economic Commission for Latin America made a similar study on the steel industry, which also offers an extensive example for the case.3/ Some other papers on programming data for

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2/ United Nations "Problems of Size of Plant in Under-developed Countries" United Nations Productivity and Industrialization, Bulletin No. II (New York 1959)

3/ Economic Commission for Latin America, A Study of the Iron and Steel Industry in Latin America (II.G.3. Vol.I. 1954) pp. 112-116.

such industries as the ones for cement, fertilizers based on natural gas and aluminium prepared by the Research and Evaluation Division of the Centre for Industrial Development United Nations Headquarters provide similar examples.[4/] The following table shows some of the results of a number of the above-mentioned studies and of the recent study undertaken by the Productivity Center of Japan in four industries, namely ball-bearings, tar, benzole and aluminium plate. (For detail see Appendix).

(Table I)

Variation in Production Cost in relation to Different Scales of Output in Selected Industries

Name of Products	Capacity and Cost	Unit	Variation in Capacity and Production Cost			
Steel	Capacity	in 1,000 tons per year	50	250	500	1,000
	Cost per ton	in 1948 U.S. dollars	209.4	158.8	137.5	127.2
Cement	Capacity	in 1,000 tons per year	100	450	900	1,800
	Cost per ton	in 1959 U.S. dollars	26.0	19.8	16.4	13.9
Ammonium Nitrate	Capacity	in short tons per day	50	100	150	300
	Cost per ton	in 1957 U.S, dollars	190.4	145.1	125.6	101.5

4/ See United Nations, Centre for Industrial Development, Programming Data and Criteria for the Cement Industry, Fertilizers based on Natural Gas, and Pre-investment Data on the Aluminium Industry.

Beer Bottles	Capacity Cost per gross	number of moulding machines in 1957 U.S. dollars	1 8.51	2 7.25	6 6.13	12 5.69
Glass Container	Capacity Cost per gross	number of moulding machines in 1957 U.S. dollars	1 8.66	2 7.77	6 6.78	12 6.33
Radial ball-bearing	Capacity Cost per 1,000	production index (1961 = 1) in 1961 yen	1 79,800	2 67,100	3 63,100	
Tar	Capacity Cost per ton	tons per day in thousand 1961 yen	100 10.5	200 9.6	300 9.2	400 8.9
Benzole	Capacity Cost per ton	tons per day in thousand 1961 yen	50 29.2	100 27.1	200 25.9	300 25.4
Aluminium Plate	Capacity Cost per ton	tons per year in thousand 1960 yen	200 276.8	1,200 272.2	3,000 269.1	5,000 263.5

Source: For steel, Economic Commission for Latin America, A Study of the Iron and Steel Industry in Latin America; op.cit.
For cement, Economic Commission for Asia and the Far East, Formulating Industrial Development Programmes. Sales N. 61.II.F. 7. Bangkok, 1961
For fertilizers and glass containers, "Problems of Size of Plant in Under-developed Countries" Bulletin of Industrialization and Productivity, op.cit.
And for other products, Japan Productivity Center: A Research Project in the Size of Plants, (mimeo) Tokyo, 1961.

Since each item has been calculated on different assumptions, the table above does not serve for comparative purpose among various industries. It shows, however, as a first approximation, that the production cost in industry is normally lower in large-scale production than in small-scale production.[5]

Each component of production cost shows different variations in accordance with the types of products and technology. This, together with different weights of these components in total cost, makes economies of scale un-uniform throughout industrial activities.

5/ It should be mentioned that the cost of production is affected differently by the scale of capacity and by the scale of output (actual operation). In using the word "scale" in this paper it is implicitly assumed that the degree of operation - i.e. the degree of capacity utilization - remains constant. Needless to say, higher scales of operation lead to lower costs, smaller investment per unit of production, and higher productivity.

For the sake of simplicity, total production cost may be divided into the following four groups:

(i) cost of raw materials and supplies, including all current purchases made by the factory and excluding supplies for maintenance;

(ii) cost of power and fuels, wherever such distinction can be made;

(iii) labour cost, including all wages and related payments, other than the wages of regular workers;

(iv) cost relating to capital investment, including depreciation, labour and materials for maintenance and the normal renumeration of capital and miscellaneous charges, such as short term interest and insurance charges.

Cost of raw materials and supplies. Raw materials requirements in physical terms are, in most of industries, virtually independent of size of operation and change almost proportionately with the scale of production. Unit cost of raw materials, however, often decreases with the possibility of lower cost in bulk purchasing and shipping, and with the possibility of reduced waste in handling them.

Among the above cases, no change in the unit cost of raw materials and supplies has been assumed in the cases of ammonium nitrate, beer bottles, tar, benzole and cement, although the raw materials cost may, in practice, slightly change, as is seen in other cases. In the cases of aluminium plate and finished steel, they show a certain amount of savings in raw material inputs, mainly due to the lower cost of bulk purchasing and the savings arising from better handling and operating methods which are technologically feasible only in large scale plants.

Costs of power and fuels. In general, physical inputs of fuel and power slightly change with changes in the size of operation, the magnitude of which is, however, likely to be insignificant in most cases. A contribution of savings of power and fuel input is, therefore, rather small. This is especially true in such industries where the costs of power and fuel hold a small proportion of total costs; for example: in ball bearing plants (where the power cost is only 1.1 - 1.6 per cent of the total cost) and in the aluminium fabrication (3.5 per cent), the contribution of saving of power to total decrease is only 1 per cent and 8.9 per cent respectively, when the scale of production increases four times the present level in the case of ball bearing and from 1,200 tons to 5,000 tons in the case of aluminium fabrication.

In high fuel or power consuming industries such as the manufacture of ammonium nitrate where the share of unit cost of fuels and power in the total cost is large, the size factory may affect total production cost to some extent, due to the technology involved in the process. The size factor may not be, however, a decisive factor in determining the cost of product, the unit cost of fuels and power being, in general, rather independent of size.

Cost of labour. An increase in the size of plant would require a lesser number of workers to engage in its operation. Unit cost of labour shows remarkable decrease in all of the above cases: for example, 41.1 per cent in the case of ball-bearing, 56.7 per cent in tar, 59.7 per cent in benzole and 33.5 per cent in aluminium plate.

In general, some part of labour inputs is independent of size and remains unchanged even if the size increases, while the remaining part changes proportionately with an increase in the scale of output. The proportion between these two parts, fixed and variable, of the labour inputs varies from one industry (or plant) to the other, depending on the technology involved. In such industries as metal and chemical process industries, especially in those modernized plants with continuous process and automated machines, where the labour is more or less of supervising type, the proportion of the fixed part is relatively larger than the other. The scale effect is greater in this item of cost. However, in relatively more labour intensive type of plants, the fixed labour is relatively small, and, accordingly, the labour cost decreases very slowly with an increase in size of operation. In the case of glass containers, for example, it is considered that total labour requirements tend to follow more closely the increase in scale of output than in the case of the production of fertilizer.

It has to be noted that in the above cases marginal labour costs, both wage rates and productivity, are assumed to be constant. In reality, however, it is not constant as will be discussed later.

Costs relating to capital. Costs relating to capital investment include such items as depreciation, labour and materials for maintenance and the normal renumeration of capital and miscellaneous charges, such as short-term interest and insurance charges. Some of them are variable and some are fixed, in relation to changes in the scale of capacity.[6] The scale effect of the unit costs of capital on the total cost is in general great, and varies from one industry or plant to the other depending on the structure of cost and the marginal price of capital.

According to the above studies, total capital cost in the case of ammonium nitrate increases proportionally with the 0.6th power of the capacity and in the case of glass containers increases approximately with the 0.75th power of capacity. In the case of ball bearings in the above study, the unit cost of capital increases as the scale of production increases, the reason being that the enlargement of the scale of production requires additional installation of new machines and equipment which are supposed to be more expensive than the original. The increase of capital costs in this case, however, is far more offset by the savings in labour inputs resulting from the application of new machines and equipment.

6/ The relationship for variation of each item of capital cost with the size of plant (capacity or output) is complicated and needs separate detailed study. It involves those problems of, among others, depreciation rate, tax rate, wage rates for labours in maintenance, cost of research, etc.

III. Factors affecting the Scale of Production or Capacity

Although the cost of production of manufacturing goods is, as was mentioned above, lower - in many cases much lower - in large scale plants than in small-scale ones, the size of plants (measured by volume of production or by capacity) is affected by a number of factors, such as (a) type of technology involved, (b) the price of competitive imports, (c) the size of prospective market and its anticipated growth, (d) the distribution costs of product, and (e) the availability of managerial personnel.

Technological factor. In the cases mentioned earlier, it has been assumed that the quantitative composition of main production factors - labour and capital - in the process of producing goods remains the same; in other words, unchanged technology is assumed. In practice, however, alternative processes seem to be technologically feasible, which involve different relative amounts of capital and labour. The factor mix in industrial processes is adjusted to the relative costs of labour and capital. The problem has been known as a choice between capital-intensive and labour-intensive industries.

In under-developed countries, a change in technology resulting in a relatively larger input of the less costly labour factor and a corresponding reduction of the higher costly capital factor tend to lower the minimum scale of capacity.7/

However, substitution of labour for machine and equipment in the main part of the industrial process may technologically be limited in modern industries. In the steel industry, for example, the available techniques are such that even the smallest feasible plant has a substantial capacity. The choice of technology in turn is affected by the volume of output, and for this reason the use of automated machine is often limited in under-developed countries.

7/ Market prices of production factors in developing countries do not precisely reflect their relative scarcities; if factors are valued at prices reflecting relative scarcities, the pattern of relative costs may differ even more from that prevailing in industrialized countries. The costs of raw material will also have to be adjusted when indigenous materials may be available only in poor quality or irregularly.

Greater requirements of labour input due to lower labour productivity may also limit the substitution. Various levels of mechanization are, however, possible in a number of ancillary operations such as unloading, conveying and mixing raw materials and handling of finished products. The Centre for Industrial Development has conducted many studies on this subject of choice of technology.[8/]

Market[9/]: The size of market is one of the important factors limiting the scale of operation especially in small developing countries. In determining the scale of capacity, one should take into account not only the present volume of demand but also the future growth of the market. The optimum scale in a growing economy is, however, very difficult to determine. This problem of "anticipated market" is particularly important in the cases of industries whose increase in capacity of output proceed by substantial "jumps", each involving a considerable additional investment outlay.

8/ See, for example:
United Nations Bureau of Economic Affairs, "Capital Intensity in Industry in Under-developed Countries", Industrialization and Productivity Bulletin N. 1 (New York, 1958)
Jan Tinbergen, "Choice of Technology in Industrial Planning", Industrialization and Productivity, Bulletin N. 1 (New York, 1958)
G.K. Boon, "Choice of Industrial Technology: The Case of Wood-working", Industrialization and Productivity, Bulletin N. 3 (New York 1960)
Saburo Okita, "Choice of Techniques", Industrialization and Productivity Bulletin N. 4 (New York 1961)
United Nations Centre for Industrial Development, Choice of Capital Intensity in Operational Planning for Under-developed Countries (New York 1962)

9/ It is assumed here, that the market is sufficient to absorb the whole production of at least one firm of optimum size, and that the market is competitive enough not to create monopolistic prices. This assumption, however, may not always be true.

If a plant is installed on the basis of present level of demand and yet the actual demand grows rapidly, the plant will have to be expanded frequently and, thus, a considerable amount of capital as well as time will be wasted. If a plant, on the contrary, is designed for the anticipated market in the future, it may begin to operate at a level lower than its capacity, and the return on investment in the early years will be quite low.

The optimum scale is set at the point where the discounted value of production over time exceeds the discounted costs (including depreciation) by the greatest amount. The rate of discount used should represent the social return to capital in alternative uses, which is measured by its accounting price. A high discount rate will therefore lead to the construction of smaller plants, while a low discount rate will lead to the erection of larger plants.

Minimum capacity. Minimum scale of capacity is determined by the price at which the same product is available as an import. In other words such capacity should result in production cost on the basis of which the price of the locally manufactured product is equal to that of the imported product; operation below this capacity would confront with the import price lower than the price at which the local product can be sold. Minimum scale is thus distinguished from optimum capacity. The two would coincide only if the anticipated market including external market for the locally manufactured product over the period of years corresponding to the useful life of the equipment, were met by output at the minimum capacity. This case, however, is unlikely to occur, since, among other reasons, the market is more likely to grow rather than to remain stagnant. If market studies indicate that the market is too small to sustain this minimum capacity, it would be cheaper to meet local needs through imports.

In this connexion, the cost of transporting both inputs and outputs becomes an important factor in determining the level of capacity. This factor is of particular importance when and where transportation cost is high relative to production cost. In establishing a cement plant in a

Southeast Asian country, for example, the cost of production in a proposed 300,000 ton plant at a specified location was estimated to be $13 per ton. And, railway freight charges to two major markets located some 100 miles and 600 miles respectively from that plant were estimated to be $2.60 and $10 per ton or 20 and 70 per cent of production cost. By virtue of this location problem, plants may be operated at levels well below the optimum scale and yet have a competitive advantage over large plants which are located farther from the market.10/

The petroleum refining industry is another example of the case. A refinery with a crude oil throughput of 120,000 barrels a day is generally considered the optimum scale of plant in the United States. This is, however, on the assumption that the refinery can transport its products to the market by ship or that it is located in close proximity to a very dense market so that transport by road or rail entails only short hauls. In the inland areas of the country, on the other hand, there are a number of refineries with much smaller capacities.11/

Likewise in equating import prices to local production costs to determine the minimum capacity, the resulting scale will be much lower in under-developed countries than the average capacity of a corresponding plant operating at optimum level in an industrialized country, because transportation cost accounts for a considerable part of the import prices of competitive products. Thus, in under-developed countries the minimum size is often less than the average size of plants in the older industrialized countries.12/

10/ In other cases, where transport cost may not be high relative to production cost, inadequate distribution facilities may be another limiting factor. Inadequate services such as irregular deliveries may be partly resolved by, among other things, the use of motor transport, the establishment of transit stores at appropriate locations as well as the installation of relatively small scale plants.

11/ Joe S. Bain, Barriers to New Competition (Cambridge, 1956)

12/ The minimum size of plant would be further reduced if the rate of domestic taxation applicable to the products were smaller than the rate applicable to the competing foreign products in their own countries; *a fortiori*, exemption from domestic taxation would bring about an even greater reduction in the minimum size of plant. A further reduction - of a scope varying from one industry to the other - would be obtained through devaluation or through imposition of customs duties on the competing imported products.

Management: One of the limiting factors on plant size, especially in less developed countries, is the problem of management. "The entrepreneurial organization is really a constellation of functions including the management of risk and uncertainty, planning and innovation, co-ordination, administration and control, and routine supervision, and in the larger enterprise where capital per worker is high, this complex of functions is an important factor."13/ In smaller plants, these functions are naturally embodied in a small group of managers, while in larger plants a large staff is required, which, in most cases, is costly and in short supply in under-developed countries.

Concluding remarks: The problem of economies of scale and size of plants is certainly very complicated and is not by any means simple to present in a general formula. The data used in this paper are only indicative of orders of magnitude and explain only some aspects of the whole problem. Increased effort would be required for assembling a systematic and coherent documentation on the cost structure of a large number of industrial products and on the variation of costs in relation to the size of plant.

Many studies show that a large-scale plant has greater advantages over a small plant in many aspects. In general it may be stated that:

(i) from the technological point of view a large plant can achieve a standardization of both parts and products, and a specialization of work, resulting in higher quality of products. It is also more suitable for adoption of quality control system, continuous flow of materials and an integration of different processes. Also, it can utilize by-products and wastes more economically;

(ii) from the management point of view, it saves input of manpower, by the division of labour and by the substitution of skilled labourers by semi-skilled labour force;

13/ ECAFE, Economic Development and Planning in Asia and the Far East, (December 1958. Bangkok) p. 54.

(iii) also, a large organization has advantages in purchasing of raw materials, in obtaining credit, and in carrying out research for products;

(iv) and, the establishment of a large plant may be followed by development of sub-contracting firms and the creation of a complex of small and large-scale firms.

The foregoing, however, does not imply that rapid industrialization consists solely of the creation of large-scale plants. Small-scale plants may also be justified for various reasons. First, as was mentioned earlier, there is a technological limit in scale beyond which the production cost shows no favourable decrease. Secondly, from market point of view a smaller scale of production may be justified if the market for the product is small. Thirdly, local supply of raw materials, labour and capital, as well as the condition of infra-structure such as water and power supply, and housing, may also justify the existence of small plants. And finally, the scale of plant is also often limited in order to minimize the risks of uncertainty and business fluctuation.

Decision on the scale of industries or plants, thus, depend on a number of technological, economic, social and political factors such as the supply of inputs, geographical distribution of market, distribution cost, the anticipated pattern of growth of the industry, government policy, and so forth. In other words, the decision of scale concerns not only with the firm's interest but also with the regional and national plan.

(Table 1)

Production Cost of Ammonium Nitrate for
Different Scales of Production, United States

(in 1959 U.S. dollar per short ton of ammonia content)

Components of cost	Scale of capacity in short tons per day			
	50	100	150	300
Raw materials and supplies	27.0	27.0	27.0	27.0
Labour	46.0	28.8	23.0	17.2
Cost relating to capital	117.4	89.3	75.6	57.3
Total	190.4	145.1	125.6	101.5

Source: United Nations, "Problems of Size of Plants in Industry in Underdeveloped Countries", Bulletin of Industrialization and Productivity N. 2

(Table 2)

Production Cost of Beer Bottles for
Different Scales of Production, United States

(in 1959 U.S. dollars, per gross, packed)

Components of cost	Number of bottle-moulding machines				
	1	2	4	6	12
Raw materials	2.40	2.40	2.40	2.40	2.40
Labour	3.09	2.31	1.93	1.80	1.67
Cost relating to capital	3.02	2.54	2.13	1.93	1.62
Total	8.51	7.25	6.46	6.13	5.69

Source: United Nations, "Problems of Size of Plants in Industry in Underdeveloped Countries", Bulletin of Industrialization and Productivity N. 2.

(Table 3)

Production Cost of Radial Ball Bearings[a/]
for Different Scales of Production, Japan

(in yen per 1000 units)

Components of cost	Scale of Production		
	present production level	double scale	4 times scale
Raw materials	44,600	41,200	39,200
Labour	17,700	10,400	8,600
Supplies from outside	8,100	5,000	4,700
Taxation	300	800	800
Depreciation	3,200	4,900	5,100
Power	1,100	1,200	1,200
Others	4,700	3,600	3,600
Total	79,800	67,000	63,100

Source: Japan Productivity Center: A Study on the Size of Firms, mimeographed, (Tokyo, 1961)

a/ Size of bearing being between 10 and 20 millimeters.

(Table 4)

Production Cost of Taper Roller-Bearings[a] for Different Scales of Production, Japan

(in yen per 1000 units)

Components of Cost	Scale of Production	
	Present Production Level	double scale
Raw materials	165,800	149,000
Labour	57,000	41,600
Sub-contract	26,900	16,900
Depreciation	12,600	16,000
Taxation	1,100	2,100
Power	4,600	5,100
Others	12,300	11,200
Total	280,300	241,900

Source: Same as Table 3.

a/ Size of bearing being between 20 and 50 millimeters.

(Table 5)

Production Cost of Tar for Different Scales of Production, Japan

(in yen per metric ton)

Components of Cost	Scale of Production (in metric tons per day)			
	100	200	300	400
Raw materials	6,500	6,500	6,500	6,500
Auxiliary sector	1,328	1,195	1,072	955
Labour	473	300	242	205
Cost of equipment	1,053	841	734	673
Administration	1,300	953	809	736
By-product and others	(-) 150	(-) 150	(-) 150	(-) 150
Total	10,504	9,639	9,207	8,919

Source: Same as Table 3.

(Table 6)

Production Cost of Benzole for Different Scales of Production, Japan

(in yen per metric ton)

Components of cost	Scale of Production (in metric tons per day)			
	50	100	200	300
Raw materials	20,725	20,725	20,725	20,725
Auxiliary sector	2,904	2,519	2,464	2,437
Labour	655	400	264	218
Cost of equipment	3,659	2,854	2,280	1,991
Administration	1,610	1,194	1,766	623
Others (minus)	(-) 357	(-) 597	(-) 597	(-) 597
Total	29,196	27,095	25,902	25,397

Source: Same as Table 3.

(Table 7)

Production Cost of Cement for Different Scales of Production

Input and investment per 1,000 tons	Capacity of plant (in thousand metric tons)						
	35	50	100	230	450	900	1,800
Labour input (in man-years)	1.43	1.20	1.00	0.80	0.75	0.65	0.50
Capital investment (in 1,000 dollars)	50	46	43	40	35	28	22
Cost per ton (in dollars):							
Operating cost[a/]	16.2	15.5	15.2	14.7	11.0	9.4	8.4
Capital charges[b/]	12.5	11.5	10.8	10.0	8.8	7.0	5.5
Total Cost	28.7	27.0	26.0	24.7	19.8	16.4	13.9

Source: United Nations Commission for Asia and the Far East, Formulating Industrial Development Programmes, Bangkok, 1961, p. 46.

a/ Raw materials inputs are assumed to be constant. Fuel and power decrease with scale.

b/ Charges for depreciation and returns to capital calculated at 25 per cent of capital stock.

Note: Estimates are based on United States International Co-operation Administration Publication and Soviet Programming norms. Similar data can be obtained from the study prepared by the Research and Evaluation Division, Centre for Industrial Development, United Nations: Programming Data and Criteria for the Cement Industry.

(Table 8)

Production Cost of Finished Steel for
Different Scales of Production, Latin America

(in 1948 U.S. dollars)

Cost per ton[a]	Capacity of plant (in 1,000 metric tons per year)			
	50	250	500	100
Raw materials	33.84	31.26	31.26	25.68
Labour cost	32.00	15,20	8.57	6.60
Capital charges	122.93	101.20	87.10	85.05
Maintenance & Miscellaneous	20.59	11.11	10.57	9.83
Total cost	209.36	158.77	137.50	127.16
Total investment per ton	492	405	348	340

Source: United Nations Commission for Asia and the Far East, Formulating Industrial Development Programmes, (Bangkok, 1961) p. 44.

a/ The costs (in dollars) are taken from engineering calculations for hypothetical integrated plants of different sizes located in the eastern part of the United States. Labour costs are taken here at 50 per cent of the United States and charges for depreciation and profit at 25 per cent capital invested to reflect Latin American conditions.

(Table 9)

Production Cost of Aluminium Plate for Different Scales of Production, Japan

(in yen per ton)

Components of cost	Scale of production (in metric ton per year)				
	50	200	1,200	3,000	5,000
Raw materials	230,220	225,300	229,220	223,880	223,120
Labour	20,940	16,050	10,120	6,730	5,250
Power	12,400	11,800	9,590	9,160	8,770
Depreciation	7,880	14,150	12,800	18,780	16,380
Others	7,350	8,780	11,040	10,560	9,610
Total	278,790	276,080	272,770	269,110	263,530

Source: Same as Table 3.