No. 9 · 1972

# asian industrial development news

UNITED NATIONS

## ASIAN INDUSTRIAL DEVELOPMENT NEWS

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ECONOMIC COMMISSION FOR ASIA AND THE FAR EAST
BANGKOK, THAILAND
ASIAN INDUSTRIAL DEVELOPMENT COUNCIL

No. 9 · 1972

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UNITED NATIONS, New York, 1972

E/CN.11/1066

UNITED NATIONS PUBLICATION

Sales No.: E.73.II.F.11

Price: US$2.00 or the equivalent in other currencies

# CONTENTS

## Part I

## NEWS IN BRIEF



## Part II

## INDUSTRIALIZATION



## Part III

## THE IRON AND STEEL INDUSTRY

# Part I

# News in Brief

## EIGHTH MEETING OF THE REGIONAL GROUP FOR ASIA OF THE ADVISORY COMMITTEE ON SCIENCE AND TECHNOLOGY (ACAST)

The meeting was held at Bangkok from 29 August to 1 September 1972 and was attended by the following members of the Group: Mr. Takashi Mukaibo (Japan), Mr. M. G. K. Menon (India), Mr. A. Salam (Pakistan) and Mr. M. Yeganeh (Iran), as well as by representatives of various United Nations organizations and specialized agencies.

The purpose of the meeting was to finalize the "Asian Plan of Action for the Application of Science and Technology to Development" which had earlier been submitted to the Committee on Industry and Natural Resources and the sixteenth session of the Advisory Committee (April 1972).

Part One of the final Plan of Action, prepared by the Group itself, lists selected priority areas, of particular importance for the Asian countries, on which the application of science and technology can make a significant impact.

Part Two was compiled after the review of the draft and the incorporation of material submitted by the secretariats of the United Nation bodies and specialized agencies and of comments made by various representatives. It consists of more detailed proposals covering a wider range of areas.

Some of the highlights of the Plan of Action are:

*The building up of indigenous scientific and technological capability.*

It is pointed out in the plan that although the implementation of national development plans has a high scientific and technological content, that factor is seldom taken into account. Often the processes of production and technological ideas borrowed or brought from abroad are not adapted to local conditions and in many cases are executed by foreign experts unacquainted with the country concerned. The local scientific community is seldom made use of and hardly even given a proper share in executing the tasks of development; many of the developing countries insist on running their scientific and technological institutions in the same manner as their administrative sectors.

Given these circumstances, it is of vital importance to build up a scientific and technological infrastructure within the countries of the ECAFE region. This will require, among other things:

(a) Close interaction between national planning bodies and national science agencies. It is essential that all ECAFE countries should have national science planning policy bodies looking after the "health" of science and its deployment for national development;

(b) Larger expenditure on science and technology. It is important that countries should set up first-rate technology dissemination centres from which technical information is readily available;[1]

(c) Science policies should be geared towards retaining and making the best use of individual scientists' talent. In order to guarantee the standing, maturity and freshness of their leading scientists and technologists, countries should keep them in close contact with the world scientific community and prevent them from losing enthusiasm, confidence and interest in innovation. If the scientist or technologist is to give of his best, his working conditions and the command structure must be very different from those of administrative personnel;

(d) Integration between research workers and users of industrial research.

*Priority areas for research*

Priority areas for research may have different sequences in different regions, even in industrial countries. Stress should be given to the inter-disciplinary approach to research programmes and their integration with extension services in the attainment of social and economic development goals.

The critical areas outlined in the plan are: (1) high-yielding varieties of staple foods, (2) edible protein, (3) fish, (4) pest and vector control, (5) tropical hardwoods and fibres, (6) groundwater, (7) weather, (8) desalination, (9) arid land, and (10) industrial research and design in (a) metallurgy, (b) problems of corrosion, (c) industrial chemicals, (d) small-scale and cottage industries and handicrafts, (e) the food industry, (f) agro-based industries, (g) appropriate technology, and (h) maintenance, repair and standardization.

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[1] See report in the following section on a recent meeting which dealt with regional and subregional arrangements for technology transfer centres through ECAFE and other United Nations agencies.

*Priority areas for the application of existing knowledge*

The application of available scientific knowledge to specific local conditions requires research, often of a fundamental nature, together with appropriate supporting facilities.

The proposed selected areas are (a) storage and preservation of agricultural products, (b) livestock and control of livestock diseases, (c) human disease control, (d) housing, building and human settlements, (e) science teaching, (f) education, (g) natural resources, (h) human resources, (i) transport, and (j) instrumentation facilities for analytical work.

*Implementation of the Asian Plan of Action*

While recognizing that the task of implementation will primarily fall on individual countries, it is suggested that ECAFE could provide the focal point of efforts to strengthen the national machinery. To this end, ECAFE should establish close contact with member countries with regard to the regional plan and organize meetings of the Regional Group of ACAST, national science policy agencies and research institutes.

## REGIONAL CENTRE FOR TECHNOLOGY TRANSFER AND INVESTMENT PROMOTION

A proposal to set up a regional centre for technology transfer and investment promotion was examined by a Preparatory Meeting held at Bangkok from 28 September to 4 October 1972.

Problems pertaining to foreign private investment and increasing the volume of domestic private capital formation in industry have been examined by various ECAFE—sponsored bodies over the years. The first Asian Conference on Industrialization (ACI) in 1965 urged the developing countries to increase their efforts, through appropriate policies and institutions, to encourage greater private foreign investment in industry within the context of individual economic policies. In pursuance of the directives of the conference, steps were taken to prepare comprehensive reports on such subjects as existing legislation, measures to promote foreign private investment, and the financing of industry. The conference recommended that an investment centre should be set up in order to facilitate investors and provide information to them and to host Governments on industrial opportunities in the region. The AIDC, applying this recommendation, undertook further studies on the existing state of investment promotion in the region. The Council, in considering practical steps to be taken at the regional level, drew attention to the need to avoid duplication, as there were several international organizations which dealt with the subject of investment promotion. It felt that there was a need for a closer examination of the problem so as to determine the need and the specific functions of a centre in the context of existing activities.

In the final preparation of the proposal, matters pertaining to technology transfer were also given consideration in view of the strong emphasis given to that subject by ACI and by the Economic Commission. Transfer of technology had, in the meantime, begun to attract international concern and several studies on problems pertaining to technology transfer were undertaken by UNCTAD and other international agencies. The recent session of UNCTAD at Santiago, Chile, gave special attention to technology transfer and recommended, in its resolution on transfer of technology, that multilateral institutions such as technology transfer centres should be set up. With these developments in mind, a proposal for a centre with the dual function of technology transfer and investment promotion were drawn up and placed before the Preparatory Meeting. The Preparatory Meeting examined the subpect in detail and recommended to AIDC that a decision should be taken to implement the proposal for a regional centre on transfer of technology and investment promotion.

It is expected that the future centre will, primarily serve to assist member Governments to meet the requirements of existing institutions for investment promotion and technology transfer at the national level and to assist developing countries which do not have such centres to develop the capability to deal with these problems. Technology and investment are closely connected. Hitherto, developing countries placed greater emphasis on industrial development and adopted measures to encourage investment in it with no serious examination of the financial and technological components.

One of the basic problems faced by a developing country is that its technological capabilities are inadequate to provide growth momentum independently. In many areas there has been a continuous transfer of technology without any consideration of its impact on either the available resources or the other technological capabilities of the country. Consequently, little impact has been made by such investment. Planners in developing countries now feel that technology should become a part of the growth process, particularly in industry, and that it should at the same time be able to react to particular national needs and resources. Here, problems such as employment and the availability of large numbers of unemployed and underemployed, and the appropriateness of technology in terms of other endowments are matters of primary relevance. Furthermore, the process of transfer of technology in the past involved licensing, patents and other invisible payments which, with the progress of industrialization, assumed considerable proportions. Studies done by UNCTAD have revealed that the developing countries as a whole were paying as much as US$1,500 million (1968) for direct transfer of technology, which reflected only a small fraction of the total cost involved. Estimates for the 1970s indicate that these payments may rise to some US$9,000 million, the equivalent of roughly 15 per cent of the total exports of the developing countries (excluding oil exports).

The proposed centre, apart from helping to improve conditions at the national level for assessing and evaluating technology and investment, will provide information on various aspects of investment and technology. It will encourage greater intraregional flow of technogical know-how and investment; assist the developing countries to exchange information and to co-ordinate their activities in this field; promote co-ordination with other organizations in the field of investment and technology; and contribute, by way of studies, to greater understanding of the problems of investment. Finally, the centre will co-ordinate training facilities and organize seminars in order to improve the efficiency of industrial administrators.

## EXPERT WORKING GROUP MEETING ON AN ASIAN INSTITUTE FOR DEVELOPMENT OF AGRICULTURAL MACHINERY

The Expert Group met at Bangkok from 11 to 13 October 1972. Senior officials from Australia, India, Indonesia, Iran, Japan, the Republic of Korea, Laos, Malaysia, Papua New Guinea, the Philippines and the Republic of Viet-Nam attended, together with representatives of various United Nations organizations and specialized agencies and other international bodies.

The Group recommended the establishment of an Asian institute for development of agricultural machinery, which was considered necessary for various reasons. Climatic, physical, agronomic and economic conditions on Asian farms are different from those in other areas and called for different types of agricultural equipment. Again, at the existing level of industrialization in many countries, it was desirable that there should be some measure of regional standardization in the production of various agricultural tools and equipment and that it should be organized on a regional basis so as to take advantage of economies of scale. Furthermore, considerable progress could be achieved in the advancement of technology if countries could co-operate through such an institution in the transfer of technology for the production of agricultural machinery and its adaptation to Asian agricultural conditions.

The specific functions of the Institute, as formulated by the Group, are:

(i) Development and commercialization of suitable machinery designs and acting as a co-ordinating centre for design, development, adaptation, prototype fabrication, manufacturing and product performance evaluation;

(ii) Selection and adaptation of suitable existing machines for local and regional conditions, and co-ordinated industry-oriented research and commercial development;

(iii) Information collection, development and dissemination, technology transfer, extension and market development programme;

(iv) Advisory and consultancy services to national institutes, governments, manufacturers and national professional engineering societies;

(v) Training of design, development and, if necessary, industrial engineers for local development and manufacture;

(vi) Co-operation with national and international organizations, professional associations and technological institutes in both developing and industrialized countries.

The Group felt, however, that some details still had to be worked out regarding the site, duration, facilities and finances of the Institute. This subject will be discussed at the AIDC's eighth session in February 1973.

## STATUS OF THE ASIAN INDUSTRIAL SURVEY FOR REGIONAL CO-OPERATION

Regional or subregional co-operation is advocated by ECAFE as an effective instrument to advance the pace of industrialization in the developing countries and to narrow the disparity between their growth rates and those of the industrially advanced countries. The reasoning is that such co-operation can yield enormous benefits through the establishment of industries transcending national market boundaries and taking full advantage of economies of scale, specialization and the expansion of trade.

At the very first meeting of the Advisory Group for the Asian Industrial Development Council it was emphasized that there was an urgent need to take an over-all and long-term view of the problem of regional industrialization and co-operation. It was felt that a long-term perspective study would greatly facilitate the formulation of optimum co-operative programmes of industrialization.

The approval of that proposal by AIDC, the Commission and the Asian Conference on Industrialization enabled the secretariat to gather enough support, in terms of cash and expert services, to launch the survey officially on 1 October 1971. It was to be completed within 18 months, i.e. by the end of March 1973.

A number of developing countries within the region and some developed countries within and outside the region contributed cash and expert services and the project was greatly strengthened by a substantial cash contribution by Asian Development Bank (which pledged up to $200,000) and contributions from other agencies, such as UNDP, UNIDO and UNCTAD.

Although the survey was originally intended to cover a large group of medium- and small-sized countries in the region, for several reasons the geographical scope of the survey had to be limited to ten countries, Indonesia, the Khmer Republic, the Republic of Korea, Laos, Malaysia, the Philippines, Sri Lanka, Singapore, Thailand and the Republic of Viet-Nam.

The investigations of selected branches of industries consisted in assembling the necessary information concerning feasible regional projects and comparing their relative advantages with a view to working out "package deals" acceptable to the countries concerned. The industry experts, under the leadership of Professor H.C. Bos, co-ordinator of the survey, have completed the following nine industry studies:

Fertilizer manufacture;
Pulp and paper;
Transformer and cable manufacture;
Petrochemicals;
Manufacture of industrial machinery;
Cement;
Flat glass;
Wood products;
Chemicals.

In addition, summaries of reports prepared by other group of experts on regional co-operation between some of the countries of the region for ferro-alloys and steel were reworked.

The final phase of the survey, now being carried out by the permanent team for the survey, involves the summarizing the data collected through sectoral studies, and the design and analysis of "packages" of investment projects. "Packages" consist of one or two plants in each industry which are allocated to a specific country but supply the markets of all. For industries such as those chosen in the Asian industrial survey, large-scale operation yields substantial economies; large-scale operation can be achieved only by specialization of production in a single, or perhaps two, countries.

Certain sample "packages" will be assembled and analysed by the permanent team, in order to estimate the costs of meeting product demands within the region and for each country, the countributions to employment, profits and incomes. A procedure will be provided for the evaluation of other "packages", selected in any way whatsoever.

The final report of the survey is expected to be ready for release and recommendations sent to the Governments of the countries covered by the survey by May 1973.

# Part II
# Industrialization

## CURRENT INDUSTRIAL DEVELOPMENT PROGRAMMES IN SELECTED ECAFE DEVELOPING COUNTRIES

### Fiji: the sixth development plan, 1971-1975

Fiji's gross domestic product (at 1970 factor costs) is to grow under the plan from F$178 million in 1970 to F$246 million in 1975, or at an average annual increase of 6-7 per cent. The growth expected in each sector is outlined in table 1.

TABLE 1. PROJECTED SECTORAL GROWTH RATES DURING THE SIXTH DEVELOPMENT PLAN PERIOD

| *Sector* | *GDP (million Fijian dollars, 1970 prices)* | | *Annual growth rate (percentage)* | |
|---|---|---|---|---|
| | *1970* | *1975* | *Sixth plan period* | *Fifth plan period* |
| Agriculture, forestry and fishing | 48.4 | 57.7 | 3.5 | 2.3 |
| Mining and quarrying | 2.5 | 2.8 | 2.4 | –1.9 |
| Manufacturing and processing | 19.3 | 24.0 | 4.5 | 5.2 |
| Building and construction | 15.0 | 23.1 | 9.0 | 12.8 |
| Electricity and water | 2.0 | 2.9 | 8.0 | 5.9 |
| Transport and communication | 15.0 | 21.7 | 7.7 | 11.8 |
| Commerce | 28.0 | 39.1 | 6.9 | 2.6 |
| Tourism | 6.0 | 15.0 | 20.2 | 20.2 |
| Government services | 12.9 | 19.3 | 8.4 | 5.5 |
| Other services | 28.5 | 40.0 | 7.0 | 7.1 |
| GDP at factor cost | 177.6 | 245.6 | 6.7 | 5.3 |

During the plan period, manufacturing is projected to grow at 4.5 per cent per annum, reaching F$24 million in 1975. The sector's share in total GDP will fall from 10.9 per cent to 9.8 per cent, primarily on account of the declining importance of the sugar industry. Employment in industry is expected to grow to 13,500 persons in 1975, as against 12,000 in 1970.

Since investment is overwhelmingly in private hands, the Government will confine its activities largely to promotional policies, including the provision of infrastructural facilities. To increase the inflow of overseas capital, the Government will seek to ensure equitable treatment of investments and their profits, placing no major restraints on overseas repatriation of funds, while maintaining equitable taxation. The skills of the labour force are to be improved steadily through the extension of education, especially vocational and technical training courses.

A major industrial estate at Vatuwaqu is due to be completed in 1971. Plans exist for additional government-sponsored estates at Nasinu, Ba and Lautoka.

The Fiji Development Bank will have an increasing role in financing and assisting the expansion of industrial activity by, among other measures, equity participation.

### Republic of Korea: third five-year economic development plan, 1972-1976

Manufacturing output grew at an average annual rate of 21.7 per cent during 1964-1970, and its ratio to gross national product has risen from 15.6 per cent to 20.5 per cent. This development has been accompanied by change of emphasis in the structure of manufacturing industries from consumer goods to capital goods. Thus, whereas in 1964 the ratio between the light and heavy industries stood at 66.5:33.5 in terms of output, in 1970 it was 64.1 to 35.9.

During the previous two plan periods, imports of textiles, paper, fertilizer, and cement plants and oil refineries have been largely replaced by domestic production. Exports of manufactured goods have sharply increased.

*Major manufacturing programmes*

*Metal industry*

The total production capacities for iron, steel and rolling increased from 48,000 t, 322,000 t and 648,000 t, respectively, in 1964 to 203,000 t, 853,000 t and 1,412,000 t in 1970.

With the development of the machine industry and the expansion of construction projects, the demand for steel products is expected to increase from 1.5 million t in 1970 to 4 million t in 1976. To satisfy this demand annual steel production will be increased from 1,276,000 t in 1970 to 3,589,000 t in 1976, to be obtained largely from the expansion of production of the country's integrated iron and steel mill.

In order to meet the demand for pig-iron, which is expected to rise from 121,000 t in 1970 to 266,000 t in 1976, a foundry pig-iron plant with an annual production capacity of 200,000 t will be built. A special steel plant of 60,000 t capacity will also be built to supply the demand of machine industries, which is expected to increase from 32,000 t in 1970 to 103,000 t in 1976.

*Machine industry*

*General machine industry.* The demand for high-precision machine tools is expected to increase from 6,000 tools in 1970 to 15,000 in 1976, while that for heavy construction equipment, such as bulldozers, wheel loaders with buckets, and graders, is also expected to increase sharply. With the construction of new capacities for heavy machinery works, domestic products will largely replace the nation's annual imports of machine tools and heavy equipment. Self-sufficiency in farm machine production will also be expedited during the plan period.

*Electrical machinery industry.* In order to meet the demand for heavy electric machinery and other apparatus, expected to rise sharply during the plan period, efforts will be made to speed the construction of plants producing circuit-breakers and switches. To replace imports of industrial electrical machines such as power tools and electric welders, existing plant facilities will be expanded.

*Automotive industry.* Assembling capacity has reached 63,100 units/yr, far exceeding demand. The demand for motor vehicles, however, will reach 82,500 units by 1976, so that expansion of existing plant facilities will be required. To make the automotive industry an integrated machine industry, plants for the manufacture of part such as engine, body, axle and transmission gear will be built.

*Shipbuilding.* Annual shipbuilding demand in 1976 is forecast at 1,172,000 gross t, including the export of vessels. To meet the demand a new shipyard will be built and existing shipyards expanded to acquire a total ship-building capacity of 1,300,000 gross t. In view of the country's low wage standards and increasing world demand for vessels, shipbuilding will be developed as a promising export industry.

*Electronic industry.* During 1964-1970, the Republic's electronic industry experienced a rapid annual increase in production and exports, of 51 per cent and 102 per cent respectively. Total exports in 1970 accounted for 51.8 per cent of domestic production. The annual export of electronic products will increase from US$55 million in 1970 to US$452 million or to 71 per cent of the projected total demand in 1976.

*Chemical industries*

*Petrochemical industry.* As the first component of a petrochemical industrial complex, the construction of a naphtha cracking plant with an annual production capacity of 100,000 t of ethylene, together with nine allied plants, was initiated during the latter half of the second plan period and will be completed during the third plan period.

*Fertilizer industry.* In 1970, annual production capacity reached 585,000 t or more than seven times the 1964 amount, thus not only satisfying domestic demands but providing also some exports. During the third plan period, preparations will be made to set up an ammonia centre and a superphosphate plant.

*Rubber industry.* Intensive efforts will be made to develop export markets for tires, rubber shoes and boots. A synthetic rubber plant with an annual production capacity of 25,000 t will be built to supply the domestic rubber industry with its total raw material needs.

*Oil refining.* With the completion of three oil refineries, total crude oil processing capacity in 1970 reached 215,000 barrels/day. Expansion and establishment of new refineries will be pursued during the third plan period with a view to developing related industries and to shifting the emphasis in fuel policy from coal to petroleum products. Fuel demand in 1976 is anticipated to rise sharply to 26.5 million kl, or 2.5 times that of 1970. Existing refineries will be expanded.

*Textile industry.* During 1964-1970, this industry registered an annual growth rate of 20.7 per cent. Exports are expected to rise from US$340 million in 1970 to US$1,237 million in 1976. Natural textile industries, such as cotton spinning, will be renovated and replaced, whereas the chemical textile industries will be expanded to reach international production scales.

*Medium and small-scale industries*

In 1969, medium and small-scale industries accounted for 29.8 per cent of total production of the mining and manufacturing industry and for 50.3 per cent of the total labour employed in industry. Recently, exports have reached US$255 million, or 36.3 per cent of total exports. While some medium and small-scale enterprises have grown rapidly in recent years, the sector as a whole has made sluggish progress owing to technical and financial shortages, substandard facilities and excessive internal competition. Intensive efforts will be made to improve productivity and to increase exports and employment.

Greater integration will be purused by encouraging the medium and small-scale firms to specialize in the production and supply of specific parts needed by the large-scale enterprises. The merging of medium and small-scale enterprises will also be promoted through the extension of tax and financial incentives.

## Malaysia: the second Malaysia plan, 1971-1975

### Growth targets

During the plan, the gross national product is projected to grow at 6.5 per cent per annum, which implies an average yearly growth rate of 3.7 per cent *per capita,* or an increase from M$1,080 in 1970 to M$1,300 in 1975.

During the 1960s manufacturing was the most rapidly growing sector in West Malaysia, and during the first plan period (1966-1970), the rate of growth of net value added in manufacturing (10.4 per cent) was nearly twice that of the over-all economic growth (5.4 per cent).

Manufactured exports showed even greater dynamism during the 1960s, with an annual growth rate of 14.2 per cent, or more than double the rate of over-all exports. Whereas in 1960 manufactured products accounted for less than 5 per cent of total exports, in 1970 they exceeded 10 per cent.

There were marked variations of performance in the manufacturing industries. During the first half of the 1960's the leading industries were food, wood products, off-estate processing (rubber, coconut and tea), chemicals and chemical products and non-metallic mineral products, accounting for more than half of the total value added. In the second half, however, this share declined significantly owing to the high rates of growth achieved in the new and relatively small intermediate and capital goods industries, such as assembly of motor vehicles, primary iron and steel, boatbuilding and fertilizers.

In Sabah and Sarawak during the 1960s, manufacturing grew respectively at 3.6 per cent and 5.6 per cent per year. In Sabah, the major industries are sawmills, plywood, food processing and motor-vehicle repairing, whereas in Sarawak they are those concerned with petroleum products, wood products and food-processing.

*Objectives and targets*

*In West Malaysia,* value added in manufacturing under the second Malaysia plan is due to grow by 11.7 per cent/yr at constant prices, and its share in GDP will have risen to 17 per cent in 1975, compared with 13 per cent in 1970. Despite further prospects for import substitution in such fields as food products, metal and non-metallic products, electrical and non-electrical machinery and transport equipment, an annual 15 per cent expansion of exports is expected to play a crucial role in achieving the output target for manufacturing.

In East Malaysia, manufacturing development during the plan period will be based largely on the processing of primary resources such as timber, petroleum and other minerals, and of agricultural and fishing products such as pepper, rubber, palm oil, coconuts and fish.

Manufacturing is also to play a key role in achieving the employment target by effecting a rise from 270,000 in 1970 to 378,000 in 1975. This will entail the adoption of more labour-intensive techniques.

### Papua New Guinea: a revised development programme (1970/71-1974/75)

The industrial programme is summarized in table 2, from which it will be seen that the value of total manufacturing output is expected to rise from A$86.2 million in 1969/70 to A$116.6 million in 1972/73 and A$156 million in 1974/75. Employment in manufacturing industries should increase from about 14,000 in 1969/70 to 21,000 in 1972/73 and 27,000 by 1974/75.

TABLE 2. MANUFACTURING INDUSTRIES

| | (million Australian dollars and persons) | | |
|---|---|---|---|
| | Actual 1969/70 | 1972/73 | 1974/75 |
| *Engineering* | | | |
| Output | 27.3 | 40.1 | 51 |
| Value added | 14.9 | 21.5 | 27 |
| Employment | 4,858 | 7,900 | 9,700 |
| *Food, drink and tobacco*[a] | | | |
| Output | 25.0 | 29.4 | 40 |
| Value added | 9.3 | 13.6 | 19 |
| Employment | 3,304 | 3,300 | 3,800 |
| *Timber-processing* | | | |
| Output | 15.4 | 24.4 | 33 |
| Value added | 8.1 | 13.1 | 18 |
| Employment | 3,958 | 6,500 | 8,800 |
| *Other industries* | | | |
| Output | 8.5 | 22.7 | 32 |
| Value | 7.6 | 8.1 | 12 |
| Employment | 1,719 | 3,200 | 4,800 |
| *Total manufacturing* | | | |
| Output | 86.2 | 116.6 | 156 |
| Value added | 39.9 | 56.3 | 76 |
| Employment | 13,839 | 20,900 | 27,100 |

[a] Excluding the primary processing of tea, coffee and cocoa.

*Engineering*

Most of the growth in output will come from the general engineering and motor-vehicle industries. By 1974/75, nearly 24 per cent of the increase in value of output of the general engineering industry is expected to result from products not previously produced in the country. These include welded wire products, galvanized pipes, hot-water systems and crop-driers. The rapid increase in imports of motor vehicles in recent years could well entail the establishment of a motor vehicle assembly plant towards the end of the programme period.

Sheet-metal production is expected to reach A$7.0 million by 1974/75 with a significant contribution coming from the factories which it is proposed to establish for the manufacture of beverage cans and metal office furniture. Similarly, the expansion of factories producing metal roofing and panels will assist the building industry.

Planned development of electrical engineering includes the assembly of radio and amplifying apparatus and further integration in wire-working processes. The establishment of steel boat building is expected to stimulate marine engineering.

*Food, drink and tobacco*

The rapid growth of this sector will be sustained. Existing industries, such as baking, beverage-making and processing of tobacco and cigarettes will be augmented by the setting up of several new industries, such as fish-canning, prawn-processing, ice-cream, biscuits and margarine. This development will appreciably replace imports and will entail higher export sales.

*Sawmills, plywood and joineries*

It is anticipated that the value of output of this entire group will climb from A$15.4 million in 1969/70 to A$38.4 million by 1974/75, with sawn timber accounting for a major share of the increase.

*Other manufacturing*

The output of cement and cement goods is due to increase from A$2.0 million to A$6.4 million, it being assumed that the plan to establish a large-scale cement factory will be put into effect. Production of whitelead paints and varnishes appears to be meeting domestic market requirements. Significant capacities will have been added in palm-oil processing and detergents by 1974/75. The structure of the clothing industry will change sharply when a large-scale clothing factory is set up to cater mainly for the export market. An intensification of the country's commercial activities will lead to expanded output in the printing, paper-bag, and fibre-board packing factories. Similarly, the output of glass containers, fibre-glass products, matches, plastic mouldings, footwear, soap, neon lighting and tanning facilities is scheduled to expand during 1969/70 — 1974/75.

*Exports*

While it is envisaged to export a wide range of manufactured consumer goods to the nearby islands of the Pacific and to northern Australia, the value involved is not likely to be significant within the programme period. Goods likely to be exported include clothing, margarine, glass bottles, chemicals, reconditioned tyres, bakery products, joinery products, prepared foodstuffs, beer, cigarettes, paint, and cottage industry products.

*Investment in manufacturing and industrial policies*

The investment required during 1970/71 — 1974/75 to achieve the manufacturing target has been estimated at A$43.5 million. Rapid development of the manufacturing industries is heavily dependent on overseas investment.

Recently, legislation has been passed establishing the Investment Corporation of Papua New Guinea. Within the funds available to it and in accordance with the terms of its charter, the Corporation is expected to participate in major overseas enterprises operating in the country.

### Philippines four year development plan (1972-1975)

*General features*

The plan's basic objectives are to achieve (a) a higher *per capita* income; (b) widespread employment; (c) a more equitable income distribution; (d) regional industrialization and development; and (e) internal stability. It also aims at the expansion and diversification of exports; more labour-intensive methods of production; and the strengthening of industrial linkages.

The annual growth rate of real GNP is projected to increase from 6.5 per cent in 1972 to 7.0 per cent in the following three years, as against 5.5 per cent in 1971. Assuming a population growth rate of 3.1 per cent yearly, *per capita* real GNP will grow at a rate of 3.8 per cent per annum in the plan period, and will reach ₱ 1,010 in terms of 1967 price levels.

With an annual growth rate of 9.0 per cent manufacturing output's contribution to net domestic product (NDP) will rise from 19.0 per cent in 1971 to 20.9 per cent 1975.

Mining and construction will grow at an average annual growth rate of 21.8 per cent and of 13.5 per cent, respectively.

*Manufacturing*

As a result of earlier policies which cheapened foreign exchange and overpriced labour, the attractiveness of capital-intensive industries has pushed the development of relatively labour-intensive industries into the background. A second effect has been the predilection towards big-scale finished product enterprises at the cost of small — and medium-scale industries. Import substitution is losing its impetus, while exports of new industrial products have risen very slowly, which is symptomatic of the lack of well-designed incentive measures, with some industries over-protected and others insufficently protected. As a result, excess capacity has been built up over the years.

In order to rectify the imbalances described, steps will be taken: (i) to alleviate the trade deficit via export-oriented industries based on the processing of indigenous raw materials, including traditional primary export items; (ii) to promote the development of intermediate and capital goods industries, particularly those which have the greatest potential for forward and backward linkages; and (iii) to disperse industries to different regions in order, for example, to generate wider employment opportunities.

The investment requirements of manufacturing and mining during 1972-1975 will amount to ₱ 11,240 million at current prices.

### Sri Lanka: five-year plan (1972/1976)

*Plan framework*

Under the objectives and strategy of the plan, the economy has been projected to grow at an average annual rate of 6.1 per cent. At 1970 factor cost prices, GDP will increase from Rs 11,760 million in 1970 to Rs 16,822 million in 1976. Assuming a population growth rate of about 2.1 per cent per annum, per capita income will increase from Rs. 910 to Rs. 1,150 in 1976. A substantial part of the increase in domestic product is to be obtained from the fuller and more efficient use of existing capacities in the different sectors. The sectoral growth is given in table 3.

TABLE 3. SECTORAL CONTRIBUTION TO GROSS DOMESTIC PRODUCT, 1970 AND 1976

| | | (million rupees at 1970 prices) | |
|---|---|---|---|
| | 1970 | 1976 | Annual rate of growth (percentage) |
| Agriculture | 4,264 | 5,671 | 4.9 |
| Industry | 1,523 | 2,692 | 10.1 |
| Construction | 771 | 1,094 | 6.0 |
| Services | 5,202 | 7,365 | 5.9 |
| GDP at 1970 factor cost prices | 11,760 | 16,822 | 6.1 |

*Industrial programme*

Gross value of industrial output, which was Rs 5,438 million in 1970, is expected to increase to Rs 8,920 million by the end of the plan period, which implies an increase of an average rate of growth of 8.6 per cent per annum. The share of industry in GDP will increase to 16 per cent in 1976, from 13 per cent in 1970.

High rates of growth in the plan period are planned in the following industrial groups: rubber products (including footwear), 108 per cent; machinery and equipment (excluding transport equipment), 100 per cent; chemicals and chemical products, 98 per cent; textiles, 95 per cent; and processed food and animal feed, 83 per cent.

A substantial part of the additional output expected during the plan period will be obtained through fuller utilization of existing capacity in the field of steel (rolled steel and wire products), sugar, rubber tyres and tubes, coconut oil, kerosene cookers and stoves, aluminium ware and soap. In such cases as salt, poultry and animal feed, sawmilling, bricks and tiles, ceramic ware and sewing-machines, relatively small investments are sufficient to achieve the output planned for 1976.

Planned investment in industry during the plan period is Rs 2,240 million, of which the foreign exchange component is estimated at about Rs 1,190 million.

Employment in industry during the period is estimated to increase by about 165,000 (and total employment by about 810,000). Textiles, wood products, mining and quarrying, light engineering, paper products, printing and publishing, and structural clay products are expected to offer the greatest scope for labour absorption.

Investment in the public sector will be primarily oriented to the production of steel, cement, tyres, chemicals and paper.

The surplus capacity in the industrial sector will be fully utilized, and is expected to generate an export market of around Rs 250 million in 1976, with food, beverages and tobacco contributing Rs 35.0 million; textiles, wearing apparel, Rs 37.5 million, chemical products, Rs 42.5 million; non-metalic mineral products, Rs 20.0 million; metal products (including implements and tools, fittings, foundry products) Rs 10.0 million; machinery (excluding electrical machinery and transport equipment) Rs 20.0 million; electrical goods Rs 25 million; and miscellaneous industries, Rs 15.0 million.

New export capacities will also be created; the investment required for the expansion has been estimated at Rs 1,000 million.

## INDUSTRIALIZATION IN THE ECAFE DEVELOPING COUNTRIES AND ITS SOCIAL AND TECHNOLOGICAL ASPECTS

*Introduction*

In recent years, the belief has been gaining more and more ground that a development strategy would be more effective if it were to stress the need for raising economic and industrial growth and, at the same time, to meet certain social and national objectives. This idea appears to be implied also in the international development strategy, which noted that qualitative and structural changes in society must go hand in hand with rapid economic growth and offered some general guidance on the policy objectives that the countries would have to set themselves with regard to a more equitable distribution of income and wealth and on such issues as employment, nutrition, education, health, housing and social welfare[2].

The practice in the past, however, has been to consider the attainment of social objectives more or less as a passive effect of economic development rather than as an active element to induce further development. A more realistic approach should have been pursued towards complementarity between economic growth and social development. It is believed that measures towards the realization of such a strategy are within the reach of the developing countries in the ECAFE region. This means that, in the context of industrialization, past development policies need re-orientation. New driving forces for industrial growth should also be found in elements of social development.

No doubt, industrialization in the region has contributed significantly to the growth of national output and income. It has also participated in the process of modernization of the national economies in terms of expansion of technical and managerial skills, application of new technologies, greater diversification of production, stimulation of expansion of infrastructural facilities, and so on. On the other hand, the fruits of progress in industrialization have not been shared equally among the countries of the ECAFE region, as witnessed by the increasing disparities of growth among countries as well as between various domestic branches of industry.

[2] See *International Development Strategy*, (United Nations publication, Sales No. E.71.II.A.2), p.4.

Furthermore, the impact of industrialization on employment and equitable distribution of income appears to be minimal. In this context, the bias towards capital-intensive technologies have played a not insignificant role.

*Growth features of industries*

The characteristics of present-day industry in the developing ECAFE countries are, of course, the result of a long-term growth process. The existing wide differences in industrial performance among the countries are therefore attributable to the varying degree of importance of the growth factors in each country.

India is in a class apart, in view of its vast domestic market and long industrial experience dating back to pre-war days. The country's manufacturing sector, however, recorded only a relatively low rate of growth of output during the 1960s (5.4 per cent, see table 4). This slow pace is due primarily to the country's substantial orientation towards highly capital-intensive producer goods industries which are characterized by long gestation periods.

Iran, the Republic of Korea and Singapore, to which group Hong Kong may be added, represent the countries registering fastest growth rates, ranging from over 15[3] per cent to 20 per cent a year. The success achieved by export industries was largely responsible for the rapid industrial growth.

A second group of countries, representing Malaysia, Pakistan, Sri Lanka and Thailand, are those which experienced medium annual growth rates of around 10 per cent. While the industries in Malaysia and Sri Lanka are only of recent origin, those in the remaining countries of the second group started early in the post-war years and were fostered generally by a favourable external sector and a relatively large population size or income. Industrial growth in the former subgroup generally reflects an increase from a relatively low base.

A third group is made up of countries which recorded a low rate of growth in industrial output of less than 5 per cent. Here again, subdivisions need to be made. On the one hand, Burma, Indonesia and the Philippines, although inheriting from pre-war days a manufacturing sector that was relatively large as compared with most developing countries in the region, suffered from a very weak performance, due primarily to foreign exchange difficulties. Indonesia, however, made an appreciable recovery towards the end of the second half of the 1960s. In the remaining countries of the third group industrialization is only at its very early stages of development. The growth rate of industrial output in the latter subgroup, again relatively high, reflected mainly an increase from a very low base.

In general, it is the rapid growth of industrial output that caused the first group of countries to attain the highest growth rates in GDP. At the same time, their share of manufacturing reached the highest levels (see table 5) in the economies of the developing ECAFE countries.

TABLE 4. AVERAGE ANNUAL RATE OF GROWTH OF GDP AT CONSTANT PRICES

| | Period | Total GDP (percentage) | GDP by manufacturing (percentage) |
|---|---|---|---|
| Burma | 1962-1965 | 5.2 | 3.3 |
| | 1965-1967 | -2.2 | -2.7 |
| | 1962-1967 | 2.7 | 1.0 |
| India | 1960-1965 | 3.5 | 7.7 |
| | 1965-1968 | 4.7 | 2.9 |
| | 1960-1968 | 3.1 | 5.4 |
| Indonesia | 1960-1965 | 1.7 | 4.2 |
| | 1965-1968 | 3.6 | 0.0 |
| | 1960-1968 | 2.1 | 1.9 |
| Iran | 1960-1965 | 7.4 | 11.3 |
| | 1965-1969 | 10.5 | 15.2 |
| | 1960-1969 | 9.0 | 13.1 |
| Khmer Republic | 1962-1965 | 3.7 | 9.8 |
| | 1965-1966 | 2.2 | 3.1 |
| | 1962-1966 | 3.4 | 8.8 |
| Korea, Republic of | 1960-1965 | 6.7 | 12.3 |
| | 1965-1969 | 12.2 | 23.2 |
| | 1960-1969 | 9.1 | 16.9 |
| Malaysia | 1960-1965 | 5.9 | 10.8 |
| | 1965-1966 | 5.6 | 12.5 |
| | 1960-1966 | 5.9 | 11.1 |
| Nepal[a] | 1962-1965 | 19.0 | 1.3 |
| | 1965-1968 | 8.4 | 12.5 |
| | 1962-1968 | 13.7 | 6.9 |
| Pakistan | 1960-1965 | 6.6 | 10.8 |
| | 1965-1970 | 5.2 | 6.9 |
| | 1960-1970 | 5.9 | 8.9 |
| Philippines | 1960-1965 | 4.8 | 4.4 |
| | 1965-1969 | 4.8 | 5.4 |
| | 1960-1969 | 4.9 | 4.6 |
| Singapore[b] | 1960-1965 | 8.4 | 17.5 |
| | 1965-1970 | 13.3 | 22.7 |
| | 1960-1970 | 10.8 | 20.1 |
| Sri Lanka | 1963-1965 | 4.5 | 9.5 |
| | 1965-1969 | 6.0 | 9.7 |
| | 1963-1969 | 5.2 | 8.9 |
| Thailand | 1960-1965 | 7.4 | 10.7 |
| | 1965-1969 | 8.7 | 10.4 |
| | 1960-1969 | 8.2 | 11.0 |
| Developing countries in east and southeast Asia | 1960-1965 | 4.2 | 8.0 |
| | 1965-1969 | 5.6 | 6.3 |
| | 1960-1969 | 4.4 | 6.8 |

Source: United Nations Yearbook of National Account Statistics 1970, volume II.

Monthly Bulletin of Pakistan.

[a] GDP at market prices.

[b] GDP at current factor cost.

[3] This rate of growth was achieved by Iran only in the latter half of the sixties.

TABLE 5. SHARE OF MANUFACTURING IN GDP (AT FACTOR COST)
(Percentages)

| *Country* | *1960* | *1965* | *1970* |
|---|---|---|---|
| Burma | 13.2 | 9.5 | 9.1[a] |
| Fiji | ... | 12.3 | 13.1[b] |
| India | 14.1 | 15.4 | 14.1[c] |
| Indonesia | 8.4 | 8.3 | 9.2[c] |
| Iran | 24.8 | 30.2 | 35.7 |
| Khmer Republic | 12.0 | 17.2 | 18.4 |
| Korea, Republic of | 8.7 | 10.2 | 13.1 |
| Malaysia, West | 12.2 | 8.1 | 8.6[b] |
| Nepal | 9.5 | 11.6 | 12.5 |
| Pakistan | 18.6 | 17.9 | 18.8 |
| Philippines | 7.2 | 13.4 | 20.5 |
| Singapore | 5.2 | 9.4 | 10.6[c] |
| Sri Lanka | 11.6 | 12.5 | 11.5 |
| Thailand | 10.8 | 10.8 | 6.8[b] |
| Viet-Nam, Republic of | ... | 10.7 | 11.6[b] |

Source: Statistical Division ECAFE.

[a] For the year 1967.
[b] For the year 1968.
[c] For the year 1969.

In the second group of countries, the difference in the growth rates of both manufacturing output and non-manufacturing output in the Philippines and Thailand — as in the case of India — was small, so that the share of manufacturing in GDP remained virtually stagnant. On the other hand, Malaysia, Sri Lanka and to a lesser extent Pakistan, recorded appreciably high growth rates of the share of manufacturing in the total product, owing to a far slower expansion of the other sectors of the economy. In Sri Lanka in particular, the continuous decline in world prices of its primary product pulled down the growth rate of over-all development, overwhelming a relatively rapid growth in a small manufacturing sector. This accounted for the more rapid growth in the share of manufacturing output in comparison with Malaysia.

In the third group of countries, manufacturing output accounted for less than 10 per cent of GDP. In some countries — Burma, Nepal and the Republic of Viet-Nam, for instance — the tendency seemed to be one of a decline in the share of manufacturing output in the total product, owing to the lagging growth rate in the former compared with the latter.

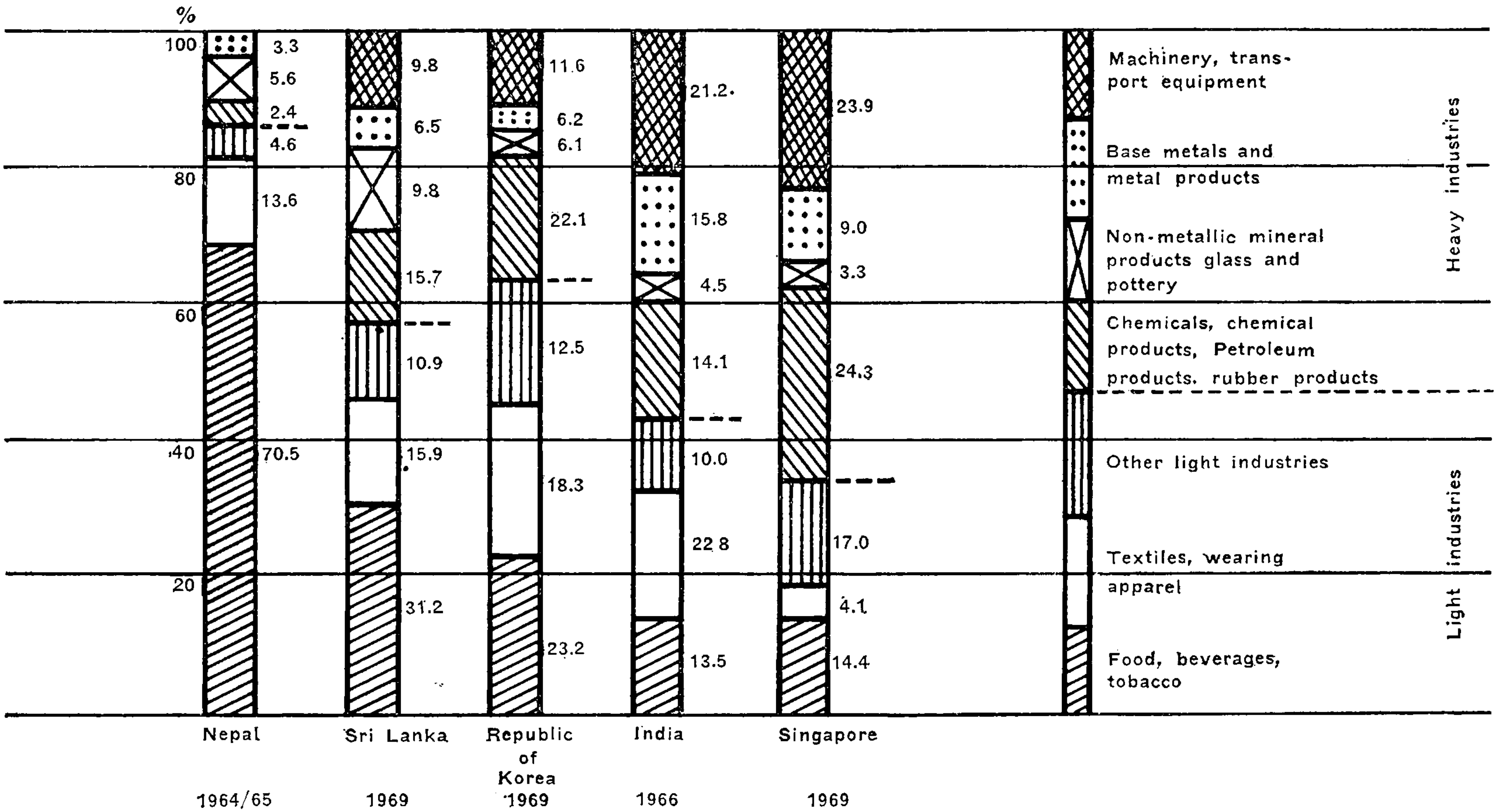
Underlying the rates of growth of total industrial output is the trend of output in various branches of industry. In this context, the countries in the region again showed marked differences in the degree of diversification of their respective industries. One of the most striking differences in structure relates — to the participation of the food, beverages and tobacco industries (see the figure). The latter's share in total output seems to vary in inverse proportion the relative degree of industrialization. Thus, in Nepal — representative of countries in their early stages of industrial development — the sector accounts for 70.5 per cent of the total value added by manufacturing, compared with as little as 13.5 per cent in India.

The group of industries producing textiles, wearing apparel and footwear, however, does not show a similar trend, although in Nepal it still represents a significant share of the total (13.6 per cent). This proportion is even higher in India or in the Republic of Korea, and then declines to 4 per cent in Singapore as a result of greater diversification of the manufacturing sector.

For the metallurgical and metal-transforming industries, on the other hand, the proportion rises sharply, from about 3 per cent in Nepal to 17.8 per cent in the Republic of Korea and 37 per cent in India. A somewhat similar trend applies in the chemicals and chemical product industries.

All in all, the dynamic sector, which more or less coincides with the heavy industries, accounts for 11.3 per cent of value added by manufacturing in Nepal, as against 54.6 per cent in the Republic of Korea and 62.1 per cent in India; whereas the light or slow-growing industries show an inverse order of importance. Any conclusions to be drawn from this comparison should however be made with significant caution. For one thing, the accuracy of the inclusion of certain industrial establishments under "slow-growing industries" is highly questionable, bearing in mind the low *per capita* consumption of manufactures in most countries of the region and the scope for the expansion of output of consumer products if deliberate policies were implemented to that end. This problem is closely associated with the level of income, redistribution of which no doubt can pave the way for a more dynamic growth of demand for many of the manufactures currently produced by the slow-growth or traditional industries. Further, it should be taken into account that the level of aggregation of dynamic dynamic industries would also be erroneous as this group includes varying proportions of industries which are in reality slow growth units. Thus, for example, the chemical industries invariably include manufacturing units for such products as matches, joss sticks or baby powder and the metal transforming industries include a great variety of industries engaged only in simple tools. Conversely, the traditional industries include certain lines of production for which the demand is certainly more dynamic. Thus, it is clear that if appropriate classifications were made, the proportion of truly dynamic industries would be much lower than presented above and the differences in the industrial structure of the group of countries would be even greater.

Figure: COMPOSITION OF VALUE ADDED IN MANUFACTURING



### Investment and its economic use

The lack of capital resources is one of the significant obstacles to a more rapid expansion of industry in the region. Differences in industrial performance among the countries of the region are therefore closely linked to the disparity in the level of their investments. Unfortunately, the information available is too scanty and heterogeneous for a detailed analysis of the composition and utilization of industrial capital. None-the-less, some indications are provided by the differences in over-all investment performance (see table 6). At one end of the scale, the Republic of Korea, Singapore, Hong Kong and Iran, which have the highest growth rates in industrial output, are also those which have attained very high rates of capital formation. The investment rate achieved by Thailand, however, is the highest in the table (29.2 per cent), although the rate of increase was somewhat lower than that of the Republic of Korea. At the other extreme, Burma, Indonesia and certainly several other countries in the initial stages of industrialization recorded the lowest growth rates of output together with the lowest rates of capital formation. The high investment rates of Afghanistan, the Khmer Republic and the Republic of Viet-Nam were largely due to external financing, a finding which is also true of the high growth countries. In several other countries, such as Malaysia and Sri Lanka, there was a net outflow of capital, a situation commonly associated with servicing of external debts or external investment. In the remaining countries listed in the table only slight changes in the rate of investment took place during the 1960s.

TABLE 6. GROSS DOMESTIC FIXED CAPITAL FORMATION

| | *Gross domestic fixed capital formation (as a percentage of GDP)* | | | *Gross foreign savings: average (as a percentage of GDP)* | | *Share of manufacturing in total investment* | *Average ratio of capital goods imports to gross domestic fixed capital formation* | |
|---|---|---|---|---|---|---|---|---|
| | *1960-1962* | *Average 1966-1968* | *Change* | *1960-1962* | *Average 1966-1968* | *1966-1968* | *1960-1962* | *1966-1968* |
| Afghanistan | 18.7 | 20.4 | 1.7 | 9.9 | 16.8 | | 3.7 | 7.0 |
| Burma | 17.1 | 7.6 | -9.5 | 5.1 | 4.0 | | 36.7 | 44.2 |
| Hong Kong | 23.8 | 20.6 | -3.2 | 18.0 | -1.6 | | 62.6 | 54.5 |
| India | 15.9 | 16.5 | 0.6 | 2.9 | 3.3 | | 20.9 | 17.5 |
| Indonesia | 9.4 | 8.8 | -0.6 | 2.4 | 0.7 | | 23.6 | 24.9 |
| Iran | 14.7 | 18.9 | 4.2 | -0.2 | -0.3 | | 12.4 | 21.1 |
| Khmer Republic | 19.1 | 19.2 | 0.1 | 9.3 | 5.7 | | 23.4 | 24.3 |
| Korea, Republic of | 11.4 | 24.7 | 13.3 | 7.6 | 7.5 | 26 | 14.4 | 20.9 |
| Malaysia (West) | 16.1 | 16.2 | 0.1 | -9.5 | -12.1 | | 51.7 | 57.9 |
| Pakistan | 13.2 | 14.3 | 1.1 | 2.5 | 5.3 | | 26.3 | 21.1 |
| Philippines | 13.4 | 18.3 | 4.9 | 4.0 | 7.7 | 10.6[a] | 31.4 | 27.9 |
| Singapore | 17.1 | 25.7 | 8.6 | -4.3 | 13.3 | 54 | 76.4 | 81.7 |
| Sri Lanka | 14.3 | 13.8 | -0.5 | 1.3 | -4.9 | 28[b] | 36.5 | 25.3 |
| Thailand | 18.0 | 29.2 | 11.2 | 0.9 | 3.4 | 21 | 41.1 | 38.0 |
| Viet-Nam, Republic of | 10.0 | 18.3 | 8.3 | 8.6 | 6.0 | | 32.1 | 38.9 |

*Source:* United Nations, World Economic Survey, 1969/70.

[a] 1968 only.

[b] Including mining.

As the above variations might lead one to expect, the proportion of capital set aside for investment in industry differed widely from country to country. The limited information available indicates that in Singapore industry was the main recipient of fixed capital investment during the 1960s (54 per cent), as against an average of about 25 per cent in the Philippines, the Republic of Korea, Sri Lanka and Thailand.

For most of the countries considered the expansion of investment was accompanied by an increase in the ratio of capital goods imports to fixed capital formation. This increase reflects the dependence of capital formation on imports due to the continuing low level of capacity for the production of machines and equipment in the developing countries of the ECAFE region. A similar ratio for industries only would show that the smaller the capacity of the domestic capital goods industry, the higher would be the import content of capital formation and vice versa. The data on Singapore and Hong Kong, for example, show that, while the very high import content of investment is due to industrialization as the main determinant of the import pattern in question, the ratio for the former was higher than that for the latter, owing to smaller domestic capacity for the production of capital goods.

As a general rule governmental participation has been substantial in basic industrial activities, calling for relatively high investment with relatively high risks. In some countries public direct investment in other fields is also an important supplement to private initiative, while in others the role of public enterprises is largely confined to the provision of basic facilities. The share of the public sector in total industrial investment is high in India and the Republic of Korea and very low in the Philippines, Malaysia and Thailand.

Domestic private investment predominates in those industries which are traditionally family-owned. Foreign capital, though not a large proportion of total industrial capital, has gone largely to some of the fastest-growing branches of industry — motor vehicles, petroleum products and petrochemicals, electric machinery, electronics and tyre manufacturing.

A problem just as important as the availability of investment funds is the necessity to ensure the most economic and efficient use of capital. The achievement of this aim has been adversely affected by specific policies and practices, which have resulted in diseconomies of scale or waste of capital. Specific measures to prevent such occurrences need to be introduced, if greater efficiency of investment is to be achieved.

It is true that much difficulty is experienced in the implementation of public investment programmes in many countries of the ECAFE region. Shortage of finance, including foreign exchange, on the one hand, and the lack of administrative and technical skills, on the other, seem to be the main causes of this situation. While practically all countries were affected to some degree by the shortage of skills, the financial constraints were a very serious problem in some of them. Even where investment funds have not been plentiful, it has often been found that allocations to particular branches of industry could not be spent for lack of viable projects which, in turns, reflects the lack of absorptive capacity. Improved industrial plans and planning machinery are therefore called for.

In some countries, no further expansion of productive capacities can occur without better infrastructural facilities. Inadequate infrastructure has placed a heavy burden on enterprises, which often had to build extra roads and install their own electric power generating capacity, water supply and railway sidings, or maintain unduly large inventories of raw materials as a precaution against irregularities in the public transport services.

In the domestic private sector, there is a great need to break away from the exclusive character of family-owned small enterprises. Incentive schemes should be provided to encourage the merging of enterprises in the same sector of activity so as to establish plants of more economic size. Such a policy would help to make the enterprise financially sound, and strengthen its solvency position.

The contribution that foreign investment makes to the developing countries in the region in terms of technology and organizational skills must be so organized that detrimental competition among countries is avoided. Hitherto foreign investment, because of its bias towards import substitution, has contributed in no small measure to the perpetuation of non-complementarity and duplication of investment effort among the countries of the region.

*Import substitution and export promotion*

During the 1960s, as in the preceding period, import substitution continued to be the main industrialization strategy in most developing countries in the region. Although significant progress was made in the substitution of various import items, the net impact was more than offset by new import requirements generated by the expansion of industrial development.

Most of the countries listed in table 7 showed an upward trend in imports of industrial products. In India, however, imports of manufactures and semi-manufactures had, by and large, become stabilized at a relatively low level. In Sri Lanka the somewhat slow increase in imports of semi-processed products and the decline in imports of manufactures during the second half of the 1960s, far from reflecting the result of import substitution, was largely attributable to retrenchment in imports because of foreign exchange difficulties. The increase in imports of industrial goods in Hong Kong, the Republic of Korea and Singapore was partly due to the requirements of the countries' expanding export industries.

The varying levels of import coefficients reflected the differences in industrial base and the strength in substitution capabilities of the countries. India recorded the lowest coefficient in view of the advanced stage of its substitution process. Malaysia and Sri Lanka, on the other hand, recorded the highest coefficients. These two countries, where the external sector is most relevant and where there consequently seems to be wide scope for substitution activities, are in fact those in which the size of the domestic market imposes the most severe limitations. The coefficients for the other countries are much closer to that of Malaysia or Sri Lanka than with that of India, indicating a continuing weak substitution capability.

While the upward trend in imports of industrial goods and related import coefficients will generally be associated with the expansion of industrial activities, the point at issue is the questionable value of the prolongation of such a situation. It seems that for many countries the process of import substitution created, on the one hand, rigidity and vulnerability of the external sector, and, on the other, over-all economic growth subject to increases in the level of imports. One indication of this effect is the coincidence of the generally upward evolution of the import coefficient and the earlier observed slackening growth of the region's industrial output during the second half of the 1960s, (see table 4 and 7), which is symptomatic of the growing weakness of industrialization based on import substitution. This phenomenon would, to a large extent, explain the prevalence of large excess capacities in the region's industrial sector.

TABLE 7. EXPORT AND IMPORTS OF MANUFACTURES AND SEMI-MANUFACTURES

(thousand US dollars)

| | Year | Value of exports: Manufactures (A) | Value of exports: Semi-manufactures (B) | Value of imports: Manufactures (C) | Value of imports: Semi-manufactures (D) | (A) As a percentage of GDP (E) | (B) As a percentage of GDP (F) | Total (E) + (F) | (C) As a percentage of GDP (G) | (D) As a percentage of GDP (H) | Total (G) + (H) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hong Kong[a] | 1960 | 359.1 | 84.6 | 365.7 | 325.0 | | | | | | |
| | 1966 | 776.1 | 136.5 | 786.7 | 525.3 | | | | | | |
| | 1970 | 1,721.4 | 179.0 | 1,381.6 | 921.6 | | | | | | |
| India | 1960 | 212,954 | 408,011 | 849,592 | 624.961 | 0.7 | 1.4 | 2.1 | 2.9 | 2.1 | 5.0 |
| | 1967 | 183,323 | 618,380 | 867,878 | 657,006 | 0.5 | 1.5 | 2.0 | 2.2 | 1.6 | 3.8 |
| | 1970 | 364,332 | 736,448 | 729,386 | 669,006 | 0.8 | 1.7 | 2.5 | 1.7 | 1.5 | 3.2 |
| Indonesia | 1960 | 134,981 | 1,040 | 174,159 | 254,768 | 2.5 | 0.02 | 2.52 | 3.2 | 4.7 | 7.9 |
| | 1966 | 64,370 | 1,963 | 203,470 | 186,490 | | | | | | |
| Iran | 1963 | 271,273 | 5,946 | 275,566 | 186,928 | 5.6 | 0.1 | 5.7 | 5.6 | 3.8 | 9.4 |
| | 1967 | 317,179 | 9,229 | 660,453 | 435,363 | 4.2 | 0.1 | 4.3 | 8.8 | 5.8 | 14.6 |
| Korea, Republic of | 1963 | 7,026 | 23,605 | 139,166 | 173,803 | 0.2 | 0.7 | 0.9 | 4.0 | 5.0 | 9.0 |
| | 1966 | 64,146 | 71,938 | 239,872 | 270,868 | 1.8 | 2.1 | 3.9 | 6.8 | 7.7 | 14.5 |
| | 1970 | 308,071 | 178,760 | 561,333 | 457,322 | 4.3 | 2.5 | 6.8 | 7.8 | 6.3 | 14.1 |
| Malaysia, West | 1960 | 45,712.5 | 187,929.2 | 313,208.8 | 116,464.6 | 2.7 | 11.1 | 13.8 | 18.4 | 6.9 | 25.3 |
| | 1966 | 100,309.5 | 294,292.3 | 419,874.6 | 161,528.4 | 4.5 | 13.2 | 17.7 | 18.9 | 7.3 | 26.2 |
| | 1970 | 149,091 | 434,839 | 542,336 | 234,944 | 5.4 | 15.6 | 21.0 | 19.5 | 8.4 | 27.9 |
| Singapore | 1960 | 376,286 | 99,456 | 473,356 | 147,713 | | | | 9.8 | 7.5 | 17.3 |
| | 1966 | 550,213 | 126,835 | 605,853 | 209,504 | | | | 7.7 | 6.8 | 14.5 |
| | 1970 | 765,783 | 161,453 | 1,205,015 | 550,726 | | | | 7.1 | 7.1 | 14.2 |
| Sri Lanka | 1961 | 261.4 | 2,946.7 | 129,458.6 | 98,537.8 | 0.02 | 0.2 | 0.22 | 10.5 | 5.5 | 16.0 |
| | 1966 | 724.3 | 1,960.8 | 124,499.7 | 111,361.6 | 0.04 | 0.1 | 0.14 | 10.6 | 5.6 | 16.2 |
| | 1968 | 1,464.4 | 1,947.5 | 118,237 | 118,142 | 0.09 | 0.1 | 0.19 | 10.0 | 5.3 | 17.3 |
| Thailand | 1960 | 22,104.5 | 18,456.5 | 267,642.1 | 139,813.3 | 0.9 | 0.7 | 1.6 | 7.7 | 4.1 | 11.8 |
| | 1965 | 31,886.0 | 34,989.6 | 429,454.3 | 226,826.8 | 0.8 | 0.9 | 1.7 | 8.1 | 4.6 | 12.7 |
| | 1969 | 62,610 | 103,207 | 737,650 | 328,442 | 1.0 | 1.7 | 2.7 | 9.1 | 4.9 | 14.0 |
| Philippines | 1960 | 12,501 | 23,082 | 315,872 | 168,334 | 0.3 | 0.6 | 0.9 | | | |
| | 1965 | 44,227 | 66,154 | 370,240 | 210,210 | 1.0 | 1.4 | 2.4 | | | |
| | 1969 | 29,715 | 50,047 | 648,358 | 348,625 | 0.4 | 0.7 | 1.1 | | | |

[a] Value in million U.S. dollars.

The dependence on imported raw materials and intermediates created by the earlier rounds of import substitution, renewed efforts to reduce dependence on imported inputs through further substitution. This kind of chain reaction, whereby substitution in the case of a given item immediately entails a new import requirement, has led to over-expansion of productive capacity without commensurate growth in the capacity to import.

In India unutilized industrial capacity of 1967/68 ranged from less than 40 per cent in industries producing beverages, tobacco, textiles, wood and furniture, paper and rubber products, to 75 per cent in fertilizers. In 1971 industries with under-utilized capacity of 40 per cent and more accounted for 47 per cent of all industrial units. In Indonesia the rate of under-utilization in 1969 varied from 22 per cent in fertilizers to over 70 per cent in bicycle tyres, whereas in Pakistan the average for all industries in 1965 was 26 per cent.

An impression of the severe cost of excess capacity in some cases may be gained from the following quotation: "......over-capitalized engineering industry, especially heavy engineering industry, is lying idle to the extent of 70 per cent of its capacity, while the import of engineering equipment of the order of Rs. 6,000 million a year continues. It could be proved by a rigid analysis that at least Rs 4,000 million worth could be manufactured utilizing only half the idle capacity installed in India...... It is also noteworthy that this Rs 4,000 million production could bridge the gap between our exports and imports."[5]

Another study, on Pakistan, relating to conditions in 1958 revealed that "......if there had been no further investment in industry operating below capacity for lack of raw materials or demand, Rs 500 million to Rs 800 million of investment funds could have been saved.[6] Similar cost savings would obtain in other countries.

It seems that the expansion of industrial development and the increase in imports of industrial products has not been the result of criteria dictated by the interest of the economy as a whole, but on considerations of expediency stemming primarily from the pattern of protectionist policies. Old economic policies which were no longer applicable to the new phase of import substitution were retained, while adequate and timely studies of which industries deserved preferential treatment were neglected. Indiscriminate encouragement was given to too broad a range of domestic market-oriented industries in too short a time. As this process involved industries which are less suited to the size of the domestic market, excess capacities and higher costs inevitably ensued. The proliferation of industries of every kind also weakened attempts to achieve greater specialization and improve efficiency. Less attention was paid to the importance of interindustry linkages. Owing to quantitative import control and protective tariffs, windfall profits could accrue in spite of generally high costs of production.

All in all, import substitution and the preferential treatment it implies have led to excess capacity and over-capitalization, lack of specialization, distorted price and cost structure, and adverse conditions for opening up export industries. This is perhaps the hardest and most difficult problem that industrial policy will have to face in the Second Development Decade. What is needed is not the abandonment but the revision of import substitution strategies. Two corrective considerations readily suggest themselves. Firstly, it would seem that extensive growth or growth in breadth should no longer be allowed to persist, and the re-orientation of industries should be directed towards greater internal structural integration and greater specialization. Secondly, indiscriminate protection should be prevented so as to keep costs, and the burden on national consumers, low.

These issues have an important bearing on policies for increasing exports of manufactured goods, for unless corrective measures are taken to improve export capabilities through competitiveness, very little can be achieved in that direction. This assertion however does not lessen the importance of further reduction by the developed countries of the tariff and non-tariff barriers on exports of manufactures and semi-manufactures from the developing countries, in addition to the measures already provided for in the recently introduced Generalized System of Preferences (GSP). Regardless of preferential treatment that has been or may be accorded by the advanced countries in buying industrial products from the developing countries, the ECAFE developing countries must still seek industries capable of competing on world markets in terms of price and quality standards.

So far only the Republic of Korea, Singapore and Hong Kong have made significant progress in exports, thanks to the early development of export-oriented industries, and they are not seriously affected by distortions created by import substitution such as those discussed above. The other developing countries of the ECAFE region have generally recorded only marginal advances in exports of non-traditional industrial products.[7] For the latter group of countries, exports of genuinely new industrial products make up far less than 1 per cent of GDP, as illustrated by the case of Sri Lanka (see table 7). This state

[5] Address by Mr. M. M. Suri to the Association of Scientific Workers of India, 13 April, 1968, reproduced in *Economic Bulletin for Latin America*, vol. XV, 1970, p. 29.

[6] G.F. Papanek, *Pakistan's Development, Social Goals and Private Incentives*, Harvard University Press, 1967, p. 123.

[7] This excludes such products as petroleum products from Iran and Indonesia, canned fruits from Malaysia and the Philippines, canned shrimp and prawns from India, tin metal from Malaysia and Thailand, textiles from India, and shaped wood from Malaysia and the Philippines.

of affairs is in sharp contrast with that prevailing in the Republic of Korea, which experienced an increase in the export coefficient of industrial goods from 0.9 per cent of GDP in 1963 to 6.8 per cent in 1970. Practically all of these exports are new products.

In the process of seeking new opportunities for exports, the first and most urgent step is to identify under-utilized industries offering scope for exports. That exports are required should be obvious from the fact that they are utilized to pay the cost of imports generated by higher levels of production, so that the foreign exchange position of the countries concerned may be no worse than it would be had production been geared only to the domestic market. In this connexion, it is important to note that the use of additional labour and idle capacity to produce for exports requires little sacrifice of society, so that differential cost pricing becomes feasible. If such exports could be arranged through regional co-operation, the introduction of preferential import duties would be another incentive for greater utilization of excess capacity for exports.

*Employment in industry and the problem of income distribution*

The population explosion, rapid urbanization and the size of the existing unemployed and underemployed labour force together constitute a serious employment problem in most countries of the region. The magnitude of the problem may be gauged from the fact that the growth rate of the total labour force in the ECAFE countries is more than double that of the developed countries (see table 8). In south East and East Asia, the labour force is expected to grow from 810 million in 1970 to 1,016 million in 1980, implying that roughly 200 million new entrants to the labour force will have to be provided with new jobs during the Second Development Decade. In addition, new employment opportunities will have to be created in order to absorb the backlog of the unemployed.[8]

TABLE 8. ANNUAL GROWTH RATE OF THE LABOUR FORCE

| | 1965-1980 | 1970-1980 |
|---|---|---|
| Developed countries | 1.0 | 1.0 |
| Less developed countries | 2.2 | 2.3 |
| 1. Middle south Asia (India, Iran, Pakistan, Sri Lanka) | 1.9 | 2.0 |
| 2. Southeast Asia (Burma, Indonesia, Laos, Malaysia, the Philippines, Thailand) | 2.4 | 2.5 |

*Source:* D. Turnham: The Employment Problem in Less Developed Countries, OECD, Paris, 1971, p. 31.

The employment problem is therefore sufficiently serious to require every branch of the economy, including industry, to contribute to its solution.

[8] In the 1960s, the rate of unemployment ranged from 6 per cent of the total labour force in the Republic of Korea to 13.5 per cent in Sri Lanka.

[9] In the Philippines the share of manufacturing in total gainful employment went down slightly, from 11.2 per cent in 1966 to 11.1 per cent in 1971.

Industrialization in the ECAFE region, however, has failed to contribute sufficiently to the absorption of the rapidly growing labour force.

With the exception of Hong Kong, the Republic of Korea and Singapore, in which in 1960 the manufacturing sector employed 40 per cent, 16 per cent and 14 per cent respectively of the total labour force (see table 9), the share of manufacturing in all countries of the region was no more than 10 per cent for those listed in the table and much lower for others. In some countries the share shows a tendency to decline.[9]

TABLE 9. MANUFACTURING EMPLOYMENT AND CHANGES IN REAL WAGES

| | Percentage of labour force in manufacturing (around 1960) | Average annual change in real wages | |
|---|---|---|---|
| | | Period | Percentage |
| Asia | 9 | | |
| 1. Burma | 7 | 1960-64 | 0.5 |
| 2. Hong Kong | 40 | 1961-70 | ... |
| 3. India | 10 | 1961-67 | –2.2 |
| 4. Pakistan | 8 | 1960-66 | 2.0 |
| 5. Philippines | 10 | 1964-68 | 0.3 |
| 6. Republic of Korea | 16 | 1966-68 | 12.8 |
| 7. Singapore | 14 | 1960-68 | — |
| 8. Sri Lanka | 9 | 1960-68 | –0.1 |
| 9. Thailand | 3 | 1961-67 | –1.5 |

*Source:* United Nations World Economic Survey, 1969/70, p. 38.

The growth rate of employment in manufacturing for the developing region as a whole was slower in the second half of the 1960's than in the first half.

In analysing the poor performance of manufacturing in the employment of labour, account should be taken of the shrinking share of artisan-type industry, as against the rising share of factory employment; the growth of the latter has occurred primarily because of the replacement of artisan by factory employment. The manufacturing sector as a whole has failed to absorb much of the increase in the total labour force.

Another reason for the poor absorptive capacity of manuftcturing for labour arises in the changing structure of manufacturing production.

More rapid expansion of output took place in the dynamic sector which, however, had fewer workers per unit of output in comparison with the traditional sector. Nevertheless, the largest proportion of the total labour force in manufacturing is still absorbed in the latter sector. The ratio between employment in light and heavy industries ranged from around 5:1 in Indonesia, West Malaysia, Thailand and the Republic of Viet-Nam to 2.5:1 in the Republic of Korea as against 1:1 in Japan. It implies that under the circumstances, any change in the structure of the sector will entail a slower increase in industrial employment.

The bias towards less labour-intensive technologies has been reinforced by the sharp difference between market prices of the factors of production and their opportunity costs, which made the cost of capital low.

In view of the slow manpower absorption and the prevailing shortage of skilled personnel, a contradictory situation is faced by industry today: a steady demand for skilled personnel co-exists with extremely high levels of unemployment of unskilled labour.

The low response of manufacturing to employment may be further explained by the level of income distribution. While rapid growth of the dynamic industries has been induced by demand with high income elasticities, growth in the traditional industries has been restricted by the bulk of the population's slow growth of income. Unfortunately, it is in the context of relatively low elasticity of demand that a weakening in manpower absorption has been considered as an inherent feature of industrialization. It should be borne in mind, however, that the demand for traditional products could be significantly raised through greater income redistribution.

Hitherto only a relatively small part of the population represent the main market for several categories of industrial products while most of the population — those with very low income levels —are to a large extent excluded from the market for manufactures. If greater mass consumption could be induced in this low-income group today's slow growing industries could be encouraged to expand significantly. Such inducement, to be successful, would require acceleration of the current rate of employment. In this connexion a firm decision should be made in favour of more labour intensive technologies in new employment policies. The significance of this step might be better appreciated if a choice had to be made between new work costing £1,500 and, say, £150 or £100, which implics a difference in employment of perhaps 500,000 jobs and 5 million or 7.5 million.[10] To choose the latter would be all the more important in view of the region's fast-growing unemployment. It would at the same time set in motion a series of changes leading to more equitable distribution of income, which in turn would eventually exert its impact on the slow-growing industries.

Today's income distribution, however, instead of being progressive is tending towards increasing inequality. In the Philippines, for example, data on personal income show that during 1956-1961, the top decile increased its share from 39.3 per cent to 40.7 per cent, whereas the share of the five lowest deciles declined from 18.5 per cent to 17.9 per cent. A similar situation generally obtains for most countries in the region. Hence the already slow tempo of growth in the traditional industries will have been made even more sluggish by the regressive features of income distribution.

Income generated within industry itself was also marked by the same disadvantage, as is reflected by increased concentration of property. Thus, according to a survey made among 30,000 industrial firms, in Pakistan in 1959 25 per cent of their total assets was owned by only 7 industrial units and nearly 50 per cent of all assets was countrolled by 24 units.[11] This situation can be assured to have persisted in the 1960s.

Another study on the distribution of income in India revealed that 10 groups had an interest of one kind or other in 929 firms in 1958, representing 27 per cent of the share capital of non-governmental companies. Among the 10, the top 4 accounted for 20.8 per cent of the share capital of the entire corporate private sector thus showing a still higher degree of concentration.[12]

Analysing the trend in the share of income generated by manufacturing that fell to wage-earners (see table 9), it will be found that the wage level in manufacturing—which in itself was already relatively low—remained by and large stationary.[13] The main exception seems to be the Republic of Korea, where the wage level improved significantly. In most countries, therefore, labour absorbed a lower and even a declining proportion of value added generated by manufacturing.

In short, the bias towards capital-intensive technologies has not only interfered with the faster creation of employment opportunities; it has also intensified a tendency towards greater inequality in the distribution of income between labour and capital in the manufacturing sector.

### Transfer of technologies

One of the features of industries in the ECAFE region is their strong dependence on imports of technology. Indigenous technological capability is too weak and fragmented to enable imported technologies to be adapted to the special conditions of the region's environment. Even the passive absorption prevalent in most countries is concentrated only in specific sections of the productive system, so that remarkable differences exist in the kind of technologies used in one and the same branch. A number of relatively more developed establishments that are able to use new technologies exist side by side with others that are backward and seemingly not in need of technical

[10] E. F. Schumacher, "The work of the Intermediate Technology Development Group in Africa," *International Labour Review*, vol. 10b, 1972, p. 76.

[11] G. F. Papanek, *Pakistan's Development, Social Goals and Private Incentives* (Cambridge, Masachusetts, Harvard University Press, 1967).

[12] Planning Commission, Government of India, *Report of the Committee on Distribution of Income and Levels of Living*, part I, pp. 40-41.

[13] One of the underlying reasons for the lack of improvement in the wage level is the policy pursued by some countries, aimed at maintaining a relatively low wage level in order to promote industrial development or to maintain their competitive power in export markets.

improvement. Under present circumstances, it would seem more appropriate to speak of the "super-imposition" rather than of the "assimilation" of technical know-how.

Inevitably, weak technological capacity retards the transfer of the latest technologies. India, for example, though better equipped technologically than the other developing countries in the region, is still facing serious constraints on the effective transfer of technologies. A specific example is the experience of Kirloskar-Cummins with the establishment and operation of an assembly plant for diesel engines. The industrial product concerned was a highly sophisticated one in terms of manufacturing techniques, material requirements and quality standards necessary to yield a product commensurate with its economic costs. Serious problems arose rather from India's less developed industrial economy than as an outgrowth of governmental policy. It proved impossible to develop suppliers for certain essential parts, nor could the latter be imported efficiently or locally manufactured economically. Costly production delays resulted. The company's manufacturing operations had to be scaled down to a small fraction of internationally competitive production, and procurement was forced to adapt to the small-scale and limited range of industrial capability in the Indian economy.[14]

Other cases are not wanting, where processes have been adopted that are not suited to the resource endowment and market conditions in the region, or requiring a large number of skilled workers. It sometimes happens that an industry is set up in one country with the equipment and production scale often by far exceeding the combined requirements of three or four countries. It is perhaps in this respect that maladjustment of technologies and the attendant overcapitalization are most conspicuous.

An important contributing factor to the limitation upon the development of technological capacity in many countries stems from the predominance of small and medium-sized industries. Owing to the latters limited resources, narrow scope of operations and circumscribed managerial outlook, the entrepreneurs concerned are in most cases unable adequately to appraise, select and utilize foreign technologies. This type of adverse condition, however, has been appreciably minimized in, for example, the Republic of Korea, Hong Kong and Singapore and particularly Japan, by the adoption of a series of related governmental measures aimed at encouraging an industry-oriented, rather than an enterprise-oriented, outlook among manufacturers operating in small establishments. These measures have been most effective in the creation of close interindustry relationships. In Japan, national policies have been systematically implemented with a view to improving the technical competence of small-scale industries. Among the positive results may be included: the acquisition of a highly skilled industrial labour force; engineering and technical skills capable of converting foreign techniques to domestic requirements and of improving upon these techniques, eventually; and a strong sector of small-scale industrial subcontractors well integrated with the large-scale industries.

An intricate network of small establishments acting as efficient adjuncts to modern industrial complexes, as in Japan, would obviously be a long-term objective for the developing countries in the region. Nevertheless, attention needs to be paid to the urgent need for generating inducement to technical change in the small-scale industries sector. It is in this field in particular that, owing to their common socio-economic environment, the ECAFE developing countries could fruitfully benefit from each other's experience to speedily establish indigenous technologies that are more labour-intensive and less dependent on foreign exchange. Since the development of technologies to meet demand for cheap but less sophisticated manufactures would generally not be developed in advanced countries, there is all the more reason for the developing countries to co-operate in the mutual transfer of technology for small-scale industries.

Apart from the small-scale industries sector, an important area for indigenous technological innovation could be found in the processing of domestic natural resources. This may be illustrated by Thailand's new industry for the production of kenaf pulp. The Technological Research Institute of the Applied Scientific Research Corporation of Thailand (ASRCT) has developed, with technical assistance from UNIDO, several processes for the production of various grades of pulp from locally grown kenaf. Thailand's is the first modern mill of its kind in the world. A second phase of the research programme is currently under way to devise means of processing kenaf seed for vegetable oil.

A lack of research and development activities is undoubtedly the common denominator of the disparities in technology among the countries themselves and vis-à-vis the advanced countries. In contrast with the situation in the developed countries, expenditure on research and development in the developing countries represents only a small fraction of the national income. Thus, while in Japan, the Soviet Union and the United States, for example, such expenditure accounts for over 3 per cent of the national income, the proportion in the region is much less than 0.5 per cent. It should be further noted that, in view of the small size of the national income in the developing countries of the region, the absolute size of total expenditure allotted to research and development is extremely small, resulting in an extremely meagre impact on technological innovation.

The very low level of research and development has been further aggravated by the migration of scientists and technical experts from the region in the

[14] Jack Baranson, *Manufacturing Problems in India*, Syracuse University Press, 1967. 146 pp.

1960s (see table 10). Such migration has been both a sympton and a cause of the relative backwardness of the region's technological capability. Efforts to contain it would in itself constitute an innovation, as it would reflect a radical change of attitude implying growing attention to research and development activities.

Furthermore, the Governments have not paid sufficient attention to the programming of scientific training, so vital to the application of science and technology to development. Educational programmes seem to have been designed with heavy concentration on the university and vocational skills required for highly sophisticated activities. More efforts should have been devoted to the education and training of manpower for intermediate technology and the like, which would have obviated the present growing unemployment of highly educated people in the region.

There are thus very strong reasons for widening and deepening the scope of the technologies currently applied in the region, if only to accelerate the selection, adaptation and absorption of foreign technologies. There is an urgent need for regional co-operation to strengthen the development of indigenous technological capabilities.

## Summary and conclusions

The foregoing analysis has shown that the overall picture of Asian industry today comprises a variety of situations. Growth in industrial output during the 1960s ranged from as high as 15-20 per cent per year for Iran, the Republic of Korea and Singapore to as low as less than 3 per cent for Burma and Indonesia. The remaining countries registered a medium rate of about 10 per cent, although here subdivisions should be made. India, like China is in a special class of its own, owing to the significant share of development in the heavy industries.

Further, there have been varying degrees of growth in the non-industrial sectors, reflecting in part the impact of industrialization on the other sectors and *vice versa*.

On the whole, the share of manufacturing in the national product tended to increase more rapidly in the group of countries showing the fastest growth in industrial output; it remained more or less stagnant or increasing at a slow pace in the countries with medium growth; and was either declining or stationary in the third group.

Regarding the structure of manufacturing, the traditional industries — food, beverages and tobacco industries — were most predominant in the third group, whereas the dynamic industries such as metal and metal-transforming accounted for 55 per cent or more value added to manufacturing in the Republic of Korea, India and Singapore. The traditional industries generally showed a sluggish growth rate.

To a significant extent, differences in levels of investment caused industrial development among the

TABLE 10. IMMIGRANTS INTO THE UNITED STATES, CANADA AND FRANCE, BY OCCUPATION 1962-1966

| | Immigrants with occupation (1) | | Professional, Technical and kindred workers (2) | | Col. 2/Col. 1 (percentage) (3) | | Engineers (4) | | | Natural scientists (5) | | | Physicians (6) | | | Professional nurses (7) | | Social scientists (8) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | United States | Canada | United States | Canada | United States | Canada | United States | Canada | France | United States | Canada | France | United States | Canada | France | United States | Canada | United States |
| Burma | ... | 28 | ... | 19 | ... | 67.9 | 25 | 4 | — | 3 | 3 | — | 9 | 7 | — | 3 | 1 | 1 |
| Hong Kong | 851 | 2,991 | 411 | 848 | 48.2 | 28.4 | 251 | 190 | — | 90 | 63 | — | 50 | 77 | — | 75 | 143 | 8 |
| India | 3,315 | 3,243 | 2,604 | 1,967 | 78.6 | 60.7 | 1,074 | 408 | 57 | 355 | 206 | 36 | 87 | 164 | — | 14 | 150 | 38 |
| Indonesia | 2,430 | 19 | 559 | 13 | 23.0 | 68.4 | 14 | 3 | 3 | 9 | 2 | 1 | — | 1 | — | 2 | 2 | 1 |
| Iran | 2,178 | 147 | 1,014 | 93 | 46.6 | 63.3 | 236 | 17 | 73 | 57 | 15 | 43 | 188 | 33 | 1 | 32 | 3 | 10 |
| Korea, Republic of | 1,454 | ... | 1,065 | ... | 73.2 | ... | 185 | ... | 21 | 140 | ... | 11 | 93 | ... | — | 37 | ... | 34 |
| Malaysia | 165 | 144 | 75 | 102 | 45.5 | 70.8 | 27 | 13 | — | 17 | 20 | — | 22 | 8 | — | 14 | 21 | 3 |
| Pakistan | 245 | 772 | 205 | 477 | 83.7 | 61.8 | 62 | 144 | 13 | 28 | 52 | 1 | 19 | 37 | — | 4 | 7 | 1 |
| Philippines | 5,555 | 3,746 | 2,621 | 3,266 | 47.2 | 87.2 | 86 | 237 | — | 81 | 202 | — | 608 | 221 | — | 358 | 1,902 | 21 |
| Thailand | ... | ... | ... | ... | ... | ... | ... | 1 | 3 | 3 | ... | — | 32 | ... | — | 76 | ... | 2 |
| Viet-Nam, Republic of | 59 | ... | 39 | ... | 66.1 | ... | 21 | ... | 185 | 3 | ... | 27 | 1 | ... | 2 | 12 | ... | 1 |

*Source:* The ILO, *International Labour Review*, vol. 99, 1969 table 1, p. 402/403.

developing ECAFE countries to vary in quality of performance. The share of manufacturing in over-all investment ranged from 54 per cent in Singapore to 11 per cent in the Philippines.

The sheer lack of capital resources would seem to be considered less important than the vital necessity of attaining a more efficient and economic use of capital. Even if abundant funds were available, the lack of absorptive capacity, reflecting inadequate preparation of viable projects, would easily constrain industrial growth. Many countries are still considerably wanting in so far as adequate preparation of industrial plans and efficient working of planning machinery are concerned.

Import substitution, the bellwether of industrial development in most countries in the region, appears to have been pursued too far. This is borne out by the slowing down of industrial growth in the second half of the 1960s and by the availability of considerable excess capacity. While it is true that import substitution has helped most countries to achieve a faster rate of industrial development than would otherwise have been possible, the economic and social costs have often been far greater than the benefits and have dimmed the outlook for sustained long-term growth. Unexpectedly, import substitution has led to high prices of industrial products, a high import content and has generally impaired competition in the world market. It has also brought about indiscriminate protective measures which resulted in lack of specialization and complementarity at both the country and the regional level. It has once again shown the need for a well-devised and adequately implemented strategy for a more fluid process, leading to selective import substitution on the one hand and penetration of export markets for manufactures and semi-manufactures on the other. This strategy, in order to be successful, would call first and foremost for measures to rectify the current distortions in price and cost relationships.

Another striking feature of the region's industrialization process is its failure to provide adequate employment for the fast growing labour force. The growth of employment in manufacturing, in addition to lagging behind that in industrial output, slowed down significantly in the latter half of the 1960s. At the same time, the evolution of industrial employment resulted to a marked degree from the bias towards less labour-intensive technologies, conditioned in part by the artificial drop in the cost of capital.

Similarly, the growth of industries seems to have been affected by the trend of greater inequality in the distribution of the national income, to which industry itself contributes its share, as the gap between the shares of labour and capital in income generated by manufacturing has been widening. Thus, the slowness of growth of the traditional industries, viewed from the angle of demand, may be attributed to the increasing exclusion from their markets of a large proportion of the low-income group. In other words, growth of the traditional industries could have been stimulated had an increase been induced in the relevant demand among the low-income brackets. This could have been achieved by measures aimed at a more equitable distribution of income, with the promotion of more labour-intensive technologies occupying a prominent role. Reorientation of past policies to that end is all the more urgent in view of the vast "reserve army" of unemployed labour.

The devising of appropriate labour-intensive technologies that are nevertheless in consonance with capital-intensive technologies calls for the existence of sound technological capability.

So far, industries in the region have depended heavily upon the advanced countries in matters of technology, which clearly illustrates the very strong need for most countries of the region to strengthen the existing weak and fragmented position of their technological capability. Moreover, the countries should further co-ordinate their efforts by setting up a regional centre for technology transfer and investment promotion, as has been recommended by a preparatory meeting on the subject, held at Bangkok in September/October 1972.

# Part III

## The Iron and Steel Industry

# THE IRON AND STEEL INDUSTRY IN THE ECAFE DEVELOPING COUNTRIES

### PROSPECTS OF THE IRON AND STEEL INDUSTRY IN LAOS, THE KHMER REPUBLIC, THE REPUBLIC OF VIET-NAM AND THAILAND

In April-May 1971, a joint ECAFE/UNIDO mission conducted in co-operation with the Committee for Co-ordination of Investigations of the Lower Mekong Basin, a review of the iron and steel industries in the four countries of the lower Mekong basin and recommended the installation of additional capacities.

According to the forecast made in the mission's report, the consumption of steel during 1973-1985 would be as shown in table 11.[15]

TABLE 11. FORECAST OF STEEL CONSUMPTION
(Thousand tons)

| Country | 1969 | 1975 a Total | Flat products | Long products | 1980 b Total | 1985 b Total |
|---|---|---|---|---|---|---|
| Khmer Republic | 64 | 75.9 | 15.6 (20.60%) | 60.3 (79.40%) | 136.6 | 193.4 |
| Laos | 7 | 9.3 | 4.7 (50.44%) | 4.6 (49.56%) | 13.7 | 19.3 |
| Thailand | 813 | 1,268.0 | 502.9 (39.66%) | 765.1 (60.34%) | 1,828.0 | 2,445.9 |
| Viet-Nam, Republic of | 222 | 278.3 | 155.8 (55.99%) | 122.5 (44.01%) | 459.6 | 707.4 |
| Total | 1,106 | 1,631.5 | 699.0 | 952.5 | 2,437.9 | 3,366.0 |

a Based on the "trend method".
b Based on the "steel-intensity" method.

On the basis of this level of demand and the availability of raw materials, the mission considered it justified to establish at the national level non-integrated steel mills with electric arc furnaces and appropriate rolling-mills. It has been further suggested that rerolling mills could be built for the production of merchant products utilizing either rerollable scrap or imported billets.

It is assumed that cheap electricity available from the power development of the lower Mekong basin would provide a strong impetus to the development of the steel mills.

Briefly, the proposed plants would be as follows:

### LAOS

*Short-term plan*

In view of the limited supply of scrap, the installation of steel making facilities in Laos would not seem advisable before 1985, unless an improved electric power situation should prove otherwise. Nevertheless a start could be made on the setting up of a small foundry of about 1,000 — 1,200 t/yr, for the manufacture of iron castings such as soil pipes, agricultural tractor parts, small valves and general-purpose castings. The major production facilities would include a melting unit, pouring and moulding equipment, and core drying and fettling facilities. There is sufficent local scrap for a plant of this size.

The choice of melting facilities would be governed by the availability and cost of electric power vis-a-vis the cost of imported coke. A preliminary evaluation of the relative economics of using a cupola or an induction furnace for melting scrap indicates that, if power is made available at 4.5 US mill/kWh, as envisaged for exporting to Thailand from Nam Ngum, or at a slightly higher rate, an induction furnace would be more economic—as well as advantageous for producing some steel castings.

Total investment for the foundry is estimated at about US$164,000 as indicated in table 12:

TABLE 12. PRELIMINARY ESTIMATE OF THE CAPITAL COST OF AN IRON FOUNDRY IN LAOS a
(Thousand U.S. dollars)

| Item | Cost |
|---|---|
| Land and site preparation | 2.0 |
| Civil and structural work | 4.0 |
| Equipment as erected | 129.9 |
| Design, engineering and administration during construction | 13.5 |
| Contingencies | 14.9 |
| Total | 164.3 |

a Based on an annual production of 1,200 t castings.

[15] Report (document AIDC(7)/3) submitted to the seventh session of the Asian Industrial Development Council in February 1972.

A preliminary estimate of the average annual operating costs given in table 13 works out at about US$145,000/yr.

TABLE 13. PRELIMINARY ESTIMATE OF THE ANNUAL OPERATING COSTS OF A FOUNDRY IN LAOS [a]

| | '000 US$ |
|---|---|
| *Materials* | |
| Scrap | 31.2 |
| Coke | 10.8 |
| Ferro-silicon | 3.6 |
| Subtotal | 45.6 |
| *Variable costs* | |
| Sand and other supplies | 12.8 |
| Electric power, water and utilities | 8.4 |
| Repair and maintenance | 5.2 |
| Subtotal | 26.4 |
| *Fixed cost* | |
| Wages and salaries | 42.0 |
| Sales and office expenses | 10.0 |
| Interest on working capital | 3.0 |
| Interest on loan capital | 2.5 |
| Deferred charges | 3.0 |
| Depreciation | 13.0 |
| Subtotal | 73.5 |
| Total annual operating cost | 145.5 |

[a] Based on an annual production of 1,200 t castings.

*Long-term plan*

During the long-term period, installation of a simple open-type rolling-mill with a capacity of 6,000-8,000 t/yr mainly for production of rods, bars and flats, would be feasible. The following two possibilities have been suggested:

| | I | II |
|---|---|---|
| Raw material | Re-rollable scrap | Billets |
| Production | 6,000 t/yr<br>2 shifts/day, 300 days/yr | 8,000 t/yr<br>1 shift/day, 300 days/yr |
| Reheating facility | One, oil-fired, 4 t/h pusher-type furnace | One, oil-fired, 5 t/h pusher type furnace |
| Roughing mill | — | One 300 mm, 3-high, single stand, 400 hp |
| Finishing mill | One, 3-high, 250 mm, 7-stand, 450 hp | One, 3-high, 250 mm, 6-stand, 500 hp |

Table 14 gives a preliminary estimate of the capital costs.

TABLE 14. PRELIMINARY ESTIMATE OF THE CAPITAL COSTS OF ROLLING-MILLS IN LAOS

| *Item* | *I* | *II* |
|---|---|---|
| Basis: major facilities | One, 3-high, 250 mm, 7-stand mill, 450 hp | One, 3-high, 300 mm, single-stand mill, 400 hp<br>One, 3-high, 250 mm, 6-stand mill, 500 hp |
| Production | 6,000 t/yr, rods, bars, flats etc.<br>2 shifts/day, 300 days/yr | 8,000 t/yr, rods, bars, flats, angles etc.<br>1 shift/day, 300 days/yr |

| | *US dollars* | *US dollars* |
|---|---|---|
| Land and site preparation | 50,000 | 50,000 |
| Civil and structural work | 100,000 | 148,000 |
| Equipment as erected | 157,800 | 460,680 |
| Design, engineering and administration during construction | 25,780 | 60,868 |
| Contingencies | 33,358 | 71,955 |

A preliminary estimate of the annual operating costs is given in table 15.

TABLE 15. PRELIMINARY ESTIMATE OF THE ANNUAL OPERATING COSTS OF ROLLING-MILLS IN LAOS

| *Item* | *I* | *II* |
|---|---|---|
| Basis: production | 6,000 t/yr<br>2 shifts/day<br>300 days/yr | 8,000 t/yr<br>1 shift/day,<br>300 days/yr |
| Raw materials | Rerollable scrap | Billets |
| | *Thousand US dollars* | *Thousand US dollars* |
| Raw materials | 636.50 | 882.00 |
| Variable costs | 25.92 | 47.71 |
| Fixed costs | 170.54 | 158.94 |
| Total | 832.96 | 1,088.65 |

On the basis of table 15, the average cost of product for the first possibility works out at about US$139/t and that for the second at US$136/t, both of which are lower than the current selling price of imported rods and bars (US$200/t).

## KHMER REPUBLIC

*Short-term plan*

It is suggested that during the short-term development, a bar and rod mill with an annual capacity of 22,500 t be installed. (The present scrap and electric power position may not justify the introduction of a semi-integrated plant in the immediate future). Preliminary estimates of the capital investment required are given in table 16. It is suggested thaf an additional roughing stand should be installed at a later date.

TABLE 16. PRELIMINARY ESTIMATES OF CAPITAL COSTS OF A BAR AND ROD MILL IN THE KHMER REPUBLIC [a]
(Thousand U.S. dollars)

| *Item* | *Cost* |
|---|---|
| Land and site preparation | 100.0 |
| Civil and structural work | 192.0 |
| Equipment as erected | 460.0 |
| Design, engineering and administration during construction | 65.2 |
| Contingencies | 81.7 |
| Total | 898.9 |

[a] On the following basis:
(i) major facilities —
One oil-fired reheating furnace, 6 t/h
One 350 mm, 3-high, single-stand, 400 hp roughing-mill
One 250 mm, 3-high, 5-stand, cross-country, 500 hp finishing mill
One incline-type, manually operated rolling-bed
(ii) production —
22,500 t/yr of rods, bars, flats, angles, etc.

The mill would operate on imported billets, possible sources of which could be the proposed regional billet plant.

Preliminary estimate of the annual operating costs involved is given in table 17. The plant would operate three shifts per day and the total manpower required would be about 110.

TABLE 17. PRELIMINARY ESTIMATE OF THE ANNUAL OPERATING COSTS OF A BAR AND ROD MILL IN THE KHMER REPUBLIC [a]
(Thousand U.S. dollars)

| Item | Cost |
|---|---|
| Imported billets | 2,500 |
| Variable costs | 181 |
| Fixed costs | 360 |
| Total | 3,041 |

[a] Based on an annual production of: 22,500 t of rods, bars, flats, angles etc.; 3 shifts/day, 300 days/yr.

The average cost of the rolled product works out at US$135/t. The current (normal) selling price of this category of product is Ri 17-20/kg, which corresponds to about US$167/t at the market exchange rate of US$1=Ri 120.

*Long-term plan*

During the long-term period, the initial plant could be expanded by installing a wire-rod mill with an annual capacity of about 20,000 t, possibly together with arc furnace facilities to produce small ingots, using scrap as melting-stock. An additional roughing-stand would have to be installed to roll the ingots.

The major facilities envisaged for installation during the long-term period are:

Steelmaking: One 30-t, 12,500 kVA, arc furnace with conventional casting facilities

Rolling-mill: One 450 mm roughing stand in the bar mill
One 20,000 t capacity wire-rod mill

A preliminary estimate of the capital costs involved is given in table 18.

TABLE 18. PRELIMINARY ESTIMATE OF THE CAPITAL COSTS OF AN ARC FURNACE AND AN ADDITIONAL ROUGHING-STAND IN THE BAR AND WIRE-ROD MILL IN THE KHMER REPUBLIC
(Thousand U.S. dollars)

| Item | Cost |
|---|---|
| Site preparation | 50 |
| Civil and structural | 1,030 |
| Equipment as erected | 2,925 |
| Design, engineering and administration during construction | 396 |
| Contingencies | 440 |
| Total | 4,841 |

The total investment would be about US$4.84 million. If, however, steel-making facilities were not installed and only a wire-rod mill were set up, the total investment would be about US$2.0 million. In such a case, the additional roughing-stand need not be installed in the bar and rod mill, which is primarily intended for rolling ingots.

## REPUBLIC OF VIET-NAM

*Short-term plan*

In addition to the expansion of existing plants (VICAST and SADAKIN) and the setting up of two new plants (Dong-A and Vitac), all of which is expected to increase the annual output of reinforcing bar and wire rods by 57,000 t, the establishment of 90,000 t of annual capacity to produce light sections should be considered. Another plant (capacity 78,000 t/yr), from imported hot-rolled coils should also be established.

The preliminary estimates of the capital and operating costs entailed is shown in tables 19-21.

TABLE 19. PRELIMINARY ESTIMATES OF THE CAPITAL COSTS OF A LIGHT-SECTION MILL IN THE REPUBLIC OF VIET-NAM [a]
(Thousand U.S. dollars)

| Item | Cost |
|---|---|
| Land and site preparation | 75 |
| Civil and structural work | 6,836 |
| Equipment as erected | 13,956 |
| Design, engineering and administration during construction | 2,079 |
| Contingencies | 2,316 |
| Total | 25,262 |

[a] On the following basis:
(i) major facilities —
Two 3-t, 12,500 kVA arc furnaces,
One 3-stand continuous-casting machine,
One semi-continuous merchant mill
(ii) Production —
90,000 t/yr of merchant sections bars and rods

TABLE 20. PRELIMINARY ESTIMATE OF CAPITAL COSTS OF A COLD-ROLLING MILL IN THE REPUBLIC OF VIET-NAM [a]
(Thousand U.S. dollars)

| Item | Cost |
|---|---|
| Land and site preparation | 350 |
| Civil and structural | 5,500 |
| Equipment as erected | 10,150 |
| Design, engineering and administration during construction | 1,565 |
| Contingencies | 1,757 |
| Total | 19,322 |

[a] On the following basis:
(i) major facilities —
One 1,420 mm, 4-high cold-reversing mill with pickling, cleaning, annealing and skin-pass facilities
(ii) production —
78,000 yr of as-rolled and as-annealed sheets.

TABLE 21. PRELIMINARY ESTIMATE OF ANNUAL OPERATING COSTS OF A LIGHT-SECTION MILL IN THE REPUBLIC OF VIET-NAM [a]

| | Price (US dollars per ton) | Consumption (Tons) | Annual cost (Thousand U.S. dollars) |
|---|---|---|---|
| *Raw materials costs* | | | |
| Scrap | 25.00 | 108,000 | 2,700 |
| Limestone | 11.00 | 13,000 | 143 |
| Fluorspar | 300.00 | 400 | 120 |
| Ferro-manganese | 172.00 | 1,065 | 237 |
| Ferro-silicon | 301.00 | 533 | 161 |
| Iron ore | 20.00 | 4,000 | 80 |
| Coke | 100.00 | 1,000 | 100 |
| | | | 3,541 |
| *Variable costs* | | | |
| *Steelmaking* | | | |
| Electric power | | | 1,815.0 |
| Water | | | 3.7 |
| LP gas | | | 2.1 |
| Fuel oil | | | 34.5 |
| Diesel oil | | | 39.5 |
| Electrodes | | | 513.6 |
| Refractories | | | 632.0 |
| Copper moulds | | | 30.0 |
| Mould lubricant | | | 3.8 |
| Pyrometer tips | | | 5.0 |
| General lubricant and miscellaneous supplies | | | 15.8 |
| Repair and maintenance | | | 200.0 |
| Subtotal | | | 3,295.0 |
| *Rolling-mills* | | | |
| Electric power | | | 184.2 |
| Water | | | 3.5 |
| Fuel oil | | | 103.5 |
| Repair and maintenance and tools | | | 640.0 |
| Provision for rolls | | | 135.0 |
| Subtotal | | | 1,066.2 |
| *Fixed costs* | | | |
| Labour and supervision | | | 502.8 |
| Interest on working capital | | | 252.0 |
| Interest on loan capital | | | 425.0 |
| Depreciation | | | 2,015.0 |
| Insurance of plant and equipment | | | 504.0 |
| Sales and office expenses | | | 128.0 |
| Deferred expenses | | | 200.0 |
| Subtotal | | | 4,026.8 |
| Total annual operating cost | | | 11,929.0 |

[a] On the basis of an annual production of 90,000 t of sectional products.

The average cost of cold-rolled sheets works out at US$231 t, which is lower than the current selling price of US$273.

### *Long-term plan*

During the long-term period, it is suggested that the initial cold mill and light-section mill plant be expanded by the installation of a skelp mill. This would cater for the growing demand for skelp for manufacture of steel tubes in the Republic of Viet-Nam as well as in Thailand.

Table 22 gives a preliminary estimate of the capital costs involved.

TABLE 22. PRELIMINARY ESTIMATE OF THE CAPITAL COSTS OF A SEMI-CONTINUOUS SKELP AND STRIP MILL IN THE REPUBLIC OF VIET-NAM [a]
(Thousand U.S. dollars)

| | Cost |
|---|---|
| Site preparation | 67 |
| Civil and structural work | 4,270 |
| Equipment as erected | 15,556 |
| Design, engineering and administration during construction | 1,983 |
| *Contingencies* | 2,188 |
| | 24,064 |

[a] On the following basis:
(i) major facilities —
Two 40-t, 14,500 kVA arc furnace,
One continuous slab-casting machine,
One semi-continuous skelp and strip mill
(ii) Production—
120,000 t/yr of furnished skelp or strip

## THAILAND

Almost all Thailand's existing steel producers have expansion programmes which are likely to be implemented by 1980. Notable amongst these is the installation of LD converters at the Siam Iron and Steel Co. Ltd., to increase rolling capacity to 220,000 t/yr; and of an additional 20-t arc furnace at GS Steel Co. Ltd., to increase production to 150,000 t/yr; the expansion of rolling facilities at Bangkok Steel Industry Co. Ltd. and Thai-India Steel Co. Ltd., to 120,000 t/yr and 60,000 t/yr, respectively. Consequently, total installed capacity by 1980 is expected to be about 575,000 t.

The output capacity for iron and steel castings of the Royal State Railway Workshop and the Siam Iron and Steel Co. Ltd. is expected to increase from 14,200 t in 1971 to about 20,000 t in the near future.

Demand in the early 1980s, to judge from that estimated for flat products in the four riparian countries, is likely to equal the capacity of *one continuous strip-mill.* There have been many studies by various international agencies and United Nations bodies, including ECAFE, which have examined the subject of the establishment of an integrated steel plant at a deep seawater coastal site. The mission considered this plant to be of tremendous importance to the economic growth of Thailand.

The mission recommended that the project be implemented in the following three stages, with the cold flat-product mill serving in addition the regional needs of the four riparian countries.

*First stage (short-term plan).* Construction of a reversing cold mill with an initial capacity of about 80,000 t/yr, for the production of cold-rolled sheets. Hot coils for processing into cold-rolled sheets would be imported.

At the same time, the choice of site and provision of infrastructural facilities for the second stage should be investigated and preparatory work undertaken.

*Second stage (medium-term plan).* Construction of a cold tandem mill with a capacity of about 420,000 t/yr. The accessional facilities, such as a cleaning line, annealing and shearing, should be designed for a capacity of about 500,000 — 600,000 t of cold-rolled products.

*Third stage (long-term plan).* The installation of a hot-strip mill, together with a blast-furnace and LD steel making facilities.

The capital cost of a cold-rolling mill of 500,000 t or so is estimated at approximately US$70 million, excluding the cost of land and off-site facilities.

The production programme envisaged for 1980 is summarized in table 23.

TABLE 23. INSTALLED CAPACITY IN THE IRON AND STEEL INDUSTRY, 1980
(Thousand tons)

| Country | Product | Installed capacity: Excluding that proposed by the mission | Installed capacity: Including that proposed by the mission |
|---|---|---|---|
| Laos | Iron castings | 1.5 | 7.5-9.5 |
| Republic of Viet-Nam | Mild-steel bars and rounds | 70.0 | |
| | Steel castings | 1.5 | 358.0 |
| Khmer Republic | Iron castings | 10.0 | |
| Thailand | Iron castings | 15.0 | 57.5 |
| | Cold-rolled sheets | — | 580.0 |
| | Mild-steel bars and rounds | 575.0 | 575.0 |
| | Steel castings | 5.0 | 5.0 |
| | Iron castings | 15.0 | 15.0 |

The mission further suggested that the billet requirements of the lower Mekong riparian countries should preferably be met from the regional billet plant which it is proposed to install in southeast Asia and on which a brief report follows.

## PROSPECTS OF REGIONAL CO-OPERATION IN STEEL BILLET PRODUCTION IN SOUTHEAST ASIAN COUNTRIES

### *Introduction*

Decision taken by the Asian Industrial Development Council (AIDC) at its sixth session in January 1971, a two-man team, organized by ECAFE, conducted a survey the following year on the prospects of regional co-operation for the production of steel billets in southeast Asian countries.

The team's report proposed a policy for co-ordinating steel billet production in the Philippines, Indonesia, Singapore, Malaysia and Thailand, taking into account the needs of the other three riparian countries of the lower Mekong basin — Laos, the Khmer Republic and the Republic of Viet-Nam — through the setting up of two billet plants of 250,000 t/yr capacity or alternatively one 1.5 million t integrated plant.[16] The possibility has been demonstrated of producing billets at approximately the price of imports, but with a gross return of 7 per cent on total investment for the billet plant or 12 per cent for the integrated plant. The former could employ approximately 660 persons; the latter, about 5,190. Many of the re-rolling mills in the subregion (perhaps one-fifth of total bar capacity) process ship-plate, split rails and other appropriate scrap for rounds, which are often of inadequate quality. Such mills do not have the reheating furnaces or mill stands to handle billets, but it would be possible to modify their equipment with rerollers if billets could be made available at competitive costs. That would give higher mill yields and better product quality than rolling from scrap.

### *Steel supply and demand*

Estimates of current primary steel production and consumption will be found in table 24.

TABLE 24. ESTIMATES OF STEEL PRODUCTION AND CONSUMPTION, 1971
(Thousand tons)

| | Indonesia | Malaysia | Philippines | Singapore | Thailand | Total |
|---|---|---|---|---|---|---|
| *Production* | | | | | | |
| Flat products | — | — | — | — | — | — |
| Structurals [a] | — | — | — | — | — | — |
| Bars and rods [b] | 10 | 160 | 306 | 146 | 300 | 922 |
| Total | 10 | 160 | 306 | 146 | 300 | 922 |
| *Consumption* | | | | | | |
| Flat products | 286 | 240 | 280 | 348 | 350 | 1,504 |
| Structurals | 24 | 125 | 408 | 190 | 550 | 2,025 |
| Bars and rods | 290 | 210 | | 228 | | |
| Total | 600 | 575 | 688 | 766 | 900 | 3,529 |

[a] Heavy structurals, railway material.
[b] Bars, light shapes, wire rod.

[16] Report (document AIDC (8)/10) submitted to the eighth session of the Asian Industrial Development Council, 1-7 February 1973.

Indigenous primary steel production varies from less than 2 per cent of consumption to 45 per cent. Thailand is a relatively large consumer, and Singapore, the Philippines, Indonesia and Malaysia follow in that order.

*Future billet demand and the possibilities of supply*

In dealing with this aspect, the team's report made the following country observations:

## INDONESIA

Steel consumption in Indonesia dropped from 222,000 t in 1965 to 145,000 t in 1967. In the subsequent 4 yr, it rose to 600,000 t; this exceptional rate of 42 per cent annually, due to the small initial base, which could not be sustained. The primary production of only 10,000 covers less than 2 per cent of requirements.

To forecast the steel situation requires that a view be taken on when the pent-up demand for rehabilitating industry will have been met and normal growth resumed. As a result of recent trends, demand is expected to grow at about 15 per cent annually up to 1975, and at about 7 per cent thereafter, as follows (in thousand tons):

| | *1975* | *1980* |
|---|---|---|
| Non-flat | 525 | 750 |
| Flat | 475 | 750 |
| Total | 1,000 | 1,500 |

Consumption of structurals has been small (for example, about 4 per cent of total in 1971), and future demand will depend greatly on the railway development programme in the second plan. The need for bars, rods and wire products for construction and manufacturing is expected to remain high, reaching about 400,000 t by 1975 and 550,000 t by 1980.

The use of flat products, including pipes, has been rising unevenly. In future it can be expected to follow the early pattern in other oil-rich developing economies such as Venezuela and Iran, peaking to about 50 per cent of total consumption in 1980.

Probable billet capacity and shortfall are estimated in tables 25 and 26

TABLE 25. CURRENT AND PROBABLE FUTURE CAPACITY FOR MAKING INGOTS OR BILLETS IN INDONESIA
(Tons per year)

| *Works* | *Present capacity (1972)* | | *Probable future capacity (1975)* | |
|---|---|---|---|---|
| 1. Air Trading Co. | 1-30 t open-hearth | 15,000 | — | 15,000 |
| 2. Djakarta Iron Products | 1-5 t furnace | 5,000 | — | 5,000 |
| 3. Irosteel Work | 1-8 t furnace | 18,000 | Additional 1-8 t furnace ) ) 2-30 t furnace ) | 100,000 |
| 4. Gadung steel | — | — | 1-8 t furnace | 18,000 |
| Total | | 38,000 | | 138,000 |

Production in 1972 will have been under 20,000 t. Both Air Trading and Djakarta Iron Products have been operating well below capacity, owing to a shortage of power and other operational problems.

TABLE 26. ESTIMATE OF FUTURE BILLET SHORTFALL IN INDONESIA
(Thousand tons)

| | *1975* | *1980* |
|---|---|---|
| Demand of products rolled from billets and scrap | 400 | 550 |
| *Deduct* products rolled from scrap (say 50 per cent in 1975, 35 per cent in 1980) | –200 | –200 |
| Products rolled from billet | 200 | 350 |
| Billet equivalent at 94 per cent | 210 | 373 |
| *Deduct* probable expanded billet or ingot capacity by 1975 | –138 | –138 [a] |
| Billet shortfall | 72 | 235 |

[a] Billet capacity would of course continue to expand beyond 1975. But the purpose of this exercise is to assess the probable gap after 1975, which would have to be met by expansion of existing and new capacity, a regional plant as well as imports.

Present rolling-mill capacity, located in Djakarta, Surabaya and Medan, is about 200,000 t of bars and rods. In addition, Krakatau Steel's rolling mill and Irosteel's mill should be commissioned by 1975. Currently substantial tonnages are rolled from scrap, but this would decrease as billets became available and better quality products were needed.

## MALAYSIA

In the period 1962-1967, steel consumption grew at a rate of 14.6 per cent/yr, against a GNP growth rate of 5.4 per cent in the same period. It then rose from 333,000 t in 1967 to 575,000 t in 1971, again an increase of 15 per cent annually. Indigenous production, however, was only about 160,000 t.

It is not unreasonable to expect a growth in steel consumption of 7 per cent annually up to 1980, giving a demand of 785,000 t in 1975 and 1.1

million t in 1980. The share of flat products is expected to increase from the present 41 per cent of the total to 45 per cent by 1980. Of the non-flat products, two-thirds would be bars, rods and light sections rollable from billets, the balance being heavy structurals, railway materials, etc.

Current and future steelmaking capacity and the estimated billet shortfall are shown in tables 27 and 28, respectively.

Against the above steelmaking capacity, present rolling-mill capacity is estimated at 329,000 t/yr.

TABLE 27. CURRENT AND PROBABLE FUTURE CAPACITY FOR MAKING INGOTS OR BILLETS IN MALAYSIA
(Tons per year)

| Works | Present capacity (1972) | | Probable future capacity (1975) | |
|---|---|---|---|---|
| 1. Malayawata, Prai ......... | 2-12 t LD converter) 1-10 t arc furnace ) | 120,000 | — | 120,000 |
| 2. United Malaysian Steel Mills | 1-10 t arc furnace | 20,000 | Additional 1-20 t arc furnace | 60,000 |
| 3. Dah Yung, Kuala Lumpur .. | 1-3 t arc furnace | 6,000 | Additional 1-6 t arc furnace | 18,000 |
| 4. Malaysian Steel Works, Kuala Lumpur ........... | — | — | 1-10 t arc furnace | 20,000 |
| 5. Southern Iron and Steel Works, Nibong Tebal ...... | — | — | 1-6 t arc furnace | 12,000 |
| Total .......... | | 146,000 | | 230,000 |

TABLE 28. ESTIMATE OF FUTURE BILLET SHORTFALL IN MALAYSIA
(Thousand tons)

| | 1975 | 1980 |
|---|---|---|
| Demand of products rolled from billets and scrap .............. | 300 | 400 |
| Deduct products rolled from scrap (say 15 per cent in 1975, 12.5 per cent in 1980) ............... | –45 | –50 |
| Products rolled from billets or ingots | 255 | 350 |
| Billet equivalent at 94 per cent .... | 270 | 370 |
| *Deduct* expanded billets or ingot capacity by 1975 ............. | –230 | –230 |
| Billet shortfall .................. | 40 | 140 |

## PHILIPPINES

The Philippines iron and steel industry is relatively larger and more sophisticated (possessing hot and cold-rolling sheet mills) than others in the sub-region under review. Consumption of finished steel rose from 884,000 t in 1967 to 996,000 t in 1969 and dropped to 686,000 t in 1971.

The proportion of flat products in the total was remarkably high (66 per cent in 1969), but has dropped with the recent lower total consumption. Both steelmaking and rolling capacities are well in excess of demand, yet billets and rolled products continue to be imported.

If a new impetus is given to the economy, steel consumption may be expected to rise to about 1.25 million t by 1975 (including 650,000 t of non-flat

TABLE.29. CURRENT AND PROBABLE FUTURE CAPACITY FOR MAKING INGOTS OR BILLETS IN THE PHILIPPINES
(Tons per year)

| | Present capacity (1972) | | Probable future capacity (1975) | |
|---|---|---|---|---|
| 1. Philippines Blooming Mills .... | 2–40 t open-hearth | 100,000 | – | 100,000 |
| 2. Marcelo Steel ............... | 1– 8 t arc furnace) 1–10 t arc furnace) 1–12 t arc furnace) 3– 3 t arc furnace) | 76,000 | – | 76,000 |
| 3. Iligan Steel Mills ............ | 1–25 t arc furnace | 45,000 | – | 45,000 |
| 4. General Construction Supply Co. | 2–15 t arc furnace | 54,000 | – | 54,000 |
| 5. Apollo Steel Mills .......... | 1–10 t arc furnace | 18,000 | Additional 1–10 t arc furnace | 36,000 |
| 6. Marsteel Corp. .............. | 1– 5 t arc furnace | 10,000 | Additional 1– 5 t arc furnace | 20,000 |
| 7. Union Steel ................ | 1– 5 t ace furnace | 7,500 | – | 7,500 |
| 8. Globe Steel ................ | 1–10 t arc furnace | 20,000 | – | 20,000 |
| 9. Armstrong Industries ........ | 1– 5 t arc furnace | 12,000 | – | 12,000 |
| 10. Master Steel Products ....... | 2– 3 t induction furnace | 3,600 | – | 3,600 |
| 11. Steel casters .............. | – | – | 1–12 t arc furnace) 1–18 t arc furnace) | 54,000 |
| Total .................... | | 346,100 | | 428,100 |

products), and 2.2 million t by 1980 (including 1.1 million t of non-flat products). Of the demand for non-flats, the bulk (about 85 per cent would be bars, rods and light structural shapes rolled from billets, as the demand for heavy structurals is not significant.

Capacity for production of billets and future shortfalls are estimated in tables 29 and 30, respectively.

TABLE 30. ESTIMATE OF FUTURE BILLET SHORTFALL IN THE PHILIPPINES
(Thousand tons)

| | *1975* | *1980* |
|---|---|---|
| Demand of products rolled from billets and scrap | 550 | 940 |
| *Deduct* products rolled from scrap (3 per cents in 1975, 2 per cent in 1980) | — 16 | — 18 |
| Products rolled from billet/ingot | 534 | 922 |
| Billet equivalent at 94 per cent | 570 | 980 |
| *Deduct* expanded billet or ingot capacity by 1975 | —428 | —428 |
| Billet shortfall | 142 | 552 |

The current production pattern of bars as well as billets is interesting. There is said to be a bar and rod rolling capacity (in 32 mills) of about 1,335,000 t, but actual production in 1971 was only 306,000 t while 28,000 t was imported. Similarly, from the steelmaking capacity of 346,000 t (with 10 of the rolling-mill plants), actual production of billets was only 233,000 t in 1971 while 194,000 t was imported. This was partly due to lack of modern steelmaking equipment as well as a tariff structure which did not discourage billet imports. In fact, import of billets has been steadily around 200,000 t/yr, representing about two-thirds of billet requirements. At the same time, both rolling-mill and steelmaking capacities are being continuously expanded. With the new import duty on billets (expected to be 20 t 30 per cent), the use of indigenous production facilities would be encouraged.

## SINGAPORE

The growth of the Singapore economy, and of steel consumption, in the last 3 yr has been spectacular. GDP has risen to US$2,500 million, at a rate of 15 per cent annually in the 1969-1971 period, giving a *per capita* GDP of about US$1,180. GDP is expected to continue to rise at 15 per cent annually at least till 1976, and at 12 per cent thereafter to 1980.

Sectors with large steel requirements, e.g. construction and manufacturing, have contributed substantially to this boom. The share of manufacturing in GDP has doubled to 23 per cent during the 1960s. Construction grew by 47 per cent in 1970 and by 16.6 per cent in 1971.

The phenomenal growth of steel consumption has exceeded all earlier forecasts. (See table 31.) Demand for product categories has risen somewhat erratically. Consumption in 1971 gives a high *per capita* figure of 365 kg, the same level as in Japan 5 yr earlier. However, of the total steel used, only 146,000 t (19 per cent of the total) was produced in Singapore, the balance being imported.

TABLE 31. STEEL CONSUMPTION IN SINGAPORE, 1967-1971
(Thousand tons)

| | *1967* | *1968* | *1969* | *1970* | *1971* |
|---|---|---|---|---|---|
| Flat products | 140 | 161 | 230 | 305 | 274 |
| Heavy structurals | 11 | 17 | 50 | 13 | 106 |
| Bars, rod and light sections | 120 | 160 | 203 | 239 | 284 |
| Others (including pipes, wire, etc). | 5 | 5 | 42 | 86 | 108 |
| Total | 276 | 343 | 525 | 643 | 772 |
| Annual growth | | 24% | 53% | 22% | 20% |

Over the last four years, total demand has risen at an average of 30 per cent annually. A growth rate of 9 per cent is expected up to 1975, and a lower rate of 6 per cent thereafter. Total steel requirements would then reach 1.1 million/t by 1975 and 1.45 million/t by 1980.

Of this, in 1975, requirements of flat products may be 500,000 t and of structurals 250,000 t leaving about 350,000 tons of bars or rods and light sections (about 32 per cent of the total). This would rise to 500,000 t (about 34 per cent of the total) by 1980.

The billet availability and shortfall exercise is repeated for Singapore in tables 32 and 33.

TABLE 32. CURRENT AND PROBABLE FUTURE CAPACITY FOR MAKING INGOTS OR BILLETS IN SINGAPORE
(Tons/per year)

| *Works* | *Present capacity (1972)* | | *Probable future capacity (1975)* | |
|---|---|---|---|---|
| 1. National Iron and Steel Mills (NISM) | 2-20 t arc furnace<br>1-40 t arc furnace | 180,000 | Additional 1-40 t arc furnace | 270,000 |
| Total | | 180,000 | | 270,000 |

With the addition of a new rolling-mill now under construction (phase I — 100,000 t), NISM's rolling capacity (265,000 t) should match its expanded steelmaking capacity by 1975. But both steelmaking and rolling output may still be short of probable 1975 demand, necessitating further expansion. The new NISM rolling-mill has provided, with a small additional investment, to expand to about 200,000 t in phase II. NISM's plans for a third 40-t furnace may have to await the availability of electric power.

TABLE 33. ESTIMATE OF FUTURE BILLET SHORTFALL IN SINGAPORE
(Thousand tons)

| | *1975* | *1980* |
|---|---|---|
| Demand of products rolled from billets and scrap | 350 | 500 |
| *Deduct* products rolled from scrap | –10 | –10 |
| Products rolled from billet | 340 | 490 |
| Billet equivalent at 94 per cent | 360 | 520 |
| *Deduct* probable expanded billet or ingot capacity by 1975 | –270 | –270 |
| Billet shortfall | 90 | 250 |

## THAILAND

Steel consumption in Thailand, having risen by 15 per cent annually in the period 1965-1968 and slowed down in 1969-1971, is now showing signs of picking up again. Consumption in 1971 was about 900,000 t, of which about one-third (mainly in bars and rods) was produced indigenously. The bulk of steel is used in construction-related activities, and as these have slackened lately, the demand for reinforcing rods is currently below available capacity. Only small tonnages of steel structural shapes are consumed.

The demand for thin cold-rolled sheet is high for the three galvanizing plants and one hot-dip tinplate plant. A 60,000 t/yr electrolytic tinning line is under installation. In view of the rising demand for flat products, a new integrated plant (capacity between 1 million and 1.5 million t) is under consideration, which is expected to start with about 400,000 t of cold-rolled sheet and to be fully back-integrated by 1980/81.

Steel demand is expected to grow as follows (in thousand tons):

| | *1975* | *1980* |
|---|---|---|
| Total | 1,250 | 1,700 |
| Non-flat | 750 | 1,060 |
| Flat | 500 | 640 |

After deduction of the demand for heavy and special sections, the requirements of bars, rods and light shapes is estimated at 650,000 t by 1975 and 900,000 t by 1980.

At present, there are five plants with steelmaking and rolling facilities and another six with only rerolling mills. The present rolling capacity is geared to production of mainly bars and rods, for which demand is currently low. These mills are therefore now modifying their facilities to roll special products.

Probable future steelmaking capacity is estimated in table 34.

TABLE 34. CURRENT AND PROBABLE FUTURE CAPACITY FOR MAKING INGOTS OR BILLETS IN THAILAND
(Tons per year)

| | *Present capacity* [a] *(1972)* | | *Probable future capacity* [a] *(1975)* | |
|---|---|---|---|---|
| 1. G. S. Steel | 3-20 t arc furnace | 120,000 | Additional 1-20 t arc furnace | 160,000 |
| 2. Siam Iron and Steel | 2-30 t arc furnace | 120,000 | Additional 1-30 t arc furnace | 180,000 |
| 3. Bangkok Steel Industry | 1-20 t arc furnace | 40,000 | Additional 1-20 t arc furnace | 80,000 |
| 4. Bangkok Iron and Steel Works | 3-6 t arc furnace | 36,000 | Additional 1-10 t arc furnace | 56,000 |
| 5. Thai-India Steel | 1-6 t arc furnace | 12,000 | Additional 1-10 t arc furnace | 32,000 |
| Total | | 328,000 | | 508,000 |

[a] arc furnace.

As expansion plans have not yet been formulated, it has been assumed that each plant would add one furnace. However, the additional capacity realized by 1975 may be, say, 450,000 t, full capacity being achieved a year or two later. On the foregoing basis, billet shortfall is estimated in table 35.

This would indicate that the present rolling capacity for bars and rods (said to be 550,000 t/yr) would have to be augmented by 1975, together with existing steelmaking capacity. It may also be expected that, as quality standards begin to be enforced to meet more sophisticated needs, the tonnage of rolling from scrap would increase only slightly over present levels.

### *Countries of the lower Mekong basin*

The above-mentioned estimates have not provided for steel exports beyond the five southeast Asian countries under study. Such exports could increase billet requirements by 10-20 per cent.

TABLE 35. ESTIMATE OF FUTURE BILLET SHORTFALL IN THAILAND
(Thousand tons)

| | 1975 | 1980 |
|---|---|---|
| Demand of products rolled from billets and scrap | 650 | 900 |
| *Deduct* products rolled from scrap | –150 | –180 |
| Products rolled from billet | 500 | 720 |
| Billet equivalent at 94 per cent | 632 | 765 |
| *Deduct* probable expanded billet or ingot capacity by 1975 | –508 | –508 |
| Billet shortfall | 124 | 257 |

Laos, the Khmer Republic and the Republic of Viet-Nam, the three riparian countries of the lower Mekong basin (Thailand being the fourth), are natural trading partners, and their steel requirements should be kept in mind. These are summarized in tables 36 and 37, on the basis of the report of an ECAFE/UNIDO mission to the lower Mekong basin in 1971.

TABLE 37. ESTIMATE OF FUTURE BILLET SHORTFALL IN THE KHMER REPUBLIC, LAOS AND THE REPUBLIC OF VIET-NAM
(Thousand tons)

| | 1975 | 1980 |
|---|---|---|
| Demand of products rolled from billets (excluding structural and scrap rerolling) | 110 | 200 |
| Billet equivalent at 94 per cent | 117 | 213 |
| *Deduct* probable billet or ingot capacity by 1975 | –40 | –40 |
| Billet shortfall | 77 | 173 |

*Over-all demand situation*

Total estimated steel demand for 1975 and 1980 is summarized in table 38:

TABLE 36. POSSIBLE STEEL REQUIREMENTS OF THE KHMER REPUBLIC, LAOS, AND THE REPUBLIC OF VIET-NAM
(Tons per year)

| | 1975 | | | 1980 | | |
|---|---|---|---|---|---|---|
| | Non-flat | Flat | Total | Non-flat | Flat | Total |
| Khmer Republic | 60,300 | 15,600 | 75,900 | 105,600 | 31,000 | 136,600 |
| Laos | 4,600 | 4,700 | 9,300 | 7,200 | 6,500 | 13,700 |
| Viet-Nam, Republic of | 122,500 | 155,800 | 278,300 | 219,600 | 240,000 | 459,600 |
| Total | 187,400 | 176,100 | 363,500 | 332,400 | 277,500 | 609,900 |

TABLE 38. ESTIMATED TOTAL STEEL DEMAND
(Thousand tons)

| | 1975 | | | 1980 | | |
|---|---|---|---|---|---|---|
| Country | Non-flat | Flat | Total | Non-flat | Flat | Total |
| Indonesia | 525 | 475 | 1,000 | 750 | 750 | 1,500 |
| Malaysia | 450 | 335 | 785 | 600 | 500 | 1,100 |
| Philippines | 650 | 600 | 1,250 | 1,100 | 1,100 | 2,200 |
| Singapore | 600 | 500 | 1,100 | 750 | 700 | 1,450 |
| Thailand | 750 | 500 | 1,250 | 1,060 | 640 | 1,700 |
| Subtotal | 2,975 | 2,410 | 5,385 | 4,260 | 3,690 | 7,950 |
| Khmer Republic, Laos and the Viet-Nam, Republic of | 187 | 176 | 363 | 332 | 277 | 609 |
| Total | 3,162 | 2,586 | 5,748 | 4,592 | 3,967 | 8,559 |

Total consumption in the five countries under study is expected to rise from the current 3.53 million t to 7.95 million t by 1980, an average increase of 9.5 per cent annually. Against this, 1972 capacity is only about one million t, wholly at non-integrated steelworks (except for the small Malayawata integrated plant).

About 7 million t of new capacity has to be added between now and 1980, that is, almost one million t/yr. At the present rate of progress, southeast Asia will not have a major integrated steelworks before 1980, a fact of serious consequence to the problem of steel availability for development.

*Shortfall in billets and the regional plant*

Table 39 summarizes estimates of billet demand, possible indigenous capacity and the consequent shortfall. The shortfall will be larger in so far as indigenous capacity does not materialize by 1975 as envisaged, and actual production may be even less than this installed capacity. On the other hand, some billets and bars may continue to be imported as special qualities of materials and part of turn-key projects. In balance, it may be assumed that the shortfall estimated represents the actual gap that should be filled by indigenous capacity.

TABLE 39. BILLET SHORTFALL IN THE SUBREGION
(Thousand tons)

| | Expected billet production capacity | | 1975 | | 1980 | |
|---|---|---|---|---|---|---|
| | 1972 | 1975 | Billet requirement | Shortfall | Billet requirement | Shortfall |
| Indonesia | 38 | 138 | 210 | 72 | 373 | 235 |
| Malaysia | 146 | 230 | 270 | 40 | 370 | 140 |
| Philippines | 346 | 428 | 570 | 142 | 980 | 552 |
| Singapore | 180 | 270 | 360 | 90 | 520 | 250 |
| Thailand | 328 | 508 | 632 | 124 | 765 | 257 |
| Subtotal | 1,038 | 1,574 | 2,042 | 468 | 3,008 | 1,434 |
| Other lower Mekong countries | 40 | 40 | 117 | 77 | 213 | 173 |
| Total | 1,078 | 1,614 | 2,159 | 545 | 3,221 | 1,607 |

Thus, if 1975/76 is taken as the time horizon, the shortfall in the region will probably be around 545,000 t. However, if a major integrated steel plant is envisaged, the long gestation period would necessitate a longer-term view upto 1980. On the basis of the billet production capacity foreseen for 1975, the shortfall would be 1,607,000 by 1980. If it is assumed that the subregion's production capacity will continue to rise at the present pace to, say, 2.5 million by 1980, the shortfall would be about 750,000 t in that year.

In proposing the capacity of the billet plant to meet the afore-mentioned shortage in demand for the subregion, the team observed that new technological developments now permit a non-integrated "mini" steel plant of 100,000—300,000 t capacity, to operate viably in competition with large, fully integrated plants in certain circumstances.[17]

In this context, the team suggested that an economic size for a *sponge iron* plant is around 200,000 t/yr, and that this could be designed to feed an *electric arc furnace* continuous casting plant of say 250,000 t/yr. From the point of view of *continuous-casting* machine design 250,000 t is also a good size, as it enables a four-strand machine to be used for casting 80-mm square billets from arc furnaces of 40—60 t capacity. *A quarter of a million tons therefore forms a good minimum capacity for an electric are furnace plant.* The plant should be designed for manifold expansion in future.

For a steelworks with an initial size of, for instance, one million—1.5 million t, it would be desirable to adopt a different process flow-sheet, namely, blast-furnaces based on iron ore, followed by basic oxygen convertor steelmaking. A good minimum size for a modern blast-furnace is around 2,000 t/day, and with at least two furnace to ensure continuity of operations, there is an annual iron-make of 1.3 million t. (Alternatively, a single blast-furnace of about 4,000 t/day could be adopted). This would result in an output of *about 1.5 million t of steel, a good minimum size for a blast-furnace based steelworks,* starting with iron ore.

*Selection of Processes and equipment*

Four alternative process routes were evaluated for a billet plant of 250,000 t capacity. For the larger 1.5 million t plant only one process route was considered appropriate.

*250,000 t plant*

Alternative

- I. Blast-furnace for ironmaking, followed by LD steel-making and continuous casting (designated "BF + LD")
- II. Electric smelting furnaces for iron-making, followed by LD steel-making and continuous casting (designated "ESF + LD")
- III. Electric arc furnances based on 100 per cent scrap, followed by continuous casting (designated "AF")
- IV. A. Direct reduction, to produce sponge iron using a solid reductant.
- IV. B. Direct reduction using a gaseous reductant. Sponge (about 65 per cent) with scrap (35 per cent) would be charged into electric arc furnaces, followed by continuous casting (designated "DR + AF").

*1.5 million t plant*

- V. Large blast-furnaces followed by an LD converter, continuous casting and a billet mill (designated "BF + LD + BM").

[17] See more about the advantages of the "mini" steel mill in the following article on technological trends.

On the basis of preliminary process and equipment size calculations, the major items envisaged are indicated in table 40.

*Raw material requirements*

The materials needed for the alternative process routes are indicated in table 41.

TABLE 40. SELECTION OF MAJOR EQUIPMENT

| | I—BF+LD | II—ESF+LD | III—AF | IV—DR+AF | V—BF+LD+BM |
|---|---|---|---|---|---|
| *Production requirements* (in thousand tons per year) | | | | | |
| Coke | — | — | — | — | 950 |
| Sinter | 290 | 290 | — | — | 1,750 |
| Iron | 229 | 229 | — | 200 | 1,400 |
| Liquid steel | 269 | 269 | 269 | 269 | 1,600 |
| Billets | 250 | 250 | 250 | 250 | 1,580 blooms<br>1,500 billets[a] |
| *Production facilities* | | | | | |
| Coke-making | — | — | — | — | 260-oven batteries |
| Sintering | 150 $m^2$ strand | 150 $m^2$ strand | — | — | 1200 $m^2$ strand |
| Iron-making | 1550 $m^3$ furnace (700 t/day) | 330,000 kVA electric smelting furnaces (210 t/day each) | — | 1600 t/day direct reduction unit | 21,700 $m^3$ blast-furnaces (2,200 t/day each) |
| Steel-making | 225-30 t LD converters | 225-30 t LD converters | 255-60 t electric arc furnaces (30,000 kVA each[b]) | 355-60 t electric arc furnaces (30,000 kVA each[b]) | 380 t LD coverters (2 operating) |
| Continuous casting | 22-strand machines | 22-strand machines | 24-strand machines | 24-strand machines | 44-strand bloom casters |
| Rolling | — | — | — | — | One continuous billet mill |

[a] Alternatively, half the steel could be processed into billets and half to slabs (for further rolling to hot cold rolled sheet and strip).

[b] Plant capacity could be doubled by adding 255-60 t arc furnaces and related equipment.

TABLE 41. ANNUAL RAW MATERIAL REQUIREMENTS
(Tons)

| | I (BF+LD) | II (ESF+LD) | III (AF) | IV (DR+AF) | V (BF+LD+BM) |
|---|---|---|---|---|---|
| Imported iron ore | | | | | |
| — lump | 117,000 | 117,000 | 10,800 | — | 690,000 |
| — fines | 175,000 | 175,000 | — | — | 1,060,000 |
| Total | 292,000 | 292,000 | 10,800 | — | 1,750,000 |
| Imported pellet | — | — | — | 320,000 | — |
| Indigenous iron ore | | | | | |
| — lump | 29,000 | 29,200 | — | — | 170,000 |
| — fines | 44,000 | 44,000 | — | — | 260,000 |
| Total | 73,200 | 73,200 | — | — | 430,000 |
| Blast furnace coke | 133,000 | — | — | — | 760,000 |
| Small size coke | — | 92,000 | — | — | — |
| Coal | — | — | 1,300 | 140,000[a] | — |
| Manganese ore | 6,800 | 6,800 | — | — | 40,000 |
| Blast furnace limestones | 71,000 | 46,000 | — | — | 420,000 |
| SMS limestone | 55,000 | 55,000 | 55,000 | 60,000 | 325,000 |
| Dolonite | 27,000 | 26,000 | 17,000 | 17,000 | 160,000 |
| Fluospar | — | — | 1,100 | 1,100 | — |
| Bauxite | 6,400 | 1,100 | — | — | 37,000 |
| Imported scrap | — | — | 235,000 | 62,000 | 250,000 |
| Indigenous scrap | 62,000 | 62,000 | 62,000 | 62,000 | 62,000 |
| Ferrosilicon | 1,000 | 1,000 | 1,000 | 1,000 | 6,000 |
| Ferro manganese | 2,800 | 2,800 | 2,800 | 2,800 | 16,500 |
| Aluminium | 125 | 125 | 125 | 125 | 600 |

[a] Alternatively, if a gaseous-reductant sponge-iron process were adopted, the natural gas needed would amount to one million $m^3$/day.

*Cost and profitability*

(a) *Capital cost estimates*

Mainly for the purpose of comparing the alternative processes, capital cost estimates as in table 42 were made. The capital costs are based on international prices of equipment and typical construction costs in southeast Asia. They include, in each department, contingencies at 10 per cent and design, engineering and construction administration at 10 per cent.

The estimates exclude harbour development and any rise in costs during construction. It is assumed that utilities such as water and electric power will be provided at the plant perimeter.

Land cost has been taken at US$2,000/ha, together with US$8,000/ha for the clearing and initial levelling of half the total land. Pre-operational expenses to be capitalized include promotional costs, training and start-up. Interest has been provided at 8 per cent on half the total plant cost, the balance being equity. Working capital includes:

(a) three months' stock of raw materials
(b) one month's stock of billets
(c) one month's receivables.

TABLE 42. CAPITAL COST ESTIMATES FOR ALTERNATIVE PROCESS ROUTES
(US dollars)

| | *250,000 t/yr* | | | | *1.5 million t/yr* |
|---|---|---|---|---|---|
| *Item* | *I (BF+LD)* | *II (ESF+LD)* | *III (AF)* | *IV (DR+AF)* | *V (BF+LD+BM)* |
| Land and site preparation | 540,000 | 540,000 | 540,000 | 540,000 | 1,200,000 |
| *Production departments* | | | | | |
| Materials handling | 1,200,000 | 1,200,000 | 400,000 | 750,000 | 7,200,000 |
| Coke-oven plant | — | — | — | — | 19,300,000 |
| Sinter plant | 2,500,000 | 2,500,000 | — | — | 10,500,000 |
| Iron-making plant | 10,500,000 | 9,250,000 | — | 12,000,000[a] | 35,000,000 |
| Steelmelt shop | 9,500,000 | 9,500,000 | 7,500,000 | 7,900,000 | 40,200,000 |
| Continuous casting | 4,250,000 | 4,250,000 | 6,800,000 | 6,800,000 | 19,000,000 |
| Billet mill | — | — | — | — | 15,500,000 |
| Subtotal | 27,950,000 | 26,700,000 | 14,700,000 | 27,450,000 | 146,700,000 |
| *Ancillary departments* | | | | | |
| Power, water and utility systems | 4,380,000 | 4,150,000 | 1,960,000 | 3,360,000 | 21,500,000 |
| Works transport, repair and maintenance | 2,880,000 | 2,830,000 | 1,200,000 | 2,450,000 | 13,200,000 |
| Miscellaneous buildings, storages and laboratories | 750,000 | 750,000 | 600,000 | 700,000 | 3,200,000 |
| Subtotal | 8,010,000 | 7,730,000 | 3,760,000 | 6,510,000 | 37,900,000 |
| *Total plant cost* | 36,500,000 | 34,970,000 | 19,000,000 | 34,500,000 | 184,600,000 |
| Pre-operational expenses | 1,800,000 | 1,800,000 | 1,300,000 | 1,800,000 | 3,800,000 |
| Interest during construction | 2,185,000 | 2,100,000 | 710,000 | 2,060,000 | 14,300,000 |
| *Total Investment* | 40,485,000 | 38,870,000 | 21,010,000 | 38,360,000 | 202,700,000 |
| Working capital | 7,376,000 | 6,737,000 | 7,608,000 | 6,827,000 | 42,778,000 |
| TOTAL CAPITAL EMPLOYED | 47,861,000 | 45,607,000 | 28,618,000 | 45,187,000 | 245,478,000 |
| *in foreign exchange* | (30,970,000) | (29,602,000) | (18,311,000) | (29,381,000) | (156,918,000) |
| *in local currency* | (16,891,000) | (16,005,000) | (10,307,000) | (15,806,000) | (88,560,000) |

[a] At this stage, it may be assumed that the capital cost of a direct reduction plant based on solid reductant and that for one based on a gaseous reductant would be of the same order.

Plant costs per annual ton of billets are summarized below (in US dollars):

| *250,000 t* | *Capital cost* |
|---|---|
| I (BF + LD) | 146 |
| II (ESF + LD) | 140 |
| III (AF) | 76 |
| IV (DR + AF) | 138 |
| *1.5 million tons* | |
| V (BF + LD + BM) | 123 |

It is clear that the straight electric arc furnace route (alternative III), based on a 100 per cent scrap charge, has the lowest capital cost (US$76/annual t up to the billet stage). Here lies the main advantage of developing the small steel mill all over the world.

(b) *Foreign exchange*

The foreign exchange component in the various process alternatives varies from 68 to 73 per cent. When the foreign exchange component of pre-operational expenses, interest during construction and working capital are added, the proportion comes to about 65 per cent of the total capital employed. During the detailed engineering stage, concerted efforts are needed to have as much of the structural steelwork and simple equipment manufactured locally, in order to reduce foreign supplies.

(c) *Construction*

The magnitude of work is substantial and requires proper planning by experienced steel-plant consulting engineers. The basic decision to proceed with the project having been taken, the time required for completing construction and erection work would be approximately:

2 yr for the straight arc furnace plant (alternative III)

3 yr for the blast furnace (alternative I), electric smelting furnace (alternative II), and direct reduction/arc furnace (alternative IV).

4 yr for the 1.5 million t blast-furnace plant (alternative V)

(d) *Material costs*

In order to prepare production cost estimates, the costs of major raw materials and supplies delivered at works site have been estimated in (table 43). Figures are typical for Malaysia, for instance. Again, they are solely for the purpose of comparing processes.

TABLE 43. COSTS OF MAJOR MATERIALS AND SUPPLIES (DELIVERED AT PLANT SITE) (US dollars per ton)

| *Item* | *Cost* |
|---|---|
| Imported iron or (lump, 64% Fe) | 14.00 |
| Imported iron ore pellets (64% Fe) | 16.60 |
| Imported iron ore fines | 12.00 |
| Local iron ore (lump, 58% Fe) | 9.00 |
| Local iron ore fines | 7.00 |
| Metallurgical coke | 50.00 |
| Small-sized coke | 30.00 |
| Coal (coking) | 25.00 |
| Cocal (non-coking) | 20.00 |
| Natural gas | 1.19[a] |
| Limestone | 5.00 |
| Burnt lime | 25.00 |
| Steel scrap, imported | 50.00 |
| local | 30.00 |
| Electric power, for smelting furnaces | 0.012[a] |
| for arc furnaces | 0.017[b] |
| Electrodes | 600.00 |
| Electrode paste | 150.00 |
| Ferro-silicon (78%) | 300.00 |
| Ferro-maganese (78%) | 140.00 |

[a] Per million kilocalories.
[b] Per kilowatt hour.

(e) *Labour costs*

Labour costs are significant in the steel industry, constituting about 10—15 per cent of the production cost. Manpower requirements for the five cases under study are given in table 44.

TABLE 44. ESTIMATE OF TOTAL MANPOWER

| | *I (BF+LD)* | *II (ESF+LD)* | *III (AF)* | *IV (DR+AF)* | *V (BF+LD+BM)* |
|---|---|---|---|---|---|
| *Production departments* | | | | | |
| Coke-oven plant | — | — | — | — | 590 |
| Sinter plant | 36 | 36 | — | — | 260 |
| Iron-making plant | 151 | 200 | — | 110 | 380 |
| Steelmelt shop, including continuous casting | 278 | 278 | 250 | 240 | 560 |
| Billet mill | — | — | — | — | 260 |
| Subtotal | 465 | 514 | 250 | 350 | 2,050 |
| *Auxiliary departments* | | | | | |
| Utilities, services, laboratories | 164 | 164 | 85 | 138 | 680 |
| Repair, maintenance and transport | 294 | 294 | 165 | 260 | 1,170 |
| Subtotal | 458 | 458 | 250 | 398 | 1,850 |
| *Administration and general* | | | | | |
| Administration, accounts, personnel and planning | 110 | 120 | 70 | 100 | 550 |
| Purchasing, store and sales | 142 | 147 | 90 | 135 | 740 |
| Subtotal | 252 | 267 | 160 | 235 | 1,290 |
| Total | 1,175 | 1,239 | 660 | 983 | 5,190 |

In the proposed billet plant the personnel requirement would be roughly as follows:

| | *Percentage* |
|---|---|
| Managerial and supervisory | 10 |
| Skilled operative | 65 |
| Office and store staff | 10 |
| Unskilled workers | 15 |

The *weighted average cost* per man-month of employment in the steel plant would be as follows:

| | *US dollars per month* | *Index (Malaysia = 1000)* |
|---|---|---|
| Singapore | 178 | 127 |
| Malaysia | 140 | 100 |
| Tailand | 95 | 68 |
| Philippines | 94 | 67 |
| Indonesia | 88 | 63 |

For the purpose of comparing alternative processes, labour costs in Malaysia have been used.

*Production costs*

Preliminary production cost estimates have been prepared. In the case of direct reduction process (alternative IV), these include:

IV. A. DR (Solid reductant) + AF

IV. B. DR (Gaseous reductant) + AF

Table 45 gives the break-down of production costs, and these are summarized as follows (in US dollars per ton of product):

For the 250,000 t plant, the cost of US$92.35/t of billets by the electric arc furnace-continuous casting route (alternative III) is the lowest, including interest and depreciation charges at 15 per cent of total plant cost. However, the following additional situations may be noted

(i) For alternative I (BF + LD), if local ore (at US$9/t) and charcoal (at US$35/t) could be utilized, the cost would be reduced to US$82.37/t of billets, including fixed charges. Similarly, for alternative II

| | *I* (*BF+LD*) | *II* (*ESF+LD*) | *III* (*AF*) | *IVA* (*DR+AF*) | *IVB* (*DR+AF*) | *V* (*BF+LD+BM*) |
|---|---|---|---|---|---|---|
| Iron (excluding fixed charges) | 62.71 | 77.21 | — | 44.46 | 37.41 | 48.48 |
| Billet (excluding fixed charges) | 74.22 | 86.60 | 79.75 | 79.35 | 72.64 | 63.45 |
| Billet (including fixed charges) | 98.57 | 109.85 | 92.35 | 102.35 | 95.64 | 83.10 |

(ESF + LD) the cost would be reduced to US$102.35/t of billets if local ore could be used.

(ii) For alternative IVB (DR + AF), if natural gas could be made available at US$0.80/million kcal (i.e. US$0.20/million BTU) and if indigenous high-grade ore (at US$12/t) could be used, the cost would be reduced to US$86.15/t of billets.

(iii) for alternative (AF), it has been assumed that electric power would be available at US$0.017/kWh If power could be negotiated at a lower rate (say, US$0.010/kWh, as may be possible in Singapore or Iligan (Philippines) ), the production cost (including fixed charged) would be reduced to US$87.80/t of billets.

Thus, costs under the assumed conditions and under the more favourable conditions outlined above would be as follows (in US dollars per ton of billets)

| | *I* (*BF+LD*) | *III* (*ESF+LD*) | *III* (*AF*) | *IVB* (*DR+AF*) |
|---|---|---|---|---|
| Assumed conditions .... | 98.57 | 109.85 | 92.35 | 95.64 |
| Favourable conditions .. | 82.37 | 102.35 | 87.80 | 86.15 |

For the present purpose the somewhat higher, more realistic costs are taken in the estimation of profitability and so on.

The broad conclusion that may be reached for the 250,000 billet plant under conditions which can be realistically expected to prevail is that the electric arc furnace (alternative III) with 100 per cent scrap is a good process route. This requires the import of materials valued at US$12.5 million, including US$11.75 million of scrap. (Alternatively, it might be possible to import sponge iron.)

At a future date, if scrap availability became more difficult or if scrap prices rose abnormally, a direct reduction unit could be added at the plant which, in effect, would result in alternative IV. This would reduce, perhaps eliminate, the import of scrap, but require high-grade iron ore pellets to be imported.

The 1.5 million t integrated plant using blast-furnaces shows the lowest costs. Its implementation would involve substantial investments and the harmonization of long-term steel industry development plans between countries of the region.

(g) *Sales realization*

In order to evaluate the profitability of the proposed project, an estimate has to be made of the possible selling-price of billets. International trade in this product has been quite erratic. When the world steel market is buoyant, billet prices rise to high levels or the product is not available at all for import by southeast Asia countries; consequently, the rerolling mills have no feed material. When steel trade is slack, billets may be readily imported, often on the basis of marginal pricing whereby f.o.b. export prices may be US$10/t lower than in the producer's home market. At such times, the entrepreneur in the developing country is reluctant to embark upon an expensive steel project in view of the attractive, albeit temporary, prices of imports.

Present prices of commercial quality billets are around US$100 c.i.f. When duties and other charges have been added, the price comes to US$105-115/t. In countries where prices of rolled bars are high, there is enough margin in rolling operations for the purchase of billets at US$115-120/t.

For the present exercise, an average billet price of US$100/t ex-works has been taken. Thus, if required, billets could be sold on the home market at, say, US$105/t and for export to the countries of the region at, say, US$95/t (about US$105 c.i.f.).

(h) *Profitability estimate*

The following bases for evaluating the profitability of the process alternatives have been adopted:

(1) The shareholder's equity/loan ratio in the financing of project investment will be 50:50

(2) Long-term credit will be available at 8 per cent per annum interest and working

TABLE 45. PRODUCTION COST ESTIMATES FOR ALTERNATIVE PROCESS ROUTES

| | Price per ton material (US$) | I (BF+LD) Consumption per ton (kg) | I (BF+LD) Cost per ton (US$) | II (ESF+LD) Consumption per ton (kg) | II (ESF+LD) Cost per ton (US$) | III (AF) Consumption per ton (kg) | III (AF) Cost per ton (US$) | IV A (DR+LD) (solid reductant) Consumption per ton (kg) | IV A (DR+LD) (solid reductant) Cost per ton (US$) | IV B (DR+LD) (gaseous reductant) Consumption per ton (kg) | IV B (DR+LD) (gaseous reductant) Cost per ton (US$) | V (BF+LD) Consumption per ton (kg) | V (BF+LD) Cost per ton (US$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A. IRON | | | | | | | | | | | | | |
| *Cost of materials* | | | | | | | | | | | | | |
| Iron ore | 14.00 | 560 | 7.84 | 560 | 7.84 | | | | — | | — | 560 | 7.84 |
| Sinter | 14.50 | 1,260 | 18.27 | 1,260 | 18.27 | | | | — | | — | 1,200 (at US$14.20) | 17.04 |
| Oxide pellet | 16.60 | — | — | — | — | | | 1,600 | 26.56 | 1,600 | 26.56 | | — |
| Coke (blast-furnace) | 50.00 | 580 | 29.00 | — | — | | | — | — | — | — | 540 (at US$38) | 20.50 |
| Small coke | 30.00 | — | — | 400 | 12.00 | | | — | — | — | — | | |
| Coal | 20.00 | — | — | — | — | | | 680 | 13.60 | 5.5 million kcal (at US$1.19 million kcal) | 6.55 | | — |
| Miscellaneous materials | | | 1.50 | | 1.50 | | | | 0.40 | | 0.40 | | 1.20 |
| Subtotal | | | 56.61 | | 39.61 | | — | | 40.56 | | 33.51 | | 46.58 |
| *Less:* credit for gas | | | -2.50 | | -1.50 | | | | — | | — | | -2.30 |
| Net materials cost: | | | 54.11 | | 38.11 | | — | | — | | — | | 44.28 |
| Electric power | 0.012/kWh | | — | 2,100 kWh | 25.20 | | | | — | | — | | — |
| Electrode paste | 150.00 | | — | 25 | 4.50 | | | | — | | — | | — |
| Subtotal | | | | | 29.70 | | | | | | | | |
| *Cost above materials* | | | | | | | | | | | | | |
| Labour and supervision | | | 0.80 | | 0.90 | | | | 0.70 | | 0.70 | | 0.40 |
| Utilities, repairs, refractories, etc. | | | 6.30 | | 7.00 | | | | 2.20 | | 2.20 | | 5.60 |
| General plant expenses | | | 1.50 | | 1.50 | | | | 1.00 | | 1.00 | | 1.20 |
| Cost above | | | 8.60 | | 9.40 | | | | 3.90 | | 3.90 | | 7.20 |
| *Work cost of iron:* | | | 62.71 | | 77.21 | | — | | 44.46 | | 37.41 | | 51.48 |
| B. STEEL BILLETS | | | | | | | | | | | | | |
| *Cost of materials* | | | | | | | | | | | | | |
| Hot metal/sponge | | 840 (at US$62.71) | 52.67 | 840 (at US$77.21) | 65.00 | | | 930 (at US$44.46) | 41.50 | 930 (at US$37.41) | 34.79 | 840 (at US$51.48) | 43.20 |
| Scrap—domestic | 30.00 | 270 | 8.10 | 270 | 8.10 | 270 | 8.10 | 270 | 8.10 | 270 | 8.10 | 270 | 8.10 |
| —imported | 50.00 | | — | | — | 870 | 43.50 | | — | | — | | — |
| Ferro-alloys | | | 2.30 | | 2.30 | | 2.00 | | 2.00 | | 2.00 | | 2.30 |
| Limestone (burnt) | 30.00 | 60 | 1.80 | 60 | 1.80 | | 0.73 | | 0.73 | | 0.73 | 60 | 1.80 |
| Miscellaneous materials | | | .50 | | .50 | | 1.00 | | 1.00 | | 1.00 | | 0.50 |
| Subtotal | | | 65.37 | | 77.70 | | 55.33 | | 53.33 | | 46.62 | | 55.90 |
| *Less:* Credit for scrap | 30.00 | 40 | -1.20 | 40 | -1.20 | 40 | -1.20 | 40 | -1.20 | 40 | -1.20 | 40 | -1.20 |
| Net materials cost: | | | 64.17 | | 76.50 | | 54.13 | | 52.13 | | 45.42 | | 54.70 |
| Electric power | 0.017/kWh | | — | | — | 580 kWh | 9.86 | 640 | 10.88 | 640 | 10.88 | | — |
| Electrodes | 0.6/kg | | — | | — | 6 | 3.60 | 7 | 4.20 | 7 | 4.20 | | — |
| Subtotal | | | | | | | 13.46 | | 15.08 | | 15.08 | | |
| *Cost above materials* | | | | | | | | | | | | | |
| Labour and supervision | | | 1.30 | | 1.30 | | 1.56 | | 1.54 | | 1.54 | | 0.65 |
| Utilities, repairs, refractories, etc. | | | 7.00 | | 7.00 | | 9.10 | | 9.10 | | 9.10 | | 6.60 |
| General plant expenses | | | 1.80 | | 1.80 | | 1.50 | | 1.50 | | 1.50 | | 1.50 |
| Cost above: | | | 10.10 | | 10.10 | | 12.16 | | 12.14 | | 12.14 | | 8.75 |
| *Work cost of steel billets:* | | | 74.27 | | 86.60 | | 79.75 | | 79.35 | | 72.64 | | 63.45 |
| Fixed Charges | | (at 15% of US$162) | 24.30 | (at 15% of US$155) | 23.25 | (at 15% of US$84) | 12.60 | (at 15% of US$153) | 23.00 | (at 15% of US$153) | 23.00 | (at 15% of US$131) | 19.65 |
| *Total cost of billets* | | | 98.57 | | 109.85 | | 92.35 | | 102.35 | | 95.64 | | 83.10 |

capital will be borrowed at short-term commercial rates of 12 per cent per annum.

(3) Depreciation is taken as an average 7 per cent per year on plant cost, assuming a 15-yr economic life for the project.

(4) Deferred charges (preliminary work, pre-operational training, start-up) and interest on loan during construction have been amortized in equal instalments over 20 yr.

(5) The sales price of billets is taken at US$100/t.

On the above bases, the profitability of alternative process routes has been compared in table 46.

TABLE 46. PROFITABILITY ESTIMATE OF PROCESS ALTERNATIVES
(Thousand US dollars and percentages)

| | I (BF+LD) | II (ESF+LD) | III (AF) | IV A (DR+AF) (solid reductant) | IV B (DR+AF) (gaseous reductant) | V (BF+LD+BM) |
|---|---|---|---|---|---|---|
| Total investment | 40,485 | 38,870 | 21,010 | 38,360 | 38,360 | 202,700 |
| Share capital | 20,243 | 19,435 | 10,505 | 19,180 | 19,180 | 101,350 |
| *Sales volume*, tons | 250,000 | 250,000 | 250,000 | 250,000 | 250,000 | 1,500,000 |
| *Income* | | | | | | |
| Sales realisation | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 150,000 |
| *Cost of production* | | | | | | |
| Materials and supplies | 15,743 | 12,986 | 16,058 | 15,330 | 13,681 | 83,506 |
| Labour | 1,974 | 2,081 | 1,109 | 1,651 | 1,651 | 8,719 |
| Electric power | 850 | 6,600 | 2,771 | 2,856 | 2,828 | 3,800 |
| Total | 18,587 | 21,667 | 19,938 | 19,837 | 18,160 | 96,025 |
| *Other expenses and charges* | | | | | | |
| Administration and sales | 425 | 425 | 425 | 425 | 425 | 1,875 |
| Interest on working capital | 885 | 807 | 912 | 818 | 580 | 5,130 |
| Deferred charges | 199 | 195 | 100 | 193 | 193 | 905 |
| Depreciation | 2,550 | 2,440 | 1,330 | 2,410 | 2,410 | 12,900 |
| Interest on long-term loan | 1,620 | 1,552 | 845 | 1,530 | 1,530 | 8,100 |
| *Total cost* | 24,246 | 27,086 | 23,500 | 25,213 | 23,298 | 124,935 |
| *Earnings before taxes* | 754 | –2,069 | 1,451 | –213 | 1,702 | 25,065 |
| Pre-tax earnings on share capital | 3.72% | — | 13.81% | — | 8.90% | 24.73% |
| Pre-tax earnings on total investment | 1.86% | — | 6.91% | — | 4.45% | 12.36% |
| Pre-tax earnings on sales | 3.02% | — | 5.80% | — | 6.81% | 16.70% |
| Value added | 8,407 | 5,413 | 6,171 | 6,814 | 8,491 | 62,694 |
| Value added on sales | 33.62% | 21.65% | 24.68% | 27.25% | 33.96% | 41.79% |
| Foreign exchange component of production cost | 11,080 | 7,650 | 12,563 | 6,004 | 6.004 | 70,980 |
| Foreign exchange on sales | 44.32% | 30.60% | 50.25% | 24.01% | 24.01% | 47.32% |
| Manpower employed, persons | 1,175 | 1,239 | 660 | 983 | 983 | 5,190 |

The 1.5 million t plant (alternative V) shows a return of 12.36 per cent on total investment (24.73 per cent on equity).

Among the 250,000 t plants, the electric arc furnace route (alternative III) gives a profit of 6.91 per cent on total investment (13.81 per cent on equity), under the conditions visualized here. This would be considered an acceptable rate of return. As this plant doubled in capacity to 500,000 t the profitability would increase, as follows:

| | *Percentage* |
|---|---|
| Pre-tax earnings on share capital | 38 |
| Pre-tax earnings on total investment | 19 |
| Pre-tax earnings on sales | 12 |

(i) *Social benefits*

Table 47 gives estimates of the social benefits, details of which are also given below for alternatives III, IVB and V.

TABLE 47. SOCIAL BENEFITS

| | Alt III—AF (250,000 t) | Alt IV B-DR+AF (250,000 t) | Alt V-BF+LD+BM (1,500,000 t) |
|---|---|---|---|
| 1. Value added, US dollars per year | 6,171,000 | 8,491,000 | 62,694,000 |
| percentage of sales | 24.68% | 33.96% | 41.79% |
| 2. Foreign exchange savings, US dollars per year | 11,887,000 | 17,998,000 | 73,770,000 |
| 3. Employment generated, persons | 660 | 983 | 5,190 |
| 4. Resource utilization, US dollars per year | 2,475,700 | 5,943,000 | 11,445,000 |

*Value added.* This has been taken as the difference between the sales realization and the cost of raw materials and utilities. This would be 24.68 per cent of sales receipts, or US$6.17 million/yr for the recommended process route. For the processes starting with iron ore, value added would be higher (33-42 per cent).

*Foreign exchange savings.* This is estimated as the difference between the sales realization (assuming that the billets would otherwise be imported) and the foreign exchange component of annual manufacturing costs, together with annual interest on the foreign exchange component of the total capital employed. It should be noted that the annual foreign exchange saving represents 85 per cent of the exchange component of the investment; that is, the foreign exchange cost of the initial investment would be recovered in about 1.25 yr for the recommended process.

*Employment generated.* The 250,000 t plant would provide direct employment to about 660 people in the first phase. In addition, the chain of developments it would set in motion would generate employment opportunities in transport, manufacturing, construction and ancillary industries even beyond the borders of the host country.

*Resource utilization.* The plant would ensure the productive use of local limestone, dolomite, coal, and other materials which might otherwise remain unexploited. The subsequent addition of a direct reduction plant could provide an opportunity to mine local iron ore or import ore from one of the participating countries in the region.

*Criteria for the plant's location*

The main criteria to be met in locating the billet plant have been indicated as follows:

(a) proximity to sources of scrap, iron ore and reductants, in order to reduce raw material assembly costs;

(b) an expanding home market for bars and rods, so as to reduce costs of product distribution;

(c) adequate land with good subsoil conditions;

(d) port facilities with a depth of, say, 12 m for the purposes of importing materials and exporting billets;

(e) availability of electric power at reasonable cost, together with an ensured water-supply;

(f) availability of construction materials and services;

(g) good infrastructural facilities, such as roads or tracks for the internal distribution of products, technical training institutes, repair and maintenance shops;

(h) availability of "trainable" manpower.

As a plan of action the report suggested, on the one hand, that meetings be called of expert groups of the Governments concerned, to discuss the study prepared by the survey team and, on the other, that a project report be prepared on the techno-economic feasibility of the proposed regional billet centre.

## TECHNOLOGICAL TRENDS IN IRON AND STEEL-MAKING OF INTEREST TO ECAFE DEVELOPING COUNTRIES

*Introduction*

Development of the iron and steel industry is one of the most striking features of maturity attained by an economy's manufacturing sector. Steel products in general show a highly dynamic demand pattern and their use extends to a wide range of activities, including construction and transport, as well as to many other branches of the sector.

The steel industry in the ECAFE region, however, is still at its initial stages of development. The region's output of steel in 1970 was only 7 million t, as over 85 per cent was produced by India alone, the small or non-producing countries accounted for the largest proportion of steel imports. Nearly 6 million t of steel, worth US$700 million, is imported each year by the countries in the region. *Per capita* consumption of steel remains very low: 20 kg, compared with an average of 160 kg for the world as a whole.

Consumption of steel in the region can be expected to double within the next 10 yr, simultaneously with the growth of the economy. The magnitude of future demand will thus necessitate an expansion of domestic industry, if imports and scarce foreign exchange are to be economized.

*Economies of scale in the iron and steel industry*

There are certain basic considerations which have to be carefully considered in establishing an iron and steel industry. Firstly, the generally very large economies of scale of metallurgical operations call for a market greater than that provided by a single country. At the same time the market area to be served cannot be too extensive, lest transport costs become prohibitive. It is partly for this reason that AIDC has adopted a subregional approach when commissioning survey missions on iron and steel industries.

The second concern is to choose a plant location with the lowest cost, bearing in mind for example, the cost of transporting the raw materials and of distributing the final products. Normally, an inland iron and steel plant will be located close to iron ore deposits, and a coastal plant near a port having the advantage of cheap sea transport. A precise calculation of the most suitable location will entail estimating both the consumption at the market centres and the transport costs to each of these.

Regarding the former issue, it will be recognized that, in the last 15 yr, the iron and steel industry has experienced revolutionary changes resulting in better use of raw materials, increased efficiency of equipment and improved quality of products. These modern techniques need to be adopted where appropriate and adapted where necessary, to suit Asian requirements.

The starting size for a new integrated steelworks has now increased to about 2 million - 3 million t/yr, while a number of plants have expanded to 10 million t capacity or over. At the same time, sizes of individual production units have increased dramatically. Whereas a decade ago, a blast-furnace of 2,000 t/day was considered large, furnaces are now being built to produce up to 10,000 t/day. The size of basic oxygen (LD) converters has increased to 350 t/heat, each vessel thus producing over 10,000 t/day. Optimum equipment sizes have also increased appreciably in the rolling-mill field; particularly for flat products, where a single hot-strip mill may have an annual throughput of 6 million t.

Thus, in Asia itself, there is on the one hand, the new Oita works of Nippon Steel which will reach a 4 million t capacity with a single blast-furnace of 10,000 t/day, two LD converters of 300 t capacity, three continuous-casting machines, a plate mill and a hot-strip mill; on the other hand, there is the Malayawata plant in Malaysia, also fully integrated, with a capacity of about 150,000 t/yr, using two blast-furnaces, two LD converters and a rolling-mill. The different conditions have called for different solutions.

In developing countries with substantial steel demands, large integrated steelworks having optimum-sized production units are clearly needed. This is the case, for instance, in India, the Republic of Korea, Indonesia, the Philippines and Iran. In Iran, it is interesting to note that, even before the 600,000 t integrated plant at Isfahan was completed, work had to be started on its expansion to 2.5 million t.

In Thailand, the present consumption of rolled steel products of about one million t is expected to double by 1980, and work needs to be initiated now on setting up a major integrated steelworks. Steel demand in Singapore is rising very rapidly, having exceeded 700,000 t in 1971. A long-term strategy must be devised to meet such fast-growing requirements.

Practically all major new integrated steelworks are now being built at coastal sites, to take advantage of international trade in iron ore and coking coal as well in finished steel products. This is a trend to be noted when planning a new plant.

*The "mini" steel mill*

In many ECAFE countries, however, the relatively low steel requirements and lack of resources call initially for plants of smaller size. Here again, new technological developments now permit a non-integrated steelworks of 50,000-300,000 t capacity to operate viably in competition with large integrated plants, in both developing and developed countries. In the United States, for example, 40 such plants have been built in the last decade, mostly with outputs of 100,000-150,000 t.

The "mini" steel mill is based on electric arc furnaces to melt steel scrap, continuous casting to produce billets (or sometimes conventional ingot casting), and a bar mill to roll these into reinforcing rods and light sections. Such mills can be constructed rapidly (in, say, 2 yr), have lower investments and give earlier returns than an integrated steelworks. An arc-furnace, continuous-casting and bar-mill plant with an annual capacity of, say, 100,000 t would require an investment of about US$16 million, that is US$160/annual t. Against this, an integrated steelworks may cost over US$350/annual t.

A major advantage of the electric-arc furnace route is that it does not need iron ore or coking coal (which are generally not available in many ECAFE developing countries). However, this route does require abundant steel scrap and electric power.

The "mini" mill has the additional advantages of low over-heads and flexibility to respond quickly to the needs of local customers, as well as low transport costs for product delivery. An important consideration for developing countries is that it uses simple processes and equipment for which personnel can be trained quite easily.

The requisites for a plant of this type are a ready market for bar products, a good supply of scrap and the availability of power from a stable electricity grid. In most developing countries, there is a growing market for reinforcing rods needed by the construction sector. However, power costs are relatively high in some countries. Also, there is usually a shortage of steel scrap, and this constitutes a major limitation. Local generation of capital scrap and process scrap is low in the initial stages of economic development, while the availability of imported scrap is often uncertain and prices fluctuate widely. Hence, the tremendous interest in sponge iron which is a good scrap substitute.

The arc furnace route is a serious challenge to the blast-furnace — LD route under specific conditions. One can expect the installation of many "mini" mills in both the large and the small Asian countries.

*Sponge iron processes*

In recent years there have been important advances in direct reduction for production of sponge iron. This material could either replace part of the scrap charge in the electric arc furnace, or be charged into iron-making furnaces.

Direct reduction processes are of particular interest to ECAFE countries which generally lack the coking coal deposits needed for blast-furnace iron-making. Unfortunately, these countries (with the exception of India) also lack high-grade iron ore. With ore of less than, say, 63 per cent Fe content, the sponge iron produced has an excessive gangue content which, when charged in the electric arc furnace, result in a high consumption of fluxes, electric power and refractories.

Direct reduction processes based on natural gas are in commercial operation in the world today. There are three HyL plants using stationary reactors in Mexico; two Midland-Rose plants using shaft furnaces in the United States and one in Germany;

and an HIB plant using fluidized bed in Venezuela. Other gaseous reduction process plants (e.g. the Purofer process) are reported to be under commission — or planned. These systems are producing a prereduced pellet of about 90 per cent iron which can be used (to the extent of 50-70 per cent) in the electric arc furnace. Such processes with plant capacities of 60,000 t-250,000 t/yr are under consideration in Iran, India, the Republic of Korea and Thailand.

ECAFE countries where natural gas or naptha is not freely available at low prices must consider the use of a solid reductant (non-coking coals or lignite). Sponge iron plants need to be investigated for countries such as Malaysia, Singapore, Indonesia and the Philippines. Plants using the SL/RN process have been built in Canada, New Zealand, the Republic of Korea and Brazil. A plant is being built by Krupp in South Africa. Similar techniques have been tried in Yugoslavia and Venezuela. Processes using rotary kilns have experienced serious operating problems, and future developments as well as results from new plants under installation will have to be watched carefully, to enable a successful project to be planned in the region.

At the same time, raw materials need to be thoroughly tested. Laboratory and pilot-plant test programmes will have to be undertaken on beneficiation, agglomeration and direct reduction of iron ores.

Various figures have been reported regarding the capital costs of sponge iron plants. These are expected to range from about US$75/annual t for plants of 100,000 t/yr capacity, dropping to US$60/t as plant size increases.

The production cost of sponge iron depends primarily on the costs of high-grade ore and the reductant (solid or gaseous). Present estimates for various projects indicate costs of US$40-$50/t sponge, including fixed charges. These figures, which await confirmation in actual commercial plants, may not be acceptable in places where the prices of imported and domestic scrap are lower.

With improvements in technology in the next 2-3 yr, direct reduction may well become a viable process route. This would give a further boost to electric arc-furnace steelmaking in "mini" plants of up to 300,000 t, as well as to medium-sized plants producing 500,000-1 million t/yr.

Present world output is around 2 million t of pre-reduced ore. It has been estimated that about 30 million t may be produced by annually 1980. It is not unreasonable to expect that over one million t of this will be in the ECAFE region.

*Electric arc-furnace steel making*

In the ECAFE countries, the oxygen converter and the electric arc furnace will soon become the only two principal processes. The LD process has grown rapidly, from about 12 million t in 1960 to about 300 million t today, with another 100 million t capacity under installation. Even so, the new OBM (bottom-blown oxygen) process may well pose a threat in the coming years.

The electric arc furnace has made rapid progress. Large furnaces of 200-t capacity are now in use. An important development is the use of ultra-high capacity transformers to cut down the scrap melting time. For instance, a decade ago, an arc furnace with a nominal capacity of 20 t would have had, say, a 7 MVA transformer; today it would be equipped with a transformer of 10 MVA or even higher, to give a melt-down time of only 1-1.5 h. This requires good quality refractories and careful control of furnace operations.

Other new developments include continuous charging of sponge iron, intensive use of oxygen, pre-heating of scrap, and use of high-density high-strength electrodes. With scrap pre-heating to 350°C, production increases of 10-15 per cent and reduction in power consumption of about 10 per cent have been achieved. This technique is of interest in specific situations where electric power costs are high or at plants which need to increase their steel production into order utilize their rolling-mill more fully.

By 1975, electric furnace steel is expected to rise to over 100 million t, out of an anticipated world production of 700 million t. Moreover, its use is no longer confined to special steels — in Japan and the United States, for instance, almost two-thirds of the output of electric furnaces is in plain carbon tonnage steels. The availability of pre-reduced ore in the future would accelerate the growth of arc furnace steelmaking in Asia.

The new "argon-oxygen refining process" has made possible savings in the production of stainless steel. In this two-step operation, the arc furnace is used for melting the charge which is then transferred to a refining vessel where it is decarbonized by injecting controlled amounts of oxygen and argon. This permits the use of high-carbon ferrochrome which is low in cost.

There is renewed interest in continuous steelmaking by processes such as spray refining (United Kingdom) and the IRSID (France) method. However, these are still in the development stage and not of immediate interest in the ECAFE countries.

*Vacuum degassing*

Vacuum degassing of molten steel was originally developed to remove hydrogen which caused defects in large forgings. It is now being used as a steelmaking process, for both special and tonnage steels. In addition to hydrogen, oxygen and carbon removal, the process is useful for carrying out finishing operations outside the steelmaking furnace. In the early 1960s, most plants were of the stream degassing type, but then ladle degassing and now circulation-lift plants are being increasingly adopted.

Production of vacuum-treated steels has been growing at the rate of 25 per cent/yr since the last decade, owing to advantages of accurate control of alloying additions, shorter heat-treatment times and improved steel quality. This process will find use in Asia in the coming years. A unit is in operation at the Durgapur Alloy Steel Plant in India.

Another development which will be of interest to ECAFE countries is the electroslag remelting process. Here a consumable electrode is remelted in a protective slag kept molten by resistance heating. It results in an ingot which is free from axial unsoundness. The main applications are for alloy structural and special steels which must have high purity for high-strength, high-temperature uses.

*Continuous casting*

Plants for the continuous casting of billets are in operation in ECAFE countries such as India, Iran, Malaysia and Thailand. The yield from liquid steel to continuously cast semis is about 93 per cent, which is 10-15 per cent higher than by conventional ingot casting, stripping, re-heating and cogging. Surface and internal quality is, in many cases, superior. In view of this as well as lower investment and operating costs, the continuous casting process has made major strides. Ten years ago there were only 50 machines in operation; today there are over 400, either installed or under construction. Almost 75 million t of total world production is now cast continuously.

While the process is proved to be technically successful and economical under a variety of conditions, there are some steels which cannot be continuously cast, and some plants which require a larger number of bloom sizes than can be conveniently handled. Recent developments, such as strand reduction, sequence or "continuous" casting, and casting of partially shaped blooms, are extending the use of this process.

*Pollution control*

The steel industry is considered to be one of the environment's major polluters, in its exploitation of natural resources as well as its dust emission and effluent disposal. Effective pollution abatement technology is now being developed, but it is expensive. Since 1951 the United States steel industry has spent US$1,200 million on pollution control, and the annual operating cost of these systems is now US$1.5 million. The Japanese steel industry expects to spend US$300 million (more than 10 per cent of its total investment) on pollution control in 1973. This country has embarked on a nuclear steelmaking pilot project in order to combat environmental pollution and to reduce its dependence on imported coke.

As the steel industry in the developing ECAFE countries is still in its infancy, there has so far been little adverse impact on ecology. Where new plants are being planned, severe financial constraints give rise to the temptation to postpone the installation pollution control equipment. Undoubtedly, as steel production expands, close consultation will be needed between industry and the Governments to protect the environment while permitting steel to be produced economically.

*Computer applications*

On-line computers are now being used to control blast-furnace operation, LD vessels, electric arc furnaces and rolling-mill processes, through linkages with measuring devices. The signals are evaluated by the computer which then modifies the parameters to achieve the objectives desired. The difficulties and high costs of continuous and accurate measurements are the main problems. With the improvement of sensors and of computer programmes, it should be possible to automate many of the operations in a new iron and steel complex.

Off-line computers are more widely used for data-processing applications such as order systems control, production planning, general accounting and purchasing.

Both on-line and off-line computer developments need to be watched in Asia, as their usefulness does not depend on reducing labour employment but on cost saving through improved yield, better quality and higher throughputs.

*Conclusion*

The developing ECAFE countries must now greatly increase their efforts to expand their steel industries in the Second Development Decade, otherwise continuing shortages of steel and increasing dependence on imports may seriously hamper economic growth.

Steel plants are getting more and more expensive to build in developing countries and the cost of steel produced may for a few initial years be higher than in the industrialized countries. Costs can be reduced by careful selection of new processes and equipment.

Regional co-operation between the developing countries on appropriate steel projects may enable them to insulate their growth from the vagaries of the international steel trade and to take advantage of the economies of scale for reducing costs.

Such regional collaboration could consist in establishing one or a few iron and steel plants, to meet the requirements of subregions, so as to obtain economies of scale; and to supplement them with rerolling mills located in the member countries concerned. Since the subregional plant would be selling to a number of countries, it would be necessary to propose a framework of co-operation on such aspects as financing, control of prices and quality, duty preferences and supervision of market sharing arrangements. The framework and a detailed appraisal of the techno-economic feasibility of the proposed regional plant would have to be carried out simultaneously.

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Printed in Hong Kong
72-26221—June 1973—2,925

Price: US$2.00 or equivalent in other currencies

United Nations Publication
Sales No. E.73.II.F.11
E/CN. 11/1066