TECHNOLOGICAL GOVERNANCE IN ASEAN – FAILINGS IN TECHNOLOGY TRANSFER AND DOMESTIC RESEARCH

by
Jon Sigurdson & Krystyna Palonka

Working Paper 162
October 2002

Postal address: P.O. Box 6501, S-113 83 Stockholm, Sweden. Office address: Sveavägen 65
Telephone: +46 8 736 93 60 Telefax: +46 8 31 30 17 E-mail: japan@hhs.se Internet: http://www.hhs.se/eijs

Technological Governance in ASEAN – Failings in Technology Transfer and Domestic Research

Prepared for
Workshop on

INSTITUTIONAL CHANGE IN SOUTHEAST ASIA

Stockholm School of Economics
10-11 June 2002

Jon Sigurdson
Krystyna Palonka
East Asia Science and Technology Programme
The Stockholm School of Economics
Box 6501
S-113 83 Stockholm, Sweden
Tel. +46 - 8 736 93 69
Fax +46 - 8 31 30 17
e-mail:
Jon.Sigurdson@HHS.SE
Krystyna.Palonka@HHS.SE
web site: www.hhs.se/eijs/eastp

Abstract

Technological governance has only been partially successful for technological upgrading in the five ASEAN countries discussed, with the exception of Singapore. This is a reflection of the fact that FDI is poorly integrated in local and national structures which severely limits the spill-over effects. The early successful export-oriented economic development is no longer viable unless policies and institutions undergo major changes. Furthermore, a continued high rate of economic growth in China, making country into the "factory of the world, is also upsetting assumptions and viability of earlier policies for technological upgrading in most ASEAN countries.

Key words: technology policy, R&D, FDI
JL codes: H1, L0, O3

Table of contents

Introduction[1]

Southeast Asia has been improving its international position as a home for plants of electrical machinery/electronics companies and each country is excelling in specific fields of business. In Singapore, the region's high-tech leader, engineers are abundant, and the country has successfully attracted foreign makers of semiconductors and liquid-crystal displays. Malaysia follows Singapore, centring on the audiovisual field, and is highly valued as a country with expertise in producing electronics parts.

Indonesia serves as an assembly base, making the most of low labour cost, while the Philippines, where English is used as an official language, is being utilized as a base for information-related products such as hard-disk drives and software. Thailand has fewer engineers than Singapore and Malaysia, but it has an abundant supply of line workers and a large domestic market. It is more politically stable and has a higher average national income than Indonesia and the Philippines. Consequently, Thailand has become established as a production base for consumer-electronics products. In the past several years, investment in the region has cantered on Thailand due to the political turmoil in Indonesia and the Philippines, which kept investment away.

Though the largest export category of Thailand is information-technology-related appliances and parts, the export value of such products has fallen. In contrast, exports of home appliances have continued to climb. They will likely support the Thai economy to some extent, though the outlook depends partly on future demand.

In the post-crisis period Singapore has implemented policies to strengthen the domestic innovation and invention climate and to promote industrial innovation activities through grants and tax incentives. Singapore has also decided a train a large number of high-level researchers. However, foreign expatriates continue to play a dominant role in domestic R&D.

Malaysia has continued to strengthen planning and management in science and technology and to promote technology transfer among industries, government research institutes and universities. Innovations are also supported by tax incentives and subsidies.

A debate has been raging on the relative importance of factors that contributed to the financial crisis that hit Pacific Asia in 1997. A major line of thought is that many countries lacked a solid basis for sustained economic development by primarily relying on expanding inputs of more capital and labour. The corollary is that technology and education were neglected sectors. This paper will attempt to highlight some of the shortcomings in science and technology regimes with a particular focus on selected ASEAN countries.

This paper will focus on two things. First, it will highlight some of the characteristics in science and technology regimes with a particular focus on selected ASEAN countries – Philippines, Indonesia, Vietnam, Malaysia and Singapore. A second section will discuss the

---

[1] This draft paper is partly based on a project, Technological Mapping of Asia Pacific, that was started in 1998 with partial results appearing in:
Sigurdson, Jon (jointly with Cheng, Alfred Liping) *A New Technological Landscape in Asia Pacific*, Special Issue of the International Journal of Technology Management, Vol. 22, No 5/6, 2001.

shortcomings that existed and examine the changes in technology regimes, which have taken place since the financial crisis. The analysis will have a focus on the interaction between the public and private sectors, as seen in the context of an ongoing globalisation process.

Available data show substantial increases in patenting by Asian companies in the major market for industrial products - the United States. Pacific Asia overtook the European Union already in the mid-1980s and has expanded dramatically in sectors like telecommunications, and computers and data processing systems[2]. This may indicate that Pacific Asia is more stirred than EU to protect their intellectual property rights in the US. Furthermore, increases in the number of scientific papers also indicate a substantial expansion in research activities, which are likely to strengthen the support for future innovative activities in Pacific Asia. Finally, US is ahead of EU in establishing closer links both in joint research and in joint patenting with partners in the region. However, Japan followed by Taiwan and Korea, and more recently China, is dominant in these statistics.

Long before the financial crisis in Asia there was in the region a preoccupation with the role of technology and exploitation of R&D resources although with varying results from country to country. However, the countries in Asia Pacific, with the possible exceptions of Japan and Korea, had already been influenced by rapid changes in the global economy, which has drastically reduced the prospects for establishing truly national innovation systems. The reasons are threefold.

- First, corporate R&D has become taken on the character of a global resource as a consequence of markets and production becoming increasingly global.
- Second, as a sequel large product segments, particularly in electronics, have become integral parts of Cross-National Production Networks (CPNs), which is today clearly exemplified by the production of the hard disk drives that is used in every computer.
- Third, services and other commercial activities, based on telecommunications and other digital technology, have recently and rapidly emerged as crucial and momentous parts of national economies, which have become most visible in the US.

Technological opportunities are opening up on a global scale and can be seen as paralleling and complementing priorities in marketing strategies. Thus, large global companies develop new organisational practises in order to fully utilise decentralised technological opportunities. Notwithstanding, national objectives exist and have to be formulated in light of global changes.

It has in recent years been argued that the confines of national innovation systems have become increasingly locked up and that national science and technology is becoming subordinated to corporate technology strategies, which sustain Cross-National Production Networks for many types of products.

Apparent that the intensity of global competition in many industries, clearly exemplified in the electronics sector, has forced even innovation-oriented companies to forcibly pursue efficiency in production. Subsequently, there is a tendency for global companies to let their subsidiaries abroad take on a larger responsibility for competitiveness, which often include important elements of product development. This would often require a high degree of

[2] Sigurdson, Jon & Persson, Olle, The new technological landscape in Pacific Asia: an enquiry into the dramatic changes in patenting and scientific publishing, Research Evaluation, April 1998, pp 31-38

responsiveness that will be better served by using local creative resources. This provides a potential, within sub-national regions, of creating fundamental and indispensable technology in such a way that a technological clustering of corporate activities may emerge in appropriate locations.

The key to improving technology performance, as stated by OECD in its study of National Innovation Systems, dwells in the understanding of the linkages among the actors involved in innovation[3]. Such an insight requires broad and systematic knowledge of the domestic innovation system, of systems in other countries, and of the increasingly interlocking character of large global companies. Without such intelligence realistic national objectives cannot be formulated. Even if so, goals and instruments still have to be constantly modified in the light of changes within a national innovation system, which is increasingly taking on global characteristics. This paper will for selected countries identify and discuss changes in technology regimes, which have taken place since the financial crisis.

The countries chosen include the Philippines, Indonesia, Vietnam, Malaysia and Singapore, which not only exemplify countries at very different levels of economic development but also illuminate very policies and conditions for their implementation. The Philippines is a country that has been weak in both formulation and implementation and rudimentary infrastructure and institutions for technological development and has been less able to attract foreign investment (FDI). Indonesia has pursued a two-thronged policy of developing of developing high-technology sectors an actively encouraging FDI. Both policies are partial failure because infrastructure, institutions and human resources have been lacking. Vietnam has in recent years moved from a planned economy with well developed institutions towards a market economy, which requires completely different policies, and institutions. Malaysia has from its early success in attracting FDI of increasing sophistication moved towards an emphasis on selective development of high-technology sectors, for which clustering is an important policy instrument. Singapore at an early stage decided that it would integrate its nation with the global economy and has become a heaven for FDI in specific sectors. The success made Singapore into a high-wage country, which prompted a policy shift towards mobilising the means to make Singapore into a knowledge-based economy. However, in hardly any of the countries, with the partial exception of Singapore has technology yet made as significant contribution to economic development as might be expected.

The technology and innovation policy requires a broad understanding of the interaction between long-term economic development, the internationalisation (globalisation) of the world economy, government intervention into economy, and microeconomics of the innovation on company level. It is worth to mention that the most advanced of the countries studied spend over 2% of their GDP on research and development and the others have the ambitions to follow Thus the term "political economy of technological development" came to existence.

Political Economy of Technological Development[4]

Technological change has been accelerated by globalisation, as markets opened and

[3] OECD 1997 National Innovation Systems, Paris

[4] This section is based on a discussion in Technology Policy in the European Union, by Peterson, John and Sharp, Margaret, London (MACMILLAN Press) 1998

competitors looked to innovation as a means of gaining market advantage. The globalisation has raised several fundamental issues for developing and latecomer countries. First, national policy makers aiming to catch-up with more developed world have to formulate science and technology programs that are in tune with rapid technological development. Second, national governments want to assist their own national companies but it is no longer clear - through the cross-border process of mergers and acquisitions - which companies are national as the identities of firms are increasingly blurred. The second issue prompts a shift in policy focus from the macro to the micro-level, where governments seek to influence the performance of firms and industries - active industrial policy. The first issue requires a close interaction with a global system of innovation - active science, technology and education policies).

The world economy shows broad inequalities that arise from globalisation. A widening of disparities in technological capability between more and less technologically advanced countries is an important political issue of technological development. Many multinational companies have globalised their production, but few have shifted research and development capabilities or corporate headquarters away from their traditional home bases. An important reason for this situation is that technology, in terms of machines and blueprints has become extremely mobile while technological competence embodied in capable humans is still much less so.

Furthermore, it has become recognised that the capacity to innovate is cumulative as innovation gives birth to more innovation. A firm may shift production facilities plant and machinery overseas but people tend not to move. Knowledge and skills acquired over time by the people who work in research remain key factors and it is not easy to pick up new, state-of-the-art technologies without the knowledge and the skills required for making good use of them.

This pattern of technological development has powerful political effects. Countries, and firms, that start with less sophisticated technological competence may be left behind, and often find it very difficult to catch up. More intense competition, between more firms pushes forward the development of ever more sophisticated technologies. This means that the process of competition reinforces the advantage of those in the lead and takes them further along the learning curve. The tendency for technological development to reinforce existing competitive advantages has powerful repercussions, which may be illustrated by the development of the Internet - creating a wide gap between industrialised and developing countries.

A further change in the political economy of research and technological development arises from new industrial structures. Nation states are scarcely able to influence the activities of large, oligopolistic MNCs whose businesses and internal structures are global in scale, and can easily be shifted to new production sites. Simultaneously many multinational companies with globalised activities have decentralised their productive and distributive capacities. The phenomenon is usually referred to networked organisations and is constantly increasing in scope and scale.

So, countries must develop catch-up policies with foundations strongly based on facilitating the access to new technologies and active inducement of foreign direct investments. It has become evident that technologies become diffused more easily if they are embraced widely by citizens in democratic societies. However the historical perspective of the last half of the 20th century in East Asia proves that strong but enlighted political regimes were more successful in imposing development oriented, catch-up policies than the weaker governments.

Nowadays though, technology policies, which in the past have traditionally been producer-driven, have to thoughtfully consider the demand side. A broad and similar lesson may be drawn from the cases of nuclear power in the 1970s, cattle growth hormones in the 1980s and gene technologies in the 1990s Such technologies will not catch on unless they are viewed by citizens as safe, ethical and consumer friendly. Thus successful diffusion depends just as much on social attitudes as it does on technology.

While examining the governmental structures of selected countries one finds variety of state agencies with the special responsibilities for education, technology and science. On the very top level there are the example, as in Philippines, of secretaries of the president cabinet responsible for the area and in other countries a respective ministry in the prime minister's office. The following summary is a first attempt to highlight the character of technology policy and technology development in five ASEAN countries by focusing on inherent features, perceived shortcoming and significant changes that taken place during the past few years.

The Shortcomings of S&T Policies in the Philippines

Philippines ranks low in several R&D indicators such as the ratio of R&D expenditure to GNP, which is very low. Similarly, the country ranks low in terms of number of personnel engaged in R&D. In a study from the Philippine Institute of Development Studies (PIDS) it is stated that the number of scientists and engineers per million population was only 152 in 1992. However the composition of the national cabinet shows at least two bodies responsible for science and education - Secretary for Education, Culture and Sports and Secretary of Science. Secretary of Science leads the Department of Science and Technology (DOST).

The *co*untry's educational system produces low number of graduates in science and engineering although the number of students at the tertiary level is actually quite high in the Philippines. PIDS points out that there is a great demand for technical and engineering-related graduates by local industries and that the private tertiary schools primarily train non-technical students. An important reason for this mismatch is that the private colleges are not able or not willing to invest in costly laboratory equipment. This mismatch continues at the next level and PIDS reports that more than 50% of R&D personnel with Ph.D. degrees - in government agencies, and state universities and colleges - have their degrees in social sciences.

PHILIPPINES – Selected Statistics

POPULATION		**GDP** **1999**		**GDP** 1997	
YEAR2000 Million	GROWTH % 1995/2000	US$million	Per capita	US$ million	Per capita
78,4	2,2	**77967**	**1050**	88372	1200
GDP COMPOSITION BY SECTOR IN %					
Agriculture 2000year \1980year		Industry 2000year \1980year		Services 2000year \ 1980year	
15,9	25,1	31,1	38,8	52,9	36,1
FOREIGN TRADE					
As % GDP		Net Exports per GDP% 2000 1990		Export regions % in year 2000 Asia \ WestEurope	
91,0		1,5	5,5	42,1	19,7
FOREIGN DIRECT INVESTMENTS In US$ million					
Year1999		Year 1998		Year1990	
573,0		2287,0		530,0	
EDUCATION Year1996**					
GDP US$ Per capita PPP year1999		As total government expenditures in%		Number of students in tertiary education per 100 000 inhabitants year1996 \year1990	
3,805		17,6		2958	2817

* Source: Asia Development Bank - www.adb.org
**Source: UNESCO - www.unesco.org

There has been a general failure in the Philippines to use technology to gain competitive advantage. Resource-based exports (timber, copper) are basically in raw material or unprocessed form. Traditional agricultural exports (coconut, sugar, and banana) are also exported without infusing technology-based processing in the valued-added chain. The overall assessment on the state of science and technology in the Philippines is at level set by UNESCO for less developed countries. In terms of human resources, the Philippines has only 155 R & D scientists and engineers per million population which are far below the UNESCO target of 380 for Asian LDCs. Science and engineering education needs to be strengthened. Curricula are outdated, qualified teachers are needed, and laboratory facilities have to be procured.

The government created the National Science and Development Board (NSDB) in 1958 to formulate and implement S&T policies, and to co-ordinate S&T agencies. In 1974, a national science development plan was incorporated in the Medium-Term Development Plan: 1974-1977. All succeeding Medium-Term Development Plans contained a chapter or sections related to S&T policies, plans, and programs. The Department of Science and Technology (DOST) introduced the Science and Technology Master Plan (STMP) in 1990 which set the goals and objectives for the Science and Technology (S&T) sector, and provided a framework for the effective co-ordination of S&T projects and programs consistent with national development policies. The Comprehensive Technology Transfer and Commercialisation (CTTC) program was initiated to disseminate and commercialise locally developed technologies. But there was a lack of locally developed commercially viable technologies. In 1993, DOST introduced a Science and Technology Agenda for National Development (STAND), a successor to STMP.

There were three main strategies of the STMP: (1) modernisation of the production sector through massive technology transfer from domestic and foreign sources, (2) upgrading of R&D capability through intensive activities in high priority sectors, and (3) development of S&T infrastructure, including institution building, manpower development and development of S&T culture.

STAND's objective was to help realise the vision of Philippines 2000 by focusing S & T activities on export niches identified by the private sector. The renewed attempt to formulate industrial policy is a reiteration of the vital role of industrial progress to sustain future economic growth in the country. However, ad-hoc or de-facto industrial policies have not stressed the need for active promotion of technology to build up a strong foundation for industrialisation.

The major thrust of Philippine S&T policy has been recently subjected to contrasting recommendations. One view recommends that the universities and research institutes focus on the basic sciences and advanced technologies to provide the foundation for sustained technological development. This view is popularly called "supply-push" or "technology-push." The other view argues that it makes more sense for the government to provide the enabling environment for the private sector to purchase technologies that it needs.

The most reasonable conclusion that can be made is that both STMP and STAND cannot be implemented. Therefore DOST must effectively address the following problems: (1) shortage of high-quality S & T manpower, (2) dependence on technology importation, (3) low level of private sector participation in R & D, (4) low level of basic research in core, strategic, and emerging technologies such as biotechnology, new materials science, robotics, and information technology, (5) lack of technology data bank and information network, (6) absence of science programs for the younger generation, and (7) insufficient financial resources for S & T development.

In 2000s DOST under new Science Secretary undertook new initiatives. The Medium Term Plan for 1999-2004 outlines the vision and priority goals for establishing a competitive science community. As a result the department supported some 15000 students and trained 1635 teachers in science and mathematics in year 2001. DOST also started the Philippine Research Education and Government Information Network, and it offers over 15 different technological assistance programmes for SMEs through different DOST offices and agencies in the country. There are about 16 offices willing to help the local entrepreneur, among them: Technology Training Centre, DOST-Academe Technology, Global Technology Search, Couple of technology financing, investors for a and fairs, Municipal S&T Program, Intellectual Property Rights Program and others. DOST also advertises and supports successful innovative initiatives via perfectly designed website.

These new actions are too fresh to be assessed; however they prove the new government consciousness about the importance of country internal visions of development in confrontation with dramatic cuts in FDI inflow in the late 1990s**.** To improve the R & D delivery system the authors suggest the consequent strengthening of following measures: (1) reorganise the government-supported R & D institutes into a new corporate structure that gives them flexibility and autonomy; (2) strengthen network of schools or consortia to maximise use of resources and develop core competence; (3) promote the development of S&T culture.

The Dominance of FDI in Indonesia

Indonesia was considered to be the poorest of the countries in the region. It also has the most complicated ethnical structure and serious political problems – party as a result of the latter. The manufacturing sector in Indonesia has sustained a high rate of growth for a number of years and both its share of GNP and exports have increased rapidly. New industrial sectors include electronics and transportation equipment and the textile has through modernisation become highly competitive.

The above mentioned phenomena can be attributed to the significant inflow of FDI. The government organisation in Indonesia is relatively complicated with broad prerogatives given to provincial governors. However at the state level there is an office of Minister for National Education responsible for overall science and education policy.

The technological foundation of the country is weak, as the capital goods sector is underdeveloped. The country's ability to absorb and improve imported technologies is also weak, particularly when it comes to complex technologies. A number of successful export industries controlled or propelled by FDI, have remained concentrated in labour-intensive assembly or resource processing activities. Moving away from this pattern of development will require a significant reorientation of the country's technology strategy. Almost all R&D activities in Indonesia are carried out in government research institutes (GRI), although there is an increasing demand for industrial R&D due to the rapid expansion of the industrial sector. This poses a challenge for reform as the GRI activities rarely in their orientation or research results correspond to the needs within the industrial sector.

INDONESIA – Selected Statistics

POPULATION		**GDP** 1999		**GDP** 1997	
YEAR2000 million	GROWTH % 1995/2000	US$ million	Per capita	US$ million	Per capita
210.5	1,6	125043	600	221533	1110
GDP COMPOSITION BY SECTOR IN %					
Agriculture 2000year \1980year		Industry 2000year \1980year		Services 2000year \ 1980year	
16,8	24,8	47,3	43,4	35,8	31,8
FOREIGN TRADE					
As % GDP		Net Exports per GDP% 2000year \ 1990year		Export regions % in year 2000 Asia \ West Europe	
67,8		7,8	1,5	58,0	15,3
FOREIGN DIRECT INVESTMENTS In US$million					
Year1999		Year 1996		Year1990	
(-)2745,0		6194,0		1093,0	
EDUCATION **Year 1996****					
GDP US$ Per capita PPP year1999		As total government expenditures in%		Number of students in tertiary education per 100 000 inhabitants Year1996 \year1990	
2,857		7,9		1157	930

* Source; Asia Development Bank; www.adb.org
**Source: UNESCO - www.unesco.org

Since mid-1997 Indonesia's economic policy-makers have been primarily concentrated their efforts in dealing with the most serious financial and economic crisis the country has faced since its independence. However, once macroeconomic stability is restored, the Indonesian economy will once again be facing the same challenge as it was facing before the onset of the crisis, namely how to sustain the growth of Indonesia's manufactured exports. Sustaining it is crucial to nourishing the growth of the manufacturing sector, which since the end of the oil boom era in the early 1980s has emerged as the major engine of growth as well as the major source of foreign exchange earnings. Indonesia can no longer continue to rely on its traditional sources of comparative advantage, namely its cheap but low skill labour and its natural resources. Instead, it would, just like the first tier newly industrialising countries (NICs) in East Asia, have to develop a more sustainable base of comparative advantage.

Foreign direct investment (FDI) has generally been the major vehicle for the transfer of technology and other resources (capital, managerial and marketing know-how, and access to world markets) from the advanced to the developing countries. To what extent FDI leads to the development of local technological capabilities depends a great deal on the economic policies pursued by the host government as well as on the local absorptive capability, that is the availability of adequately skilled human resources. Unlike Singapore, Japan and South Korea and to a lesser extent Taiwan pursued highly restrictive policies towards FDI, as they put a high priority on promoting indigenous enterprises and deepening local technological capabilities. Indonesia has in general not been very successful in using FDI to promote the development of local technological capabilities, despite the fact that it has since the late 1960s been receiving large amounts of FDI, at least until the severe economic crisis of 1997/1998 virtually halted the inflow of new FDI.

Therefore, Indonesia has not been successful in using FDI more effectively for its industrial technology development. This has been caused by the fact that the Indonesian government has, unlike for instance the government of Singapore and the other Southeast Asian countries, not taken a more pro-active approach to attracting the kind of FDI the country needed for promoting its industrial technology development.

Findings of some recent firm-level studies on the impact of FDI on Indonesia's industrial technology development in Indonesia's manufacturing sector indicate serious shortcomings. Surveys indicate that in joint ventures the interest of the foreign investors in technology transfer was mainly limited to production engineering that is the smooth operation of the plants. As the foreign-controlled firms mostly relied on the designs developed by the parent company, their design capability is also low. Similarly, industrial engineering capabilities of joint ventures are low, because these ventures rely on their parent companies for these capabilities.

During the period of import-substituting industrialisation in the 1970s and early 1980s, many foreign investors may have been tempted to use relatively obsolete technologies, specifically obsolete capital equipment, as even with these technologies they were able to sell their products in the highly protected domestic markets.

Development in Indonesia has indicated that in most joint ventures the technology transferred from the MNCs to the local employees has been mostly limited to the basic technological capabilities required during the early stages of industrialisation, which is the skills and knowledge required for the efficient operation of the plant. Other factors which have hampered Indonesia from taking more advantage from FDI to promote technology transfer and diffusion has been the shortage of an adequately skilled labour force and the weakness of its relatively few supporting supplier industries.

The development of industrial technological capabilities (ITCs) such as operational (production), acquisitive (investment), adaptive (minor change), and innovative (major change) capabilities, are essential. In order to obtain greater technological benefit from FDI than it has so far, the Indonesian government must pursue sound macroeconomic policies and pro-competition policies to ensure a competitive business environment. The country must also pursue a much more consistent and transparent policy to attract the FDI that it now needs more than ever for its economic recovery and subsequently for sustaining its economic growth and export- oriented industrialisation.

To achieve this, the Indonesian government needs to continue dismantling its still cumbersome regulatory framework in order to further reduce the still high facilitation costs associated with setting up a new plant or office. No less important, the Indonesian government will need to pay a high priority on further developing its human resources in order to raise their capacity to absorb, assimilate, modify, and improve the imported technologies, whether transferred through FDI or purchased through technical licensing agreements.

For a developing country, such as Indonesia, which in various ways still lags behind its East Asian neighbours in its industrial development, industrial technology development does not primarily involve the costly development of new technologies. The development of industrial technological capabilities should in first instance focus on developing the capacity to select, diffuse, and build on imported technologies. A favourable incentive system conducive to industrial technology development should include both sound macroeconomic as well as outward-looking and pro-competition policies. This would motivate and encourage manufacturing firms to undertake the necessary but risky long-term investments in industrial technology development. The training of skilled people and improvements of the educational sector is, as in the Philippines, of crucial importance.

Recent research on technological development in Indonesia summarises the situation in the following five assumptions[5].

- First, S&T policies that target specific high-technology industries will fail when technological, managerial and institutional infrastructure is underdeveloped, and micro-level intervention cannot achieve desired objectives.
- Second, foreign direct investment (FDI) is essential for technological development to offset constraints in domestic structures. However, FDI does not automatically generate technological spillover and linkage effects, which require complementary actions and resources in the domestic economy.
- Third, systematic efforts are needed in the public sector to acquire, upgrade and disseminate technology and know-how when a country moves up the technological ladder, and will require direct government intervention.

[5] Okamoto, Yumiko & Sjöholm, Fredrik, Technology Development in Indonesia, EIJS WWP No. 124 (May 2001), Stockholm School of Economics

- Fourth, external sources of technology are not only important but also essential in early stages of industrial development and require efficient channels of transfer, which must be accompanied by openness to trade, investment and skilled labour.
- Fifth, the shift in focus to the role of FDI in the globalisation process has exposed the important but not relatively unexplored link with human capital. Indonesia must, like other developing countries, formulate efficient policies that can exploit the shift in demand for certain model skills that FDI bring with them[6].

[6] Ref, " Technological Mapping"

Science and Technology in Vietnam

The supply of scientific and technical expertise is of critical importance for Vietnam. Industrialisation and economic growth have been at the forefront of the country's development strategy for a long time, although there has until recently not been much attention to reforms and strategy in the domain of science and technology policy. Within the national government there are Ministry of Science and Technology[7] and Ministry of Education and Training.

The apparent science and technology policies in Vietnam have been designed to encourage and support the acquisition of new technologies. However, taxation laws and the tax collection systems impose constraints on the process of acquiring technology for enterprises, the private ones in particular.[8] The new law for private enterprises being implemented in 2002 has changed the situation and doubled into 70000 the number of SMEs in Vietnam amounting to some 45% in the whole economy. However majority of private sector is located in agriculture and consist of so-called family-household activities.

VIETNAM – Selected Statistics*

POPULATION		**GDP** 1999		**GDP** 1997	
YEAR2000 Million	GROWTH % 1995/2000	US million	Per capita	US$ million	Per capita
77,7	1,6	28733	370	24008	310
GDP COMPOSITION BY SECTOR %					
Agriculture 2000	1980	Industry 2000	1980	Services 2000	1980
24,3	50,0	36,6	23,1	39,1	26,9
FOREIGN TRADE					
As % GDP		Net Exports per GDP% 2000year	\ 1990year	Export regions % in year 2000 Asia	\ West Europe
94,1		2,5	9,7	46,3	30,2
FOREIGN DIRECT INVESTMENTS In US$ million					
Year1999		Year 1997		Year1990	
1609,0		2745,0		16,0	
EDUCATION Year1990**					
GDP US$ Per capita PPP year1999		As total government expenditure %		Number of students in tertiary education per 100 000 inhabitants 1996	1990
1,860		7,5		678	1194

* Source: Asia Development Bank - www.adb.org
**Source: UNESCO - www.unesco.org

[7] Until mid-2002 MOSTE - Ministry of Science ,Technology and Environment.
[8] This problem is highlighted in "Vietnam at the Crossroads: The Role of Science and Technology. Report of the International Mission", IDRC 1998

The situation has become more critical as information and communication technologies have become more pervasive at the same time as the economy of Vietnam has taken on an outward orientation. Given the opportunities of a knowledge-based economy there is an immediate need to identify the necessary structural reforms in the science and technology sector as the country is being integrated into the international economy. Remaining competitive in international markets will require introduction and upgrading technologies that will reduce the effect of rising labour costs.

After the exodus of the French in the late 1950s the science and technology system in Vietnam took on the character of that in socialist planned economy, with a direct and strong influence from USSR and other countries in Central Europe. They provided training and education for engineers, doctors and administrators and most S&T programs were based on models from USSR and Eastern Europe. As a consequence science and technology activities were almost completely isolated from the rest of the economy. Innovative activity was controlled from the top by decrees and was focused on capital goods and defence equipment, which received priority attention.

The "doi moi" of economic reforms that was introduced in 1986 and the subsequent reforms have provided a policy orientation of cautious liberalisation and decentralisation. Furthermore, a fiscal crisis has been affecting the R&D institutions in Vietnam. As a result, the state does no longer hold a monopoly on S&T activities and serious budget constraints have forced government agencies to decentralise, privatise and even abandon a number of S&T programs. The National Centre for Natural Science and Technology exemplifies this new situation. The Centre has come to rely extensively on contract research and consultancy without which it would most likely cease to exist. The result is that the Centre has become oriented towards applied research and more directly linked to the demand of industrial firms.
The two powerful institutions managing research and technology policy on the state level are the Central Institute for Economic Management (CIEM) associated with Ministry of Industry and Trade and National Institute of Science and Technology Policy and Strategic Studies (NISTPASS) affiliated into Ministry of Science and Technology. They promote state programs and co-operate actively with foreign institutions.

Another change is a growing collaboration with foreign partners. The Foreign Investment Law, and Law on Science and Technology of 1995 are of particular importance as they include rules for the protection of industrial property rights, copyrights and also a legal framework to govern technology transfer.[9]

It is important that efficient mechanisms be established for a systematic monitoring of technical change that is taking place in other countries. Only on this basis is it possible to identify the appropriate means for obtaining, adapting and diffusing already available technology to be utilised in Vietnam. However, the S&T sector in Vietnam is lacking the dynamic character that could boost the country's economic development, and the reasons are manifold.

- First, many research institutes are still dependent on government funding, which usually is insufficient due to budget constraints.

[9] The new Science and Technology Law came into existence in 2002 with more autonomy for research institutions and individuals. It also covers the intellectual property rights issue.

- Second, the linkages between enterprises and research institutes remain weak, or even very weak, which reflects the lack of an articulated demand within the enterprise sector, which is still dominated by state-owned enterprises.
- Third, the opportunities for advanced overseas training have been quite limited since the 1980s, whereas much of the older generation of scientists and engineers received their training and higher education in the socialist planned economies.
- Fourth, there is an unmet need for high-level training in areas like policy formulation and implementation not only in science and technology policy but also in areas such as labour, environmental, financial and macroeconomic policies.

Finally, it is important to note that the state sector dominates the economy in Vietnam but is unlikely to be an engine of growth during the present decade. An important reason is that the SOEs will not generate enough jobs to absorb a significant share of new entrants into the labour market, which is estimate to be in the region of 1.2-1.4 million per year. Thus, it appears that private SMEs, and joint venture with FDI partners, will play an increasingly important role in the country's economic development.

It has become obvious that Vietnam during the past couple of years has been experiencing serious political and economic difficulties in its transition from a centrally planned economy to an economy based on risk-taking, incentives and a role of the government that should preferably be limited to general guidance and encouragement. Under these circumstances it is critical for Vietnam to develop a capability to analyse the country's scientific and technological environment, both domestically and internationally. This capability should be brought forward to include advanced skills to formulate and implements science and technology that are appropriate in a constantly changing environment.

A recent report[10] says that there seems to exist a strong commitment to integrate the science and technology system with national social and economic objectives, and also making S&T an integral part of the country's industrialisation efforts. The innovative ideas of establishing private education system in Vietnam is welcomed in enhgineering sciences but meets certain obstruction as far as social sciences are concerned.[11] There are a number of accompanying policy changes to make research demand-driven and create more autonomy for research institutes. However, weak implementation remains the major hurdle for efficient use of science and technology resources in Vietnam.

---

[10] Kang, Olivia Ho-Kyung, Science and Technology Strategy Review in Vietnam, EIJS WP No. 133 (October 2001), Stockholm School of Economics

[11] The Australia's Royal Melbourne Institute of Technology has a freshly established branch campus in Ho Chi Minh City and Harvard University and Connecticut College are initiating training programs and academic exchange. – "Open minds open doors" Far Eastern Economic Review August 1, 2002 page28.

Technology Modernisation in Malaysia

Malaysia in its long-term visionary plan for 2020 strongly emphasised the role of R&D for technological development. This is also reflected in the Action Plan for Industrial Technology (TAP 1990).It is also underlined in The Third Outline Perspective Plan 2000, prepared by Economic Planning Unit[12]. The National Council for Scientific Research and Development (MPKSN) plays an important role in co-ordinating and developing the country's resources for R&D. Among government ministries there are Ministry of Education and Ministry of Science, Technology and Environment.

MALAYSIA – Selected Statistics*

POPULATION		**GDP** 1999		**GDP** 1997	
YEAR2000 Million	GROWTH % 1995/2000	US$ million	Per capita	US$ million	Per capita
23,3	2,4	76 944	3390	98 195	4530
GDP COMPOSITION BY SECTOR IN %					
Agriculture 2000	1990	Industry 2000	1990year	Services 2000	1990r
8,6	15,2	51,7	42,2	39,7	42,6
FOREIGN TRADE					
As % GDP		Net Exports per GDP% 2000year	\ 1990year	Export regions % in year 2000 Asia	\ West Europe
219,7		19,9	2,0	53,8	14,9
FOREIGN DIRECT INVESTMENTS In US$ million					
Year1999		Year 1996		Year1990	
1552,9		5136,5		2333,0	
EDUCATION Year1996**					
GDP US$ Per capita PPP year1999		As total government expenditures in%		Number of students in tertiary education per 100 000 inhabitants Year1996	\year1990
8,209		15,4		1048	680

* Source; Asia Development Bank; www.adb.org
**Source: UNESCO - www.unesco.org

In a first inventory, 1994, of Malaysia's human resources in R&D it was found that the number of researchers per 10,000 people is only 2 while the corresponding figure for Singapore is 40. The GDP per capita expenditures on education places Malaysia in the second place after Singapore among the 5 analysed countries. Relatively low numbers of tertiary students is considered to be the result of huge numbers of country students being educated abroad.

[12] EPU, Kuala Lumpur 2000.

Malaysia has substantial industrial activities in electronics industry, namely in packaging integrated circuits. Basically all global manufacturers of ICs have part of their activity located in Malaysia. This reflects the fact that Malaysia has been perceived as an attractive location for economic and non-economic reasons. The latter factors include the country's political stability, the welcoming attitude of government as expressed in a number of favourable government policies, a good infrastructure in urban areas, a highly productive labour force, and well developed financial and banking sectors. Following from an early emphasis of FDI as an instrument for employment generation Malaysia has substantially upgraded its technological capabilities, which has encouraged existing FDI to expand into more sophisticated production.

MIGHT was set up in 1993 as an independent non-profit company providing a platform for government and industry collaboration. Organisationally it is located under the office of the Science Advisor in the Prime Minister’s Department and led by a joint industry-government board. MIGHT, in the words of its Chief Executive, Dr. Ahmed Tasir: “In a nutshell, MIGHT is a symbiotic relationship between the private and public sectors of Malaysia for the pursuit of a common goal of heralding a new era of technology-led development in the country”.
MIGHT’s activities are focused on the following sectors earmarked for national development:

- Aerospace
- Advanced materials
- Low emission vehicles
- Telecommunications
- Road haulage
- Pharmaceuticals
- Housing and construction

Malaysia has, under the leadership of its Prime Minister, taken a bold visionary initiative to establish multimedia Super Corridor (MSC) close to Kuala Lumpur. The new airport is located in the same area and eventually the capital with its government agencies will move to the same location. The MSC covers an area, which approximately the same size as Singapore.

“The Multimedia Super Corridor (MSC) is Malaysia’s gift to the world.” On this note almost all presentation materials on the MSC commence - making clear that the MSC initiative, launched in 1996, is an open invitation to the global multimedia community. The MSC is a 15 by 50 kilometre “green corridor” stretching from the Kuala Lumpur City Centre (KLCC) in the north to the new Kuala Lumpur International Airport (KLIA) located in the south, due to be opened in mid-1998. Two new cities are taking form within the MSC, the new administrative seat of the to-become-electronic federal government called Putrajaya, and the new IT city of Cyberjaya. The latter, located in the western part of the centre of the corridor, will consist of enterprise, commercial and residential precincts and will also include public and recreational areas. Cyberjaya is to be the core development zone of the seven MSC flagships (see below), and is estimated to have a population of 240,000 (90,000 residents) and to be the location of 500 IT and multimedia companies by the year 2020. Development would take place in four phases; the first was scheduled for completion in 1999. Unfortunately the financial crisis and a bigger than threefold drop in FDI have drastically limited the assumed results of MSC, as “Silicon Valley of Southeast Asia”. The MSC remains so far in the state of infancy and in is not possible to make any evaluation.

The Multimedia Development Corporation (MDC) is a government-appointed and government-backed corporation with the task of leading the management and development of the MSC. MDC sees its role as a promoter and facilitator handling the application process for companies wishing to receive MSC status, expediting permit and licence approvals, and establishing contacts with local partners and financiers. Being a government-owned corporation that is actively supported by the Prime Minister Dr. Mahathir Mohamad, MDC has a unique ability to cut through bureaucratic red tape, and guarantees a 30-day turnaround for all applications.

The MDC has set a 20-year timeframe for the full implementation of the MSC, at the end of which Malaysia expects to be one of the leaders of the Information Age. Development has been divided into three phases of activity. The success of the MSC rests on the successful development of four supporting pillars: 1) soft infrastructure (legislative framework, manpower, attractive incentives); 2) physical infrastructure; 3) high-capacity telecom infrastructure and; 4) the MDC. To attract companies to establish themselves within the MSC, and receive "MSC status", a promising Bill of Guarantees complemented with generous financial incentives has been set-up.

The budding technological capability in Malaysia owes its existence to an early nurturing of FDI and a strong commitment by the government to support selected sectors by developing infrastructure and formulate appropriate policies. There are however problems arising from the fact that chosen economic zones can hardly integrate with the rest of economy. There are also artificial barriers between zones and the rest of country economy and significant diversities between regions in economic development and among local policies. For example relatively successful development of Penang as a "mini-Singapore" is a result of local government policy supporting (mainly Chinese) SMEs. This is evidently contrary to federal attitude against the Chinese minority. The country is still lacking the educational resources to sustain continued and rapid technological development.

Singapore – A Global Centre for R&D

Singapore is after Japan the most advanced country in Asia Pacific and has started to implement large-scale changes in its knowledge and information sectors as they are expected to become the most important factors for future economic growth. Singapore has declared that it wants to turn the nation into a knowledge-based economy. This declaration is expressed by the most developed system of government ministries devoted to accomplish the task. They include Ministry of Education, Ministry of Communication and Information Technology and Ministry of National Development.

SINGAPORE – Selected Statistics*

POPULATION		**GDP** 1999		**GDP** 1997	
YEAR2000 million	GROWTH % 1995/2000	US$ million	Per capita	US$ million	Per capita
4,0	2,6	95429	24150	101834	32810
GDP COMPOSITION BY SECTOR IN %					
Agriculture 2000 1980		Industry 2000 1980		Services 2000 1980	
0,1	1,3	34,3	38,1	65,6	60,6
FOREIGN TRADE					
As % GDP		Net Exports per GDP% 2000year \ 1990year		Export regions % in year 2000 Asia \ West Europe	
277,1		18,3	6,8	57,2	15,4
FOREIGN DIRECT INVESTMENTS In US$ million					
Year1999		Year 1996		Year1990	
6984,3		8984,1		5574,7	
EDUCATION Year1996**					
GDP US$ Per capita PPP year1999		As total government Expenditures in%		Number of students in tertiary education per 100 000 inhabitants Year1996 \year1990	
20,767		23,4		2730	1846

* Source; Asia Development Bank; www.adb.org
**Source: UNESCO - www.unesco.org

Singapore has realised that it is need of post-crisis growth strategy as it feels threatened by both, developing countries such as China, which has low labour costs, cheap production costs, and thus price competitiveness, and by developed countries such as the United States, which has technological competitiveness and production efficiencies. Therefore, Singapore feels some pressure to shift its development strategy from a traditional government-led industrialisation strategy to a different strategy that can utilise Singapore's most important competitive advantage - namely, its well-educated people. This implies that the transformation of its economy should be made in a knowledge-based economy.

A knowledge-based strategy consists of making more effective use of new and existing knowledge and technology throughout the whole economy. There are four important elements in a knowledge-based strategy:

1. An economic and institutional regime that provides incentives for the efficient use of existing knowledge and the creation of new knowledge and entrepreneurship.
2. An educated and skilled population that can create and use knowledge.
3. A dynamic information infrastructure that can facilitate the effective communication, dissemination, and processing of information.
4. An effective innovation system where enterprises, research centres, universities and other organisations interact effectively to create and diffuse technologies using the growing stock of domestic and global knowledge.

Singapore has a small population and limited space. The state has created an attractive climate for foreign high technology companies to locate within this limited area. This has been achieved through a combination of tax incentives, government investments and subsidies, and more recently through development of R&D infrastructure. As a result almost one half of the global production of hard disk drives takes place in Singapore, which contributes about 12 per cent of GNP.

In terms of share of foreign direct investment (FDI) in its gross domestic investment Singapore is the most FDI-intensive economy in the Asia Pacific region, not be matched anywhere else in the world. However, Singapore has encouraged internalised modes of technology transfer, although with thorough targeting in the FDI selection and in the process of technology development. Singapore has extensively use subsidies and other incentives to cause the foreign companies to bring in more advanced technologies and thereby boost local technological activity. Although, industrial activity in Singapore is mainly driven by foreign MNCs the country is relaying on upgrading technological skills and industry contributes considerably to local design and development.

The nature of FDI into Singapore has become increasingly sophisticated and is a key instrument in continuously upgrading the economy. The adoption of a very liberal immigration policy is aimed at attracting foreign professionals and skilled labour to become permanent residents and offset local workforce shortages. The government is also an active player in driving economic development by establishing state-owned enterprises or government-linked corporations in key industrial areas that are either not satisfactorily pursued by the private sector, or deemed to be of strategic national importance.

The R&D activities in Singapore are, similar to the industrial structure, closely geared to meet the needs of information technologies (IT) and a number of R&D organisations are specifically focused on IT development. The second five-year NSTP - NSTP 2000 - launched in 1996, projected S$4 billion government spending until the year 2000, which is twice the figure allocated in 1991, representing 1.6% of gross national output but still short of the 2% goal. The number of RSEs was targeted at 65 per 10,000 labour force.

The new organisations in mid-90s were established to strongly support the country's S&T policies. The National Science and Technology Board is focusing on basic research while the Economic Development Board is concentrating on applied and development activities. Offering high salaries and an open labour market Singapore has been able to attract by 1999, about 17% of its science and technology personnel from foreign countries. Generous grants have been offered to MNCs to undertake R&D activities and the Skills Development Fund offers substantial funds for training. However, the efficiency in linking public research institutes wih enterprises is lacking and mobility of local researchers may pose a long-term threat.

The NSTP provides the Singapore Government with an policy framework to guide and support national research and technological diffusion through activities such as fiscal incentives, R&D funding, infrastructure and manpower development and setting up national research facilities, which include 8 research institutes and 5 research centres. Today, the key industry and service clusters targeted for development by NSTB are:

- Manufacturing and engineering systems
- Information technology and services
- Electronic components and systems
- Chemicals and environmental technology
- Life sciences - biotechnology, food and agrotechnology

Under the guidance of the Economic Development Board (EDB) Singapore is undertaking ambitious biomedical initiatives such as the building of a clinical trials centre for drug manufacture and the development of a genetic reference database program and bioinformatics centre. The database will be established in collaboration with the Singapore Genomics Program (SGP) that is collaborating with the Massachusetts Institute of Technology. The Bioinformatics[13] Centre (BIC) that was established in 1966 with funding from EDB plays a leading role in the Asia-Pacific Bioinformatics Network, and has during 2000 undergone a major reorganisation to give it a more commercial edge.

Singapore is already recognised as a pharmaceutical-manufacturing centre. International companies like Aventis, Glaxo Smith-Kline, Merck Sharp and Dohme, Schering-Plough and American Home Products have invested over $1.3 billion in plants to produce active pharmaceutical ingredients and finished products.[14] Glaxo also coordinates its clinical trials research in the region out of Singapore.

Singapore's single-minded aim at becoming a developed nation soon after the turn of the century starts from the National Innovation Framework for Action (NIFA), which was made public in January 1998. The NIFA document was prepared during 1997 by three agencies: Economic Development Board (EDB), National Science and Technology Board (NSTB) and Singapore Productivity and Standards Board (SPSB). Taking into consideration the recent regional currency turmoil, the framework aims to be the starting point from which an innovation roadmap for Singapore can be developed.

The underlying rationale for NIFA is that Singapore can no longer rely on labour and capital to sustain growth in the global economy. The new competitive environment forces Singapore to focus on enhancing capabilities to be able to compete globally in new areas. Innovation is identified as the instrument that will give Singapore a differential advantage in the third millennium. Previous instruments promoting and encouraging technological innovation, development and commercialisation are not considered sufficient. Innovation will be the differentiating factor in sustaining Singapore's long-term competitiveness because it will allow rapid advances in capability and value-added growth.

---

[13] Bioinformatics is an interdisciplinary research area that may be broadly defined as the interface between biological and computational sciences. It involves solving complex biological problems using computational tools and systems. It also includes the collection, organization,, storage and retrieval of biological information and databases.

[14] Discovering Drugs in Singapore, Andrew Witty (Glaxo Vice-President), Far Eastern Economic Review, November 5, 2001

Impressed observers argue that if any country can break into the life-sciences industry from a standing start Singapore probably has the best chance. The government in Singapore has a track record in other fields of sticking with its plans, which is important as the development of a life-science industry with require sustained efforts over many years. However, critics argue that Singapore will only gain jobs and training from its huge investments in biomedical science. They argue that students and researchers will consider Singapore as little more than a stopover in their careers. It remains an open question whether Singapore will be able to compete with cities such as Shanghai and be able to create a critical mass of first-class scientists and infrastructure to successfully commercialise products.

The China Factor

China has become the great competitor for Southeast Asia. It is already a challenge in terms of attracting foreign direct investment, and it is going to be a threat to Southeast Asia's world trade. As China becomes the world's leading supplier of mass-produced goods, Southeast Asia, as well as Japan and South Korea, will have to be opting for niche products of high quality and prestige. The moves by Minolta in Japan illustrate ongoing changes[15].

By moving nearly all production of information-technology equipment, which accounts for nearly four-fifths of consolidated sales, as well as low-end cameras overseas, Minolta hopes to enhance cost competitiveness and earnings. Minolta Co. plans to halt domestic production of photocopiers, printers and other equipment and shift it to two plants in China by 2006. Minolta plans to halt during fiscal 2002 production of cameras in Malaysia, as the operations are losing money. All camera production, except single-lens reflex and other high-end models, will go to a plant in Shanghai.

Since China in the early 1980s embarked on its open-door policy, manufacturing companies from all over the world have congregated in China to exploit the prospects for substantially lower costs combined with a relatively skilled and disciplined labour force - not to forget the huge domestic market potential. During the past 20 years China has emerged as the “workshop of the world” leaving Japan behind. However, it would be a great mistake to continue to view China as the “workshop”. China is rapidly advancing in many technological fields, although its technological prowess still lags behind.

The increasingly close technological and industrial relations between Taiwan and the Mainland is also effecting the ASEAN countries, considering that Taiwan directly controls 70 per cent of the global production of motherboards and indirectly another 15 per cent shipped in complete PC sets – in total the figure is approaching 90%. Taiwan produces some 55% of all notebooks and design and miniaturising prowess gives Taiwan an edge in the manufacture of many IT products. Five years ago 70% of Taiwan’s production of IT hardware came from Taiwan itself. The figure has annually been reduced by some 5% and is now down to 46%. In the future it is expected that China will host 40% and Taiwan 40% while remaining will locate close to markets. Production in Malaysia used to 10% but is now down to 4%.

It is becoming clear that China is not only becoming the factory of the world but also increasingly attractive location for industrial research and development. Electronics and information equipment manufactures, which are among chipmakers' largest customers, are

[15] Minolta shifts production of key products to China, Nihon Keizai Shimbun, April 1, 2002

increasingly shifting their chip design and development operations to China. Chipmakers, for their part, face the need to strengthen their operations in China in order to work closely with corporate customers from the early stages of chip design.

In a trend indicative of China's growing dominance as a chip producer, Toshiba Corp. and other major semiconductor manufacturers are rushing to strengthen their chip design and development operations in the country[16]. Toshiba plans to increase the number of engineers at its chip-development centre in Shanghai from 40 to 100-200 this year and to 1,000 by the end of fiscal 2003. The centre, established in July of last year, develops software to enhance the audio and image-processing functions of system chips used in home electronics and information equipment. Toshiba will shift its chip design and development operations to China because it does not have a sufficient number of software engineers in Japan and personnel expenses for Chinese engineers are around one-forth those of Japanese engineers.

Mitsubishi Electric Corp. will raise the number of staff members at its chip-design centre in Beijing to nearly 300 from about 40 in the next three years. The centre will design and develop micro-controllers for home electronics and other equipment to be supplied to local electronics makers. NEC Corp. will expand the staff at its chip-design centre in Beijing to more than 200 by end of 2002 from the current 170. In January 2001, Matsushita Electric Industrial Co. established a software-development centre for mobile communications and audiovisual equipment in Beijing. The company will raise the number of engineers at the centre to 1,500 in 2005 from about 60 at present.

An appreciation of the changing technological prowess was reflected in a heated debate in Taiwan in early 2002 whether the Government would allow the transfer of 8” wafer plants from Taiwan to China in order to manufacture advanced integrated circuits on the Mainland. Capturing market shares for increasingly sophisticated products has motivated the investment of 8” wafer plants in China. One example is the smart cards as the Chinese government has decided that every citizen should have a smart card – and that everything has to be produced in China. However, only old equipment will be used – as Taiwan is moving into 12” wafer production. Subsequently, the National Science Council in Taiwan drafted a national science and technology protection bill.[17] At the same time the Mainland Affairs Council (MAC) argues that, while not all high-tech talent will be restricted from working in China, there is a need for supplementary legislation to prevent an exodus of high-tech workers and protect core-advanced technology, following from the decision to allow idle 8” wafer plants to be transferred to China.[18]

China is being able to attract multinational companies to establish not only their production bases but also sites for industrial research and development. Furthermore, the size of the China market is attractive in itself but high-tech companies that want to serve FDI plants in China are subsequently forced to establish themselves if they want to remain suppliers there. Thus, China becomes a magnet that has strong attraction of technologies that will serve China’s continued development. Thus, China is becoming a centre for companies like Flextronics and Solectron that provide electronic manufacturing services (EMS) to the large electronic MNCs like Alcatel, Siemens, HP and Ericsson.

---

[16] Japan Chipmakers head for China, Nihon Keizai Shimbun, January 28, 2002
[17] Taiwan needs science tech protection laws to safeguard security, The China Post, April 10 2002
[18] MAC backs restrictions on China-bound tech workers, Taiwan News April 9 2002

> Flextronics in early April 2002launched its industrial park in Shanghai and has thereby brought the concept of electronics manufacturing services (EMS) to China. Flextronics announced that it will develop a complete manufacturing centre that makes components, cables, plastics, and metal parts needed for assembling products on site. It Flextronics will provide a range of services centred on manufacturing, including innovative design, engineering tests and logistic solutions – to meet the need of their customers such as IBM, dell, Cisco, Siemens, Ericsson and Alcatel. will also integrate with strategic suppliers who have formed partnerships with Flextronics in China.

The same consequences are evident also in more mundane industrial sectors like motorcycles and cars. The massive importation of motorcycle components into Vietnam in recent years, which indicates a losing control of government technology and industrial policy.[19] In an interview in mid-2002 a leading Chinese exporter of motorcycles provided the following information to Vietnam[20].

The recent rapid expansion of exports to Vietnam indicates great possibilities for the motorcycle manufacturers in China – and possibly also for other engineering sectors. Hardly any Chinese motorcycles were exported to Vietnam in 1998 while Chinese companies captured 16 per cent of the market in 1998 of which Lifan & Hongda captured almost one fourth – 3-4% of the market in Vietnam. Dr Li says that the prediction is that motorcycles from China will capture some 30 per cent of the market in Vietnam in 2000 and it is expected that the share will increase substantially. This has greatly upset the Japanese manufacturers who have actually ruled the market for motorcycles in Vietnam where they established substantial production facilities.

The strategy to enter Vietnam was taken in late 1996 and early 1997 – at the time when the Group entered into the assembly of motorcycles. A major policy change took place in 1998 when Lifan & Hongda Group was given a general export license and could trade directly. Before that time all exports had to go through one of the import/export companies

The emergence of strong industrial and technological prowess is also evident in the car industry where the emergence of the Chery and he Merie – two locally made cars that have unexpectedly materialized during 2002 as the fasted selling models – have surprised almost everybody. One manufacturer is a former motorcycle parts maker and the other is company that was established in one of the outlying provinces only 5 years ago[21]. An important part of the explanation lies in the rapid development of the Chinese car parts market that the companies such as Volkswagen, Citroën, Peugeot and Fiat have worked diligently to develop since they entered China in the mid-1980s. As a result car parts that are often identical to foreign brand components are today manufactured by thousands of Chinese companies, and being sold on the open market.

The Future of S&T in ASEAN countries

[19] Vietnam's Economy in 2001, Central Institute for Economic Management (CIEM), National Political Publishers, Hanoi, 2002, pp 124-125
[20] Interview with Manager in Charge of Marketing at Lifan & Hongda in Chongqing, June 9, 2000
[21] Kynge, James, China's reverse shock, Financial Times June 7 2002

ASEAN countries have to cope with the rapid development of technology that lies at the core of the cross-national production systems (CNPS) that in the past have greatly supported export-oriented policies – originally based on labour-intensive assembly. The changes at Seagate, the leading manufacturer of hard disk drives provides illuminating insights. Seagate and other manufacturers of hard disk drives, as well as many other producers of IT products established large manufacturing networks in the region. The past two decades of technology-driven mass-manufacture in Southeast Asia has given many countries in the region a physical infrastructure that can compare with that of Europe – with wide roads, uninterrupted electricity, and modern ports and airports. However, the CNPS are requiring much less manpower as both product and production technology rapidly changes. China is at the same time becoming the preferred site of location for many activities.

The FDI inflow into chosen countries has decreased dramatically in the late 1990s. It has also reshuffled the ranks of recipients. The most vulnerable in this respect appears to be Indonesia and Philippines, which partly reflects the political turmoil, with Singapore and Vietnam remaining relatively immune.

FOREIGN DIRECT INVESTMENTS In US$			
	Year1999	Year 1996	Year1990
Indonesia	**(-)2745,0**	6194,0	1093,0
Malaysia	**1552,9**	5136,5	2333,0
Philippines	**573,0**	2287,0*	530,0
Singapore	**6984,3**	8984,1	5574,7
Vietnam	**1609,0**	2745,0**	16,0

* year 1998
** year 1997

The future of the countries in Southeast Asia is intimately linked with their development of a sustained science and technology capability. Competitiveness has been defined on the basis of many criteria, including science, technology and management. Factors contributing towards competitiveness include people, infrastructure, good governance, management and science and technology. However; it is not only the financial crisis of 1997 that in a major way has effected the economic development in the ASEAN countries. The same countries have in recent years been greatly influenced by the emergence of China as the factory of the world.

The countries covered in this paper continue to differ in performance. Singapore has successfully kept ahead of its counterparts in the region by staying in the 2nd place for years – according to World Competitiveness Yearbook (WCY) released by the International institute of Management Development[22]. Malaysia has been declining and Thailand, Philippines and Indonesia are even lower. See table.

Table
Competitiveness ranking among selected ASEAN countries

	1998	1999	2000
Singapore	2	2	2
Malaysia	20	27	25
Thailand	39	34	33
Philippines	32	32	39
Indonesia	40	46	45

Technological development in the five countries that have been briefly reviewed shows a number of similarities with the exception of Singapore. They are still bogged down by low-skill workers and low productivity. They require new key elements of competitiveness, which will have to come from enhanced capability in production, marketing and services.

The sectoral structures of their economies are changing but agriculture remains substantial part of their GDP composition. The new capability should be based on technology and competence in management to a large degree. Southeast Asia in general has to develop new technology- and management-based capabilities, which will allow the countries to offer higher quality, or new, goods and services at competitive prices, hence finding new niches in global trade. It should be noted that the technology base required for new competitiveness does not necessarily require massive investments in R&D resources.

Vietnam remains still a very poor country but introducing significant reforms towards privatisation and supporting private companies. Still the most critical issue is the level of education and technological capabilities of private businesses located in particular in agriculture

While still having relatively low labour cost, countries like Indonesia and the Philippines are forced to restructure. Factors contributing towards competitiveness include people, infrastructure, good governance, management and science and technology. Each factor depends in turn on a number of variables, but a key variable governing all of these factors to a greater or lesser extent, at the present state of development of many Southeast Asian economies, is innovation. Innovation is defined here, not in a narrow technical sense, but as a broad dynamic process of introduction of new beneficial elements into a system, which will lead to better, more efficient performance of the system. Philippines at the beginning of 21st century undertook appealing efforts to stimulate local entrepreneurial forces.

A lack of sustainability characterises the development paths of many countries in this region, although the future of these countries is intimately linked with the future of their science and technology and education. A shift in focus of the role of FDI in the globalisation process has brought to the forefront the important but still relatively unfamiliar link with the development of human capital. The MNCs create by their exposure to the global economy an awareness of

[22] WCY, IMD, Lausanne, April 2000

modern technology and management. By exploiting this understanding the host countries should not shift their educational policies to not only meet this demand and also diffuse such skills throughout the economy.

While much of the blame can be laid on the weak financial infrastructure and poor corporate governance, one of the root causes for development un-sustainability is the lack of competitiveness of their economies, in turn resulting from lack of innovative capability based on science and technology. This is required in order for these countries to make economic transitions necessary for advanced developing economies. A balanced development is required, with emphasis placed on niche areas where these countries have strategic advantages.

If a government wants to be successful in using technology to achieve rapid economic growth it must not only identify and adopt the right basics but also be ale to effectively implement them[23]. This will require the country to have institutional mechanisms that should include an environment that encourages private investment, a competent bureaucracy that can implement adopted policies, and also institutions that facilitate communication between the state and private sector.

Examination of the structural problems of countries like Indonesia, Philippines and Vietnam reveals a serious lack of human and social capital needed for sustainable participation in the global economy. Although they have large populations, the countries lack the capability required for continually changing work demands. The importance of strategic, long-term policy and planning in science, technology, and education is very clear, from the fact that they need both considerable resources in order to carry out the planned activities, and a long lead time to accumulate the required trained manpower.

Education-basic data

	GDP US$ Per capita PPP year1999	As total government expenditures in%	Number of students in tertiary education per 100 000 inhabitants	
			year1996	year1990
Indonesia	2,857	7,9	**1157**	930
Malaysia	8,209	15,4	**1048**	680
Philippines	3,805	17,6	**2958**	2817
Singapore	20,767	23,4	**2730**	1846
Vietnam	1,860	7,5	**678**	1194

[23] Lee, Chung H., The State and Institutions in Asian Economic Development, EIJS WP No. 127 (June 2001), Stockholm School of Economics

Source: ADB, UNESCO

Strategic planning in Southeast Asia has started to acquire an impetus with long-term policy statements, such as Malaysia's Vision 2020, and ASEAN Vision 2020. A vision provides the wanted scenario to strive for, and indicates the future point of a long-term policy. Even when the government does involve itself, programs do not form an integrated technology strategy, and the public often does not have good access to the process. It is generally agreed that governments are most effective when they act as catalysts by providing missing components such as R&D, education, agricultural extension etc. Thereby they are in the position to induce firms to get on with effective innovations, and making markets work effectively. However, even well intentioned and well formulated programs may become captured by vested interests, which are likely to undermine the original objectives.

It is usually the case that the public learns about the government's plans after they have been drafted. So public hearings are often more about selling the proposal than gathering public input. The current technological system operates in most countries largely within a market-based framework. There is a need for transparency in both the nature of technology, as well as the decision-making process. Exposing the decision-making process goes a long way to ensuring better public accountability. It is not surprising that in many areas where the press has a high degree of freedom, we see greater public accountability in technological projects.

REFERENCES

Blomstrom, M. and A. Kokko (1998), 'Multinational Corporations and Spillovers', Journal of Economic Surveys, 12 (3), pp. 247-277.

Dodgson, M. (2000), 'Policies for Science, Technology, and Innovation in Asian Newly Industrializing Economies', in Kim and Nelson (eds), pp. 229-268.

Funston, John (ed) (2001) " Government and Politics in Southeast Asia", ISEAS, Singapore

Hill, H. and Thee Kian Wie (eds) (1998), Indonesia's Technological Challenge, Institute of Southeast Asian Studies, Singapore.

Hobday, M. (1999), 'Understanding Innovation in Electronics in Malaysia', in Jomo, Felker and Rasiah (eds), pp. 76-106.

Hobday, M. (2001), 'The Electronics Industries of Pacific Asia', Asia-Pacific Economic Literature, 15 (1), pp. 13-29.

Jomo, K.S. and G. Felker (eds) (1999), Technology, Competitiveness, and the State: Malaysia's Industrial Technology Policies, Routledge, London.

Lall, S. (1998), 'Technological Capabilities in Emerging Asia', Oxford Development Studies, 26 (2), pp. 213-244.

Lall, S. (1998a), 'Technology Policies in Indonesia', in Hill and Thee (eds), pp. 136-170.

McKendrick, D.G., R.F. Doner, and S. Haggard (2000), From Silicon Valley to Singapore: Location and Competitive Advantage in the Hard Disk Drive Industry, Stanford University Press, Stanford.

Mathews, J.A. and D-S Cho (2000), Tiger Technology: The Creation of a Semiconductor Industry in East Asia, Cambridge University Press, Cambridge.

NSTB (National Science and Technology Board) (1997), National Science and Technology Plan, Singapore.

NSTB (2000), National Survey of R&D in Singapore, 1999, Singapore.

Okamoto, Y. and F. Sjoholm (2001), 'Technology Development in Indonesia', Working Paper No. 124, The European Institute of Japanese Studies, Stockholm.

Rasiah, R. (1999), 'Malaysia's National Innovation System', in Jomo and Felker (eds).

Sigurdson, Jon, Cheng, Alfred Li-Ping (eds) (2001), A New Technological Landscape in Asia Pacific, Special issue of the *International Journal of Technology Management*, Vol. 22, No 5/6

Sigurdson Jon, & Cheng, Alfred Li-Ping 2001), Introduction – New Technological Landscape in Asia Pacific, Special issue of the *International Journal of Technology Management*, Vol. 22, No 5/6.

Soesastro, H. (1998), 'Emerging Patterns of Technology Flows in the Asia-Pacific Region: The Relevance to Indonesia', in Hill and Thee (eds), pp. 303-325.

Thee Kian Wie (1998), 'The Determinants of Indonesia's Industrial Technology', in Hill and Thee (eds), pp. 117-135.

Wong Poh Kam (2001), 'From Leveraging Multinational Corporations to Fostering Technopreneurship: The Changing Role of S&T Policy in Singapore', in L. Low and D.M Johnston (eds), Singapore Inc: Public Policy Options in the Third Millenium, Asia Pacific Press, Singapore.