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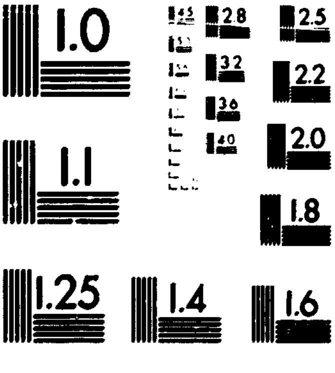

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THE BUILDING MATERIALS INDUSTRY IN DEVELOPING COUNTRIES: AN ANALYTICAL APPRAISAL

Sectoral Studies Series
No. 16, Volume I

SECTORAL STUDIES BRANCH
DIVISION FOR INDUSTRIAL STUDIES

Fred Moavenzadeh

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Main results of the study work on industrial sectors are presented in the Sectoral Studies Series. In addition a series of Sectoral Working Papers is issued.

This document presents major results of work under the element Studies on Building Materials Industries in UNIDO's programme of Industrial Studies 1984/85.

Preface

The purpose of this analytical appraisal of the building materials industry in developing countries is to describe the actual and potential contributions of the industry to socio-economic growth, to identify constraints on the development of domestic industries in this sector and to suggest possible means of overcoming those obstacles. Implicit in this raison d'être is the belief that the building materials industry has a special role to play in development and that the suggestions made herein are realistic and realizable in the current context of development. The potential contributions this industry can make to economic growth and to the satisfaction of human needs support our claim that planners should carefully consider this sector for state promotion.

This study is to a large extent based on work prepared by a team of experts, headed by Professor Fred Moavenzadeh and including Professor Nazli Chourci, Professor Clifford Winston, all of M.I.T., and Professor David Wheeler, Boston University. Also contributing to the report were Ms. Nancy Otis, Ms. Eileen Pollak, Ms. Patricia Vargas, Ms. Hagopian and Mr. Alexander Demacopoulos. Sections 3 through 5 of chapter 2 are based on a special analysis made by the UNCTAD secretariat for this study. UNIDO is grateful for these valuable contributions.

The study will serve as background document to the First Consultation on the Building Materials Industry, Athens, 26 March to 30 March 1985. Additional background statistical information on the building materials industry is given in volume II of the study, to be issued at a later date.

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EXPLANATORY NOTES

References to dollars ($) are to United States dollars, unless otherwise stated.

A comma (,) is used to distinguish thousands and millions.

A full stop (.) is used to indicate decimals.

A slash between dates (e.g., 1980/81) indicates a crop year, financial year or academic year.

Use of a hyphen between dates (e.g., 1960-1965) indicates the full period involved, including the beginning and end years.

Metric tons have been used throughout.

The following forms have been used in tables:

> Three dots (...) indicate that data are not available or are not separately reported.
>
> A dash (-) indicates that the amount is nil or negligible.
>
> A blank indicates that the item is not applicable.
>
> Totals may not add up precisely because of rounding.

Besides the common abbreviations, symbols and terms and those accepted by the International System of Units (SI), the following abbreviations and contractions have been used in this report:

Economic and technical abbreviations

BTU	British Thermal Unit
CPE	Centrally planned economy
GDCF	Gross domestic capital formation
GDP	Gross domestic product
GNP	Gross national product
GSP	Generalized System of Preferences
ISIC	International Standard Industrial Classification of all economic activities
ME	Market economy
NTM	Non-tariff measures
SITC	Standard International Trade Classification
t/a	Metric tons per annum
t/d	Metric tons per day

Organizational abbreviations

ASEAN	Association of South East Asian Nations
CCCN	Customs Co-operation Council Nomenclature
EEC	European Economic Commission
ESCAP	Economic and Social Commission for Asia and the Pacific
GATT	General Agreement on Tariffs and Trade
HABITAT	United Nations Centre for Human Settlements
IEA	International Energy Agency
ILO	International Labour Office
IMF	International Monetary Fund
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNIDO	United Nations Industrial Development Organization
UNSO	United Nations Statistical Office

Country groupings

Developing countries

Tropical Africa:	All of Africa South of the Sahara, except for the Sudan and the Republic of South Africa
North Africa:	Rest of Africa
West Asia:	The Arab countries of Asia, Iran, Turkey and Cyprus
South Asia:	Afghanistan, Bangladesh, Bhutan, Burma, India, Nepal, Pakistan and Sri Lanka
East Asia (Mfg):	The area of Hong Kong, Republic of Korea, Philippines, Singapore and Thailand
East and South-East Asia:	Rest of Asia except CPE Asia, Taiwan Province of China and Japan, plus the South Pacific Islands
Latin America:	South and Central America and the Caribbean, except Puerto Rico and U.S. Virgin Islands
Centrally planned economies (ASIA):	People's Republic of China, Democratic Kampuchea, Democratic People's Republic of Korea, People's Democratic Republic of Lao, Mongolia, Viet Nam
European centrally planned economies:	Albania, Bulgaria, Czechoslovakia, German Democratic Republic, Hungary, Poland, Romania and USSR

Developed market economies

North America:	Canada, United States and United States Territories
West Europe:	Austria, Belgium, Luxembourg, Denmark, Federal Republic of Germany, Finland, France, Iceland, Ireland, Italy, Netherlands, Norway, Sweden, Switzerland, United Kingdom, Greece, Malta, Portugal, Spain, Yugoslavia, Israel
Japan:	Japan
Other developed:	Australia, New Zealand, South Africa

1. INTRODUCTION

The building materials industry is a construct, representing a group of industries whose products are inputs to the construction sector. As such, the economic contributions of the building materials industry is closely linked to the construction industry, which consumes its products. For a list of sectors which produce building materials see table 1.1. This table provides a reference list stated in terms of the International Standard Industrial Classification and the Standard International Trade Classification. Yet, because the manufacturers of these materials may also produce goods used by other sectors, factors outside the construction industry may shape the growth and vitality of the building materials industry.

The linkages between this industry and other sectors in the national economy, as well as its potential to block or facilitate industrial growth and to provide jobs and better living conditions to large numbers of people, make it a worthy target of development. Since the technologies of production in the building materials industry range from the rudimentary adaptation of indigenous materials such as earth, to complex operations requiring substantial capital investment, this sector can play a central role in a wide variety of development plans, each tailored to a unique set of national factor endowments.

This study is intended to provide a description of the current status and possible future trends in the sector. It examines various possibilities for enhancing the contribution of the sector to economic development and economic welfare in developing countries and contains recommendations for action. One particularly important theme of this report concerns the role that might be played by small scale facilities in the building materials industry in developing countries. It is in fact concluded that there exists much scope for increasing the role of the small scale operations in the building materials industry.

This chapter will introduce the main argument of this report by describing in detail the current context of development and the way in which the economic conditions of this decade have shaped the priorities of

Table 1.1. Main industrial sectors and trade categories relating to building materials

SITC, Rev. 2

Code	Description
247	Wood in the rough
248	Wood simply worked
248.1	Railway/tramway sleepers
248.2	Wood, coniferous
248.3	Wood, non-coniferous
273	Stone, sand and gravel
533	Pigments, paints, varnishes
533.41	Water thinned paints
533.42	Other paints and enamels
533.43	Pigments in paint or enamel
533.51	Prepared pigments, etc.
533.54	Glazier's putty, etc.
634	Veneers, plywood, etc.
635.3	Builders' carpentry, etc.
641.6	Building board of wood pulp
661	Lime, cement and fabricated construction materials
661.1	Lime
661.2	Portland cement
661.3	Building and monumental stone
661.8	Construction materials of asbestos-cement
662	Clay
662.3	Refractory bricks
662.4	Non-refractory bricks
664	Glass
664.4	Glass: surface polished
664.5	Glass: cast or rolled, unworked
664.6	Glass bricks, tiles, etc.
664.91	Glass: cast, rolled, drawn or blown
672	Ingots and other primary forms of iron and steel
673	Iron and steel: bars, rods, angles, shapes, sections
673.3	Iron and steel: angles, sections, shapes, etc.
674	Iron and steel: universals, plates, sheets
676	Rails and railway construction materials
678	Iron and steel: tubes, pipes, fittings
682.25	Tubes, pipes of copper
682.26	Tubes, pipe fittings of copper
684.21	Bars, rods, angles, shapes, sections, wire of wrought aluminium
684.22	Plates, sheets and strips of wrought aluminium
684.25	Tubes, pipes, blanks, hollow bars of aluminium
684.26	Tube and pipe fittings of aluminium
691	Structures and parts of iron and steel
694	Nails, screws, etc. of iron, steel or copper

ISIC, Rev. 2

Group	Description
2901	Stone quarrying, clay, sand pits
3219	Manufacture of hard-surface floor coverings
3311	Sawmills, planing and other wood mills
3319	Manufacture of wood and cork products not classified elsewhere
3521	Manufacture of paints, varnishes, lacquers
3620	Manufacture of glass and glass products
3691	Manufacture of structural clay products
3692	Manufacture of cement, lime, plaster
3699	Manufacture of non-metallic mineral products
3710	Iron and steel basic industries
3720	Non-ferrous metal basic industries
3813	Manufacture of structural metal products
3819	Manufacture of fabricated metal products except machinery

industrializing nations; this is necessary to prepare for the rest of the report, which attempts to show that the building materials sector can fulfil these objectives. Since this sector is not a distinct economic entity, it is also necessary to understand its place in the construction industry and the role of construction in the economy as a whole before proceeding to later chapters.

With these two sections as background, chapter 1 is concluded by sketching the scope of the rest of the study.

1.1 The context of development

The severe recession which occurred on a global scale at the turn of the decade and brought the very rapid rise in commodity prices, of the last part of the previous decade, to an abrupt halt. Commodity prices actually fell sharply at the outset of the recession, and though the recession is no longer present on a global scale the rise in most commodity prices has been modest. They are in most instances at historically very low levels. Commodity prices, measured in terms of their purchasing power over the exports of developed country manufactures to developing countries, in many instances are lower today than they were in 1960. How long the present structure will last is uncertain.

This problem is most serious for countries that depend heavily on primary commodity exports. According to the World Bank, the per capita income of low-income African countries has fallen so steadily that it may be lower by the end of the 1980s than it was in 1960.[1/]

A further problem facing developing countries, and one shared by the developed countries, is the potential for gains in trade liberalization achieved during the Tokyo round of tariff negotiations to be neutralized by an increased protectionist sentiment arising as a result of protracted unemployment in many developed countries.

1/ World Bank, World Development Report 1983, Washington, D.C., 1983, p. 2.

The repercussions of deteriorating terms of trade have been felt acutely by many middle-income developing countries in their need to service their large foreign debts.

Table 1.2 shows that the debt service ratios of oil importers and oil exporters have increased to an average of 20 per cent in 1982. For the heaviest borrowers, the real figures are alarmingly higher. The debt service of 21 major borrowing countries soared from 50 per cent of exports in 1979 to 75 per cent in 1982.[2/]

Since more than half of the medium- and long-term debts of developing countries carry variable interest rates, any change in international interest rates will significantly affect interest payments of those countries. The Economist estimated that the most recent rise of one-half percentage point in the United States' prime rate (the fourth increase this year) added $US 800 million to the annual interest bill of Latin America alone.[3/]

Many middle-income and poorer countries have been forced to pursue austerity policies, which restrict domestic spending, investments, and imports, and to divert to debt service capital that could otherwise have been used to underwrite development programmes.

Twenty years of economic progress in Brazil, for example, have been halted by the country's large external debt, which has forced the government to institute stringent austerity measures. Where once the country experienced a high rate of growth in the production of building materials and the

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2/ Debt service includes interest on total external debt plus all maturing debt, including amortization of medium-and long-term debt and all short-term debt. The 21 countries include: Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, Peru and Venezuela in Latin America; Indonesia, Republic of Korea, Malaysia, the Philippines, Taiwan Province of China and Thailand in Asia; and Algeria, Egypt, Israel, the Ivory Coast, Morocco, Nigeria and Turkey in the Middle East and Africa. Data are from Morgan Guaranty Trust Company of New York, World Financial Markets, February 1983, pp. 5-6.

3/ The Economist, "Banking on Latin America", 30 June 1984, p. 17.

Table 1.2. Key indicators 1973-1982 (percentages, in real values)

Indicator	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982a/
World trade growth (volume)b/	12.5	4.0	-4.0	11.5	4.5	5.0	6.5	1.5	-	-2.0
Industrial countries										
GDP growth	6.3	0.6	-0.7	5.1	3.6	3.9	3.2	1.3	1.0	-0.2
Unemployment	3.4	3.7	5.5	5.5	5.4	5.1	5.0	5.6	6.5	8.0
Inflation rate	7.7	11.6	10.2	7.3	7.4	7.3	7.3	8.8	8.6	7.5
Developing countries										
Oil importers										
GDP growth	6.5	5.3	4.0	5.3	5.6	6.6	4.2	5.0	2.2	2.0
Debt service ratioc/	12.6	11.4	13.3	12.6	12 7	15.7	14.7	13.9	16.6	21.5
Oil exportersd/										
GDP growth	9.1	7.2	3.7	8.2	4.8	2.4	1.2	-1.3	1.5	1.9
Debt service ratio	12.2	6.7	7.8	8.4	11.1	14.9	15.5	13.0	15.7	19.1

a/ Estimated.
b/ IMF data for 1973-1981; GATT data for 1982.
c/ Service on medium- and long-term debt as a percentage of goods and services.
d/ Excludes the People's Republic of China.

Source: World Bank, World Development Report 1983, p. 1.

construction of dams, roads, industrial plants and housing, many companies have now been forced to cut production severely or close entirely. Some engineering projects, which were largely financed by imported capital, have been suspended; national housing programmes, paid for by internal savings and a tax on employers, have been choked off by the domestic recession.4/

The gloomy prospects for new commercial borrowing by many developing countries will severely restrict their capacity to import the inputs they need for industrialization. While external finance accounts for only 13 per cent of total investment in developing countries, it permits imports of vital machinery, transport equipment, materials and technology.5/

Energy emerged as a major concern for developing countries following the first round of petroleum price increases in 1973-1974. The sudden and substantial increase in oil prices has not destabilized the developing world as badly as was feared. But the price of energy will exert a major influence on strategies for industrialization until the end of the century.6/

While energy prices have stabilized in recent years it is widely expected that prices will rise in the future as demand grows and as petroleum reserves are depleted. The International Development Strategy for the Third Development Decade calls upon the international community to devote adequate financial and technical resources to the development of new and renewable sources of energy, and to conserve energy derived from hydrocarbons.7/

4/ The building materials industry in Brazil, a background paper prepared by Luiz Carlos Martins Bonilha, July 1984 (Microfiche No. 14070).

5/ World Bank, World Development Report 1982, Washington, D.C., 1982, p. 3.

6/ Yearbook of National Accounts Statistics 1978, Volumes 1 and 2, New York, 1978, p. 5.

7/ United Nations General Assembly, International development strategy for the Third United Nations Development Decade (A/35/464), 23 October 1980, paragraphs 34 and 35.

From the above discussion of the current economic situation, it is clear that now is an appropriate time to examine the options available in the developing countries for adapting the building materials industry to the new circumstances. While many of the ideas developed in this report are not new, it is useful to examine them specifically in relation to the building materials industry. One option which is examined is that of shifting production towards smaller scale operations which tend to be more labour-intensive, less demanding of imported technology and more easily operated at near their design capacity.

Construction is itself an industry which produces capital goods. Capital goods provide a service over a long period of time and can be used in the production of other goods. Obviously civil works such as dams, bridges and roads are used to produce other goods. They, thus, directly raise productivity and so contribute to economic development. Housing provides a service which is typically consumed directly, though perhaps not by the owner. Nevertheless, in most national income accounting systems home construction is considered part of investment just like roads or factories. The rationale for considering housing construction to be an investment expenditure is that housing creates income over a long period of time in the same way as building a factory creates income by increasing productive capacity.

For an economy to experience increased activity in the construction industry means, other things being equal, that it must find the financing for this increased investment spending. To advocate increased output in the construction sector without addressing this fact would be pointless. This report, however, is concerned first with the building materials industry and only incidentally with the construction industry. The expansion of the building materials industry, does not necessarily imply expansion of the construction industry since the increased output can be used to replace imported materials or can be exported. Also since one important constraint on activity in the construction sector is the limited availability of foreign exchange to purchase imported building materials, the production of construction materials from indigenous materials can be very beneficial to expanding construction activity. As will be shown, the level of imports contained in building materials supplied to the construction industry in developing countries is very high. It is argued here that it is too high in relation to what makes the most economic sense in the present economic setting.

In addition, since building materials are a large share of the total costs of the construction sector, any improvements in the local building materials sector will inevitably benefit the local construction industry.

The building materials industry can be made more vigorous in developing countries, by which, in this report, is meant more labour-intensive, more reliant on locally available raw materials and more manageable (decentralized and simplified).

In chapter 4 it will be seen that at least 40 per cent of the citizens of most developing nations are too poor to afford even the cheapest public housing offered in the formal market. In the current context of development, only the informal construction sector seems capable of providing shelter for these people. This capacity is based on the amenability of construction and building materials production to small-scale enterprises and the use of indigenous inputs, traditional techniques and high labour/capital ratios. This is dealt with in greater depth in chapter 4. To illustrate this assertion here, consider a case in point from Zambia as described in a working paper from the World Bank.

The rapid urbanization of the city of Lusaka after Zambia achieved independence in 1964 led to a housing problem so serious that by 1974, half of the city was living in illegal, unsafe shantytowns. The government's housing policies created only a small number of public units, and these were too expensive for most people. Increases in the price of oil and the ensuing global inflation eroded the new Zambian currency, and when the price of copper, which provided 45 per cent of the nation's revenues and 95 per cent of its foreign exchange, fell to a record low in the mid-1970s, the government was hard-pressed to continue even its minimal housing programmes.

These pressures led to a new housing policy in Lusaka, under which the government offered plots of land equipped with basic services to low-income residents, who could purchase these sites and build houses on them. This self-help project worked so well that by 1981, it had added 11,500 units to the city's stock of housirg (at one-tenth the per-unit cost of the cheapest public housing) and had upgraded 20,000 others. The project gave the majority of its residents better access to water and garden plots than they had before and integrated significant numbers of the urban poor into Lusaka's political and social system. Many residents also were able to supplement their incomes by renting rooms in their new homes to single migrants.

Since many residents hired workers from the informal sector to help build their homes, the project generated 8,000 person-months of work and $US 1 million in wages. This suprised the programme's planners, who had assumed that many residents would not only build their own homes, but also produce their own sun-dried bricks. Instead, most families bought ready-made cement blocks from the settlement store, creating a shortage of these blocks, a bottleneck in construction and an increase in the price of each unit. Research later revealed that a larger proportion of the participants were employed than had been expected; many could not spare the 100-160 person-hours of hard labour needed to make enough soil-cement bricks for a two-room house. But even jobless residents were too eager to move out of their shanties to make their own bricks. Others simply doubted their ability to make high-quality bricks. If the leaders of the project had given residents greater access to raw materials and technical assistance, or had encouraged the jobless to set up informal enterprises to produce, sell and distribute bricks, these problems might have been avoided.[8/]

The Lusaka project indicates not only the power of the informal construction sector in providing shelter and social benefits to significant numbers of the poor, even in times of national recession, but also the

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8/ M. Bamberger, B. Sanyal and N. Valverde, Evaluation of sites and services projects: The experience from Lusaka, Zambia, World Bank Staff Working Paper No. 548, Washington, D.C., 1982.

importance of informal suppliers of building materials to the success of low-income housing projects. For this reason, section 4.5 takes a closer look at the informal production of building materials. But this activity cannot be considered in isolation from the formal and informal construction sectors, any more than the formal production of building materials can be considered apart from construction; therefore, we will now consider the role of the construction industry in economic development.

1.2 The role of construction in developing countries

As capital goods industry, construction plays an important part in economic development. The contribution of construction to GDP is typically 3 to 8 per cent in developing countries, and even higher in some centrally planned economies and Middle Eastern countries (table 1.3). The sector also plays an important role in economic growth through multiplier effects on other sectors of the economy. Construction output constitutes from 40 to 70 per cent of gross fixed capital formation in most developing countries.[9/] In this role, the construction industry produces not only the infrastructural facilities required for transportation, water and power supply, communications and waste treatment and disposal, but also housing and other buildings which shelter various social and economic activities and facilities for a wide range of industrial activities.

The state of capital formation and accumulation is a critical determinant of industrialization; if the output of construction were to lag, so too would economic growth. At least three studies have demonstrated that construction activity increases faster than per capita income. A 1972 study by the University College Environmental Research Group estimated that each change of one per cent in per capita GDP is accompanied by a 1.2 per cent change in per capita value added by the construction sector. A 1980 study,[10/] which

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9/ United Nations Centre for Human Settlements, Nairobi, Kenya, Role and contribution of the construction industry to socio-economic growth of developing countries, Cambridge, Massachusetts: CMT Inc., November 1980, revised April 1982, p. 11-22.

10/ Ibid.

Table 1.3. Construction as a percentage of GDP, selected countries, 1979

Country	Per cent	Country	Per cent
Afghanistan	5	Libyan Arab Jamahiriya	11
Australia[a]	7	Mexico	7
Austria	8	Nepal	7
Bangladesh	5	New Zealand	4
Belgium	7	Nicaragua[a]	3
Benin[a]	4	Norway	7
Bolivia	5	Oman	8
Botswana[a]	5	Pakistan	5
Brazil	5	Paraguay	5
Bulgaria	8	Peru	2
Burundi	4	Philippines	7
Canada	5	Poland	11
Colombia	4	Romania	10
Costa Rica	6	Saudi Arabia	15
Cyprus	13	Senegal	4
Ecuador	7	Singapore	6
Egypt	5	South Africa	4
El Salvador	5	Spain	8
Fiji	7	Sri Lanka	7
Finland	6	Sweden	6
France	7	Syrian Arab Republic[a]	5
Gabon	8	Tanzania	3
German Dem. Rep.	7	Thailand	5
Germany, Fed. Rep. of	7	Togo	8
Greece	9	Trinidad and Tobago[a]	8
Honduras	5	Tunisia	7
Hungary	12	Turkey[a]	5
India	5	United Arab Emirates[a]	10
Indonesia	6	United Kingdom	5
Israel	10	United States of America	5
Italy	7	USSR	11
Ivory Coast[a]	9	Uruguay	5
Jordan	12	Venezuela	7
Kenya	5	Yugoslavia	11
Korea, Rep. of	9	Zambia	4
Kuwait	3	Zimbabwe	3
Liberia	7		

a/ 1978 data.

Source: United Nations, Yearbook of National Accounts Statistics 1980, (New York, 1980).

examined time-series data for 11 developing countries, found that construction's share of GDP increased from 1960 to 1977, reflecting a higher rate of growth than the economy as a whole. Finally, a 1982 study,[11/] which fitted a regression model to time-series data for 53 countries over 18 years, demonstrated that during the intermediate phase of development, the share of GDP represented by construction rises rapidly, from approximately 7 per cent at $US 200 per capita to 13 per cent at $US 3,100 per capita (in 1979 United States dollars). National accounts statistics since 1965 for all developing countries confirm the findings of these studies: growth of the construction sector has increasingly outpaced overall economic growth. Due to this relatively high growth, the construction sector's share of the GDP in developing countries increased from 5.3 per cent in the early 1960s to 6 per cent in the mid-1970s.[12/] (The same is not true for developed economies, where growth of construction lagged behind that of GDP.) In the initial stages of their development countries tend to divert a substantial portion of their national resources to construction, which assumes an increasing role in the economy before levelling off at some point.

While the main contribution of construction to economic development is obviously its contribution to productive capacity and to raising living standards directly through the provision of housing, safe water supplies, roads and other infrastructure, it also can make an indirect contribution to economic growth. Such indirect contributions include employment effects and perhaps an ability through forward and backward linkages to stimulate other related sectors of the economy.

The construction sector in principle could occupy the centre of any redistributive growth strategy. Developing countries have long been left the unenviable choice of pursuing development strategies which promote growth at

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11/ David Wheeler, *Major relationships between construction and national economic development*, Center for Construction Research and Education, Massachusetts Institute of Technology, Cambridge, Massachusetts, 1982.

12/ Jurgen Riedel, *Global prospects for the development of the construction and building materials industries*, Institute for Economic Research, Munich, June 1983.

the expense of social welfare, or which redistribute income at the expense of the expansion of assets. But developing countries can reverse this dilemma by devising an industrialization strategy that permits both redistribution and growth.[13/] The crux of distributional growth strategies that would not sacrifice capital accumulation is to make poor groups more productive. While various measures such as redistributing income, redirecting investment, or transferring assets to the dispossessed would be steps in that direction, the central element in making the poor more productive is providing them with jobs. Not only does this eliminate the need for a trade-off between growth and equity, but it also allows for an industrialization strategy based on the expansion of employment opportunities.

Investment in construction is well-suited to accomplishing such a strategy. The sector accounts for approximately 5 per cent of total employment: 3 per cent in Africa, 4 per cent in Asia and 6 per cent in Latin America. Wage rates in the sector tend to vary with the skills of the workforce: as the economy develops, the skills of the workers in each sector grow. In industrial countries, wages for employees in the construction sector tend to be higher than those in many other sectors.

Given the structure of wages and the state of production technologies in most developing countries, construction is a logical employer of the unskilled and semi-skilled; it has great absorptive capacity, particularly when labour-intensive methods are adopted. The use of labour-intensive construction techniques, demonstrated to be feasible in at least 60 developing countries by a World Bank study, can and should be designed to absorb excess labour without sacrificing productivity or squandering resources. In various

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13/ These arguments and their supporting evidence are derived from Hollis Chenery, Montek S. Ahluwalia, C.L.G. Bell, John H. Duloy and Richard Jolly, Redistribution with Growth, which has been summarized as a World Bank Publication Summary, IBRD, 1974; and Syamaprasad Gupta, "A Summary of a Model for Income Distribution, Employment, and Growth: A Case Study of Indonesia," A World Bank occasional paper, Number 24, 1977. Both stress that there is no firm empirical basis for believing that the objectives of rapid growth and equity need conflict, and that any trade-off between the two depends on the specific policies adopted to redistribute income.

countries, the construction sector plays the most important part of any sector in absorbing farm labour. Construction has been characterized as an industry which serves as a bridge between the unskilled workers of the informal labour market and the skilled labourers of the formal sector. Construction activities make a significant contribution to the rest of the economy by training entry-level workers in the fundamental skills and discipline necessary for industrial activity. Construction may even be superior to competing economic activities in producing these skills, although this hypothesis warrants further investigation. Jobs generated in other sectors by the construction industry's intermediate consumption of products, i.e. building materials, should also be taken into consideration.

Not only is the construction industry responsible for providing low-cost shelter, one of the longest-standing and most pressing problems of developing countries, it is also vital to the success of the Water Decade, a programme to provide the world's population with a safe supply of drinking water and adequate means of sanitation by 1990. Most of the world's poor are in more critical need of housing, schools and hospitals than of many consumer goods, which are often too expensive for them to afford and whose production generates less employment than comparable investments in infrastructure. Improved health and sanitation made possible by construction projects would improve the productivity of the poor. A small farm, too, could be made more productive by the construction of rural roads.

The success of any rural development scheme hinges on the participation of the construction and building materials industries. Supplies of agricultural credit alone cannot provide the rural poor with roads or irrigation facilities; these can only be supplied by a flexible construction industry. Moreover, rural inhabitants will be increasingly unable to derive a livelihood from the soil, and rural industries will be an important element of any programme to revitalize the countryside. Producing materials in rural areas, which would not only provide jobs, but also reduce the cost of vital construction projects by cutting freight costs, would be especially desirable in such a context.

Thus, the construction industry provides critical forward and backward linkages to other economic sectors. Its special contributions to development are capital formation - as much as 70 per cent of gross fixed capital formation in some developing countries - and the provision of employment to the reservoirs of unskilled and semi-skilled workers in poorer countries. The products of the construction industry - civil works, industrial plants, schools, hospitals, and housing - are essential to both economic growth and social welfare. Construction can therefore be viewed as a motor of development whose uninterrupted output is a precondition for material progress.

As the sector's major supplier, the building materials industry contributes approximately half of construction output. The vitality of the building materials industry is as crucial to the smooth functioning of the construction industry as the latter is to the performance of the overall economy. As the major source of intermediate consumption, the industry is the major stimulus or bottleneck to the construction sector as a whole. Once this is understood, it becomes imperative to identify measures by which developing countries can strengthen their building materials industry; the remainder of this report therefore will progress towards the identification of such measures.

1.3 Purpose and scope of the study

To this end, chapter 5 examines various forecasts of the demand for building materials through the year 2000, describes the constraints that could keep developing countries from meeting this demand and suggests policies and strategies for easing these constraints, with the hope that these measures will allow developing countries to install and strengthen all sectors of the building materials industry for which they are favoured by their natural and human resources.

2. ROLE AND CONTRIBUTION OF BUILDING MATERIALS TO THE NATIONAL ECONOMY

This chapter reviews the role of the building materials industry in the national economy and the factors that affect the demand for building materials. It also examines patterns of international trade that influence this sector and examines issues of tariff and non-tariff obstacles to trade in building materials. This latter discussion is based on a special contribution made for this study by UNCTAD.

2.1 Building materials and the national economy

As stated in chapter 1, the construction and building materials industries are so intertwined that it is difficult to disaggregate the contribution of building materials *per se* to economic growth. While some materials, such as bricks, are used exclusively in construction, materials such as steel are used widely in other industries. Manufacturing output is rarely disaggregated to show the precise production levels of materials destined solely for building.

Despite these difficulties, the contribution of building materials to gross domestic product (GDP) can be distinguished from that of construction because its deliveries to construction, classified as intermediate consumption, recorded separately in input-output tables and elsewhere from construction's own value added. Typically, expenditure on building materials in developing countries represents 3 to 5 per cent of their GDP.[14/] A survey of building materials plants in France, India, Israel, Japan and Yugoslavia in the late 1960s indicated that intermediate inputs tend to represent more than half of total production cost.[15/] Metal products such as tubes, pipes, bolts, nuts and screws tend to have a low value added to total value ratio, while products such as structural steel and assemblies of metal frames, which are produced by less-automated processes, have a higher

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14/ *Industrialization of developing countries: Problems and prospects, Building materials industry* (ID/40/3), UNIDO, New York, 1969, p. 1.

15/ *Ibid.*, p. 47, 50.

value added ratio. Clay bricks and concrete products, which have the highest value added ratio of all building materials, are relatively labour-intensive. Offsetting the labour component of production, which tends to heighten value added, is the use of imported raw materials. The value added for asbestos-cement products represents a smaller percentage of output than for concrete products because of the relative expense of importing asbestos.[16/]

Table 2.1 indicates that developing countries performed well in the production of building materials during the 1970s. In certain product groups, notably non-metallic minerals and basic metals, production expanded faster than did manufacturing as a whole. This was not true of the industrialized countries, where the share of building materials in total manufacturing declined in every category except mining products. For virtually every significant material, developing countries collectively improved their share of global production by significant margins during the decade (table 2.2); in 1981, they produced 34.5 per cent of the world's cement. The aggregate figure in table 2.2 does not show that many developing countries installed plants in sectors where previously there had been none. A large number of developing countries today are producing or are preparing to produce, steel.[17/]

But these figures do not mean that all developing nations are well on their way to enjoying growing building materials industries. First, the distribution of these production gains among developing countries is highly uneven, with the majority of gains accounted for by a relatively few countries. Second, despite these advances, developing countries remain dependent to a very large extent on building materials imported from industrialized countries. Although import levels are as low as 5 to 10 per cent in some countries (e.g. Mexico), they are 60 per cent in other countries.

16/ Op. cit., 49-50.

17/ The world iron and steel industry (second study), prepared by the Sectoral Studies Section, International Centre for Industrial Studies (UNIDO/ICIS/89), 20 November 1978, p. 71, and Scenarios de l'industrie sidérurgique 1990, "Les dossiers" (ID/WG.374/2/Add.1), UNIDO, 1982.

Table 2.1. Excess of individual building materials growth rates over total manufacturing growth rates, by country group/world region, 1968-1980 (percentage points)

	Other mining	Wood products	Non-metallic mineral products	Basic metal products
World	-0.6	-1.4	-0.1	-1.7
Centrally planned economies	-3.0	-2.1	-1.4	-2.6
Developed market economies	-	-0.9	-0.2	-1.7
Developing market economies	-1.6	-2.0	0.3	0.4
Caribbean, Central and South America	-1.4	-2.2	0.7	0.7
Asia	0.2	-2.3	0.3	-

Source: Jurgen Riedel, Global prospects for the development of the construction and building materials industries, Munich, Institute for Economic Research, June 1983, p. 5.

Table 2.2. Building materials: Reported production in developing countries in 1972 and 1981[a]

ISIC	Material	Units	Africa [b] 1981	Africa [b] 1972	Latin America [c] 1981	Latin America [c] 1972	Asia [d] 1981	Asia [d] 1972	Developing countries as a percentage of world total[e] 1981	Developing countries as a percentage of world total[e] 1972
369204	Cement	(MMT)	26	15	26	14	197	94	28.5	18.1
369901	Asbestos-cement articles	(TMT)	353	222	1,529	1,364	830	449	39.8	32.0
369910	Concrete blocks and bricks	(TMT)	666	248	...	...	310	310	1.7	1.3
369913	Concrete pipes[f]	(TMT)	12	186	129	...	...	310	...	...
369916	Concrete, other products[f]	(TMT)	1,465	807	3,403	3,055	1,570	1,570	9.1	9.2
369101	Building bricks of clay[f]	(MU)	499	2,410	4,593	4,418	18,879	7,875	23.9	13.9
369104	Tiles, roofing, clay[f]	(MU)	4	5	892	863	455	469	40.0	39.0
369107	Tiles, floor and wall[f]	(TSM)	9,928	2,650	152,859	38,135	41,297	9,418	34.8	13.5
290119	Clay	(TMT)	1,663	1,207	6,319	4,142	2,782	2,247	...	...
321901	Floor covering	(TSM)	...	...	...	...	514	1,952	...	...
290116	Gravel and crushed stone	(MMT)	4	4	12	7	7	6	...	...
290113	Sand, silica and quartz	(TMT)	7,203	3,612	42,774	20,358	25,559	9,455	...	...
290110	Lime stone flux and calcareous stone	(TMT)	9,363	8,752	98,863	40,934	119,569	45,850	...	...
331101	Wooden railway sleepers	(TCM)	464	949	355	500	704	592	20.9	22.4
331104	Sawnwood, coniferous	(TCM)	533	402	13,257	7,725	17,878	14,065	10.1	6.5
331107	Sawnwood, broadleaved	(TCM)	5,428	2,604	14,014	8,111	31,935	22,908	45.9	32.3
331110	Veneer sheets	(TCM)	300	294	364	191	544	501	28.1	26.0
331113	Blockboard	(TCM)	2	2	20,793	24,243	...	...	...	...
331116	Plywood	(TCM)	1,252	333	1,467	1,058	7,098	3,649	24.8	12.9
331122	Particle board	(TCM)	185	122	1,613	611	673	285	6.1	3.8
352101	Paints, cellulose	(TMT)	6	26	...	17	137	25	...	...
352104	Paints, water	(TMT)	5	7	125	171	87	15	...	...
352107	Paints, other	(TMT)	87	59	244	281	133	134	...	...
362001	Glass, drawn or blown in rectangles, unworked[f]	(TMT)	...	...	171	87	1,797	204	32.6	4.1
362004	Glass, cast, rolled drawn or blown	(TMT)	...	21	12	891	...	...	...	...
362007	Glass, safety or toughened or laminated	(TMT)	...	1	1,069	540	...	...	...	...
371019	Crude steel, ingots	(TMT)	1,984	636	21,500	15,003	57,901	35,032	12.1	8.3

a/ Many production figures are based on UN estimates and some countries are not included in the totals at all. Also there is a wide variation in the definitions of the product groups, some outputs are inevitably allocated to the wrong categories.

b/ Excluding South Africa.

c/ Latin America includes all countries of North America and South America, with the exceptions of Canada, the United States, and Puerto Rico.

d/ Excluding Japan and Israel.

e/ The developing countries of Europe have not been included.

f/ For these materials production is sometimes reported in metric tons and sometimes in cubic meters. Metric ton production shown in this table only represented what was reported to the UNSO in metric ton units.

Abbreviations: TMT = thousand metric tons
TCM = thousand cuybic meters
TSM = thousand square meters
MU = million units

Source: UN Yearbook of Industrial Statistics, 1981 Edition, Volume II, Commodity production data.

2.2 The market for building materials

The building materials industry is subject to direct and indirect influences on the demand for its product. The levels and composition of construction will determine which building materials should be produced and in what quantities. Construction activity, in turn, depends upon such factors as per capita income, investment patterns, credit policies, funding sources and general business conditions. Below, first, world and regional trends in consumption are examined. Then the factors directly affecting the demand for building materials are described.

2.2.1 World trends in consumption and production

Tables 2.3 and 2.4 contain information on production growth rates of certain building materials in ten developing countries. Table 2.3 shows the growth rates for the period 1970-1975 and table 2.4 for 1975-1980. The ten countries vary in size, population, and per capita income. Appendix A contains detailed production data for these countries from 1970-1980. Figures 2.1(a) and 2.1(b) graphically present the growth of construction versus that of GDP, and the growth of three common building materials versus that of construction for these countries for 1970-1975 and 1975-1980.

Except for Saudi Arabia, the growth of construction has been somewhat less than the growth of GDP during 1970-1975, while in the later period only in Kenya and India did construction growth lag behind GDP growth. The data also indicate that the production of building materials has not grown as fast as construction, which means it is likely that these countries had to meet the increased demand for building materials with increased imports. From 1975 to 1980, construction in Egypt grew at an annual rate of more than 40 per cent, while production of basic building materials fell far behind. In some cases, as for brick and plywood, production has actually decreased.

Table 2.5 contains information on the consumption of cement in selected regions of the world. Columns 4 and 5 show that in North America and Latin America, a balance exists between the production and consumption of cement. Europe, however, exports a surplus of cement, and the Middle East meets its

Table 2.3. Annual growth rates in real GDP, construction and building materials production in selected developing countries, 1970-1975

	Argentina	Egypt[a]	India	Kenya[a]	Republic of Korea	Malaysia	Mexico	Saudi Arabia	Thailand
Population	1.3		2.2		1.8	2.8	3.5	-1.3	2.9
GDP	2.9		3.0		9.5	10.4	6.5	11.6	6.3
Construction	1.0		0.8		7.7	10.6	6.9	28.2	-0.4
<u>Building materials production</u>:[b]									
Plywood	4.9		-0.2		5.0	15.4	2.8		1.6
Glass			-0.6		4.2		8.1		5.6
Building bricks of clay					10.4				
Quicklime								6.6	
Cement	2.4		3.1		11.9	7.0	9.0	11.3	8.6
Asbestos and cement articles			6.1						
Concrete blocks					12.8				
Crude steel, ingots	1.8		4.8		33.1		6.2		42.6
Angles, shapes, etc.	2.1				16.3	2.4	7.4		
Aluminium			0.8		2.9		3.3		
Nails, screws, etc.					16.0				
GDP/capita	1.5		7.5		7.6	7.4	3.0	13.1	3.3
Construction/capita	-0.4		-1.4		5.7	7.6	3.3	29.8	-3.2
<u>Building materials production</u>:[b] (per capita)									
Plywood	3.5		-		3.1	12.3	-0.6		-1.2
Glass			-2.7		2.3		4.4		2.8
Building bricks					8.2				
Quicklime								8.0	
Cement	1.0		0.9		9.9	4.1	5.4	12.8	5.6
Asbestos and cement articles			3.9						
Concrete blocks					11.1				
Crude steel, ingots	0.5		2.5		30.8		2.6		38.7
Angles, shapes, etc.	0.8				13.8	-	3.8		
Aluminium			-				-		
Nails, screws, etc.					14.9				

a/ Data not available.
b/ Measured in physical output.

<u>Notes</u>: GDP, construction in constant currency values. Data for Egypt are available for 1975-1979 only. ISIC based codes: Plywood-331116; glass-362001; building bricks-369101; quicklime-369201; cement-369204; asbestos and cement articles-369901; concrete blocks-369913; crude steel, ingots-371019; angles, etc.-371035; aluminium-372022; nails, etc.-381913.

<u>Sources</u>: United Nations, <u>Statistical Yearbook 1981</u> (Population); United Nations, <u>Yearbook of National Accounts 1981</u> (GDP, Construction); United Nations, <u>Yearbook of Industrial Statistics 1979 and 1981</u> (Building materials production).

Table 2.4. Annual growth rates in real GDP, construction and building materials production in selected developing countries, 1975-1980

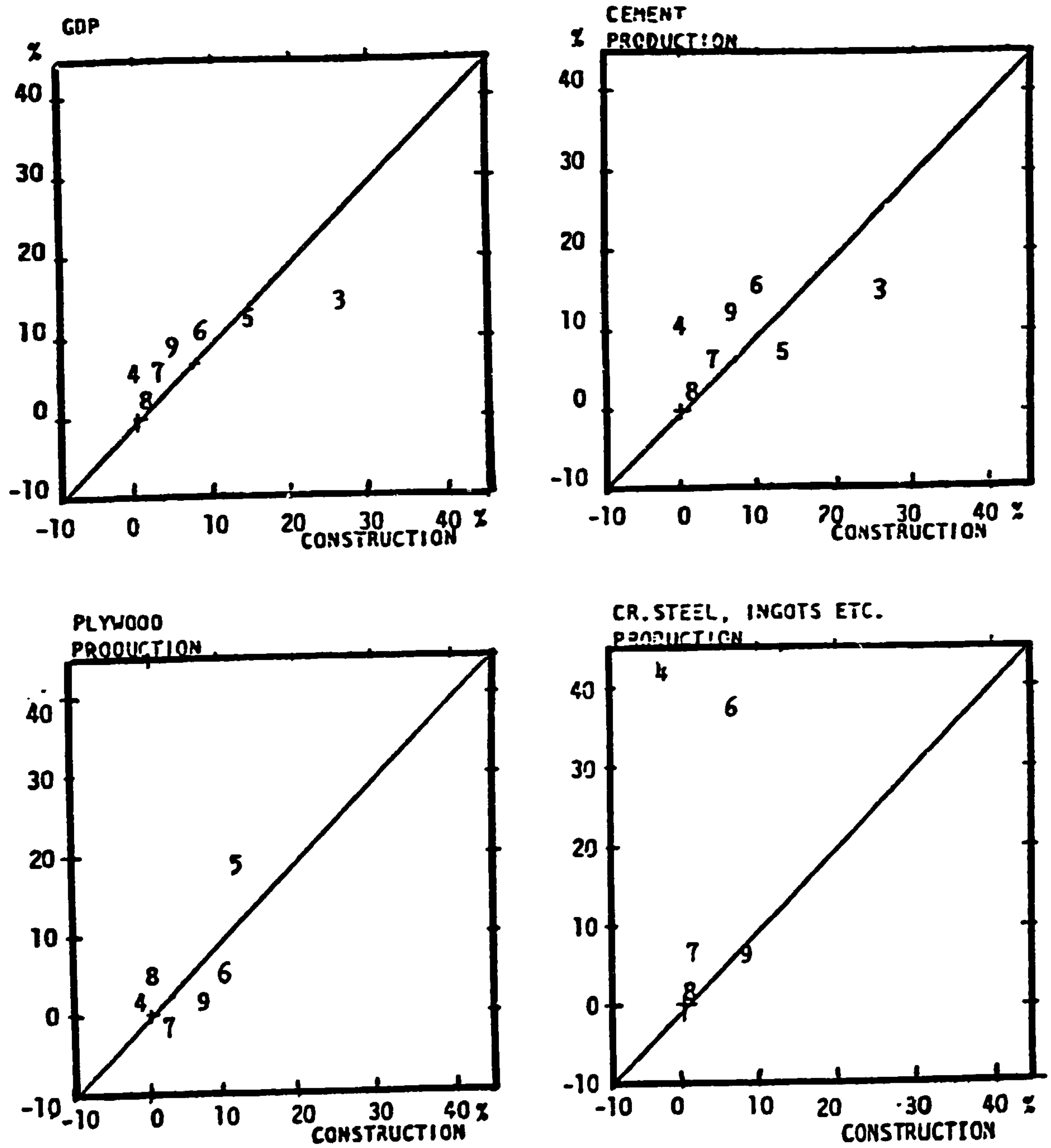
	Argentina	Egypt[a]	India	Kenya[a]	Republic of Korea	Malaysia	Mexico	Saudi Arabia	Thailand
Population	1.3	2.7	2.0	4.2	1.6	2.4	3.6	2.8	2.4
GDP	2.0	8.6	3.4	5.2	7.6	8.6	6.6	9.3	7.6
Construction	6.8	28.0	1.8	4.4	12.2	12.6	7.2	11.4	14.3
<u>Building materials production</u>:[b]									
Plywood	-2.8	-6.9	7.2	3.4	3.4	3.9	18.2		11.8
Glass			10.2		13.3		5.6		
Building bricks of clay		-9.2		-4.4	-6.3				
Quicklime		1.8	17.3		16.0			22.8	
Cement	6.3	0.4	1.8	7.4	9.1	10.2	7.9	23.8	6.2
Asbestos and cement articles			5.8				6.9		
Concrete blocks				46.8	43.7				
Crude steel, ingots	4.9	23.1	3.5		23.2		6.2		14.0
Angles, shapes, etc.					19.3	7.6	4.2		
Aluminium	43.3	167.2	2.0		3.7		1.3		
Nails, screws, etc.		6.2	0.8		24.5				
GDP/capita	0.7	5.8	1.4	0.9	5.9	6.0	2.9	6.2	5.0
Construction/capita	5.4	24.4	-0.2	0.2	10.5	10.0	3.4	8.3	11.6
<u>Building materials production</u>:[b] (per capita)									
Plywood	-4.0	-	5.2	-0.7	1.8	1.5	14.0		9.2
Glass			8.0		11.3		1.9		
Building bricks		-11.6		-8.3	-7.6				
Quicklime		-11.6	14.9		14.5			19.3	
Cement	5.0	-2.2	-0.2	3.0	7.4	7.6	4.1	20.3	3.7
Asbestos and cement articles		-	3.7				3.1		
Concrete blocks				40.9	41.3				
Crude steel, ingots	3.5	19.9	1.5		21.3		2.4		11.3
Angles, shapes, etc.					17.5	5.3	0.5		
Aluminium	41.4	123.6	-		3.7		-2.2		
Nails, screws, etc.		-	-		22.9				

a/ Annual growth rate 1975-1979.
b/ Measured in physical output.

<u>Notes</u>: GDP, construction in constant currency values.
ISIC based codes: Plywood-331116; glass-362001; building bricks-369101; quicklime-369201; cement-369204; asbestos and cement articles-369901; concrete blocks-369910; crude steel, ingots-371019; angles, etc.-371035; aluminium-372022; nails, etc.-381913.

<u>Sources</u>: Supporting data shown in annex tables B.1-B.9.

Figure 2.1.(a) Annual growth rates of GDP and cement, plywood and steel production in selected countries, 1970-1975

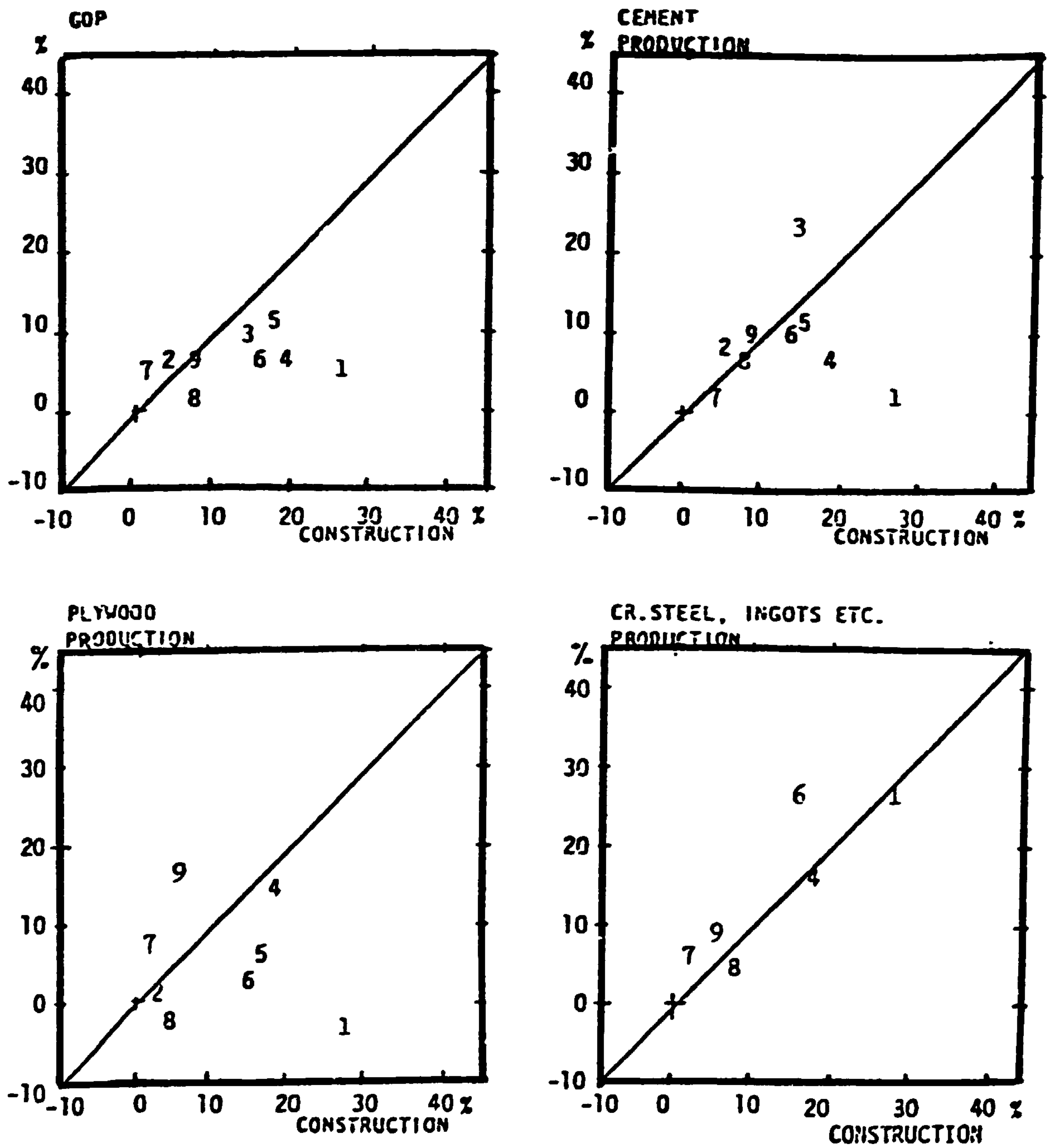


Notation:

1 Egypt (no data 1970-1975)
2 Kenya
3 Saudi Arabia
4 Thailand
5 Malaysia
6 Republic of Korea
7 India
8 Argentina
9 Mexico

Source: Based on table 2.3.

Figure 2.1.(b) Annual growth rates of GDP and cement, plywood and steel production in selected countries, 1975-1980



Notation:

1 Egypt
2 Kenya
3 Saudi Arabia
4 Thailand
5 Malaysia
6 Republic of Korea
7 India
8 Argentina
9 Mexico

Source: Based on table 2.4.

deficit by importation.[18/] The Far Eastern countries are self-sufficient. An interesting point in table 2.5 is the ratio of consumption per capita to construction per capita, which shows that in North America and Europe, both of which have fully developed infrastructure systems, cement consumption relative to construction expediture is much lower than in most other parts of the world.

Figure 2.2 presents information on construction per capita, and production and consumption for cement per capita versus GDP per capita. It is clear that per capita consumption of cement (except for Japan) seems to level off at a GDP per capita of around $US 5,000. Construction per capita seems to be directly related to the growth of GDP/capita, while consumption levels off at about $US 5,000 per capita. Comparison of these figures again indicates that as income increases, either a downward shift occurs in the relative consumption of cement, or material costs become a smaller fraction of total construction cost as other input factors, primarily labour, increase in cost.

2.2.2 Factors influencing demand

The pattern of construction output. Because different facilities use different building materials, and in different proportions, the composition of construction output will be a factor in the demand for building materials. Table 2.6 shows the patterns of material inputs into construction projects in Kenya, disaggregated by the type of construction. As is readily apparent, civil engineering is a relatively large consumer of steel and aggregate. Non-residential buildings also consume large proportions of steel, though to a lesser extent than infrastructural projects. The second most important material in these buildings is cement. Housing consumes proportionally more wood, paints, tiles and various finished products, such as plumbing fixtures and electrical installations, than civil engineering projects.

18/ As a result of the recent slowdown in construction in the Middle East and the great emphasis that region has placed on developing a domestic capacity in the production of cement and other building materials, the cement imports to that market seems to have fallen substantially and may have been completely eliminated. Some experts believe that the Middle East, especially the Arab countries excluding Egypt, could well become cement-surplus markets.

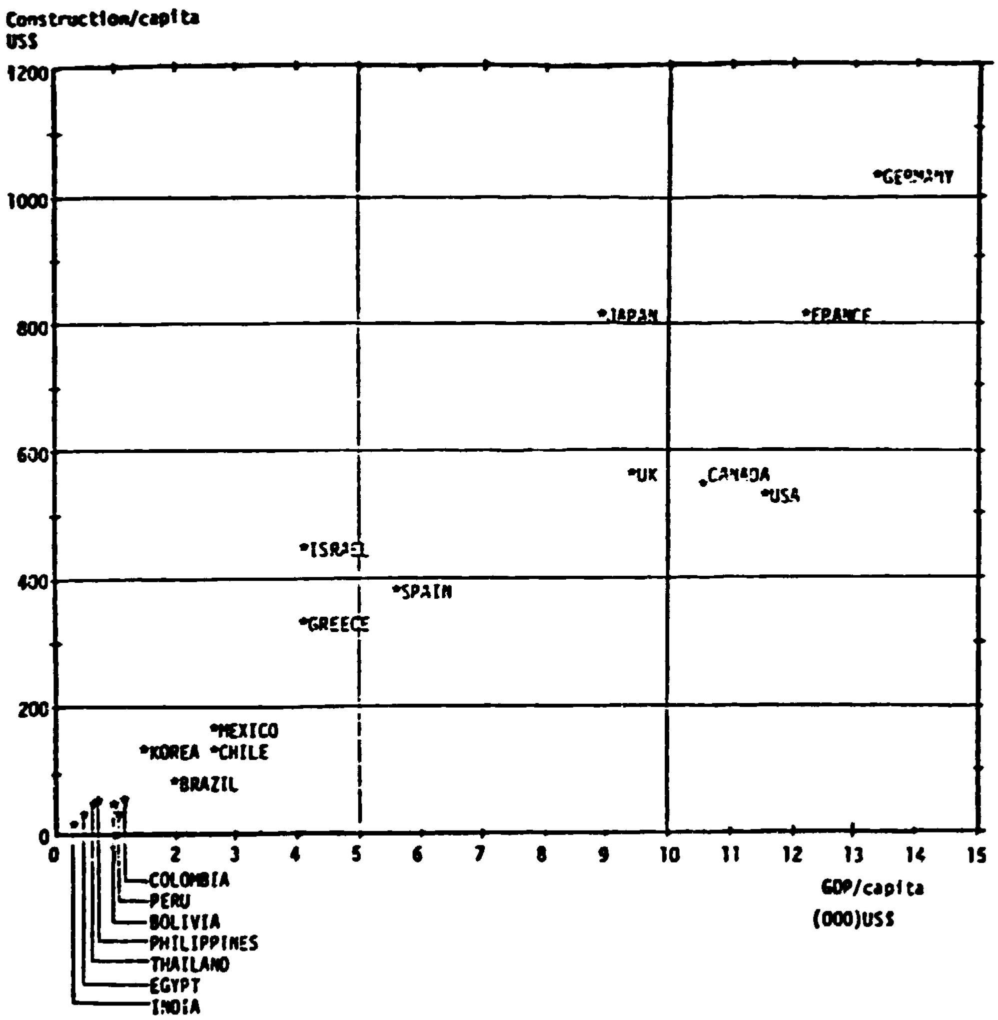
Table 2.5. Production and consumption of cement in relation to various economic indicators, selected countries, 1980

Country	GDP	Per capita figures in $US: Construction activity	Cement production	Cement consumption	Ratio of prod. to constr.	Ratio of consumpt. to constr.
North America						
United States	11,416	539	20	21	0.037	0.039
Canada	10,582	553	26	26	0.046	0.047
Europe						
Greece	4,181	318	55	33	0.173	0.103
Germany, FR	13,306	1,036	37	36	0.036	0.035
United Kingdom	9,355	542	25	24	0.047	0.045
Spain	5,618	391	41	30	0.105	0.077
France	12,137	806	39	36	0.048	0.045
Latin America						
Colombia	1,237	59	9	8	0.159	0.136
Argentina	5,657	479	63	63	0.131	0.132
Bolivia	983	40	4	4	0.103	0.103
Peru	1,082	31	7	5	0.212	0.154
Mexico	2,591	167	25	25	0.150	0.151
Chile	2,529	128	17	17	0.134	0.134
Brazil	2,021	99	11	11	0.109	0.108
Far East						
Thailand	709	41	7	7	0.161	0.159
Philippines	733	57	20	20	0.358	0.345
India	241	10	2	2	0.183	0.204
Rep. of Korea	1,528	139	26	20	0.185	0.141
Japan	8,873	811	60	57	0.074	0.070
Middle East						
Egypt	422	22	6	10	0.272	0.430
Israel	4,177	456	33	41	0.072	0.090

Note: The ratios are estimated using non-rounded per capita figures.

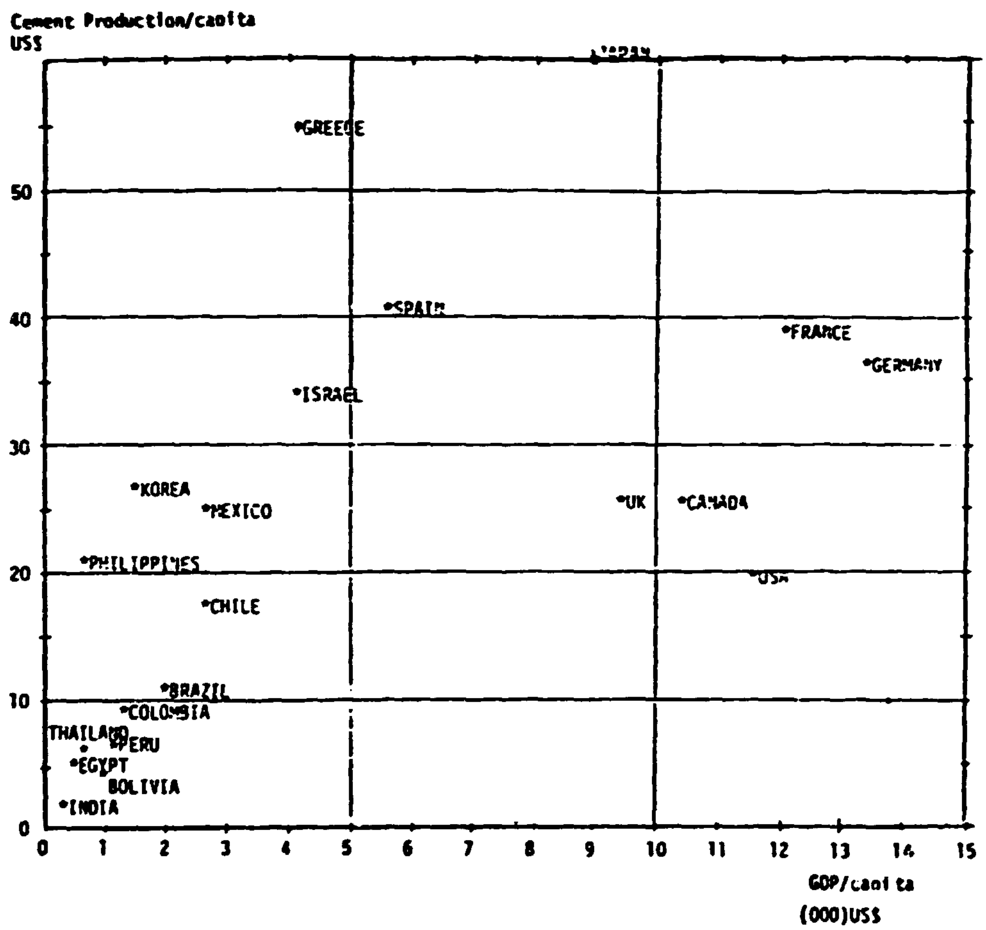
Sources: United Nations, Yearbook of Statistics 1981 (New York, 1981); United Nations, Yearbook of National Accounts 1981 (New York, 1981); United Nations, Yearbook of Industrial Statistics 1981 (New York, 1981); United Nations, Yearbook of International Trade Statistics 1981 (New York, 1981); International Monetary Fund, International Trade Statistics, February 1984; Engineering News Record, 4 September 1980 and 18 September 1980.

Figure 2.2. The ratio of construction, cement consumption and cement production per capita to GDP per capita in selected countries, 1980



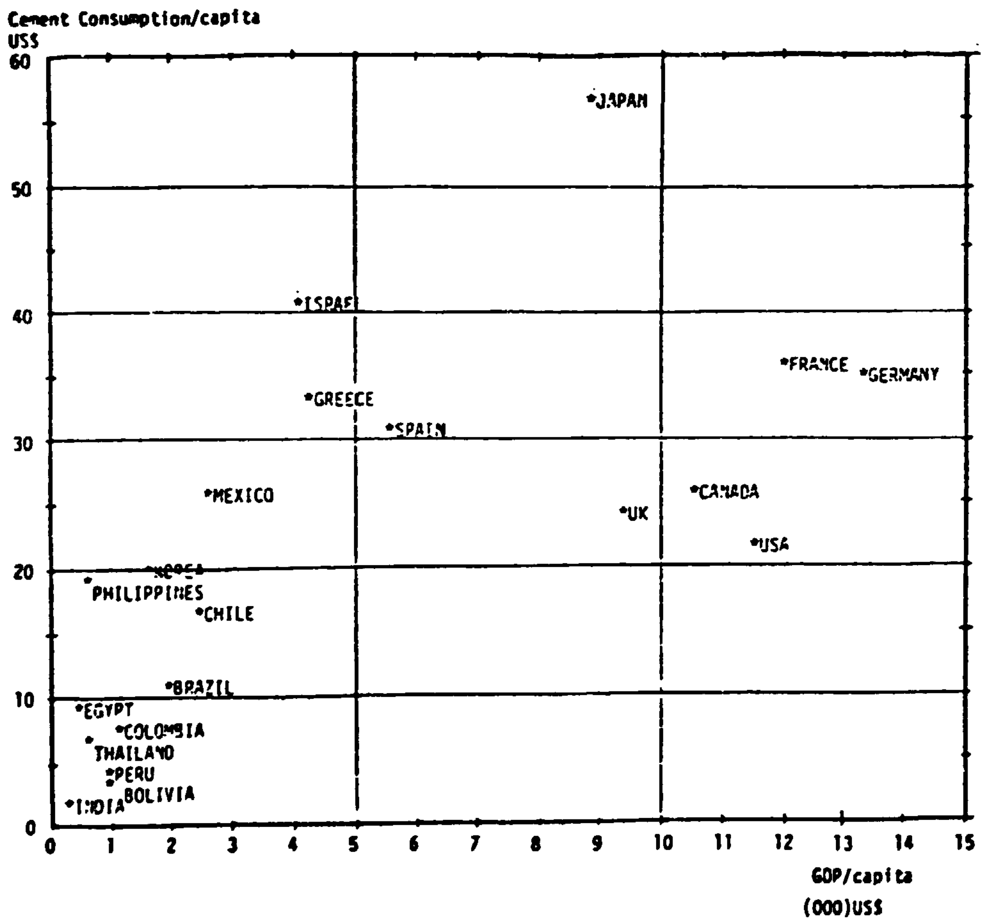
Construction per capita vs GDP per capita

Figure 2.2. The ratio of construction, cement consumption and cement production per capita to GDP per capita in selected countries, 1980 (continued)



Cement production per capita vs GDP per capita

Figure 2.2. The ratio of construction, cement consumption and cement production per capita to GDP per capita in selected countries, 1980 (continued)



Cement consumption per capita vs GDP per capita

Source: Based on table 2.5.

Table 2.6. Materials inputs as a percentage of total expenditure for three types of construction projects in Kenya

Type of input	Residential buildings	Non-residential buildings	Civil engineering
Sand	4.60	6.40	2.98
Aggregate	5.60	5.20	9.94
Cement	10.00	13.40	2.98
Hydrated lime	-	-	2.39
Concrete products	6.00	3.80	2.78
Hardcore filling	1.50	0.90	-
Wood products (timber, doors, etc.)	8.90	3.00	0.40
Steel products	3.00	17.90	22.88
Hardware and windows	4.50	2.90	2.98 a/
Paints	8.20	2.20	
Glass	1.00	1.30	-
Floor tiles	5.20	1.65	-
Roofing materials	4.10	2.30	-
Plumbing and sanitary fixtures	7.80	5.00	-
Electric installations	5.20	2.05	-
Explosives	-	-	2.98
Fuels, bitumen and lubricants	-	-	2.40
Total all materials	75.60	68.00	52.71

a/ Includes paints.

Source: United Nations Centre for Human Settlements, Nairobi, Kenya, Role and contribution of the construction industry to socio-economic growth of developing countries, Cambridge, Massachusetts: CMT Inc., November 1980 (revised April 1982), IV-44.

<u>Technological change</u>. The pattern of usage of building materials depicted above will prevail only as long as the technologies of construction and of building materials production remain stable.

Three examples of advances in construction that may affect future demand for building materials in Egypt may be cited. A study from 1977 showed that pre-fabricated housing was to be introduced in Egypt in the late 1970s.[19/] Its manufacture was to have begun in ten new factories purchased by the government in 1977. By 1980, these new plants were to have been operating at full capacity, producing 2000 housing units per year. It was estimated that 12 tons of cement would be needed for each pre-fabricated unit, so that each factory would use a total of 240,000 tons of cement per year. This type of housing was expected to consume more than 100 kg more cement per square meter than housing built by conventional methods. The use of cement was also expected to be more intensive in a second technological innovation, pre-cast concrete components, already used in Egypt for panels and slabs in industrial buildings. Off-setting the effects of these two advances would be an increase in ready-mix operations, which deliver pre-mixed concrete to the work-site. The unreliable quality of site-mixed concrete has often led builders to draw up specifications that require excessive amounts of cement to ensure proper strength. This practice could be eliminated with pre-mixed concrete, thereby reducing the consumption of cement per unit.

Changes in the technology of building materials production could affect patterns of consumption and demand through pricing and product substitution. As dynamic technologies bring new building materials within the purchasing ability of low-income consumers, the demand for the products they replace will fall. In Egypt, for example, the introduction of concrete and gypsum blocks

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19/ Cairo University/Massachusetts Institute of Technology, The Joint Research Team on the Housing and Construction Industry, "The housing and construction industry in Egypt", Interim Report Working Papers 1977, TAP Report 78-3, Massachusetts Institute of Technology, Cambridge, Massachusetts, 1978.

has slowed the rate of growth in the demand for bricks. Similarly, the introduction of gypsum panels would probably have a significant effect on the demand for bricks, concrete and gypsum blocks.[20/]

Availability and prices of materials. The availability and prices of building materials are subject to multiple determinants. The first is demand from sectors other than construction. While building materials such as cement are consumed exclusively by the construction sector, other materials are not. Only 42 per cent of total steel usage in the United States in 1976 (based on shipments) was for construction,[21/] although the proportion is probably higher in developing countries. UNIDO[22/] estimated that in the late 1960s, construction accounted for as much as 50 per cent of steel consumption in the developing countries of Asia and the Far East. Similarly, a survey by the Food and Agriculture Organization showed that the proportion of sawnwood used in contruction varied widely, from 40 to 86 per cent. Generally, the proportion was towards the upper limits in those countries with a timber surplus (over 70 per cent), in the middle range for countries with an approximate timber balance (55-70 per cent), and on the lower end of the spectrum for countries with a timber deficit (under 55 per cent).[23/]

A FAO study of wood use in the developed countries in the 1970s[24/] found that construction accounted for roughly 60 per cent of all sawnwood and 50 per cent of all wood-based panels used; nearly half of this amount went into housing. The second most common use of wood was for packaging, while the furniture industry consumed the third largest share of sawnwood and wood-based

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20/ Fred Moavenzadeh and Frances Hagopian, Construction and building materials industries in developing countries, TAP Report 83-19, Massachusetts Institute of Technology, Cambridge, Massachusetts, August 1983.

21/ The world iron and steel industry (second study), prepared by the Sectoral Studies Section, International Centre for Industrial Studies (UNIDO/ICIS/89), 20 November 1978, p. 37.

22/ Industrialization of developing countries: Problems and prospects, Building materials industry (ID/40/3), UNIDO, New York, 1969, p. 17.

23/ Ibid., p. 17-18.

panels of any sector. An increase in the demand for non-construction products such as automobiles or furniture would raise the prices and reduce the availability of steel or sawnwood, respectively.

A second determinant of prices and supplies of building materials relates to world production and consumption trends of these commodities, especially materials with uses other than construction. Commodity gluts and scarcities will affect the world prices for these raw materials and processed goods, which will be reflected in the price structure within developing countries. Where alternative materials are available, upward or downward pressures on prices will affect the demand for the interchangeable material inputs, even as the demand for the final constructed product remains constant.

Finally, in some cases, governments regulate the prices of certain building materials. In Egypt, the government controls not only the price, but also the supply and distribution of cement.[25/] The influence of public policies on consumption are treated below.

For these reasons, it is not surprising to see a wide variation in the prices of building materials on an international, regional, or even national scale. As table 2.7 shows, the price of cement, at a given time, varied from $US 12 per metric ton in Buenos Aires to $US 90 per metric ton in Amman, Jordan. Price disparities this great could certainly have a great influence on international trade in building materials and therefore on the availbility (and prices) of these materials in developing nations. If information such as this were to become available on a regular basis, the results would be a boost to international trade and a significant savings to nations that import basic building materials.

24/ Wood resources and their use as raw materials, Sectoral Studies Series No. 3 (UNIDO/IS.399), 3 August 1983, p. 45.

25/ Cairo University/Massachusetts Institute of Technology, The Joint Research Team on the Housing and Construction Industry, "The housing and construction industry in Egypt", Interim Report Working Papers 1977, TAP Report 78-3, Massachusetts Institute of Technology, Cambridge, Massachusetts, 1978, p. 20.

Table 2.7. Prices of building materials in world markets, March 1983 (current $US/metric ton)

	Structural steel	Cement	Lumber	Sand	Gravel	Reinforcing Bars
Europe						
Athens	522.88		381.45	4.44	3.53	360.20
Lisbon	433.18	35.94	87.34	4.69	4.84	364.14
Madrid	399.83	43.14	236.76	4.75	4.40	362.70
Paris	346.04	46.62	128.06	13.04	12.51	281.29
United States						
Chicago	388.01	73.05	103.44	4.96	4.88	385.81
Dallas	869.72	63.93	133.47	6.70	10.20	429.90
San Francisco	779.11	71.76		8.98	9.24	
Latin America						
Buenos Aires	85.00	11.71				126.00
Mexico City	143.75					137.74
Santiago				11.19	11.19	
Asia						
New Delhi	515.79	57.62	551.21	4.71	7.06	505.26
Seoul	477.94	64.96	337.23	5.07	3.08	378.17
Taipei	542.93	68.51				328.28
Tokyo	383.27	68.09	210.12	11.57	11.57	214.01
Middle East						
Amman	554.64	90.16	259.56	15.03	7.17	457.65
Cairo	518.29	67.07	390.24	5.04	12.20	463.41
Istanbul	255.23	27.19	151.06	2.31	2.66	253.78

Source: Engineering News Record, "First quarterly cost roundup: Focus on Europe", 24 March, 1983.

Trends in product substitution. To assess the relationship between construction and the demand for building materials, it is necessary to take into account the possibility of substituting other inputs for materials whose prices have risen or whose supplies have been curtailed. The range of materials suitable for civil engineering projects is normally limited. Cement, steel, bitumen and a variety of aggregates and filling materials are the sub-sector's main-stay, although steel, wood and concrete are somewhat interchangeable for pilings and certain spanning structures, and bitumen may be used in place of cement as a binder in roads.

In contrast to some civil engineering structures, such as roads and dams, a wide range of substitutions even among conventional building materials is possible for residential buildings. Newly processing methods for indigenous materials add to the possibilities. For example, gypsum wallboards may be substituted for bricks in interior walls in countries, where gypsum is widely available. Pre-fabricated wall panelling could be used in the interior walls of commercial buildings instead of bricks or concrete panels. Finding alternatives for conventional materials for roofing, exterior and interior walls and floors is basic to any strategy for constructing more low-cost housing in developing countries in the coming years.

Government policies and regulations. Public policies in many areas affect the demand for building materials. Mentioned above were the regulation of price, supply and distribution. Related to this are importing and exporting policies. Incentives to export certain building materials (or their raw materials) will result in increased prices and reduced consumption of these items domestically, while tariffs on imports will raise the domestic price of the protected product.

The role of the government as a purchaser should also be considered. Major defense or public engineering works may completely alter the nature of demand for building materials by requiring heavy imports or severely retarding other construction works by creating shortages of materials.

2.2.3 Forecasting demand for building materials

The direct and indirect influences on the demand for building materials reviewed above should serve as a basis upon which to project demand for these materials. Adequate methods of predictions of demand are necessary for planning the installation or expansion of production facilities in developing countries. The pesent section will discuss methods for projecting the demand for building materials as a tool in national planning. In section 5.1 a projection of the construction and building materials sectors is presented.

Trends in consumption. The simplest method for forecasting demand is to extrapolate from past trends in consumption for each material, or from trends in consumption in countries that have passed through a similar stage of development. In either case, data for a number of years are required to establish trends.

Past consumption, however, does not take into account unsatisfied demand. For example, in India in the mid-1970s, whatever cement was being produced domestically and offered for sale at official prices was quickly being consumed. The Cement Research Institute of India conjectured that because of limited domestic production capacity and restrictions on imports, the nation's unsatisfied demand for cement (at international prices) in 1978 was approximately 3 million tons.[26/]

A second, more fundamental, drawback to projecting demand on the basis of past trends is that they are typically not very stable.

Projecting demand on the basis of past consumption is the simplest but weakest approach to forecasting. Rather, the demand for building materials needs to be linked to cycles of economic activity and to the demand for construction.

26/ Appropriate technology for the production of cement and building materials: Strategies for development of cement and allied industries in developing countries (ID/WG.282/2), Working Group No. 5, background paper for the International Forum on Appropriate Industrial Technology, New Delhi/Anand, India, 20-30 November 1978, p. 27.

Regression analysis and macroeconomic trends. Perhaps the most commonly used method to forecast demand for building materials is regression analyses correlating growth in the consumption of building materials with the growth of macroeconomic variables such as GDP per capita or gross fixed capital formation. Studies suggest that some building materials are linked more closely than others to macroeconomic indicators, and that gross fixed capital formation may be a better predictor of demand for building materials than gross domestic (or national) product. However, since any variables on which the forecast for building materials depends must themselves also be known (i.e. forecast), it may not be practical to include too much disaggregation in specifying the forecast model.

Fifteen years ago, Turin related per capita consumption of key building materials to gross national (or domestic) product or gross domestic capital formation (GDCF).[27/] The results of his analyses, provided in table 2.8, reveal that consumption of wood-based panels (plywood, particle board) and plastics, two relatively new building materials in the early 1960s to be conditioned less by changes in macroeconomic variables than other building materials are. Rather, panels, for example, were coming into increasing use as a substitute for sawnwood. Consumption of plastics was increasing rapidly as they were being substituted for other building materials.[28/] While the consumption of wood panels and plastics have since fallen in line with overall economic growth, the consumption of other new products must be expected to grow more rapidly than other building materials in the early phase of the product cycle as they are substituted for more costly or lower-quality goods.

27/ Only first- or second-order equations were found to be necessary. The regression equations were of the form:

$$\log y = a \log x + b$$
or
$$\log y = c \log x - d(\log x)^2 + e$$

where: y = per capita consumption of a given building material;
x = GNP, GDP, or GDCF in construction, measured in US dollars per capita;
a, c, d = regression coefficients;
b, e = regression constants.

28/ Industrialization of developing countries: Problems and prospects, Building materials industry (ID/40/3), UNIDO, New York, 1969, p. 15-21.

Table 2.8. Summary results of regression analysis of trends in consumption of building materials

Dependent variable a/ log y	Year	Independent variable b/ x	Number of countries	Regression coefficients for log x	for (log x)2	Constant term	Per cent of variance explained
Cement	1965	GNP	100	1.02	-	-0.58	78
				3.22	-0.43	-3.27	81
Cement	1965	GDCF	42	0.72	-	0.91	87
				1.62	-0.26	0.22	90
Cement	1960	GDCF	26	0.82	-	0.71	90
				1.50	-0.21	0.24	92
Cement	1965	GDCF	26	0.75	-	0.83	90
				1.48	-0.21	0.30	92
Steel	1965	GNP	69	1.42	-	-1.92	87
Steel	1960	GDCF	20	0.83	-	-0.05	93
Sawnwood	1961	GDP	25 b/	1.21	-	-1.31	86
Sawnwood	1965	GNP	73	1.51	-	-2.39	85
Wood panels c/	1961	GNP	25 b/	1.51	-	-2.26	85
Plastics c/	1965	GNP	22	1.20	-	-1.23	78

a/ Expressed in kg per capita except for wood products which are in 1,000 m^3 per capita.

b/ Subregions, not countries.

c/ Equations in form: log y = a log x + b.

Source: Industrialization of developing countries: Problems and prospects. Building materials industry, based on the Proceedings of the International Symposium on Industrial Development, Athens, November-December 1967 (ID/40/3), United Nations, New York, 1969.

The discussion which follows makes use of the concept of elasticity of demand. This is a measure of how the quantity demanded of a commodity responds to changes in another variable such as price or income. Specifically it is defined as the percentage change in quantity demanded divided by the percentage change in the other variable, e.g. price or income. Thus, to say that the income elasticity of the demand for cement is equal to one means that, other things being equal, if income increases by 10 per cent then the quantity demanded of cement will also increase by 10 per cent. In the case of price elasticity an increase in quantity demanded corresponds to a decrease in price, sometimes the sign is ignored so that saying the price elasticity of demand is two would mean that, other things being equal, if price falls 1 per cent then quantity demanded would increase by 2 per cent.

For cement and steel, Turin's regression analysis confirmed the existence of a non-linear relationship between consumption and changes in GNP and GDCF per capita. The elasticity of cement consumption, found to decrease with an increasing GNP, was equal to one when GNP was approximately $US 390 per capita (in 1965 dollars) and cement consumption was 148 kilograms per capita. Below this, cement consumption increased faster than GNP, and above this, slower. The elasticity of steel consumption was equal to one when the GNP was about $1,600 per capita (in 1965 dollars) and steel consumption was 480 kilograms per capita.

Expenditure on construction as measured by fixed capital formation was found to explain an even greater percentage of variance in the demand for cement than did GNP. Data from 41 countries for 1965 revealed that the construction elasticity of cement consumption was unity when the expenditure on construction in GDCF was approximatey $US 16 per capita (1965) and cement consumption stood at 60 kilograms per capita. Moreover, a review of figures for 1960 and 1965 for 26 countries for which data were available showed no significant difference between the relationship in the two years, suggesting that the relationship between cement consumption and expenditure on construction is fairly stable.[29/] The construction elasticity of steel

29/ *Op. cit.*, p. 16.

consumption, on the other hand, appeared to be less than unity, meaning that the rate of growth of steel consumption in construction was less than the rate of growth of experditure on the GDCF in construction.[30/]

But the world-wide recession in the steel industry which began in the late 1970s may invalidate forecasting methods based on general economic indicators. For many years, future demand for steel had been estimated by a steel intensity curve which linked the consumption of steel to the level of the per capita gross national product. The success of this method depended on long and regular growth and on a strong relationship between the rise in the consumption of steel and the rise in national income. When demand for steel slumped far longer than in normal steel cycles, this relationship could no longer be assumed.

The International Iron and Steel Institute discovered there was actually a low degree of correlation between per capita national products and the level of steel consumption in developing countries. Analysis of the Republic of Korea, Mexico, Brazil, Iran, the Philippines, Colombia and Tunisia showed that the Republic of Korea had the highest steel intensity, whereas it had (in 1963 prices) a low level of per capita national product. In contrast, Mexico had a relatively low steel intensity and the highest per capita national product in the developing countries under review.[31/]

An even higher correlation exists between the pattern of construction output, which can be expected to shift as development proceeds, and the demand for building materials. Cement and steel, which are used more heavily in civil engineering and industrial and commercial buildings than in housing, will be in greater demand in the earlier stages of development, while the demand for building materials with more extensive usage in housing can be expected to rise in later stages.

30/ Ibid., p. 17.

31/ The world iron and steel industry (second study), prepared by the Sectoral Studies Section, International Centre for Industrial Studies (UNIDO/ICIS/89), 20 November 1978, p. 24.

Input-output and final demand analysis. Analysis based on input-output tables can also be used to forecast demand for building materials. Forward linkages for building materials are registered in full as deliveries to the construction sector. Tables 2.9, 2.10, and 2.11 demonstrate to what extent the demand for specific building materials can be expected to rise commensurate with increases in the gross output of the construction sector, while figure 2.3 shows the pattern of inputs to construction of various building materials in numerous developing countries. Based on past patterns, then, it should be possible to predict the types and quantities of building materials that will be needed to achieve a given increase in construction activity.

Despite these advantages, there remain drawbacks to the use of input-output tables for forecasts. The assumption of zero substitution among the inputs of production is obviously a gross simplification. Price changes and the development of new materials suggest that substitutions occur as a matter of course in production. Gypsum may replace brick as a material for interior partitions, as cited earlier in the case of Egyptian housing. There are other problems relating to the expense in collecting the basic data and the time required between the beginning of the data collection period and the publication of the final table - typically, for a large model this is 6 to 10 years. Also there is a problem in ensuring the basic integrity of the data. This stems from various sources which include: (a) joint production of various commodities within the same establishment, which makes it difficult to assign specific inputs to each output; (b) establishments may not be willing to diligently answer the survey questions; and (c) the data set itself is large and difficult to manage, so there are a lot of opportunities for simple clerical errors to creep in. Also, it is difficult to account for deliveries recorded in the informal economy. Yet it is well known that housing production in the informal sector is considerable. Finally, the level of aggregation may make it difficult to isolate effects on an individual product.

Nonetheless, input-output analysis is a useful technique, linking changes in building materials production to changes in construction or changes in final demand, as e.g. residential construction, private and public investment, etc.

Table 2.9. Construction sector purchases from other sectors per thousand Kenyan Pounds of gross output - Kenya 1976

Sector[a]	Increases in intermediate outputs, by sector, in thousand Kenyan Pounds
Mining	42
Wood furniture	26
Paper/printing	7
Petroleum products	92
Rubber products	7
Paint/detergents	14
Other chemicals	17
Non-metallic products	86
Metals-machinery	156
Transport - B & R	14
Electricity - Supply	5
Construction	119
Trade	47
Transport services	17
Restaurant/hotel	12
Financial services	30
Business - Premises	5
Other intermediate	17
Total intermediate	713
Wages and salaries	233
Other inputs	54
Total primary inputs	287
Gross output	1,000

a/ Sector divisions are taken from the 1976 input-output table for Kenya.

Source: United Nations Centre for Human Settlements, Nairobi, Kenya, Role and contribution of the construction industry to socio-economic growth of developing countries, Cambridge, Massachusetts: CMT Inc., November 1980 (revised April 1982).

Table 2.10. Construction sector purchases from other sectors per thousand Mexicans Pesos of gross output - Mexico 1970

Sector[a]	Increases in intermediate outputs by sector in thousand Mexican Pesos
Quarrying	12
Wood processing	39
Other wood products	6
Oil refining	18
Other chemicals	17
Rubber products	3
Plastic products	8
Glass	4
Cement	29
Non-metallic mining products	103
Basic iron/steel	63
Non-ferrous metals	7
Furniture	3
Metal structures	20
Other metal products	18
Non-electrical equipment	8
Other equipment - Elec.-AC	4
Electricity	3
Trade	78
Transport	38
Financial services	5
Professional services	10
Other services	5
Other intermediate	9
Total intermediate	510
Wages	304
Other value added	179
Indirect taxes	7
Gross value added	490
Gross output	1,000

a/ Sector divisions are taken from the 1970 input-output table for Mexico.

Source: United Nations Centre for Human Settlements, Nairobi, Kenya, Role and contribution of the construction industry to socio-economic growth of developing countries, Cambridge, Massachusetts: CMT Inc., November 1980 (revised April 1982).

Table 2.11. Construction sector purchases from other sectors per thousand Greek Drachmas of gross output - Greece 1970

Sector[a]	Increases in intermediate outputs by sector in thousand Greek Drachmas
Agriculture	6
Mining, etc.	41
Wood	44
Plastic	14
Chemicals	6
Oil	13
Cement	49
Glass	12
Non-metal	84
Basic metal	34
Metal	86
Electrical	59
Transportation	21
Trade	30
Financial	6
Other intermediate	15
Total intermediate	520
Wages - salaries	221
Social security	32
Other income	176
Indirect taxes	51
Total primary inputs	480
Gross outputs	1,000

a/ Sector divisions are taken from the 1970 input-output table for Greece.

Source: United Nations Centre for Human Settlements, Nairobi, Kenya, *Role and contribution of the construction industry to socio-economic growth of developing countries*, Cambridge, Massachusetts: CMT Inc., November 1980 (revised April 1982).

Figure 2.3(a). Construction sector domestic purchases from other sectors - shares of supplying sectors

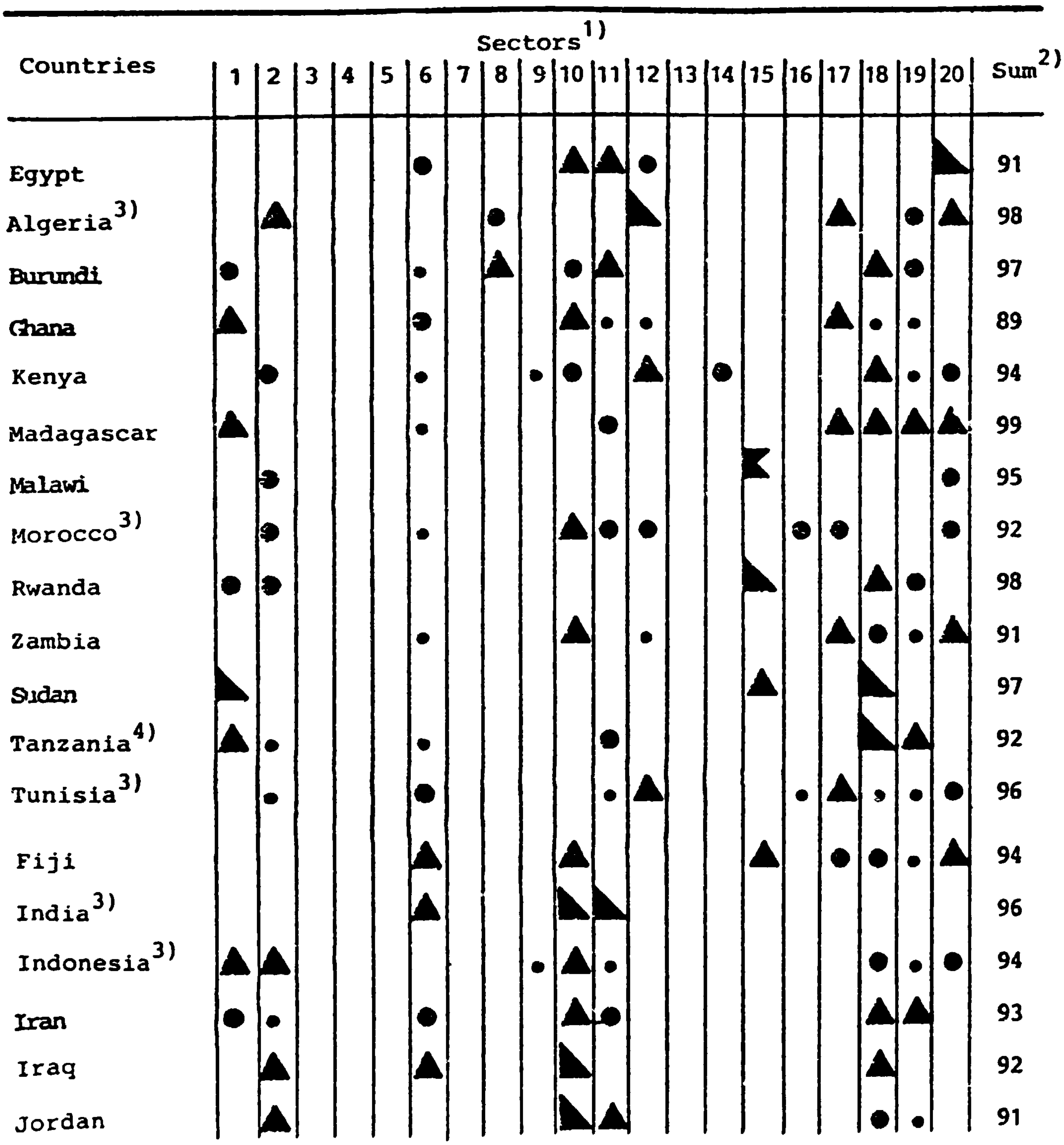

Figure 2.3(a). Construction sector domestic purchases from other sectors - shares of supplying sectors (continued)

Countries	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Sum[2)
	Sectors[1)																				
Korea (Rep.)	•	•				●		•	•	▲	▲		•					●	●		89
Malaysia (West)	•					▲				▲	•	●				•		▲			78
Philippines		•				▲				▲	●		•					▲		●	91
Singapore[3)		•				●			•	▲	▲		•				●		•	▲	95
Sri Lanka		●				●				▲	▲							▲	●		97
Syria		•				▲		•		▲					•			▲		•	94
Taiwan		●				●				◣	●		•					●	●		93
Argentina						▲			•	◣	▲									●	99
Bolivia		▲							●						◣			▲	•	•	100
Chile		●				●		•		◣	▲								•	•	93
Ecuador[3)		◣													◣				●	•	100
Columbia		•				•		●		◣	●		●							▲	93
Mexico						●				▲	▲	▲						▲		•	94
Peru						▲				◣	▲										94
Trinidad and Tobago									●						◣			▲	●		98

Note:

• : 3 - 7 %
● : 8 - 13 %
▲ : 14 - 25 %
◣ : 26 - 50 %
⧗ : 51 - 75 %

1) For sector definition see figure 2.3.(b).
2) Sum of indicated shares in per cent.
3) Imported supplies included.
4) Sansibar excluded.

Source: Long-term forecasting and planning of the construction and building materials industries, prepared by Jurgen Riedel (ID/WG.425/2, July 27, 1984).

Figure 2.3(b). Economic sectors (UN-classification)

Nr.	Sector	ISIC 1958	ISIC 1968
1	Agriculture, forestry, fishing	01-04	11-13
2	Mining and quarrying	11-14, 19	21-23, 29
3	Food, beverages, tobacco	20-22	31
4	Textile, wearing apparel	23, 24	32 ./. 323
5	Leather	29	323
6	Wood, furniture, paper, printing, publishing products	25-28	33, 34
7	Rubber	30	355
8	Chemical, plastic products	31	351, 352, 356
9	Petrochemicals	32	353, 354
10	Non-metallic minerals	33	36
11	Basic metals, metal products	34, 35	37, 381
12	Non-electrical machinery	36	382
13	Electrical machinery	37	383
14	Transport equipment	38	384
15	Others	39	385, 39
16	Electricity, gas, water	51, 52	41, 42
17	Construction	40	50
18	Trade	61	61, 62
19	Transport, storage, communication	71-73	71, 72
20	Other services	62-64, 81-85	63, 81-83, 91-94, 951-953, 959
21	Non defined	90	-

Sources: Statistical Office of the United Nations, ISIC Statistical Papers, Series M, No. 4., Rev.1, 1958 and Statistical Office of the United Nations, ISIC Statistical Papers, Series M., No. 4, Rev.2, Add.1, 1968.

Construction investment and technical studies. Predictions may also be based on the materials required for planned investments in construction. For example, construction projects can be broken down by project type (i.e. low-story buildings, high-story buildings, roads, dams and bridges) and timetables for completion. It is necessary to estimate the amounts of various kinds of building materials that will be needed for these projects. To obtain reliable figures on building materials requirements data on consumption and a survey of current and predicted construction designs would be required in order to develop coefficients that express the proportions of various materials used in each type of construction project.

Table 2.12 provides an illustration of such coefficients for cement consumption for various types of Egyptian housing; table 2.13 shows coefficients for steel and concrete used in single-story factories and medium-span bridges in Europe.

While civil engineering designs are likely to be similar in developed and developing countries, housing designs vary according to the availability and prices of natural resources, as well as national customs. Accordingly, for this approach to work, technical studies would be needed to determine the housing sector's patterns of consumption of building materials on a country-by-country, or perhaps regional, basis.

Forecast accuracy and descision making. There are no methods for forecasting future demand which are 100 per cent reliable. Therefore it is essential to know how operations might be affected by forecast errors. What will happen if the forecast is off by 10 per cent or by 100 per cent? Alternative outcomes need to be built into the decision analysis. One approach is to examine options which are less sensitive to forecast error. The decision maker has to look not only at the best options given the forecast demand levels, but also how sensitive each of those options are to the demand forecasts being wrong.

One of the most common mistakes of decision makers is to treat forecast quantity demanded as a given - a target that must be met at all costs. This is equivalent to treating the demand curve as if it were vertical, i.e.

Table 2.12. Technical coefficients for cement allocation/distribution in housing in Egypt (Standard units of technical coefficients are kg of cement/m^2 of floor area)

1. Standard rule for materials distribution at Government level
   10 tons of cement/1,000 Egyptian Pounds of construction cost (official) - beginning 1972

Housing type	1970-76 official cost E.P./m^2	Technical coefficient for cement-kg/m^2
low cost	8-12	80-120, midpt. 100
middle income	12-16	120-160, midpt. 140

2. Ministry of Housing and Reconstruction from a study by Ahmed Gharib - summer 1977 a/

Skeleton frame or bearing wall construction, assuming 5 floors, excluding foundation	- 119kg cement/m^2
Skeleton frame construction, assuming 5 floors including foundation	- 154kg cement/m^2 (isolated footings)
	- 172.5kg cement/m^2 (raft footing)
Bearing wall construction, assuming 5 floors, including foundation*	- 142kg cement/m^2

3. Expected materials usage in prefabricated units
   Estimates of Dr. Adel Fareed - summer 1977

Shell, including floors, roof, walls	180-220kg cement/m^2
foundation	35-50kg cement/m^2
Total for dwelling	215-270kg cement/m^2

4. Cairo University/MIT preliminary field survey of low income formal and informal housing in Cairo - summer 1977

Zone and housing type	Number of units surveyed	Average area m^2/unit	Technical coefficient for cement kg/m^2
Formal skeleton frame construction			
Abbassayia	22	73	74
Shoubra	38	75	82
Informal, skeleton frame construction			
El Haram	7	51	93
Mataria	17	59	85
Meet Okba	11	30	111
Formal, bearing wall construction			
Helwan	27	58	75
Informal, bearing wall construction			
El Haram	14	51	119
Mataria	31	30	113
Meet Okba	24	30	126

a/ This includes cement for plain ground slab and reinforced roof slabs, columns, beams, foundation items, brick and tile mortars, plastering, and sanitary work.

Source: Cairo University/Massachusetts Institute of Technology, The Joint Research Team on the Housing and Construction Industry, "The housing and construction industry in Egypt", Interim Report Working Papers 1977, TAP(Report 78-3, (Massachusetts Institute of Technology, Cambridge, Massachusetts, 1978), pp. 33-35.

Table 2.13. Steel consumption for single-story factories and medium-span bridges

Type of structure	Range of Bay size (m^2)	Range of Steel consumption (kg/m^2)
Single-story factories		
Steel framed (with heavy cranes)	200-350	30-65
Reinforced concrete	100-500	24-36
Pre-stressed concrete	100-800	15-36
Medium-span bridges[a/]	Bridge-span (m)	
Ordinary steel	20-80	174-475
High-tensile steel	35-80	100-370
Reinforcing steel for deck		20-60
Pre-stressed concrete[b/]	20-70	40-140
Reinforced concrete[b/]	10-50	60-204

a/ Steel consumption for bridges is expressed as kg/m^2 of deck area for given spans.

b/ Including steel in girder and deck.

Source: Industrialization of developing countries. Problems and prospects. Building materials industry. (Based on the Proceedings of the International Symposium on Industrial Development, Athens, November-December, 1967). United Nations, New York, 1969. (ID/40/3) quantity demanded is independent of price. It is important that a forecast provides not only the expected price and quantity demanded but also tells how the expected quantity demanded changes as price changes. Even if the forecast does not provide this information, it is probably a good idea for the decision maker to make his own best guesses just to help clarify thinking and to avoid the often alluring trap of treating quantity demanded as being independent of price.

Another advantage that comes from this approach is that the decision maker then begins to see exactly how the forecast can be used to make a better decision. It is important to know how the accuracy of the forecast relates to how well the decision meets such basic goals as providing jobs and contributing to economic development and general economic welfare. The value of increased forecast accuracy is best judged by the decision maker in the context of the decision to be made.

2.3 Trade in building materials[32/]

International trade in building materials accounts for a significant proportion of both world production of building materials and of total world trade. For this reason its development and the problems associated with it should be considered when discussing the current situation in the building materials sector. This chapter aims at facilitating such a discussion and its objective is to provide empirical evidence on tariff and non-tariff obstacles to international trade in this sector. Consequently, after a review of the salient features of international trade flows in this section, tariffs are discussed in section 2.4 and non-tariff obstacles in section 2.5.

It is a difficult task to estimate the value of international trade in the sector of building materials. This is because the category includes several types of products which for statistical purposes are classified in

32/ This and the following two sections (2.4 and 2.5) are very closely based on a background paper contributed by UNCTAD, Tariff and non-tariff obstacles to international trade in building materials, (UNIDO/IS. forthcoming).

disaggregated 4 and 5 digit groups (see appendix C). While nowadays a considerable amount of data on international trade is available, detailed statistics at such low levels of aggregation are still very incomplete, especially for the centrally planned economy countries of Eastern Europe and Asia as well as for a large number of developing countries. Therefore, table 2.14 - showing flows of trade during the 1970-1980 period - cannot contain precise data on trade among the centrally planned economy countries and of necessity, several figures shown are only estimates based on the statistics available.

Table 2.14 shows that the market economy country imports of building materials totalled over $US 26,000 million in 1970 and increased in 1980 to over $US 140,000 million; they accounted for 9.3 per cent of the total exports of these countries in 1970 and 7.9 per cent in 1980. The drop in relative importance was due to the increase in the importance of fuels, as the share of building materials in the total of industrial exports (i.e. exports other than food and fuel) remained stable throughout the decade of the 1970s (12.2 per cent in 1970 and 12.1 per cent in 1980). Total exports of the market economy countries in current prices expanded between 1970 and 1980 at a rate of 18.7 per cent, while corresponding imports grew at a rate of 18.3 per cent. Both, exports and imports of developing countries grew faster, 21.4 and 23.3 per cent, respectively, than those of developed countries, 18.3 and 16.4 per cent, respectively.

Developed market economy countries are the dominant exporters of building materials and they accounted for 89 per cent of world exports in 1970 and 86.2 per cent in 1980. While the share of these countries in imports is very large, it is nonetheless much smaller than in exports and is decreasing - from 76.5 per cent in 1970 to 64.8 per cent in 1980. During the decade of the 1970s, developing countries emerged as major importers of building materials. Due to the very high annual rate of growth of 23.3 per cent which was higher than that for developed country imports, at 16.4 per cent, and that for total industrial imports of developing countries, 12.8 per cent, they increased their share by almonst 12 percentage points. A significant consequence of this rapid expansion was a large and increasing negative balance of trade. In 1970, developing countries' net imports of building materials amounted to

Table 2.14. Market economy trade in building materials, 1970-1980 (current $US 10^6)

Origin	Year	Destination: Developed ME countries	Destination: Developing countries	Destination: CPE countries of Eastern Europe and Asia
Developed ME countries	1970	16,982	4,734	1,277
	1975	36,417	20,377	6,667
	1980	76,602	38,203	8,409
Developing countries	1970	1,882	800	162
	1975	3,258	2,270	480
	1980	10,385	8,450	950
CPE countries of Eastern Europe and Asia	1970	1,047	570	...
	1975	1,926	1,560	...
	1980	3,881	2,720	...

Abbreviations: ME = market economy
CPE = centrally planned economy

Source: Tariff and non-tariff obstacles to international trade in building materials, Working Paper prepared by the UNCTAD Secretariat, (UNIDO/IS. forthcoming, 1985), p. 1. Estimates based on data from UNSO trade tapes.

$US 3,300 million; in 1975 to $US 18,200 million in 1980 to $US 29,600 million and in 1982 to about $US 35,000 million: building materials were responsible for a considerable outflow of foreign exchange from the developing countries.

Another important development in the international trade of these goods is the very fast expansion of trade among the developing countries. Between 1970 and 1980 this trade increased almost eleven-fold, i.e. it was growing at an average annual rate of 26.6 per cent. This rate is over one percentage point higher than that recorded for the total intra-developing country trade in industrial goods and 3.4 percentage points higher than the annual growth rate of developing country imports of building materials from the developed market economy countries. Growth was particularly high during the 1975-1980 period, namely 30.1 per cent when the rate considerably exceeded that for imports from the developed countries. Since the rate of growth of developing country exports in other directions was also very fast, it indicates a substantial increase in developing countries' capacity to produce and export building materials. Thanks to this expansion, the share of developing country products in total developing country imports of building materials increased from 13.1 per cent in 1970 to 17.1 per cent in 1980.

A third important characteristic of the trade (in addition to growth and geographical distribution), is its commodity structure. For the purpose of this study building materials were classified into six product groups: articles of wood, mineral products, glass, paint, metal products and equipment (for details, see appendix C). Three of these groups together accounted for as much as 91 per cent, namely: metal products - 45.4 per cent, equipment - 23.6 per cent and articles of wood - 21.8 per cent. A fourth group was that of mineral products (7.5 per cent), while paints and glass amounted for only a very small proportion of the total trade.

The high and predominant share of metal products warrants a few comments particularly in view of the complex state of affairs in today's world metal trade, especially in the steel industry. The steel industry is characterized by three significant features. First, by its widespread production in about 70 countries, even though it is dominated by four strong economies, namely the USSR, the EEC, the United States and Japan, which together account for about

70 per cent of world production and about 65 per cent of the world market.[33/] Second, the steel industry of the developed countries is characterized by excess capacity, while a continued expansion of capacity is seen in developing countries. Production in the developed market economy countries dropped from 99 per cent of effective capacity in 1973 to 79 per cent in 1975, and 76 per cent in 1977. In contrast, the capacity of developing countries has expanded by some 50 per cent since 1974. Third, a large proportion of the steel industry is owned by the State. It is estimated that the proportion of world steel production accounted for by state-owned enterprises approaches 55 per cent and is growing. Consequently the State, both in developed and developing countries, is frequently influencing national steel production and regulating its foreign trade in steel.

For purposes of this report, building materials have been classified into three product categories and a distinction has been made between resource, labour and capital-intensive products.[34/] It is argued frequently that:

> "The chief gains which accrue from exports of unskilled commodities are employment and the profits that accrue therefrom. The chief gains from the exports of skilled and highly capitalized commodities are the realization of economies of scale (where they exist) and the learning associated with producing at a more optimal scale; a faster growth rate of output of the exports in question, which sets in motion a learning process associated with the introduction of new investment goods or the stretching of existing capacity, etc.; and learning associated with greater exposure to international competition."[35/]

33/ All data in this paragraph are drawn from B. Kneeling, "The World Steel Industry", The Economist Intelligence Unit Special Report No. 128, London, 1982.

34/ See appendix C. Products were classified into these three categories on the basis of UNIDO, World Industry in 1980 (ID/269), New York, 1981, p. 63-108.

35/ A. Amsden, "Profit effects, learning effects and the direction of trade", World Bank Conference, Does the direction of trade matter, Brussels, 28 February - 2 March 1983, p. 13-14.

Expressed in simple terms, the exports of skilled labour and capital-intensive products generate more extensive and complete benefits for the economy of the exporting country. Building materials exports are, to a large extent, capital-intensive (47 per cent of total world exports of building materials) and labour-intensive (25.1 per cent). Resource based products account for less than one-third of total world trade.

However, as table 2.15 shows, resource-based products account for as much as 77.5 per cent of the developing countries' exports to the developed market economy countries, with capital-intensive goods accounting for only 20 per cent. The relatively low proportion of capital-intensive exports only to a certain degree indicates the smaller production capacity in developing countries, since the commodity structure of their exports to other markets is strikingly different. For example, metal products, which account for only 16.7 per cent in the developing country exports to developed market economy countries, have a share of 29.6 per cent in trade among developing countries and 37.7 per cent in the exports to centrally planned economy countries. Similarly, equipment accounts for 6.9 per cent, 15.1 per cent and 25.7 per cent of these respective trade flows. In contrast, the share of articles of wood in the exports to centrally planned economy countries is only 18 per cent, whereas in trade among developing countries it is 41.4 per cent, and as much as 74.4 per cent in exports to developed market economy countries. As a consequence, the share of resource-based products increases from 29.1 per cent in exports to the centrally planned economy countries to, as already mentioned, the high 74.4 per cent in the exports to developed market economy countries. To a large extent, an explanation for these differences can be found in the protectionist import policies of many developed market economy countries, which protect their domestic capital and labour-intensive industries, rendering difficult an expansion of developing country exports. Before investigating this problem in more detail, however, it is possible to conclude that the commodity structure of developing country intra-trade and their exports to the centrally planned economy countries indicates a potential for an increase in the share of processed, labour and capital-intensive goods in their exports to developed market economy countries and therefore for more extensive benefits from the exports of building materials.

Table 2.15. Commodity structure of selected trade flows of building materials, 1980 (percentage)

Product group	Developed market economy country exports to		Developing countries exports to		
	Other developed market economy countries	Developing countries	Developed market economy countries	Other developing countries	Centrally planned countries
Wood articles	21.1	4.7	74.4	41.4	18.0
Mineral products	7.5	7.5	3.4	13.2	6.1
Glass	1.4	0.6	-	0.3	-
Paints	3.5	3.2	0.1	1.9	14.4
Metal products	47.1	53.6	16.7	29.6	37.7
Equipment	22.1	32.9	6.9	15.1	25.7
Total	100.0	100.0	100.0	100.0	100.0
Resource-based	29.0	8.0	77.5	46.3	29.1
Labour-intensive	23.0	37.5	2.6	17.8	16.6
Capital-intensive	48.0	54.5	19.9	35.9	54.3

Source: Tariff and non-tariff obstacles to international trade in building materials, Working Paper prepared by the UNCTAD Secretariat, (UNIDO/IS. forthcoming, 1985). Original based on data from the UNSO trade tapes.

2.4 Tariffs on building materials

While international trade faces a variety of barriers, the type of restraint most often encountered is the import tariff. Stated in simple terms, a tariff is a tax placed on a product as it enters a country, calculated either as a monetary amount in relation to the volume of goods entered, or as a percentage of the value of the goods as assessed at the point of entry. While it would appear to be a simple matter to compare levels of tariff protection in various countries and for various products, such comparisons are in fact hindered by a number of practical problems, one of them being the choice of averaging procedure.[36/]

Two techniques are most frequently used in this respect. The first is a simple average of tariff rates over the relevant group of products. This method has the advantage of being quite easy to compute but it rests on the assumption that all items in the group are of equal importance. The second method is an average of tariff rates weighted by the values of imports for each product in the group. Such average, however, is known not to reflect the full impact of tariffs since import values will be inversely related to tariff levels, high tariffs exerting a strong restrictive influence.

The first technique was employed to obtain tariff averages (table 2.16). Due to a lack of detailed tariff line data, both on duties and on trade flows, only simple, unweighted, averages could be computed for developing and centrally planned economy countries and only for large product groups covering, inter alia building materials. Twenty-six developing countries, 4 centrally planned economy countries of Eastern Europe and 21 developed market economy countries were included in this exercise. For the purpose of comparison, similar calculations were made for developed market economy countries, even though more detailed data are available for these countries. Thus, the data in table 2.16 provide a general idea of the magnitude of nominal tariff protection facing international trade in building materials.

36/ UNCTAD has prepared similar analyses for the sectoral studies on wood products and on vergetable oils and fats. Tariff and non-tariff measures in the world trade of wood and wood-processing products, Sectoral Working Paper Series No. 5 (UNIDO/IS.396) and The vegetable oils and fats industry in developing countries: Outlook and perspectives, Sectoral Studies Series No. 13 (UNIDO/IS.477), section 3.3.

The level of this protection is significant. Average tariff rates range from 4.5 to 7.8 per cent in the developed market economy countries; from 9.7 per cent to 15.6 per cent in the centrally planned economy countries of Eastern Europe and from 19.5 to 36.9 per cent in developing countries. The highest duties are assessed on imported glass and the lowest are applied to mineral products. While the tariffs applied in the developed market economy countries escalate with the level of fabrication (duties on wood and mineral products are lower than those on other products which are processed and transformed) this phenomenon does not seem to be present in the tariff profiles in the other groups of countries.

Table 2.16. The nominal level of tariff protection by large product groups covering building materials

	Developed market economy countries	Developing countries	Centrally planned economy countries of Europe and Asia
Wood	4.5	31.9	14.4
Crude minerals and products thereof	5.0	25.0	9.7
Glass	7.4	36.9	15.6
Chemicals	6.9	19.5	10.5
Metal manufactures	6.3	25.4	10.8
Machinery	7.8	23.9	14.9

Source: UNCTAD data base on trade measures.

Since the detailed, tariff-line data on imports are available only for selected developed market economies, the weighted tariff rates could only have been computed for 10 major developed markets. As can be seen from table 2.17[37/] they are rather low and the overall average ranges from

37/ The weighted tariff rates shown in this table combine MFN as well as preferential rates. In order to calculate them, the following procedure was applied. First, a tariff average for each tariff line was calculated, using actual trade weights together with the import duty facing the individual exporting countries (i.e., MFN, GSP, special preferences). Second, the average rate for each tariff line was aggregated to the product level, using weights based on the tariff line's importance in the total imports of a product group.

1.6 per cent in the case of imports from developing countries to 3.2 per cent in the case of trade among developed market economy countries. There are two reasons for this difference. First, the two groups of products, namely metal manufactures and equipment, which account for 70 per cent of developed market economy country imports from other developed market economy countries, face relatively high duties (see table 2.16), while wood, which accounts for 74 per cent of developed market economy country imports from developing countries, is subject to low tariffs. Secondly, developing countries benefit from special preferences and in particular from the Generalized System of Preferences (GSP) extended to them by the importing countries included in table 2.17.

Table 2.17. Weighted average post-Tokyo Round tariff rates facing the imports of building materials in 10 major developed market economy countries (by product group)

Product group	Imports from: Developed market economy countries	Developing countries	Centrally planned economy countries of Europe and Asia
Articles of wood	0.8	1.4	1.4
Mineral products	3.5	3.5	1.9
Glass	6.2	1.6	5.4
Paints	6.4	2.4	8.7
Metal products	4.1	2.7	4.2
Equipment	4.6	3.2	4.4
Overall average	3.2	1.6	2.3
Resource-based	1.1	1.4	1.5
Labour-intensive	3.2	5.3	4.6
Capital-intensive	4.2	2.2	4.1

Note: For product definition see appendix C.

Source: UNCTAD data base on trade measures.

As table 2.18 shows, due to the GSP, the average weighted rate facing developing countries is reduced by 0.6 points. In other words, if the GSP was not applied, the average tariff on imports from developing countries would have been 2.2 per cent.

Table 2.18. An impact of the GSP reductions on the average tariff rate facing imports of building materials from developing countries to 10 major developed market economy countries

Importing market	Average post-Tokyo round tariff rate	
	Including GSP	Not including GSP
EEC	1.3	2.1
Austria	2.0	2.9
Japan	0.4	0.5
Finland	0.8	1.9
Canada	5.9	6.4
Australia	7.9	10.3
United States	4.3	5.1
Switzerland	0.2	1.7
Norway	-	2.9
Sweden	-	1.8
Total	1.6	2.2

Source: UNCTAD data base on trade measures.

Another important conclusion which can be drawn from estimates in table 2.17 is that the highest duties face trade flows which exert the strongest (in comparison with imports from other sources) competitive pressure on domestic producters in the developed market economy countries. Imports of labour-intensive products from developing and centrally planned economy countries face rates of 5.3 per cent and 4.6 per cent respectively, while products from the developed market economy countries face the rate of 3.2 only, and the imports of capital-intensive manufactures from developing countries and centrally planned economy countries face rates of 4.2 and 4.1 per cent, respectively. While labour-intensive building materials account only for a small percentage of current developing country exports to the developed market economy countries, they have considerable growth potential. The high duties facing these products should therefore be of concern, since they adversely affect their expansion.

Finally, it should be noted that the GSP preferences of individual developed market economy countries have a varying impact on average tariff duties facing developing countries. While in two countries, Norway and Sweden, they provide for duty-free treatment, in Japan and Canada they allow only very small reductions. As it is clearly indicated by the data in table 2.18, there is still a lot of scope for improvements in the GSP treatment by extending it to products which are not yet covered by the present schemes and/or by increasing preferential margins on products already benefitting from the preferences.

2.5 The restrictive effects of non-tariff measures

While the role of tariffs as trade barriers has been declining due to a series of multilateral negotiations, the application of non-tariff measures (NTM) and their restrictive effects has become more intensive. Governments are substituting these measures as tariffs fall. An important reason for the lack of progress in removing NTMs, or restraining their wider application, is that in many cases the most trade-restrictive measures are concentrated in the most politically sensitive sectors such as agriculture, textiles or iron and steel: the magnitude of the potential structural adjustment needed in these sectors in the developed countries has limited attempts to liberalize trade.

While a full discussion of all the implications is beyond the scope of the present report, it is asserted that the trade, economic and welfare effects of non-tariff measures may be quite different from those created by import duties. In general it is conceded that the effects of such measures are often more detrimental than tariffs for the international community.[38/] The nature of these effects can be illustrated by reference to a quantity control measure such as a quota.

38/ For related analyses see: J. Bhagwati, "On the equivalence of tariffs and quotas", in R.E. Baldwin, et. al. (eds), Trade, tariffs and growth, Chicago: Rand McNally, 1965; M.E. Kreinin, "The equivalence of tariffs and quotas once again", Kyklos, March 1970, p. 165-199; and A. Yeats, Trade barriers facing developing countries, Macmillan Press, London, 1979, p. 108-112.

In simple terms, a quota is a quantitative restraint that stops the import of specific goods once a predetermined ceiling is reached. However, several different types of quotas exist. Specifically, global quotas fix the total amount of a product that can be imported from any source during a given time period, while selective discriminatory (country-specific) quotas apply to specific foreign suppliers. Seasonal quotas are used in the agricultural sector to limit importing to those periods when there is no domestic harvest or when domestic supply conditions are tight. Where a tariff quota applies, a pre-determined volume of goods is admitted under a base tariff rate, while additional imports incur higher duties. Voluntary export restraints are bilateral agreements under which a particular country agrees to reduce exports to a particular market. In spite of their variety, however, the welfare and trade effects of these quotas on quantitative restraints are much alike.

From the viewpoint of international price stability, a tariff is preferable to a quantitative restraint. In a period of falling international demand and prices, the duty collected under an ad valorem tariff would decline as prices drop. Declining prices and lower import duties would have the effect of reducing the landed price of foreign goods. As a consequence, there would be a rise in imports, which from the global perspective would act as a brake on the decline in production or prices. However, under a fixed import quota, imports are insensitive to the changes in world prices. After the quota ceiling is reached, further imports are not allowed, irrespective of how far these prices decline. Thus, prices at the lower end of the range may be less stable under a regime of fixed import restraints than under tariffs. In a period of economic expansion a quota can curtail imports and shift demand to more expensive domestic goods, with the result that domestic inflation is accelerated.

Given a large diversity of non-tariff measures, perhaps more than 200 different types of NTMs, what method should be used to assess the trade-restrictive effects of these measures? Two general methods have been used. The first involves an estimation of the price effects or the price increase in the landed price of the foreign goods due to the imposition of the non-tariff measures. The second method consists of tabulating the value of the trade, or the number of items, in a particular product group which is subject to trade restraints. These two methods are discussed in detail in the forthcoming complete presentation of the UNCTAD study.[39/]

The UNCTAD secretariat has established a comprehensive data base into which information on a large number of NTMs applied in 45 countries is being collected.[40/] From this data base information on 8 selected types of measures was studied. These measures are explicit non-tariff barriers, that is to say they are designed to regulate the quantity (quota, prohibitions, discretionary import authorizations), or the price (minimum price systems, variable levies, anti-dumping and countervailing duties) of imports. Automatic import authorizations and price investigations and surveillance are measures designed to monitor import transactions - frequently with the aim of facilitating subsequent specification to regulate prices and volume[41/]; they therefore create uncertainty, act as a harrassment[42/] to imports and encourage self-restraint in exports.

Table 2.19 presents frequency indices (Fui) of non-tariff measures affecting the imports of building materials. This frequency index shows the share of the four-digit CCCN groups affected by non-tariff restraints in a particular product category (i.e. an aggregation of several four-digit CCCNs). The word affected is used here in preference to restricted or covered

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39/ UNCTAD, Tariff and non-tariff obstacles to international trade in building materials, (UNIDO/IS. forthcoming).

40/ For a description of this data base, see "Non-tariff barriers affecting the world trade of developing countries and transparency in world trading conditions: The inventory of non-tariff barriers", UNCTAD (TD/B/940).

41/ EEC regulations (e.g. Council regulation (EEC) 288/82) explicitly refer to surveillance for this purpose (see Official Journal of the European Communities, No. L.35, 9 February 1982.

42/ An empirical investigation of anti-dumping and countervailing duty actions revealed that these actions have an adverse impact on imports, regardless of their final outcome, i.e. that the anti-dumping and countervailing duty investigations are in themselves impediments to trade. See Anti-dumping and countervailing duty practices, UNCTAD, TD/B/979, p. 11-12.

as a given NTM may apply only to a part of a given four-digit CCCN, thus, this measure provides, essentially, an uncertainty index for exporters because similar restrictions could be and in fact are, as historical experience demonstrates, extended to other items in the group which may be close substitutes for the affected products. This index (Fui) is defined as:

$$(1)\quad Fui = \frac{Nci}{NCi}$$

where Nci is the number of 4-digit CCNs where at least one tariff line is subject to reported NTMs, while NCi denotes the total number of CCCNs within a given product class.

Three major comments can be made about the estimates in table 2.19. First, the average frequency index indicates a wide application of non-tariff measures to the imports of building materials: over one-fifth of all product groups are subject to one or more of the selected NTMs. Barriers occur more frequently in the developing countries where over one-fourth of the product groups examined is affected by NTMs than in the developed market economy countries where about 18 per cent of the products are affected. This difference can be explained to a large extent by the severe balance-of-payments difficulties of developing countries. Despite various international efforts to resolve these difficulties, a very large number of developing countries are still dramatically short of foreign exchange.

Second, there are marked differences in the frequency of application of NTMs in individual product groups. While in the developed market economy countries only 5.8 per cent of paints are affected by NTMs, the corresponding percentage of metal products is 29.1 per cent. This extraordinarily large extent of the application of non-tariff protection in the metal sector demonstrates the structural difficulties felt in particular in the iron and steel industry, which is fast becoming as tightly regulated as the textile sector. A feature of the measures applied in respect to imports of metal products is the intensive use of price controls. Among them, anti-dumping and countervailing duty procedures are prominent. In 1982, for example,

Table 2.19. Frequency of non-tariff measures affecting imports of building materials

Product group	Importing markets		
	Developed[a/]	Developing[b/]	All
Articles of wood	16.2	27.0	21.5
Mineral products	12.1	23.3	17.6
Glass	14.1	20.5	17.2
Paint	5.8	24.2	14.8
Metal products	29.1	30.8	30.0
Equipment	12.3	30.3	21.1
Average of all products	17.7	27.2	22.3
Resource-based	11.2	24.2	17.5
Labour-intensive	14.3	24.3	19.2
Capital-intensive	24.8	31.0	27.8

a/ Australia, Austria, Belgium, Canada, Denmark, Federal Republic of Germany, Finland, France, Greece, Ireland, Israel, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States.

b/ Algeria, Brazil, Cameroon, Chile, Guatemala, the area of Hong Kong, Indonesia, Ivory Coast, Kenya, Republic of Korea, Malawi, Mexico, Nigeria, Pakistan, Peru, Philippines, Saudi Arabia, Sri Lanka, Thailand, Tunisia, Turkey, Venezuela.

Source: Tariff and non-tariff obstacles to international trade in building materials, Working Paper prepared by the UNCTAD Secretariat, (UNIDO/IS. forthcoming, 1985). Original data from UNCTAD data base on trade measures.

234 anti-dumping and countervailing actions (or 58 per cent of all actions taken in the developed market economy countries) affected metals and basic metal products. In the first half of 1983, a further 18 anti-dumping and countervailing duty actions were initiated. This indicates a disturbing phenomenon, namely the use of these measures designed for other purposes, in an attempt to remedy problems of a structural character.

Third, the problem in the steel industry is also responsible for the high index values calculated for capital-intensive goods. As can be seen from table 2.19, in both developed and developing countries these products face non-tariff measures much more frequently than resource based or labour-intensive manufactures. This could indicate that non-tariff barriers in the trade of building materials affect primarily the exports of the developed market economy countries - since capital-intensive goods account for almost 90 per cent of these countries' exports.

This suggestion could be verified by comparing frequency indices with trade coverage indices. This method is based on the proportion of total imports subject to NTMs. Specifically, this NTM coverage measure (Vji) is defined as:

$$(2) \quad Vji = \frac{Mri}{Mji}$$

where Mri represents the value of imports from exporter i subject to restraints, and Mji is the total value of imports from exporter i in the product category j.

Table 2.20 shows V indices for the EEC Member States. It should be noted here that individual EEC countries apply both EEC and national non-tariff measures and thus, NTMs - in contrast to tariffs - need to be evaluated for each country separately and not for the European Community as a whole. The import statistics employed were for 1980 while the data on non-tariff barriers is from 1983. All calculations were performed at the tariff-line level.

Table 2.20. Estimates of the frequency (F) and trade coverage (V) indices for non-tariff measures applied by the EEC member countries to imports of building materials

	Imports from					
	Developing countries		Developed market economy countries		Centrally planned economy countries of Europe and Asia	
	F	V	F	V	F	V
Belgium/Luxembourg	12.7	6.8	16.5	12.0	22.8	28.5
Denmark	12.7	20.2	12.7	16.6	20.3	39.8
Federal Republic of Germany	12.7	4.6	13.9	16.2	24.1	42.0
France	19.0	37.5	19.0	49.4	25.3	83.2
Ireland	12.7	0.2	12.7	4.3	15.2	51.2
Italy	13.9	16.1	16.5	17.4	35.4	48.8
Netherlands	12.7	0.7	16.5	7.4	22.8	17.9
United Kingdom	12.7	12.1	12.7	14.3	15.2	14.5

Source: UNCTAD data base on trade measures.

These results seem to confirm the earlier observation. The share of imports subject to non-tariff measures is higher in the case of imports of building materials from the developed countries than from developing countries. Only in one instance, Denmark, is the value of the trade coverage index (V) higher for developing countries than for the developed market economy countries. Since the prime objective of non-tariff barriers is a protection of capital-intensive production, and given the existing geographic structure of imports, the highest proportion of trade affected by NTMs is to be found in imports from the developed countries. This, however, does not mean that imports from the developing countries are less affected. On the contrary, the NTMs facing capital-intensive products are an important constraint on the expansion of the developing countries' exports of these products and freeze their share in total shipments at a low level.

With some exceptions, protection indices are disturbingly high for all countries. They bear witness to the fact that non-tariff protection is a major factor to be taken into account in examining international trade in building materials.

3. SOME ECONOMIC CHARACTERISTICS OF THE BUILDING MATERIALS INDUSTRIES

3.1 Measuring linkages: The input-output approach

Input-output models are based on a matrix that describes the pattern of deliveries by important economic sectors, both to other sectors and to final users of products (consumers, government and investors). Input-output analysis has been widely employed as a planning tool because its accounting framework provides a useful means for anticipating the effects of changes in the components of final demand on the full pattern of economic activity. In input-output analysis the input-output table, or matrix, is the basic tool. It describes the decomposition of gross output value into the value of materials and payments to labour and capital.

The input-output table is itself simple, but also very powerful. Considering first the rows of the table, each row represents one industry and reading across the row one obtains the sales of output of the sector to each sector in the economy. Normally a sector sells part of its output not only to several of the other sectors but may also purchase a portion for its own use. The steel sector for example sells steel not only to the automobile and construction industries, but it also purchases steel as an input in its own production processes. These own purchases are sometimes a significant portion of the sector's total sales. In addition to sales to other industries a row of the input-output table also shows a sector's sales to final demand which is usually broken down by investment, private consumption, government purchases and exports.

A column of the matrix represents the purchases of a sector from each of the sectors of the economy. As in the case of the rows the column includes purchases of a sector from itself. A column in addition to accounting for purchases from other sectors of the economy, and itself, includes purchases of labour and capital services. It also includes purchases of imports. In more elaborate models these may be broken out both by sector and country of origin. For example a recent model of the ASEAN countries includes detailed reports on imports of the ASEAN countries from each other, from certain other countries with whom they have extensive trade and also a general category for trade with the rest of the world.43/

Since in this chapter input-output tables are used to show economic linkages among industries, it is necessary to make precise the meanings of the terms direct, indirect and total, sales (or deliveries) and direct, indirect and total, purchases (or requirements).

Direct requirements and sales are just the purchases and sales described above in the description of the input-output table. By the indirect requirements of a sector is meant the goods that must be produced in order to in turn produce the intermediate outputs which are used in its production. Thus, if to produce a wooden house requires 10 kilograms of nails, among other things, then since steel is needed to produce the nails there will be also an indirect requirement for a certain amount of steel. But the indirect requirements do not stop here, in fact, the production of the steel has its own required materials, and so on. Direct as well as indirect requirements (total requirements) are all accounted for and shown by the Leontief inverse matrix. This matrix is the exact analogue of the input-output table except that instead of showing only the direct requirements and sales it shows the total, direct plus indirect, requirements and sales of each sector.

The rows of the Leontief inverse matrix then show the total deliveries (direct plus indirect sales) of a sector to all the sectors of the economy, including itself. The columns show the total requirements (direct plus indirect purchases) of each sector from all sectors. To simplify using the matrix it is usual to convert its entries to requirements and sales per unit of output delivered to final demand. These per unit sales and requirements data are what are shown in this chapter.

43/ International input-output table for ASEAN countries, 1975, Institute of Developing Economies, Tokyo, Japan, March 1982.

Returning now to the question of linkages, by backward linkages is meant the requirements of a sector from all sectors. It is characterized by the industry's column in the Leontief inverse matrix and describes the bundle of inputs (direct plus indirect) which is required in order to produce one unit of final demand from a sector. This column of the Leontief inverse matrix gives not only the direct purchases from the various sectors but also, as was stated above, takes into account indirect requirements.

The basic notion of backward linkage can be extended to ascertain the degree of labour intensity and import intensity. This aspect of the analysis depends upon an extension of the requirements column to include payments for labour (through wages) and imports. Payments for labour provides an estimate of the labour intensity of the sector. Payments for imports provide an estimate of foreign exchange requirements. The extension of the notion of backward linkage from produced goods and services to productive factors has proven very beneficial for the planning of industrial projects in developing countries.

3.2 An illustration: The building materials industry in Kenya

To illustrate the linkages of the building materials industry with other economic sectors, consider the case of Kenya, a lower-middle-income African country of 17.4 million people, which had a per capita income in 1981 of $US 420. Among developing countries, Kenya has one of the most complete sets of macro-economic statistics. The input-output table for the Kenyan economy provides a basis for linkage calculations of the sort which are important for this study. A disadvantage of the example based on Kenyan data is that the data is not very current. The most recent update, published in 1976 by the Central Statistical Bureau, is based on data collected for 1971; this is a typical publication lag for input-output information. As the structure of the Kenyan economy may have changed in important ways since the last collection of data, the matrices derived from the 1971 flow estimates may not be accurate representations of input-output relations in 1985. It is used here only for purposes of illustration.

Since linkage calculations depend on aggregated information in input-output tables, it is not possible to consider any building materials subsectors at a completely satisfactory level of disaggregation in this kind of analysis. The best available Kenyan input-output table contains interindustry information only for 28 sectors. Of these, six include important building materials activities: (1) mining, which includes stone, sand, gravel, and clay; (2) sawmilling; (3) wood products, including printing and publishing; (4) paint, detergent and soap; (5) non-metallic mineral products, which includes cement, glass and bricks; and (6) metal products and machinery, which includes ingots, bars, shapes, rails, tubes, and so forth.

Table 3.1 presents the construction sector column vector for the Kenyan Leontief matrix. The elements of the vector are ranked in descending order, so the most important intermediate inputs can be readily identified. As previously noted, the elements of this column vector represent the proportion of gross production value in the construction sector accounted for by the 28 sectors. The sum of the coefficients is substantially less than one because the columns of the matrix include only payments for intermediate deliveries. Not surprisingly, the building materials sectors rank prominently among the supplying sectors for the construction industry. The other prominent sectors are the construction industry itself, miscellaneous services and transport-related sectors.

While the importance of the building materials industries as direct suppliers to the construction industry can be assumed in advance, the total requirements should be considered in any full evaluation of the relationship between the construction industry and the building materials industries. In table 3.1, the construction column of the Leontief matrix is also presented. The delivery sectors are again presented in order of their size.

As previously explained, total requirements include all inputs, direct and indirect, necessary to support one unit of delivery from a sector to final demand. Since at least one unit of delivery from the construction sector to itself is required, the observed value of the own-coefficient for this sector is as expected. When the Leontief entries are compared with the entries of the input-output matrix, it can be seen that the relative ordering of building

Table 3.1. Construction sector requirements in Kenya, 1976

Direct requirements per 100 Kenyan Pounds of construction output		Direct plus indirect requirements per 100 Kenyan Pounds of construction output	
Metal products[a]	16.6	Construction	108.3
Non-metal mineral products	9.1	Metal products	22.4
Construction	7.5	Trade	10.9
Trade	7.4	Non-metal mineral products	10.6
Chemicals, petroleum	4.7	Chemicals, petroleum	7.8
Mining[a]	4.2	Mining	7.5
Sawmilling[a]	3.2	Miscellaneous	5.0
Transportation equipment	2.0	Transportation, communication	5.0
Transportation, communication	1.5	Sawmilling	4.5
Wood products, publishing	1.5	Transportation equipment	3.9
Paints, soaps	1.4	Wood production, publishing	3.3
Miscellaneous	1.1	Electricity, water	1.8
Hotels, restaurants	0.8	Miscellaneous services	1.6
Electricity, water	0.7	Paints, soaps	1.6
Financial services	0.7	Financial services	1.6
Miscellaneous services	0.7	Own business	1.3
Own business	0.4	Agriculture	1.0
Raw textiles	0.1	Rubber	1.0
Clothes	-	Hotels, restaurants	1.0
Agriculture	-	Raw textiles	0.5
Food preparations	-	Beverages, tobacco	0.3
Beverages, tobacco	-	Food preparation	0.3
Finished textiles	-	Finished textiles	0.1
	-	Clothes	0.1

a/ Sectors produce significant elements of building materials.

Source: Central Statistical Bureau of Kenya, 1976 Kenya input-output table.

materials sectors remains the same. Their ordering with respect to other sectors changes somewhat, however. As expected, some indirectly related sectors rise in the rankings once the indirect linkages in the economy are taken into account.

For expositional purposes, the following procedure has been adopted (figure 3.1). The Leontief matrix has been ordered so that the building materials industries occupy the first six columns. Wherever the Leontief coefficient linking a demander industry with a supplier industry is greater than .02, a "*" has been entered. Otherwise, the table entries have been left blank. This procedure separates the upper quartile of coefficients for Kenya.

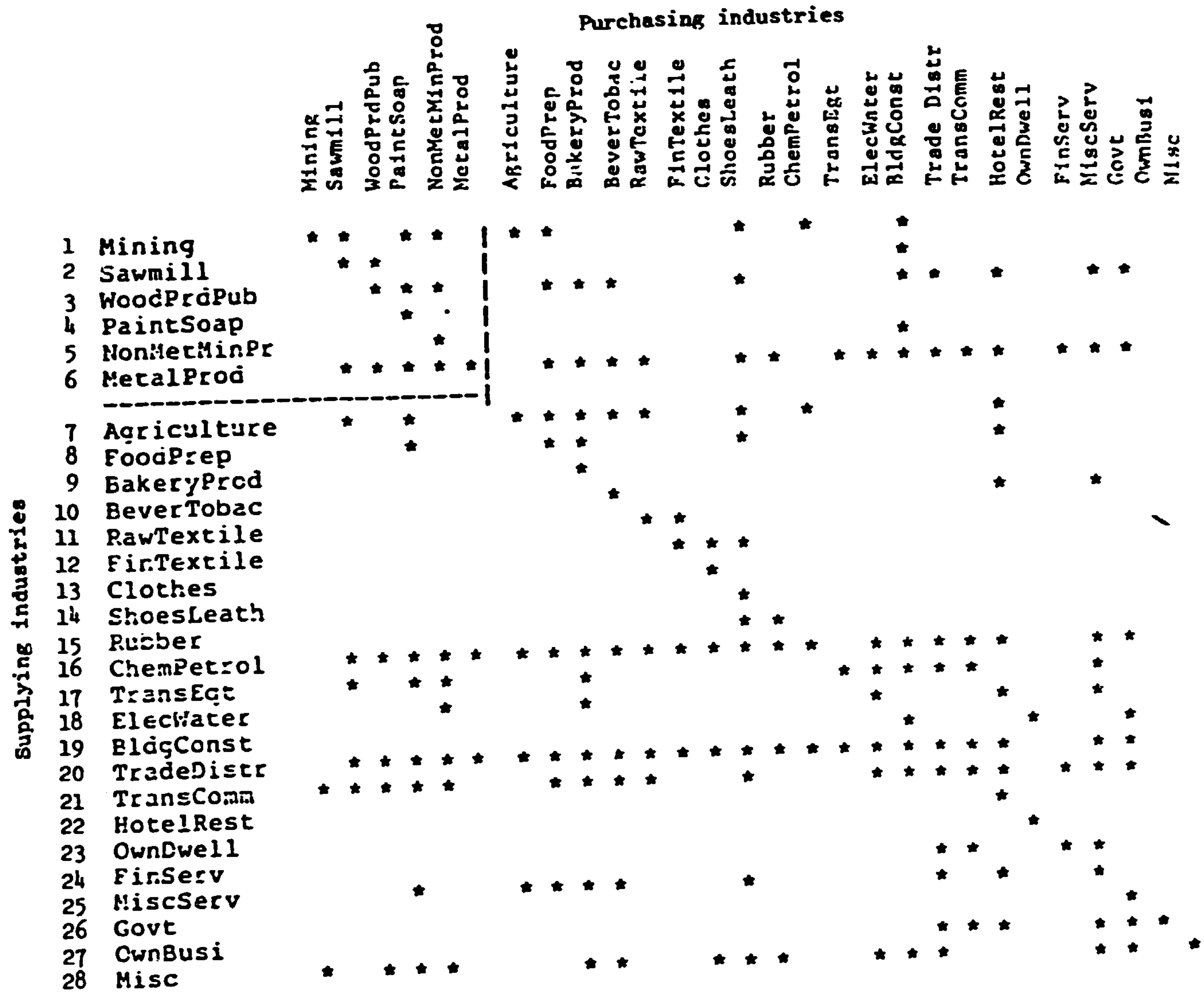
The purchasing industries are arrayed across the top of the figure in the same order as for their position as sellers in the first column.

This kind of representation makes certain characteristics of the Kenyan economy more apparent. First only a few sectors have major direct and indirect supply arrangments with many other sectors. In the lower part of the figure, transport-related activities, trade and miscellaneous services play important roles. Among the manufacturing sectors, the dominance of the building materials sectors as a group stands out. Only food-related industries seem comparable in their overall integration as suppliers to other sectors. Among the building materials sectors, three are most notable as general suppliers: mining, wood products and metal products. The building materials subsector (the 6 x 6 space bounded by the dotted lines in figure 3.1) seems relatively well integrated in Kenya.

3.3 Labour intensities and import requirements

Some sense of the labour intensities and import requirements associated with expansion in different sectors can be gained by extending the backward linkage methodology to a consideration of the direct and indirect uses of labour and imported intermediate inputs.

Figure 3.1. Significant Leontief matrix entries for Kenya



Abbreviations:

1 = Mining
2 = Sawmilling
3 = Wood products, publishing
4 = Paints, soaps
5 = Non-metallic mineral products
6 = Metal products
7 = Agriculture
8 = Food preparation
9 = Bakery products
10 = Beverages, tobacco
11 = Raw textiles
12 = Finished textiles
13 = Clothes
14 = Shoes, leather
15 = Rubber
16 = Chemicals, petroleum
17 = Transportation equipment
18 = Electricity, water
19 = Construction
20 = Trade
21 = Transportation, communication
22 = Hotels, restaurants
23 = Own dwellings
24 = Financial services
25 = Miscellaneous services
26 = Government
27 = Own business
28 = Miscellaneous

Source: Central Statistical Bureau of Kenya, 1976 Kenya input-output table.

In Kenya, as in most developing countries, capital and foreign exchange are relatively scarce, and labour is relatively plentiful. Other things being equal, it is an advantage for a sector to have high direct and indirect labour requirements and low foreign exchange requirements. It is possible to gain some sense of these requirements by premultiplying the Leontief inverse matrix by the sectoral shares coefficients of labour and imports (see table 3.2).

The measure of labour intensity that is shown in table 3.2 is total labour required and so is affected not only by the labour intensity of the specific sector but also by labour intensities of the sectors from which it purchases inputs. However, this does not carry through to the labour content of imports. Thus, those sectors which are most import intensive are typically those with the lowest labour requirements. Sawmilling, which is widely known to be relatively labour-intensive, per se is in fact the least labour-intensive of the five building materials industries shown in the table and also the most import intensive of the five.

While no specific conclusion should be base on such limited data and analysis as presented here, it is possible to see how input-output tables can be used in an analysis of important issues relating to development. This analysis can also be carried out at a more detailed level to assess the labour and import intensities of different ways of achieving specific goals relating to the construction sector. Thus, different policies with regard to the construction sector, e.g. a policy to promote road building over housing, will usually imply the use of a different mix of building materials requirements and so different total labour and import intensities.

3.3.1 Import substitution versus export-led growth

The recent world trade recession has warranted a closer look at the effects of export instability on the growth prospects of developing countries. In particular, the effects of the variance in the price of export commodities, in addition to the more obvious effects of a decline in commodity prices, has been investigated.

Table 3.2 Sectors ranked by labour intensity and import intensity, Kenya, 1976

Sectors ranked by labour intensity[a]		Sectors ranked by import intensity[b]	
Miscellaneous services	85.6	Government	74.6
Metal products[c]	75.2	Construction	42.0
Rubber	71.9	Transportation, communication	41.8
Transportation equipment	62.9	Trade	37.4
Chemicals, petroleum	62.1	Sawmilling[c]	35.9
Mining[c]	61.4	Financial services	32.7
Finished textiles	60.6	Hotels, restaurants	30.0
Non-metal mineral products[c]	60.4	Bakery products	26.2
Wood products, publishing	60.0	Agriculture	25.5
Clothes	58.2	Raw textiles	24.9
Shoes, leather	52.1	Food preparations	24.0
Construction	41.7	Electricity, water	23.8
Raw textiles	41.4	Wood products, publishing[c]	21.8
Paints, soaps[c]	39.5	Paints, soaps[c]	20.0
Bakery products	36.7	Shoes, leather	19.6
Sawmilling[c]	36.6	Non-metal mineral products[c]	18.9
Electricity, water	31.6	Transportation equipment	18.8
Transportation, communication	31.6	Miscellaneous services	17.5
Food preparation	30.8	Beverages, tobacco	14.5
Hotels, restaurants	28.6	Clothes	13.8
Trade	26.1	Metal products[c]	9.4
Government	24.1	Finished textiles	8.3
Agriculture	16.8	Chemicals, petroleum	8.2
Financial services	16.3	Rubber	6.8
Beverages, tobacco	16.3	Mining	6.7
Own dwelling	3.2	Own dwelling	2.3

a/ The amounts shown are the total direct and indirect payments to labour per 100 Kenyan Pounds of output delivered to final demand.

b/ The amounts shown are the total direct and indirect payments for imports per 100 Kenyan Pounds of output delivered to final demand.

c/ Sectors which produce significant amounts of building materials.

Source: Central Statistical Bureau of Kenya, 1976 Kenya input-output table.

During a period of export led economic upswing, large-scale construction projects are initiated. As domestic capacity becomes fully utilized, bottlenecks quickly emerge in local markets and buyers turn to foreign sources. For some project inputs there is no local source of supply in the first place.

Even for building materials that are available locally, the use of imported substitutes increases during a boom phase. In Egypt, for example, the volume of imported cement increased from 700,000 metric tons in 1970 to 7.9 million tons in 1976. Generally, other import-intensive activities also expand. Unfortunately, many are difficult to reverse once boom turns to bust in commodity markets.

Among the attractive targets for cuts in the allocation of foreign exchange are construction projects, which are sometimes erroneously thought to be easily delayed in the short run. If such projects could be interrupted without cost, this procedure would not be harmful. But interruptions are apt to be costly. The trained labour force evaporates, and project-specific skills, which may have been acquired at great cost, are dissipated. Incomplete construction projects may be subject to high rates of deterioration, especially if the climate is severe. Maintenance is sometimes abandoned along with construction. Furthermore, delays postpone the activities the projects are intended to serve.

Much of the incipient infrastructure developed during a boom phase may have degraded before the next upward movement in primary product prices. The skills needed to finish the projects may have to be re-established at a high cost. Instability in export prices may thus interfere with completion of construction projects which would otherwise contribute to long-run economic expansion.

Faced with such problems, planners in developing countries have begun to find local autonomy more attractive than before. Of course, the history of import substitution as a development strategy is also replete with unfortunate stories. The basic principle of comparative advantage cannot be overthrown by fiat, and attempts by relatively small economies to achieve autonomy across the range of basic industries have not often worked.

It is now appropriate to move the discussion from the level of abstraction to a concrete example. In this section the import-substitution policy of Mexico and the export led growth strategy of the Republic of Korea are compared.

Both Mexico and the Repulic of Korea were categorized as upper-middle-income countries in 1983 by the World Bank. That year, the Republic of Korea had a per capita GNP of $US 1,700 and Mexico of $US 2,250. In both cases, high GDP growth rates were responsible for rapid growth (in 1960, the equivalent figures for the Republic of Korea and Mexico (in constant 1981 dollars) were $US 400 and $US 1,000, respectively). The Republic of Korea's GDP grew at 8.6 per cent during the 1960s and 9.1 per cent during the 1970s, while the rates for Mexico were 7.6 per cent and 6.5 per cent. During the past two decades, both countries have grown rapidly by international standards.

The Republic of Korea has pursued a policy of export export led growth and has followed an aggressive world marketing strategy as a key component of its development planning. Mexico, on the other hand, has stressed the import substitution aspects. Its import shares by sector are subsantially lower than the Republic of Korea's, as is the proportion of its GNP accounted for by exports. The contrast between the export orientations of the two countries can be seen by comparing their exports of goods and non-factor services as a percentage of GDP. For the Republic of Korea, this rose from 3 per cent in 1960 to 39 per cent in 1982; for Mexico, it rose only 7 points in the same period, from 10 per cent in 1960 to 17 per cent in 1982.[44/]

44/ World Bank, World Development Report 1984, Washington, D.C., 1984, p. 227.

This section draws on the results of an input-output study undertaken at the World Bank during the late 1970s. As part of that study, consistently measured interindustry flow tables were constructed in historical series for several developing economies. For Mexico, consistent tables were constructed for 1950, 1960, 1970 and 1975. The tables for the Republic of Korea were constructed for 1955, 1963 and 1975. In both cases, the data were sufficient for producing a complete matrix of import flows, as well as the standard domestic input-output table.

Thus, for the data presented here, tables for 1955, 1963 and 1973 have been used for the Republic of Korea. For Mexico, tables for 1950 and 1975 are used.

Twenty-two sectors were included for each country. Among those sectors, four include major building materials activities: mining; wood products; non-metallic minerals products; and basic metal products. In the following discussion, these four sectors are identified as the building materials sectors.

3.3.2 Trends in import dependence

Here relative import dependence in the two economies over time is discussed. The ratio of total imported deliveries to each sector versus total deliveries of goods and services to that sector is used to indicate its degree of import dependence.

Tables 3.3 and 3.4 portray shifts in dependence on imported building materials for the two economies. The evident success of the Korean economy since 1960 has frequently been given as evidence for those who favour export led growth strategies. Since part of its rapid growth has been based on assembly operations and raw materials processing, it is not surprising to note the relatively high degree of import dependence that has continued to characterize many sectors of the Republic of Korea's economy since 1960.

Table 3.3. Ratio of imported building materials inputs to domestically produced materials inputs, Republic of Korea, 1955 and 1973

	1955	1973
Wood products		
Wood products	2.08	-
Transportation equipment	.41	-
Miscellaneous manufactures	.21	-
Public utilities	.30	-
Textiles	-	.29
Non-metallic mineral products		
Construction	.25	-
Miscellaneous manufactures	1.63	.91
Unallocated	.32	.18
Machinery	.98	.74
Public utilities	.42	-
Printing	1.18	-
Transportation equipment	.27	.52
Wood products	-	.79
Basic metal products	.12	.86
Basic metal products		
Basic metal products	1.75	1.02
Rubber	3.62	.20
Chemicals	5.09	.74
Construction	.61	.49
Mining	.42	-
Public utilities	1.29	-
Printing	.56	.34
Transportation, communication	-	.29
Textiles	.18	.54
Wood products	-	.11
Agriculture	-	.40
Clothing	.12	.93
Oil, coal	-	.59
Paper	.14	.99
Miscellaneous manufactures	.28	.46
Unallocated	-	.34
Food processing	-	1.36
Machinery	.50	.82
Transportation equipment	.73	.92

Source: Data supplied by UNIDO consultant Fred Moavenzadeh.

Table 3.4. Ratio of imported building materials inputs to domestically produced materials inputs, Mexico, 1950 and 1975

	1950	1975
Wood products		
Textiles	.81	-
Clothing	.18	-
Construction	.11	-
Paper	-	.27
Food processing	-	.45
Wood products	-	.61
Miscellaneous manufactures	-	1.67
Non-metallic mineral products		
Food processing	.31	-
Non-metallic mineral products	.20	.17
Chemicals, petrol	-	.13
Transportation equipment	-	.22
Basic metal products	-	.25
Construction	-	.22
Machinery	6.11	9.54
Miscellanous manufactures	-	18.82
Basic metal products		
Construction	1.59	-
Food processing	1.28	.18
Public utilities	2.34	-
Wood products	.70	.15
Agriculture	.41	-
Leather	-	-
Trade	-	-
Other services	-	-
Non-metallic mineral products	1.20	1.28
Transportation, communication	.27	1.26
Miscellaneous manufactures	.29	.49
Textiles	1.06	3.18
Rubber	-	1.41
Mining	.11	1.30
Clothing	.18	1.37
Paper	-	1.50
Printing	-	3.38
Chemicals, petrol	-	3.72
Transportation equipment	-	2.73
Basic metal products	.36	3.28
Machinery	-	9.24

Source: Data supplied by UNIDO Consultant Fred Moavenzadeh.

Concerning the building materials sector itself the data indicate that three building materials sectors (wood products, non-metallic minerals products and basic metal products) have become less dependent on imports. It should be noted that during the 1960s and 1970s the Republic of Korea developed a significant wood products export sector based on imported timber resources.

There has also been a sharp downward shift in the dependence of the construction sector on imported building materials. In wood products, the modest import/domestic ratio of 6.6 per cent dropped even further, to 1.4 per cent by 1973. For non-metallic mineral products used in construction, the import/domestic ratio dropped from 25.4 per cent in 1955 to 2.8 per cent in 1973. A similar drop was registered for construction use of imported basic metal products. From 60.5 per cent in 1955, the import/domestic ratio fell to 48.6 per cent by 1973. Table 3.4 presents similar data for three building materials industries in Mexico. The 1950 import/domestic ratios for wood, non-metallic minerals, and metals confirms that the building materials sector was not import intensive in the 1950s.

Since the 1950s, many Mexican industries have increased their import requirements. For wood products used in construction, the import/domestic ratio dropped from 11.4 per cent to 1.1 per cent over the observation period. In its own use of wood products, however, the wood products sector has experienced a substantial jump in the ratio - from a negligible 2.6 per cent in 1950 to 60.5 per cent in 1975.

In non-metallic minerals products, the own-use ratio declined slightly, from 19.9 per cent to 17 per cent. The import/domestic ratio for non-metallic minerals products jumped, however, from 8.9 per cent to 21.5 per cent. Substitution away from imported metal products in the construction industry seems to have been largely counteracted by increases in the dependence of the metal products sector itself.

The pattern of overall change in the ratio of imports to domestic production for the three building materials industries suggests that the dominant tendency in the Mexican economy has followed the global trend of increased participation in international trade.

The picture then is one of two economies which have both grown rapidly over the last three decades and which represent good examples of the two development strategies, the export led growth strategy of the Republic of Korea and a more trade neutral strategy of Mexico. The discussion can serve as little more than an example of how either approach can result in growth and that an overall export led growth strategy does not necessarily imply anything concerning how specific sectors will behave. In this case the building materials sectors moved counter to the overall trends in imports in both countries.

4. TECHNOLOGY AND ORGANIZATION OF PRODUCTION

4.1 Introduction

This chapter addresses issues relevant to the choice of building materials technology which is appropriate to conditions in developing countries. It begins with a review of the socioeconomic conditions that influence technology choice in developing countries, then proceeds to an examination of the theoretical and empirical evidence for the feasibility of small-scale enterprises and the technology options for producing building materials. Section 4.5 attempts to clarify the nature, scope and potential of the informal market in building materials. The chapter concludes by considering measures to promote the small-scale manufacture of building materials in the formal and informal sectors.

4.2 Review of socio-economic conditions in developing countries

Independence brought many developing regions a desire to industrialize quickly and maximize the inflow of technology. They favoured capital-intensive methods and large-scale enterprises for a variety of reasons: the prestige of Western technology, the promotion of this technology by interests firmly entrenched in the new state, and government policies granting incentives to capital-intensive enterprises. The preference of the wealthy for goods resembling imports and the desire of decision makers to avoid the problems of managing a large, unskilled labour force also militated against more labour-intensive modes of production.[45/]

Substantial capital investment, coupled with a strong belief in economies of scale, resulted in the creation of large-scale enterprises throughout the developing world in the 1950s, 1960s and 1970s. Yet the unsuitability of capital-intensive technology to the resources of developing countries, the rising cost of energy and the increasing debt burden, have led to a re-examination of factors and methods of production in the developing world.

45/ World Bank, World Development Report 1979, Washington, D.C., 1979, p. 5.

The following section attempts to determine the scale and mode of production best suited to conditions in developing nations, with emphasis on the production of building materials. The issues considered are the impact of market size on the choice of technology and the choices concerning labour-intensity and technological complexity and how energy costs affect the sector.

4.2.1 Market base restrictions

Market size in developing countries is largely determined by population, per capita income, distribution of income prices and availability of infrastructure, including means of transport. Population growth and urbanization increase the demand for construction, principally housing, but also urban sewerage, water and transport systems. Urbanization *per se* is thought to exert an upward pressure on housing demand because urban incomes are higher than rural, and the share of construction expenditure devoted to housing appears higher for city dwellers than rural inhabitants in most countries. In Pakistan, this expenditure share is typically 19 per cent for urban dwellers and 12.5 per cent for rural inhabitants. In most countries, the rapid urbanization of the population seems to be outstripping the ability to provide adequate housing. As discussed in chapter 2, a strong correlation exists between per capita consumption of cement and other building materials and per capita GDP.

Distribution of income is also important in determining demand. In most developing nations, the poorest 40 per cent of the population receive only 8-16 per cent of the national income. These lower income groups in developing countries are usually unwilling or unable to obtain housing through the formal market. Evidence for this can be seen in the vast slums and squatter settlements in most cities and the percentages of the population unable to buy even the cheapest housing. In an optimistic scenario assuming no down payment, a repayment period of 25 years and an interest rate of 10 per cent, this group makes up more than 60 per cent of the population in Nairobi, Ahmedabad and Madras, and only slightly less than that in Mexico City. Thus, for one major component of construction, namely housing, income distribution has an overriding influence on demand.46/

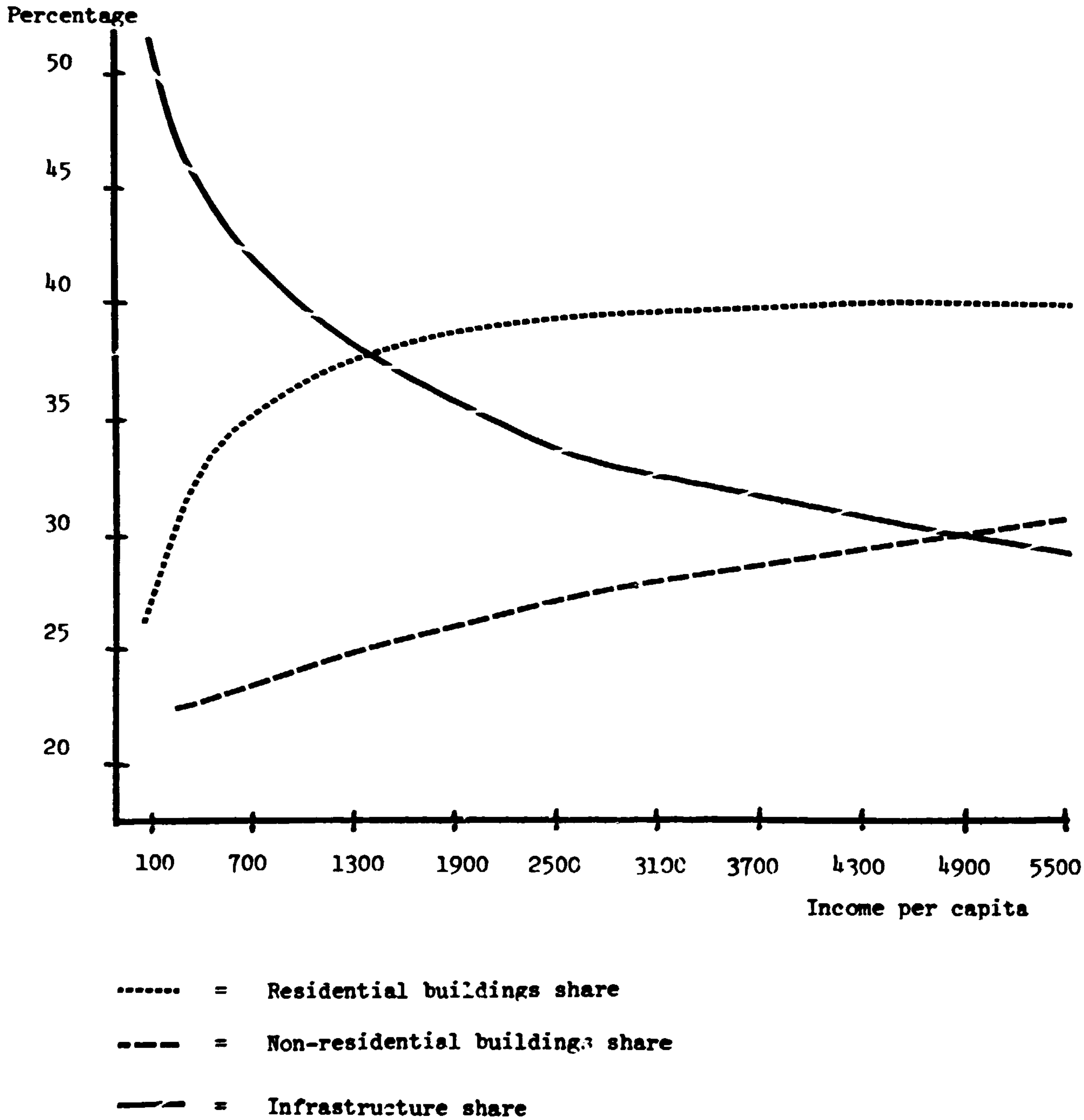
But the demand for housing is conditioned by other factors as well. With advances in development, the proportions of construction represented by dwellings, non-residential buildings and infrastructure will shift. As figure 4.1 indicates, in early phases of development, a proportionally greater demand exists for infrastructure and civil engineering, followed by a proportional increase in the demand for industrial facilities. A proportionally stronger demand for housing begins only in the later stages of development. Specifically, infrastructure fades from approximately one-half of all construction in the first stages of development to 30 per cent in higher-income societies, while the share of residential construction rises almost as quickly as infrastructure falls, from around 28 per cent at $US 200 to nearly 40 per cent at $US 2,000 per capita. The non-residential share, which begins near the residential share in poor societies, climbs slowly but more steadily than the residential share, moving from around 23 per cent at $US 200 to about 28 per cent at $US 3,100. The two converge in societies with incomes around $US 10,000.47/

At the same time, the geographic size of the market base is determined to a large degree by the availability of transportation. The low value/weight ratio of many building materials renders transportation costs a more serious constraint for this industry than for virtually any other. Figure 4.2 demonstrates the severity of this constraint on cement production. In the Sudan, Honduras and Botswana, after 100 miles the cost of transporting cement is higher than its production cost.

46/ Fred Moavenzadeh and Frances Hagopian, Construction and building materials industries in developing countries, TAP Report 83-19, Massachusetts Institute of Technology, Cambridge, Massachusetts, August 1983, p. 104-107.

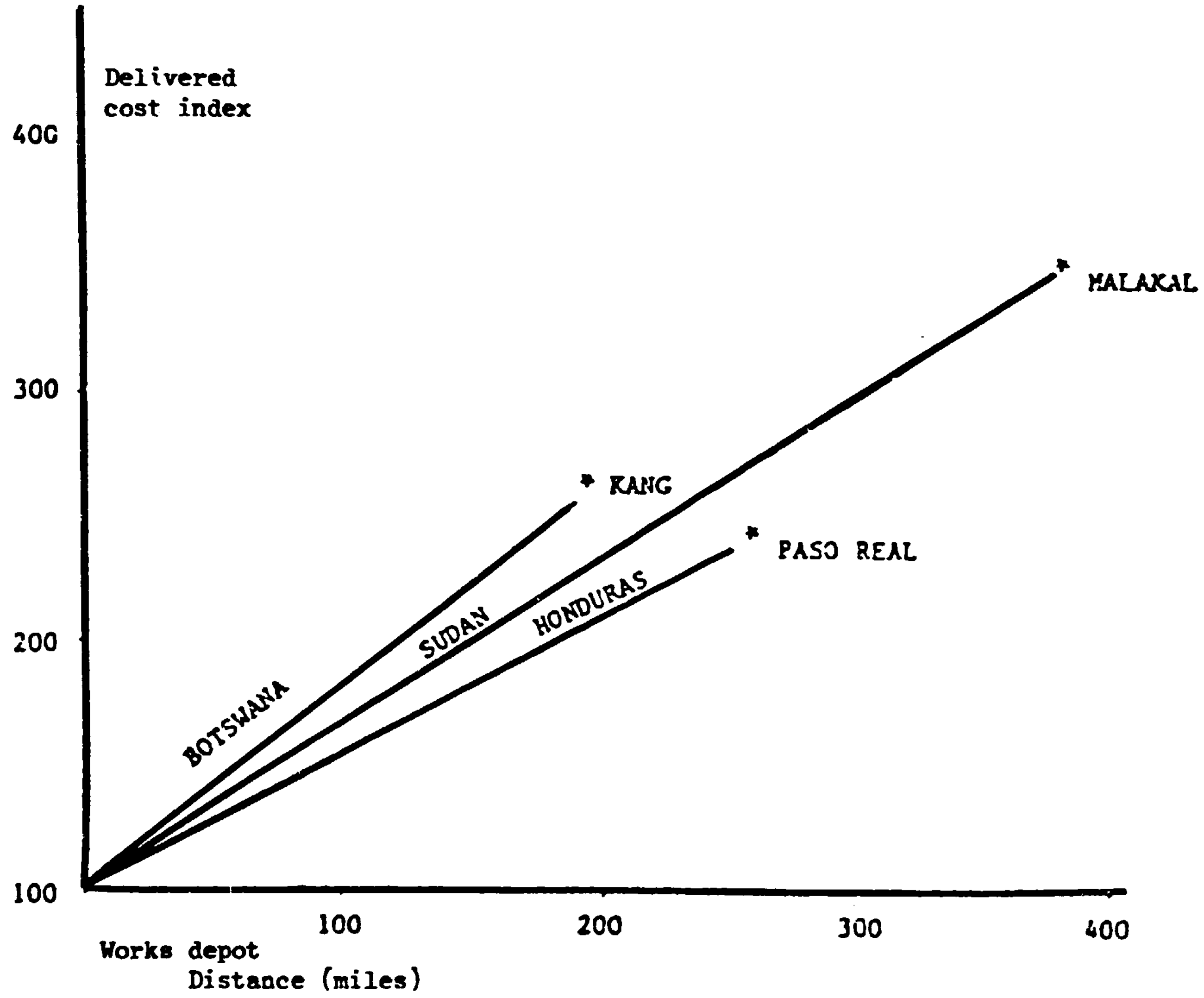
47/ David Wheeler, Major relationships between construction and national economic development, Center for Construction Research and Education, Massachusetts Institute of Technology, Cambridge, Massachusetts, 1982.

Figure 4.1. Residential, non-residential and civil engineering construction as a percentage of total production



<u>Source</u>: Fred Moavenzadeh and Frances Hagopian, <u>Construction and building materials industries in developing countries</u>, TAP Report 83-19 (Massachusetts Institute of Technology, Cambridge, Massachusetts, August 1983).

Figure 4.2. Examples of the effect of transport distance to remote rural areas on the delivered price of cement



Note: Based on delivered cement price compared with prices at Works or Depot at Kosti, Sudan; Lobatse (ex Mafeking), Botswana; San Pedro Sula, Honduras. In these examples transport costs exceed the ex-depot price of cement after about 100 miles over poor roads.

Source: Fred Moavenzadeh and Frances Hagopian, Construction and building materials industries in developing countries, TAP Report 83/19 (Massachusetts Institute of Technology, Cambridge, Massachusetts, August 1983), p.284.

The market base thus expands and contracts in response to varying demand and the availability of transport. This calls for an industry responsive to changing market conditions and flexible in its scales of production.

4.2.2 Labour/capital choices

In developing countries, where investment capital is scarce and the supply of unskilled labour is plentiful, importing technologies that require large amounts of capital but offer few jobs may be a poor way to allocate resources.

In contrast, labour-intensive production techniques generate a high rate of employment per unit of investment: studies of road construction in India, the Philippines and elsewhere have found that labour-based methods can create seven to eight times as many jobs as equipment-based alternatives. This can generate significant income to workers who previously were not part of the formal cash economy. Labour-intensive construction methods also benefit the local construction industry and certain support-industries such as manufacturers of tools, simple equipment and indigenous construction materials. A key advantage of labour-based production in the 1980s lies in its potential for saving foreign exchange. The true cost of importing capital equipment may be higher than its nominal value, if the price to be paid in hard currency requires export promotion schemes.

Labour-intensive practices not only provide employment for a job-hungry work force, but may also make possible housing, rural access roads and other facilities that could only be built by the mobilization of labour.

A final set of benefits from labour-intensive practices stems from the smaller scale of most labour-intensive industries relative to their capital-intensive counterparts. Statistics indicate that as firm size increases: (1) capital investment per worker increases, (2) value added per worker rises, (3) wage rates rise, and (4) value added per unit of capital falls.[48/] It follows that "small enterprises with a lower level of investment per worker tend

48/ World Bank, World Development Report 1978, Washington, D.C., 1978, p. 19.

to achieve a higher level of productivity of capital than do larger, more capital-intensive enterprises".49/ This is particularly significant in developing countries, where, as we noted earlier, capital is at a premium.

4.2.3 Management

As the scale of operations increases there are both advantages and disadvantages in terms of management. On the plus side the increased division of labour made possible through larger scale, allows for individual tasks to be simplified and perhaps carried out more easily. However, on the negative side, the large organization often must formalize concepts and practices which in a small operation can be done more or less intuitively. Such activities may range from accounting and personnel management to inventory control and maintenance scheduling. Such formalization often relies on tools and techniques which require a lot of education to implement; they are in effect capital-intensive in the sense that the workers responsible for implementing them must have university level training or its equivalent. Not only that, but in developed countries, where these techniques are the norm in larger and even some small operations there is a ready support facility in universities and research organizations to help out should anything go wrong. Such facilities are not as readily available in developing countries.

For developing countries, from the perspective of management efficiency, smaller operations are often likely to be more efficient than large scale operations. There are of course instances where the inherent technology of the product dictates that, for example, engineering or marketing costs need to be spread over a large volume of production and so large scale operations become the best choice.

4.2.4 Technological complexity

An increase in technological complexity was initially heralded as a means of reducing the number of labourers needed and therefore the potential for management problems. At the same time, industrialists sought to benefit from economies of scale.

49/ Op. cit.

Yet a system that works efficiently in the industrialized world cannot simply be transferred to a developing country with similarly positive results. Technologically complex plants require auxiliary facilities often unavailable or extremely expensive in the developing world: sophisticated transport facilities, loading and unloading machinery, storage and distribution systems, warehousing for spare parts, large machine shops, etc. These additional facilities can increase overhead costs substantially.

A case study comparing two cement plants of similar design, one in the United States and the other in Indonesia, illustrates this point. As table 4.1 indicates, there is a large difference in the cost per ton of capacity: $US 115 for the Java plant and $US 34 for the United States plant. The large expenditure incurred by the Java plant for employee benefits such as housing and community development accounts for much of this discrepancy. The cost of utilities also contributed to this difference since the Java plant had to build its own electrical power plant and supply its own water. The United States plant was located at a lower elevation than its deposit of raw materials, making it possible to convey the materials by gravity. In Java, the deposit was at the same elevation as the plant, requiring more equipment for transportation. The raw material used in the United States was of higher quality than its Indonesian counterpart, resulting in more output per unit of input. Finally, the cost of building the Java plant was higher due to the high price of imported cement.

As table 4.2 shows, almost every aspect of production, with the notable exception of labour, is more costly in Java than in the United States, despite the similar levels of technology involved. In fact, many of the costs of the Java plant were not direct production costs. The costs of building housing and general administration could be viewed as an expenditure for general social well-being which would have been undertaken whether the project had been built or not, similarly the expenditure to develop the electrical water utilities could be spread over other industrial activities in addition to the cement factory. Another incommensurable is the lower grade of the Java deposit - it would be in fact better to compare this operation with more similar operations in a developed country if data were available. Even so it

Table 4.1. Comparison of cost per ton of capacity for two cement plants

	Java plant		United States plant	
	tons/year	$US	tons/year	$US
Rated capacity	275,000		425,000	
General administration, housing and community development		10,100,280		-
Company administration		1,564,872		1,153,093
Machine shop and warehouse		552,198		237,526
Total:		12,217,350		1,390,619
Utilities and related facilities:				
Oil storage/docking		1,590,261		-
Power plant and electrical lines		2,204,087		365,914
Water line and treatment plant		1,265,003		501,129
Electrical equipment and installation		942,334		1,203,559
Total:		6,001,685		2,070,602
Production:				
Quarrying		3,988,099		2,636,393
Grinding (raw)		1,105,621		1,561,899
Kiln		3,142,889		3,602,518
Gypsum storage		12,644		-
Final grinding		1,371,548		1,563,946
Storage silos, loading facilities		2,046,992		1,436,264
Total:		11,667,793		10,801,020
Bag factory		520,714		-
Railroad facilities		1,155,386		286,474
Total cost of plant:		31,562,928		14,548,715
Cost per ton of capacity		115		34

Source: Unpublished data, supplied by UNIDO consultant Fred Moavenzadeh.

Table 4.2. Cement production cost comparison

	Java	United States
Production (tons)	282,804	422,631
Total cost/ton (in $US/ton)	23.73	14.68
Depreciation cost (in $US)	7.42	3.56
Interest	3.71	1.78
Labour (operating)	0.18	0.60
Repair and maintenance	2.33	1.71
Other services	1.00	0.64
Utilities	5.31	4.08
Administration	2.67	1.51
Materials	1.11	0.80
Number of workers	996	204
Workers/1,000 tons	3.6	0.5

Source: Unpublished data, supplied by UNIDO consultant Fred Moavenzadeh.

is clear from the analysis that a conservative estimate of the costs of the Java operation are significantly higher than for the technically similar palnt in the United States.

Additional pitfalls may accompany the transfer of complex, large-scale technologies to developing countries. Machines may break, with no local mechanic to fix them. Plants are frequently operated at less than full capacity because market size may not warrant high production. Lastly, capital-intensive technology increases the need for workers skilled enough to run complex machinery. The administrator of a Mexican wood-products subsidiary concluded that the best solution to this problem was to use machinery from the 1930s, because it was at a level of mechanization that his uneducated workers could understand.[50/] A simple technology designed for a small-scale enterprise and able to meet the efficiency standards of the 1980s would clearly be a better solution.

4.2.5 Energy costs

Building materials industries, which are by nature energy intensive, consume significant amounts of energy. In 1981, the United States cement industry alone bought 385×10^{12} Btu of energy, or 3.5 per cent of the total purchased by all manufacturing industries. The share of these industries in the consumption of energy in developing countries is also high, of course, depending on the degree of the development of these industries and their composition in individual countries. In India, cement industry accounted for 17 per cent of the coal consumption of the industrial sector and 4 per cent of the power consumption in the beginning of the 1980s.

Energy intensities of other basic building materials such as lime, bricks, ceramics and glass are also high since firing, melting and drying play a central role in the technological processes used in production of these

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50/ Paul Strassman, Technological change and economic development, Cornell University Press, Ithaca, New York, 1986, p. 71.

items. Manufacturing of other materials used in construction, namely ferrous metallic products, aluminium and plastic parts also requires significant energy input. The construction process itself is not so energy intensive as compared to the manufacturing of building materials used in construction. Therefore, the main energy implications of expanding construction relate to production of building materials.

The high energy dependency of the building materials industries made them particularly hard hit by increasing prices of energy. In response to this process, intensified efforts have been made to reduce energy consumption, improve the efficiency of energy use and switch users from oil based fuels to locally available energy sources. But even such efforts have not always offset the negative impact of increasing fuel prices on production cost. A study of 18 building materials industries in the United States found that the number of BTUs purchased per production hour had dropped between 1971 and 1981 in two-thirds of the industries, but the cost of fuels and electric energy per worker hour had at least quadrupled (in nominal terms) in more than 70 per cent of the industries (table 4.3).

The increasing cost of energy input to the production of building materials coupled with the increasing demand for building materals required in the process of industrialization have put many industrializing countries in a difficult position vis-à-vis the development of their building materials industry. They have essentially three options.

First, they can employ the same technology they have used in the past with a corresponding pattern of energy consumption and attempt to increase their exports to pay for the increased cost of imported energy. This choice, however, may not be realistic in view of the growing foreign exchange pressures faced by developing countries. Another possibility is to curtail energy use by cutting production. A final alternative is to adopt energy, conserving production techniques and technologies. This has been achieved in many plants through conventional conservation practices, such as adding insulation, tightening up operating procedures, closing leaks and increasing conservation awareness among the work force. It is also possible to reduce

Table 4.3. Shipments, capacity utilization and measures of energy purchases and costs for 18 selected building materials industries - 1971, 1976 and 1979-1981

Description	Year	Value of industry shipments (million $)	Industry capacity utilization rates (per cent)	Purchased fuels and electric energy		Per cent of cost of materials	Average cost of energy per million Btu purchased
				1×10^{12} Btu	Million $		
Sawmills and planing mills general	1971	4,765	...	83	57	2.2	0.70
	1976	8,744	99	70	209	4.1	2.99
	1981	11,836	55	52	357	4.6	6.84
Softwood veneer and plywood	1971	...	...	...	...	...	...
	1976	3,164	93	33	78	4.1	2.36
	1979	4,295	91	30	110	3.9	3.67
	1980	3,731	85	25	114	4.5	4.56
	1981	3,688	78	23	129	4.8	5.73
Building paper and board mills	1971	466	...	44	36	16.4	0.82
	1976	516	a/	36	74	26.6	2.06
	1979	550	87	31	98	31.2	3.16
	1980	528	69	27	105	34.0	3.89
	1981	540	59	25	117	34.3	4.60
Paints and allied products	1971	3,656	...	20	22	1.1	1.10
	1976	5,931	79	15	47	1.4	3.13
	1979	7,911	80	17	70	1.5	4.12
	1980	8,340	a/	17	83	1.7	4.88
	1981	9,144	69	16	90	1.7	5.53
Paving mixtures and blocks	1971	804	...	38	29	6.2	0.76
	1976	1,251	a/	32	70	8.8	2.19
	1979	1,938	a/	39	124	9.5	3.18
	1980	2,245	85	35	143	9.4	4.09
	1981	2,223	75	30	145	9.5	4.78
Asphalt felts and coatings	1971	808	...	24	15	3.0	0.63
	1976	1,894	62	29	54	4.6	1.86
	1979	2,922	87	33	96	5.0	2.91
	1980	2,885	62	31	113	5.6	3.65
	1981	2,886	54	28 .	121	5.7	4.39

Table 4.3. Shipments, capacity utilization and measures of energy purchases and costs for 18 selected building materials industries - 1971, 1976 and 1979-1981 (continued)

Description	Year	Value of industry shipments (million $)	Industry capacity utilization rates (per cent)	Purchased fuels and electric energy: 1 x 10^{12} Btu	Purchased fuels and electric energy: Million $	Per cent of cost of materials	Average cost of energy per million Btu purchased
Flat glass	1971	811	...	58	35	14.6	0.60
	1976	1,336	75	54	100	19.2	1.85
	1979	1,638	75	57	161	23.9	2.82
	1980	1,547	71	51	182	26.0	3.57
	1981	1,657	57	52	220	28.5	4.24
Cement, hydraulic	1971	1,560	...	457	243	43.0	0.53
	1976	2,604	74	434	618	53.0	1.42
	1979	4,017	91	450	931	49.9	2.07
	1980	3,963	71	391	954	50.4	2.44
	1981	3,715	57	385	1,034	57.0	2.69
Brick and structural clay tile	1971	460	...	78	46	29.7	0.59
	1976	631	91	57	96	36.5	1.68
	1979	916	90	69	184	46.0	2.67
	1980	823	a/	57	180	48.0	3.16
	1981	739	49	47	171	49.1	3.64
Other structural clay products	1971	185	...	24	14	23.7	0.58
	1976	195	a/	17	25	35.2	1.47
	1979	203	a/	14	35	40.2	2.50
	1980	174	a/	11	37	48.1	3.36
	1981	145	a/	9	34	50.7	3.66
Concrete brick and block	1971	778	...	14	14	3.6	1.00
	1976	1,075	84	17	38	6.5	2.24
	1979	1,495	87	15	51	5.4	3.40
	1980	1,524	62	12	52	5.9	4.33
	1981	1,404	88	10	51	6.3	5.13
Other concrete products	1971	1,749	...	...	23	3.3	0.85
	1976	2,430	67	20	47	4.5	2.35
	1981	3,839	57	18.	93	5.2	5.21

Table 4.3. Shipments, capacity utilization and measures of energy purchases and costs for 18 selected building materials industries - 1971, 1976 and 1979-1981 (continued)

Description	Year	Value of industry shipments (million $)	Industry capacity utilization rates (per cent)	Purchased fuels and electric energy: 1 x 10^{12} Btu	Purchased fuels and electric energy: Million $	Per cent of cost of materials	Average cost of energy per million Btu purchased
Ready-mixed concrete	1971	3,280	...	85	69	3.7	0.81
	1976	5,312	75	50	120	3.9	2.40
	1979	8,962	74	54	177	3.4	3.28
	1980	8,810	74	52	204	3.9	3.92
	1981	8,983	67	44	209	3.9	4.81
Lime	1971	212	...	92	46	47.9	0.50
	1976	456	a/	94	138	59.5	1.47
	1979	604	85	94	189	58.7	2.01
	1980	599	72	86	317	63.1	2.33
	1981	654	64	88	223	62.1	2.52
Gypsum products	1971	526	...	41	29	11.1	0.71
	1976	748	75	41	75	16.6	1.83
	1979	1,555	98	51	145	18.8	2.84
	1980	1,342	89	43	154	20.2	3.58
	1981	1,314	81	43	180	22.4	4.21
Mineral wool	1971	640	...	44	32	11.9	0.73
	1976	1,390	88	53	120	19.1	2.26
	1979	2,180	91	58	198	20.6	3.41
	1980	2,235	76	54	224	21.7	4.15
	1981	2,339	61	53	255	23.0	4.84
Fabricated structural metal	1971	3,398	...	17	26	1.4	1.53
	1976	5,205	72	16	54	1.9	3.38
	1979	7,418	78	15	73	1.7	4.87
	1980	8,548	74	15	90	1.8	6.00
	1981	9,060	75	15	102	1.9	6.92
Sheet metal work	1971	1,925	...	14	16	1.7	1.14
	1976	4,284	70	12	36	1.5	3.00
	1979	6,210	71	11	47	1.3	4.27
	1980	6,408	71	11	57	1.5	5.18
	1981	6,754	63	12	65	1.6	5.44

Table 4.3. Shipments, capacity utilization and measures of energy purchases and costs for 18 selected building materials industries - 1971, 1976 and 1979-1981 (continued)

Description	Year	Value of industry shipments (million $)	Industry capacity utilization rates (per cent)	Purchased fuels and electric energy		Per cent of cost of materials	Average cost of energy per million Btu purchased
				1×10^{12} Btu	Million $		
For the 18 industries in this table	1971	28,400	-	1,193	789	5.5	0.66
	1976	47,164	-	1,080	1,999	7.7	1.85
	1979	70,481	-	1,127	3,077	7.6	2.73
	1980	70,016	-	998	3,321	8.1	3.32
	1981	70,920	-	950	3,596	8.5	3.79
For all industries	1971	670,971	...	13,010	10,432	2.9	0.08
	1976	1,185,695	76	12,625	27,587	4.0	2.19
	1979	1,727,000	79	12,867	42,768	4.3	3.32
	1980	1,850,927	75	11,874	48,205	4.4	4.06
	1981	2,017,543	72	11,563	55,255	4.6	4.78

Description	Year	Value of industry shipments (per cent)	Purchased fuels and electric energy	
			Volume (per cent)	Value (per cent)
For the 18 industries in this table as a percentage of all industries	1971	4.2	9.2	7.6
	1976	4.0	8.6	7.6
	1981	3.8	8.4	6.5

a/ Data withheld because the estimate did not meet publication standards.

Source: C.B. Pitcher, "Energy use and conservation in the construction materials industries", Construction Review, September/October 1983.

expenditure on imported energy by converting to cheaper, more abundant fuels, utilizing waste heat through heat recovery programmes; for example in sawmilling facilities the kiln can be fuelled from wood residues.

This third option has been followed by a number of industries in both the industrialized and developing regions. The hydraulic cement industry, one of the largest energy consumers in the manufacturing industries, has conserved energy through housekeeping measures such as those outlined above, as well as through technological changes. Wet process plants, which produced about 46 per cent of total United States cement clinker in 1981 while accounting for 53 per cent of total energy use in the industry, have gradually been replaced by the more energy-efficient dry process plants. The flat-glass industry has adapted a new float-glass process, which requires about 25 per cent less fuel than the sheet-glass process, while the asphalt industries have reduced their energy consumption by making major changes in the composition of their product.

These examples show that technology may solve the problem of escalating energy costs. Completely different modes of production or more efficient variants of traditional methods may be developed. But research is also needed to develop alternatives to hydrocarbon-based fuels. Solar energy may be one such possibility.

New technologies are not the province alone of large scale operations. In some respects small scale facilities are in a better position to adapt to changing circumstances than their large scale counterparts. Small scale operations do, however, often need help in terms of know-how. This can sometimes be supplied by the organization supplying the technology. For example the manufacturer of a wood-fired boiler for a lumber drying kiln can also assist in helping small firms to adapt its operation to the special requirements of this technique. In other cases the government must fill this role through research and technical assistance centres. World-wide dry process facilities are becoming more predominant, mainly because they are more energy efficient.

4.3 <u>The concept of scale economies</u>

While automation has proved its ability to produce high quality standardized output at low cost, it has often required large scale facilities in order to be feasible. An example of such systems can be found in the modern automobile assemoly line. In recent years the construction of such facilities has declined. Issues of scale have been dealt with at some length in a recent UNIDO study.[51/] It is observed there that very large scale operations have never accounted for the majority of manufacturing operations in advanced industrial countries. Further, the construction of such facilities has slowed down considerably in the past few years.

The main reason for the recently reduced enthusiasm for very large-scale facilities is that they generally are only efficient when operated near design capacity. In developing countries, in particular, actual operating rates have tended to be below design capacities. The reason for this can be found on both the marketing and production sides. Forecasting demand is always fraught with uncertainty and often demand turns out not to be as great as had been forecast. However, this is not strictly a matter of forecast inaccuracy. In fact there is a tendency to be overly optimistic in projecting demand in feasibility studies. Even if market demand turns out to be basically as forecast, it may still be that marketing arrangements are indadequate or production costs may turn out to be higher than was anticipated and so the price is raised to cover costs. One of the most frequent deficiencies in demand forecasts is that price is not explicitly included in the analysis.

Production bottlenecks are also frequent contributors to lower than capacity production levels. This is particularly the case in developing countries where large-scale operations tend to rely to a larger extent on imported supplies. In addition, in many instances in developing countries there are exchange controls which can make it difficult to obtain supplies, raw materials and repair parts, especially when a price increase or other

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51/ <u>Optimum scale production in developing countries: A preliminary review of prospects and potentialities in industrial sectors</u>, Sectoral Studies Series No. 12 (UNIDO/IS.471), June 1984.

unexpected contingency has resulted in import requirements exceeding what had originally been budgeted. Such difficulties are related to factors which are not directly under the firms' control. In other areas there could in principle be some advantages to large scale operations in the sense that the firm is able to have control within the organization of mechanics, plumbers, engineers and so forth to ensure that equipment is properly serviced. However, to some extent this advantage is offset by the fact that more sophisticated production technology tends to require more careful and skillful maintenance.

In addition, economists distinguish between internal and external economies of scale. The term internal economies of scale refers to economies of scale which a single firm enjoys as it increases it scale of operations. The term external economies of scale refers to economies of scale that affect the industry as a whole as it expands. In the latter instance, economies of scale are not dependent on the size of the individual production facility but depend on the size of the industry as a whole. In either instance per unit costs fall as output increases. In fact, unit costs may fall as scale increases for reasons which economists would not attribute to the existence of scale economies. Thus, for example if a large firm is able to exert significant market power in purchasing inputs, it may be able to purchase them at less than the price which small firms pay. This should not be confused with the potential for a large purchaser to buy inputs cheaper because suppliers find their costs, for example delivery costs, are lower for large volume sales.

The question of the existence of scale economies is an interesting one and important to policy considerations in developing countries. The question could be put a little more concretely. Typically, firms face what is called a U-shaped average cost curve, i.e. average costs first fall over some range of output then may be more or less flat and finally increase. In fact, this is probably a bit too simplistic since there are maybe a few bumps along the bottom of the U-shaped curve. The point is that all firms in most industries face first decreasing then perhaps constant and eventually increasing returns to scale. So the question is not really so important as to whether economies of scale exist. They do in almost every sector - as do decreasing and also constant returns to scale.

The question needs to be asked a little more precisely. Over what output are economies of scale decisive? It is not reasonable to build facilities which are too small to capture the typically pronounced economies of scale that characterize the initial falling part of the U-shaped average cost curve. Equally inefficient is to construct facilities which are beyond reasonable production levels on the rising portion of the U-shaped average cost curve.

There is another dimension to the question of scale. In some sectors one finds large plants and small plants operating side by side in the same market. The range in size may be from five employees to over a thousand as in say a furniture and joinery establishment. In the case of an integrated plant producing not only furniture and joinery but other wood products, the size may be even greater. This provides good empirical evidence that economies of scale are not a dominating force in the sector. However, in some instances the very small scale facility, while it makes a worthwhile contribution to economic development especially in the early stages of development, is not apt to be suitable for middle income economies. This means that the small-scale operation is competitive with larger plants only because it is able to draw on a pool of very low wage unskilled workers, in some cases it may be a family operation. As economic development proceeds, a different type of operation becomes relatively more efficient and it is necessary to use more sophisticated technology. It may be that such fundamental changes result in a different range of viable production scales.

At any rate, the discussion which follows attempts to show that, for the building materials sector, in many instances economies of scale are dissipated at fairly low levels of output and small labour-intensive facilities can be viable entities.

Bela Gold points out in a recent UNIDO report that the very definition of scale is fuzzy. For example, plant B might be called large-scale in relation to plant A when it merely carries out the same activities as plant A in greater number, or carries out a greater number of related activities (i.e., plant B is an integrated plant whereas plant A is non-integrated). Small- and medium-sized plants are better able than large-scale plants to provide distinctive products, to change their product mix frequently and to adapt to selective market niches.[52/] Finally, recent technological advances such as computer-assisted manufacturing will allow small- and medium-scale plants to gain the advantages of automation without the high costs and rigid production systems previously associated with such methods. This is discussed further in section 4.4.6.

We now turn to the empirical evidence for their existence. Several reviews of the literature have shown that this empirical backing is also inconclusive.[53/] Since most studies deal with average statistical relationships in a variety of industries, it is difficult to ascribe a variation in production level to a specific variable such as an economy-of-scale effect. This has proved true even when studies have been based on seemingly homogeneous sectors of industry, since even these studies have ignored differences in the factor proportions, product mixes and technologies used by the plants studied.

Once, engineering estimates seemed a potential source of information on the projected effects of increases in scales of production, but so far these estimates have been based on extrapolations of current experience rather than on serious research. Most of the specialists consulted in engineering studies, for instance, have limited expertise in estimating the results of increasing a scale of production substantially beyond what exists

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52/ Changing determinants of optimal scale in production and exploring resulting opportunities in developing countries, background paper prepared by Bela Gold, 19 June 1983 (Microfiche No. 13379), p. 26-27.

53/ Ibid., p. 13.

already.[54/] Furthermore, engineering studies have often treated large-scale plants as if they were simply blown-up versions of smaller plants, rather than plants with fundamentally different organizations of production.[55/]

Although plants of all scales continue to have important roles in most economies, the scarcity of capital, the huge surplus of unskilled labour and the need to accommodate a rapidly changing market demand may make large-scale enterprises a poor choice for many developing nations.

A prime candidate for the promotion of small-scale technologies is the building materials industry, given the general importance of this sector to the economy and the living standard of many developing countries. The potential for creating technologies suitable for small-scale enterprises is very high in this sector because of the vast array of possible ways to produce a given item. This flexibility will be detailed in the following section.

4.4 Suitability of the building materials industry to small-scale production

Evidence exists that many sectors of the building materials industry may operate at constant returns to scale over a range that includes fairly small plants. Subsequent sections argue that the resources necessary for the manufacture of building materials are widely available, and the technologies associated with the industry are flexible enough to allow varying degrees of technological complexity and labour intensity.

A look at the market for semistructural and auxiliary components of buildings and for secondary goods fabricated from basic structural materials reveals even more opportunities for small-scale operations in this sector than

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54/ *Op. cit.*, p. 16-17.

55/ *Optimum scale production in developing countries: A preliminary review of prospects and potentialities in industrial sectors*, Sectoral Studies Series No. 12 (UNIDO/IS.471), 12 June 1984, p. 6.

is commonly realized. An examination of the informal construction industry in developing nations indicates that a vast pool of knowledge, experience and manpower for small-scale enterprises already exists.

Small-scale plants seem especially appealing for non-metallic building materials such as bricks. The costs of making, firing and drying bricks, using either a tunnel or Hoffmann kiln, decrease very slowly, with increasing capacity, even in a developed country.[56/] In a developing nation, per-unit costs may be significantly higher in large-scale plants, as a study of the brickmaking industry in the Gambia showed (see tables 4.4 and 4.5). Such studies lead to the conclusion that brick-making technologies with a high capital component are not always the most efficient choices for developing countries. "This is particularly true of processes preceeding the firing. Techniques with a high labour content or improved or mechanized techniques for preparing, forming and drying the clay are in some cases more efficient than such highly mechanized or automatic techniques as tunnel kilns and drying".[57/] Moreover, the costs of mining and transporting the increased quantities of clay necessary for the larger plants, and the costs of the fuel and power for the larger kilns, may rise disproportionately with the increase in output; in developing countries especially, the increase in transportation and energy costs could outweigh any savings from productive efficiency even if these existed.

Wood-related industries show essentially no scale economies with regard to the amount of raw material or number of workers. Although production of medium-density fibreboard, oriented strandboard, hardboard and comply requires large, capital-intensive plants, the production of sawn wood can be a very small scale operation. Plywood and cement or gypsum fibreboard can be

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56/ Brickmaking plant: Industry profile, Development and Transfer of Technology Series No. 10 (ID/212), 1978, p. 31.

57/ Sid Boubekeur, Outline of a policy for expertise and technological selection in capital goods for cement and brick manufacturing (ID/WG.425/4), prepared for UNIDO, Vienna, 27 August 1984, p. 50.

Table 4.4. Investments by output level for brickworks in the Gambia in 1980 ($US)

Unit size	Installation costs	Running costs	Total investment per brick
Small unit: 300,000 bricks/year	25,500	32,125	0.19
Medium-sized unit: 3 million bricks/year	700,044	410,175	0.37
Large unit: 10 million bricks/year	2,117,250	1,121,610	0.32

Table 4.5. Production costs by unit size for brickworks in the Gambia in 1980 ($US)

Unit Size	Cost of producing 1,000 bricks	Cost of producing one brick
Small unit: 300,000 bricks/year	107.0	0.10
Medium-sized unit: 3 million bricks/year	136.7	0.13
Large unit: 10 million bricks/year	112.15	0.11

Source: UNIDO, Outline of a policy for expertise and technological selection in capital goods for cement and brick manufacturing, prepared by Sid Boubekeur (ID/WG.425/4, August 27, 1984, p. 47.

produced with medium-scale or labour-intensive methods.[58/] Since the latter items account for the great majority of wood products used in construction, a small to medium scale wood industry is possible in most developing countries. (In Brazil, for example, only 145 of the nation's 15,058 producers of wood products are large firms, while 994 are medium-sized or small firms and 13,919 are very small.)[59/]

The notion that small cement plants are not feasible may be rooted in the vague idea that only a large plant could produce the major ingredient of massive concrete-based construction projects, but the success of small cement plants throughout the world belies this notion. Even with capacities as low as 20,000 metric tons per year, plants have proved economically efficient. Table 4.6 shows that the ratio of net output to capital for a small cement plant in India is nearly double the ratio for a large plant. According to figures published by the Cement Research Institute of India in 1978, the capital investment per ton of installed capacity for a domestic plant producing 1,200 tons of cement per day was Rs. 741.25 (roughly $US 77), but only Rs. 597.29 ($US 61) for a plant with a 50 ton per day capacity.

Mini cement plants can be brought on-line in 1 to 1.5 years, as against 4-6 years for large-scale plants. Upkeep costs for mini plants are low, and much of their equipment (i.e. kilns, silos, sheds and conveyor belts) can be produced locally, stimulating the rural economy.[60/]

As early as 1966, a vertical-kiln plant in Dalmiapuram with a capacity of 30 tons per day was showing a 15 per cent savings in total capital costs over competitors with capacities 20 to 40 times as great.[61/] The small plant

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58/ A review of technology and technological development in the wood and wood-processing industry and its implications for developing countries, prepared by the Sectoral Studies Branch, Division for Industrial Studies, Sectoral Working Paper Series No. 8 (UNIDO/IS.413), November 1983, p. 115.

59/ Luiz C.M. Bonilha, The building materials industry in Brazil, a background paper prepared for UNIDO, July 1984, p. 32.

60/ Sid Boubekeur, Outline of a policy for expertise and technological selection in capital goods for cement and brick manufacturing (ID/WG.425/4), prepared for UNIDO, Vienna, 27 August 1984, p. 40.

61/ N. Ramachandran, "World's smallest cement plant", Rock Products, May 1967, p. 74.

Table 4.6. Economic factors in large-scale versus small-scale production of cement, India

Economic factors	Large-scale cement production (Rupees/worker)	Small-scale cement production (Rupees/worker)
Fixed capital	4,550	1,854
Working capital	1,850	1,750
Total invested capital	6,400	3,604
Annual wage	936	537
Annual value of processed raw material	1,747	1,561
Annual value of gross product	3,550	3,150
Annual net product	1,350	1,860
Annual surplus product	410	845
Gross output/capital ratio	0.60	0.90
Net output/capital ratio	0.21	0.39
Annual profit norm	0.06	0.23

Source: Fred Moavenzadeh, "Global prospects for concrete production", Concrete International, February 1984, p. 29.

cost $US 0.25 million to build, as compared to $US 5 million for a typical large cement plant in India, and its compact design allows for still greater savings by minimizing haulage distances within the plant. Although the cost of producing a barrel of cement in the small plant when it opened was $US 1.72, compared to $US 1.58 in a typical large plant, the small plant served a market within a 20-mile radius, while the larger plants served customers as far away as 250 miles. This allowed the small plant to package, transport and distribute each barrel for $US 0.49, for a total cost of $US 2.21 per barrel, while the large plants had to spend $US 1.10 to package and deliver each barrel, for a total cost of $US 2.68. In most developing countries, where capital is scarce, transportation systems inadequate, fuel expensive and quality packaging materials in short supply, small, decentralized plants are able to provide cement to local markets at a lower total cost than large plants. Some countries might choose an intermediate solution: a few large, centralized plants to produce clinker, and a number of small, local plants to grind and bag it. Since clinker is cheaper to bag and transport than cement and less subject to spoilage during transport significant savings are possible.

A recent ESCAP report provides another argument in favour of small-scale cement plants when it states that few of the large and modern cement plants in the region are running at full capacity, although cement is still being imported.[62/] In fact, utilization of only half a cement plant's capacity is common in the developing world.[63/] Such difficulties might be less common in a country with an even distribution of small plants serving local demand than in a country with a few large factories near the major cities. Countries

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62/ Economic and Social Commission for Asia and the Pacific (ESCAP), The building materials industry in the ESCAP region, Working paper prepared for UNIDO, Bankgkok, 1984.

63/ Optimum scale production in developing countries: A preliminary review of prospects and potentialities in industrial sectors, Sectoral Studies Series No. 12 (UNIDO/IS.471), 12 June 1984, p. 44.

that are considering new investments in cement plants might do well to look at the experience of nations with similar resources that chose to build large-scale cement works in the past.

Even industrialized nations are moving towards a system of smaller-scale cement plants. By the late 1960s, communities in the United States had begun to resist the construction of mammoth cement plants. The passage of pollution control regulations made some old equipment obsolete and new equipment more costly, while a decrease in the rate of return on investments in cement plants made the industry less attractive and a decrease in capacity utilization of cement plants created apprehension among United States firms about expanding their facilities.

The sharp rise in fuel prices in 1973 further jeopardized large, centralized plants which relied on distribution systems so extensive that a truck might carry cement a great distance to a regional storage facility, only to have other trucks carry it back for sale to outlets a few miles from the plant. The major firms continued to divest themselves of their least profitable operations, while smaller companies entered the field. Advances in the design of the vertical kiln (i.e. development of the pan-type nodulizer) made small plants more productive than previously, while the thermal efficiency and relatively clean operation of vertical kilns made them a viable alternative to large rotary kilns.

Similarly, scale economies in the manufacture of steel bore their fruit during the period of long growth when installations were operating at 90 to 100 per cent of capacity. The world crisis in steel made these levels fall consistently until they were below 80 per cent, and in certain European mills, below 60 per cent. Since 1977, the ten American "Big Steel" companies have closed, idled, transferred or sold 20 plants or parts of plants.[64/] Against this background, minimills, which melt scrap in electric furnaces and roll the hot steel into a relatively few products, have flourished. In Italy alone,

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64/ Robert J. Miller, "Steel minimills", Scientific American, May 1984, p. 33.

there are 120 minimills, accounting for more than half the country's output of steel. In 1980, minimills accounted for 46 per cent of the total steel output of Spain, 32 per cent for the United Kingdom, 29 per cent for Republic of Korea, and 23 per cent for Japan.65/ Small rolling mills for concrete reinforcing rods are operating successfully in Tunisia, contradicting guidelines which advised integrated plants not to drop below one million tons per year of long-term products. The reduced scale of such units can be appreciated by comparing their production capacities of 50,000 to 150,000 tons per year with that of giant blast furnances in Japan which can produce up to 14,000 tons of pig iron per day.66/

Minimills may not be a marginal phenomenon, but an important and lasting development in the iron and steel industry. In America, their number has increased from the 10 or 12 minimills sharing 2 per cent of the steel market in 1960, to the 50 minimills which accounted for 15-18 per cent of the market at the start of 1984, and experts predict this market share will rise to 24 per cent by 1990 as innovations in minimill technology bring down production costs and improve product quality.

4.4.1 Distribution of raw materials

The distribution of natural resources necessary for the building materials industry is widespread enough to allow for a system of small-scale plants. Clays suitable for brickmaking can be readily found nearly everywhere in the world. The ingredients of cement are available at low cost in nearly all regions, and where the ingredients of Portland cement are scarce, blended cements based on industrial and agricultural wastes may be substituted for many construction projects - at lower cost. Deposits of gypsum are scattered throughout the world; recently, it is being made available as a byproduct of fertilizer manufacture in many parts of the world.

65/ Optimum scale production in developing countries: A preliminary review of prospects and potentialities in industrial sectors, Sectoral Studies Series No. 12 (UNIDO/IS.471), June 1984, p. 21.

66/ The world iron and steel industry (second study), prepared by the Sectoral Studies Section, International Centre for Industrial Studies (UNIDO/ICIS.89), 20 November 1978.

Concerning wood based building materials, small-scale logging and processing operations are feasible in many developing countries.

The resources necessary for the production of steel are not as easily found as for other building materials. Only 30 per cent of the world's known deposits of iron ore are in developing countries and only 5.2 per cent of the world's supply of high-quality coking coal. But even without domestic supplies of the most common raw materials, a country can develop a steel industry, as long as it does not view large, integrated mills with coke-fuelled blast furnaces as its only option. The discussion on mini-mills has opened up entirely new perspectives in this respect.[67/]

4.4.2 Technological complexity

The adaptability of the building materials industry to a wide range of raw materials is only a small indication of the flexibility of its technologies, a flexibility which not only allows plants to exist within a wide range of sizes, levels of technological complexity and ratios of labour to capital, but also to remain profitable by adapting to changes in the economy. The potential for technological variety and change comes in part from the many degrees of freedom in the construction industry; a perturbation in one sector does not upset the industry as a whole, and vice versa.[68/] For example, a country's favoured method for constructing roads may change from labour-intensive to capital-intensive, but the proportion of total construction costs that must be allocated to building materials and implements will remain fairly constant; table 4.7 illustrates this with statistics of rural road construction in Thailand. Nor is technological choice limited by a dichotomy that equates large plants with modern methods and small plants with

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67/ See e.g. Mini-Mills: the way ahead. Proceedings of the Metal Bulletin's Second International Mini Mills Conference, Vienna, 1982 and Techno-economic considerations for the establishment of a steel industry based on the direct reduction technology for sponge-iron production, prepared by UNIDO (ECE document STEEL/SEM.9/R.31), 1983.

68/ Hungarian building and production technologies for transfer to developing countries, prepared by G. Kunszt and T. Mezos, 1983 (Microfiche forthcoming), p. 10.

Table 4.7. Costs of rural road construction in Thailand
(10 km feeder road with gravel surface)

Technique	Equipment	Implements and materials	Skilled labour	Unskilled labour	Total
2,000 Bahts/year equipment Utilization rate Low fuel price					
Capital intensive					
Baht	2,976,471	2,338,720	483,187	354,096	6,152,464
Per cent	48	38	8	6	100
Labour intensive					
Baht	1,441,243	2,756,060	579,304	2,313,164	7,089,771
Per cent	20	39	8	33	100
100 Bahts/year equipment Utilization rate High fuel price					
Capital intensive					
Baht	4,134,744	2,338,720	483,187	354,096	7,320,747
Per cent	56	32	7	5	100
Labour intensive					
Baht	2,089,467	2,756,060	579,304	2,323,164	7,737,995
Per cent	27	6	7	30	100

Note: Low fuel prices are those that prevailed before October 1973. High fuel prices correspond to a trebling of those prevailing prior to October 1973.

Source: Clifford Winston, "Industrial economic policy toward the building materials industry in developing countries to achieve maximal economic growth", Working Paper, Technology Adaptation Program, Massachusetts Institute of Technology, Cambridge, Massachusetts, June 1984, p. 13.

traditional methods - traditional in many reports being a synonym for backward. An enormous integrated steel mill with 1920s technology now being built in a developing country is as backward as the humblest cottage brick business; a mini-cement plant with a vertical kiln can employ state-of-the-art methods more energy efficient than the rotary kilns in very large plants. Rather, a continuum of choices for the pairing of plant size and technological complexity is possible.

At the small-scale, simple-technology end of the spectrum, the extent and success of the informal sector of the construction industry proves that untrained, self-employed builders relying on indigenous materials, traditional methods and ingenuity can provide housing for a large number of people. This sector is believed to be responsible for a large share of housing in developing countries - perhaps half the homes in urban Egypt, perhaps 90 per cent in Honduras.[69/]

A single worker with a good supply of clay, for example, can handcraft, fire and market enough bricks for a small business to be viable. Firing can be done in a hollow mound by lighting a fire inside, using wood or agricultural waste as fuel. At slightly more elaborate levels, a brickmaker might build a more permanent kiln, or scove, with outer walls of mud-covered bricks. In villages and towns with rudimentary industrial facilities, these or slightly more complex methods might be sufficient. In cities, large, dense markets might justify investment in a modern factory with a tunnel kiln costing hundreds of thousands of dollars but able to produce 60 tons of bricks per day.

In the past 20 years, new tools, such as integrated multiband saws and chippers and new cutting knives have led to greater yields from raw wood. New methods that can break down the wood into strands, scrim and wafers have made products such as processed boards possible, and microcomputers have allowed for the increased automation of processing plants and the scanning and sorting

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69/ International Labour Office, Informal sector employment in Egypt, prepared by Mahmoud Abdel-Fadil, Geneva, 1980, p. 31.

of diverse species of trees to allocate them more efficiently to end-uses. Small sawmills producing lumber for local consumption are also widely used. But researchers in Australia have recently developed two types of kilns which are transportable, inexpensive and designed to suit the needs and limitations of small-scale sawmills in developing nations. Both kilns run on cheap, locally available fuels.[70/] Small-scale production of processed boards is also possible, with only a few workers needed to cast the boards on flat concrete tables and roll in vegetable fibres during setting. In pilot plants in Botswana and the United Kingdom, two workers using these methods were able to produce 6-10 sheets per day at a cost of only $US 4 per sheet. Although such cement- and gypsum-based boards are too heavy for cheap transport, they can be ideal for local use as internal and external linings and flooring. The quality of their finish can be high, and the inert matrix makes them resistant to fire, decay and biological attack. Between technological extremes are processes such as the production of wood wool, wood-cement particle boards and wood-fibre cement, which use a mixture of simple and more complex technologies. Table 4.8 is a summary of the technological considerations a developing country might take into account when deciding which domestic wood industries to encourage.

The cement industry in Mexico provides a microcosmic view of the range of technologies in this sector. In 1975, it comprised 26 plants, the smallest able to turn out 115,000 metric tons per year, the largest 1,848,000. The oldest equipment in use would have been considered obsolete for new production units, while the most recently installed equipment enabled some plants to carry out completely automated production and quality control. The complexity of processes and modernity of equipment can vary enormously within a single plant - in the 1970s, the Monterrey mill of Cementos Mexicanos included three kilns dating from the 1920s operating beside three brand new kilns - and within a single size category, as evinced by an inspection of the five largest

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70/ A review of technology and technological development in the wood and wood-processing industry and its implications for developing countries, prepared by the Sectoral Studies Branch, Division for Industrial Studies, Sectoral Working Paper Series No. 8 (UNIDO/IS.413), November 1983, p. 26-27.

Table 4.8. Technological considerations for developing countries

Aspect	Sawn wood Sawmill	Plywood	Fibre board hardboard	Medium density fibre board	Particle board	Wafer board	Strand board	Cement particle board	Cement fibre board	Gypsum fibre board	Kiln dryer for sec processing
Wood raw material yield (%)	40-50%	30-50%	85%	90%	90%	85%	85%	90%	90%	90%	-
Suitability for developing countries	Simple	Simple	Wet batch. Simple Wet cont. Inter dry- advanced	Advanced	Suitable most devel. countries	Suitable most devel. countries	Advanced	Suitable most	Simple all	Simple all	Yes
Maintainability of plant	Simple	Simple	Medium- sophisti- cated	Sophisti- cated	Medium	Medium	Sophisti- cated	Medium	Very simple	Very simple	Simple
Industrial infrastructure required	Simple	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Very simple	Very simple	Simple
Operation of process	One shift possible	One shift possible	Continu- ous except batch	Cont.	Cont.	Cont.	Cont.	Cont.	One shift simple	One shift simple	One shift or cont.
Min. econom. capacity Local market export	Varies	m^3/day 20 120	m^3/day 15-20 70	m^3/day 75-100 200	m^3/day 30-40 200	m^3/day 30-40 200	High	m^3/day 20-30 50	Low	Low	m^3/day 5-10 or less
Energy Fuel (heating)	Low None	Medium Medium	High High	Higher High	Medium Medium	Medium Medium	Medium Medium	Medium Medium	V. low -	V. low -	High
Water	-	small	Wet high Dry small	Small	Small	Small	Small	Medium	Low	Low	-
Ecological considerations	Small	Medium problem	Wet serious dry medium	Medium	Medium	Medium	Medium	Low	Nil	Nil	Small

Source: A review of technology and technological development in the wood and wood-processing industry and its implications for developing countries, Sectoral Working Paper Series No. 8, (UNIDO/IS.413, 1983) plants in the country. A study of these five plants[71/] further showed that the age of equipment was not as important in determining productive efficiency as the ability of the staff to select the most appropriate equipment and methods available on the world market and tailor them to local conditions, introduce innovations of their own, and effectively maintain the plant to prevent shutdowns. But the proficiency of a plant's employees in these activities was not correlated to the modernity of its equipment and methods; rather, success was a function of plant organization and management philosophy. Observations of the cement industry in India bear out such generalizations and reinforce the conclusion that manufacture of cement may occur at a multiplicity of scales and technological levels. A summary of the characteristics of production at each of these scales is provided by table 4.9.

The manufacture of steel is inherently more complex than that of other building materials, but more leeway is possible than is commonly believed. A mill that uses scrap as its raw material can ignore the difficulties of ore reduction and the creation of intermediate products such as pig iron, while a mill that limits its mix of final products to rods and bars can eliminate the need for elaborate casting and shaping machinery. But this doesn't mean that minimills must limit themselves to simple or old-fashioned methods. Free of the need to spend vast amounts of money to build and maintain the facilities of an integrated plant, a minimill can more easily invest in modern equipment for the steps of steel manufacture within its domain.[72/]

4.4.3 Labour-capital substitution

Closely related to the flexibility of an industry's technology is the ease with which manufacturers can interchange labour and capital in production processes. The more elastic this ratio, the greater the likelihood that entrepreneurs will be able to find combinations of workers and machinery that

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71/ Ruth Pearson, The Mexican cement industry: Technology, market structure and growth, Working Paper No. 11, prepared for ECLAC, Buenos Aires, September 1977.

72/ Robert J. Miller, "Steel minimills", Scientific American, May 1984, p. 34.

Table 4.9. Characteristics of various scales of cement production

Scale of production	Output (tons/day)	Kiln type	Availability of technology to developing countries	Raw materials	Type of cement produced	Quality and uses of product
Medium to large	500-3000+	Rotary	Must primarily be imported	Limestone; a siliceous or alumnous material such as clay or blast-furnace slag; additives such as gypsum or pozzolana	Portland cement (PC) Portland pozzolana cement (PPC) Portland slag cement (PSC)	Satisfies international (ISO) standard for strength; may be used for any building project. Q=0.9-1.0
Small	100-500	Rotary or vertical shaft	Primarliy imported	Same as above	Same as above	Same as above
Mini	20-100	Vertical shaft	Indigenous	Generally same as above with some variation	Same as above	May be full-strength or less; uses vary accordingly. Q=0.8-1.0
Village	Less than 20	Vertical shaft	Indigenous rural	Limestones of inferior quality, volcanic tuffs, ground-brick waste, ash from burnt agricultural waste	Hydraulic limes and lime-pozzolana mixtures	Low-grade cements, weaker and slower setting than PC, but well-suited to mortars, plasters, soil-stabilizing concrete blocks and foundation concretes. Q 0.6

Note: The Q-index is a measure of the strength of cements in relation to their ability to substitute for Portland cement. It is the amount of Portland cement which can be replaced by the substitute.

Source: Optimum scale production in developing countries: A preliminary review of prospects and potentialities in industrial sectors, Sectoral Studies Series No. 12 (UNIDO/IS.471, June 12, 1984), pp. 45-48.

allow them to enter the field and to respond efficiently to changing conditions within it. A plant that can use more labour than machinery will have greater latitude in responding to fluctuations in supply and demand. A labour-intensive plant will also be less vulnerable to equipment breakdowns and difficulties obtaining spare parts from foreign suppliers.

The building materials industry is amenable to a broad spread of labour-to-capital ratios. Labour intensity, measured in the number of people engaged in one million rupies worth of production, and income generation, expressed in wages as a percentage of output, is especially high in the informal sector, as table 4.10 shows for Sri Lanka. Estimates performed across the building materials industries of many developed and developing nations and within various countries across wide time spans provide convincing evidence that labour and capital are highly interchangable in the face of differentials in factor prices.[73/] Moreover, the estimates are in part based on data from existing mills in developing countries, many of whose technologies are capital-intensive simply because they have been imported from countries in which such methods are more economical than labour-intensive methods. Conceivably, research could lead developing countries to adopt technologies better suited to conditions of scarce capital and abundant labour. For instance, mill owners in most industrialized nations have switched from casting steel into ingots, which are later melted and rolled into finished products, to feeding the liquid steel directly into a continuous caster, which creates finished products immediately. But casting from ingots is much more labour-intensive than continuous casting, and so may be economically preferable for steel plants in developing nations. Separate melting and rolling facilities also may help steel mills weather market fluctuations more efficiently by allowing them to use their full melting capacities during slack times to create stockpiles of ingots, which can be rolled during times of peak demand.[74/]

73/ David Wheeler, The economics of the building materials industry in developing countries, Center for Construction Research and Education, Massachusetts Institute of Technology, Cambridge, Massachusetts, 1982, p. 72.

74/ Optimum scale production in developing countries: A preliminary review of prospects and potentialities in industrial sectors, Sectoral Studies Series No. 12 (UNIDO/IS.471), June 1984, p. 21.

Table 4.10. Labour, capital resources used and capacity utilization in selected material production units, Sri Lanka, 1973

Building materials	Number of stablish-ments	Number of workers per 10^6 Rs. of production	Wages share[a/] (percen-tage)	Capital per worker (m.v.) Rs.	Machinery and tools per worker (m.v.) Rs.	Capacity utilization (per cent)
Traditional and small scale units:						
Bricks	37	1,120	47	700	10	67
Sand	13	850	79	400	13	44
Country tiles	4	850	47	500	6	63
Cadjan (woven coconut roofing)	5	800	52	400		
Aggregate:						
(a) Manual quarry	2	560	45	1,300	110	81
(b) Mech. crusher	6	110	21	8,400	4,000	14
Lime	17	240	28	1,600	40	50
Brassware	19	140	25	1,400	700	53
Drainage fittings	15	100	26	7,300	3,700	65
Modern medium-scale and large industrial units:						
Flat tiles	5	140	21	6,400	2,500	65
Hardware	1	100	31	25,000	20,000	25
Cement	1	26	14	93,000	46,000	67
Asbestos cement products	2	16	10	12,000	5,100	68
Steel	1	16	9	59,000	29,000	41
Paint, varnish, dis-temper, etc.	9	14	8	26,000	14,000	31

Notes: a/ Wages as a percentage of total value of output.
m.v. = market value
Rs. = Rupees

Source: Economic and Social Commission for Asia and the Pacific (ESCAP), The building materials industry in the ESCAP region, Working Paper prepared for UNIDO, Bangkok, 1984, p. 11.

As stated earlier, brickmaking may be accomplished almost entirely by hand. In developed countries, winning clay through manual labour is profitable for outputs up to 14,000 bricks per day. In developing countries, it would be profitable at much higher levels. Evidence shows that teaching workers to use their shovels more efficiently and offering financial incentives for increased productivity may be more cost-effective than investing in clay-winning machines.[75/]

At the highest level of mechanization attained so far in the clay and brick industry, the input of labour is less than one man-hour per thousand bricks; at the highest level of labour intensity in unmechanized plants, it may be 167 man-hours per thousand bricks. But the hourly wage in developing countries in 1978 was as low as $US .11 and as high as $US 11.00 in developed countries, and since owners of the more mechanized factories also had to pay more for their initial capital, equipment depreciation, fuel, power, spare parts and process additives, the labour-intensive plants in the developing world were able to offer bricks at less than half the price of bricks from factories in the developed nations.[76/]

Arguments have been presented, that uncertainties as to the quality of handmade cement may lead engineers to prescribe more concrete in building projects or reinforce it with more costly materials.[77/] Yet high-grade cement may be superfluous for many local building projects, and the study of the Mexican cement industry cited earlier showed that the effectiveness of quality control can be independent of production technology. India and several other developing nations have been exploring alternatives to costly

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75/ Brickmaking plant: Industry profile, Development and Transfer of Technology Series No. 10 (ID/212), 1978, p. 7.

76/ René Urien, "Alternative strategies for building material industries in developing countries", ECO No. 83-16, Centre Scientifique et Technique du Bâtiment, Paris, 4 May 1983, p. 39-40.

77/ The building materials industry in the ESCAP region, Economic and Social Commission for Asia and the Pacific (ESCAP), Working Paper prepared for UNIDO, Bankgkok, 1984, p. 9.

on-line instrumentation controls of quality.[78/] Though the manpower per ton of output is two to three times greater in mini cement plants than in large plants, the quality of cement produced in India's mini plants rivals that produced in its giant rotary-kiln plants. The single unit design and compact size of the vertical-kiln plant at Dalmiapuram has facilitated production efficiency and quality control; a single superintendent in an elevated office can supervise nearly all the operations in the factory.

4.4.4 Plant mobility

Mobile plants may allow factory owners to remain competitive by moving their plants when sources of raw materials are depleted or the construction needs of a small market are met. Workers with cranes can dismantle a complete vertical-kiln cement plant, which weighs less than 200 tons, reconstruct it at another site and have it ready to resume production within a month.[79/] Field plants to produce concrete precastings on-site and then be relocated when a construction project is finished are now available; manufacturers have sold several in the Middle East.[80/] Engineers have developed a mobile limeburner which combines the advantages of shaft and rotary kilns and is able to process limestone of many grain sizes into 20 tons of high-quality lime per day.[81/] Mobile sawmills have long been available and have been used successfully in both developed and developing countries.

78/ Fred Moavenzadeh, "Global prospects for concrete production", Concrete International, February 1984, p. 30.

79/ N. Ramachandran, "World's smallest cement plant", Rock Products, May 1967, p. 76.

80/ Fred Moavenzadeh, "Global prospects for concrete production", Concrete International, February 1984, p. 31.

81/ Hungarian building and production technologies for transfer to developing countries, prepared by G. Kunszt and T. Mezos, 1983 (Microfiche forthcoming), p. 23.

For regions where a dispersed population would make a permanent brick-making plant unprofitable, a mobile forming plant has been invented which can produce a respectable 1,000-15,000 bricks per hour.[82/] With respect to Africa, special initiatives have been taken by UNIDO. The population living in rural areas has only very limited access to load bearing bricks. The mere cost of transporting bricks to the point of use would raise the end price to an unacceptable level and the local market is still not sufficient to justify a production on the spot. A UNIDO project initiated in 1984 has introduced a mobile mechanized brickmaking plant. The production unit will be composed of traditional brickmaking equipment and will have a capacity of 1,000-1,500 bricks per hour, but will be mounted on a trailer which makes it possible to tow it from one place to the other depending on the demand. The project will allow a realistic assessment of the potential role of this type of unit in satisfying the requirements of rural areas for high quality bricks.

4.4.5 Product mix

Entrants into the building materials industry also should have little trouble finding a product mix compatible with their resources and the needs of the local market, or altering this mix as conditions change. There exists a wide range of possible wood products, as shown by table 4.8. Although wafer boards, strandboards and medium-density fibreboards may now be beyond the technological capabilities of many developing nations, as supplies of common species of trees decline and a familiarity with more modern wood production methods and equipment grows, these products may become more attractive to manufacturers in developing countries. Even bricks can come in a surprising assortment of sizes, strengths, compositions, perforation patterns and shapes, suited to a variety of contruction needs. Ferrocement, a highly versatile form of reinforced concrete made of wire mesh, water and cement, is a building material with great promise for houses, boats, barns and factory components. Relatively easy to make and light to transport, ferrocement panels nonetheless

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82/ Sid Boubekeur, Outline of a policy for expertise and technological selection in capital goods for cement and brick manufacturing (ID/WG.425/4), prepared for UNIDO, Vienna, August 1984.

are strong, mouldable, inexpensive, and resistant to corrosion, compression, tension, bending, stresses and water. Not only are ferrocement panels valuable as the basic components of prefabricated housing, but especially in hot, dry climates, they may alleviate the shortage of roofing material. The lack of low-cost, durable roofing is the single greatest obstacle to building low-cost housing in developing countries, were roofing can represent 50 per cent of the total cost of a simple home. Yet the raw materials of ferrocement are available in most countries, its production is labour-intensive, and the skills involved are easily acquired and include many methods already common in the informal sector.[83/]

Computer-assisted manufacturing (CAM), which permits factories to shift rapidly from the production of one item to any of numerous other items by the replacement of instruction tapes in programmable machinery, will give the building materials industry in developed nations greater flexibility and responsiveness in product mix in coming years. With CAM, plants of all sizes will be able to run relatively small batches, stockpile smaller surpluses (with proportionately lower costs for warehouse space), reprogramme their machinery to produce a second item, and switch back quickly and cheaply to the first item if demand warrants it.

The above-mentioned UNIDO study[84/] claims that the diffusion of CAM/CAD technologies will be precisely in sectors where developing countries have made a notable progress. Failure to catch up in these technologies will threaten the industrialization of the South.

So far, the diffusion of computer-aided technologies to developing countries has been less than encouraging. Yet, developing countries need not

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83/ Roofing in developing countries: Research for new technologies, National Academy of Sciences (NAS), Washington, D.C., 1974, p. 45.

84/ Optimum scale production in developing countries: A preliminary review of prospects and potentialities in industrial sectors, Sectoral Studies Series No. 12 (UNIDO/IS.471), June 1984.

be excluded from such advances.[85/] As small computers become cheaper, easier to use and more reliable than they are even today, their transfer to developing countries will become more and more feasible. Computers exist that can diagnose their own malfunctions and either tell an operator which circuit board to replace, or automatically switch to a backup board. The potential effect of microcomputers on the building materials industry is significant, with applications throughout the wood, steel and cement sectors. A rapid development of appropriate synergistic linkages is, however, a prerequisite for the integration of these new technologies in developing countries.

4.4.6 Responsiveness to energy costs

The building materials industry has proved itself able to survive dramatic increases in the cost of energy and appears to have an even greater potential for adaptation. The world cement industry has responded to the changes in the prices and availability of commercial fuels, which took place in the 20th century, by reverting to more available fuels. The basic technological fuel before the 1960s was coal. Fuel oil and natural gas became preferable since the mid-1960s. This was associated on the one hand with the availability of cheap oil and on the other hand with the convenience of using oil as a fuel.

However, after the dramatic increase of the price for oil in 1973-1974, many countries started reverting to coal again. A significant number of developing countries, particularly those having coal resources, use coal as a main technological fuel in cement production. Even countries possessing oil deposits, such as e.g. Indonesia are now making efforts to substitute coal and other energy resources for oil in cement production in order to conserve oil which is the most valuable energy and raw material resource.

The increase in the cost of fuel input has been one of the main reasons that many countries converted their cement product technology from wet to dry or semi-dry which consumes substantially less heat (up to 40 per cent), which

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85/ Changing determinants of optimal scale in production and exploring resulting opportunities in developing countries, background paper prepared by Bela Gold, 19 June 1983 (Microfiche No. 13379), p. 31.

accounts for the major share of energy requirement in cement production. Information on some examples of conversion of projects from wet to dry process and from oil to other fuel from several countries is given in table 4.11.

A very important point is that improvement in technology for cement products leads to improvement of production in existing plants as well as efficiency of energy utilization. However, conversions of existing cement plants from wet to dry production process and from fuel oil to coal are not always possible and feasible due to economic and other factors. They require particularly large capital investments.

One of the basic ways to decrease energy consumption in production of bricks, another important part of building materials, is to convert plants to the manufacturing of nozzle bricks. Various measures to improve the efficiency of energy use are also of importance for this industry. In many developing countries wood is a primary fuel for brick manufacturing, often in small-scale and rural industry. Therefore substitution of wood by locally available organic residues such as saw dust, coffee husks is very important.

The basic type of fuel in glass production is natural gas and fuel oil. This is due to the specific technological requirements of the production process. The main technological option here to reduce specific consumption of energy and to shift over to other types of energy is the use of electric melting. However, there is also significant scope for improvement of energy use in existing plants by utilizing flue gases, adding scrap glas, etc.

Yet even without capital investment, a savings of 10-15 p... cent in energy consumption is possible, simply through improvements in operating procedures. A further reduction of 20-40 per cent is possible in the production of some cements by stretching the clinker with slag, fly ash and pozzolana. Cement plants in developing nations are increasing their use of industrial and agricultural wastes, peat and wood chips as supplementary fuels in precalciner kilns; these fuels are difficult to feed into the kilns of more mechanized plants, but less of a problem in labour-intensive plants. Small plants, especially those with vertical kilns, are also able to minimize heat losses more effectively than large plants with rotary kilns.

Table 4.11. Estimated result for some recent conversions to more energy efficient technology

Country	Project completion date	Project outline	Project cost ($US million)	Plant capacity (tons per day) Before	Plant capacity (tons per day) After	Fuel consumption (kcal/kg) Before	Fuel consumption (kcal/kg) After	Rate of return on investment
A. Wet to dry process conversions:								
France	-1977	One wet kiln to precalciner, other closed	25	1,500	1,500	1,400	750	17
Canada	-1980	Two wet kilns replaced by 4-stage preheater	70	1,400	1,200	1,400	800	15
Brazil	1982	Wet kiln to 4-stage preheater	10	440	550	1,450	900	17
Malaysia*	1982	Wet kiln to 4-stage pre-heater/ precalciner	95	1,500	4,300	1,335	830	20
B. Oil to alternate fuel conversions:								
France	1979	4-stage pre-heater from oil to 70% coal/ 30% oil	...	3,000	3,000	900	900	14
Uruguay		Four wet kilns, oil to direct coal/rice hulls	1.5	800	800	1,560	1,685	57
United States		4-stage pre-heater gas	2	1,450	1,450	850	870	42

Source: M. Fog and K.L. Nadkarni, "Energy efficiency and fuel substitution in the cement industry with emphasis on developing countries", World Bank Technical Paper, Washington, D.C., 1983, p. 68.

Similarly, energy savings in the steel industry are possible through capital investment and reforms in operating procedures at large integrated plants and through increased reliance on minimills, which are three times as energy-efficient as integrated mills. Through conservation alone, the state-owned Siderbras system of steel works in Brazil reduced its consumption of primary fuel by one-quarter between 1976 and 1980, though production of liquid steel nearly doubled. Plants in Brazil's private sector were even more successful, with integrated steelworks reducing their consumption of fuel oil by 43.6 per cent between 1978 and 1981 and semi-integrated and scrap mills by 27.1 per cent.[86/]

Wood-drying kilns powered by the sun or by high-pressure steam, direct natural gas or wood wastes instead of fossil fuel or electricity are viable, as prototypes in Australia have proved. Agricultural wastes such as husks, chaff and straw are high in caloric value and, when properly used, make excellent fuels for many types of brick kilns. Even a country as small as Togo throws away enough coconut husks in a year to generate 176 billion kJ of energy. Though such fuels are not compatible with large tunnel kilns, they are eminently suitable for the smaller, simpler kilns in rural areas where they would more likely be used.

4.4.7 Opportunities for second-stage production of building materials

The evolution of the building materials industry in developed nations indicates that small-scale production has been a much more favoured response to economic pressures, especially in recent years, than is commonly thought. This becomes apparent if the industry is divided according to the final uses of its products: structural, such as beams, outer walls, foundations; semistructural, such as partitions, floors, roofs and claddings; and auxiliary, such as doors, windows, insulation and fixtures. In developed market economy countries, the majority of suppliers of semistructural and

86/ *International cooperation for rational use of energy in industry*, Inernational Energy Agency (IEA) and Latin American Energy Organization (OLADE), Paris, July 1983, p. 290-313.

auxiliary components are small and privately owned. Though the sector producing structural materials is dominated by large, capital-intensive plants, this domination is being eroded by smaller, specialized factories, such as the mini plants for steel and cement discussed earlier in this report.

Although large integrated steel plants still roll many of their own slabs, billets and blooms, an increasing number of minimills and small finishing mills are competing with them; minimills melt and roll scrap to do this, while finishing mills use billets and blooms bought from integrated mills.

Typically, fabrication of steel products does not occur at mills of any kind, but in shops of all sizes nearer the construction market. Here, workers cut small steel shapes into appropriate sizes, then weld, rivet, or bolt the pieces together to form the sashes and frames of steel windows. Others may cut, punch, and drill other shapes to form the sub-assemblies of larger structural frames, which are welded together on-site or incorporated into masonry. A prime function of fabrication shops is to cut and bend steel bars to the lengths and shapes required to reinforce concrete.

Similar opportunities exist for suppliers of secondary products from cement. In the United States, manufacturers of ready-mixed concrete consumed 63.1 per cent of the nation's cement output in 1971. Moreover, these were small companies,[87/] the top eight firms in the field produced only 10 per cent of the nation's ready-mixed concrete, with 3,978 firms competing for the rest of the market. Manufacturers of precast concrete products consumed an addititional 13.4 per cent of the cement produced in the United States in 1971. Most of the remainder was fabricated on-site by general construction workers and those more skilled in the mixing and pouring of concrete. Opportunities are now available all over the world in small-scale concrete contracting in the breaking, cutting, sawing, coring and drilling of concrete, in the sale of blocks and shapes, construction forms, curing and treating materials, mixers and pumps, patching compounds, prestressed concrete

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87/ US Department of Commerce, 1972 Census of Manufacturers, Washington.

and concrete reinforcements, as well as the sale of ready-mixed concrete and precast products such as sewerage and cesspool systems, steps, floor and roofing units, curbing and lighting equipment.

Most developing countries have not had the time or resources to spawn such a myriad of suppliers of secondary steel, concrete and wood products. But the need for these products, as well as for semi-structural and auxiliary construction materials, is already significant in developing nations, as the statistics in table 2.6 show. Doors, windows, shutters and ironwork fittings are needed as much for low-cost housing as they are for multi-story office buildings and factories. Though domestic demand may be greater for these products than for plumbing and sanitary fixtures, plastics, electrical equipment, elevators, etc., a failure to develop indigenous supplies of such auxiliary items may result in perpetual reliance on imports.88/

The manufacture of concrete products, for instance, requires virtually no heat, which means that even though cement is energy-intensive, concrete is one of the least energy intensive building materials. Hauling pre-cast and pre-fabricated construction components from distant factories is more expensive than pouring concrete on-site, but this may not be true if the components are made locally. It has already been shown that local production of ferrocement panels is desirable and feasible, and that portable pre-casting plans already exist. The use of pre-mixed and pre-cast concrete, as well as pre-fabricated components relying heavily on cement, has increased rapidly in the past decade in developing areas such as Egypt. Recent advances have made practical the small-scale manufacture of concrete blocks from boiler slag, flyash, volcanic tuff and soft limestone, while new construction techniques have made these blocks highly suitable for low-cost housing.89/

88/ Research priorities for the building materials industries in developing countries, prepared by Gyula Sebestyen (ID/WG.425/1), 27 June 1984, p. 17.

89/ Hungarian building and production technologies for transfer to developing countries, prepared by G. Kunszt and T. Mezos, 1983 (Microfiche forthcoming), p. 53.

We have already discussed the extreme need in developing countries for low-cost semistructural housing components such as roofing, and the promise held by ferrocement and cement-fiberboard panels for meeting this need. The Central Building Research Institute of India has developed five additional kinds of simple, prefabricated concrete roofing units; each uses economical amounts of cement and steel and is easily precast in a small plant or on-site.90/

Experts in Hungary have devised prefabricated flooring systems of reinforced concrete beams and hollow concrete blocks; workers can put together a floor on-site by laying beams in place and filling the spaces between them with blocks.91/ Although floor tiles are usually produced in large factories, skilled artisans can handcraft small quantities of tiles using local supplies of clay. In Brazil, the production of ceramic glazed tiles from a mixture of common clay, kaolin and feldspar doubled between 1970 and 1977, providing clean, water-resistant floors and walls for kitchens, bathrooms, laundries, restaurants and hospitals. Although the recent domestic recession has created underutilized capacity in Brazil's tile factories, the potential for regional trade in this sector is still good.92/

Even if concrete is poured on-site, the demand for the off-site fabrication of steel reinforcing bars and wire mesh will increase. Nothing would indicate that metalworkers and small investors in developing countries, given an adequate supply of simple steel shapes from foreign or indigenous minimills, would not avail themselves of the opportunity to set up steel fabrication shops similar to those described above. The steel shapes required

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90/ Roofing in developing countries: Research for new technologies, National Academy of Sciences (NAS), Washington, D.C., 1974, p. 50-52.

91/ A review of technology and technological development in the wood and wood-processing industry and its implications for developing countries, prepared by the Sectoral Studies Branch, Division for Industrial Studies, Sectoral Working Paper Series No. 8 (UNIDO/IS.413), 18 November 1983, p. 60.

92/ The building materials industry in Brazil, a background paper prepared by Luiz Carlos Martins Bonilha, July 1984 (Microfiche No. 14070), p. 23.

for most fabricated items are not large, production is possible with two or three workers, and the capital needed to buy a saw, brake, drill press, rivetters, cutting torches and hand-tools is modest.

The fabrication of secondary lumber products (i.e., window frames and sashes, door frames and jambs, roofing panels, partitions, sheathing, upper-story floors and forms to hold concrete) is suitable not only to large-scale methods using microprocessors and heavy electrical machinery, but also to small scale facilities using simple mechanical or hand tools.

4.4.8 Conclusions

Statistical evidence suggests that economies of scale are not decisive in many sectors of the building materials industry; the worldwide success of small-scale manufactuers of materials such as bricks, wood products, cement and steel proves that such enterprises are indeed feasible. Even if scale effects were positive in the production of a given building material, the high costs of capital and transportation in developing countries could outweigh them.

The ubiquity of natural resources necessary for the production of most building materials, and the existence of technologies and strategies to circumvent shortages even in seemingly essential inputs, means that developing nations can successfully establish indigenous building materials industries. The many degrees of freedom in choosing technologies and scales of production will allow entrepreneurs to find methods of manufacture that make it relatively easy for them to enter the market; these same methods will bring advantages to society through increased employment and a decreased reliance on imports.

Once in business, manufacturers will find themselves able to remain competitive by adjusting their product mixes, using energy-efficent processes, and in some cases, moving their plants to new sources of raw materials or new markets.

These features of the building materials industry have already led to the evolution of a number of small-scale suppliers, even of iron and cement products, in developed nations. The large assortment of suppliers of products fabricated from iron, wood and cement in developed countries indicates that many more opportunities for small-scale enterprises exist in the building materials industry than is generally realized.

The suitability of building materials production to small-scale enterprises is also responsible for the extensive and surprisingly successful sector of informal suppliers in developing countries. The next section will explore the characteristics of this sector, and describe its potential to provide housing for families who cannot afford even the most minimal public housing - roughly 40 per cent of the population in many cities.

4.5 The informal production of building materials

The importance of the informal construction sector in providing shelter and commercial structures for the urban poor has been recognized for more than a decade, and has been increasingly well documented, especially in studies by the International Labour Office (ILO). But a review of such studies reveals little agreement even as to the definition of the sector. The ILO based the first definition of informal enterprises on a list of their typical characteristics: operation on a small scale, use of labour-intensive methods adapted from traditional techniques, reliance on domestic resources and skills acquired outside the formal school system, family ownership and participation in an unregulated, competitive market. But later researches objected that this list does not add up to a unique defintion of a sector.[93/]

An alternative definition is possible, based on a firm's purpose rather than its characteristics: the motivation of entrepreneurs in the formal sector is to maximize their profits; in the informal sector, owners seek only

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93/ A survey of empirical studies in industrial and manufacturing activities in the informal sector in the developing countries, prepared by Caroline Moser and Judith Marsie-Hazen for the Global and Conceptual Studies Branch, Division for Industrial Studies, (UNIDO/IS.470), 23 May 1984, p. 4.

employment. But this definition is also open to question. The purpose of construction firms in the formal public sector and of some activities in the informal sector may simply be the provision of shelter. On the other hand entrepreneurs in the informal sector, once they have assured themselves of emloyment, can be as concerned as their counterparts in the formal economy with increasing their profits.

Another problem appears when the informal construction sector is viewed in terms of location. In rural areas, the unregulated construction of shelter is centuries old. But defining this activity as an informal market seems meaningless, for it often forms the only market in rural areas; the term traditional might be more appropriate.

The urbanization of the developing world brought many of these traditional industries to the cities. Since the formal construction sector was hard-pressed to provide shelter for so many new inhabitants, the migrants continued to rely on the methods of the village. Were these methods still to be called traditional? Or could they now be defined as informal, in contrast to the methods of the formal urban market? As the inhabitants of squatters' settlements adapted traditional techniques to urban conditions, improving them with materials and methods from the formal urban sector, the lines of distinction blurred further.

If the definition of the informal construction industry is murky, the outlines of its subsector, the informal building materials industry, are even fuzzier. In theoretical discussions and studies, this subsector is rarely treated apart from its parent sector.94/

The relationship between the informal building materials industry and other sectors of the economy is not simple. The informal construction industry, for example, does not rely solely on building materials produced in the informal sector; builders may buy, scavenge or steal materials produced by

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94/ Small-scale building materials production in the context of the informal economy, United Nations Centre for Human Settlements (UNCHS), Nairobi, Kenya, 1984.

formal manufacturers. Similarly, construction firms in the formal sector may buy materials from informal producers to save money, to obtain products for which no formal substitutes exist, or to evade taxes or labour regulations.

The relationship between the formal and informal building materials industries is also somewhat arbitrary. Firms in both sectors may use the same production factors, and these inputs may come from either the formal or informal market. Both sectors may labour under similar constraints, and both may claim similar linkages to the rest of the economy. A broad distinction in terms of final products has been proposed,[95/] with the manufacture of glass, cement, nails, asphalt, steel and plastics limited to the formal sector, and the manufacture of lime, pozzolana, bricks, tiles, concrete blocks, thatch roofing, stone and fibercement relegated to the informal sector. But this is confusing, since the formal sector may also produce items from the second set. Nor is it accurate to classify the informal sector by the number of emloyees in each firm: though the average firm in this sector employs few people, a formal, capital-intensive operation may employ even fewer. Again, most researchers have resorted to an operational definition in the form of a list of traits typical of informal producers: small number of employees, small volume of output, low capital investment, reliance on locally available raw materials, local markets whose conditions fluctuate widely.[96/]

Clearly, more work is needed to identify the limits and functions of the informal building materials sector. Although such a study is outside the scope of this report, the remainder of this section gives a rough idea of the nature and extent of the sector, as well as its potential to furnish the informal and formal construction industries with low-cost inputs, to increase a developing nation's self-sufficiency through import substituion, and to contribute to economic growth.

95/ Op. cit., p. 7.

96/ Ibid., p. 6.

4.5.1 Characteristics

The informal construction sector is not an anomaly of developing countries. It is pervasive in even the most industrial nations, though its nature may vary with national income. Few houses in developed nations are built entirely by workers from the informal sector; instead, most informal activity is confined to maintenance or home improvement.

In developing countries, where the formal sector is less regulated and less well-entrenched, the informal production of building materials is more widespread. Studies reveal that entry into the informal market is relatively easy. The average firm employs two people and is small enough that the owner's managerial instincts are sufficient to run it. Training is acquired through on-the-job training, apprenticeship and skills passed down from older relatives; methods are adapted from traditional practices.

Wages for employees in the informal building materials sector are generally lower than the national minimum wage, but higher than the average wage for agricultural labourers. Owners tend to earn more than the minimum wage, and since many employees are members of the owner's family, they may be receiving greater returns from their work than their wages would indicate.[97/]

Although the informal and formal sectors use the same factors of production, they combine them in differing ratios. Informal production requires a far lower capital investment - the small-scale manufacture of country tiles in Sri Lanka, for instance, requires 0.6 per cent of the investment necessary for the large-scale manufacture of galvanized iron

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97/ Small-scale building materials production in the context of the informal economy, United Nations Centre for Human Settlements (UNCHS), Nairobi, Kenya, 1984; Caroline Moser and Judith Marsie-Hazen, A survey of empirical studies in industrial and manufacturing activities in the informal sector in the developing countries (UNIDO/IS.470), prepared for the Global and Conceptual Studies Branch, Division for Industrial Studies, 23 May 1984; and Mahmoud Abdel-Fadil, Informal sector employment in Egypt, International Labour Office, Geneva, 1980.

sheets.98/ Production is also more labour-intensive in this sector. In Sri Lanka, the capital/labour ratio for the traditional production of building materials is 1,700 rupies per worker, as opposed to 2,500-24,000 for medium-scale producers in the formal sector, and 3,300-182,000 for large-scale units.99/ Land for workshops may be obtained by squatting rather than purchase, or a plant may be located in a house or a backyard. Financing is more likely to come from moneylenders or family donations than from banks. Machinery is likely to be manufactured locally and repaired with ingenuity and scavenged parts. Transportation of raw materials and finished products is by low-cost vehicles, such as animal-drawn carts. Informal producers use virtually no foreign exchange in their inputs, as opposed to the 10 per cent of inputs in modern, medium-scale units and the 40-80 per cent in plants that make asbestos-cement and galvanized iron.100/

The combination of factors in the informal sector results in a lower productivity per worker than in the formal sector but a typically higher ratio of output to capital. Statistics specifically related to the productivity of the informal building materials sectors are rare, but it has been estimated that one million Kenyan shillings invested in the informal manufacturing sector of Nairobi would create jobs for 5,500 workers and produce 2,250,000 shillings of output, while the same amount invested in the formal sector would employ 500 people and produce only 744,000 shillings of output.101/

The total output of the informal building materials sector is not known, but the next section attempts a rough estimation.

98/ Small-scale building materials production in the context of the informal economy, United Nations Centre for Human Settlements (UNCHS), Nairobi, Kenya, 1984, p. 9.

99/ A survey of empirical studies in industrial and manufacturing activities in the informal sector in the developing countries, prepared by Caroline Moser and Judith Marsie-Hazen for the Global and Conceptual Studies Branch, Division for Industrial Studies, (UNIDO/IS.470), 23 May 1984, p. 127.

100/ Ibid.

101/ Small-scale building materials production in the context of the informal economy, United Nations Centre for Human Settlements (UNCHS), Nairobi, Kenya, 1984, p. 15.

4.5.2 Extent

A recenc study of several developing countries[102/] found that a substantial amount of their building materials are produced by small-scale units using domestic resources. These materials "sometimes meet all the needs of small-scale private developers in rural trading centers and peri-urban areas, not only for shelter, but also for ... workshops, commercial cooking areas, market stalls, kiosks, private clinics, restaurants, day nurseries, etc." In addition, small-scale suppliers of lime, aggregates, and laterite "have contributed immensely to the construction of civil engineering projects."

The study goes on to cite examples of such industries. In Java, workers produce lime in wood-fired kilns and mix it with a natural pozzolana to make blocks called batako. These enterprises employ an average of one to ten workers, with each worker producing 200-300 blocks per day. The industry is based on techniques that are 1,200 years old, although the Bandung Housing Research Centre has taught workers to improve the quality of their product. The batako is sold locally or in nearby cities.

In Indonesia, the informal manufacture of bricks, tiles, cement products, bamboo and timber products, stone, gravel and lime are common. In Colombia, small-scale producers accounted for 1.7 per cent of the total number of bricks manufactured in Bogota in 1972. Cottage industries in the Philippines furnish a substantial amount of bamboo producıs, bricks and roofing materials, and more than 35 per cent of the total value of building materials used in Sri Lanka are supplied informally, mostly in the form of bricks, country tiles sand and lime. Stonecutting in Kenya is basically informal, with easy entry into a field that requires little capital investment or equipment and provides a return of about 80 per cent on the costs of production.[103/]

102/ Op. cit.

103/ Ibid., p. 7-9.

The survey by Moser and Marsie-Hazen (1984) provides measurements of informal activity more quantitative than the descriptions given above, but these figures are not focused as directly on the building materials subsector. The survey describes the 1972 study by the ILO, which found that 20 per cent of all income opportunities in Nairobi (and up to 50 per cent in small towns) were in the general informal sector; the study also found that the informal construction industry was responsible for 31 per cent of the Kenyan investment in housing, 26 per cent in non-residential buildings, and 43 per cent in public works. A 1982 study by S. Ganesan revealed that a majority of building materials producers in the area of Hong Kong could be roughly defined as informal: 93 of 123 sawmilling units employed fewer than ten workers, as did 11 of 20 producers of structural clay products, and 136 of 213 producers of nails, screws and hinges.

The extent of the informal market in secondary building materials seems greater than might be imagined. The study by Ganesan showed that 39 of 48 suppliers of non-metallic mineral products (i.e. concrete pipes and blocks) in the area of Hong Kong are in the informal sector, as are 731 of 804 producers of metals windows and doors. A 1981 study of Lagos, where half the city's workers belong to the informal sector, found that 51 of the 2,074 informal enterprises surveyed were small-scale manufacturers of fabricated metal and machine equipment; a study of Freetown, Sierra Leone, showed that roughly the same proportion of the city's informal enterprises (2 per cent) were fabricators of metal products.

The uncertainty in quantifying the output of the informal building materials industry makes it even more difficult to trace its linkages to other sectors. Nonetheless, the following section offers evidence for the strength of these ties.

4.5.3 Role in economic development

The informal building materials sector not only provides shelter for the poor, but also commercial structures for retail outlets, the repair of vehicles and machinery, the manufacture of tools, the operation of commercial laundries, etc. In rural areas, it also supplies farmers with barns, silos and other structures. The sector may also contribute to the building of infrastructure.

Since the informal production of building materials uses almost no imported inputs,104/ it conserves scarce foreign exchange and stimulates demand for domestic resources, machinery and labour. The sector has strong backward linkages to both the informal and formal economies, creating a demand for providers and carriers of raw inputs (i.e. sand, lime, stone and sawn lumber), makers of simple tools such as wheelbarrows and pick-axes, mechanics, suppliers of fuel, chemicals and adhesives, and manufacturers of more complex tools and machinery.105/

Such linkages have not been quantified for the informal sector as a whole, but the logic for their existence is apparent. As we have seen in the previous section, the production of building materials, since it is well-suited to small-scale techniques and local deposits of resources, is able to bring jobs and commodities to rural areas. Its labour-intensive nature makes its job-generating capacity significant for urban areas as well. Workers who produce building materials acquire skills that can be transferred to the formal sector.

The role of informal building materials production in job creation is fundamental. A traditional plant that produces ten million bricks per year employs 160 workers, but an automated plant with the same output employs only eight. Similarly, the production of country tiles for roofing might employ 960 workers, while the production of an equivalent value of galvanized iron sheets would create jobs for seven. The greater number of jobs created in the informal sector would also heighten the demand for the goods and services of other small-scale enterprises, multiplying the effects of job creation.106/.

104/ *Op. cit.*, p. 27.

105/ *Ibid.*, p. 14.

106/ *Ibid.*, p. 15-16.

Unfortunately, the benefits of increased activity in this sector are currently limited by the restrictions described in the following section.

4.5.4 Constraints

The owners of small-scale, unregistered firms are far less likely than registered firms to receive institutional financing, as shown in a study of urban businesses in South India.107/ Owners who did not obtain loans from banks usually financed their enterprises with money from relatives, personal savings, chit funds, private financiers or petty moneylenders; the study found that moneylenders charged interest rates as high as 10 per cent per week or 20 per cent on a loan of 1000 rupies over 100 days. A study of the informal sector of building materials producers in the area of Hong Kong 108/ showed that owners also find it difficult to acquire working capital. Complaints about shortages of storage facilities, factory space and efficient machinery indicate that owners have problems obtaining money for capital expansion and improvement as well; this is borne out in the study by UNCHS.109/

Both reports show that informal producers find it difficult to obtain key raw materials, energy and tools. Informal producers are in a weak bargaining position relative to large-scale firms. They are less visible to the government and so receive few subsidies; they do not have licenses to import raw materials and spare parts and so must go without these items or buy them at high prices from large firms. They are also at a disadvantage in marketing it. Large firms in Kumasi obtain bulk orders to provide furniture for government institutions; these firms then acquire their raw materials or even the furniture itself from the informal sector and resell it to the government at much higher prices. A survey of informal manufacturers throughout

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107/ A survey of empirical studies in industrial and manufacturing activities in the informal sector in the developing countries, prepared by Caroline Moser and Judith Marsie-Hazen for the Global and Conceptual Studies Branch, Division for Industrial Studies, (UNIDO/IS.470), 23 May 1984, p. 140.

108/ Ibid., p. 125.

109/ Small-scale building materials production in the context of the informal economy, United Nations Centre for Human Settlements (UNCHS), Nairobi, Kenya, 1984, p. 12.

Ghana[110/] revealed that a lack of sufficient raw materials or spare parts and insufficient working capital were viewed as the major constraints on expansion by 52 per cent and 42 per cent of those questioned, respectively.

The market for the goods of the informal sector may also be limited by their uneven quality. Handmade items may also lack regularity and smoothness.[111/] Regardless of the actual quality of the products of the informal sector, the public perception that they are inferior to the goods of the formal market creates a bias against them, thus creating an additional marketing obstacle.

Although developing countries have conducted a great deal of research to improve the productivity of workers and the quality of goods in the informal sector, the results have rarely been disseminated with success, and the construction industry has remained reluctant to use innovative building materials.[112/] Such failures are not surprising, since the informal sector is so little understood. If its potential is to be fully realized, its needs, operation and capacity must first be determined. This and other recommendations for promoting the small-scale manufacture of building materials are presented below.

4.6 Measures to enhance small-scale production of building materials

Market distortions. Governments should examine their procedures for awarding contracts, making sure these do not penalize companies for using domestic building materials or subcontracting work to smaller firms, such as

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110/ A survey of empirical studies in industrial and manufacturing activities in the informal sector in the developing countries, prepared by Caroline Moser and Judith Marsie-Hazen for the Global and Conceptual Studies Branch, Division for Industrial Studies, (UNIDO/IS.470), 23 May 1984, p. 31.

111/ Small-scale building materials production in the context of the informal economy, United Nations Centre for Human Settlements (UNCHS), Nairobi, Kenya, 1984, p. 17.

112/ Ibid., p. 9.

fabricators of steel and concrete products. In such developing countries, where markets are largely free of such biases, small firms have contributed significantly to economic and social development.113/

Financing resources. The relatively short gestation time and low capital requirements of small businesses should increase the willingness of banks to invest in them. But commercial banks in developing nations are still wary of the high default rates and administrative costs associated with a portfolio of many small loans.

Since entrepreneurs are often deeply committed to the success of their ventures, they are highly motivated to save and to plough profits back into their businesses, which diminishes their dependence on commercial sources of credit.114/ But the volatility of markets in the building materials industry can make owners run short of cash despite their best intentions. When this happens, they often have little choice but to seek help from middlemen and moneylenders. Such credit is ubiquitous, but expensive and risky.

Developing countries should look seriously into ways to make capital more accessible to worthy borrowers. This might entail state guarantees of loans, direct financing through state banks and modifications of the commercial banking system, such as a decentralization of banking services. Making loans available only through a few state-run institutions can encourage abuses in the allocation of the limited supply of low-interest credit.115/ Setting too low a ceiling on interest rates could actually decrease the capital pool

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113/ Keith Marsden, "Creating the right environment for small firms", Economic development and the private sector, Washington, D.C., World Bank, 1981, p. 15.

114/ World Bank, World Development Report 1978, Washington, D.C., 1978, p. 71.

115/ Keith Marsden, "Creating the right environment for small firms", Economic development and the private sector, Washington, D.C., World Bank, 1981, p. 14. See also Types of financing for industry, Sectoral Working Paper Series No. 13, 1983 (UNIDO/IS.417).

by making commercial banks even less willing than before to offer loans to small businesses; entrepreneurs in developing countries are probably less concerned about a few percentage points difference in commercial rates than a dearth of financing which sends them to moneylenders.116/ More effective than ceilings might be a campaign to inform entrepreneurs how to approach a bank, a reduction in the paperwork necessary to apply for a loan and guidelines to help bank personnel objectively evaluate the risks and capital requirements of small businesses and devise payback schemes that are reasonable given the volatility of the market.

Encouraging commercial banks to handle loans for working capital as well as fixed capital (the former being less risky), would allow a bank to reduce the overall risk on its investment in a given business and induce it to develop a more lasting and effective involvement in the firm's operation. Banks might also supply credit by offering mortgages on machinery rather than money to buy it outright; since the capital would remain the property of the bank during the firm's start-up period, the risk to the bank would be reduced.117/

Extension services, which can increase the viability and profitability of small businesses, would also make banks more inclined to lend them money. This is discussed in the next section.

Access to information. Many small firms will need help not only in obtaining capital, but in choosing equipment and production methods, conducting market studies and setting up bookkeeping systems. At later stages, they may need advice about training employees and managers, acquiring and handling subcontracting assignments and fulfilling goverment regulations. Entrepreneurs emerging from the informal sector will probably require the most assistance.

116/ World Bank, World Development Report 1978, Washington, D.C., 1978, p. 44.

117/ Optimum scale production in developing countries: A preliminary review of prospects and potentialities in industrial sectors, Sectoral Studies Series No. 12 (UNIDO/IS.471), 12 June 1984, p. 116-117.

The World Bank has found that an agency independent from financial institutions but working closely with them is the best means to provide technical assistance to small businesses.[118/] An independent agency will be less likely to promote capital-intensive methods than the consultants and salesmen from industrialized nations who are now the main sources of information to businesses in developing countries.[119/] But extension services must include advisers aware of the broad range of methods suitable to the various sectors of the building materials industry, specialists in important sectors, workers who can be of practical use in the field and people who are experienced in running small businesses.

Brokers can help match the needs of large companies with the resources of smaller suppliers of fabricated metals and concrete.[120/]

Research and development. The collection of information leads to the search for better data and methods, and search leads to research.[121/] In developing nations, this should focus on downscaling production processes that have been successful for large businesses, designing new technologies especially for small businesses and finding new, inexpensive building materials suitable for indigenous production and use.

A combination of institutional support and private participation will make it more likely that businesses adopt new methods than if the government or a large foreign firm were to conduct research alone and try to hand over new methods whole to small businesses. Technological capacity - the ability

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118/ World Bank, World Development Report 1978, Washington, D.C., 1978, p. 43-44.

119/ Frances Stewart, "International technology transfer: Issues and policy option", World Bank Staff Working Paper No. 344, Washington, D.C., July 1979, p. 94.

120/ World Bank, World Development Report 1978, Washington, D.C., 1978, p. 25.

121/ Frances Stewart, "International technology transfer: Issues and policy option", World Bank Staff Working Paper No. 344, Washington, D.C., July 1979, p. 94.

to choose an appropriate production method, adapt it to local conditions, improve it and eventually generate new technologies from within - comes from giving the staff of a plant the chance to learn by doing.122/ As the study of the Mexican cement industry shows, this can be an important determinant of a factory's success, regardless of its technological complexity. In Argentina, the staff of a steel mill made improvements in the reduction process which accounted for more than half the increase in the plant's output.123/ Innovation of this sort is likely to become self-sustaining; the government should then step back to avoid smothering local initiatives.

Many developing nations have already established research institutes but much work remains to be done. Since institutes need about ten years to become efficient, further progress in the development of new materials, production techniques and building designs will require immediate action by governments that have not yet taken such intitiatives.

At the beginning, a country might import new technologies from nations with more advanced research programmes. Since the characteristics of raw materials vary greatly across national boundaries, the importing nation will need to develop research facilities in which it can adapt new, imported technologies to local conditions. This will enable the fledgling research institute to become familiar with the latest research and production techniques. As the capabilities of the institute grow, it will be able to conduct studies into the distribution of raw materials withir the country and to develop new production techniques and products more suitable for its needs.124/

122/ Op. cit., p. 39.

123/ Ibid., p. 40.

124/ Research priorities for the building materials industries in developing countries, prepared by Gyula Sebestyen (ID/WG.425/1), 27 June 1984, p. 6.

Advances in the use of ferrocement, pozzolana, secondary species of timber and flyash bricks, concretes and mortars have shown how much can be gained from research into new, indigenous building materials.

Patents encourage firms to develop technical innovations by allowing them to extract full financial returns for their research. This may concentrate profits in the private sector at first, but eventually it will confer widespread benefits of jobs and low-cost housing. Governments may also find it worthwhile to invest in the future by subsidizing technical education.[125/]

Research into new building materials cannot be divorced from research into new building techniques. It is impossible to design pre-cast concrete blocks without a knowledge of the way they can be put together to form a comfortable, well-ventilated house or to design a new roofing material without knowing how it can be installed to shed rain and withstand wind and its own weight. Thus, construction research goes hand in hand with product development and can often take place in the same research institute.

Since new products are less apt to be competitive than materials whose production techniques are standard and for which mass markets already exist, governments should promote the adoption of new materials through demonstration projects and guidelines for the construction industry.

As an example of the power of such endeavours we cite research by the National Buildings Organization of India (NBO), established in 1954, which has led to the opening of 20 hydrated-lime plants, 6 mechanized brick plants, 6 asphaltic corrugated roofing sheet plants, 2 cellular concrete plants, a number of small plants making rice-husk lime binders and several seasoning and treatment plants for timber.[126/] The NBO also has established one

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125/ Clifford Winston, "Industrial economic policy toward the building materials industry in developing countries to achieve maximal economic growth", Working Paper, Technology Adaptation Program, Massachusetts Institute of Technology, Cambridge, Massachusetts, June 1984.

126/ G. C. Mathur, Development and promotion of appropriate technologies in the field of construction and building materials industries in India, unpublished paper, 1983, p. 30-31.

"Demonstration-cum-Training Plan" for the production of hydrated lime and lime-pozzalana and another for the production of improved bricks, has undertaken 42 projects to demonstrate the use of new materials and design concepts and has built 50 clusters of housing for the rural landless, using indigenous materials and construction techniques.[127/]

Regulations and standards. Increased competition and research will bring a wider variety of product types and grades to the marketplace. This will benefit consumers - if the government sets and enforces appropriate standards for building materials and construction designs.

For each product, a government can require either a single national standard or a range of strengths according to specified uses. Although a universal standard might seem justified on the basis of safety, this is probably unnecessary and wasteful; for example, only about 20 per cent of the world's construction projects demand cement that would meet the international standard for full-strength Portland cement.[128/]

To permit the use of various grades of materials, building codes must be performance-oriented rather than prescriptive. Instead of requiring 20 cm. brickwork in a party wall, a performance standard would specify how fire-resistant, load-bearing and soundproof the wall must be. A builder could then use any combination of materials that fulfilled these specifications, though government guidelines could suggest wise choices.[129/]

127/ Fred Moavenzadeh and Frances Hagopian, Construction and building materials industries in developing countries, TAP Report 83-19, Massachusetts Institute of Technology, Cambridge, Massachusetts, August 1983, p. 303-304.

128/ Optimum scale production in developing countries: A preliminary review of prospects and potentialities in industrial sectors, Sectoral Studies Series No. 12 (UNIDO/IS.471), June 1984, p. 48.

129/ Economic and Social Commission for Asia and the Pacific (ESCAP), The building materials industry in the ESCAP region, Working Paper prepared for UNIDO, Bangkok, 1984, p. 16.

Performance standards would encourage not only the use of indigenous materials but also the reduction of design requirements to levels appropriate for local conditions: a house in an arid climate may not need a roof that sheds water, though a building code imported from a developed nation might have mandated one.

The expertise for setting standards will come partly from information acquired in joint construction ventures with firms from developed nations, partly from research at the national, regional and international levels. Some uniformity of national codes will be needed to facilitate international trade in building materials. But developing nations must be careful not to import complete packages of standards from developed nations, as these have often been ill-suited to local needs and therefore impossible to enforce.

Voluntary compliance is not enough. Consumers may want reliable quality, but they also want a low price, and manufacturers may be tempted to remain competitive by skimping on extra features, such as protective coatings and finishings for wood products.[130/] With appropriate standards, compliance, and therefore enforcement, should be feasible.

Governments may also need to safeguard people who live near factories and those who work in them. Although the limited size and need for infrastructure of small plants may disperse their effects on the environment, they may still pollute. Similarly, the workplace needs to be made safe to workers. This is important for both small-scale and large-scale facilities.

Employee training. New ideas for programmes to train workers deserve attention. Developing apprenticeship systems for small firms could be especially fruitful.

Virtually all developing nations find technical and managerial talent in short supply. Acquiring these skills requires long-term education and opportunities for practical experience. Governments should offer incentives for native workers to begin such training progammes.

130/ *Op. cit.*, p. 9.

Understanding the informal sector. In promoting domestic industries, it is logical to begin with existing workers and businesses, no matter how rudimentary their skills and operations. We have already seen that the informal sector holds great promise for narrowing the chasm between the vital needs for housing and the scanty supply of materials and trained builders in developing countries. Yet its organization and operation remain largely a mystery.

Although workers in the informal sector often differ from their counterparts in the formal sector only in the lower productivity of their jobs, the lower wages they receive and the poorer quality of their working conditions as well as a lack of mobility between sectors may produce a troublesome surplus of labour in the informal market and severe shortages of workers in the formal sector of the same industry in the same region.[131/] Since workers in the informal sector are experienced in devising small-scale production methods using the raw materials at hand to satisfy housing needs of their customers, researchers hoping to understand to promote such techniques may have much to learn from them.

This will entail research to more clearly define the nature and scope of the informal sector and the constraints on its productivity. At least two types of studies are needed for a full understanding of the sector. Cross-sectional surveys of the market in building materials in a city or region can yield valuable information as to its size, composition and capacity. But such surveys may not give policy-makers a feeling for the complex linkages between this sector and the rest of the economy or for the barriers to its growth and efficiency. Although broader anthropological studies may provide insights into the operation of informal enterprises and the contribution of this sector to national development, they may forfeit the detail of closer, cross-sectional surveys.[132/]

131/ International Labour Office, Informal sector employment in Egypt, prepared by Mahmoud Abdel-Fadil, Geneva, 1980.

132/ A survey of empirical studies in industrial and manufacturing activities in the informal sector in the developing countries, prepared by Caroline Moser and Judith Marsie-Hazen for the Global and Conceptual Studies Branch, Division for Industrial Studies, (UNIDO/IS.470), 23 May 1984, p. 199.

But even the evidence now available suggests that it should be possible to enhance the productivity of the informal sector by increasing the supply and decreasing the cost of its inputs. Governments might want to augment sources of low-interest seed capital, working capital, and loans for expansion and provide low-rent plots for informal enterprises, with services available at a reasonable fee. Urging informal producers to organize could give them the bargaining power to obtain lower prices for their products. More effective ways of providing technical assistance and managerial training and of disseminating the results of laboratory research could increase the output of the sector and the quality and durability of its products.

Government officials might also examine their housing policies to make sure these do not discriminate against informal producers, whether by precluding the use of their goods in government construction projects or denying them access to raw materials or subsidized distribution systems.

Finally, programmes might be needed to help workers and firms make the transition from the informal to the formal sector if market conditions so warrant. This does not necessarily mean that governments should try to upgrade the informal sector until it becomes identical with the formal. Several studies show that requiring small-scale enterprises to obtain licenses and obey labour regulations can hinder operations whose greatest competitive edge is the informality of their production systems.[133/] This may cause the demand for workers to drop.

4.6.1 International and regional co-operation

International organizations can bring financial resources and know-how which can foster the self-sufficiency of local small-scale industries. Such contributions may include:

(a) Promoting trade among developing countries to extend the scarce supplies of raw materials and small market bases of each;

133/ *Op. cit.*, p. 201.

(b) Helping to plan complementary patterns of industrial growth to free the smallest and poorest nations from the need to establish plants in all lines necessary to service even one major industry and to assure nearby markets to fledgling industries in slightly more developed nations;134/

(c) Providing advice for financing small businesses;

(d) Facilitating the collection of uniform industrial statistics and the exchange of information among developed and developing nations through meetings and publications;

(e) Providing technical advisers, who have practical experience in the use of indigenous materials and the operation of small businesses; these advisers can assist in studying the availability of raw materials, forecasting demand and devising appropriate standards for materials and buildings.

But programmes at the international level are less likely to enhance the growth of small-scale industries in developing nations than programmes at the regional level. While each country should exploit its own capacity, collaboration among neighbouring countries will augment the capital and know-how available to each, allow planning of complementary industrial bases, as described above and permit research into materials and methods not yet in enough demand in any one country to attract commercial or government investment there.135/

This will only be possible given that the institutional support described above already exists in each nation. India, for example, has designed and installed a mini cement plant in Iraq and has sold clinker-crushers to Kuwait,

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134/ Measures and actions to increase production of indigenous building materials in the context of enhanced import substitution, background paper prepared by Fred Moavenzadeh and Jeffrey M. Starr, April 1984 (ID/WG.425/3), p. 137-138.

135/ Optimum scale production in developing countries: A preliminary review of prospects and potentialities in industrial sectors, Sectoral Studies Series No. 12 (UNIDO/IS.471), 12 June 1984, p. 113.

but is reluctant to expand such transfers of technology to other nations without guarantees of payment. Similarly, the Cacavelli Centre in Togo has developed techniques that use local materials and simple production methods to manufacture high-quality, low-cost bricks. The Centre is trying to disseminate its research to other African countries, but is finding this difficult because of a lack of private or state agencies that could handle such transfers.[136/]

136/ Outline of a policy for expertise and technological selection in capital goods for cement and brick manufacturing, prepared by Sid Boubekeur (ID/WG.425/4), 27 August 1984, p. 53-55.

5. ENHANCING DOMESTIC BUILDING MATERIALS INDUSTRIES IN DEVELOPING COUNTRIES

The demand for construction, and therefore building materials, is tied not only to the prices of these materials, but also to a country's population, its ratio of rural to urban inhabitants and its per capita income. This chapter contains a discussion of various scenarios for the course of these variables and discuss the implications of these projections for future building materials demand.

This chapter also discusses some constraints that developing nations will have to overcome if they are to begin to meet their future building materials needs and gives some suggestions for actions to accomplish this. An essential follow-up to this analytical appraisal of the sector would be, however, to elaborate elements of alternative strategies to develop domestic industries based on indigenous materials. The continued study work on this sector will be oriented in this direction, with the ultimate aim of practical application of the findings in developing countries.

5.1 Perspectives towards the year 2000

A judicious use of global models of economic development will permit a rough estimate of future demand for building materials in industrializing nations; such estimates lead to the conclusion that domestic demand in this sector could well double by every fifteen years.

Projections of economic growth at the global, regional and sectoral levels diverge according to the scenarios on which they depend. The 1981 report of the UNITAD Project was based upon three scenarios for the development of the world's economy up to 1990.[137/] The first was an extrapolation of past trends, while the other two took into account the goals expressed in the International Development Strategy (IDS) for the Third United Nations Development Decade.

137/ The UNITAD System, 1981 Report, prepared by the Global and Conceptual Studies Branch, World Modelling Working Paper (UNIDO/IS.337), September 1982.

The scenario based on past trends predicted that growth rates would decline worldwide from 1975 to 1990 compared with GDP performance between 1963 and 1975; this reflected the global deceleration of economic development in the early 1970s. But the IDS 1 and 2 scenarios assumed that economic growth would resume, particularly in the 1980s. According to these IDS projections, developing regions as a whole would experience growth rates of 7 per cent per year during the current decade - twice as fast as the 3.5 per cent projected for the developed countries.

The UNITAD projections as revised in 1984, however, predicted that annual growth rates of GDP for developing regions as a whole would be only 3.73 per cent for the current decade, while annual growth rates for developed regions would be 3.19 per cent (the projections for 1975-90 were 4.04 per cent for developing regions and 3.28 per cent for developed regions). The predictions of the 1984 UNITAD Model are shown in table 5.1.

What, then, will be the effect on demand for building material of the annual GDP growth rates of developing nations for this decade and the next predicted by the models described above? The 1984 UNITAD projections agree with the results of the regression models presented in chapter 4 which suggest that construction activity will expand faster than the economy as a whole. According to the 1984 UNITAD projections, the demand for construction and basic products (including building materials) will grow significantly through 1990 in all developing nations. The demand will grow the most in East Asia, where the projected growth rate for construction is 6.87 per cent, and 13.26 per cent for basic products (table 5.1).

The results of the UNITAD projections show that the rates of growth of construction and related sectors will generally be faster in developing than developed regions because of the higher rates of GDP growth in these nations (with the exception of Tropical Africa).

The growth rate of construction of 4.36 per cent if continued in the next decade would result in construction activity tripling between 1975 and 2000. Since the ratio of intermediate inputs to value added by construction is relatively stable, the consumption of building materials being also likely to

Table 5.1. Annual real growth rates of world GDP, construction, capital goods and basic products, 1975-1990, as predicted by the UNITAD Model

	GDP Actual 1975-80	GDP 1980-90	GDP 1975-90	Construction 1975-90	Basic products 1975-90	Capital goods 1975-90
Developing regions			4.04	4.36	6.36	5.52
Latin America	4.84	2.90	3.53	4.06	5.01	4.45
Tropical Africa	4.65	2.40	3.10	3.02	3.45	4.63
Near East (N. Africa, W. Asia)	3.88	3.60	3.62	3.82	2.36	2.97
Indian Sub-continent	4.20	5.00	4.86	5.25	8.92	8.38
East Asia	7.84	5.50	6.18	6.87	13.26	9.40
Centrally planned economies of Asia	6.00	5.50	5.67	3.90	7.00	5.85
Developed regions			3.28	3.71	5.23	4.02
North America	3.28	3.20	3.22	4.82	6.44	4.38
Western Europe	3.03	2.30	2.55	2.87	4.15	2.17
Eastern Europe	4.10	3.80	4.01	4.19	4.91	5.46
Japan	5.01	4.40	4.59	3.40	5.59	4.18
Other developed	2.47	3.40	3.29	2.45	6.22	6.70

Source: Based on unpublished data from UNIDO's global economic model (UNITAD).

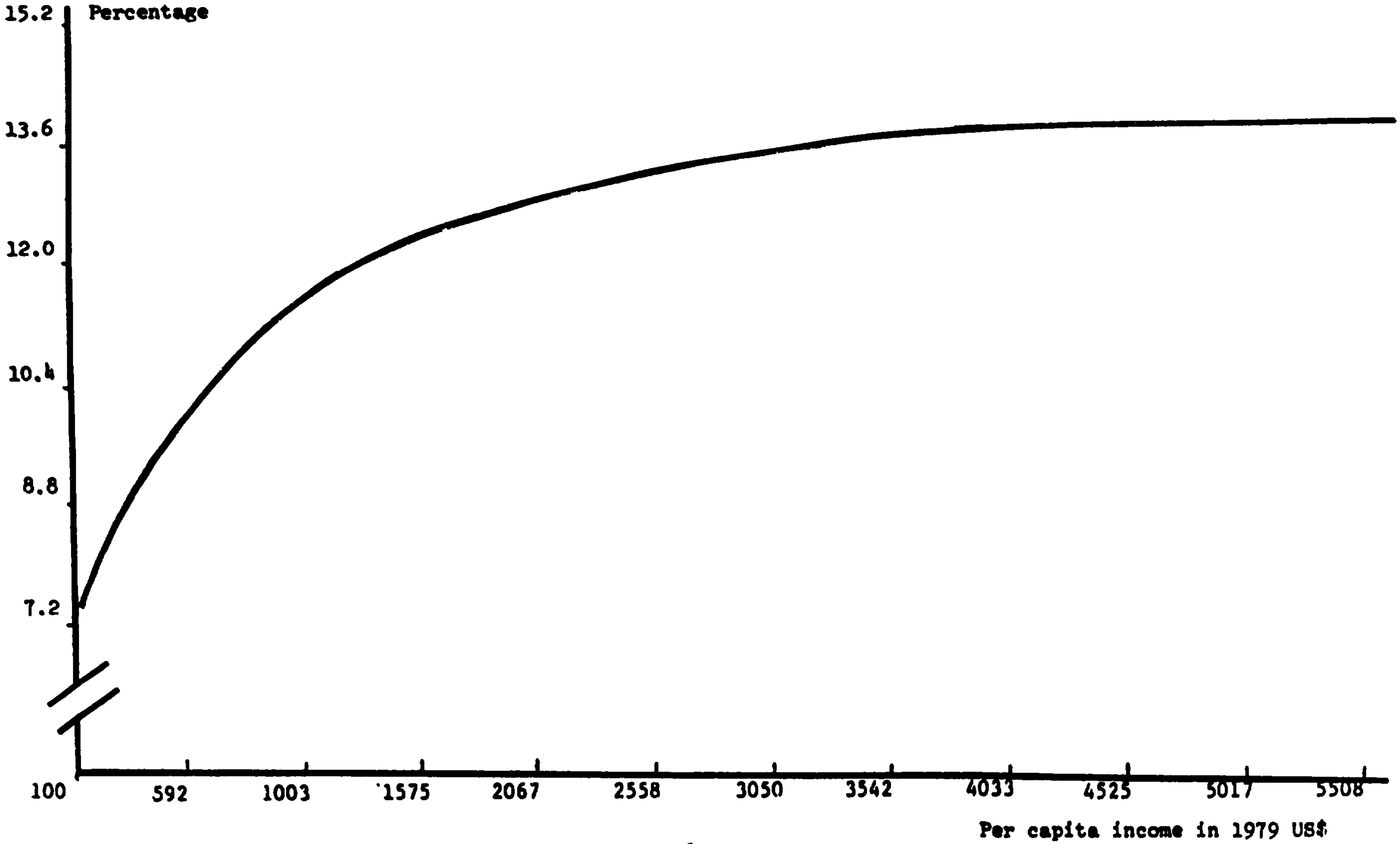
triple. These projections may be a little low since they assume that construction will account for a constant share of the total GDP in developing market economies in 1975, but this percentage can be expected to rise as development proceeds. The regression study by Wheeler (1982) discussed in chapter 2 shows how this share might change. Figure 5.1 shows the results of that regression graphically.

The global models reviewed here do not attempt to predict the distribution of construction sectors demand for different building materials. Yet this level of detail is important. Both input-output and regression models provide a way to predict disaggregated consumption from projections of GDP or specific sector growth rates.

5.2 International trade

Building materials accounted for a large share of trade in the decade of the 1970s. In 1980 it totalled over $US 140,000 million, which was 12 per cent of the market economy country exports of industrial products. The main features of this period were: the dominant role played by the developed market economy countries in world exports (86.2 per cent in 1980); the emergence of developing countries as major importers, reflected in the increase of their share of world imports, from 23.5 per cent in 1970 to 35.2 per cent in 1980; the high and still growing negative balance of developing country trade (almost $US 30,000 million in 1980). Imports of building materials were responsible for a considerable outflow of developing country foreign exchange. The elevenfold expansion of building material trade among developing countries, indicating a considerable increase in their capacity to produce and export building materials; the high and predominant share of metal products among building materials (45.4 per cent of world exports in 1980), that is, of products of an industrial sector characterized by severe structural problems and, in particular, by the high excess production capacity in developed countries; and the fact that building materials consist mostly of processed, capital-intensive (47 per cent of world exports) and labour-intensive (25.1 per cent) products, generating more extensive benefits to national economies than the unskilled, resource-based goods. While the

Figure 5.1.
Predicted share of total construction in GDP



*Based on the equation: $\log Y - A_1 + A_2 \log X + A_3 (\log x)^2$

where: $y = \frac{\text{construction}}{\text{GDP}}$; $X = \frac{\text{GDP}}{\text{Population}}$; $A_1 = -5.11458$; $A_2 = 0.67056$; $A_3 = 0.03509$

<u>SOURCE</u>: Wheeler, 1982.

capital and labour-intensive products accounted for a substantial share of developing country exports to the developing countries and centrally planned economies (53.7 and 70.9 per cent, respectively), they are relatively insignificant (9.2 per cent) in exports to the developed market economy countries. This characteristic indicates the importance of trade among the developing countries, as well as a strong potential for the expansion of exports of skilled products to the developed country markets.

For the period 1980-1982 only data for the developed market economy countries are available. Their analysis reveals that trade in building materials decreased substantially: imports (in current values) in fact declined by 17.4 per cent and exports by 7.6 per cent. This decline was the result of the economic recession in the developed market economy countries during this period. The demand for imported building materials was particularly weak in the case of the centrally planned economy countries' products (developed market economy country imports from this direction decreased by 28.3 per cent) and developing country products (19.1 per cent). In contrast, both developing and centrally planned economy countries performed well as importers and the developed market economy country exports to these countries increased by 5.3 per cent and 3.1 per cent, respectively. Thus, in building materials - as in the case of many other product groups - developing countries provided an extremely important cushion to the developed market economy countries during a period of sluggish demand.

The level of tariff protection given is signficant: unweighted average tariff rates range from 4.5 to 7.8 per cent in the developed market economy countries, from 9.7 to 15.6 per cent in the centrally planned economy countries of Eastern Europe and Asia and from 19.5 to 36.9 per cent in the developing countries.

The Generalized System of Preferences (GSP) has an important moderating influence on tariff rates facing developing countries. There is scope for further improvements both in the product coverage and in the extent of preferential margins provided under the existing schemes.

The effects of non-tariff barriers are perhaps more detrimental to the international community than those of tariffs. Over one-fifth of all building material product groups is subject to one or more of the NTMs investigated. They occur more frequently in the developing countries (they are applied to 27.2 per cent of product groups) than in the developed market economy countries (17.7 per cent).

The following three facts should be addressed when discussing international co-operation and action: the sharp decline in the volume of trade in the 1980s, the high and increasingly negative balance of developing country trade and the adverse commodity structure seen in developing country exports to the developed market economy countries.

The performance of developing countries as importers of building materials continued to be strong also during the 1980s. However, the large and increasingly negative balance in their trade in building materials, if continued, will restrain further expansion of imports. To counter this barrier, developing countries should give a high priority in their trade policies to trade among themselves. With this aim in mind, the existing high tariff and non-tariff barriers should be removed, in the framework, for instance, of the Global System of Trade Preferences (GSTP). Other preferential arrangements could also be envisaged. For example the provision of duty- and barrier-free entry for building materials imported for construction projects carried out by foreign companies from other developing countries.

The low level of capital and labour-intensive products in developing country exports to the developed market economy countries is to a certain degree the direct result of high barriers applied to these products. Removal of these barriers is not an easy task, since many are used to protect domestic industries struggling with structural difficulties. The developed market economy countries should intensify their efforts to promote structural adjustment in industries where comparative advantages have shifted in favour of foreign suppliers. Prolonged protection of inefficient industries imposes high penalties in the long run on the economies of both importing and exporting nations. Also, since in may cases structural problems are the result of a failure to anticipate important developments in international trade (e.g. expansion of production capacity and technological innovation abroad, etc.), there is a case for intensifying international efforts to monitor current and probable future developments in international trade. If governments wish to have the capacity, then the relevant information needs to be made available. It could be proposed that governments consider all practical arrangements which could be established for the exchange of information - both on current developments and on intentions concerning investment, production and trade, as well as on policies and instruments being evolved in this regard.

5.3 Special considerations relating to the small-scale and informal sectors

The small-scale and informal sector in developing countries accounts for a significant part of total production of building materials. Estimating their share with precision is impossible, since in many cases their activities are not part of the formal national economic accounting systems. It is clear, however, that any effort that improves productivity in these two sectors will have a major effect on living standards and economic development.

The small-scale sector and the informal sector are not precisely the same but in the present context they share enough in common so that the same recommendations can largely apply to both. Small-scale is used to mean firms relying on limited mechanization and equipment and having only a few employees. By the informal sector is meant the collection of firms (or sometimes just single individuals) which does business largely outside the normal channels of distribution and are typically able to ignore or evade minimum wage, social security and health and safety regulations. The fact that they can escape the enforcement of these regulations does not imply that they are oblivious to the considerations which the regulations address. This is perhaps obvious in the case of the firm which comprises only a single worker. It is not likely that he will be uninterested in his gaining for himself as high a wage as he can manage, but he may not resign his post if he is paid the minimum. In many cases it represents the only employment open to a large portion of the population. Naturally, productivity and wages tend to be higher in the formal sector. Activities which ultimately result in a portion of the informal sector melding into the formal sector are then a positive development. However, activities which try to force the informal sector only to act like the formal sector are apt to have negative effects.

Based on these considerations then the following actions could be proposed:

(a) Governments could provide a secure short-term market for a portion of the product of the small-scale and informal sector. This could be done especially easily in rural areas where much of non-governmental construction is carried out with unconventional building materials typically supplied by the informal sector. It should be stressed that such a scheme needs to closely match price with value. There is no particular reason to expect that it would be in the overall interest of economic development to pay a value in excess of what the materials are worth. The main advantage to the particular producers who win such contracts would be the opportunity to concentrate on improving production techniques and perhaps even upgrading equipment. Upgrading equipment would be facilitated by eliminating from the investment decision the uncertainty of marketing the anticipated increase in output which the investment would be expected to cause. Such a reduction in uncertainty would also assist in obtaining financing.

(b) The small scale sector is particularly dependent on research and development activities undertaken by the local or national government. While, in many instances, the results of research accrue somewhat strongly to those located near the research facility there is typically a significant spillover effect that is national and so to a certain extent funding should be national rather than local. Also, in connection with the immediately preceding proposal regarding government purchasing, there could be a programme for evaluating the applicability of unconventional materials in government funded construction. This type of research could be very beneficial, not only to small scale building materials producers but to the overall effectiveness of the construction sector. Use of locally produced building materials can help to ease a bit the apparent over-dependence of developing countries on imported building materials.

(c) With regard to unconventional building materials, once it is clear exactly how they can be effectively used in government construction, consideration could be given to government subsidized demonstration projects. It is emphasized that such demonstration projects are appropriate only in non-experimental situations. Demonstration projects are not the same as prototypes and have a different role to play. While the simple fact that the government is regularly using certain materials for its efforts would tend to improve the standing of the material in the opinion of many potential customers, there are instances where such use has been premature and in fact produced exactly the opposite of the intended effects. Such products of the small-scale and informal sector as pozzolana-lime and soil-cement building blocks would be given additional prestige simply from their use in government construction projects.

(d) There is a need for making self-instruction materials available in the local vernacular, presented clearly, and easily available to those who would benefit from them. In many instances the production processes in use for building materials are fairly simple but at the same time great increases in quality could be achieved by paying close attention to certain aspects of the production process.

(e) Small scale operations are generally dependent on economic and technical information supplied by equipment and materials suppliers or by governmental organizations. It would be useful if the government were able to increase the availability of technical and economic information on a local basis. One way in which this might be accomplished would be for technical and economic information to be available through an organization also concerned with training or research and development or both. Such advisers could also help to disseminate economic information, especially concerning the availability of markets and the supply of tools and raw materials. It might be considered that the government programme for purchasing building materials from the small-scale/informal sector could be administered in the first instance through this local technical adviser.

5.4 Planning, optimal scale and finance

Planning. The extreme swing in construction activity reported in some developin countries as a result of not having correctly anticipated the difficulties in financing on one hand and shortages of critical building materials on the other illustrates the importance of good planning. Adequate methods of forecasting supply and demand involve not just endeavouring to make the accurate forecasts but of developing sensible methods for implementing the forecasts into planning. A useful technique in this regard is to evaluate a number of options in light of several scenarios.

Concerning the supply of building materials it would be very useful to have reliable estimates of how the output of locally produced building materials would respond to various policies to encourage their production. One such technique is input-output analysis which could be extended to include the production requirements which characterize the simple technology of the informal sector. A frequent deficiency in the use of input-output tables is that they are published only at infrequent intervals, however, economists have developed inexpensive methods for updating them. Without prejudice to other techniques, it is possible to recommend that where input-output tables are available, they should be used in the planning process. The recent success of the ASEAN governments together with the Insitute of Developing Economies in Tokyo in linking existing national models to construct a multi-country input-output model of the regional is a noteworthy example of the type of research collaboration which is needed in this area.

It is also important in this connection to have available an inventory of the existing distribution of key raw materials. Research and development work on developing new building materials and new uses of existing materials depends on the assurance that sufficient supplies exist to warrant the research effort.

The appropriate scale of operation. In any economy it is likely that there will be operations of various scales existing simeltaneously in the same sector. While economies of scale are such that in some industries the larger the plant the lower will be its unit costs this is rare. More typical is the situation where large scale facilities are more efficient than small-scale ones but only up to acertain point, beyond that output level long run average costs are approximately flat with respect to scale up to a point at which they then begin to rise steeply. This seems to be the situation in the building materials industry. One question then has to do with determining the range of output levels for which the average cost curves are flat for various building materials. Another question has to do with the fact that generally labour-intensive methods are more efficient in developing countries and capital intensive methods in developed countries. Since empirically it is known that there is a tendency for capital intensity and scale to increase together it is not advisable for developing countries to assume that examples of optimal scale from developed countries are good models for them to follow.

A recent development which is important to the choice of optimal scale is the introduction of computers into the manufacturing processes. Computer-aided manufacture of some building materials can greatly reduce set-up costs in repetitive production processes and so enable smaller production lot sizes to become efficient. As underlined above, as well as in other UNIDO studies, it is essential that developing countries participate actively in the diffusion of computer-oriented techniques. Failure to do so may, far from having a labour saving impact, result in a further loss of comparative advantages. The development of flexible manufacturing systems or multipurpose plants, which is now gaining nomentum in the industrialized countries, is a case in point.

Finance. Finance is - as was stated at the outset - critical to the development of the construction sector, which directly produces capital goods for investment. However, this report emphasizes the role of the building materials industry and it is also appropriate to look to the financial needs of the building materials industry itself. An important consideration is the financing of small-scale and informal sector operations. It was mentioned above that the ability of small firms to obtain bank financing would be enhanced by a programme of government purchases of their output. In addition it would be useful if means could be found for reducing the difficulty that banks and other financing institutions (including the government) face in processing applications from individual and small firms. International organizations can help by ensuring that their technical assistance is not unduly discriminatory against the financial needs of the small-scale sector.

5.5 Some final observations

Economic assumptions and conditions that held sway in the world from the early part of the century until the mid-1970s led newly independent nations to try to develop large-scale, capital-intensive industries, reliant in some cases on imported raw materials, technologies, advisers and technicians, and in other cases dependent on the stability of world-wide export markets. The recent collapse in the supply of investment capital in developing nations, energy shortages and wide fluctuations in world demand have frustrated many such enterprises; the unsuitabilty of technologically complex methods to local conditions doomed others.

But developing nations cannot do without essential goods just because they are costly to import or difficult to produce using large-scale, imported technologies. The demand for low-cost housing, infrastructure, industrial plants and commerical buildings, and thus for building materials, is critical in many developing nations, and their governments must seek ways to fill these needs at minimum cost and maximum benefit to the society.

The analysis and evidence in this report indicates that small-scale, labour-intensive enterprises, relying on indigenous inputs and methods whenever possible, may be more successful than past attempts to produce building materials. The informal sector holds special promise for supplying housing to the poorest half of the population in many developing countries, with concomitant social benefits and stimulation of other sectors of the economy. In many instances in the building materials industry, small-scale factories can be as efficient as, and sometimes more efficient than, large-scale plants.

This is not to say that a given country should try to develop factories in all sectors of the building materials industry - such overextension has been disastrous in the past. But the wide range of choices open to each country will permit it to find a combination of facilities that exploits its own strengths and fulfils local needs as nearly as possible. Collaboration at the regional level should let nations dovetail their plans for growth in the industry as a whole.

Programmes at all levels will be necessary to provide domestic industries with the capital, knowledge and trained and professional workers they need; to set standards and regulations; and to carry out research into new materials and methods. But institutional forebearance will also be necessary to avoid mistakes which in the past have caused overly persistent measures to protect inefficient producers, market distortions in the prices of labour and transportation and policies that favoured the importation of capital-intensive technologies.

Appendices

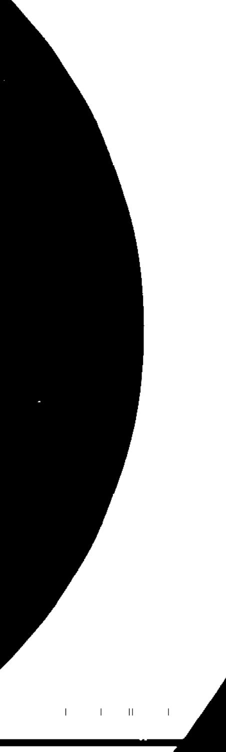


Table A.1. GDP, construction and building materials production, Argentina, 1970-1980

	1970	1975	1980	Average annual growth rate (per cent) 1970-75	1975-80
Population (in thousands)	23,748	25,384	27,064	1.3	1.3
GDP (millions of A.P.[a])	87,970	101,287	111,738	2.9	2.0
Construction (millions of A.P.[a])	5,025	5,272	7,319	1.0	6.8
Building materials production:					
Plywood (TCM)	48	61	53	4.9	-2.8
Glass (TSM)					
Building bricks of clay (MU)					
Quicklime (TMT)					
Cement (TMT)	4,770	5,361	7,289	2.4	6.3
Asbestos and cement articles (TMT)					
Concrete blocks (TMT)					
Crude steel, ingots (TMT)	1,821	1,994	2,528	1.8	4.9
Angles, shapes, etc. (TMT)	397	441		2.1	
Aluminium (TMT)		22	133		43.3
Nails, screws, etc. (TMT)					
GDP/capita (A.P.[a])	3,704	3,990	4129	1.5	0.7
Construction/capita(A.P.[a])	212	208	270	-0.4	5.4
Building materials production: (per thousand inhabitants)					
Plywood (CM)	2.1	2.4	2.0	3.5	-4.0
Glass (SM)					
Building bricks (Units)					
Quicklime (MT)					
Cement (MT)	200.9	211.2	269.3	1.0	5.0
Asbestos and cement articles (MT)					
Concrete blocks (MT)					
Crude steel, ingots (MT)	76.7	78.6	93.4	0.5	3.5
Angles, shapes, etc. (MT)	16.7	17.4		0.8	
Aluminium (MT)		0.9	4.9		41.4
Nails, screws, etc. (MT)					

a/ A.P. = Argentinian Pesos at constant 1970 prices.

Abbreviations and sector ISIC codes:

Production in units as follows: CM - cubic meters, SM - square meters, MT - metric tones, TCM - thousand cubic meters, TSM - thousand square meters, MU - million units, TMT - thousand metric tons.

ISIC based codes: plywood-331116; glass-362001; building bricks-369101; quicklime-369201; cement-369204; asbestos and cement articles-369901; concrete blocks-369910; crude steel, ingots-371019; angles, etc.-371035; aluminium-372022; nails, etc.-381913.

Sources: United Nations, Statistical Yearbook 1981 (Population); United Nations, Yearbook of National Accounts 1981 (GDP, Construction); United Nations, Yearbook of Industrial Statistics 1979 and 1981 (Building materials production).

Table A.2. GDP, construction and building materials production, Egypt, 1975-1979

	1970	1975	1979	Average annual growth rate (per cent) 1970-75	1975-79
Population (in thousands)		37,011	41,108 a/		2.7
GDP (millions of E.P. b/)		5,247	7,303		8.6
Construction (millions of E.P. b/)		243	651		28.0
Building materials production:					
Plywood (TCM)		8	6		-6.9
Glass (TSM)					
Building bricks of clay (MU)		600	408		-9.2
Quicklime (TMT)		82	88		1.8
Cement (TMT)		3,579	3,638		0.4
Asbestos and cement articles (TMT)		66			
Concrete blocks (TMT)					
Crude steel, ingots (TMT)		348	798		23.1
Angles, shapes, etc. (TMT)					
Aluminium (TMT)		2	102		167.2
Nails, screws, etc. (TMT)		7	9		6.2
GDP/capita (E.P. b/)		142	178		5.8
Construction/capita (E.P. b/)		7	16		24.4
Building materials production: (per thousand inhabitants)					
Plywood (CM)		0.2	0.2		-
Glass (SM)					
Building bricks (Units)		16.2 c/	9.9 c/		-11.6
Quicklime (MT)		2.2	2.1		-11.6
Cement (MT)		96.7	88.5		-2.2
Asbestos and cement articles (MT)		1.8			-
Concrete blocks (MT)					
Crude steel, ingots (MT)		9.4	19.4		19.9
Angles, shapes, etc. (MT)					
Aluminium (MT)		0.1	2.5		123.6
Nails, screws, etc. (MT)		0.2	0.2		-

a/ By interpolation between 1975 and 1980.
b/ E.P. = Egyptian Pounds at constant 1975 prices.
c/ Per capita.

Abbreviations and sector ISIC codes:

Production in units as follows: CM - cubic meters, SM - square meters, MT - metric tons, TCM - thousand cubic meters, TSM - thousand square meters, MU - million units, TMT - thousand metric tons.

ISIC based codes: plywood-331116; glass-362001; building bricks-369101; quicklime-369201; cement-369204; asbestos and cement articles-369901; concrete blocks-369910; crude steel, ingots-371019; angles, etc.-371035; aluminium-372022; nails, etc.-381913.

Sources: United Nations, Statistical Yearbook 1981 (Population); United Nations, Yearbook of National Accounts 1981 (GDP, Construction); United Nations, Yearbook of Industrial Statistics 1981 (Building materials production).

Table A.3. GDP, construction and building materials production, India, 1970-1980

	1970	1975	1980	Average annual growth rate (per cent) 1970-75	1975-80
Population (in thousands)	539,075	600,763	663,596	2.2	2.0
GDP (10^9 Rupees[a/])	403	466	552	3.0	3.4
Construction (10^9 Rupees[a/])	20	20	22	0.8	1.8
Building materials production:					
Plywood (TCM)	128	127	180	-0.2	7.2
Glass (TSM)	14,712	14,260	23,146	-0.6	10.2
Building bricks of clay (MU)					
Quicklime (TMT)		180	400		17.3
Cement (TMT)	13,956	16,248	17,803	3.1	1.8
Asbestos and cement articles (TMT)	361	485	644	6.1	5.8
Concrete blocks (TMT)					
Crude steel, ingots (TMT)	6,234	7,865	9,355	4.8	3.5
Angles, shapes, etc. (TMT)					
Aluminium (TMT)	161	167	185	0.8	2.0
Nails, screws, etc. (TMT)		29	30		0.8
GDP/capita (thousands of Rupees[a/])	747	775	832	7.5	1.4
Construction/capita(thousands of Rupees)	36	34	33	-1.4	-0.2
Building materials production: (per thousand inhabitants)					
Plywood (CM)	0.2	0.2	0.3	-	5.2
Glass (SM)	27.3	23.7	34.9	-2.7	8.0
Building bricks (Units)					
Quicklime (MT)		0.3	0.6		14.9
Cement (MT)	25.9	27.1	26.8	0.9	-0.2
Asbestos and cement articles (MT)	0.7	0.8	1.0	3.9	3.7
Concrete blocks (MT)					
Crude steel, ingots (MT)	11.6	13.1	14.1	2.5	1.5
Angles, shapes, etc. (MT)					
Aluminium (MT)	0.3	0.3	0.3	-	-
Nails, screws, etc. (MT)		0.1	0.1		-

a/ Rupees at constant 1970 prices.

Abbreviations and sector ISIC codes:

Production in units as follows: CM - cubic meters, SM - square meters, MT - metric tones, TCM - thousand cubic meters, TSM - thousand square meters, MU - million units, TMT - thousand metric tons.

ISIC based codes: plywood-331116; glass-362001; building bricks-369101; quicklime-369201; cement-369204; asbestos and cement articles-369901; concrete blocks-369910; crude steel, ingots-371019; angles, etc.-371035; aluminium-372022; nails, etc.-381913.

Sources: United Nations, Statistical Yearbook 1981 (Population); United Nations, Yearbook of National Accounts 1981 (GDP, Construction); United Nations, Yearbook of Industrial Statistics 1979 and 1981 (Building materials production).

Table A.4. GDP, construction and building materials production, Kenya, 1975-1980

	1970	1975	1980	Average annual growth rate (per cent) 1970-75	1975-80
Population (in thousands)		13,399	16,466		4.2
GDP (millions of K.P.a/)		1,424	1,830		5.2
Construction (millions of K.P.a/)		68	85		4.4
Building materials production:					
Plywood (TCM)		11	13		3.4
Glass (TSM)					
Building bricks of clay (TCM)		25	20		-4.4
Quicklime (TMT)			26		
Cement (TMT)		897	1,280		7.4
Asbestos and cement articles (TMT)					
Concrete blocks (TMT)		89	607		46.8
Crude steel, ingots (TMT)					
Angles, shapes, etc. (TMT)					
Aluminium (TMT)					
Nails, screws, etc. (TMT)					
GDP/capita (K.P.a/)		106	111		0.9
Construction/capita (K.P.a/)		5	5		0.2
Building materials production: (per thousand inhabitants)					
Plywood (CM)		0.8	0.8		-0.7
Glass (SM)					
Building bricks (CM)		1.9	1.2		-8.3
Quicklime (MT)			1.6		
Cement (MT)		67.0	77.7		3.0
Asbestos and cement articles (MT)					
Concrete blocks (MT)		6.6	36.9		40.9
Crude steel, ingots (MT)					
Angles, shapes, etc. (MT)					
Aluminium (MT)					
Nails, screws, etc. (MT)					

a/ K.P. = Kenyan Pounds at constant 1976 prices.

Abbreviations and sector ISIC codes:

Production in units as follows: CM - cubic meters, MT - metric tons, SM - square meters, TCM - thousand cubic meters, TSM - thousand square meters, MU - million units, TMT - thousand metric tons.

ISIC based codes: plywood-331116; glass-362001; building bricks-369101; quicklime-369201; cement-369204; asbestos and cement articles-369901; concrete blocks-369910; crude steel, ingots-371019; angles, etc.-371035; aluminium-372022; nails, etc.-381913.

Sources: United Nations, Statistical Yearbook 1981 (Population); United Nations, Yearbook of National Accounts 1981 (GDP, Construction); United Nations, Yearbook of Industrial Statistics 1981 (Building materials production).

Table A.5. GDP, construction and building materials production, Republic of Korea, 1970-1980

	1970	1975	1980	Average annual growth rate (per cent) 1970-75	1975-80
Population (in thousands)	32,241	35,281	38,124	1.8	1.6
GDP (10^9 K.W.a/)	6,315	9,952	14,342	9.5	7.6
Construction (10^9 K.W.a/)	344	498	885	7.7	12.2
Building materials production:					
Plywood (TCM)	1,126	1,436	1,693	5.0	3.4
Glass (TSM)	12,647	15,514	28,690	4.2	13.3
Building bricks of clay (MU)	99	162	117	10.4	-6.3
Quicklime (TMT)		100	210		16.0
Cement (TMT)	5,782	10,129	15,631	11.9	9.1
Asbestos and cement articles (TMT)					
Concrete blocks (TMT)	75	137	839	12.8	43.7
Crude steel, ingots (TMT)	481	2,010	5,712	33.1	23.2
Angles, shapes, etc. (TMT)	70	149	360	16.3	19.3
Aluminium (TMT)	15	18	21	2.9	3.7
Nails, screws, etc. (TMT)	17	36	108	16.0	24.5
GDP/capita (thousands of K.W.a/)	196	282	376	7.6	5.9
Construction/capita(thousands of K.W.a/)	11	14	23	5.7	10.5
Building materials production: (per thousand inhabitants)					
Plywood (CM)	34.9	40.7	44.4	3.1	1.8
Glass (SM)	392.3	439.7	752.5	2.3	11.3
Building bricks (Units)	3.1	4.6	3.1	8.2	-7.6
Quicklime (MT)		2.8	5.5		14.5
Cement (MT)	179.3	287.1	410.0	9.9	7.4
Asbestos and cement articles (MT)					
Concrete blocks (MT)	2.3	3.9	22.0	11.1	41.3
Crude steel, ingots (MT)	14.9	57.0	149.8	30.8	21.3
Angles, shapes, etc. (MT)	2.2	4.2	9.4	13.8	17.5
Aluminium (MT)	0.5	0.5	0.6		3.7
Nails, screws, etc. (MT)	0.5	1.0	2.8	14.9	22.9

a/ K.W. = Korean Won at constant 1975 prices.

Abbreviations and sector ISIC codes:

Production in units as follows: CM - cubic meters, SM - square meters, MT - metric tones, TCM - thousand cubic meters, TSM - thousand square meters, MU - million units, TMT - thousand metric tons.

ISIC based codes: plywood-331116; glass-362001; building bricks-369101; quicklime-369201; cement-369204; asbestos and cement articles-369901; concrete blocks-369910; crude steel, ingots-371019; angles, etc.-371035; aluminium-372022; nails, etc.-381913.

Sources: United Nations, Statistical Yearbook 1981 (Population); United Nations, Yearbook of National Accounts 1981 (GDP, Construction); United Nations, Yearbook of Industrial Statistics 1979 and 1981 (Building materials production).

Table A.6. GDP, construction and building materials production, Malaysia, 1970-1980

	1970	1975	1980	Average annual growth rate (per cent) 1970-75	1975-80
Population (in thousands)	10,390	11,926	13,436	2.8	2.4
GDP (millions of M.R.[a])	10,588	17,365	26,188	10.4	8.6
Construction (millions of M.R.[a])	395	654	1,186	10.6	12.6
Building materials production:					
Plywood (TCM)	197	404	490	15.4	3.9
Glass (TSM)					
Building bricks of clay (MU)					
Quicklime (TMT)					
Cement (TMT)	1,030	1,446	2,349	7.0	10.2
Asbestos and cement articles (TMT)					
Concrete blocks (TMT)					
Crude steel, ingots (TMT)					
Angles, shapes, etc. (TMT)	8	9	13	2.4	7.6
Aluminium (TMT)					
Nails, screws, etc. (TMT)					
GDP/capita (M.R.[a])	1,019	1,456	1,949	7.4	6.0
Construction/capita (M.R.[a])	38	55	88	7.6	10.0
Building materials production: (per thousand inhabitants)					
Plywood (CM)	19.0	33.9	36.5	12.3	1.5
Glass (SM)					
Building bricks (Units)					
Quicklime (MT)					
Cement (MT)	99.1	121.3	174.8	4.1	7.6
Asbestos and cement articles (MT)					
Concrete blocks (MT)					
Crude steel, ingots (MT)					
Angles, shapes, etc. (MT)	0.8	0.8	1.0	-	5.3
Aluminium (MT)					
Nails, screws, etc. (MT)					

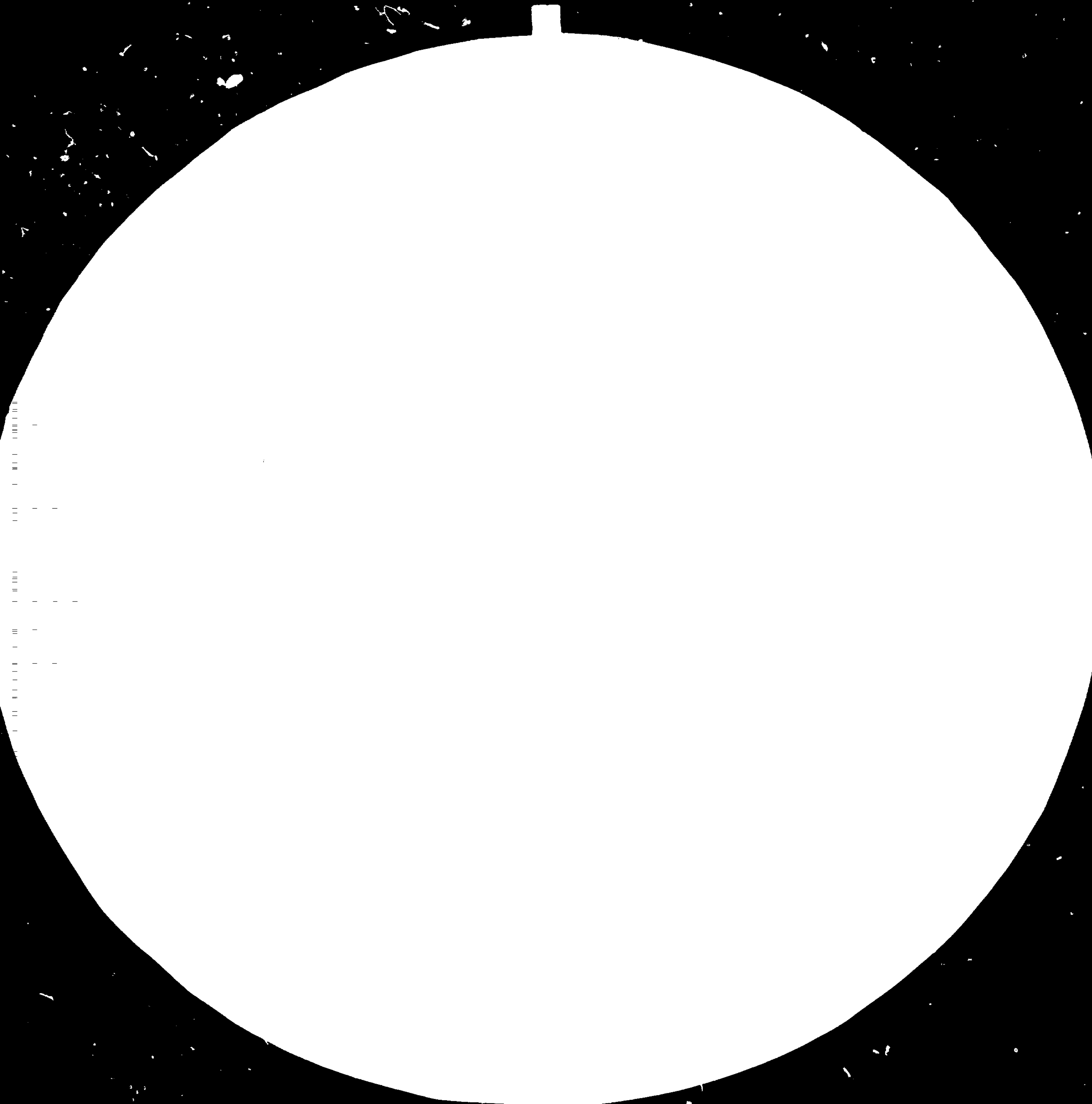
a/ M.R. = Malaysian Ringitt at constant 1970 prices.

Abbreviations and sector ISIC codes:

Production in units as follows: CM - cubic meters, SM - square meters, MT - metric tones, TCM - thousand cubic meters, TSM - thousand square meters, MU - million units, TMT - thousand metric tons.

ISIC based codes: plywood-331116; glass-362001; building bricks-369101; quicklime-369201; cement-369204; asbestos and cement articles-369901; concrete blocks-369910; crude steel, ingots-371019; angles, etc.-371035; aluminium-372022; nails, etc.-381913.

Sources: United Nations, Statistical Yearbook 1981 (Population); United Nations, Yearbook of National Accounts 1981 (GDP, Construction); United Nations, Yearbook of Industrial Statistics 1979 and 1981 (Building materials production).



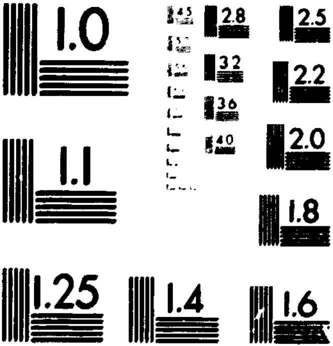


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Table A.7. GDP, construction and building materials production, Mexico, 1970-1980

	1970	1975	1980	Average annual growth rate (per cent) 1970-75	1975-80
Population (in thousands)	50,695	60,145	71,911	3.5	3.6
GDP (millions of M.P.a/)	444,271	609,976	841,855	6.5	6.6
Construction (millions of M.P.a/)	23,530	32,792	46,379	6.9	7.2
Building materials production:					
Plywood (TCM)	96	110	254	2.8	18.2
Glass (TMT)	82	121	159	8.1	5.6
Building bricks of clay (MU)					
Quicklime (TMT)			4,354		
Cement (TMT)	7,267	11,200	16,398	9.0	7.9
Asbestos and cement articles (TMT)		303	423		6.9
Concrete blocks (TMT)					
Crude steel, ingots (TMT)	3,831	5,176	6,981	6.2	6.2
Angles, shapes, etc. (TMT)	387	554	679	7.4	4.2
Aluminium (TMT)	34	40	43	3.3	1.3
Nails, screws, etc. (TMT)					
GDP/capita (M.P.a/)	8,764	10,142	11,707	3.0	2.9
Construction/capita (M.P.a/)	464	545	645	3.3	3.4
Building materials production: (per thousand inhabitants)					
Plywood (CM)	1.9	1.8	3.5	-0.6	14.0
Glass (MT)	1.6	2.0	2.2	4.4	1.9
Building bricks (Units)					
Quicklime (MT)			60.6		
Cement (MT)	143.4	186.2	228.0	5.4	4.1
Asbestos and cement articles (MT)		5.1	5.9		3.1
Concrete blocks (MT)					
Crude steel, ingots (MT)	75.6	86.1	97.1	2.6	2.4
Angles, shapes, etc. (MT)	7.6	9.2	9.4	3.8	0.5
Aluminium (MT)	0.7	0.7	0.6	-	-2.2
Nails, screws, etc. (MT)					

a/ M.P. = Mexican Pesos at constant 1970 prices.

Abbreviations and sector ISIC codes:

Production in units as follows: CM - cubic meters, SM - square meters, MT - metric tones, TCM - thousand cubic meters, TSM - thousand square meters, MU - million units, TMT - thousand metric tons.

ISIC based codes: plywood-331116; glass-362001; building bricks-369101; quicklime-369201; cement-369204; asbestos and cement articles-369901; concrete blocks-369910; crude steel, ingots-371019; angles, etc.-371035; aluminium-372022; nails, etc.-381913.

Sources: United Nations, Statistical Yearbook 1981 (Population); United Nations, Yearbook of National Accounts 1981 (GDP, Construction); United Nations, Yearbook of Industrial Statistics 1979 and 1981 (Building materials production).

Table A.8. GDP, construction and building materials production, Saudi Arabia, 1970-1979

	1970	1975	1979	Average annual growth rate (per cent) 1970-75	1975-79
Population (in thousands)	7,740	7,251	8,112	-1.3	2.8
GDP (millions of S.A.R.[a])	19,907	34,461	49,127	11.6	9.3
Construction (millions of S.A.R.[a])	957	3,309	5,091	28.2	11.4
Building materials production:					
Plywood (TCM)					
Glass (TSM)					
Building bricks of clay (MU)					
Quicklime (TMT)	8	11	25	6.6	22.8
Cement (TMT)	667	1,140	2,674	11.3	23.8
Asbestos and cement articles (TMT)					
Concrete blocks (TMT)					
Crude steel, ingots (TMT)			45		
Angles, shapes, etc. (TMT)					
Aluminium (TMT)					
Nails, screws, etc. (TMT)					
GDP/capita (S.A.R.[a])	2,572	4,753	6,056	13.1	6.2
Construction/capita (S.A.R.[a])	124	456	628	29.8	8.3
Building materials production: (per thousand inhabitants)					
Plywood (CM)					
Glass (SM)					
Building bricks (Units)					
Quicklime (MT)	1.0	1.5	3.1	8.0	19.3
Cement (MT)	86.2	157.2	329.6	12.8	20.3
Asbestos and cement articles (MT)					
Concrete blocks (MT)					
Crude steel, ingots (MT)			5.6		
Angles, shapes, etc. (MT)					
Aluminium (MT)					
Nails, screws, etc. (MT)					

a/ S.A.R. = Saudi Arabian Riyals at constant 1969 prices.

Abbreviations and sector ISIC codes:

Production in units as follows: CM - cubic meters, SM - square meters, MT - metric tones, TCM - thousand cubic meters, TSM - thousand square meters, MU - million units, TMT - thousand metric tons.

ISIC based codes: plywood-331116; glass-362001; building bricks-369101; quicklime-369201; cement-369204; asbestos and cement articles-369901; concrete blocks-369910; crude steel, ingots-371019; angles, etc.-371035; aluminium-372022; nails, etc.-381913.

Sources: United Nations, Statistical Yearbook 1981 (Population); United Nations, Yearbook of National Accounts 1981 (GDP, Construction); United Nations, Yearbook of Industrial Statistics 1981 (Building materials production).

Table A.9. GDP, construction and building materials production, Thailand, 1970-1980

	1970	1975	1980	Average annual growth rate (per cent) 1970-75	1975-80
Population (in thousands)	36,370	41,869	47,173	2.9	2.4
GDP (millions of T.B.[a])	150,092	203,514	292,852	6.3	7.6
Construction (millions of T.B.[a])	8,705	8,514	16,576	-0.4	14.3
Building materials production:					
Plywood (TCM)	47	51	89	1.6	11.8
Glass (TMT)	31	41		5.8	
Building bricks of clay (MU)					
Quicklime (TMT)					
Cement (TMT)	2,627	3,976	5,359	8.6	6.2
Asbestos and cement articles (TMT)					
Concrete blocks (TMT)					
Crude steel, ingots (TMT)	40	236	454	42.6	14.0
Angles, shapes, etc. (TMT)					
Aluminium (TMT)					
Nails, screws, etc. (TMT)					
GDP/capita (T.B.[a])	4,127	4,861	6,208	3.3	5.0
Construction/capita (T.B.[a])	239	203	351	-3.2	11.6
Building materials production: (per thousand inhabitants)					
Plywood (CM)	1.3	1.2	2.0	-1.2	9.2
Glass (MT)	0.9	1.0		2.8	
Building bricks (Units)					
Quicklime (MT)					
Cement (MT)	72.2	95.0	113.6	5.6	3.7
Asbestos and cement articles (MT)					
Concrete blocks (MT)					
Crude steel, ingots (MT)	1.1	5.6	9.6	38.7	11.3
Angles, shapes, etc. (MT)					
Aluminium (MT)					
Nails, screws, etc. (MT)					

a/ T.B. = Thai Baht at constant 1972 prices.

Abbreviations and sector ISIC codes:

Production in units as follows: CM - cubic meters, SM - square meters, MT - metric tones, TCM - thousand cubic meters, TSM - thousand square meters, MU - million units, TMT - thousand metric tons.

ISIC based codes: plywood-331116; glass-362001; building bricks-369101; quicklime-369201; cement-369204; asbestos and cement articles-369901; concrete blocks-369910; crude steel, ingots-371019; angles, etc.-371035; aluminium-372022; nails, etc.-381913.

Sources: United Nations, Statistical Yearbook 1981 (Population); United Nations, Yearbook of National Accounts 1981 (GDP, Construction); United Nations, Yearbook of Industrial Statistics 1979 and 1981 (Building materials production).

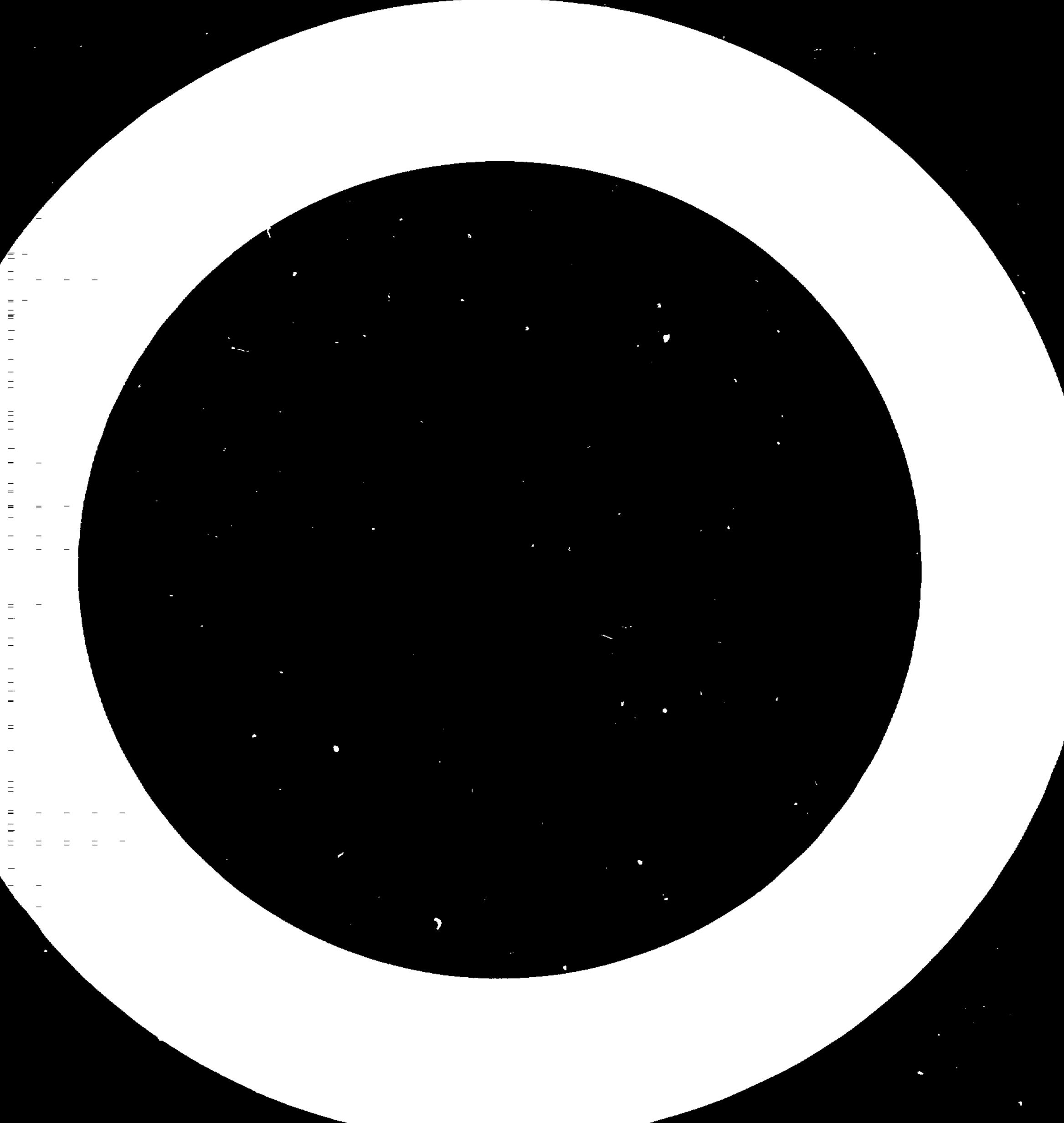


Table B.1. Major world traders in glass, 1981 (ranked by percentage of world trade volume, measured in thousands of $US)

SITC 664 (Rev.1)	Value	Percentage
Major importers		
World	3,763,923	100.00
Germany, Federal Republic of	405,694	10.78
France	301,783	8.02
United States	274,533	7.29
United Kingdom	236,658	6.29
Netherlands	232,622	6.18
Saudi Arabia	196,947	5.23
Italy	183,261	4.87
Canada	166,437	4.42
Belgium	112,828	3.00
Switzerland	95,487	2.54
Japan	81,415	2.16
Sweden	79,395	2.11
Austria	69,341	1.84
Republic of Korea	64,356	1.71
Norway	59,413	1.58
Singapore	57,983	1.54
Hong Kong	57,002	1.51
Australia	56,147	1.49
Denmark	51,716	1.37
Brazil	48,040	1.28
Subtotal:	2,831,058	75.21
Major exporters		
World	3,387,747	100.00
United States	587,511	17.34
Germany, Federal Republic of	526,689	15.55
Belgium	467,995	13.81
France	310,457	9.16
Japan	267,674	7.90
Italy	258,608	7.63
United Kingdom	231,481	6.83
Netherlands	130,185	3.84
Sweden	94,183	2.78
Finland	70,374	2.08
Spain	67,750	2.00
Mexico	47,582	1.40
Denmark	42,887	1.27
Turkey	26,588	0.78
Brazil	21,822	0.64
Republic of Korea	21,793	0.64
Austria	20,622	0.61
Switzerland	19,728	0.58
Singapore	18,079	0.53
Argentina	16,230	0.48
Ireland	15,281	0.45
South Africa	12,100	0.36
Subtotal:	3,275,619	96.70

Source: United Nations, Yearbook of International Trade Statistics 1981, New York.

Table B.2. Major world traders in clay, refractory building products, 1981 (ranked by percentage of world trade volume, measured in thousands of $US)

SITC 662 (Rev.1)	Value	Percentage
Major importers		
World	4,091,826	100.00
Germany, Federal Republic of	541,677	13.24
France	534,335	13.06
United States	272,993	6.67
South Africa	239,340	5.85
Belgium	189,608	4.63
Canada	150,113	3.67
Italy	120,900	2.95
Austria	115,154	2.81
Australia	105,147	2.57
Netherlands	104,425	2.55
Switzerland	98,692	2.41
United Kingdom	95,539	2.33
Brazil	93,952	2.30
Singapore	74,272	1.82
Hong Kong	73,682	1.80
Libya	68,774	1.68
Argentina	65,799	1.61
Venezuela	54,748	1.34
Indonesia	52,656	1.29
Sweden	50,359	1.23
Subtotal:	3,102,165	75.81
Major exporters		
World	4,011,958	100.00
Italy	1,198,282	29.87
Germany, Federal Republic of	678,395	16.91
Japan	342,903	8.55
France	272,881	6.80
United States	247,002	6.16
Spain	224,941	5.61
United Kingdom	176,856	4.41
Austria	175,694	4.38
Netherlands	151,727	3.78
Belgium	68,387	1.70
Brazil	58,464	1.46
Yugoslavia	49,255	1.23
Republic of Korea	35,682	0.89
Sweden	35,037	0.87
Mexico	32,960	0.82
Canada	25,584	0.64
Switzerland	23,659	0.59
Ireland	23,036	0.57
Greece	22,243	0.55
Denmark	22,112	0.55
Singapore	14,512	0.36
Portugal	13,976	0.35
Subtotal:	3,893,588	97.05

Source: United Nations, Yearbook of International Trade Statistics 1981, New York.

Table B.3. Major world traders in iron and steel bars, rods, etc., 1981 (ranked by percentage of world trade volume, measured in thousands of $US)

SITC 673 (Rev.1)	Value	Percentage
<u>Major importers</u>		
World	13,136,819	100.00
United States	1,907,310	14.52
Germany, Federal Republic of	1,454,593	11.07
France	902,916	6.87
Saudi Arabia	641,465	4.88
Netherlands	430,340	3.28
Iran	387,527	2.95
United Kingdom	378,079	2.88
Italy	337,556	2.57
Canada	334,889	2.55
Belgium	327,340	2.49
Hong Kong	322,678	2.46
Iraq	281,260	2.14
India	268,131	2.04
Switzerland	265,975	2.02
Egypt	252,548	1.92
Nigeria	240,770	1.83
Singapore	232,276	1.77
Algeria	227,065	1.73
Malaysia	224,624	1.71
Republic of Korea	219,748	1.67
Subtotal:	9,637,090	73.36
<u>Major exporters</u>		
World	12,055,653	100.00
Japan	2,554,298	21.19
Germany, Federal Republic of	1,537,094	12.75
Belgium	1,186,865	9.84
France	1,155,633	9.59
Italy	1,001,779	8.31
Spain	923,889	7.66
United Kingdom	539,136	4.47
Sweden	417,502	3.46
Canada	387,485	3.21
United States	356,145	2.95
Austria	302,802	2.51
Republic of Korea	290,382	2.41
Brazil	198,369	1.65
Netherlands	179,241	1.49
South Africa	120,888	1.00
Switzerland	106,164	0.88
Zimbabwe	93,994	0.78
Qatar	79,109	0.66
Norway	75,539	0.63
Finland	69,159	0.57
Australia	59,169	0.49
Yugosalvia	51,219	0.42
Subtotal:	11,685,861	96.92

<u>Source</u>: United Nations, Yearbook of International Trade Statistics 1981, New York.

Table B.4. Major world traders in iron and steel universals, plates and sheets, 1981 (ranked by percentage of world trade volume, measured in thousands of $US)

SITC 674 (Rev.1)	Value	Percentage
Major importers		
World	18,678,068	100.00
United States	3,119,083	16.70
Germany, Federal Republic of	1,546,688	8.28
France	1,167,082	6.25
Canada	746,912	4.00
United Kingdom	727,998	3.90
Italy	662,874	3.55
India	620,203	3.32
Mexico	481,490	2.58
Indonesia	469,178	2.51
Netherlands	459,502	2.46
Nigeria	424,950	2.28
Sweden	362,339	1.94
Singapore	355,962	1.91
Iran	353,010	1.89
Yugoslavia	328,973	1.76
Denmark	320,075	1.71
Malaysia	317,094	1.70
Switzerland	308,763	1.65
Thailand	297,991	1.60
Belgium	297,105	1.59
Subtotal:	13,367,272	71.58
Major exporters		
World	17,930,647	100.00
Japan	4,989,417	27.83
Germany, Federal Republic of	2,936,194	16.38
Belgium	2,021,265	11.27
France	1,637,806	9.13
Italy	763,692	4.26
Netherlands	711,217	3.97
United States	667,004	3.72
Republic of Korea	564,354	3.15
Austria	545,917	3.04
Sweden	446,580	2.49
Canada	430,297	2.40
United Kingdom	407,454	2.27
Spain	352,370	1.97
Finland	282,304	1.57
Australia	263,846	1.47
Brazil	239,818	1.34
South Africa	141,657	0.79
Denmark	114,267	0.64
Norway	73,227	0.41
Singapore	72,547	0.40
Venezuela	39,492	0.22
Philippines	31,402	0.18
Subtotal:	17,732,127	98.90

Source: United Nations, Yearbook of International Trade Statistics 1981, New York.

Table C.1. Building materials - product coverage

A. Product groups (SITC Rev. 2)

1. Articles of wood

247	Other wood in the rough, or roughly squared
248	Wood, simply worked and railway sleepers of wood
634	Veneers, plywood, improved or reconstituted wood, worked
635.3	Builders' carptentry and joinery
641.6	Fibre building board of wood or other vegetable material

2. Mineral products

273	Stone, sand and gravel
661	Lime, cement and fabricated construction materials
662	Clay and refractory construction materials

3. Glass

664.4	Cast, rolled, drawn or blown glass, in rectangles, ground/polished
664.5	Cast or rolled glass, unworked, in rectangles, unworked
664.6	Bricks, tiles, slabs, paving blocks, squares, etc. of glass
664.91	Cast, rolled, drawn or blown glass, shaped and worked; leaded lights

4. Paints

533.4	Varnishess and lacquers, distempers, paints, enamels, dyes, etc.
533.51	Prepared pigments, opacifiers, colours, enamels and glazes, etc.
533.54	Glaziers' putty, fillings, surface preparations, mastics, etc.

5. Metal products

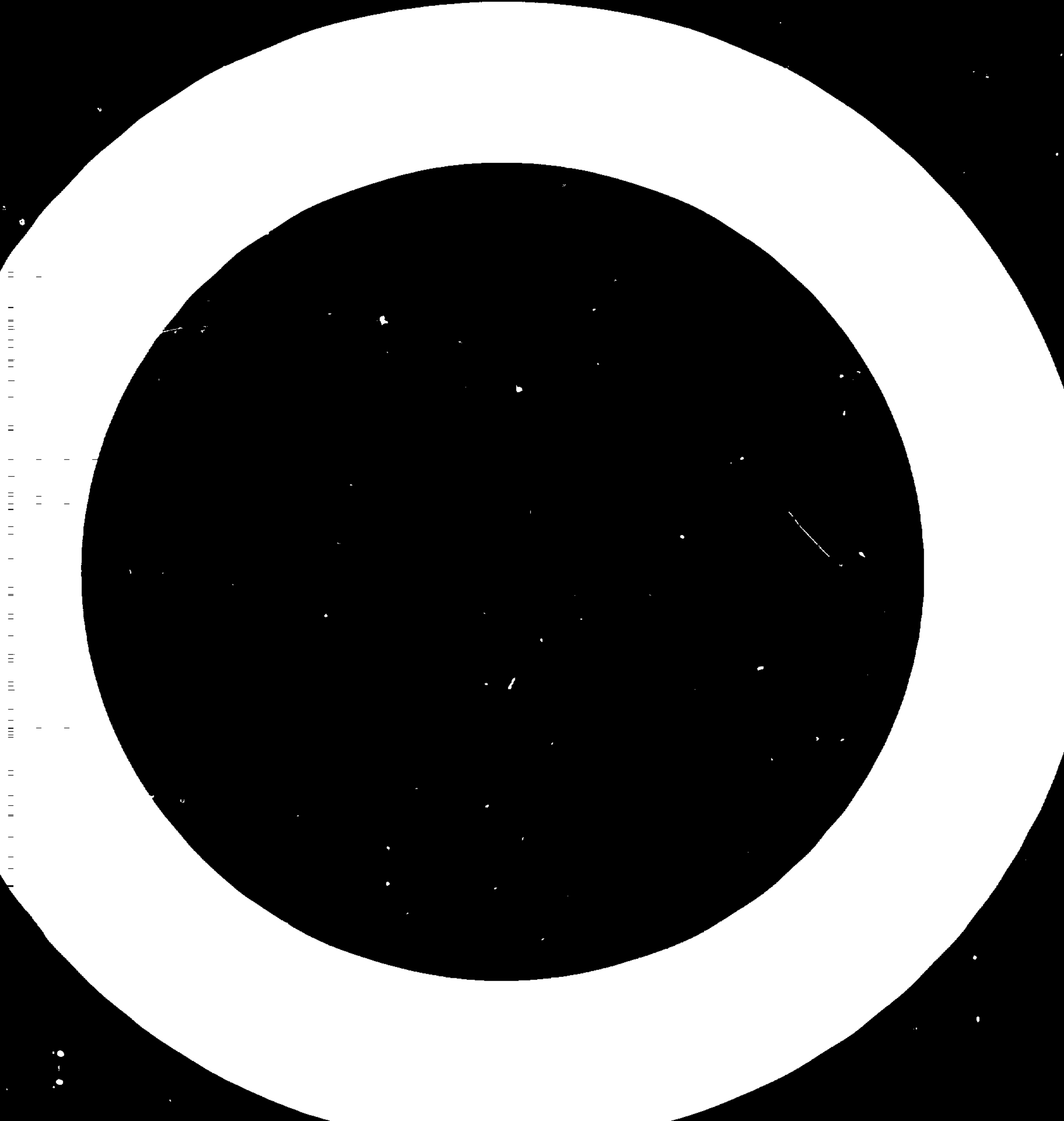
672	Ingots and other primary forms of iron or steel
673.3	Angles, shapes and sections and sheet piling of iron and steel
674	Universals, plates and sheets of iron and steel
676	Rails and railway track construction materials of iron and steel
678	Tubes, pipes and fittings of iron and steel
682.25	Tubes and pipes and hollow bars of copper
682.26	Tube and pipe fittings of copper
684.21	Bars, rods, angles, shapes and sections of wrought aluminium and wire
684.22	Plates, sheets and strip of wrought aluminium
684.25	Tubes, pipes and blanks, hollow bars of aluminium
684.26	Tube and pipe fittings of aluminium
691	Structures and parts of iron and steel, plates, strip, rods, angles, etc.
694	Nails, screws, nuts, bolts, rivets, etc. of iron, steel or copper

6. Equipment

723	Civil engineering/contractors' plant, equipment and parts
773	Equipment for distributing electricity
812	Sanitary, plumbing, heating and lighting fixtures and fittings

B. Factor intensity groups

1. Resource based products:	SITC 247, 248, 634, 635.3, 641.6, 682.25, 682.26, 684.21, 684.22, 684.25, 684.26
2. Labour-intensive products:	SITC 662, 691, 723, 813
3. Capital-intensive products:	SITC 533, 661, 664.4, 664.5, 664.6, 672, 673.3, 674, 676, 678, 694, 773



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QUESTIONNAIRE

The building materials industry in developing countries:
An analytical appraisal

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Table A.7. GDP, construction and building materials production, Mexico, 1970-1980

	1970	1975	1980	Average annual growth rate (per cent) 1970-75	1975-80
Population (in thousands)	50,695	60,145	71,911	3.5	3.6
GDP (millions of M.P.[a])	444,271	609,976	841,855	6.5	6.6
Construction (millions of M.P.[a])	23,530	32,792	46,379	6.9	7.2
Building materials production:					
Plywood (TCM)	96	110	254	2.8	18.2
Glass (TMT)	82	121	159	8.1	5.6
Building bricks of clay (MU)					
Quicklime (TMT)			4,354		
Cement (TMT)	7,267	11,200	16,398	9.0	7.9
Asbestos and cement articles (TMT)		303	423		6.9
Concrete blocks (TMT)					
Crude steel, ingots (TMT)	3,831	5,176	6,981	6.2	6.2
Angles, shapes, etc. (TMT)	387	554	679	7.4	4.2
Aluminium (TMT)	34	40	43	3.3	1.3
Nails, screws, etc. (TMT)					
GDP/capita (M.P.[a])	8,764	10,142	11,707	3.0	2.9
Construction/capita (M.P.[a])	464	545	645	3.3	3.4
Building materials production: (per thousand inhabitants)					
Plywood (CM)	1.9	1.8	3.5	-0.6	14.0
Glass (MT)	1.6	2.0	2.2	4.4	1.9
Building bricks (Units)					
Quicklime (MT)			60.6		
Cement (MT)	143.4	186.2	228.0	5.4	4.1
Asbestos and cement articles (MT)		5.1	5.9		3.1
Concrete blocks (MT)					
Crude steel, ingots (MT)	75.6	86.1	97.1	2.6	2.4
Angles, shapes, etc. (MT)	7.6	9.2	9.4	3.8	0.5
Aluminium (MT)	0.7	0.7	0.6	-	-2.2
Nails, screws, etc. (MT)					

a/ M.P. = Mexican Pesos at constant 1970 prices.

Abbreviations and sector ISIC codes:

Production in units as follows: CM - cubic meters, SM - square meters, MT - metric tones, TCM - thousand cubic meters, TSM - thousand square meters, MU - million units, TMT - thousand metric tons.

ISIC based codes: plywood-331116; glass-362001; building bricks-369101; quicklime-369201; cement-369204; asbestos and cement articles-369901; concrete blocks-369910; crude steel, ingots-371019; angles, etc.-371035; aluminium-372022; nails, etc.-381913.

Sources: United Nations, Statistical Yearbook 1981 (Population); United Nations, Yearbook of National Accounts 1981 (GDP, Construction); United Nations, Yearbook of Industrial Statistics 1979 and 1981 (Building materials production).