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INDONESIA: INDUSTRIAL TECHNOLOGY DEVELOPMENT FOR A COMPETITIVE EDGE

By Darius Mans, Senior Industrial Economist, EA3IP

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SUMMARY

INDONESIA: INDUSTRIAL TECHNOLOGY DEVELOPMENT FOR A COMPETITIVE EDGE

Darius Mans
Senior Industrial Economist, EA3IP

There is growing consensus in Indonesia that technology development is central to the nation's efforts to improve productivity, efficiency and competitiveness and to sustain the rapid growth of its industrial sector. However, there has been inadequate promotion and diffusion of best practice technologies to help Indonesian industry compete better internationally.

Now that the Government of Indonesia (GOI) has announced a major trade liberalization program to the year 2003, there is only limited time to begin to address the issue seriously.

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This report was prepared by Darius Mans (Task Manager), with contributions from Ramesh Mashelkar, Sanjaya Lall and Thee Kian Wie (Consultants). Francine Coscolluela was responsible for document processing. Deborah Davis was responsible for editing and Melissa Fossberg for the layout of the report.

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Abbreviations and Acronyms

APEC	Asia Pacific Economic Cooperation
BPPI	Agency for Industrial Research and Development, MOIT
BPPT	Agency for the Assessment and Application of Technology
FDI	Foreign Direct Investment
GATT	General Agreement on Tariffs and Trade
GOI	Government of Indonesia
GDP	Gross Domestic Product
HKPC	Hong Kong Productivity Center
HPEACs	High Performing East Asian Countries
ITD	Industrial Technology Development
ITDP	Industrial Technology Development Project
ITRI	Industrial Technology Research Institute (Taiwan, China)
KIM	National Institute of Metrology, LIPI
KTDC	Korea Technology Development Corporation
LIPI	Indonesian Institute of Sciences
MENRISTEK	State Ministry of Research and Technology
MOI	Ministry of Industry
MOIT	Ministry of Industry and Trade
MNCs	Multinational Corporations
MSTQ	Metrology, Standards, Testing and Quality
OEM	Original Equipment Manufacture
NIEs	Newly Industrialized Economies
PTSIs	Public Technology Support Institutions
PUSTAN	Center for Industrial Standards, MOIT
R&D	Research and Development
RD&E	Research, Design and Engineering
S&T	Science and Technology
SDF	Skills Development Fund
SMEs	Small and Medium Enterprises
TDC	Technology Development Center (Singapore)
TSGs	Technical Service Groups
VITB	Vocational and Industrial Training Board (Singapore)

Executive Summary

1. There is growing consensus in Indonesia that technology development is central to the nation's efforts to improve productivity, efficiency and competitiveness and to sustain the rapid growth of its industrial sector. However, there has been inadequate promotion and diffusion of best practice technologies to help Indonesian industry compete better internationally. Now that the Government of Indonesia (GOI) has announced a major trade liberalization program to the year 2003, there is only limited time to begin to address the issue seriously.

2. International experience shows that macroeconomic stability, procompetition economic policies and the development of human resources are the basic conditions required to promote industrial technology development. Although these are necessary conditions for industrial technology development, they are not sufficient to sustain it. It also is important to have policies that ensure access to foreign technology, foreign direct investment, financing for technology development, and technology support services.

3. This report identifies three priorities for technology development strategy:

- Maintain macro policies which encourage firms to make long-term investments in technology development;
- Continue economic deregulation so that firms will have to upgrade their technology to remain competitive;
- Upgrade the quality of human resources for technology development.

To improve the enabling conditions for industrial technology development, the major priorities are to:

- Improve Indonesia's access to foreign technology by expanding the role of foreign trade companies and buyers and improving technology licensing procedures and intellectual property protection;
- Make greater use of foreign direct investment as a tool for technology development;
- Strengthen the policy and institutional framework for financing technology development, and carefully target fiscal incentives for technology development;
- Reorient public technology support services toward effective diffusion of best practice technologies to industry and promote the private provision of those services.

Within this framework Indonesia should let the market play a greater role in developing technology intensive industries.

Basic Conditions

4. ***Macro Policies.*** Chapter 1 notes that stable fiscal, monetary and foreign exchange policies are essential to reduce the risks of investing in technology development, which often has a long gestation period. In this regard, Indonesia has a very good track record. Nevertheless, its real interest rates are high compared to those of other countries in the region. Prudent macroeconomic policies and financial sector improvements to reduce risk are essential to bringing down Indonesia's high domestic real

interest rates and increasing the availability of term finance.

5. ***Deregulation.*** Technological capabilities at the firm level are driven by the overall incentive framework. A competitive environment is a prerequisite for rapid adoption and diffusion of new technology, effective choice, and efficient use of technology. As noted in Chapter 2, the overall policy environment is far more important than any specific technology policies or other interventions to encourage firms to increase productivity and quality or to innovate. A key lesson from the experiences of the high-performing East Asian countries is that an outward-oriented and procompetition policy environment is critical for industrial technology development. In Indonesia, continued liberalization of external trade, as planned in the context of its APEC and GATT commitments, as well as policies to promote greater domestic competition, will drive firms to strengthen their technological capabilities.

6. Continued deregulation also could put more pressure on Indonesia's conglomerates to increase their contribution to technology development. This is surprisingly low, given their substantial human and financial resources. The dominant firms among them are insulated from competition and are almost completely concentrated on protected domestic markets. Trade liberalization and deregulation of domestic markets and distribution channels should encourage them to acquire the technological capabilities needed to move up the value added ladder and be more competitive internationally. Government should also encourage rivalry for any type of assistance it gives to firms and insist on demonstrated results.

7. ***Human Resources.*** A broadly skilled labor force, an effective technical training system, strong science and engineering faculties at universities, and good management training and development programs are key building blocks for sustained industrial technology development and for enabling a country to respond flexibly to rapid economic and technological change. Indonesia has made major strides in this regard by developing basic skills among its labor force, including a rapid rise in the stock of technicians, engineers and scientists. But despite substantial improvement in the quantity of education and training, the quality of that training, including management training, needs improvement .

8. Chapter 3 identifies the priority measures Indonesia needs to take to improve the quality of education and training for technology development, and to increase the utilization of its existing stock of scientific, technical, engineering and managerial talent. These priorities are to:

- raise the quality of primary and secondary education to provide the basis for subsequent training, and place greater emphasis on training technicians and craftsmen rather than scientists and engineers;
- facilitate the private provision of high quality pre-employment and in-service training, by establishing transparent licensing and accreditation of private training institutions, and developing systems for national skills standards and certification and for accreditation of all technical and vocational training schools;
- undertake more effective measures to foster employer-provided training, as noted in the World Bank's recent report on Training and the Labor Market in Indonesia (Report No. 14413-IND);
- improve industry's links with public technology support institutions and research universities, since that is where most of Indonesia's scarce scientific, technical and engineering talent is located;

- increase the utilization of returnees from overseas training fellowships through better human resource planning and staff deployment, and by making the bonding system more transparent;
- improve the quality of domestic university and graduate education, particularly in engineering and the natural sciences;
- strengthen formal management training programs and use foreign direct investment more effectively as a vehicle for training future generations of Indonesian managers.

ENABLING CONDITIONS

9. *Access to Foreign Technology.* Chapter 4 notes that the central issue of technology development in Indonesia is acquiring the capability to use technology developed abroad and adapting it to Indonesian conditions in order to produce more competitively. The purpose of technology development is not to acquire the capability to invent technology but to acquire and effectively utilize existing technology. This was the development strategy followed by Japan and other high-performing East Asian countries. In contrast, until the late 1980s, India pursued an inward-oriented approach to technology development through rigid controls on technology acquisition and high import barriers. This isolated many Indian enterprises from technological developments in the rest of the world, and as a result, they tended to lag behind international standards in terms of technology and efficiency.

10. Experience shows that technology development in the high-performing East Asian countries was stimulated by the discipline of having to meet export requirements. Based on low wage rates, firms initially built up basic production capabilities through simple assembly of mature products for export, often using technical assistance provided through foreign buyers. Successful firms took advantage of this learning period to develop some independent capability to undertake minor process improvements, enhancing productivity and product quality. This is the stage where many Indonesian firms are now. However, elsewhere in East Asia many leading firms were able to move on from that stage to become original equipment producers for multinationals based on their cost competitiveness and ability to consistently deliver products to precise specification. Gradually, firms in Japan (and, more recently, Korea) developed product design skills and significant capabilities to carry out research and development for products and processes in competition with Western multinationals.

11. While Indonesia's policies governing access to foreign technology have been relatively liberal, foreign trading companies should be encouraged to play a greater role as valuable sources of technical, design and marketing information to exporters. Foreign buyers, especially of more complex products sold as original equipment manufacture by large companies (e.g., electronics), could also become significant sources of technology transfer. While these linkages are forged at the firm level, government could more effectively promote them by allowing foreign investment in wholesale trade. Reduction of the high rates of effective protection on engineering products would also improve firms' access to technology. Improvements in technology licensing procedures and the administration of intellectual property rights are also needed.

12. *Use of Foreign Direct Investment.* Indonesia attracts substantial amounts of foreign direct investment. However, international comparisons indicate that it is not using that investment effectively for technological gain. Among the reasons are high required facilitation payments, costs of infrastructure services, inadequate and expensive factory

space, the lack of transparency and lengthiness of approval processes, and the past practice of forced marriages between foreign and local investors. These impediments need to be overcome if Indonesia is to extract more transfer of technology from foreign direct investment. Indonesia also will need to build up a skilled labor pool (para. 7) and take a more proactive approach to attracting the kind of foreign direct investment needed for effective technology transfer, as Singapore, Malaysia, Thailand and the Philippines have done. Development of supplier industries will be essential. In this regard, Indonesia should encourage development of backward linkages as have Singapore and Taiwan, China. Instead of relying on import barriers and local content requirements, they have emphasized provision of low-cost, user-driven technology, training and marketing support programs. These programs have been carried out in conjunction with direct support to local suppliers from multinational investors with significant purchasing needs who were willing to help reduce costs, shorten lead times, improve flexibility and reduce the need for capital investment.

13. ***The Availability of Finance for Technology.*** As noted in Chapter 5, another critical element for industrial technology development is the availability of financing. For technology-intensive industries, it is important that entrepreneurs do not lack financing as they attempt to move into competitive international markets. In this regard, Indonesia's efforts to improve the tax treatment of venture capital funds are noteworthy. The availability of term financing for investments in technology upgrading would be improved, however, by strengthening the appraisal capacity of the banking system. Approval from the technology service providers supported under the recent Industrial Technology Development Project (ITDP) should give banks the confidence to finance technology development projects of ITDP beneficiary firms.

14. Experience elsewhere is that traditional tax incentives to promote technology development, e.g., accelerated depreciation allowances and research and development tax credits, tend to benefit larger firms disproportionately. They rarely generate much additional research and development beyond that which those firms would undertake without such incentives. To improve the payoff from the fiscal resources available for industrial technology development, it would be better to use them to finance carefully targeted programs. For example, the technology matching grant program of ITDP, a program supported by the World Bank, helps small and medium-sized enterprises (SMEs) to adopt new technologies and improve productivity using existing technology.

15. ***Technology Support Services.*** Chapter 6 points out that effective technology support services are also needed to help firms improve their technological capabilities. These services include metrology, standards, testing and quality (MSTQ) support. This involves, among other things, dissemination of information on international standards and assistance to firms seeking ISO 9000 certification; industrial extension services to help firms improve productivity, quality, delivery times and product designs; and information services that keep firms up to date on best practice, globally competitive technologies. The major issues are how to make the existing technology support institutions more proactive, market driven and commercially oriented. In this respect, Indonesia's public technology support institutions are substantially behind those in competitor countries in the region. The private provision of technology support services in Indonesia is rare. In other Asian countries the use of publicly backed private firms is increasingly common.

16. GOI has recently adopted an Action Plan to improve the provision of technology support services. The Plan, to be supported by the World Bank, calls for four main actions:

- create incentives for technology support institutions to become more demand driven, commercially oriented, and self financing;
- reduce government controls to encourage these institutions to become more responsive to the technology needs of industrial firms, while also increasing their accountability for results;
- implement management reforms in the institutions to make them more efficient;
- encourage private provision of technology support services and competition among public and private technology service providers.

17. Greater accountability of the public technology institutions could be achieved by linking government funding to each institution's earnings from sale of technology, technology licensing, contract and joint research with industry, management consultancy, training and testing services. In other countries, the matching funds approach has resulted in more professional, market-responsive and outward-looking systems of R&D management within public laboratories. Incentives to commercialize research could also be enhanced by clarifying the rules under which laboratories can set up subsidiaries and take equity positions in companies that utilize the technologies they create. There may also be scope for further restructuring of the public technology support institutions by:

- merger and consolidation of institutions that serve similar client bases but report to different ministries;
- closing institutions that cannot function commercially;
- reorganization of labs along functional rather than sectoral lines to meet generic needs across industries, rather than trying to develop a full range of capabilities in particular subsectors;
- getting the private sector to play a central role in formulating the strategies and policies of the public technology support institutions through membership on their boards of directors and advisory councils and by bringing people with substantial industrial experience into their top management.

18. ***Developing Technology Intensive Industries.*** Chapter 6 also notes that the centerpiece of Indonesia's efforts to promote industrial technology development has been the acquisition of technological and manufacturing capabilities in state-owned strategic industries which have provided valuable international training opportunities and exposure for Indonesian scientists and engineers. The challenge now is to deploy those valuable industrial resources for maximum economic gain by clearly separating technology development objectives from manufacturing activities, and by putting the latter on a fully commercial basis. The provision of infant industry protection and monopoly status for those industries through trade and investment barriers and preferential treatment in government procurement should be phased out according to preannounced schedules to ensure their maturation. Labor mobility into and out of the strategic industries also needs to be encouraged to increase technological spillovers and the spinning off of new companies.

19. Large government investments in new R&D projects in the strategic industries should be strictly limited in the interest of maintaining fiscal balance. Experience elsewhere (e.g., Korea, India and Brazil) shows that concentrating government investment in heavy industries and advanced technologies leads to much less efficient growth, with high

capital output ratios and slow increases in consumption. Indonesia's scarce public resources could be used instead to help support low risk but potentially high payoff investments in restructuring and modernizing the rest of the country's technological infrastructure. This infrastructure has been relatively neglected and is in danger of not being able to meet the needs of private industry. Private investment, and foreign direct investment, in particular, should be used to develop technology-intensive industries, rather than using state-owned enterprises which require continuing government support and protection. As long as the government has laid the proper foundation by creating an environment conducive to innovation, ensuring that high-technology entrepreneurs do not lack financing, by improving the quality of human resources for industrial technology development, and by seeing to it that there is an effective infrastructure of technology support services, competitive markets should be allowed to decide which firms and industries will flourish or perish.

INDONESIA
DISCUSSION PAPER SERIES

Industrial Technology Development for Competitive Gain:

Introduction and Analytical Framework

By Darius Mans, Senior Industrial Economist, EA3IP

Developing the capability to effectively use technology and upgrade it over time is the basis of industrial technology development (ITD). This capability includes gaining the skills necessary for enterprises to set up a plant, run it efficiently, improve and expand it over time, and develop new products and processes. ITD is an integral part of the process of efficient industrial development.

Is ITD Important?

1.02 The effective use of technology is essential to maintaining and diversifying a country's industrial base in an increasingly competitive world market where technological change is constantly altering the basis of competition. The accelerating pace of technical change in industry is leading to shorter product life cycles. In addition, new technologies, such as electronics and communications, are changing the way the world does business in traditional as well as new industries.

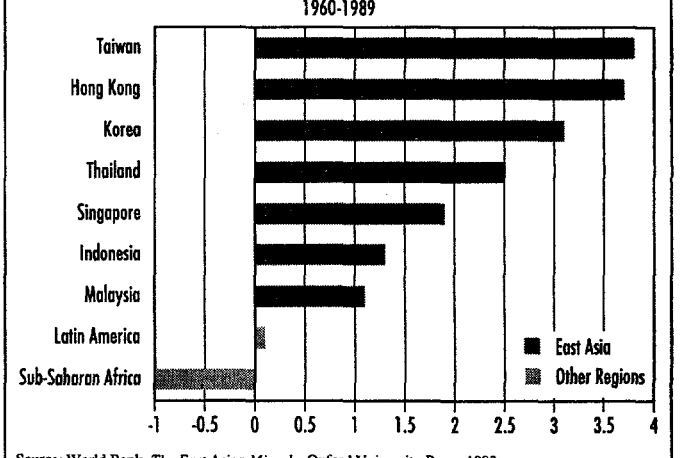
1.03 Factor cost advantages are being replaced by technology-related factors such as zero-defect product quality and international certification of firms' quality assurance systems (e.g., ISO 9000) in determining international competitiveness. Central to maintaining competitiveness is the ability of producers to respond quickly and effectively to changing demands in the international market, giving those with the best links to markets and the greatest flexibility the competitive advantage.

1.04 Technology upgrading has been a core element of the competitiveness strategy for all industrializing countries. In Indonesia, as well, improving firms' technological capabilities is an important element in the overall strategy to improve productivity and efficiency.

The Importance of ITD to Productivity: The Macro Evidence

1.05 The *East Asian Miracle Study* noted that total factor productivity (TFP) growth has been an important source of growth for many of the high-performing countries of East Asia and that technological capabilities have played an important role in TFP growth.[1] However, Indonesia's growth, like that of Malaysia and Singapore, has been driven mainly by investment, i.e., by the accumulation of physical and human capital, rather than by productivity, as it has been in South Korea, Hong Kong, and Taiwan, China. The growth of total factor productivity in Indonesia has been very low compared to other countries in East Asia (Figure 1.1).

Figure 1.1: TFP Growth in East Asia and Other Regions 1960-1989



Source: World Bank, *The East Asian Miracle*, Oxford University Press, 1993.

1.06 There was no statistically significant increase in Indonesia's TFP from 1979 to 1985. Nearly all growth during this period was due to the accumulation of physical and human capital. However, the series of deregulation packages introduced by the government beginning in 1985 have had a substantial impact on productivity. TFP growth increased by 1.95 percent per annum from 1986 to 1992 and accounted for over 30 percent of per capita economic growth during that period.[2]

1.07 Indonesia's ability to generate sustained TFP growth is important for three reasons. First, Indonesia's TFP growth rate is significantly below that of nearly all of its regional competitors. Second, the average annual rate of productivity growth in Indonesia is 1.2 percent below that of the high-income countries. This may be an indication that the already substantial gap between international best practice technologies and average practice in Indonesia may be rising, something which could affect its long-term industrial competitiveness.

1.08 Third, Indonesia's slow productivity growth is a matter of great concern because the natural resource sectors—oil, natural gas and forestry—cannot sustain rapid growth over the long term. Indonesia is likely to become a net oil importer in ten years. Soon after the year 2000, natural gas exports could drop sharply unless new discoveries are made. In the forestry sector current cutting rates exceed sustainable levels. Therefore, the manufacturing sector will need to continue its rapid expansion to keep Indonesia on a high growth path.

1.09 Continued rapid industrial growth will have to come from productivity gains. This is particularly important in light of increasing competition from other low-wage countries, since international capital will increasingly flow to countries with the best prospects and conditions for productivity gains. Industrialization based on low TFP growth proved possible at the early stages of Indonesia's industrial development. However, for Indonesia to sustain rapid industrial growth, it will need to bring traditional manufacturing activities up to modern levels of efficiency and to diversify sources of competitive advantage. This necessitates TFP growth.

THE IMPORTANCE OF TECHNOLOGY AT THE FIRM LEVEL

1.10 There is substantial evidence that technology plays an important role in determining efficiency and competitiveness at the firm level. For example, a recent World Bank survey of SMEs in Indonesia, Malaysia, Mexico, Colombia and Taiwan, China, shows strong statistical links between technology related factors and firm-level efficiency.

1.11 While there are Indonesian firms with technological capabilities at or very near world standards, these are the exceptions. As discussed in Chapter 2, the technological capabilities of most Indonesian manufacturing firms are extremely limited. This adversely affects the ability of the industrial sector to respond to the challenges, not only of increasing international competition from other low-wage countries, but also from trade liberalization within the context of GATT and APEC. Indonesia needs to address constraints on ITD as an important part of its overall strategy for sustaining rapid growth of manufactured exports and improving industrial competitiveness.

WHAT DRIVES ITD?

1.12 Macroeconomic stability, procompetition economic policies, and the development of human resources are necessary but not sufficient conditions for ITD. The enabling conditions for technology development must be created through policies that affect access to foreign technology, foreign direct investment, financing for technology development, and technology support services. Figure 1.2 illustrates the main strategic elements that influence industrial technology development. An integrated approach that addresses each of those elements is required to promote ITD successfully.[3]

THE BASIC CONDITIONS FOR ITD

1.13 ***The Overall Incentive Framework.*** Macroeconomic and procompetition policies provide the overall framework of incentives for firms to undertake the long-term planning and investment required to develop technological capabilities. Stable fiscal and monetary policies are essential to mitigate

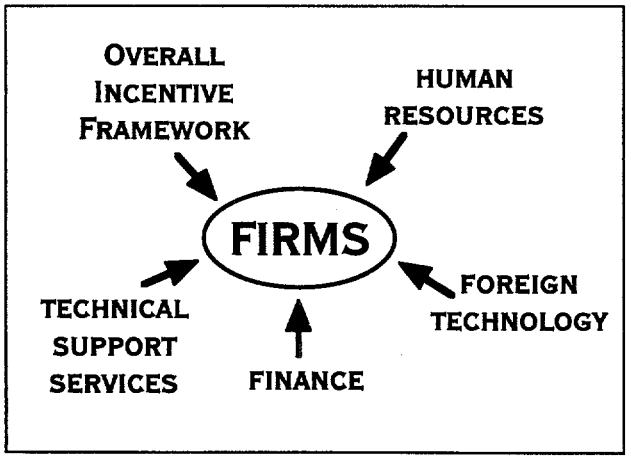
the risks of investing in technology development, which often has a long gestation period. In addition, as demonstrated by the experiences of the high-performing East Asian countries, a competitive environment is one of the prerequisites for technology upgrading. Competition is the fundamental force compelling firms to invest in technological development.[4]

1.14 ***Human Resources for ITD.*** Technological capability requires people, not just machinery. In the process of acquiring, using, improving and developing technology, a key input is the human resource base. This requires an education system that, at the primary and secondary levels, provides a good basic education, including solid training in technical and engineering-related areas, enabling workers to make local adaptations and improvements on the shop floor. At the university level, it is necessary to produce graduates who can monitor and assess technological trends and help develop a strategy for taking advantage of those trends. In addition, technically trained and qualified workers are needed at all levels to assimilate, adapt, and improve technology obtained from abroad, and to develop and manage new technology. Because of the rapidly changing nature of technology, ITD also requires on-the-job training to continuously upgrade worker skills.

THE ENABLING CONDITIONS FOR ITD

1.15 In addition to these basic conditions for ITD, there are important supply and demand issues that need to be explicitly addressed. On the demand side, technology upgrading often involves substantial costs and risks. Search, experimentation, and learning can be prolonged and expensive. Many East Asian governments have used technology policies to help firms move along the learning curve for adopting new technologies. They have also intervened to encourage positive technological externalities through spillovers to other firms. In addition, they have undertaken demonstration projects for firms which, for lack of information, may underestimate the value of and need for technology improvements. On the supply side, there is imperfect information about available technologies.

Figure 1.2: Technology Development: The Strategic Elements



1.16 In addition to pursuing policies aimed at macroeconomic stability, the promotion of competition and development of human resources, government technology policies, programs and institutions have played other important roles in the ITD process in East Asia. These roles include establishing policies to: promote access to foreign technology, attract foreign direct investment as a tool for technology development, make financing available for ITD, and provide effective technology support services.

COMPETITION HAS TO BE THE FUNDAMENTAL DRIVING FORCE COMPELLING FIRMS TO INVEST IN THEIR TECHNOLOGICAL DEVELOPMENT.

1.17 ***Access to foreign technology.*** Foreign technology can be acquired in many ways. These include formal arms-length transactions such as foreign direct investment (FDI), technology licensing agreements, import of capital goods, and foreign education and training. While these modes of technology transfer are important, much technology transfer takes place through less formal means, such as copying or reverse engineering and participating in world trade. In fact, positive technological externalities from a heavy orientation toward exports is one of the most important explanations for the high TFP increases of many of the high-performing East Asian economies (HPEACs) such as Korea and Taiwan, China.

1.18 Much technology development in the HPEACs has been export led. Based on low wage rates, firms built up basic production capabilities

through simple assembly of mature products for export, often with the technical assistance of foreign buyers. Successful firms used this assembly-based, learning period to develop their capacity to undertake minor process improvements, enhancing productivity and product quality. From there, many leading firms in East Asia were able to become original equipment manufacture (OEM) producers for multinationals based on their cost competitiveness and ability to consistently deliver products to precise specification. Gradually, they developed product design skills and later gained significant capabilities to carry out R&D for products and processes in competition with Western and Japanese multinationals. Table 1.1 shows the links between export marketing and ITD.[5] In effect, this process of export-led technology development, which has been essential in the HPEACs, turns on its head the traditional Western model of innovation, where the entry point is R&D leading to export success and the development of products which eventually become mature.

Table 1.1 Links Between Stages of Export Marketing and Industrial Technology Development

Marketing states	Technology stages
1. Passive importer - pull Cheap labour Dependent on buyers for distribution	Assembly skills, basic production assemblycapabilities Mature products
2. Active sales of capacity Quality and cost-based Foreign buyer dependent	Incremental process changes for quality and speed Reverse engineering of products
3. Advanced production sales Marketing dept. established Starts overseas marketing Markets own designs	Full production skills Process innovation Product design capability
4. Product marketing push Sells direct to retailers and distributors overseas Builds up product range Starts own-brand sales	Begins R&D for products and processes Product innovation capabilities
5. Own-brand push Markets directly to customers Independent distribution channels, direct advertising In-house market research	Competitive R&D capabilities R&D linked to market needs Advanced product/process innovation

Source: Hobday, *Innovation in East Asia* (1995)

1.19 ***Foreign Direct Investment.*** For many countries foreign direct investment (FDI) plays an important role in transferring management expertise and access to export markets, providing access to global information and technology networks. One of the most important determinants of successful technology upgrading and expansion of local technological capabilities in East Asia has been the ability to attract FDI and make effective use of it in promoting supplier industries and building up a pool of skilled labor and local managers, as well as entrepreneurs who later establish their own firms.

1.20 ***Financing.*** The ability to finance investments in technology development is also a crucial element of ITD. At low levels of industrialization, when firms use easy technologies with low capital requirements and limited possibilities for improvements, the absence of specialized technology finance may not be a major handicap. As industrial development proceeds, however, ITD takes the form of long-term and risky investments in new technologies. The local financial system is not usually geared to financing such investments, and only large firms that can cross-subsidize technological activity are able to undertake serious R&D. Capital market failures of this sort are recognized in both developed and developing countries, especially in the financing of smaller technology startups. Many of the newly industrialized economies (NIEs) have launched various schemes for financing technology activity, including establishment of funds for venture capital, innovation, SME upgrading and industrial restructuring. In addition, many countries have used an array of tax incentives to promote technology development, including accelerated depreciation, R&D, and other related tax credits.

1.21 *Technology Support Services.* To enable the effective use and diffusion of technological information, appropriate networks of support services must be developed to keep up with technology trends, both worldwide and locally, and help local firms use this information to improve competitiveness. One important part of that infrastructure is the system of metrology, standards, testing and quality control (MSTQ) which is essential to meeting increasing demands for quality products at the lowest cost in international markets. Technology extension services also can play an important role in helping SMEs reduce costs and delivery times and improve productivity, product quality, and product design and development. In the early stages of industrialization, such services are provided mainly by public technology support institutions. Later, private providers play an increasing role.

1.22 R&D institutions also important for ITD. However, their role changes over time. In most developing countries, these institutions can make an important contribution by supporting the acquisition, assimilation, adaptation and improvement of technology obtained primarily from abroad. Additionally, some R&D can be focused on special problems, such as the use of local raw materials or specific production problems and product characteristics of the local environment. It is only as the economy matures that more basic research is needed. For example, as its industrial sector developed, Korea required more advanced technology, but had difficulty acquiring it from abroad. The private sector then started to invest heavily in its own R&D, and, as a result, the publicly funded R&D institutes are now redefining their role and are moving into more basic, precommercial research.

1.23 The subsequent chapters review each of these elements of Indonesia's basic and enabling conditions for ITD. They draw on the experiences of other Asian countries to make recommendations for Indonesia's strategy for promoting industrial technology development.

ENDNOTES

[1] World Bank, *The East Asian Miracle*, Oxford University Press, 1993.

[2] World Bank, *Indonesia: Stability, Growth and Equity in Repelita VI*, Report No. 12857-IND, p. 25.

[3] A recent review of World Bank lending for Industrial Technology Development (Report No. 12138), carried out by the World Bank's Operations and Evaluation Department, highlighted the importance of such an integrated approach.

[4] This contrasts with early economic models in which economic monopolies were considered essential to technology development because monopoly profits could provide deep pockets to finance large R&D budgets.

[5] Michael Hobday, *Innovation in East Asia*, Edward Elgar, 1995, provides well-documented case studies of export-led technology development by successful latecomer electronics firms in Hong Kong, Singapore, Korea and Taiwan, China.

Using Deregulation to Drive Industrial Technology Development

A. OVERVIEW

2.01 Aimed at achieving macroeconomic stability, trade growth, and deregulation of the economy, Indonesia's economic policies have led to rapid industrialization and, in particular, to the rapid growth of industrial exports. These policies have also played a central role in promoting ITD by encouraging firms to improve productivity, product quality and product design. However, many firms' technological capabilities remain extremely limited, adversely affecting Indonesia's ability to remain competitive. Continued deregulation of external trade and domestic competition is essential to compel firms to upgrade their capabilities in order to improve productivity and competitiveness.

B. INDONESIA'S DEREGULATION PROGRAM

2.02 Since 1985/86, Indonesia's rapid economic growth has been led by annual increases of 10 percent in the manufacturing sector. Economic reform policies have played a major role in stimulating industrial growth. Maintaining macroeconomic stability through the judicious use of fiscal, monetary and exchange rate policies has been at the core of the reform program. Since 1986 the government has also introduced several deregulation packages to get rid of the restrictions put in place during the previous era of inward-oriented economic policies.

2.03 The deregulation process has focused on three broad areas: trade reform, investment deregulation and financial sector reform. In the trade regime there has been:

- a substantial reduction in the coverage of nontariff barriers in manufacturing production;
- a gradual lowering of tariff ceilings and the number of tariff rates, including a schedule announced in mid-1995 to reduce tariffs to an average level of 7 percent with a standard deviation of only 4 percent by 2003;
- reform of the customs administration by transferring customs surveillance for nearly all imports to a reputable private company;
- the provision of free trade status for exporters through the introduction of duty drawback schemes.

2.04 The second pillar of the reform program has been the progressive deregulation of the investment regime, including:

- replacing a highly complex investment licensing list, involving over 7,000 subsectors, with a short negative list and gradually reducing the number of activities on the negative list;
- simplifying investment approval procedures by reducing the number of requirements;
- providing incentives in the form of duty-free imports of machinery, equipment and inputs needed for initial production;
- encouraging FDI by providing foreign investors the same incentives as those accorded to domestic investors.

The deregulation packages of 1994/95 removed virtually all barriers to foreign investment and have made Indonesia, at least on paper, one of the most competitive FDI regimes in East Asia (Chapter 4).

2.05 Third, substantial reform measures have been undertaken in the financial sector, including:

- abolishing credit ceilings,
- eliminating interest rate controls,
- reducing subsidized directed credits,
- lowering entry barriers to permit entry of new banks,
- including joint ventures with foreign banks,
- introducing measures to develop capital markets.

C. The Impact of Deregulation

2.06. These measures have generated a strong response from the private sector, including a boom in private investment and rapid growth in output, nonoil exports, employment, and labor productivity. The manufacturing sector has led the recovery of overall GDP and helped wean the economy from its extreme dependence on oil. Growth in manufacturing averaged 12 percent a year from 1986 to 1994, increasing its share in GDP from less than 12 percent to over 20 percent, and almost tripling its absolute size from about $10 billion to $28 billion. In contrast to the period 1980-85, when a large proportion of growth originated from large capital-intensive activities, labor-intensive sectors contributed most of the growth after 1986. Growth in manufacturing employment and labor productivity averaged 7 percent a year, a rate almost double that of the rest of the economy. The manufacturing sector contributed about 30 percent of the growth in both nonoil GDP and total employment.

2.07 There has also been significant structural change in manufacturing which has become increasingly outward oriented since the mid 1980s. From 1985/86 to 1992/93, manufactured export growth averaged about 30 percent, doubling the sector export-to-output ratio to almost 20 percent. Exports contributed over 40 percent of manufacturing sector growth during the period, compared to only 13 percent during 1980-1985. The sector contributed about three-fourths of overall nonoil export growth, as the share of manufactured exports in total nonoil exports (and total exports) increased from 38 percent (12 percent) to 63 percent (about 50 percent) between 1985/86 and 1994/95. Continued strong manufactured export growth is also considered the key to Indonesia's economic performance during the current Sixth Five Year Development Plan, REPELITA VI, which covers the period 1994/95-1998/99. The Plan has programmed nonoil exports to increase by 17.8 percent a year in dollar terms, compared to 17.9 percent yearly growth realized during REPELITA V.

D. The Role of Overall Economic Policies in Technology Development

2.08 Indonesia's general economic policies have also heavily influenced the pace of industrial technology development. Indonesia's pro-export policies, in particular, have strengthened linkages of local firms with the world economy and have led to substantial technology upgrading. Indonesian manufacturers have found ways to improve their technological capabilities by meeting world market requirements for product quality, learning to manufacture to buyers' specifications and acting as subcontractors to foreign firms. In addition, import liberalization has also improved firms' access to foreign technology. In Indonesia, as in all of the high-performing economies of East Asia, expanding trade has resulted in improved technological performance.

2.09 Economic deregulation since 1986 has also led to rapid expansion of investment, including FDI. Indonesia's macroeconomic and political stability has provided a favorable environment for private sector investment in modernization of plants and equipment. In the late 1980s, private investment in new plants and equipment boomed; investment in real terms in 1990 was three times the level of ten years earlier. This private sector-led, dynamic process of acquiring technological capabilities by exploiting trade and investment linkages has been the principal driving force for technology upgrading. Today, there is hardly a firm that does not have a technology link abroad through FDI, technology licensing agreements, contacts with suppliers of equipment, or foreign buyers.

2.10 On the other hand, some of Indonesia's economic policies have adversely affected the pace of industrial technology development. Previous restrictions on domestic competition and trade protection policies stymied the development of industrial technology. For example, experimentation with local content rules in the automotive industry encouraged growth of the domestic industry but at the cost of low productivity, quality problems, high domestic prices and lack of competitiveness in the auto parts industry. The complex investment licensing process limited incentives for firms to innovate and increase

productivity. Now, greater domestic competition is being encouraged through progressive deregulation of the investment regime (para. 2.04).

2.11 On the trade side, the inward-looking protectionist policies in force from 1974 to 1984 encouraged firms to adopt excessively capital-intensive technologies and reduced the incentive for cost saving innovation. Until the trade reform packages of the mid 1990s, high average tariff and nontariff barriers shielded domestic industry from competition against imports, e.g., engineering products. High tariffs also limited competitive pressure on protected firms to use their equipment and facilities more efficiently and upgrade to international standards. However, the tariff cuts in 1995 (para. 2.03) will substantially increase import competition and will create strong incentives for firms to enhance their competitiveness and upgrade technology.

2.12 On balance, the current economic policy framework provides firms with relatively open access to foreign technology and encourages them to invest in technology upgrading. Consequently, some firms have developed substantial technological capabilities, including, for example, United Tractors and Asahimas Flat Glass.[1] But such firms are rare exceptions. The technological capabilities of most remain extremely limited.

2.13 This is apparent from the following review of firm-level technological capabilities in three key subsectors: textiles, a major industry in Indonesia but one under significant competitive pressure from other low-wage countries; electronics, one of the fastest growing industries in the country, but one that is starting from a low base and facing very sharp regional competition; and the engineering industry, which is still in its infancy.

TEXTILES AND GARMENTS

2.14 The Indonesian textile and garment industry has grown tremendously over the last few years due to policies encouraging exports. By 1994, the industry accounted for exports of $5.8 billion, about 34 percent of total manufactured exports. It is now the largest exporting industry in the country.

2.15 However, historically the industry has had a dual structure, with firms that supply only the domestic market coexisting with others that export most of their output. This dualism was encouraged by a trade system which provided access to tradable inputs at internationally competitive prices, while domestic market-oriented textile and garment producers enjoyed substantial effective protection. As a result, technological capabilities in the textile industry vary considerably. Many firms use older production methods and machinery, much of it imported secondhand in the 1970s and early 1980s, and are unable to meet the quality standards sought by foreign buyers and middle-income Indonesian consumers. They supply only the less quality-conscious portion of the domestic market. These firms, which have not invested substantially in modernizing their facilities, are under increasing competitive pressure from the export-oriented firms which are increasing their domestic sales because of increasing incomes of Indonesian consumers and heavy competition in export markets. The export-oriented firms have typically invested heavily in improving their manufacturing capabilities, often with the help of their overseas buyers and joint venture partners, in order to compete internationally. In many instances, they also have made substantial efforts to develop domestic suppliers of materials.

THE EXPORT-ORIENTED FIRMS IN THE INDUSTRY HAVE TYPICALLY INVESTED HEAVILY IN IMPROVING THEIR MANUFACTURING CAPABILITIES IN ORDER TO COMPETE INTERNATIONALLY . . .

2.16 There are three major technological weaknesses in the Indonesian textile industry that have to be addressed if it is to maintain its position against its fierce Asian competitors, China, India and Vietnam, all of which have abundant labor at lower wages, good labor productivity and plans to increase exports substantially. The first weakness is that exporters rely heavily on foreign buyers and joint venture partners for quality assessment, since there are no internationally recognized quality certification systems in place in Indonesia. This limits the capacity of exporters to quickly develop new foreign markets since buyers have to come out for site visits. Many customers prefer

to rely on the internationally recognized quality control certification which competitive countries offer.

2.17 Second, many export firms lack capability in product design and production systems that can respond quickly to meet changing market demands. While this was not a constraint only a few years ago, it is becoming increasingly important as Indonesian firms attempt to move upmarket. The lack of design capability limits their flexibility in coping with fashion trends, their capacity to work on a more equal basis with their customers, and their ability to move up the value added chain. By comparison, in the developed countries, and increasingly in some of the more competitive Asian countries, garment and textile firms have invested in computer-integrated manufacturing and quick response systems to ensure their ability to compete at the large volume and high end of the industry and to react quickly to changing fashion.

2.18 Third, the rapid growth of the industry has led to shortages of skilled technicians and managers. While there is a textiles R&D institute in Bandung that provides training, many firms find that before its graduates can work efficiently they require substantial additional training. There are also skill shortages in some key technical areas, including weaving and dyeing.

Electronics

2.19 In the last five years electronics has been Indonesia's fastest growing export. Exports were only $286 million in 1990, but reportedly reached $2 billion in 1995, equivalent to about 5 percent of total manufactured exports.[2] Although many electronics firms are joint ventures, these are primarily simple assembly operations. The industry lacks technological depth, and its major activity is relatively low value added assembly of consumer products, primarily for export. This reflects the limited range of components domestically manufactured in Indonesia, long lead times required to import parts and components, lack of support for product quality in the form of standards and technical support services, and limited design and development capability.

2.20 The component base is extremely weak for both passive as well as active components. Some simple passive components are manufactured locally but not in sufficient quality or quantity to meet domestic demand. A few joint ventures assemble some higher value added components, such as tuners, video heads and flyback transformers, and there is also some limited local capacity for the production of printed circuit boards, but not of the quality required for export. There is one integrated circuit manufacturer operating a plant that was established, but later sold, by National Semiconductor. However, its product and manufacturing technology is outdated and uncompetitive.

2.21 The development of technological capabilities in the electronics industry has been heavily influenced by government policy. For example, the deletion program of the 1970s, which required that a certain percentage of components be produced locally, discouraged final equipment makers from producing in Indonesia, thus limiting the demand for local components. Moreover, the component industry's output does not match the users' needs: Indonesia's component industry exports about 90 percent of its production, while the import share of purchased components is typically 80 percent in many product areas. Until the deregulation of the mid 1980s, substantial import protection in the form of tariff protection, as well as a range of quantitative restrictions to encourage localization, encouraged growth. In addition, substantial incentives were offered to attract foreign direct investment under that umbrella of protection. While the industry grew rapidly under these policies, foreign direct in electronics has been miniscule, in comparison to other Southeast Asian countries, and was primarily in assembly operations that supplied consumer electronics to the domestic market. In 1990, substantial reductions of tariff and nontariff protection were made. As a result, a dualistic structure emerged in which there appeared a number of export-oriented manufacturers that sell very little to the domestic market, and other producers that sell mainly to that market. However, both are primarily assembly operations.

2.22 Supplier linkages are also very weak. For example, the local procurement rate of multinationals operating in Indonesia's consumer electronics

subsector is reportedly only 30 percent. This is very low compared to other countries, especially considering the fact that materials and parts account for over 80 percent of the total manufacturing cost of consumer electronics. To the extent that subcontracting takes place, it is in relatively low-technology areas such as injection molding, printed circuit board manufacture, and some passive components where the prices offered by local suppliers are competitive. Despite competitive prices, however, a recent survey of buyer firms found many complaints about quality and the ability of local suppliers to deliver on time.[3]

2.23 With a few notable exceptions, product quality is one of the biggest problems in Indonesia's electronics industry. A few firms, particularly joint ventures and subcontractors to major international companies, have invested in total quality control systems. However, quality management, even for these firms, is not supported by an effective system of national standards and product certification. This has stifled development in an industry where product reliability and quality are essential elements of competitiveness. While some firms have a degree of in-house capability in production engineering, development and design capabilities in the industry are generally very weak. In addition, supplier companies require established industrial standards and the necessary calibration, inspection and certification facilities to qualify them to those standards. They also need support for materials testing, product development and technical training.

THE ENGINEERING INDUSTRIES

2.24 The engineering industries are a diversified subsector, comprising the manufacture of fabricated metal products, machinery and equipment. It is one of the oldest industries in Indonesia, dating back to the colonial period when Dutch entrepreneurs founded metalworking firms in Surabaya for ship repairs. Successive governments have undertaken measures to promote the industry, including trade protection and local content requirements, which have strongly influenced its technological development.

2.25 The engineering industry has enjoyed the highest rate of trade protection of any sector except food and beverages. In 1995, the effective rate of protection (ERP) for the engineering industry was 82 percent. The tariff reductions that were the centerpiece of the May 1995 deregulation package will reduce the ERP only to 61 percent by 2003, compared to a projected average of 7 percent for all manufacturing, excluding oil refining. However, investments that have received BPKM approval are already able to obtain imports of capital goods and associated inputs duty free, which has led to substantial *de facto* import competition. The industry's ability to respond to that competition has been limited because of protection granted to the government-owned steel industry which supplies its major inputs.

2.26 The automotive components subsector is an example of an industry where local content requirements have been used. Under the mandatory deletion program, which lasted from 1989 to 1993, automobile assemblers had to pay a 50 percent duty on the import of mandatory parts. Consequently, local producers set their price at a point just below the imported item's price to maximize profits and had little incentive to export, upgrade technology or look for ways to improve efficiency.

ANY ACTION PLAN TO STRENGTHEN THE ELECTRONICS INDUSTRY HAS TO INCLUDE A REDUCTION OF REMAINING INDUSTRY PROTECTION.

2.27 Due to these policies, engineering is one of the least internationally competitive of Indonesian industries, as evidenced by the low level of exports in the industry's total output (6 percent) and of engineering products in total industrial exports (5.8 percent). Engineering has also been a marginal supplier to the domestic capital goods, equipment and machinery markets, where demand continues to increase rapidly to support rapid overall industrial growth. However, these shares are not out of line with the high-performing East Asian countries when they were at comparable stages of industrial development.

2.28 In terms of technological capability, Indonesia's engineering industry has mastered a range of relatively simple and mature technologies; it can design simple products and equipment. Its enterprises show some strength in manufac-

turing technology, and, in addition, there are a number of areas of success where:

- imported technologies have been successfully assimilated,
- reverse engineering capabilities have been developed,
- product designs have been adapted to meet the needs of the domestic market,
- adequate training programs have been implemented.

Examples include technologically advanced weaving looms, plastic processing machinery, tea processing machinery, diesel generators, boilers, irrigation pumps and water treatment plants, steel pipes, tools and dies, and industrial fasteners.

2.29 However, Indonesia's overall economic policies have adversely affected development of the industry's technological capabilities. A recent study of the engineering industries[4] rated the subsector's technological capabilities in seven product categories, with each category broken down into discrete subcategories of output. These subcategories were rated strong, weak or absent, depending on the number of sources for each product, the range of models/variations available on the market, and overall strength of firms operating within that subcategory. The ratings summarized below (Table 2.1), show that only 11.4 percent of subcategories were strong, while 41.6 percent were weak and 47 percent were absent.

2.30 There are major gaps in the structure of products as well as the depth and integration of technologies and managerial capabilities. These lead to variable quality, low productivity, low local sourcing of parts and components and poor export performance. Technology upgrading in the industry is constrained by:

- a shortage of strong engineering and managerial skills;
- lack of information and technical support for small enterprises;
- underdeveloped subcontracting networks;
- the modest technological ambitions of larger enterprises, which could play a more important role as prime contractors, but do not because of highly effective protection.

Summary of Firm-Level Technological Capabilities

2.31 These subsector reviews reveal several broad patterns of ITD in the private sector. SMEs focused on the domestic market have limited capacity to upgrade their manufacturing capabilities, and poor quality and maintenance management. They also have poor design and development capabilities. However, a few have good process technologies imported from abroad, and some manufacturers have been able to adapt imported technology to local conditions. However, many of these firms have limited capability to select foreign technology. Export-oriented SMEs typically have much better quality control, but their product technologies are unsophisticated. They also have limited capability to upgrade their manufacturing methods and generally depend heavily on foreign designs.

2.32 Among the large private firms, capabilities for production engineering and product development are generally weak, since many of them have relied heavily on foreign suppliers of technology. Productivity growth among both large firms and SMEs has been lower that of their competitors in the newly in-

Table 2.1: Technological Capability Rating, Engineering Industries

Product Category	Total No. of Sub-Categories	Rating of Subcategories		
		Strong	Weak	Absent
Basic Processes	27	2	20	5
Basic Machine Elements	25	4	10	11
Industrial Components	34	2	12	20
Tooling	17	3	9	5
Machine Tools and Material Handling	10	1	3	6
Process Equipment	14	5	4	5
Electronic Components	22	0	4	18

dustrializing countries. Many large firms have difficulty conforming to international technology standards. Consequently, the technological basis for sustaining industrial growth is weak even though productivity improvement, which is heavily influenced by ITD, is becoming increasingly important to Indonesia's ability to sustain industrial growth (para 1.09).

2.33 Continued economic deregulation is needed to compel firms to improve productivity by investing in technology and adopting international best practice manufacturing methods. This will be essential if Indonesian industry is to improve its international competitiveness, diversify manufacturing exports, increase value added, and meet the targets of REPELITA VI and the Second Twenty-Five Year Long-Term Development Plan.

2.34 Deregulation also could help to maximize the role of conglomerates in ITD, which, given their substantial human and financial resources, should be leading role the development of Indonesia's technological capabilities. Although the private business sector in Indonesia is dominated by family- owned conglomerates, their contribution to Indonesia's technological development and to exports has been very limited compared to the role played by their counterparts in Korea. Excluding wood exports, the contribution of the top 50 groups to total manufacturing exports was only about 16 percent in 1992. The dominant groups are insulated from the forces of competition and are predominantly concentrated on protected domestic markets. Trade liberalization and deregulation of domestic markets and distribution channels should encourage greater export orientation of the conglomerates as well as acquisition of the technological capabilities needed to move up the value added ladder and be more competitive internationally.

ENDNOTES

[1] There also are a number of impressive examples of technological capability in the state sector; e.g., engineering capabilities at P.T. PAL, one of the government-owned strategic industries (Chapter 6); and the world-class process engineering and turnkey construction capability at Pusri, the state fertilizer manufacturer. However, their technological achievements have been driven more by government investment decisions and technology-oriented managers than by the incentive framework.

[2] This is still quite small compared to electronics exports of $13 and $8 billion from Malaysia and Thailand, respectively.

[3] Foreign Investment Advisory Services, "Indonesia, Backward Linkages: Impediments, and Opportunities," May 1995.

[4] SRI International, "Technology Development Plan for Indonesia's Engineering Industries," 1992.

Improving Human Resources for Technology Development

A. OVERVIEW

3.01 An educated and trained workforce is essential to a country's ability to respond flexibly to rapid economic and technological change, produce higher quality products, adopt and improve new production processes and technologies, and develop the skills to meet new demands. Over the last decade, Indonesia has made great strides in training and educating its labor force, including substantially increasing the number of scientists, engineers and technical workers. The quality of education and technical training will become even more important as Indonesian manufacturers switch to more complex products.

B. THE EAST ASIAN EXPERIENCE OF INVESTING IN HUMAN RESOURCES FOR TECHNOLOGY

3.02 All countries in the region have been acutely conscious of the need for high-level technical, engineering, and scientific skills to boost ITD. Korea, Singapore and Taiwan, China have invested most in the education of technicians, scientists, and engineers as part of their strategy to acquire technological capability. Their governments have been able to involve industry in setting university curricula and in the provision of technical training. In addition to understanding the importance of human capital to ITD and international competitiveness, those countries have also been flexible in adapting the educational structure to meet the demands of economic change. Some examples of human resource development strategies for ITD in those countries are given below.

TAIWAN, CHINA

3.03 Taiwan, China's early industrialization effort was helped by the initial high literacy rate of its labor force; employers could count on cheap and unskilled, yet literate and efficient, labor during the early phase of export-led growth. With the growing scarcity of unskilled workers and rising real wages in the late 1960s, compulsory primary education was extended from six to nine years. The government also placed an increased emphasis on vocational rather than academic training. Only 40 percent of Taiwan, China's high school students were in the vocational track in 1963, but by 1980 that figure had risen to almost 70 percent.

3.04. Taiwan, China's mix of public spending also shifted in favor of higher education, and within higher education, toward engineering and the natural sciences and away from the humanities and agriculture. The government intervened at the university level by providing financial support for new departments for industrial engineering, industrial design, and automatic controls. As a result, enrollment in graduate engineering and material science programs doubled to 40 percent of the total graduate enrollment from the mid 1960s and late 1980s. Government also made a major effort to encourage the return of college graduates who had gone abroad for postgraduate study.

SINGAPORE

3.05 Singapore has developed an extensive system for creating industrial skills. The higher education system is tightly regulated and directed by government to ensure high standards and relevance to emerging technological needs. It receives considerable financial support from the state. The elitist colonial educational system has been transformed into one that is merit based, vocationally oriented, and demand driven. Higher education has three levels: the public universities at the top, four polytechnics in the middle, and job-oriented training institutes at the bottom. These include centers set up by the government in collaboration with multinational corporations (MNCs), as well as a number of centers set up by statutory boards, professional bodies, and private institutions. As a result, Singapore is a regional leader in employee training programs held outside the workplace.

3.06 The Vocational and Industrial Training Board (VITB) has established an integrated training infrastructure. Since 1979, it has trained and

certified more than 112,000 individuals, about 9 percent of the existing workforce. Its Full-Time Institutional Training Program provides pre-employment skills training for school leavers. Its Continuing Skills Training Program offers workers part time skills courses and customized courses based on requests from companies and tailored specifically to their needs. Its Continuing Education Program provides part time classes for working adults, while the Training and Industry Program offers apprenticeships to school leavers and former national servicemen. The government has collaborated with MNCs to set up join specialized training centers and funds a large part of the salaries of employees while they are being trained.[1]

3.07 Under the Industry Based Training Program, employers, with VITB input, conduct training courses for their specific needs. VITB also provides testing and certification of its trainees and apprentices, as well as trade tests for public candidates. Using various grant schemes, the National Productivity Board's Skills Development Fund (SDF) created 405,621 training places in 1990. The SDF is responsible for various schemes to help SMEs finance their training needs and upgrade their operations. It has also introduced a Development Consultancy Scheme to provide grants to SMEs for short-term consultancy assignments for management, technical know how, business development and manpower training.[2] The Training Voucher Scheme supports employers in augmenting training resources. This enabled the SDF to reach more than 3,000 new companies in 1990, many of which had 50 or fewer employees. There is also a Training Leave Scheme which encourages companies to send employees for training during office hours.

KOREA

3.08 Korea has one of the highest levels of industry-relevant education of any developing country. Its secondary and tertiary level enrollment, 90 and 40 percent, respectively, is at developed country levels. Dropout rates are very low, and the system, based on international comparisons, is very good at imparting numeracy. It has impressive levels of vocational training enrollment and encourages significant in-firm training of employees. It has the highest relative university enrollments in science and technology of the Asian countries. For instance, it has more engineering students enrolled at the tertiary level than India, 347,600 compared to 201,300.

3.09. The government has promoted education of high level technical manpower by setting up institutions like the Korea Advanced Institute of Science and Technology (KAIST) at the postgraduate level, and the Korea Institute of Technology for undergraduates. These were aimed at exceptionally gifted students. KAIST had 6,652 graduates between 1975 and 1990. 832 were Ph.D.s, and the rest M.Sc.s. A foreign training program was administered by the Korea Science and Engineering Foundation.

3.10 Korea also has strongly encouraged in-firm training. The government levies a 5 percent payroll tax on large firms, refundable if they undertake employee training in approved programs. While such payroll taxes are found in many countries, they usually are around 1 percent. The exceptionally high Korean rate may have been a response to the country's urgent need for new skills as it moved into heavy and high technology industry. It may also have reflected the initial reluctance of firms to invest in employee training. Absent a tradition of lifetime employment, which allows Japanese firms to invest heavily in skill upgrading, employers feared being unable to get adequate return on their investments if their trained workers left for new jobs.

C. IMPROVING THE QUALITY OF INDONESIA'S HUMAN RESOURCES

3.11 Like all rapidly growing countries in East Asia, Indonesia has invested heavily in expanding education and training. As a result, it has made major advances in developing basic skills among its labor force. Whereas almost 70 percent of the labor force had no education at all, or an incomplete primary school education, in 1970, this proportion had fallen to 44 percent by 1990. The stock of technicians, scientists, and engineers has also grown rapidly because of increased enrollment in senior secondary, technical schools, and universities. The supply of science and engineering university graduates is relatively large and expanding. These constituted nearly one

third of all diploma and degree graduates in 1992. There were 14,000 engineering graduates alone, compared to 6,000 annually in Korea, Malaysia and Thailand. In some areas, however, enrollment rates still lag far behind those of other countries in the region. The net enrollment rate in junior secondary school in Indonesia is 47 percent, compared to 88, 75, 70 and 80 percent in South Korea, , Hong Kong, Singapore and Taiwan, China respectively. Nevertheless, the educational and skill levels of Indonesia's work force can be expected to rise rapidly as older employees retire and younger people who have benefited from the recent school and training programs take their place.

3.12 Despite the substantial quantitative improvements in education and vocational and technical training, there is concern in Indonesia about its quality. Tests show Indonesian primary and secondary students have less reading and math competency than their regional counterparts. The inferior quality of education is also indicated by low wage differentials between Indonesian workers with and without primary and junior secondary education. Poor school quality has also affected dropout and graduation rates. Secondary school enrollment has declined over the last five years, and each year 1.2 million children drop out of primary school. Employers complain that primary and secondary school graduates lack solid literacy and numeracy skills.

3.13 As noted in the World Bank's recent Training and Labor Market Study (Report No. 14413-IND), much Indonesian technical training is also of poor quality because of deficiencies in equipment and teaching materials, uneven teacher training, weak links with industry, and unresponsive administration. There are also substantial gaps in the training curriculum. For example, there are no courses available in skills, such as advanced welding, which are in great demand. Managers of SMEs complain that large firms snap up graduates of the better, often private, training schools, and those they are able to recruit are of highly variable quality. Executives in foreign firms say the weak skills base prevents them from transferring technology to local partners and subcontractors.[4]

3.14 Improving the quality of basic education is a major goal of Indonesia's Sixth Five Year Development Plan. Achieving this goal will, however, require better selection, training, and remuneration of teachers, particularly in math and science, as well as improved school materials. There is also a need for better student and school assessment systems. This is especially important since secondary education is increasingly being provided by private schools. Currently, private schools account for about 40 percent of junior secondary and over half of senior secondary education. Because of this, government needs an improved system for accreditation and licensing of educational institutions.

3.15 Indonesia's vocational training system also needs strengthening. As noted in the World Bank's recent report (see 3.13, above), one priority is to equalize public and private training through the use of clear accreditation criteria, effective licensing and training certification systems. While improving the quality of vocational training, these measures also would provide useful information both to employers and trainees. In addition, employers need to be more active in helping training institutions establish their programs.

DESPITE THE SUBSTANTIAL PROGRESS MADE IN IMPROVING THE *QUANTITY* OF EDUCATION AND TRAINING, THERE ARE SUBSTANTIAL CONCERNS IN INDONESIA ABOUT THE *QUALITY* OF BASIC EDUCATION AS WELL AS VOCATIONAL AND TECHNICAL TRAINING.

3.16 The experience of other countries, especially Singapore (para 3.05), shows that employer-based training could play a much more important role. Firms should be directly involved in worker training programs make them more responsive to their needs. This would require changing the current levy grant scheme to have the private sector undertake program management and to have the funds collected from payroll taxes kept in a dedicated account.[5]

3. 17 Utilization of scientific and engineering talent also needs improvement. Currently, almost 66 percent of Indonesia's limited number of advanced degree holders work primarily in govern-

ment. R&D laboratories, where they often are underutilized due to poor management, lack of research facilities, and scarcity of programs relevant to industry (see Chapter 6).

3.18 Another 30 percent of Indonesia's scientists and engineers with advanced degrees are employed in public higher education. University R&D activity is typically of low quality, and very little of it is of any technological use to industry. Low pay and limited career prospects cause university researchers to take second jobs, such as teaching in private universities, which do not help them keep abreast of developments in their fields. Indonesian university researchers also publish very little. The number of their articles in internationally recognized scientific journals each year is only a third that of Thailand's, less than 10 percent of Korea's, and only 2 percent of Taiwan, China's.

PRIVATE EMPLOYERS NEED TO PLAY A MORE ACTIVE ROLE AT THE INSTITUTIONAL LEVEL IN TRAINING POLICY MAKING AND IN HELPING TRAINING INSTITUTIONS ESTABLISH THEIR PROGRAMS.

3.19 Only about 6 percent of the country's R&D personnel with advanced degrees work in the industrial sector. With so few scientists and engineers working directly on industrial technological development, Indonesian industry's capacity for innovation is obviously small. However, with continuing economic deregulation and as firms strive to improve competitiveness and diversify exports, private sector demand for such employees should increase.

3.20 To stimulate that demand, GOI should subsidize scientists and engineers in R&D institutions and universities to provide technological services to industry. The experience should make the lab workers and academics more aware of and responsive to the needs of the private sector, keep their own research skills from atrophying, and make firms aware of their existence and capabilities. Government sponsorship of industrial research fellowships and sabbaticals in partnership with private business would enable researchers to spend time developing technological solutions for industry without risk to their academic careers. Experience in the high-performing East Asian countries shows that researchers in public institutions are an important reservoir of technological development talent for the private sector.

3.21 Policies regarding overseas fellowships need to be reexamined. The universities, the national R&D labs, and the civil service, especially BPPT, the Agency for Industrial Research and Development in the Ministry of Industry and Trade (MOIT), tend to monopolize overseas fellowships for upgrading of their researchers. A broader spectrum of Indonesia's scientific community should be represented in overseas fellowship programs. Moreover, returnees should be given assignments that take maximum advantage of the training they have received. Finally, and perhaps most importantly, more of them should be placed in the private sector. The current system of bonding returnees to government service should be made more transparent.

3.22 In addition to making better economic use of overseas fellowship training, the government needs to substantially upgrade the quality of domestic graduate education, particularly in engineering and science. This will require giving greater autonomy to universities, allocating public spending for them on the basis of their performance, encouraging greater private sector involvement, and, as Malaysia is now doing, allowing the private sector to offer graduate education.[6]

CONCLUSION

3.23 Indonesia needs to improve the quality of education and training, and to make better use of its existing stock of scientific, technical, and engineering talent. The priorities for developing human resources for ITD in Indonesia should be to:

- improve the quality of primary and secondary education in order to provide an appropriate basis for subsequent training, and to place greater emphasis on training of technicians and craftsmen (para. 3.14);
- facilitate private provision of high quality pre-employment and in-service training, including establishment of transparent licensing and accreditation of private training institutions, devel-

opment of systems for national skills standards and certification, and rigorous accreditation of all technical and vocational training schools (para 3.15);

- undertake measures to foster employer provided training, as noted in the World Bank's Training and the Labor Market Report (paras. 3.13 and 3.16);
- improve industry's links with public technology support institutions and research universities where most of Indonesia's scientists, technicians, and engineers talent are located (para 3.20);
- improve the use of returnees from overseas training fellowships through better human resource planning, staff deployment and mobility, and by making the bonding system more transparent (para 3.21);
- strengthen university and graduate education in science and engineering, including allowing the private sector to enter the field (para 3.22);
- strengthen formal management training programs and use foreign direct investment more effectively as a vehicle for training future generations of Indonesian managers.

ENDNOTES

[1] Soon, Teck-Wong and C. Suan Tan, *Singapore: Public Policy and Economic Development*, World Bank, 1993, background paper for *The East Asian Miracle.*

[2] Soon, Teck-Wong, "Singapore," in S. D. Meyanathan, *Industrial Structures and the Development of Small and Medium Enterprise Linkages: Examples from East Asia*, World Bank, Economic Development Institute, 1994.

[3] Agrawal, N., *Indonesia: Labor Market Policies and International Competitiveness*, Policy Research Working Paper No. 1515, 1995.

[4] See The, K. W. and M. Pangestu, *Technological Capabilities and Indonesia's Manufactured Exports*, Report for UNCTAD, 1994.

[5] See *Training and the Labor Market in Indonesia: Policies for Productivity Gains and Employment Growth*, World Bank Report No. 14413-IND.

[6] Malaysia's largest companies, including Telekom Malaysia Bhd. and Tenaga Nasional BHD, the largest power utility, have applied to have their training centers upgraded into accredited universities offering engineering and other technical or science-based courses.

SCIENTISTS AND ENGINEERS WORKING IN THE COUNTRY'S R&D INSTITUTIONS AND UNIVERSITIES SHOULD BE ENCOURAGED TO PROVIDE TECHNOLOGY SERVICES TO INDUSTRY TO MAKE THEM MORE RESPONSIVE TO THE NEEDS OF INDUSTRY.

Maximizing the Use of Foreign Technology

A. OVERVIEW

4.01 For developing countries, a key strategy is to take maximum advantage of available foreign technology. The East Asian countries have used various approaches to get foreign technology and foreign direct investment (FDI) in order to develop their technological capabilities. Each approach has its own important lessons for Indonesia.

B. INDONESIA'S APPROACH TO THE ACQUISITION OF FOREIGN TECHNOLOGY

4.02 Compared to many countries in the region, Indonesia has provided relatively open access to technology imports, including among its policies a relatively liberal regime for FDI. However, in many respects GOI's technology import policies are restrictive. As noted in Chapter 2, high rates of protection and nontariff barriers have been used to safeguard the domestic capital goods industry. Moreover, licensing of foreign technology has been hampered by weak enforcement of intellectual property laws.

4.03 Although Indonesia attracts substantial FDI, its impact on indigenous technological capabilities has been limited for several reasons. First, joint venture firms in industries which have been opened to FDI are shielded from competition. Second, until the recent liberalization, the negative list prohibited FDI in many important areas of the economy, including the Strategic Industries (para 6.61), which were, in effect, reserved for influential local private firms. Third, the past practice of matching foreign investors with preselected local partners minimized technological spillovers. The local partners were often more interested in quick returns with minimal effort than in long-term development of technological capabilities. Fourth, the imposition of equity restrictions on joint ventures in the form of requirements of equity dilution over time also discouraged foreign investors from transferring technology to local partners. These restrictions encouraged these partnerships to use outdated machinery and allow their technologies to become obsolete. Mandated equity transfers also resulted in one-time transfers of technology and skills, low value-added production, and limited export opportunity. Now that those policies have been abandoned, it is expected that FDI will play a more important role in ITD.

4.04 Indonesia's recent FDI package will be judged by its success in reducing bureaucratic red tape and delays involved in getting investment approvals, particularly approvals at the local level. Other priorities are development of the infrastructure (e.g., power, ports), required to attract FDI, facilitating trade by addressing the problem of slow turnaround at the ports and customs, reducing the cost of factory space, and also reducing facilitation payments.

4.05 The East Asian experience demonstrates that participation in foreign trade is the most significant source of information for technology upgrading (para 1.18). However, despite the shift from import-substitution policies to export promotion since the mid-1980s, Indonesia's trade policies still show a substantial anti-trade bias. For example, the rate of effective protection for import-competing products exceeds that for export-competing products.[1] Furthermore, Indonesia's export promotion/trade facilitation agencies (NAFED and ESB) are weak compared to the trade promotion offices of other countries in the region which work actively to strengthen links between producers and buyers.

C. THE EXPERIENCES OF OTHER EAST ASIAN COUNTRIES

4.06 The experiences of other East Asian countries with acquiring and using foreign technology vary substantially. Nevertheless, each country's experiences provide valuable lessons for Indonesia.

4.07 *Hong Kong:* Hong Kong's industrial and manufactured export growth began in earnest after establishment of the People's Republic of China (PRC) in 1949, when many Chinese technicians and entrepreneurs emigrated to the Crown Colony. They established dynamic SMEs specializing in labor- intensive manufacturing for world markets. The colony's strong base of *entrepot* trade and the presence of well-established, British-run

trading, finance, property, and other enterprises (the *Hongs*) provided the new SMEs with important financial and trading skills, market information and connections, and financial support. These enterprises obtained the relatively simple and quickly mastered technologies they needed in mainly externalized forms. Technological information needs were filled by international equipment suppliers and through growing contacts with export markets. Foreign buyers were also sources of technological information and assistance. The government helped technology imports indirectly through export promotion and productivity improvement measures. For example, the Hong Kong Trade Development Council provided information on markets and assisted foreign buyers in establishing contacts with local suppliers, while the Hong Kong Productivity Council assisted SMEs in importing and adopting new techniques. However, the colony's access to labor at relatively low wages and disinterest in heavy industry resulted in continuing specialization in unsophisticated labor-intensive products. Along with rising wage and land costs, this lack of technological depth has led to some significant deindustrialization.

MALAYSIA'S INITIAL SUCCESS WAS BASED ON TARGETING FIRMS THAT WERE RELOCATING LABOR-INTENSIVE ELECTRONICS ASSEMBLY ACTIVITIES AWAY FROM SINGAPORE.

4.08 The Hong Kong experience suggests that, where the skills, institutions and infrastructure are present, free market policies alone produce investment and competitiveness in low-technology industry. However, this does not necessarily lead to industrial or technological deepening. Where learning costs are high, and specialized skills and information are required, more direct government support may be needed after the first stage of industrial development has been achieved. Hong Kong now lags behind other Asian NIEs in high-technology areas such as electronics. Partly as a result of its hands-off industrial strategy, it has the lowest rate of manufacturing growth among the NIEs (around 2 percent in the 1990s), and its manufactured exports (excluding re-exports) have declined by 10 percent a year during the same period. The economy has continued growing by moving into services and relocating manufacturing facilities to lower-cost areas, especially mainland China. However, as far as technological deepening and diversification are concerned, Hong Kong's experience has not been impressive.

4.09 *Singapore:* Singapore has deepened its industrial structure far more than Hong Kong and has maintained high manufacturing growth rates. Like Hong Kong, it also started with good *entrepot* facilities, but unlike Hong Kong, it had a relatively weak entrepreneurial base and did not benefit from an influx of experienced businessmen and technologists. After an early experiment with import substitution, it switched to free trade and aggressively sought FDI. The strategy of attracting FDI, at a time when most other developing economies were shunning it, was so successful that rapidly rising wages reduced Singapore's attractiveness to the multinationals. In response, the government revised its strategy for attracting foreign companies by investing heavily in its ports, air facilities and telecommunications, the physical infrastructure required to facilitate exports, and in raising labor force productivity. It also has used a variety of interventions to guide investors into preferred activities (Box 4.1). At one time, it experimented with deliberately raising wages to force MNCs to upgrade their technology. This policy was dropped when industrial growth slowed. More recently, the government has invested in R&D centers, hoping to stimulate foreign interest and participation.

4.10 Other NICs, especially neighboring Malaysia, which has been very successful in attracting high-technology MNCs into manufacturing, have copied Singapore's strategy. Like Singapore's, Malaysia's economic growth has depended on MNC-supplied technology. Malaysia's initial success was based on targeting firms that were relocating labor-intensive electronics assembly activities away from Singapore. By offering low wages, good infrastructure, literate and trainable labor, a stable macroeconomy, efficient pro-private sector policies, as well as generous incentives for export-oriented activity, it was able to preempt other developing countries in the electronics

Box 4.1: Singapore's FDI Strategy

Basically, MNCs made the decisions about what new technologies to bring into Singapore, with the Singapore government responding (or anticipating through proactive planning and consultation) by providing the necessary skilled manpower in consultation with the MNCs. In many instances, it is the *speed and flexibility* of government response that gave Singapore the competitive edge compared with other competing host countries. In particular, the boom in investment in offshore production by MNCs in the electronics industry in the 1970s and the early 1980s created a major opportunity by ensuring that all the enabling supporting industries, transport and communication infrastructure, as well as the relevant skill development programs, were available to attract these industries to Singapore. This concentration of resources helped Singapore to achieve significant *agglomeration economies* and hence first-mover advantages got many electronics related industries. An example is the disk-drive industry, where all the major US disk-drive makers have located their assembly plants in Singapore. These industries demanded not only electronics components and PCB assembly support, but also various precision engineering-related supporting industries such as tool and die, plastic injection molding, electroplating and others. These supporting industries were actively promoted by the government as part of a "clustering" approach to ensure the competitiveness of the downstream industries.

As labor and land costs rose, the Singapore government used the opportunity to encourage MNCs to reconfigure their operations on a regional basis, making Singapore their regional administrative headquarters and/or regional marketing/distribution/service/R&D centers to support manufacturing and sales operation in the ASEAN and Asia-Pacific region. To promote such reconfiguration, new incentives such as the regional headquarters (RHQ) scheme, international procurement office (IPO) scheme, international logistics center (ILC) scheme and the approved trader (AIT) scheme were introduced.[2]

assembly boom of the early 1970s. Once established in Malaysia, MNCs responded to rising wages by increasing automation and process upgrading rather than by relocating. Having achieved almost full employment, Malaysia is now adopting Singapore-style policies to induce MNCs to upgrade further by undertaking local design and development and by deepening local supply linkages.

4.11 *Taiwan, China.*[2] In the 1960s, Taiwan, China had a strong base of human capital and a large number of dynamic SMEs. This gave it a unique opportunity for ITD in skill-based activities. The government sought to offset the lack of large private firms or groups by setting up public enterprises in heavy industry, combining interventions in technology transfer with infant industry protection. In the 1950s, it pursued liberal FDI policies, with no discrimination by origin, activity (except for services), or degree of ownership. Over time, however, the regime became more discriminatory, using case-by-case approvals to ensure that technology imports were in line with national priorities. Where domestic firms were strong, FDI was actively discouraged; where they were weak, foreign firms were allowed to invest but required to share their technology with their local partners. In the 1960s, the government encouraged labor-intensive industries such as textiles, garments and electronics assembly. It established facilities for export-oriented activities in special enterprise promotion zones. In the 1970s, it sought out high- technology investors, discouraging labor-intensive FDI and favoring automation, informatics, and precision instruments. This policy was strengthened in the 1980s with the establishment of a science park at Hsinchu to attract technology-intensive activities.

4.12 The government maximized technological spillovers from FDI to local firms by promoting local sourcing and subcontracting. This was done by setting local content rules, insisting that foreign firms transfer skills and technology to subcontractors, and raising the technological capabilities of local firms. The Singer case is a good example of how the subcontracting policy was applied (Box 4.2). The local content policy produced significant technology upgrading among local SMEs. These, unlike their counterparts in Japan (where long-term, stable relations with a few large buyers were the norm), competed aggressively for orders, switching customers, seeking out foreign joint-venture partners and soliciting government assistance to modernize their technologies.

4.13 Government played a direct role in attracting advanced technologies by entering into joint ventures with technological leaders. For instance, Taiwan, China lagged behind Korea in semiconductor production, and local private firms were too small to set up the necessary capital-intensive

facilities. In the late 1970s, the government set up the Electronic Research and Service Organization (ERSO) to import and develop process technologies for very large integrated circuits. A decade later, it set up a joint venture for wafer fabrication, the Taiwan Semiconductor Manufacturing Company (TSMC), with Philips of the Netherlands and local private participants. The government also orchestrated the design and manufacturing activities of numerous small electronics firms. Once TSMC was established, local private companies started producing semiconductors, microprocessors and related products.

4.14 Foreign firms accounted for only a small part of Taiwan, China's industrial and export success. Local enterprises, predominantly SMEs, led the export drive, first by using the Chinese connection in Asia and then, as their horizons widened, by tapping Japanese trading companies and American mass market buyers. In the 1960s, about 60 percent of textile exports were sold through Japanese *sogo shosha*, and even today these companies handle a third to half of Taiwanese exports. With the government facilitating their contacts with small suppliers, US buyers later grew more important. In addition, large numbers of relatively small local trading houses emerged. They proved to be valuable sources of technical, design, and marketing information to Taiwanese exporters. Large foreign buyers, especially of more complex products such as electronics, sold as original equipment manufacture (OEM) by large manufacturers, were even more significant sources of technology transfer.

4.15 In addition, the government set up support systems to promote exports and ITD. The China External Trade Development Council, which provided technical assistance to exporters after 1970, was funded by an 0.625 percent levy on exports. By 1989, the organization had 700 staff and 28 branch offices overseas. Its computerized data banks on foreign markets, buyers and suppliers provided the country with a one-stop export information center, and its Industrial Design and Promotion Department helped exporters develop designs and packaging for foreign markets.

4.16 Another important source of technology for Taiwan, China was the ethnic Chinese population of North America, which provided investment capital and advanced technical skills. In recent years, Taiwanese companies have acquired technology through investment in developed countries, where they establish strategic alliances with leading high-technology firms. The Bank of Communications has actively

Box 4.2: Local Content Provisions and Singer in Taiwan

When the Singer Sewing Machine Company started operations in Taiwan in 1964, there were several small sewing machine manufacturers in the country, with poor technology and no standardization, unable to compete in world markets. The government stipulated that Singer procure 83 percent of parts and components locally within 1 year, provide local suppliers with standardized blueprints, provide technical experts to improve productivity, prepare materials specifications and inspect final products. Singer was to provide local sewing machine producers with its own locally made parts at no more than 15 percent above the price of parts imported from Singer's foreign parts. The company was also required to raise exports rapidly.

The company fulfilled all these requirements, sending several technical and management experts to Taiwan to train and upgrade local suppliers and organize the entire production system. It provided a wide range of technical assistance to competing local sewing machine manufacturers free of charge. Suppliers were given standardized blueprints, enabling them to work to common specifications; they were also given measuring instruments and access to Singer's tool room and technical advice. Classes were conducted for parts suppliers in technical and management problems.

The result of the forced local content policy was a significant transfer of technology, increase in backward linkages and upgrading of competitive capabilities for the industry as a whole. Within three years Singer was using only local parts (except for some needles) and by 1986 was exporting 86 percent of its total output. Other local firms also became major exporters, as local parts became standardized and improved in quality. One reason for this striking success was that relatively little capital investment was entailed. The existing base of technological capabilities in the local suppliers made the transfer and upgrading of technology relatively rapid and low-cost. This pattern was repeated in several industries over the years.

Source: Dahlman and Sananikone, 1990.

facilitated this sort of overseas investment. However, some Taiwanese firms have failed in their attempts to start own-brand production overseas, forcing a retreat to OEM manufacture.

4.17 *Korea:* When Korea switched from import substitution to export orientation in the early 1960s, it started by encouraging exports of labor-intensive products, where it had an existing competitive advantage. Moreover, it maintained a strong import-substituting sector, especially in such heavy industries as chemicals and petrochemicals, and later, engineering, metals, electronics and transport equipment. The government provided these industries with import protection and subsidized credit, as well as other forms of support. Especially favored were a few firms that showed particular aptitude as exporters. These became the conglomerate *chaebol* that led Korea's entry into world markets for complex, high-technology products and later became major multinationals in their own right. Firms qualified for official favors by their competitive performance in government contests. Korea was thus able to contain the distortions generally created by such selective policies.[3]

4.18 Korea tended to eschew FDI as a means of obtaining technology, relying instead on imports of capital goods, licensing, and technology transfer agreements. It encouraged reverse engineering (i.e., copying), adaptation, and R&D by importing firms to develop indigenous technological capabilities. Consequently, many of its larger firms were later able to enter into collaborative ventures on an equal basis with world technology leaders. Korea used FDI when it was the only way to obtain a particular technology or to gain access to world markets; even then, the government encouraged majority Korean-owned or equal joint ventures.[4] In recent years, Korea has liberalized its foreign investment laws, but it still remains a relatively small recipient of FDI.

4.19 In the field of plant and process engineering, the government stipulated that foreign contractors transfer their design knowledge to local firms, which quickly absorbed the technologies. The government also intervened successfully in technology licensing negotiations to lower prices and to strengthen the position of local buyers. The *chaebol* soon developed sufficient international presence and the expertise to manage their technology imports independently, but the SME sector still gets government help in buying technologies overseas. Korea compiled a database on technology sources and prices that was linked to similar databases overseas and provided online in major industrial centers. There was also a government program to increase SMEs' technological linkages with the *chaebol.*

4.20 As elsewhere, foreign buyers were a valuable source of technology.[5] The Korean Overseas Trade Agency provided contacts and market intelligence and brought foreign buyers and Korean suppliers together. The *chaebol* themselves were instrumental in promoting exports by other firms, via their trading companies modeled on the Japanese *sogo shosha.* They had the financial and marketing strength to allow Korea to establish its own brand names in international markets.

KOREA ENCOURAGED REVERSE ENGINEERING (I.E., COPYING), ADAPTATION AND R&D BY IMPORTING FIRMS TO BUILD UPON TECHNOLOGY IMPORTS TO DEVELOP INDIGENOUS TECHNOLOGICAL CAPABILITIES.

4.21 *The People's Republic of China:* The PRC has turned to the West for advanced technology and know-how. The government sees technology transfer as the best way to achieve economic modernization and has embarked on a massive program for acquiring technology from abroad through a variety of channels, including direct foreign investment, technology imports, licensing and study abroad. While China has attracted substantial FDI, which has made a significant contribution to the country's economic development, it has not yet led to the transfer of high technology envisaged by the Chinese leadership. The bulk of FDI has come from Hong Kong and Taiwan, China and remains concentrated in simple, labor-intensive assembly or packaging operations for export markets, often using second-hand equipment. FDI in more technology-intensive industries has been relatively limited, owing to:

- investors' concerns about China's long-term political future and macroeconomic situation;

- uncertainty concerning the supply of local raw materials and inputs;
- weak enforcement of intellectual property right laws;
- shortage of skilled technical workers;
- inefficient infrastructure.

4.22 Another feature of China's policy has been encouragement of technology imports through tax exemptions applied to technology license fees, technology services, consulting contracts, software, or import of technology equipment. More recently, China has ceased relying on technology imports as its primary form of technology acquisition. Today, FDI is complemented by a comprehensive program of technology diffusion and assimilation and upgrading of the national science and technology system (Chapter 6).

D. LESSONS FROM CROSS-COUNTRY EXPERIENCE

4.23 These countries' experiences with gaining access to foreign technology provide valuable lessons for Indonesia. The successful countries of East Asia have all, through a variety of strategies, been able to import foreign technology and adapt it to local circumstances to improve their industrial productivity and competitiveness in international markets.

4.24 FDI can be an important conduit for skill and technology acquisition. Although the extent to which it has been permitted varies from one country to another, some, most notably Taiwan, China, have used explicit policies aimed at maximizing technological spillovers from FDI. Nevertheless, even though policies such as local content rules played an important role in developing local capabilities early on, in all these countries there was a critical mass of SME entrepreneurship and technical skills that allowed them to take advantage of opportunities. In Indonesia, which lacks that critical mass, protectionist policies have retarded the development of competitive industries. Under the circumstances, Indonesia would benefit more from using a market-based approach, rather than by encouraging the development of backward linkages, as was done in several other countries in the region (e.g., Singapore and Taiwan, China). Instead of relying on import barriers and local content requirements, their governments have emphasized the provision of low-cost, user-driven technology, worker training and marketing support programs. These programs have been carried out in conjunction with direct firm-to-firm support given to local suppliers by multinational investors who were willing to help reduce costs, shorten lead times, improve flexibility, and reduce the need for capital investment.

4.25 As noted in Chapter 1, for many countries in the region, export market development, particularly through relationships with international trading houses, licensing, subcontracting or original equipment manufacture arrangements, has been central to development of their technological capabilities. Consequently, Indonesia's participation in export markets through all these channels will continue to be important for its technological growth. In this regard, recently announced reforms to permit the establishment of 100 percent foreign-owned trading houses are welcome. In addition, restructuring of Indonesia's trade promotion agencies is in order. The experience of the successful East Asian exporters shows that such agencies must be well managed, autonomous, amply funded, and have excellent information systems and communications networks. In Indonesia, that means that NAFED and ESB should be replaced with an autonomous trade promotion institution capable of providing timely trade and market information and carrying out effective trade promotion activities. In addition, that institution should selectively offer firm-level upgrading services and have an independent source of funding.

4.26 Restrictions on capital goods imports, a form of disembodied technology, have been used by a number of countries to encourage import substitution. However, such restrictions were imposed within an overall policy of export-led growth. This has not been the case in Indonesia, where substantial tariff and nontariff protection against capital goods imports served only to make domestic industry insular and uncompetitive. Reduction of trade protection on capital goods is essential to modernization of industry.

4.27 There should be more use of FDI for technology transfer and for training Indonesian workers and managers. In this regard, impediments to higher-quality FDI need to be overcome by introducing greater transparency, reducing the time it takes for investment approvals, reducing facilitation payments, and making the cost of infrastructure services and industrial real estate more competitive. Benchmark studies show that facilitation payments, space costs and permit processing times are significantly higher in Indonesia than in competitor countries.[7] The government has to shift from a passive stance to a pro-active strategy of soliciting investments for building technological capability. It also has to work harder at providing an attractive business environment.

ENDNOTES

[1] In 1994 the antitrade bias coefficient, defined as ((1 + ERP Import-competing)/(1 + ERP export-competing) - 1), was 20, i.e.; import competing industries could be 20 percent less efficient than export industries (compared to international prices). Even after the announced trade reforms it will fall only to about 17 by 2003.

[2] Wong, P. K., "Singapore's Technology Strategy," in D. F. Simon (ed.), *The Emerging Technological Trajectory of the Pacific Rim*, New York: East Gate, 1995.

[3] Dahlman, Carl J. and Ousa Sananikone, "Technology Strategy in the Economy of Taiwan: Exploiting Foreign Linkages and Investing in Local Capability," World Bank, 1990 (draft).

[4] World Bank, *East Asia Miracle Study*, Oxford, Oxford University Press, 1993.

[5] Westphal, L. E., "Industrial Policy in an Export-Propelled Economy: Lessons from South Korea's Experience," *Journal of Economic Perspectives*, 1990; and Kim, L., "National System of Industrial Innovation: Dynamics of Capability Building in Korea," in R. Nelson (ed.), *National Innovation Systems: A Comparative Analysis*, Oxford: Oxford University Press, 1993.

[6] Apart from general measures such as devaluation and general tax incentives, there were discretionary measures such as access to restricted imports and direct cash subsidies, subsidized credit, and information support. The state-controlled banking system channeled funds into export support, and export performance increasingly became the criterion for creditworthiness. These incentives were backed by powerful direct pressures, such as regular meetings between business leaders and government, and export targeting at the industry and firm levels (backed by linking tax auditing and imported inputs and technologies to export performance). The export drive also received considerable support from trading and producing conglomerates, assistance to testing and quality assurance services, export market information, design assistance, and so on. Overt subsidies declined over the 1980s, but institutional support and the indirect influence of the government has continued strongly.

[7] The most recent study on the electronics industry is McKenzie and Company, "Study for Improving Competitiveness and Export Potential of the Indonesian Electronics Industry," World Bank, 1996.

Financing Technological Activity

5.01 Many of Indonesia's competitors have used fiscal incentives and established specialized financing instruments and institutions to encourage technology upgrading, development and R&D among industrial firms. Indonesia has also done this and plans to do much more. There may be some merit in providing SMEs with incentives to invest in technology development. However, at this stage, when Indonesia's private sector invests very little in industrial technology development, such efforts should be very selective and carefully limited in scope and cost.

THE EAST ASIAN EXPERIENCE

5.02 All of the high-performing East Asian countries have used fiscal and financial mechanisms to promote technology development. These mechanisms include technical assistance to firms for technology upgrading, lines of credit for equipment modernization, direct financing and indirect support through the tax system for firm-level research and development, and the commercialization of the results of R&D.

5.03 Levels of private sector investment in ITD, and the interventions used to promote them, vary greatly in East Asia. Korea has been the most successful of the Asian NIEs in stimulating R&D, and, as a proportion of GDP, the level of its R&D financed by industry (1.7 percent of GDP) is now higher than all other developing countries. Indeed, it is higher than that of most OECD countries. Taiwan, China comes next (0.8 percent), but because of its SME-dominated structure over half of total R&D is performed by the government. Singapore's comparable figure is 0.6 percent, with government spending accounting for 40 percent of total R&D. The new NIEs have much lower R&D propensities, with industry financed R&D reaching only 0.17 percent in Malaysia, 0.04 percent in Indonesia, and 0.03 percent in Thailand.

KOREA

5.04 In Korea, the government encouraged private R&D by making available various incentives and other forms of assistance. Incentive schemes included tax-exempt Technology Development Reserve funds; tax credits for R&D, both for upgrading human capital related to research and for setting up industry research institutes; accelerated depreciation for investments in R&D facilities; and tax deductions for part of the SMEs' investments in laboratory and inspection equipment and for all of their technical consulting expenses. The government also granted a tax exemption for 10 percent of the cost of relevant equipment, reduced import duties for imported research equipment, and lowered the excise tax on technology-intensive products. The Korea Technology Advancement Corporation helped firms commercialize research results. A 6 percent tax credit, or special accelerated depreciation, provided further incentives. Technology imports were promoted by making the cost of patent purchases and other technology import fees tax deductible. Income from technology consulting was tax free, and foreign engineers were exempted from income tax. The government also gave long-term, low-interest loans, grants, and tax privileges to participants in national R&D projects (para. 6.21). Technology finance was available from the Korea Technology Development Corporation (KTDC).

5.05 KTDC was started jointly by government and the private sector in the early 1980s with World Bank support. Industrial firms at that time had great difficulty raising funds for technology development from existing financial institutions and needed financing instruments of a risk-sharing nature, particularly for precommercial stages of research. KTDC provided these instruments, and thereby accelerated imports of advanced foreign technology and stimulated in-house work. While KTDC's activity was especially designed to benefit SMEs, it covered the entire range of premarket technological activity, reaching farther than venture capital institutions in other countries.

5.06 KTDC's primary objective was to remedy capital market failures in technology development, but it was also supposed to provide information on technological trends, and to nurture and reinforce a positive attitude towards R&D activities by industry. KTDC helped identify international trends and areas in which industry should focus its technological efforts. In addition, it served as a consultant to the government on technology policies. Over time, it introduced new

financing instruments (such as leasing), and set up a subsidiary, Korea Technology Investment Corporation (KTIC), to invest in technology startups.

5.07 An official assessment of KTDC activities in 1986 found that its financing had had a significant impact on productivity, employment, and sales of improved and new production. The assessment also declared that the incremental benefits of its operations appeared to be very high, and rated its portfolio quality "excellent." After six years of operation, only 13 projects out of 850 had failed. About half of its loans (almost 69 percent of the number of projects) went to SMEs. It also supported SMEs with promotional activities and technical/managerial advice. KTDC's success led to the establishment of several private venture capital funds in Korea, which today has the highest number of venture capital companies in the developing world and the largest outstanding loan portfolio to technology-based startups.

5.08 Despite all the financing instruments and institutions used to promote ITD in Korea, it is clear that the greatest stimulus to R&D came from the intensely competitive environment in which the technological leaders, the *chaebol*, operated, both internationally and within the country. Competition forced these firms to invest in upgrading their technological capabilities and was clearly much more important for ITD than any of the direct and indirect fiscal and financial incentives provided by government.

TAIWAN, CHINA

5.09 Taiwan, China has also employed a variety of mechanisms to promote ITD. Its basic strategy has been to promote R&D through publicly funded, but largely privately executed, national R&D programs for critical technologies, including biotechnology, production automation, electro-optics, and food. In the late 1980s, 43 percent of total R&D expenditures went into eight national strategic programs, of which 62 percent was carried out by private enterprises. Development of engineering capabilities accounted for over 70 percent.

5.10 Financial incentives for R&D offered by the Taiwanese government have included:

- Facilitation of funding for venture capital companies, including venture capital finance from the Bank of Communications (BOC). In high-risk, high-technology projects, BOC provided up to 25 percent of the equity;
- Financing for enterprises that developed strategic industrial products. One hundred and fifty-one firms benefitted in 1982, increasing to 214 in 1987. The government provided NT$20 billion in preferential interest rate loans for buying equipment. This was 65 percent of the investment required in these areas;
- Encouragement of product development, with matching grants for approved projects;
- Tax incentives for R&D, with all R&D deductible and accelerated depreciation for equipment;
- Special incentives for enterprises based in the Hsinchu Science Park, with government financial institutions able to invest up to 49 percent of the capital, and the investor able to count patents and know-how, up to a maximum of 25 percent, as part of equity.

5.11 Taiwan, China has also provided financial support for restructuring some key industries. Textiles is an important example. Textile exports, the nation's second largest foreign exchange earner ($12 billion in 1993), today consist mainly of synthetic fibers, since labor-intensive garment production has been largely relocated to lower-wage countries. Faced with rising labor costs and intensifying competition, the government embarked in the late 1980s on a major program of restructuring and upgrading the industry.

5.12 The Industrial Development Bureau of the Ministry of Economic Affairs established a $95.4 million program, of which 95 percent was allocated to private firms as grants to speed up technological renovation, encourage R&D, improve design capabilities, and train technical and managerial personnel. Over 250 textile plants are scheduled to receive financial and technical assistance under this program. In addition, substantial technical aid for technology up-

grading is being provided. The Taiwan Textile Federation and the CETRA Industrial Design Center have given information to firms, provided design training, and sponsored design shows. The China Productivity Center sends out technical teams to visit plants and advise on automation. Banks provide low-interest loans to SMEs to move their facilities overseas and have created a special credit line for them (up to $60,000 each) to import new equipment. These efforts are starting to bear fruit as textile firms use the latest open end rotor spinning, and water jet and air jet weaving technologies. Indigenous designers are beginning to establish a reputation in export markets, and there is relocation of simpler facilities to China and Southeast Asia.

HONG KONG

5.13 Even the traditionally *laissez faire* Government of Hong Kong has become much more interventionist, including getting involved in the provision of financing for ITD. The government has recently established a $25 million fund, which will match the investment of technology-intensive startup companies in exchange for an equity stake.

INDONESIA

5.14 Like its neighbors, Indonesia has also employed a variety of fiscal and financing mechanisms to promote technology upgrading. In 1990, the Indonesian government introduced tax code provisions allowing limited deductibility of training costs, R&D expenditures and royalty payments. By and large, industry has not responded to this inducement because of the limitations on allowable deductions, and also because of inadequate tax administration procedures.

5.15 The experience of other countries shows that tax credits for R&D tend to go disproportionately to larger firms, since SMEs, the usual target group for such incentives, often have low tax liabilities. Tax incentives also rarely generate additional R&D efforts by large firms beyond those they would undertake anyway. Indonesia's limited fiscal resources available to support ITD might better be used to directly finance carefully targeted programs, such as cost-sharing grants to support technology upgrading of SMEs (para. 6.51).

5.16 With World Bank support, a line of credit was also provided to facilitate restructuring for enhanced competitiveness in three subsectors of Indonesian industry: textiles, pulp and paper, and the engineering industries.[1] The evidence indicates that many companies successfully used the line of credit to upgrade production technologies, improve product quality, and increase sales in domestic and export markets.[2] However, it has been suggested that firms would have achieved even greater competitiveness gains had adequate technical services been provided as part of a comprehensive package of support for restructuring, as has been done in Taiwan, China (para. 5.11). While this was part of the original design, the technical assistance component of the project was delayed, and restructuring assistance was not made available until after the beneficiaries had used the line of credit.

THE EXPERIENCE OF OTHER COUNTRIES SHOWS THAT TAX CREDITS FOR R&D TEND TO GO DISPROPORTIONATELY TO LARGER FIRMS SINCE SMALL AND MEDIUM-SCALE COMPANIES — THE TYPICAL TARGET GROUP FOR SUCH INCENTIVES — OFTEN HAVE LOW TAX LIABILITIES.

5.17 Indonesia has also recently taken steps to encourage the use of venture capital. Technology- intensive startup projects typically do not have the collateral to secure financing from commercial banks, which, in any case, often do not know how to assess the risks involved. Consequently, private sector venture capital funds are beginning to emerge to finance them. Recently, the government has supported the growth of venture capital by improving the tax framework for the funds. However, their expansion will be constrained by:

- a shortage of experts to staff the venture funds and help startup companies develop;
- slow growth in the flow of potential deals to the venture funds due to the limited number

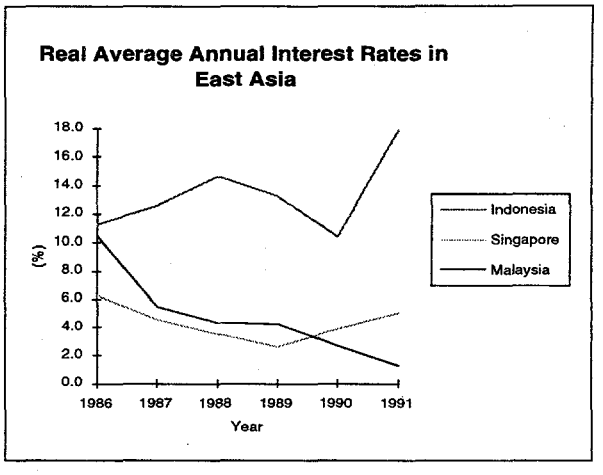
of technology-intensive companies coming into the market;

- the difficulties of being able to publicly sell shares in those companies in order to divest the shareholdings of the venture funds.

Efforts to promote venture capital as a tool to promote ITD will need to address these problems.

5.18 Perhaps a more important financing issue concerns the cost of credit. For firms contemplating long-term investments in new technologies, bank credit in Indonesia is substantially more expensive than in competitor countries (Figure 5.1). High domestic real interest rates in Indonesia disproportionately affect SMEs, which, unlike the large business groups, typically are unable to borrow at lower rates offshore. Prudent macroeconomic policies and financial sector improvements to reduce risk are essential to reducing Indonesia's high domestic real interest rates and improving the availability of term finance for investments in technology upgrading. Term finance for ITD would also be improved by strengthening the appraisal capacity of the banking system. The seal of approval from the technology service providers supported under the Industrial Technology Development Project, partly funded by the World Bank, should make banks more comfortable when deciding whether to finance the technology development projects of beneficiary firms.

Figure 5.1



ENDNOTES

[1] The line of credit was a major component of the Industrial Restructuring Project (LN 3040-IND).

[2] See *Final Report on Monitoring and Evaluation of the IRP*, PT MultiSentra, March 1995.

Focusing Indonesia's Technology Support Institutions on Effective Technology Diffusion

A. OVERVIEW

6.01 Indonesia spends about 0.2 percent of its GDP on technology infrastructure. This consists of the public R&D institutions under the State Ministry of Research and Technology and the Ministry of Industry (MOI). Government also provides technology support services in the areas of metrology, testing, calibration, quality upgrading (MSTQ), technology extension and information services. However, the contributions of these institutions to industry's technological development and enhanced competitiveness have been limited. This chapter draws from the experiences of other East Asian countries to identify reform measures and restructuring programs that can enhance the contribution of Indonesia's public technology support institutions (PTSIs) and promote private provision of technology support services. It also recommends ways to maximize the role of the strategic industries in Indonesia's industrial technological development.

B. EXPERIENCES OF THE EAST ASIAN INDUSTRIALIZING ECONOMIES

6.02 The infrastructure for ITD includes MSTQ support institutions, public research institutions, and technical support and extension services to SMEs. Many of these functions are public goods. Every country has these institutions, but many of those in developing countries suffer from similar problems: a lack of close linkages with industry; the pursuit of theoretical science rather than technology and its diffusion; poor staffing and funding of industrial technology extension services; and unreliability of the MSTQ system. MSTQ backwardness increasingly causes difficulties because the international market now requires quality management systems such as ISO 9000 and ISO 14000. There are important lessons to be learned from the experiences of those East Asian NIEs which have invested heavily in setting up technology support institutions and making them more relevant to industry.

HONG KONG

6.03 Despite Hong Kong' traditional *laissez faire* approach to economic policy, its government has provided substantial technical support to SMEs through the Hong Kong Productivity Council (HKPC). HKPC was started in 1967 to help SMEs upgrade from declining labor-intensive production to more advanced, high-value-added activities. It provides information on international standards and quality, training, consulting, and demonstration services on productivity and quality to more than 4,000 small firms a year at subsidized rates. Its on-line information retrieval system now has access to more than 600 international databases in a comprehensive range of disciplines. Its technical reference library subscribes to more than 700 journals, and has over 16,000 reference books.

6.04 HKPC also acts as a technology transfer and technology development agent, with specialized technical services for the different industrial sectors. It first identifies new technologies in the international market, builds up its own mastery of them and then introduces them to industry. It also provides management and technology courses for some 15,000 participants each year. For firms that are unable to release staff to attend courses, it organizes in-house training programs. To help disseminate information technology, it has formed strategic alliances with major computer vendors. It provides specially designed software for local industry, as well as consulting and project management in computerization. HKPC also provides consulting services in ISO 9000 systems, and has helped several firms obtain certification. In 1993/94, it undertook 1,354 consulting and technology assistance projects, trained more than 15,000 people and provided manufacturing support services in 2,400 cases. To promote private provision of technology support services, HKPC's policy is not to participate when private consultants are available. As a result of growth in the institution's

revenue-earning work, the government now contributes only about 40 percent of HKPC's budget.

6.05 Recently, Hong Kong has become much more active in supporting technology diffusion to industry because of the business community's increasing concern over the lack of industrial and technological depth in the colony.[1] The Hong Kong Industrial Technology Center (HKITC) is one of the colony's most recent commitments to supporting technology-oriented companies. The Center promotes technology development by nurturing small companies and providing relatively inexpensive state-of-the-art facilities for more established ones. The government package supporting the Center includes a one-time grant of HK$250 million, the ability to tap a HK$188 million credit line (at 7 percent a year), and 5,700 square meters of land next to one of the colony's busiest train stations. The government has provided a HK$250 million grant for a new Industry and Technology Center, has completed a new University of Science and Technology, and has initiated plans for a HK$2.8 billion science park. In addition, the government supports local design capabilities through its school of design and the Hong Kong Design Innovation Company.

SINGAPORE

6.06 Provision of technology support services to industry has also been a major priority in Singapore. Two aspects of Singapore's technology infrastructure programs are worth noting. The first is its policy on SMEs. In 1962, the EDB launched a program to help SMEs modernize equipment with funds provided by the UNDP. In the mid-1970s, EDB started several other programs for financial assistance. Of these, the most significant was the Small Industries Finance Scheme to encourage technological upgrading in SMEs.[2] The 1985 recession induced the government to take even stronger measures. It established a Venture Capital Fund to help SMEs acquire capital through low-interest loans and equity. A Small Enterprises Bureau was established in 1986 to act as a one-stop consulting agency, helping SMEs with management, training, finance and grants, and coordinating assistance from other agencies. In 1987, US$519 million was provided for eight SME programs, including product development assistance, technical assistance to import consultants, venture capital to help technology startups, robot leasing, training, and technology tie-ins with foreign companies.

6.07 The Singapore Institute of Standards and Industrial Research disseminates technology to SMEs and provides them with information on how to meet foreign standards and technical requirements. The National Productivity Board provides firms with management advice and consulting services, while the Technology Development Center (TDC) helps them to identify their technology requirements and purchase technologies. It even helps them design technology upgrading strategies. Since it was founded in 1989, TDC has provided more than 130 firms with various forms of technical assistance. It also administers the Small Industry Technical Assistance Scheme (SITAS) and the Product Development Assistance Scheme to help firms develop their design and development capabilities. It has given grants totaling more than $1 million to 29 SITAS in the past 5 years, mainly to local enterprises, and its earnings have risen to a level where its cost recoverable activities are self financing. The EDB encourages subcontracting to local firms through its Local Industries Upgrading Program, under which MNCs are persuaded to source components locally by adopting particular SMEs as subcontractors. In return for a commitment by the MNCs to make on-the-job training and other assistance available to subcontractors, the government provides a package of assistance to the latter, including cost-sharing grants and loans for equipment, consulting and training.

6.08 The second interesting aspect of Singapore's approach is its public R&D program. In 1991, the government set an R&D spending target of 2 percent of GDP by 1995, compared to less than 1 percent in the early 1990s. It selected a number of sectors for technology development,[3] and established a S$2 billion fund for R&D. Biotechnology is a good example of Singapore's systematic approach to developing a domestic innovative base by using public R&D funds and institutions to build up basic research capability and so attract R&D participation by MNCs.

6.09 Singapore is attempting to move into the scientific mainstream through the work of the Institute

of Molecular and Cell Biology (IMCB). Placed within the National Biotechnology Program, started in 1988 to strengthen the national R&D base and fund biotechnology development, IMCB is an ambitious project in the government's overall strategy of using high technology to strengthen its economy. An important incentive for firms to participate in this program is the granting of pioneer industry status, which gives tax exemption for 5 to 10 years, with the largest benefits given to technology-intensive and export-oriented projects. In addition, government funding is provided if firms actively collaborate with public sector research. The foundation of this effort is the strong program in basic research at the National University of Singapore (NUS), which houses the IMCB. NUS conducts one third of Singapore's R&D, and its scientists have achieved international recognition in several areas, including materials technology, microelectronics and information technology.

6.10 The decision to spend S$13.8 million to build IMCB and to provide annual funding of S$17.5 million reflects the government's belief that Singapore can become a world leader in biotechnology. The biotech industry requires few natural resources, is high value added and can make use of Singapore's extensive global business networks. To make this belief a reality, the government created Singapore Bio-Innovation Pte Ltd. (SBI). By 1991, SBI had invested S$41 million in 12 local biotech startup firms with 1,428 employees making health care, food and agricultural products. SBI also invests in overseas companies that might be strategic allies.

6.11 The investment in IMCB appears to be paying off scientifically. One IMCB group is at the forefront of research on tyrosine phosphates, a hot topic in cancer research. Another group is sequencing the genomes of several fish species, which could serve as a reference vertebrate genome for the human genome project. IMCB laboratories' innovative assay systems convinced Glaxo, the pharmaceutical MNC, to establish a S$31 million trust fund for a drug screening center within IMCB. Glaxo also invested S$30 million for an IMCB neurobiology lab.

6.12 Encouraged by these successes, the government expanded IMCB's research base by establishing the Bioscience Center at NUS, and the Food Biotechnology Center. The Bioprocessing Technology Unit, opened in 1990, seeks to improve purification, synthesis and fermentation methods for commercial production. The Unit recently achieved large yields of TNF-[beta], which other companies, including Genzyme in the United States and Boehringer Mannheim in Germany, are eager to put into clinical cancer trials. The National University Medical Institute, now being built near IMCB and the National University Hospital, is modeled on the U.S. National Institutes of Health.

6.13 One obstacle to Singapore's quest for scientific success, however, is its shortage of well-qualified scientists and engineers. To overcome this, IMCB recruited western scientists, offering them research freedom, ample funding, and salaries of up to $50,000 with renewable three-year contracts. Singapore's own students, however, represent the largest source of scientific talent at IMCB. Its two polytechnics are training technicians to fill the growing demand from biotech labs and industries. In addition to tuition, graduate students at IMCB receive a $10,000 a year stipend.

TAIWAN, CHINA

6.14 Taiwan, China's technology support policies have focused on the needs of the country's 700,000 SMEs, which account for 70 percent of employment, 55 percent of GNP, and 62 percent of manufactured exports.[4] In 1981, the government set up the Medium and Small Business Administration to coordinate the several agencies providing assistance to SMEs. Among these agencies are the Taiwan Medium Business Bank, the Bank of Taiwan, the Small and Medium Business Credit Guarantee Fund and the Small Business Integrated Assistance Center. Management and technology assistance are provided by the China Productivity Center, the Industrial Technology Research Institute (ITRI) and a number of industrial technology centers for the metals industry, textiles, biotechnology, food and information. The Joint Services Center of the Ministry of Economic Affairs acts as a source of information on SME assistance. The government covers 50 to 70 percent of SME fees for consulting services. The Medium and Small Business Administration has a NT$10 billion fund for SME promotion. The Center-Satellite Factory Promotion Program of the Ministry

of Economic Affairs integrates smaller factories around a principal one in a program involving vendor assistance, productivity-raising efforts, and a rational sharing of manufacturing tasks among participating enterprises. By 1989, there were 60 networks with 1,186 satellite factories in operation, mainly in electronics.

6.15 ITRI, established in 1973 to do R&D considered too risky for the private sector, became increasingly isolated from industry in its early years. The government initiated major reforms starting in 1982, when it insisted that the institute start to finance itself through the sale of services to industry. To obtain funding, ITRI's researchers have to submit proposals with fixed budgets, timetables and deliverables specified for review and monitoring by a technical group from industry, academia and government. Today, ITRI is considered one of the most successful ITD support institutions in the world.[5]

6.16 One of ITRI's most important responsibilities is technology development for SMEs. While it covers a range of industrial technologies (metals, chemicals, energy and aerospace), electronics has been its principal focus. Its Electronics Research and Service (ERSO) division accounts for two-thirds of its $450 million budget. ERSO develops new electronics technologies and diffuses them to industry through licensing and setting up joint venture companies in which government provides technical support and some funding while the private partners put up the majority stake. ERSO's laboratories also set up and spin off private manufacturing enterprises; six major integrated circuit manufacturers in Taiwan, China, including the most successful, are such spinoffs. ITRI and other government R&D institutions have also gone into joint ventures directly with the private sector. One example is the Philips wafer fabrication operation. ITRI has also trained technology-oriented venture capitalists and encourages members of its own staff to become private sector entrepreneurs.

6.17 Other SME support agencies include the Institute for the Information Industry, which complements ITRI's work on hardware by developing and introducing software technology. The Taiwan Handicraft Promotion Center supports handicraft producers, particularly small ones with export potential. The Program for the Promotion of Technology Transfer maintains close contact with foreign corporations that have developed leading edge technologies in order to facilitate their acquisition. The China Productivity Center (CPC) is well known for its efforts to promote automation. CPC sends engineers to visit plants throughout the country to demonstrate the best means of automation and solve technical problems. Over the past two years, CPC teams visited more than 1,000 plants and made more than 4,000 suggestions for improvement. CPC also does independent research on improving production efficiency and links enterprises with more complex technical problems with the appropriate research centers that can solve them.

6.18 There are three other major manufacturing R&D institutes in Taiwan, China. The China Textile Research Center was set up in 1959 to inspect exports, but its duties have expanded to include training, quality systems, technology development, and direct acquisition of foreign technology. The Metal Industries Development Center was established in 1963 to work on practical development, testing and quality control work in metalworking industries. It later organized a CAD/CAM center to provide training and software. The Precision Instrument Development Center has now moved into advanced areas such as vacuum and electro-optics technology.

6.19 In addition, the government encourages private industry to contract research to universities. The National Science Council funds about $100 million worth of such contracts a year, with enterprises providing matching funds. In the 1980s, the government spent US$500 million to set up a science town in Hsinchu, which now has 13,000 researchers in two universities, six national laboratories (including ITRI), and a huge technology institute, as well as some 150 companies specializing in electronics. Hsinchu makes special efforts to attract startups, providing them with factory space, five-year tax holidays and generous grants.

KOREA

6.20 In 1966 the Korean government set up KIST (Korea Institute of Science and Technology) to perform applied research for industry. In its early years,

KIST focused on solving simple problems of technology transfer and absorption. In the 1970s, the government set up other specialized research institutes (on machinery, metals, electronics, nuclear energy, resources, chemicals, telecommunications, standards, shipbuilding, marine sciences and so on), largely spun off from KIST. By the end of the decade, Korea had 16 R&D institutions. In 1981, the government decided to reduce their number and rationalize their operations. The existing institutes were combined into 9 under the supervision of the Ministry of Science and Technology. KIST was merged with KAIS (Korea Advanced Institute of Science) to become KAIST, but became a separate organization again in 1989.

6.21 The government launched a series of national R&D projects in 1982. These were large scale activities regarded as too risky for industry to tackle alone but considered in the country's strategic industrial interest. They were conducted jointly by industry, public research institutes, and the government, and dealt with areas such as semiconductors, computers, fine chemicals, machinery, material science and plant system engineering. These projects were part of Korea's strategy of identifying and developing the country's comparative advantages, orchestrating the activities of participants, underwriting part of the risks, providing large financial grants, and acting directly in problem areas where the market alone could not provide a solution. Total expenditure on these projects between 1982 and 1989 was $680 million. The sums involved increased steadily from $25 million in 1982 to $151 million in 1989. Strategic technological activities are still targeted and promoted today.

6.22 A recent evaluation of the Korean government research institutes (GRIs) suggests that their greatest impact has been on human resource development.[6] The institutes trained a generation of R&D specialists who helped to establish and operate the private labs that emerged as large firms increased their R&D efforts. They also played an important role in the development of national industrial strategies. However, they provided only limited technical assistance to private firms, largely due to the fact that large-scale government funding for the national research projects destroyed any incentive for the GRIs to sell technology and technical services directly to industry.

6.23 Other technology policy measures in Korea included setting up university Science Research Centers and Engineering Research Centers, the common utilization of advanced R&D facilities and the establishment of science towns. Daeduk Science Town has been under construction since 1974, and a large number of research and educational institutions are already well established there. Other such towns are under construction. The Korea Institute for Economics and Technology diffuses technology by collecting, processing and disseminating technical information to industry.

SUMMARY OF THE EAST ASIAN EXPERIENCE

6.24 All countries in East Asia have invested heavily in R&D infrastructure. However, the role of their technology support institutions, as in many other developing countries, and in some developed ones as well, is undergoing major change. Economic policymakers are disillusioned with the traditional big science, mission-oriented, supply-driven approach, which has left their laboratories isolated from industry. The public technology institutions are under increasing pressure to become more market responsive and to have their research enhance the competitiveness of industry. Budget constraints on technology support institutions are partly a result of the global trend of fiscal austerity as well as disappointment with the value added generated by the institutes. Increasingly governments have been requiring the institutions to compete for what government research money is available. For example, only 2 percent of ITRI's funding in Taiwan, China is now provided through direct government grants, and the Korean government funds just 8 percent of KIST's budget. Technology support institutes are being encouraged to operate more commercially and are being given the autonomy and authority to do so.

6.25 Recent studies have identified some common external and internal characteristics of successful institutional transformation.[7] Among the external factors, the extent to which the export market creates industry demand for technology services is paramount. Strong linkages with industry to help determine the strategic direction of the institutes are also very important. For ex-

ample, many of the most successful institutes have substantial industry representation on their boards of directors. Institutes also have had to become more self-financing to cope with stagnant or declining public sector financing.

6.26 Among the internal factors, the most important are to have:

- strong institutional leadership that emphasizes the importance of a service orientation and technical excellence;
- a clear, well-defined strategy and measurable goals;
- a technically competent staff with strong incentives to carry out the institutional strategy;
- the capacity to continually renew staff skills through training and the institutional capacity to learn from work with clients;
- good project management, monitoring and evaluation systems.

C. THE LIMITED CONTRIBUTION OF INDONESIA'S PUBLIC TECHNOLOGY SUPPORT INSTITUTIONS

6.27 Indonesia invests substantial resources, about 1 percent of the national budget annually, in its publicly funded R&D laboratories, accounting for about 80 percent of national R&D expenditure (see Table 6.1). There are several industrial labs under the State Ministry for Research and Technology (MENRISTEK). In addition, the Ministry of Industry (MOI) has established, through its Agency for Industrial Research and Development (BPPI), 12 national level R&D laboratories, specialized by industrial subsector, as well as several regional R&D institutes.[8]

6.28 Only a few PTSIs work closely with manufacturers. They lack systems to market their research to firms or to assess the R&D requirements of industry. Many entrepreneurs are not even aware of the R&D capacity that exists within the institutes. Even when they are, they are skeptical about its relevance to the technology development and competitiveness issues with which they are grappling. While firms acknowledge that some of them, e.g., the MIDC (for the metalworking industries) and the IRDTI (for textiles), played an important role in diffusing technologies to industry 10 to 15 years ago, they say the labs have not kept abreast of developments in their industries and are now years behind. Unlike those in several other countries in the region, none of Indonesia's government-funded R&D labs have industry participation on their boards of directors to help in setting agendas. Moreover, communication among the institutes and universities about the development and application of technology for industry is negligible.

6.29 Not surprisingly, Indonesia's PTSIs get relatively little income from the sale of technology and technology services to industry. For example, on average, MOI's R&D institutes generate only about 20 percent of their budgets from such sales, and very little of that comes from contract research, prototype development or licensing of technology generated by the labs. Most earnings come from training and testing services. The degree of self-financing among all of Indonesia's public technology support institutions is low compared to that of other developing countries in Asia (Table 6.2).

Table 6.1: R&D Expenditures and Sources of R&D by Country, 1990 (percent)

	R&D Expenditure as % of GDP	Source		
		Govt.	Industry	Other
Japan	2.9	16	78	6
South Korea	1.9	16	84	
Singapore	1.0	46	54	
Taiwan	1.7	45	52	3
India	0.9	67	30	3
China	0.7	62	38	
Indonesia	0.2	80	19	1

6.30 In Indonesia, incentives for the PTSIs to earn income are limited. They are unable, for example, to properly reward staff who generate income, and unused earnings must be returned to government at the end of the fiscal year. Lab directors also generally have little decision-making power. Even in the few cases where the institutes have developed commercially viable technologies in de-

mand by industry, their capacity and motivation to strengthen industry linkages are also severely limited since they lack systems for pricing, marketing, or licensing the technologies they have developed (see Box 6.1).

6.31 Indonesia's PTSIs are much more dependent on public financing of R&D than their regional counterparts. While R&D budgets grew at about 15 percent a year in the 1980s, in the past few years funding has kept only slightly ahead of inflation, and there is little prospect of a return to the healthy increases of the 1980s. Moreover, as is the trend elsewhere in the region (para. 6.24), the government has recently begun allocating a small but growing share of its public funding for R&D on the basis of competitive research grants and mandatory industrial participation. Consequently, many lab directors are coming to see that they can survive only by carrying out client-driven technology support activities, particularly R&D and technical services to private industry.

Table 6.2: Degree of Self Financing of Selected Public R&D Systems

Country	Institution	% Self-Financing
Singapore	Singapore Institute of Standards and Industrial Research	60
Hong Kong	Hong Kong Productivity Center	60
Germany	Fraunhofer Institute	50
Taiwan	Industrial Technology Research Institute	35
India	Council of Scientific & Industrial Research	33
South Korea	Korean Institute of Science & Technology	28
Australia	Commonwealth Scientific & Industrial Research Organization	25
Indonesia	Indonesian Institute of Sciences	10
	Agency for the Assessment & Application of Technology	5
	Ministry of Industry R&D Institutes[1]	30

Sources: Various World Bank reports and Institute Annual Reports
[1]These institutes now belong to the Ministry of Industry and Trade (MOIT).

Box 6.1: Technology Marketing in an MOIT R&D Laboratory

The Industrial Institute, Semarang has developed technical services in industrial design and engineering that have been well used by industry. The lab has developed good capability in pollution control technology. During the last three years the institute has served about 110 firms in providing industrial waste treatment technologies, disposal monitoring services, industrial process equipment design, waste treatment equipment and training services. It has also developed and sold waste water and disposal gas treatment facilities. Even after transferring the technology it has developed, the institute has continued to work closely with its clients for further improvements. However, the institute does not have expertise in the commercialization of technology. In cases where there is scope for selling its technologies to many clients, the institute lacks expertise in technology marketing, licensing, pricing or estimating and monitoring the costs of technology development. Many of the R&D institutes have these weaknesses in common.

MINISTRY OF INDUSTRY LABORATORIES

6.32 A recent World Bank report on Indonesia's R&D institutes under the former Ministry of Industry (now the Ministry of Industry and Trade after its recent merger with the former Ministry of Trade) shows that nearly all of the institutes are primarily engaged in training, testing and product certification (see below), and that little research is taking place.[9] With regard to quality, the assessment found that human resources, management, infrastructure, output and linkages with firms and other institutes are all weak areas for the MOIT labs.

6.33 The labs' institutional framework is an important cause of their weaknesses. They work under difficult bureaucratic restrictions on travel, materials and equipment procurement, which constrain their ability to go to industry, understand its requirements and offer services. Researchers' salaries and incentives are low.[10] They also have outmoded, poorly maintained and obsolete equipment and facilities. Box 6.2 provides specific recommendations for reform of the MOIT R&D lab system. Many of these recommendations are being implemented as part of the government's Action Plan for restructuring its technology support institutions (para. 6.45 below).

THE NONDEPARTMENTAL R&D LABORATORIES

6.34 In addition to those under line ministries such as MOIT, there are nondepartmental laboratories. The Indonesian Institute of Sciences (LIPI) was established in 1967 to assist the president in organizing national R&D; give guidance, services and advice to government on national science and technology policy; improve Indonesia's scientific capability; and cooperate with national and international scientific bodies. It does basic research and carries out technology development activities in the natural sciences, engineering sciences, social sciences, and humanities and also plays a major role in the development of the country's science and technology infrastructure, by providing MSQT and information services. LIPI employs about 4,000 people, including more than 300 with Ph.Ds and Masters degrees, and has a budget of about US$42 million, about 90 percent government funds.

6.35 The Agency for the Assessment and Application of Technology (BPPT) was established in 1978 to be in charge of the selection, assessment and application of science and technology for the development of national industry. Like LIPI, BPPT is a nondepartmental government agency reporting directly to the president. Its principal tasks are to: (a) formulate technology policies and programs to promote industrial and national development; (b) ensure coordination in the implementation of programs for the assessment and application of technology; (c) provide services to government and the private sector in the application of technology; and (d) support the government's policies on the application of technology for industrial and national development. BPPT's 21 technical directorates cover the basic and applied sciences, technology development, industrial analysis, natural resource development and systems analysis and also run technical laboratories in such fields as aerodynamics and gas dynamics, energy resources and construction testing. They employ about 3,000 people, of which about ten percent have advanced degrees. In 1993/94 BPPT's budget was about US$42 million, 95 percent funded by government.

Box 6.2: Recommendations for Reform of MOIT Labs

- Grant substantial autonomy to the institutes to ensure emergence of professional systems of R&D management and generation of strong market-responsive, outward-looking systems. Autonomy to be coupled with accountability.
- Give Swadana status to the labs so that they can retain their industrial earnings, reward staff who generate that income, and reduce dependence on government funding.
- Also decentralize recruitment (presently done at the center) to the institute level.
- Create incentive systems for the institutions. Link the development budgetary support given to the institutes annually to their industrial earnings in the previous year. Allocate 50 percent of the earnings from industry as extra budgetary support from the government, which would serve as an additional driving force for the institutes to seek more funds from industry.
- Audit earnings from industry separately. Effectively set up a "dual system" for auditing, with a faster track for funds earned from private industry.
- Review salary structure of scientists in MOIT institutes. In the meantime, implement a scheme to share industrial earnings to augment the income of MOI institute staff involved in generating those earnings.
- In each institute, set up research advisory committees with membership from private sector industry and other professionals to give an unbiased external look at the institutes and to suggest ways and means of improving their performance.
- Develop a scheme to promote mobility of scientists among the institutes under MOIT, MENRISTEK and academia.
- Organize annual meetings of the publicly funded R&D institutions, in-house R&D departments in industry and academia to discuss and debate the issues linked to commercialization of R&D.
- Create annual awards for industries which commercialize R&D from publicly funded R&D institutions; such public recognition will stimulate the usage of the expertise in R&D institutions by industrial firms.

6.36 The nondepartmental labs, like those under MOIT, also have very limited contacts with private industry. A recent analysis of BPPT and LIPI[11] found their management highly bureaucratic, operating the labs under an inefficient, rule-bound, supply-driven system inadequately responsive to the needs of the private sector. Selection of projects is largely a formal process, often merely extending existing projects with little attempt to analyze their relevance or feasibility. Project costing, control and evaluation mechanisms are extremely weak.

6.37 Human resource planning is inadequate. Job descriptions, classification systems and utilization of staff are all poor. Attitude surveys reveal low job satisfaction ratings among researchers because of:

- lack of a clear mission statement, strategic direction, or goals set by management;
- absence of clear research priorities, clear tasks, or targets;
- inadequate performance rating systems for making career development and staff remuneration decisions.

6.38 Recognizing many of these problems, BPPT and LIPI have begun pilot projects to improve office and logistics management, human resource utilization, and R&D project management systems. These pilot projects will now be expanded with support from the Industrial Technology Development Project, which has received World Bank financing.

6.39 In addition, the government has implemented a new "One Gate" policy for centralized screening of all government-financed R&D project proposals, in an effort to ensure greater relevance of publicly funded research. As the program moves forward, improvements will need to be made, particularly in the capacity of the screening panels to monitor and evaluate proposals during and after their implementation. It also will be important for the panels to have a mix of theoretical and practical perspectives by including representatives of academia and industry as well as some foreign participants.

6.40 Requiring peer and panel reviews may help improve the quality of public sector R&D projects. However, to maximize the benefits from R&D, direct measures should be taken to make the labs more market driven and to improve their working environment. This would entail both granting them greater autonomy and establishing mechanisms to ensure greater accountability.

6.41 Greater accountability could be achieved by linking government funding to each institution's earnings from industry through sales of technology, technology licensing, contract research for and joint research with industry, management consulting, and provision of training and testing services. This approach of providing matching funds has been adopted in other countries and has encouraged the emergence of more professional, market-responsive and outward-looking systems of management within R&D laboratories.

6.42 In addition, advisory boards with substantial private sector representation should be established to evaluate the performance of each lab and ensure that R&D agendas better reflect industry needs. In addition, quantitative performance indicators, such as earnings from industry, the number of publications in international research journals, and the number of patents received, should be developed to help management set targets and monitor staff performance. Such indicators could help to determine institutional funding, promotions, salaries and bonus payments.

6.43 The labs should have more freedom to retain and use their earnings from industry. In this way, they could provide better incentives to their staff and help pay for the costs of marketing and providing their services to industry. Government restrictions on recruitment and remuneration of staff, procurement of materials and equipment, and travel also need to be substantially reduced, at least where these are financed from earnings. This would give the R&D institutions incentives to market and price their services more aggressively. Today, they can only charge for direct labor and travel costs, even though private suppliers of similar services (e.g., testing) charge their clients on the basis of full recovery of costs (including overhead), plus a profit.

6.44 All MOIT and nondepartmental laboratories should strive to become client-funded, responsive, demand-driven organizations. Clearly, this will require granting them greater autonomy for

decisionmaking while at the same time holding them accountable for improved performance. This could be achieved by changing internal management systems, improving incentives, developing their capability to respond to demands from industry and reforming the public R&D financing system to reduce reliance on government funding.

6.45 The government's Action Plan to commercialize PTSIs will be supported by an Industrial Technology Development Project (ITDP), which has recently received World Bank funding. The Plan calls for the following:

- giving PTSIs the necessary incentives to become more demand driven and commercially oriented, and establishing self-financing targets;
- reducing government controls to encourage the institutions to become more agile in responding to the technological needs of industrial firms, while also increasing their accountability for results;
- implementing internal management reforms to ensure that the institutions become more professionally managed and results oriented;
- encouraging private technology support services and competition among public and private technology services providers.

Implementation of the Action Plan should significantly improve operations of the PTSIs, as should the greater emphasis given to performance measurement, including assessment of the impact of technology services on firms, and monitoring and evaluation of publicly funded R&D projects against clearly defined budgets and expected outputs.

6.46 In the next stage of PTSI reform, greater accountability could be achieved by linking government funding to each institution's earnings from sale of its R&D products and services to industry. Incentives to commercialize R&D could also be enhanced by allowing PTSIs to set up commercial subsidiaries and take equity positions in companies that utilize their technologies. There may also be scope for further restructuring, including:

- merger and consolidation of institutions that serve similar client bases but report to different ministries;
- closing institutions that cannot produce viable strategies and business plans for commercialization;
- reorganizing labs along functional rather than sectoral lines in order to meet more generic needs across industries, rather than focusing on developing a full range of capabilities in selected industrial subsectors;
- encouraging the private sector to play a central role in the formulation of PTSIs' strategies and policies through membership on boards of directors and advisory councils.

D. OTHER TECHNOLOGY SUPPORT SERVICES

TECHNOLOGY EXTENSION SERVICES

6.47 Indonesian SMEs facing productivity, efficiency and quality problems often are simply unaware of the technology assistance available to them. In many countries, including the United States, Japan, South Korea and Taiwan, China, technology extension services play an important role in improving productivity, product quality, delivery and manufacturing methods for SMEs.

6.48 International experience shows that for these firms the solution to becoming competitive is not to develop new products. Instead, it is to employ current best manufacturing practices by extending the length of the production cycle, improving inventory controls, tightening up management of facilities and staff, and increasing internal process efficiency (e.g., by reducing scrap rates, improving machine reliability and eliminating bottlenecks). Figures 6.1 and 6.2 show, in the specific areas of shoes and printed circuit boards, how technology extension services can be invaluable for improving the ability of firms in developing countries, such as Indonesia, to compete globally with manufacturers in the NICs.[12]

6.49 This has also been demonstrated in practice in Indonesia. In 1992, with World Bank support, the Ministry of Industry established semiautonomous Technical Service Groups (TSGs) to provide nationwide technical support and environmental services to firms in three subsectors (textiles, engineering products, and pulp and paper manufacture). The government provided a 90 percent subsidy to firms that used the TSGs' services.

6.50 The TSGs, now being phased out, had a mixed record. They delivered valuable services to industry and demonstrated clearly that there is demand from SMEs for a variety of technical support services, and that most firms are willing to pay, albeit at highly subsidized rates, for such support. On the other hand, their geographical coverage was limited. They provided extension services to only a few subsectors, and to only a limited number of firms in those subsectors. Costs were high, and complex government administrative procedures were burdensome. Moreover, their services were delivered primarily by expatriates, with national experts (i.e., retired engineers) and counterpart staff from the sectoral R&D institutes making a much smaller contribution. Nevertheless, the TSGs provided a useful demonstration to the institutes and some training of institute staff on how to promote and deliver technical services to industry, and helped focus the government's attention on the need to give greater autonomy and incentives to the institutes.

6.51 The provision of technology consulting services, with respect to both the number of firms and subsectors served and the suppliers of technical support, needs to be expanded. Singapore, the Philippines, Mauritius and the United Kingdom have all successfully used cost-sharing grants to stimulate SME demand and to encourage the participation of private sector consultants as well as public technology support institutions in the provision of technology extension services (see Box 6.3).

6.52 Cost-sharing schemes in Indonesia would have several benefits. They could substantially extend the sectoral and geographical coverage of extension services, and, by introducing competition among service providers, improve quality. SMEs throughout the world are often reluctant to use external expertise because of concerns about confidentiality, affordability and value. Therefore, as experience elsewhere with such schemes demonstrates, it may be necessary initially to provide subsidized services to firms to show them how technological knowledge can be applied to their production problems. Once firms see the benefits, they may be more willing to pay full cost. Cost-sharing helps develop a market for support services while providing firms with needed technical assistance. Such a scheme will be implemented in Indonesia on a pilot basis as part of a recently approved Industrial Technology Development Project (ITDP), partly funded by the World Bank.

METROLOGY, STANDARDS, TESTING, AND QUALITY SUPPORT SERVICES

6.53 To meet the demand for quality products in international markets, and to ensure fairness in domestic trade and public safety, all countries need an effective MSTQ system. To control quality it is necessary to be able to measure physical and chemical properties against properly specified standards. Consequently, MSTQ plays a very important role in helping firms improve competitiveness. They also are an important instrument for the diffusion of technological information to, and lowering transaction costs for, firms by expediting product specifications and quotations, and by eliminating the need for calibration and testing at foreign laboratories or onsite third party inspectors.

6.54 However, Indonesian MSTQ is very weak, and dissemination of national and international standards to industry, quality awareness among firms, and industry training in quality management practices, especially by SMEs, are also extremely limited. Likewise, testing and calibration services are poor. None of the Indonesian testing and calibration laboratories is internationally recognized. As a result, firms have to use foreign laboratories at considerable expense. At the same time, demand for support services for upgrading product quality is growing rapidly as firms seek

to attain the international standards, including ISO 9000 certification, which are increasingly becoming a requirement to sell in major export markets. Using German and Japanese technical assistance, Indonesia's National Standards Council (DSN) has developed a Master Plan to strengthen MSTQ.

6.55 Under this plan, the ITDP would provide technical assistance and training to the National Metrology Center (KIM-LIPI) and the Ministry of Industry's Center for Industrial Standards (PUSTAN). This will improve the ability of those agencies to disseminate standards to industry, especially SMEs, and to implement programs for improved testing and calibration services, leading to national certification of product quality and quality management practices, including ISO 9000 certification.

6.56 The National Metrology Center (KIM) is Indonesia's primary metrology center. It also operates a national calibration network consisting of a number of private and public sector calibration service providers. One of its major tasks is to calibrate the equipment in the nation's public and private sector testing laboratories. However, KIM is not yet recognized internationally. Firms can send their equipment abroad for calibration, but this is an expensive alternative. As part of the plan, ITDP will support a twinning relationship for KIM with a leading international metrology and calibration laboratory. The latter will give KIM technical assistance for building its management and institutional capacity, with the objective of its gaining international recognition and accreditation, something vital for Indonesia's ISO 9000 certification program.

6.57 MOI's Center for Industrial Standards (PUSTAN) also has an important role to play in establishing a national industrial standards system and gaining ISO 9000 certification for Indonesian industries. PUSTAN would receive technical assistance under the project from an internationally accredited laboratory to gain recognition and accreditation for five of MOI's testing laboratories. Furthermore, staff in eight MOI R&D institutes would be trained as MSTQ extension agents. PUSTAN also will receive technical assistance to: (a) develop programs, in cooperation with the Indonesian Chamber of Commerce and Industry, to promote quality awareness and implementation in industry; and (b) to gain ISO 9000 certification for 40 SMEs as a demonstration to the rest of industry and as a learning-by-doing training program for its staff. In cooperation with several Indonesian technical universities, PUSTAN will conduct a comprehensive training program for SME managers, su-

Figure 6.1

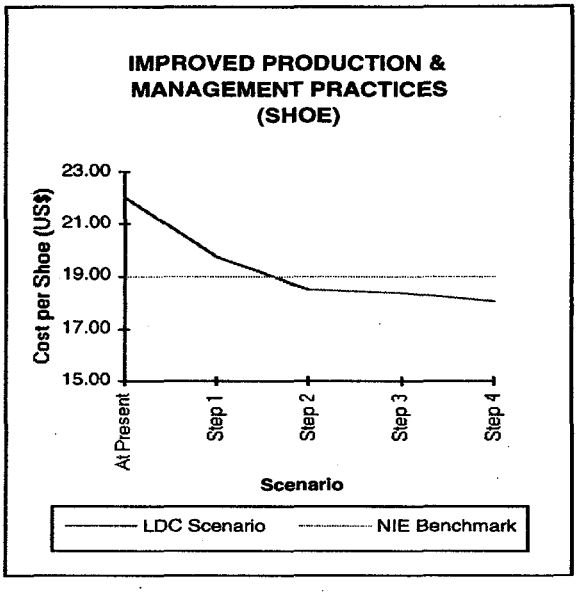
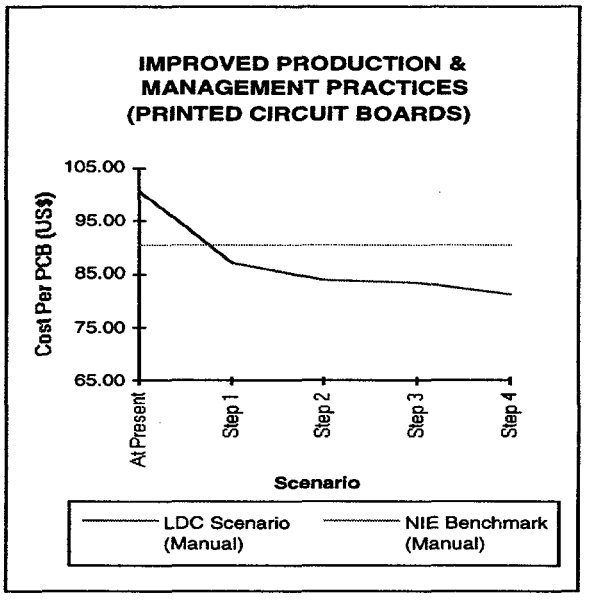


Figure 6.2



pervisors and quality-control personnel in all aspects of quality management. In addition, PUSTAN will translate into Indonesian and distribute widely eight major MSTQ textbooks.

6.58 There also are private sector testing laboratories in Indonesia. Since they are often more modern and better maintained and provide better service than the public labs, they charge higher fees. However, the private labs tend to be concentrated in West Java, are few in number, usually provide only very specialized services and are not licensed to grant ISO 9000 certification. Greater private sector participation in the provision of MSTQ services should be encouraged by privatizing some of the public testing labs, removing restrictions on specialized testing and product certification services and ensuring that private firms could, like public labs, become registrars of ISO 9000 standards.

Box 6.3: Cost Sharing Grant Schemes to Facilitate Public and Private Technology Extension Services

Examples of successful cost-sharing grant schemes for small and medium-scale industry include:

- A productivity improvement program for SMEs in the Philippines, supported by the World Bank and the Philippine Government as part of a proposed industrial technology development project; a review of the pilot program, undertaken in 1992-93, identified significant benefits for both firms and consultants.
- A cost-sharing grant scheme for SMEs in Singapore to subsidize technical and business development consultancy: The scheme has had a major impact on the growth of local consultancy firms as well as benefiting the recipients of assistance.
- A similar program in the UK, the Consultancy Initiatives, under which 50,000 consultancy projects were provided to SMEs over a five year period 1988-93: A thorough evaluation of the program demonstrated substantial benefits for participating firms and an increase in both the quantity and quality of business and technical consultants. Participating firms also demonstrated a significantly higher propensity to use consultants at full market rates for subsequent assistance.

PRODUCTIVITY CENTERS

6.59 Many countries also provide technological support and training in technologies that are relevant to a large subset of firms, e.g., computer-aided design, engineering and manufacturing; total quality control systems; just-in-time management; and flexible manufacturing. There is a need for this in Indonesia as well. The Institute for Machine Tools, Automation and Production Technology (MEPPO) in Bandung was designed for this purpose. However, it has concentrated on advancing the manufacturing technologies of large firms, particularly the strategic industries (para. 6.62). The challenge for MEPPO is to find ways to transfer technology to SMEs. In addition to establishing prototyping facilities, MEPPO could do this by encouraging participation of SMEs or their industrial associations on its board of directors and establishing demonstration projects for groups of firms. It could also use its facilities to train SME staff members and trainers, including teachers from the polytechnics and trade schools.

TECHNOLOGY INFORMATION SERVICES

6.60 Technology information centers also help private firms by accessing and processing the vast stores of data available worldwide, including best-practices technologies, approaches to solving particular manufacturing problems and information on patented and licensed technology. While provision of such services could have large economies of scale, and the services themselves are important public goods, experience shows that technology information centers have to be very well managed and proactive in responding to market needs. They require specialists to search for and process information and be able to help firms articulate their information requirements.

6.61 In Indonesia there are two public sector information services: IPTEKNET, which is administered by BPPT, and PUSDATA under MOI. The IPTEKNET system provides Internet access to six public R&D institutions. There are plans to expand both services substantially. However, they will need major restructuring if they are to survive, let alone expand, in what is a very competitive information services market with a growing number private providers. To be able to compete with the private sector for customers and employees, both PUSDATA and IPTEKNET need to be com-

mercialized, and eventually privatized, using sound business strategies to operate in viable niche markets.

E. THE STRATEGIC INDUSTRIES

6.62 Indonesia has also made substantial investments in the acquisition of advanced technological capabilities in its state-owned strategic industries. These include ship building and repair, heavy machinery, diesel, telecommunications equipment, defense rolling stock, steel and electronics. Indonesia has invested heavily in these subsidized industries, adopting an infant industry approach to their development. In comparison to other Indonesian enterprises, local or foreign, these firms have the most ambitious and the most systematic technological objectives. They also employ many of the country's best-trained R&D and technical personnel.

6.63 The strategic industries have made an important contribution by providing valuable international training opportunities and exposure to a cadre of young Indonesian scientists and engineers. The challenge now is to deploy those valuable resources for maximum economic gain. This should be done by clearly separating the strategic industries' technology development objectives from their manufacturing objectives, and by putting the latter on a fully commercial basis. To ensure maturation of those industries, their infant industry protection and monopoly status, as well as trade and investment barriers and preferential treatment in government procurement should be phased out according to announced schedules. Labor mobility into and out of the strategic industries also needs to be encouraged to increase technological spillovers, spinoffs, and the creation of startup companies.

6.64 Large government investments in new R&D projects in the strategic industries should be strictly limited for fiscal reasons. Experience elsewhere (e.g., Korea, India and Brazil) shows that substantial government investment in heavy industries and advanced technologies is inefficient, leading to high capital-output ratios and slow consumption growth. Scarce public resources could be used instead to help support low-risk but potentially high-payoff investments in restructuring and modernizing the rest of the country's technological infrastructure, which has been relatively neglected and is in danger of not being able to meet the needs of private industry.

6.65 Private investment, and FDI in particular, should be used to develop technology-intensive private industries rather than state-owned enterprises, which require continuing government support and protection. As long as the government has laid the proper foundations by creating an environment conducive to innovation, ensuring that high-technology entrepreneurs do not lack financing, improving the quality of human resources for ITD and by seeing to it that there is an effective infrastructure of technology support services, competitive markets should be

allowed to decide which firms and industries will flourish or perish.

ENDNOTES

[1] The number of employees involved in manufacturing in Hong Kong has dropped to about half a million, down 36 percent since 1980, and now accounts for one fourth of the colony's workforce. The sector contributed only 13 percent of GDP in 1992, compared to 24 percent in 1980.

[2] Soon, Teck-Wong, 1994, *op. cit.*

[3] These are: information technology, microelectronics, electronic systems, advanced manufacturing technology, materials technology, energy and water resources, environment, biotechnology, food and agrotechnology, and medical sciences.

[4] For a fuller analysis of that program, see Dahlman and Sananikone (*op. cit.*); Brautigam, D. (1995), "The State as Agent: Industrial Development in Taiwan, 1952-1972," in H. Stein (ed.), *Asian Industrialization and Africa*, London: Macmillan, 1995; and Hou, Chi-Ming and San Gee, "National Systems Supporting Technical Advance in Industry: The Case of Taiwan," in R. Nelson (ed.), *National Innovation Systems*, Oxford: Oxford University Press, 1993.

[5] See Goldman, M., *Institutions and Policies for Industrial Technology Development*, World Bank, mimeo, 1995.

[6] See *Review of Science and Technology Policy for Industrial Competitiveness in Korea*, Science and Technology Policy Institute, 1995.

[7] See Goldman, *op. cit.*, and Bessant, E., J. Arnold, M. Hobday and H. Rush, "Background/Benchmark Study for the Venezuelan Institute of Engineering," University of Brighton, 1993.

[8] In 1996, the Ministry of Industry merged with the Ministry of Trade to form the Ministry of Industry and Trade (MOIT).

[9] See Mashelkar, R., *Restructuring and Reforms in Public R&D Management Systems in Indonesia*, World Bank, mimeo, 1994.

[10] In many cases, salaries of scientists, engineers and technicians in MOI's labs are only one third those of their counterparts in MENRISTEK laboratories.

[11] Under a World Bank-funded Professional and Human Resources Development Project (LN 3134-IND), the Science and Technology Policy Institute of the Korean Institute of Science and Technology reviewed MENRISTEK's internal management systems.

[12] Indonesia was one of two industrializing countries in the studies of the footwear and printed circuit boards (Mexico was the other). See Mody *et al.*, Industry and Energy Department Working Paper No. 51, *International Competition in the Footwear Industry: Keeping Pace with Technological Change;* and No. 53, *International Competition in the Printed Circuit Board Industry: Keeping Pace with Technological Change)*, 1991.

Summary and Conclusions

7.01 Indonesia faces major challenges in its efforts to accelerate the pace of industrial technology development. Even though it has some of the lowest labor costs in the world, labor productivity and the growth of total factor productivity are low. Product quality is often inconsistent, and wage rates are rising. Other Asian countries (e.g., China and, increasingly, Vietnam and India) are becoming more competitive in many of Indonesia's export markets and are competing aggressively to attract FDI in labor-intensive export industries such as garments and footwear, where Indonesia has been strong. The competitive advantage based on low factor costs, Indonesia's traditional strength, is giving way to a new paradigm for competitiveness. Other factors, including the ability to manufacture to buyers' specification, with total quality management, reliability and fast delivery times, which add value and work effectively within buyers' global supply networks, are becoming more important.

7.02 To sustain export growth and increase value added in its traditional industries while diversifying into new industries with more demanding technological requirements, Indonesia must continue deregulating its economy. Indonesia must also shift its technology strategy away from mission- oriented, public sector-driven R&D toward:

- making more effective use of linkages to sources of foreign technology;
- improving the quality of basic and technical education;
- exercising greater selectivity in the use of public resources for financing ITD in private industry;
- providing effective, demand-driven technology support services to the private sector, including encouraging the private provision of those services.

7.03 As noted throughout this report, these have been core elements of the technology strategies of the East Asian NICs, even though emphasis has varied considerably from one country to the next. For example, government policy interventions in South Korea and Taiwan, China have been important factors shaping industrial and technological capabilities, even though the nature of intervention differed significantly in the two countries. While the Singapore government's direct role in supporting ITD has been far more limited than in those countries, it has invested heavily in technical and scientific education and training and in technology support services for SMEs. Its main strategy has been to create conditions that would encourage R&D by high-technology multinationals, although recently the government has played a more active role in promoting development of local capabilities in such industries as biotechnology and microelectronics. In Hong Kong, the government has traditionally adopted a *laissez faire* approach to technology policy. However, recently it has become much more interventionist because of concern about its lagging industrial performance and the recognition that ITD policies and programs in other East Asia countries have been instrumental in laying the foundation for sustained industrial and technological development.

7.04 Indonesia's competitors in the region have already learned these lessons and have begun to revise their technology policies accordingly. For example, India, in addition to adopting more open trade and industrial policies to encourage exports and increase competitive pressure on firms, has relaxed restrictions on importation of technology and FDI. It has also embarked on major restructuring of its public R&D labs to make them more autonomous, demand-driven and commercially oriented, tying their budgets to earnings from industry and other similar measures recommended for Indonesia (Chapter 6). In addition, the industrial standards infrastructure has been substantially strengthened. There has also been rapid development of the capital markets, including encouragement of the growth of venture capital as a source of financing for the increasing number of innovative SMEs.

7.05 In China, recent reforms in technology policy include:

- liberalizing access to foreign technology;
- encouraging technology-oriented FDI;

- granting public R&D institutions greater autonomy and promoting their restructuring through budgetary reforms to make them more market oriented;
- establishing technology diffusion agencies and productivity centers to respond more effectively to firms' need for technology support services;
- passing laws to protect intellectual property rights and implementing improved legal procedures to protect those rights.

7.06 Malaysia's recent master plan for ITD includes a broad strategy for: strengthening the educational base, including the linkages between education and industry; encouraging firm-level training; developing a more effective network of industrial technology extension services and quality improvement and productivity centers; becoming more selective in approving tax incentives for FDI and R&D; and encouraging venture capital for research-oriented firms. Thailand has emphasized the need for greater autonomy, flexibility and accountability of its publicly provided technology support infrastructure and for closer focus on ways to stimulate the demand for ITD, including the use of matching grant funds for private industry aimed at encouraging technology upgrading.

AN ITD STRATEGY FOR INDONESIA

7.07 In Indonesia, there is an emerging consensus that technology development is central to improving international competitiveness and sustaining rapid growth of its industrial sector, and that inadequate attention has been paid to promoting best-practice technologies that will help Indonesian industry compete better internationally.

7.08 To address these issues, the major elements of Indonesia's ITD strategy should be to:

USE ECONOMIC DEREGULATION TO DRIVE FIRMS TO INVEST MORE IN TECHNOLOGY UPGRADING.

Several of Indonesia's regional competitors have been much more successful in putting pressure on firms to adapt and improve on technology available from abroad through FDI, foreign buyers of their export products, imports of capital goods, and technology licenses. In Indonesia, procompetition policies of the kind described in detail in the World Bank's recent industrial sector and economic reports would have the dual benefit of helping sustain the momentum of industrial growth and of encouraging companies to view continuous upgrading of their technological capabilities as central to their competitiveness strategies.

IMPROVE THE QUALITY OF HUMAN RESOURCES FOR TECHNOLOGY DEVELOPMENT.

Indonesia needs to improve the quality of primary and secondary education in order to provide an appropriate basis for subsequent training. It must also place greater emphasis on training technicians and craftsmen rather than scientists and engineers. The private provision of high quality pre-employment and in-service training should be facilitated through transparent licensing and accreditation of private training institutions, development of systems for national skills standards and certification and rigorous accreditation of technical and vocational training schools.

Mechanisms also need to be developed to ensure better utilization of technicians and scientists who benefit from overseas graduate fellowships through: (a) wider participation of research staff of all research organizations in overseas training fellowships; (b) assigning these individuals to positions that take maximum advantage of the training they receive, should they remain in government service; and (c) encouraging greater mobility of those returnees, including movement into the private sector. Upgrading the quality of domestic university and graduate education also is essential and will require giving greater autonomy to universities, allocating funding for those institutions on the basis of performance.

MAXIMIZE THE BENEFITS FROM FOREIGN TECHNOLOGY.

Indonesia also needs to derive more technological benefits from the substantial foreign direct investment it receives. FDI should be used as a means for technology transfer and for training Indonesian workers and managers. Impediments to higher quality FDI need to be overcome by introducing greater transparency, reducing the time it takes for investment approvals, reducing facilitation payments and making infrastructure services and industrial real estate more competitive. The government has to shift from a passive to a proactive strategy of soliciting strategic investments for building technological capability, as well as providing an attractive business environment.

FDI should also become a source of new industries rather than being used to support state enterprises, which may require continuing government subsidies and protection from imports. Reduction of trade protection on capital goods imports is also needed. In addition, procedures for licensing technology need to be improved, making sure fees reflect the duration of licenses and patents and the complexity of the technologies involved. Adequate legal protection for copyrights and trademarks must be provided.

IMPROVE THE FRAMEWORK FOR FINANCING ITD.

Prudent macroeconomic policies and financial sector improvements to reduce risk are essential to bring down Indonesia's high domestic real interest rates. These disproportionately affect SMEs, which find it difficult to borrow offshore at lower interest rates. Lower rates would increase the availability of term finance for investments in technology development, which often have long gestation periods. The availability of term financing would also be improved by strengthening the capacity of the banking system to appraise technology investments. Fiscal incentives for ITD should limited and carefully targeted to encourage SMEs to adopt new technologies and improve productivity using existing technology.

REORIENT THE TECHNOLOGY INFRASTRUCTURE TOWARD THE DIFFUSION OF BEST-PRACTICE TECHNOLOGIES TO INDUSTRY.

The infrastructure of government technology services has to be substantially restructured and strengthened to support firms striving to improve their technological capabilities and competitiveness. The delivery of MSTQ has to be improved, starting with effective dissemination of information on standards and effective outreach services to industry, especially small and medium-sized engineering firms. Public R&D laboratories need to become more demand driven and service oriented. They should acquire international accreditation for granting product certification in Indonesia and for providing, in competition with private consulting firms, effective technology extension services in order to help firms improve manufacturing and design capabilities. In addition, through membership on laboratory advisory councils and boards of directors, businessmen should help ensure that PSTI programs directly benefit the private sector. Government budgetary support should reflect the laboratories' ability to generate income by sale of their knowledge, services, and products to industry.

In addition to making PSTI resource allocation more performance based, Indonesia also needs to improve coordination among PSTI programs through merger and consolidation of institutions that work in similar areas but fall under different ministries, and by restructuring institutions along functional lines to achieve generic capabilities in industrial technologies, rather than along subsector lines, as is the case today.

While greater accountability should be required of these public agencies, they should, at the same time, be allowed greater autonomy with respect to the use of income generated through the sale of services to industry, and with respect to staffing, salaries, procurement and training. For the restructuring of the institutes to succeed, government will have to make substantial investment in modernization of facilities and professional staff development. However, such investment should be undertaken only if the other recommended measures are adopted and implemented. Greater use of peer and technical panel reviews of public R&D proposals and programs to promote joint public/private sector RD&E activities should be

accompanied by better monitoring and evaluation systems. This would allow Indonesia to experiment with publicly funded but privately executed R&D projects, an approach which has worked successfully elsewhere in the region. Finally, private sector provision of infrastructure services should be encouraged by establishing clear institutional arrangements and procedures for accreditation of private testing services.

IMPROVE THE CONTRIBUTION OF STRATEGIC INDUSTRIES.

In shifting the emphasis of Indonesia's ITD strategy toward these priority areas, some attention also needs to be paid to the strategic industries, which employ some of Indonesia's best scientists and engineers. To ensure that these valuable human resources are deployed for maximum economic gain, the strategic industries' R&D work should be separated from their manufacturing and commercial activities, with the latter put on a fully commercial basis. The provision of infant industry protection and monopoly status to those industries through trade and investment barriers and preferential treatment in government procurement should be phased out. Labor mobility into and out of the strategic industries also needs to be encouraged to increase technological spillovers in the form of spinoffs and the creation of startup companies.

New government investments in R&D projects in the strategic industries should be strictly limited so there will be adequate resources to support low-risk but potentially high-payoff investments in restructuring and modernizing the rest of the country's technological infrastructure. The market should be allowed to play a greater role in the development of technology-intensive industries by creating, through deregulation, a competitive environment that is conducive to innovation, ensuring that high- technology entrepreneurs do not lack financing, improving the quality of human resources for ITD and maintaining an effective infrastructure of technology support services. Within this framework, competitive markets would decide which firms and industries will flourish or perish.

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The World Bank
East Asia and Pacific Region, Country Department III
1818 H Street, NW
Washington, DC 20433-0001
Marianne Haug, Director