Chapter 9

New Perspectives on Industry Clusters in Malaysia

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New Perspectives on Industry Clusters in Malaysia

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1. OVERVIEW

The promotion of industry clusters has become an integral part of Malaysia's industrial policy, as enshrined in the country's Second Industrial Master Plan (1996-2005). This strategy continues to stay with Malaysia's Third Industrial Master Plan (2006-2020). Several industrial clusters have emerged, driven by the private sector and supported by the government, in different parts of the country. Thus, for example, electronics industries tend to cluster in Penang, furniture and palm oil in Johor, and ICT and machinery in the Klang Valley.

Export-oriented industries, such as electrical and electronics (E&E) as well as textiles, were formed in the 1970s. This was facilitated by the availability of cheap workforce, the establishment of free trade zones, and various investment incentives. As the economy progressed, policy was shifted towards higher value-added products. To enable this, various measures to encourage foreign direct investment (FDI) to strategic sectors were implemented.

Together VISION 2020, IMP2, and IMP3 frameworks led to the creation of eight industry groups identified as growth-enhancing sectors. These groups are: (a) E&E, (b) textiles and apparel, (c) resources, (d) chemicals, (e) materials, (f) agro-based products, (g) transportation, and (h) machinery. The first two industry groups (a & b) are mainly MNCs-driven. Their products are mainly for the global market, while their growth and sustainability rely on external determinants. The third to sixth industry groups (c – f) listed above are natural resource-based clusters. The extent of indigenous involvement and ownership are high in these industries, supported by local research and development

(R&D) institutions. Examples of such industries are wood-, rubber-, and palm oil-based, petrochemicals, polymers, and composites products. Finally, the last two groups (g & h) are technology-driven. They are identified through government policy initiatives and are critical for the development of particular capabilities, industries, and competencies within the country. Examples of such industries include automotive, marine transportation, and aerospace.

Moreover, to move towards higher value-added production, indigenous technological development becomes crucial. Measures carried out include (1) acquisition of foreign technology firms, (2) purchasing of technology, (3) establishment of R&D facilities, and (4) setting up of technology incubation centers. Additional projects, such as (i) E&E, (ii) ICT, (iii) petrochemical, (iv) palm oil, (v) automotive, (vi) various manufacturing, and (vii) new economic corridors were created to attain higher value-added production.

Both E&E and ICT industries shared similar success factors, namely strategic location with good physical infrastructure, increasing trend in global outsourcing, skilled workforce, efficient telecommunication systems, and ongoing research and development (R&D) activities. However, most of these companies are small in size and in their capital outlay. As a result, policy designed to relocate them to special zones, such as the Multimedia Super Corridor (MSC) compound had failed, as they could not afford the high rentals, and hence the new MSC National Rollout policy to create suitable cybercities and cybercenters across the country.

Five cybercities and six cybercenters were identified base on eight factors: (i) commitment of the state authority, (ii) broadband and infrastructure readiness, (iii) customer-centric management with key performance index, (iv) competitive environment to attract investment, nurture start-ups or SMEs, and house knowledge workers, (v) availability of talent pool professionals, (vi) proximity to universities and R&D centers, (vii) relevant flagship applications to improve service delivery, and (viii) adherence to State ICT Blueprint, which provides value propositions for the local sector.

To meet these determinants, MDeC (the governing body of MSC) leverages on comparative advantages of each state by creating nuclei of value formation, whilst bridging the digital, mind, and economic gaps via ICT. Furthermore, MSC National Rollout is focusing on socio-economic readiness and economic potential of each state in

order to create impact. Finally, to raise volume, value, and success rate of this procedure, there is a need to foster synergistic joint ventures (JVs) among cybercities and cybercenters domestically, regionally, and internationally.

Cluster development has also assisted SMEs in building core competencies, to be part of the global production networks and supply chains. A number of SMEs in the E&E sector have progressed to become global suppliers to MNCs. Nevertheless, the prevalence of MNCs, which depend mainly on their respective parent companies for technology, restricts the technological capabilities of local supplier firms. Local firms do not regard universities and research organizations as a source of R&D, and do not invest in in-house R&D. This impedes the presence of local firms in export markets. The development of an indigenous knowledge-based industrial cluster presents a major challenge to the government.

The prosperity of the petrochemical sector depends on strategic location, such as close proximity to China. This is made possible through the formation of Asean Free Trade Area (AFTA), which has enlarged the market size of domestic petrochemical industry. Moreover, the availability of skilled technical manpower, stable supply of feedstock, and excellent integrated infrastructure also matter significantly.

The attractiveness of the palm oil industry clusters lies in its renewable energy source and cost competitiveness compared to crude oil. The key success factors of the biodiesel industry are technology and quality. Malaysia has the first integrated biodiesel plant in the world, capable of producing biodiesel and related derivatives. Various incentives such as tax waiver, R&D, special industrial building allowance, and reinvestment deduction are given to promote this industry.

Although the automotive industry was initiated much earlier, it has failed due to several reasons. The shortages of skilled labor accounted for the bulk of dissatisfaction on part of the Japanese manufacturers. Moreover, frequently changing policy measures designed to insulate the domestic car industry has impeded FDI flow into this sector. While the newly formulated National Auto Policy (NAP) attempts to promote a competitive automotive sector in Malaysia, inert second-hand market has dampened its prospect.

More recently, the government has acted as an enabler to reinvigorate some of the existing high-growth potential areas and industries. This includes the promotion of five

new economic corridors, namely Iskandar Development Region (IDR), Northern Corridor Economic Region (NCER), Eastern Corridor Economic Region (ECER) Sabah Development Corridor (SDR), and Sarawak Corridor of Renewable Energy (SCORE). These corridors cover several existing industry clusters. For example, the IDR in Johor encapsulates various resource-based industries, E&E (extension from Singapore), furniture, and textiles. However, large capital expenditures may be needed to sustain activities in these corridors. Accordingly, attractive investment packages, facilities, and tax concessions are in the works to attract more FDI flows to manage these corridors.

Finally, results from the mail survey to 20 manufacturing companies in the Klang Valley suggest that factors that promoted initial establishment have continued to prevail. These factors were (a) the availability of investment incentives, (b) liberal trade policy, (c) good physical infrastructure, and (d) the availability of general utilities. Nevertheless, barring the small sample size, these responses seem to be consistent with those of other industry clusters discussed above. The major impediments identified, include the lack of skilled labor and rigid custom procedures. Thus, there is a need for policies to correct these deficiencies. In addition, the lowering of corporate taxes should encourage more investment into Malaysia. The setting up of more training facilities for the training and retooling of the workforce would help ease the shortage of skilled workers. Lastly, the creation of a regional networking center, business parks, and certification center may also expedite cluster formation across the country.

2. POLICY FRAMEWORK

The Malaysian economy has arrived at a new crossroads. The meteoric rise of China and India and the rapid pace of globalisation have forced Malaysia to reinvent itself so that it can remain competitive and relevant. Unskilled labour-intensive manufacturing activities have migrated to countries where labour is cheaper. Malaysia has to move up the value chain away from labour-intensive low value-added production to skill-intensive and knowledge-intensive, high value-added production.

The shift to the K-Economy offers enormous opportunities through improved productivity and economic performance. However, it also brings with it formidable

adjustment challenges with implications for individuals, firms and the government. Already, the notion of a post-industrial era or a knowledge-based export-led industrialization, based predominantly on services and ICT, is causing uneasiness among certain businesses, especially the traditional and protected ones.

We need to bear in mind that Malaysia is in a catching-up situation, at least when it comes to the new growth areas. Given the scarce resources, Malaysia needs to keep its focus on areas that will soon have a profound impact on the economy. As such, the following areas, biotechnology, ICT, resources-based industries, nanotechnology and SMEs, have been chosen for a broad discussion.

3. BIOTECHNOLOGY

Biotechnology, defined as the use of living organisms or their products to modify foods, agriculture and human health, has existed in one form or another for ages. In this sense, biotechnology is not new. The fermentation of fruit juices into wine, the transformation of milk into yogurt, and the use of animal breeding techniques to produce desirable traits in animals are all instances of biotechnology. Tremendous achievements have been made in the field of biotechnology and new technologies have been developed in recent years making the face of biotechnology almost unrecognisable.

This new face of biotechnology is of sufficient importance to be adopted by the 1992 United Nations Conference on Environment and Development as part of Agenda 21. Agenda 21, which was signed by world leaders, was ambitious enough to claim that biotechnology would:

> "make a significant contribution in enabling the development of, for example, better health care, enhanced food security through sustainable agricultural practices, improved supplies of potable water, more efficient industrial development processes for transforming raw materials, support for sustainable methods of aforestation and reforestation, and detoxification of hazardous wastes."

Not all that was supposed to have been achieved by Agenda 21 has seen fruition. Yet, there is no doubt that biotechnology has made inroads into most areas of human activity. Biotechnology has applications in the fields of medicine, agriculture, environment, industrial production, and criminology, to name a few areas. In addition to its pervasiveness, biotechnology is an integral part of the world trading system. This is a mark of its viability as a commercial project. The economic aspect of biotechnology has far-reaching consequences and it promises to be an engine for economic growth.

Developing countries can play an important role in the emerging field of biotechnology and participate in the applications of modern biotechnology in diverse areas that include agriculture, medicine, environmental management and industry. Since industries that use biological resources are likely to be affected by the recent advances in biotechnology, the interrelation between biotechnology and industry will give rise to what may be called the "new bio-economy." In this context, Malaysia will be left out of global developments if it does not create the right pre-conditions for the development of biotechnology in this country. In fact, failure to actively participate in these advances will result in a 'genetic divide', and create technological disparities as well as disadvantage those countries without the necessary expertise from gaining access to niche markets in the new bio-economy.

It is crucial for Malaysia to be well-equipped in biotechnology-related fields such as genomics, genetic engineering, chemical engineering and cell technology. These disciplines are transforming industrial and environmental processes and they are making an impact in the global economy and the international trading system. At present, the cutting-edge knowledge and skills in these disciplines are concentrated in a small number of countries. Malaysia with its vast agricultural resources, long exposure to research in tropical diseases and involvement in food and beverage production will find it beneficial to gain the necessary expertise in biotechnology so that it can be productively applied in these areas. This will help Malaysia create a niche for itself in these fields and establish itself, in the time to come, as a market-leader in these sections of the global economy. The challenge for Malaysia is to employ the generic nature of biotechnology techniques to create a new bio-economy, which has prospects for commercialisation.

3.1. Status of Biotechnology in Malaysia

The Malaysian government supports the development of biotechnology. A clear sign of this interest in biotechnology can be found in the fact that biotechnology was held-out for advancement under the Eighth Malaysia Plan (2001-2005). Further, the Ministry of Science, Technology and Environment (MOSTE) founded the National Biotechnology Directorate (BIOTEK) in 1995. BIOTEK was set up with the express aim of coordinating the growth and diffusion of biotechnology research. One of the activities that BIOTEK has undertaken has been the establishment of seven biotechnology cooperative centres (BCCs). These BCCs have been created in key functional areas covering plant and animal applications, food production, molecular biology, biopharmacy and medicine. Also included are the applications of biotechnology to environmental management and industrial processes.

Another noteworthy achievement is the Malaysia-MIT Biotechnology Partnership Programme (MMBPP). This is a collaborative effort supported by MOSTE to foster links between Malaysian research institutions (including public universities and government organisations), the BCCs and MIT. The MMBPP was launched in 1999 and has two crucial research items on its agenda:

- natural product discovery from indigenous medical plants, and
- oil palm technology.

In 2001, the launching of the BioValley initiative by the then Prime Minister Mahathir Mohamad, showed the keen interest that the government has in promoting the advancement of biotechnology. BioValley was envisaged as a cluster of biotechnology research institutions, universities and companies within the Multimedia Super Corridor (MSC). Among other areas, BioValley will conduct research in the following fields:

- genomics
- molecular biology
- nutraceuticals
- pharmaceuticals, and
- agricultural biotechnology.

BioValley is not purely an academic enterprise. In fact, it is expected that the

research from BioValley will have commercial value. It is in this direction that it will have a business directorate to commercialise its research products.

Malaysia has tremendous potential to harness by participating more aggressively in biotechnology developments. The activities to be engaged in include academic research, applications development, innovations in techniques and the commercialisation of products and processes. Along with these activities there is also a need to introduce and implement an appropriate industrial policy that supports the development and use of biotechnology for industrial and commercial purposes. An effort to supplement biotechnology research and applications with an appropriate industrial policy is required in order to encourage R&D and to spur the commercial potential of the industry.

It is useful for Malaysia to focus its attention on the following areas in the development of biotechnology:

- the pharmaceutical industry
- agriculture
- the chemical industry
- environmental applications

3.1.1. Pharmaceutical Industry

The pharmaceutical industry is one that is characterised by the presence of multinational corporations and strong barriers to entry. Nevertheless, given the vast biodiversity available in Malaysia, the huge pool of traditional knowledge in indigenous medical systems, and the long experience in traditionally used medical plants, Malaysia can make a foray into this area.

Much of the knowledge of indigenous medical systems and traditional medical plants can benefit from advances in biochemistry and biotechnology since it is now possible to obtain information at the molecular and cellular level. Conventional screening of natural and synthetic chemical compounds is a long, random and time-consuming effort. This has increasingly been overtaken by rational drug design. Malaysia should direct more efforts to rational drug design. However, a feasible model is needed to facilitate this development.

Most research in biotechnology with pharmaceutical applications is carried out by

the large corporations, which enjoy a dominant global presence. These corporations have large R&D budgets that allow research to be conducted in a field that has high risks and equally high returns. An alternate model is required in the Malaysian case. The proposed model is to support the creation of 'dedicated biotechnology companies' (DBCs). DBCs are companies that begin as research institutions. Unlike established companies they will pursue R&D in niche markets, concentrating on specific technologies or particular products. The markets that Malaysia should choose to focus on would be those where the country has an advantage, either in terms of traditional knowledge or medicinal plant resources.

The government can establish new research institutions or encourage existing research institutions to explore specific ideas or possibilities. These institutions can function as DBCs by forming collaborative links with established pharmaceutical companies or biotechnology companies. Funding for DBCs can come from the government as seed money, through venture capital, stock offerings, or through relationships with established pharmaceutical companies.

3.1.2. Agriculture

Malaysia is a net importer of food. Nevertheless, an active agriculture sector exists and the Prime Minister has earmarked the sector for improvement. Although the agriculture sector in its traditional sense ceases to be an engine of growth, it is possible to modernise the sector in the light of biotechnology. The agriculture sector can be transformed into a knowledge-based sector by promoting the use of biotechnology.

There are many applications that biotechnology has in the sphere of agriculture. A brief list of such applications is as follows:

- reproductive technologies
- animal health products
- growth hormones
- transgenic animals
- microbial pesticides and other micro-organisms
- plant research
- cell culture

- transgenic plants
- food processing
- seed development

Many of these applications are being explored in the public institutions of higher learning and in other public research organisations. The large firms in the agriculture industry are also conducting their own R&D. There is no need for the government to further duplicate these efforts. Instead, there is a need to focus efforts at encouraging small firms to focus on certain key areas so that they render themselves profitable either by developing a specialisation in niche markets (e.g. isolating genes), by developing new technology, or by forming alliances with larger firms and functioning in a manner that supplements the efforts of the larger firms. Again, the government can play a very useful role by encouraging and providing a suitable incentive structure that will make possible collaborative efforts between public research institutions, small private companies, large firms and venture capitalists.

3.1.3. The Chemical Industry

The main function for biotechnology in the chemical industry is to produce chemicals that are presently produced through the use of fermentation. Biotechnology can help the chemical industry through the production of industrial enzymes and in the synthesis of complex chemicals. The following are the main applications for biotechnology in the chemical industry:

- fermentation products (e.g. amino acids, industrial enzymes)
- biosensors (e.g. for detection of biological materials such as cholesterol, narcotics, to monitor the presence of toxic substances in water and organic solvents in air)
- chemical synthesis.

The use of biotechnology in the chemical industry most often goes unnoticed. Nevertheless, the use of biotechnology has stretched as far back as the early 1980s in Germany, the US and Japan. Japan is at the forefront in the development of amino acids such as Aspartame and monosodium glutamate (MSG). It is also in the lead as far as biosensors are concerned. Most existing biosensors have limitations due to their bulkiness, short lifespan and the need for frequent calibration. There are on-going R&D

projects in many developed countries to rectify these drawbacks.

The area that is most suitable for Malaysia to concentrate on is in the production of fermentation products. Since there is a significant food and beverage production industry, this is an area that Malaysia should focus on. The second point of focus should be on disseminating research outcomes to the small and informal firms engaged in food processing and packaging.

3.1.4. Environmental Applications

There is scope in Malaysia for the use of biotechnology in the following areas:

- pollution control
- agriculture
- microbial enhanced oil recovery

Biotechnology, through the use of recombinant DNA (rDNA), can develop microbes with capabilities for waste degradation. In fact, pollution control and toxic waste treatment are areas in which abundant applications can be found. Biotechnology can be used to degrade toxic compounds and slimes, for sludge dewatering, and to decrease regulatory uncertainty. There are also environmental applications of genetically engineered organisms in agriculture. Finally, it has been estimated that more than 300 billion barrels of US oil cannot be recovered through conventional techniques. Instead, it has been suggested that biotechnology can be used to enhance oil production.

3.2. Future Directions and Policy Measures

Most developed countries such as France, the UK, the US and Japan have had well-developed biotechnology policies that go back to the 1980s. Malaysia cannot afford to lag behind in this field. One has only to look at Japan which has utilised biotechnology from sake and miso production to pharmaceuticals. Japan, like France, adopted a policy that involved considerable state participation.

Investment in biotechnology has several features that make state intervention imperative for a country like Malaysia. The following are some of the characteristics of biotechnology research:

- the multi-disciplinary nature of the area

- the long gestation period of research in applications
- the uncertain commercial viability of research in biotechnology
- high costs of training and equipment in some areas of biotechnology research

In view of these considerations, it is necessary that Malaysia adopt a strategy that involves government support and risk-taking. Several models have been pursued in the development of biotechnology by developed countries. In the United States, for example, biotechnology has been largely a private enterprise endeavour. On the other hand, in Japan there has been some government support, with private sector participation. Even in the case of Japan there have been false starts, with large corporations such as Kawasaki realising that it was not financially viable to pursue biotechnology with a view to making profits. In the United Kingdom, on the other hand, the universities have been the main locus for research in biotechnology. These examples point out that one can conceptualise a model for the development of biotechnology with three axes determined, respectively, by the government, universities, and the private sector. In the Malaysian case, it would be prudent to propose a model that is heavily tilted towards research being developed with considerable government support, but with strong links among the government, research institutions, and the private sector.

With the Biotechnology Master Plan in place, the Malaysian model must emphasise the following elements in implementing it:

- provide a role for small firms
- encourage collaborative efforts between biotechnology firms, research institutions, industry and the relevant ministries and government agencies
- offer incentives for biotechnology firms with commercially viable ideas
- enhance the role of research institutions as providers of biotechnology research
- encourage international exchange and foster creativity and originality in government-sponsored biotechnology centres
- support positive research outcomes with incentives (e.g. good equipment, research grants, links with world-class research institutes, adequate financial remuneration)
- select a small number of core areas for high funding and good staff training

The Malaysian model for the development of biotechnology may not wish to be as ambitious as in the South Korean case where a biotechnology-economy or B-economy has been proposed. In any case, Malaysia must capitalise on its abundant biodiversity, its possible niche in food production, oil production and renewed emphasis on agriculture in developing its biotechnology strategies. Malaysian biotechnology companies should seek strategic tie-ups with emerging Indian global pharmaceutical company with proven research capabilities such as Ranbaxy and Dr Reddy's Laboratories Limited.

4. ICT SERVICES

4.1. MSC the Catalyst

Since the mid 1990s, the government has acknowledged that productivity gains in the manufacturing sector have been facilitated by increased sophistication of imported production equipments that are also available to competitors. The problem of productivity has also been aggravated by rising wages. Continuous wage increase that exceeds the productivity growth has gradually eroded Malaysia's advantage as a low-cost production centre. Competitiveness can no longer depend on low wages but requires a critical mass of creativity and innovative potential that could only be achieved by transforming Malaysia from a production-based economy (P-economy) into a knowledge-based economy (K-economy).

In this Information Age, ICT services have been recognised as the most strategic enabler for the successful transition of Malaysia to a K-economy. The ICT revolution set with the formulation of the National IT Agenda in 1996 and it aims to enable Malaysia moving rapidly into an information and knowledge based nation. The two key initiatives for leapfrogging Malaysia into a K-economy are the Multimedia Super Corridor (MSC), a world test-bed for ICT development, and the enactment of a set of cyber-laws. In this era of phenomenal change, undoubtedly a strong commitment towards the application of ICT in the strategic functions of the manufacturing industry such as product design, quality control, process planning, production and materials planning, is prerequisite to achieve the fourth phase of industrial development, which is

vital for the realisation of industrialised nation status by 2020.

While a S&T parks can be generally catered for technology-based R&D, high technology manufacturing or software and ICT services, the government has chosen to position the MSC as a regional hub just for ICT and multimedia technologies. This has distinguished it from many other S&T parks in the region which mostly focus on high technology manufacturing. This probably explains why the MSC has not failed to attract world-class ICT companies to be located in it, although it is a new kid on the block in this region.

4.2. Emerging Opportunities, Potential Niches and Growth Areas

Online gaming is fast becoming a favourite form of entertainment for children and working adults. With the establishment of Terra ICT (M) Sdn Bhd in 2003, the MSC is now potentially developed into an online game development hub. Terra ICT is a joint venture between Terra Corporation of Japan and Bintai Kinden Corporation Bhd of Malaysia. As an online game aggregator and developer, the company is the first English language massive multi-player on-line role-playing games portal. Different players can log on and play a role-playing game together, irrespective of their locations. Terra ICT predicts that the global market for online gaming is presently worth US$970 million, of which Malaysia contributes between US$20 million and US$30 million. Meanwhile, research firm IDC estimates that online gaming in Asia Pacific alone was worth US$533 million in 2002, with South Korea and Taiwan leading the pack (Ganapathy, 2004). Nevertheless, considering that this is made possible only by high-speed Internet access, the underdeveloped broadband infrastructure in Malaysia would undermine the growth of the online gaming industry. In fact, as in the case of South Korea, Taiwan, China, Japan and Singapore, there is a high possibility that Malaysia will be a promising market once broadband really takes off.

Another emerging opportunity that the MSC can tap into is application services, particularly in the realm of customer relationship management (CRM). More specifically, there is a need to nurture more home-grown application service providers (ASPs) to deliver CRM software to small and medium-sized industries via the Internet. The ASP model is one where the software is delivered as a service over the Internet or any other wide-reaching network, and clients would subscribe to the software as

opposed to buying it. Surprisingly, such a business model has yet to take off successfully in Malaysia. It is reasoned that there is a big potential for the model to grow, considering that most customers now have to pay large sum of money in the traditional client/server approach (software is hosted on the company's server and the application is dished out to clients).

While offshore services are widely characterised as a non-strategic and low-value activity, Malaysia has in fact a beneficiary of the offshore outsourcing in developed countries, particularly the US. Besides R&D, it is reasoned that the MSC can also focus on the shared services and outsourcing (SSO) areas. To-date, over RM1 billion has been invested in the SSO industry in the MSC. While the R&D revolution forms the thrust of the MSC's long-term strategy, at its foundation is an evolutionary process that is changing Malaysia from a manufacturing base into a global hub for ICT-enabled services through SSO. In other words, R&D and SSO combined will help deliver the MSC's value proposition: new high-value jobs, greater exports and the transformation of the ICT industry into a major export earner (Ariff, 2004).

The microelectronics industry is crucial to the success of the industrial capability of the manufacturing sector, as it has been contributing about 30 per cent of the total manufactured exports in Malaysia over the past 20 years. Nevertheless, the efforts to move the industry up the value chain seem to be less remarkable, especially in the area of integrated circuit (IC) or chip design. Understandably, one of the biggest hindrances to start-up companies in this field is the high cost of electronic design automation tools. It is vital that the government helps Malaysian companies start their own design centres by setting up exclusive training centres in the MSC to provide hands-on experience to local design engineers.

4.3. Challenges Ahead

It is reasoned that the MSC really needs to tread its way around very carefully and strategically so as not to compete just in software development, for that is India's forte. As a matter of fact, India has gained credibility in enterprise software especially for outsourcing and call centres (customer relationship management), which Malaysia has not been able to achieve thus far. After all, it might be already too late for Malaysia to venture into the field of business process outsourcing, considering that India is already a

major player in the region. At this point in time, it is imperative that the Malaysian MSC status companies form strategic partnerships with world-class Indian ICT and software companies such as Wipro Technologies Limited, Satyam Computer Services Limited and Infosys Technologies Limited, which are reportedly going on a spree to acquire Asian ICT companies.

5. RESOURCE-BASED INDUSTRIES

Resource-based industries have been around for many years. What is more important is that it has seen some structural transformation where attention is no longer on primary exports but on downstream activities related to developing high value-added products targeted for the export market. Malaysia cannot rely on exports of primary commodities as where are steadily facing higher cost with higher wages and land prices. It is included in the emerging industry section not because it is new, but because there has been some significant progress in developing relatively higher value-added products in industries such a furniture, palm oil and food processing.

Resource-based industries are considered an important part of the Malaysian industrial sector because they can provide a cushion for the economy to fall back on if the main export-oriented manufacturing sectors face difficulty arising from the sometimes uncertain external demand. The resource-based industries have enabled the Malaysian economy to be more diversified and this has accorded more resilience to the economy. The abundant supply of natural resources is the main advantage that Malaysia has and is the driving factor in advancing the resource-based industries. The main sectors in this industry are the wood-based sector, rubber-based, palm oil-based and the food processing sectors.

Over the years, there has been a noticeable progress in the downstream activities as more and more marketable products are being developed. Nonetheless, there is a need to accelerate the production of higher value-added products for the export markets. This will require further upgrading of technology and more market-driven product development activities. There has to be acceleration in the development of downstream products with Malaysian brand names. But all this will require a sustainable supply of

raw materials.

Table 1: Manufacturing Value Added 2000-2010

	Share of Total Value Added (per cent)				Average Annual Growth Rate (per cent)	
Industry	2000	2003	2005	2010	8MP	9 MP
Resource-Based	**41.9**	**43.4**	**43.7**	**42.3**	**5.0**	**6.0**
Vegetables and Animal Oils & Fats	3.8	4.2	4.4	4.9	7.6	9.1
Other Food Processing, Beverages & Tobacco	6.0	5.9	5.8	5.6	3.6	5.7
Wood Products including Furniture	4.4	3.7	3.6	3.3	0.3	4.8
Paper & Paper Products, Printing & Publishing	3.4	3.3	3.2	2.9	2.9	4.4
Industrial Chemical including Fertilizer & Plastic Products	10.1	11.5	12.2	12.6	8.3	7.2
Petroleum Products including Crude Oil Refineries & Coal	6.7	6.8	6.4	6.6	3.1	7.4
Rubber Processing & Products	2.7	2.9	3.5	2.8	9.7	2.3
Non-Metallic Mineral Products	5.0	5.1	4.5	3.6	2.2	2.1
Non-Resource Based	**56.3**	**54.7**	**54.2**	**55.4**	**3.3**	**7.1**
Textile, Wearing Apparel & Leather	3.5	3.0	2.2	1.8	-4.8	2.0
Basic Metal Industry	0.9	0.9	0.8	0.7	2.6	4.8
Metal Products	4.3	3.6	4.9	5.8	7.1	10.2
Manufacture of Machinery Except Electrical	4.6	5.2	4.2	3.1	2.4	0.2
Electronics	29.5	26.5	28.0	29.4	3.0	7.7
Electrical Machinery	2.6	1.8	1.2	1.0	-11.3	4.1
Transport Equipment	11.0	13.7	12.9	13.7	7.5	7.8
Others	1.7	1.9	2.1	2.2	8.4	7.7
Total	**100.0**	**100.0**	**100.0**	**100.0**	**4.1**	**6.7**

Source: The Mid-Term Review of 8MP, 2000-2005, The Ninth Malaysia Plan 2006-2010
e = estimated

Table 1 above shows the importance of the resource-based industries in the economy. Although the main contributor in terms of value-added in the manufacturing sector is the non-resource-based industries accounting for a 54.2 per cent share of total in 2005, the value added contribution of the resource-based industry is still significant at 43.7 per cent share. The main contributors in the resource-based industries are the petroleum products including refinery, industrial chemicals, and food processing with shares of 6.4 per cent, 12.2 per cent and 5.8 per cent respectively.

The wood-based sector is still dominated by primary processing activities such as

saw-milling, veneer and plywood production. But over the years, there has been a marked increase in downstream activities such as the manufacture of furniture and fixtures have increased markedly. The share of veneer and plywood in total wood exports had decreased in 2006 (32.2 per cent) from 68.6 per cent in 1994. Furniture exports had grown at an average rate of 19.9 per cent during the last ten years up to 2006, much faster than the growth in veneer and plywood 8.1 per cent. The furniture industry has made significant progress advancing from a traditional cottage based into an export income earner.

The major export markets for Malaysian furniture are in USA, Japan and United Kingdom. This shows that the Malaysian furniture exports were competitive enough for the markets in developed countries, and this is a good sign. Export growth to Middle East countries have been rapid, showing that entry into new markets have been expanding rapidly. Malaysia has to continue searching for new markets so that the furniture industry will continue to make further progress.

What the furniture manufacturers are somewhat lacking is the expertise in design innovations, furniture components and fitting. Some of the components are imported from Italy and Germany. What the furniture industry needs are more furniture designers. The Malaysian Furniture Promotion Council is setting up its own design centre where foreign trainers are invited to train locals for the period of 6 months. We need to be able to come with indigenous designs that are acceptable through technological upgrade, R&D and product design. There is also a need to increase the effectiveness of marketing for Malaysian furniture. The challenging part for the furniture industry is how to ensure that the supply of logs is secure and sustainable. The government has put in efforts to ensure that timber supply are not depleting.

Malaysia continues to be the largest producer and exporter of palm oil. In 2006 Malaysia produced 43.2 per cent of global palm oil and 50.2 per cent of world palm oil exports. Palm oil exports had grown at an average rate 10.3 per cent in the last ten years up to 2006. High prices in the past year or so was due to a shortage in the supply of soybean oil he back of uncertain whether conditions. The major markets for Malaysia's palm oil are in China, India, Holland, Pakistan and Egypt. The two main determinants for palm oil consumption are income and population size. As the income in China and India rise further, there is a good chance that they will consume more palm

oil.

Malaysia cannot continue to rely on primary trading of palm oil. There is a need to focus the efforts on marketing and producing downstream products. Palm oil can be marketed as a "halal" vegetable oil to other Muslim countries. There should continue to be more R&D for downstream products that can be commercialised once new products are developed. Many food products have come out of palm oil and more efforts should be put in promoting these products. As a by-product of palm oil in the non-food sector, oleochemicals have become an important export items. Oleochemicals are used in the production of soap, detergent, cosmetic products and other industrial applications. Malaysia was a leading exporter of oleochemical in 2006, with exports amounting to RM5.60 billion, up more than double from RM2.61 billion in 2002. Changing consumer preferance for natural or plant-based products for cosmetics and personal care products has led to higher export demand for oleochemicals. There areas such as biomass and biotechnology that can be tapped further through intensive R&D activities. In the palm-based biotech sub-areas, there are potential new products that can be extracted from palm oil.

The rubber products industry is dominated by the production of latex examination gloves. Medical gloves now have higher quality and there are specialty gloves such as low protein, safety gloves and powder-free medical gloves. The top three export markets are USA, UK, and Japan. Although there is still market for glove due to SARS epidemic and other diseases, this industry is facing labour shortage problem and the technology has matured. There is an urgent need to move to higher value-added rubber products. This can be achieved by engaging in R&D to find high value-added products. The demand for rubber products can be enhanced, by increasing its linkages with the automotive sector and other relevant industries.

In line with efforts to have downstream processing of high value-added products, the processed food exports had grown at an average of 10.1 per cent in the past ten years. Quality, safety and compliance to international standards remain top priority, if we want to penetrate other markets as well. The main export category is other processed food, which include sauces, seasoning and condiments, animal feed, margarine and other edible preparations. Major export markets for processed food are Singapore, Indonesia and USA. There is potential in promoting certain processed food as "halal" to

the Middle Eastern countries.

It is often said that resource-based industries are outmoded industries and do not belong in a knowledge based economy. Some would argue that natural resources have a diminished role to play in the new information-driven universe because they have not kept up with the times. The reality is very different. The value of Malaysia's natural resources, especially the very nature of the industry, is often misunderstood. There is a need to understand that the resource-based sector builds strong links to other sectors, and the technology used in this sector today are as sophisticated and innovative as any other. Thus, there is profit in promoting the innovative nature of the country's natural resources sector, and invest in the new technologies to maintain a competitive edge and remain a truly sustainable industry for the future.

One thing for sure, Malaysia can no longer rely on the traditional trading of primary commodities. The most important future direction for all the resource-based sectors is to come up with high-value added products that are marketable worldwide. To achieve this, more efforts in R&D for product development and production processes are required. Some degree of success is already evident in the furniture industry. More automation is required in the harvesting of raw material, given the increasing labour costs. There are niche areas that can be venture into in the resource-based industries. Resource-based industries will continue to be important because the country needs the diversity and breadth to make the Malaysian economy more resilient towards external shocks, given the strong linkages which it has with other industries. More importantly, measures to ensure a sustainable supply of raw materials is critical to the development of this sector.

6. MALAYSIA'S FUTURE DIRECTION: NANOTECHNOLOGY AND PHOTONICS

While many definitions for nanotechnology exist, the United States (US) National Nanotechnology Initiatives[i] (NNI) calls it "nanotechnology" only if it involves all of the following: (available at http://www.nano.gov/html/facts/whatIsNano.html)

1. Research and technology development at the atomic, molecular or macromolecular levels, in the length scale of approximately 1 - 100 nanometer range.
2. Creating and using structures, devices and systems that have novel properties and functions because of their small and/or intermediate size.
3. Ability to control or manipulate on the atomic scale.

At the nanoscale, physics, biology, chemistry, materials science, and engineering converge towards the same principles and tools. As a result, progress in nanotechnology is surely going to have far reaching effects, although it is still in its infancy. This emerging industry will enhance technologies of all types with applications in biotechnology, manufacturing, aerospace, information systems and many other fields, which covers such nanotechnology business topics as micro-electro-mechanical systems (MEMS), micro-engineering, microsystems, microsensors, carbon nanotubes and much more. That is, nanotechnology has the potential to change our comprehension of nature and life, develop unprecedented manufacturing tools and medical procedures, and even change societal and international relations.

6.1. The Malaysian Context: Current Scenario and Future Prospects

Since the announcement of the NNI in January 2000, governments around the globe, started to plan and have placed nanotechnology as one of the priority areas in their respective science and technology planning. Malaysia is no exception. Nanotechnology is categorised under *Strategic Research* of the Intensification of Priority Research Areas (IRPA) programme under the Eighth Malaysian Plan (2001-2005) funded by the Ministry of Science, Technology and Environment (MOSTE, currently Ministry of Science, Technology and Innovation, MOSTI). A budget of RM 1 billion was allocated under this Plan, of which 35 per cent or RM 350 million is evenly distributed to *Strategic Research*. As of May 2004, the amount approved thus far for Nanotechnology and Precision Engineering over the 5-year period of 2001-2005 is around RM 149.05 million. Photonics, which could come under the category of nanotechnology and precision engineering or optical technology, saw an approved amount of RM 51.7 million.

In addition, the Second National Science and Technology Policy (STP II), launched

in 2003, included nanotechnology and photonics as priority areas in building competencies for specialisation in key emerging technologies. Besides prioritising research programmes in these two areas, the STP II also recommended the setting up of national focal points that serve as the research and development (R&D) hub for each technologies as well as enhancing the exposure to international developments in the technologies and exploitation of foreign research expertise where necessary.

Apart from MOSTI, the Malaysian Industry-Government Group for High Technology (MIGHT), the Academy of Sciences Malaysia (ASM), various centres in the institutes of higher learning, government research agencies and institutes (GRIs), and to a lesser extent, the private sector are also playing their respective roles in supporting the development of this new industry[ii]. These collaborations with the committed support from the government have led to some research and development works in nanotechnology.

Even within nanotechnology, there is a need for Malaysia to focus on selected areas which she finds comparative and competitive advantage. Judging from the current projects undertaken using IRPA funding and the MOSTE/I awards won by scientists, one can form an opinion about the potential niche areas that Malaysia can venture, that is, MEMS, nanomedicine, photonics and advanced materials. Apart from MEMS[iii], according to Malaysian Institute of Microelectronic Systems (MIMOS) Semiconductor Sdn Bhd former chief executive officer H.J. Lim, a Frost & Sullivan study prepared for Mimos has "identified advanced electronic displays, photonics, high density data storage, and conductive polymers as among emerging technologies Malaysia could consider", as quoted in the Star (2004a). Nevertheless, the decision to pursue MEMS is a natural progression towards upgrading the local electronics industry due to its close relation to the semiconductor technology as well as the fact that "a lot of low-value production works have now been relocated to China, where cheap and low-skilled labour is easily available" (Lim, as quoted in the Star, 2004a).

At present, Mimos Bhd vice-president (strategic interventions) Dr K.J. John said "Mimos was working with the Malaysian Industrial Development Authority, Collaborative Research and Resource Centre, Penang Skills Development Centre, and Penang Development Corporation to formulate a strategic plan to develop a cluster of companies (believed to be between 10 to 20 companies) in MEMS research and

development and production" (The Star, 2004a). What is lacking is the participation of the private sector in these collaborations. Thus far, MemsTech is the only company to have invested significantly in MEMS technology. As the Minister of International Trade and Industry, Datuk Seri Rafidah Aziz, pointed out in an Associated Press article by Jennifer Jacobs (2002) "venture capitalists (needs to) be more innovative and flexible… (and function as) proactive catalysts" rather than risk-averse investors.

6.2. Strategies for Nanotechnology Development in Malaysia

The short to medium term strategy of Malaysia should be geared towards "identifying researchers in various areas of nanotechnology with specific expertise; and upgrading and equipping nanotechnology laboratories with state-of-the-art facilities" (Hamdan, 2002). Moreover, it is important "to prepare a comprehensive human resource development programme for producing nanotechnologists" (Hamdan, 2002). For the longer horizon, there is a need for a coherent, long-term (5 to 10 years) vision or plan. Such a plan should be of the magnitude of the biotechnology programme.

The government can play the key role to assure that Malaysia realises the enormous benefits of nanotechnology. Investments must be made in the basic science and technologies that will enable scientists and engineers to invent totally new technologies and stimulate Malaysian industrial competitiveness in the emerging nanotechnology areas. The government should invest in the infrastructure necessary for Malaysia to lead and benefit from the revolution that is coming. It should support the expansion of university and Government/national laboratory facilities, help build the workforce skills necessary to staff future industries based on nanotechnology, encourage cross-disciplinary networks and partnerships, ensure the dissemination of information, and encourage small businesses to exploit commercial opportunities.

Moreover, the goals of nanotechnology research are too fundamental, long-term (greater than ten years), transdisciplinary, and high-risk for industry to take an immediate leadership role. Given the expectations of potential investors and the competitiveness of the global marketplace, the Malaysian industry is unable to invest significantly in long-term and risky research that takes many years to develop into products. As such, the university and government research systems must fill this gap. Government agencies will need to foster the nanotechnology teamwork because of its

transdisciplinary nature, which calls for a national nanotechnology directorate or a national institution for the development of nanotechnology.

The increasing pace of technological innovation and commercialisation demands continual compression of the discovery-invention-development time scales, which in turn requires parallel and coordinated work in both basic research and commercial product development. The requirements for and from nanotechnology transcend anything that can be supplied by traditional academic disciplines, national laboratories, or even entire industries. For all of these reasons, a national initiative is critical to establishing an effective national effort in nanotechnology as a worldwide competition is already underway in this area.

In this new millennium, innovations in science and technology will be key not only to the health of the environment, but also to the miraculous improvements in the quality of our lives and advances in the economy. One must not lose sight of the fact that it was government-funded research that brought the Internet, communications satellites, etc. into being. A major question is how can Malaysia embrace and facilitate the nanotechnology revolution to maximise the benefit to all Malaysians.

7. SME DEVELOPMENT

7.1. Malaysian SMEs' Future Direction

The phenomenal growth of the manufacturing sector over the past three decades has led SMEs into occupying an important position in the Malaysian economy. The SMEs assume such critical role through the strengthening of both forward and backward industrial linkages with the Second Industrial Master Plan (IMP2) providing the basis for the achievement of a broad based, resilient and internationally competitive industrial sector, with various policies and programmes in place.

Although large in terms of the number of establishments (more than 90 per cent of total manufacturing establishments), SMEs contribute a relatively small proportion of the total employment, total output and total value-added of all manufacturing establishments. The relatively small contribution of the SMEs to the economy warrants serious concern and attention. Several reasons were identified, and these included the

problem of funding, the high import content of the products, a lack of entrepreneurship, and the fact that most production is of original manufacturing equipment (OEM) type, where the value-added is captured by the MNCs.

While the government-assisted programmes for SMEs, such as the Global Supplier Programme and the factory audit scheme, are appropriately aimed at preparing Malaysian SMEs to develop and grow into a strong and viable enterprise capable and ready to meet the challenges of liberalisation and globalisation, much more needs to be done with the delivery mechanism. Furthermore, in the efforts to create efficient SMEs, there should be a benchmark to gauge the relative performances of SMEs on an international basis, complementing the Enterprise 50 Programme, which identifies the role models. The government has also designed the SMI Development Plan (1999-2005) to assist SMEs to adapt to new challenges brought about by the changing business environment. This complements the Second and Third Industrial Master Plans (IMP2 and 3) and will focus on the specific needs, requirements and problems of the SMEs sector.

The presence of such an impressive set of programmes to assist SMEs is, without doubt, an excellent beginning to develop highly efficient and competitive SMEs. Despite this, much more needs to be done to ensure that the growth trajectory of SMEs remains vibrant. With the change in the landscape of world trade and industrialisation, Malaysian SMEs need to adapt and adjust their mode of operations and attitude. A two-pronged strategy is required to: (i) nurture world-class SMEs and (ii) develop and enhance entrepreneurship, especially building a large pool of middle class entrepreneurs (and technopreneurs).

7.2. Nurturing World-Class SMEs

When it comes to being a low-cost base for labour intensive manufacturing sector, Malaysia is losing its comparative advantage, with the rise of Vietnam, India and China. This raises the question of whether the roots grown by the SMEs are resilient enough to hold multinational corporations in Malaysia for a sustainable period, which could imply a shift towards increasingly independent SMEs. The greatest challenge ahead to businesses worldwide will come not from low-cost producers but from low-cost and effective innovators. In other words, there is a need to reduce over-dependence on a

single parent/anchor company and to invent the future instead of replicating the past.

Moving ahead, there is a great deal of uncertainty regarding how to assist SMEs to be World Class. Experimentation with innovative pilot projects and policy instruments, which try out alternative approaches, may yield a great deal of useful information that could provide indications of what works and what does not. Furthermore, widespread dissemination of the results would greatly extend the efforts to assist the SMEs.

The simplest way is to replicate successful policies elsewhere. But workable policies and institutional arrangements from elsewhere needs to be adapted rather than adopted wholesale, as there is no such thing as a 'one size fits all' policy. Successful policies elsewhere may define a possible destination, but not the path, which needs to be taken to reach it. Nevertheless it is important to discover, first, whether there exists such a destination and if so is there one possible destination or many, and, second, the means of moving along the path(s) to the destination(s). Choosing the optimal trajectories entails experimentation as mentioned earlier.

SME development policies need to be re-examined so as to increase SMEs' absorptive capabilities and maximise the "pull factors" that will bring large corporations voluntarily into linkages with SMEs. Support measures should include improving infrastructure (physical, finance, and human resources development) and export financing. These should focus on increasing capabilities, improving firm infrastructures, and arranging institutional skills training, particularly focusing on technology skills.

One common practice in formulating SME policy is that there is too much emphasis on finance. Bearing in mind that finance is only part of a whole package, a first step in designing policies to develop SMEs is to broaden SME policy, away from the more common financial focus, towards a systemic approach, which sees SME issues as part of a broader approach to economic development and poverty alleviation. Furthermore, incentives alone only alleviate some of the problems faced by SMEs and do not solve them.

Then there is the non-financial assistance. Anecdotal evidence suggests that less progress has been made in this area. First, non-financial programmes are too supply-oriented, that is, overly focused on inputs for production (skills, technology, raw materials) and not sufficiently concerned with who would buy the outputs. Second, they are rarely sustainable. This has two components: the high cost in reaching out to a

multitude of SMEs[iv] and the low concern with cost recovery for support services. Third, they have at best a one-off effect on the performance of the assisted enterprise but rarely lead to a capacity for self-help and continuous upgrading.

Lall (2000a) points out that "support by influencing the enterprise environment: capital markets, advisory services, links with support institutions and the science, engineering and technology (SET) base, can prove to be more effective." The experience of Taiwan suggests that the best way to provide these services is by combining them in an attractive package rather than delivering them piecemeal.

There is no doubt that SMEs in general need some kind of institutional support. For these institutions to be effective, they have to be kept decentralised and well coordinated. Although SMIDEC is the main institution overlooking SMEs, there are many other agencies that are involved in SME development. Having a complementary role between these institutions are thus essential. If the loan is open to participation from SMEs, there should be coordination between various parties involved. SMEs tend to avoid going to support institutions where a lot of time and formalities are involved in getting assistance. They often cannot identify and define their own needs clearly enough to seek the best remedies. Thus, a service that can reach out, help firms to define their problems and devise a package of measures, as mentioned earlier, that deals with these problems has the best chance of success.

8. THE CHALLENGES OF REGIONAL INITIATIVES

How will the competitiveness of SMEs be affected once all aspects of the CEPT agreement have been fully implemented? Measures to respond to this problem could include (a) upgrading of the products and processes; (b) shedding off of unprofitable products, processes or activities; (c) relocating costly products, processes and activities to a more profitable and competitive location within the country, or in other ASEAN countries; and (d) forming strategic alliances with other businesses taking advantage of the ASEAN Industrial Co-operation Scheme and the ASEAN Investment Area programme. Greater information sharing and dissemination among relevant parties, however, must precipitate these measures, as currently there is still a lack of

appreciation among local businesses of the significance of AFTA and WTO commitments to them as individual entities.

8.1. Enhance Entrepreneurship

Ironically, the role of the government is very important in fostering private sector entrepreneurship in Malaysia. Nevertheless, although there are many programmes and financial support systems for entrepreneurs, they have not been as effective as they should. A common critique is that, due to the fact that most of the programmes for entrepreneurs are organised and offered by government agencies, there is a high amount of bureaucracy or "red tape" involved, thus causing delays of several months just to get approval for applications. This curtailed the level of uptake among genuine entrepreneurs who often end up feeling very frustrated with the system.

On a more positive note, the government does seem to be aware of the need to address certain pressing issues that affect entrepreneurs. Among the more salient are ensuring a healthy, conducive, and stable political and economic climate, matching the most appropriate funding models to suit the needs of businesses, making funds available to stop the liquidity crunch, having guidelines and regulations regarding intellectual property rights, and corporate governance. The need for entrepreneurs to receive more guidance and training from business incubators has also been recognised. This bodes well for the strengthening of entrepreneurship in Malaysia. Recent government efforts to improve the delivery system have contributed much to the ease of doing business in the country.

In order to finance high-technology companies, Malaysia is looking toward adopting the venture capitalist model of funding which has been proven in other industrialised countries. The Malaysian government, under the Multimedia Development Corporation (MDC), has set up MSC Venture Capital Company to provide risk capital to start-up IT-related ventures to promote, and feed into, its Multimedia Super Corridor (MSC) projects. While VC funding has been attained relatively successful by manufacturing companies, however, there are some problems associated with adopting this model of funding for high-tech start-ups in Malaysia. Specifically, there is currently what is now being termed a "funding mismatch" between the needs of Malaysian "technopreneurs" and the funding criteria of venture capitalists.

Moreover, venture capital companies, far too often, adopted a conservative approach to investing. This is evident in the treatment of lagging ventures, where venture capitalists often stop funding to failing firms because they want to devote their limited resources to firms with the greatest promise and potential. Venture capitalists, on the other hand, have frequently been unwilling to write off unsuccessful ventures, lest they incur the reputational repercussions that a failure would entail.

Malaysia has a vibrant entrepreneurial base with a huge potential to become global players. Considering the impact of globalisation, perhaps the time is ripe to begin to expand the common view of entrepreneurship from one that is centred on domestic needs and environment, to one that is more global in its outlook. In that sense, policies should be centred on how best to build resilient and competitive global entrepreneurs, and hence the need for more information sharing on entrepreneurship among regional countries and beyond on what works, why, and how to adapt it to the local context.

Since resources are scarce relative to the needs of SMEs and entrepreneurs/technopreneurs, it is important to have a strategy to guide the deployment of available resources in directions that provide maximum leverage. An important message is that there is no magic wand or single policy, which once applied, can dramatically transform the SME sector onto a high growth path. Nevertheless, there is much that can be accomplished to assist both the SME sector as well as the economy as a whole to raise long run potential growth.

8.2. What Lies Ahead?

Moving forward, there is a need to make assessments and comparisons of Malaysia's strengths and weaknesses with trade and investment opportunities, as well as providing up-to-date information on the market trends and the competitive environment in these areas. Moreover, many countries now have "foresight" programmes of various kinds. These are designed to put together the key actors and thinkers in the new fields to consider future and recommend actions on the part of policy makers and firms. The focus of such programmes is to identify trends, draft action plans and build networks. Malaysia too should initiate a foresight programme that suits its needs. Part of this could be aimed at the knowledge upgrading of foreign and local firms in order to define and meet Malaysia's future directions and targets.

NOTES

[i] The NNI "provides a multi-agency framework to ensure US leadership in nanotechnology that will be essential to improved human health, economic well being and national security", as well as "invests in fundamental research to further understanding of nanoscale phenomena and facilitates technology transfer".

[ii] See Table 2 for some of the NCCs or institutions involved in nanotechnology.

[iii] MEMS technology has a diverse range of applications: as pressure sensors, accelerometers, microphones, and thermopiles in motor vehicles, in health and life sciences products, consumer electronics, industrial and aerospace navigation systems, scientific analytical instruments and in the telecommunications industry (The Star, 2004b).

[iv] It is hoped that there will be some domino effects taking place here. Thus, the private support mechanism and industrial linkages are important to deliver the transfusion of knowledge.

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