

II Singapore's Transition to the Knowledge Economy: From Efficiency to Innovation

Singapore's commitment to efficiency has attracted FDI that has allowed it to grow rapidly. Singapore's government had always been committed to the concept of efficiency, recognizing early on that, to compensate for the country's natural "comparative disadvantage" associated with being a small economy with a limited domestic market and population size, Singapore would need to develop a highly efficient and productive infrastructure system to help reduce production costs and attract foreign investors. This commitment to efficiency, along with an honest government, which adopted proactive growth strategies and a highly educated, English-speaking workforce, has made Singapore a choice production base for multinational corporations. There are currently over 5,000 foreign companies located in Singapore and many more multinational corporations and foreign financial institutions which have established operating and manufacturing bases on the island.

Singapore has also been successful in attracting talented foreign nationals. Approximately 19 percent of the population of Singapore is made up of foreign nationals. As a result of this ability to attract foreign capital and skilled foreign workers, the Singaporean economy has grown at 8.5 percent per annum in recent years and per capita income has grown at 6.6 percent, roughly doubling every decade. Over the years, the economy has gradually moved into more technology related fields. Labor intensive industries such as textiles, once important to the island's economy are no longer part of Singapore's economic landscape.

Like other Asian countries, Singapore re-evaluated its growth strategies after the 1997 crisis. Following a period of impressive growth, the 1997 Asia economic crisis led the country to reevaluate its development strategies.⁸¹ Singapore has since recognized that efficiency alone will no longer guarantee sustained growth in the future and that it will need to formulate alternative strategies for growth.

Where does Singapore currently stand in the Knowledge Economy?

Singapore is good at incorporating existing technology, but it lags far behind other developed countries in the ability to create new technologies. In the Global Competitiveness Report, Singapore was ranked 25th in terms of firm level innovation in 2002, below most developed economies. The country ranked in the top 10 in the world in terms of technology using indicators such as quality of school science and technology education, licensing of foreign technologies etc. But it was rated much lower in technology-creating indicators like R&D spending, R&D personnel, availability of venture capital and intellectual property protection.

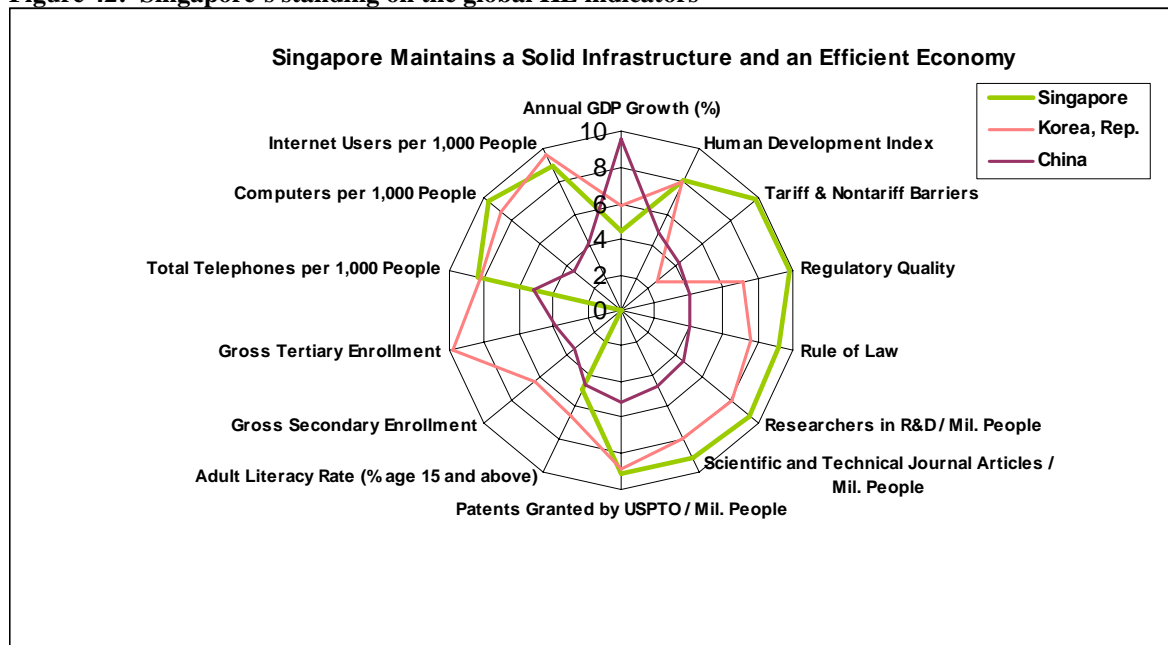
Singapore's education system is also proving a brake on improving the KE. Singapore performs poorly in terms of entrepreneurial activities, ranking 21st among the 31 countries surveyed in the 2003 Global Entrepreneurship Monitor studies.⁸² Singapore's knowledge economy scorecard further emphasizes the country's weaknesses. Adult literacy levels are much lower than Korea and equivalent to those of China (Figure 42). However, the scorecard also demonstrates the country's powerful economic and institutional regime, scoring remarkably high in rule of law, regulatory quality and tariff and non-tariff barriers.

⁸¹ Tan, Kim-Song. 2005.

⁸² Tan, Kim-Song, 2005. p. 3

Despite housing developed and active technological industries, Singapore has only recently begun to innovate domestically. Manufacturing contributes 22 percent to Singapore’s GDP with electronics obtaining half the country’s manufacturing output, while finance and business services maintain 26 percent. Manufacturing and services are the twin engines of the country’s economic growth. Singapore has become the disk drive capital of the world and is home to a semiconductor hub, currently producing one third of the world’s disk drives and housing fifteen chip fabrication plants. It has a 70 percent market share in the manufacture of offshore oilrigs. In aerospace, Singapore has the second largest cluster of aerospace maintenance, repair, and overhaul activities. In biomedical sciences, six out of 10 top pharmaceutical companies manufacture in Singapore.⁸³ The country has over time begun to recognize that in order to remain internationally competitive; it will have to focus on domestic innovation.

Figure 42: Singapore’s standing on the global KE indicators



Source: World Bank. Knowledge Assessment Methodology, www.worldbank.org/kam

Embarking on a New Innovation Strategy

Key to Singapore’s future growth is its investment in innovation over efficiency. In 2002, a high level Economic Review Committee (ERC) was organized by the government in order to assist the country in formulating a new development strategy. The ERC’s strategy focused on enhancing the economy’s innovative capacity, with the aim of making Singapore an innovation hub for Asia. The government has since devoted more resources for R&D and innovation.

Previous five year plans implemented by the National Science and Technology Board (NSTB), starting from the early 1990s, sought to target mainly short term applied technological innovations, with few attempts to deepen the culture and practice of innovation across the whole economy. Singapore’s new innovation strategy, however, seeks to accomplish these goals by developing basic innovation and cultivating a scientific culture. At the 2002 Knowledge Economy conference in Sydney, Ko Kheng Hwa, MD of the Singapore Economic Development Board (EDB) discussed the country’s strategy in making the transition to the knowledge economy without abandoning its powerful presence in manufacturing (Box 8). He emphasized that Singapore is looking to reform its innovation system to focus on “the broad

⁸³ Hwa, Ko Kheng, 2003.

and the basic”; from drug discovery, all the way to clinical development, clinical trials, process development and manufacturing to the provision of health care services. It aims not only to promote innovations in manufacturing, services and creative content, but also to do so at different levels of firm size, from giant MNCs to local small and medium enterprises. To pursue these strategies, the Government has allocated \$S7Billion in the next five years to support public sector R&D which will, in turn, stimulate private sector R&D.⁸⁴

Box 8 Singapore’s Strategy for Future Development

Strategy 1: Build bridges through a web of free trade agreements. These free trade area agreements, both multilateral and bilateral, will be a crucial part of Singapore’s strategy to build bridges to key economies to the world, and to increase market accessibility of companies based in Singapore.

Strategy 2: Broaden the industry base and develop new growth clusters. The country will focus on new industry clusters such as bio-medical, nanotechnology in manufacturing, as well as a portfolio of internationally salable services with high growth potential, such as educational services, professional services, and intellectual property management.

Strategy 3: Whether in services or manufacturing, the country will build new capabilities to move up the value chain in three particular areas. The first will be lifting the value added of production activities, for example, into highly automated manufacturing. The second is moving upstream into R&D, into innovation and tax baits for new ideas. The third is moving downstream into regional electronics supply chain management into market development, brand management in Asia Pacific, intellectual property management in Asia Pacific, enlarging the regional headquarter operations.

Strategy 4: Creating a vibrant enterprise ecosystem by developing the venture capital industry, increasing tax incentives for new ideas, and provisions of new users to try out the country’s new inventions.

Source: Hwa, Ko Kheng. “Knowledge Powers Singapore Economy.” Information Age. 13/02/2003

The new plan intends to shift the focus of innovation to developing technology within small firms in the services sector. More resources are being devoted towards long term, basic research. There is also an increased awareness that a significant part of innovation actually comes from small firms. The untapped innovative energy within the services sector has become a high priority. In addition to traditional service industries that thrive in Singapore such as financial, tourism, entrepot trade, healthcare, transport and logistics, the government is also actively promoting the country as a regional hub in other service industries like education, legal services and creative industries.

In order to make these transitions, the Singaporean government is investing heavily in innovation infrastructure, rather than efficiency infrastructure, deemed necessary to building up a critical mass of innovative people and innovative activities, with the immediate objective of attracting the right type of workers rather than the right type of firms (Box 9). There are also efforts to change the “mindset” of Singaporeans, to bring out the enterprising and adventurous spirit in them, by increasing the availability of innovation-enabling infrastructure such as R&D facilities, well-defined intellectual property laws, venture capital etc.⁸⁵

⁸⁴ Hwa, Ko Kheng, 2003.

⁸⁵ Tan, Kim-Song, 2005.

Box 9: Crafting an Innovation culture and the “One North” Project

In order to attract and retain creative talent, Singapore has been heavily investing in cultivating an environment that is both supportive and conducive to innovation and enterprise. Launched in December 2001, “One North” is quickly becoming a world class R&D hub for scientists and entrepreneurs working in the biomedical sciences, ICT and media. The project is expected to be completed within a 15-20 year period. Phase I of the project will construct two centers of activities; Biopolis which will serve as the focal point for biomedical sciences R&D and Fusionpolis which will house collections of firms involved in R&D and production works for ICT and media industries. The project will focus on the whole range of production activities, including a large portion of basic research while promising a “total living and working environment” with not only research institutes and business offices but also residential properties, shopping, public parks and other facilities. It will be equipped with state of the arts facilities in computing network, sewage disposal and energy generating systems and an internal shuttle train system.

The project claims to offer opportunity for “seamless interaction” among research scientists, entrepreneurs, and other business and services sector operators within an “enclave” environment. The project’s close proximity to other major tertiary institutions (e.g. National University of Singapore, INSEAD Asia campus) makes for easy collaboration with researchers from outside. The tenants of One-North comprise both public and private research institutions and business enterprises including The Genome Institute of Singapore and the Bioinformatics Institute. Private companies such as GlaxoSmithKline, Novartis Institute for Tropical Diseases are already set up and Vanda Pharmaceuticals and Paradigm Therapeutics have also signed up. Many of these firms intend to undertake a wide range of activities in Singapore, from basic research and development to product and process development, clinical research, manufacturing, business headquarters and healthcare delivery operations.

When fully occupied, the seven buildings in the Biopolis project will house about 4,000 researchers when the project is completed. Many of the researchers working in One-North will likely be foreigners. To overcome the shortage of scientists in Singapore, the government is actively recruiting from abroad. Already, some acclaimed researchers have moved into the Biopolis including Doctor Alan Colman, who cloned Dolly the sheep, has moved from Edinburgh to Singapore to continue his research. Dr Edison Liu, director of the National Cancer Institute of the US, is now in Singapore heading the country’s Genome Institute. Professor Yoshiaki Ito, one of the chief authorities on stomach cancer research in Japan, together with his team of 10 researchers, has uprooted and moved to Singapore to continue the research.

Source: Tan, Kim-Song. “From Efficiency-Driven to Innovation Driven Economic Growth: Perspectives from Singapore.” April 2005. (p. 14-16)

IPRs and Patents

The Singaporean government is committed to protecting innovators. The government has upgraded the Registry of Trade Marks and Patents to a statutory board called the Intellectual Property Office of Singapore (IPOS) in 2001 in order to formulate and regulate an entire range of IP legislations. IPOS has the mandate of building an environment that promotes greater IP creation, protection and exploitation in Singapore and has been active in developing regional and global networks, including signing various bilateral and regional treaties (including US, EU and Japan), to help extend the reach of Singapore’s IP community. In January 2003, IPOS also helped launch the Intellectual Property Academy, which has been mandated to help strengthen the IP competency in Singapore through research and education.⁸⁶

Venture capital

Government support has been a key feature of the venture capital industry development since the mid-1980s. The government was instrumental in setting up early venture capital funds such as Vertex

⁸⁶ Tan, Kim-Song, 2005. p. 17

Management and EDB Ventures. In the late 1990s, it launched a US\$1 billion “Technopreneurship” Investment Fund (TIF) to induce leading venture capitalists in the world to use Singapore as the regional hub and to spur training for a core of venture capital professionals. There are currently more than 100 venture capital firms in Singapore and they manage a total venture capital fund size of \$14Bn, investing in enterprises in Singapore and in the region.⁸⁷ However, Singapore’s major fault in venture capital is that these funds are reluctant to finance early seed stage projects. Thus, Singapore started a unique program whereby the EDB matches dollar for dollar any third-party investor who puts money into early seed stage start-ups, up to a max of \$300,000.⁸⁸ This is a good example of the enterprise ecosystem that Singapore is committed to establishing.

Recent Issues and Challenges facing Singapore’s Knowledge Economy

Innovation System

In innovation, as opposed to technology assimilation, Singapore will need to take bigger risks. The Singapore government plays a very active role in innovation, both in funding as well setting the strategic direction of which specific industries to promote. In the early years, Singapore catered to the known requirements of the multinational corporations, exploiting the shift in production bases over the course of the product cycle. It used existing technology without having to “push the frontiers”. Innovation businesses, on the other hand, require a considerable amount of frontier pushing and entail a great deal of uncertainty in terms of the ingredients needed to create the necessary and sufficient pre-conditions for success.⁸⁹

Singapore can develop itself into a regional hub for a number of service industries by maintaining a lighter regulatory approach. Like the manufacturing sector and innovation businesses, the services sector could leverage on Singapore’s strength in efficiency infrastructure. Indeed, combined with the existing hub status in certain service industries, such strength could also give Singapore a “first mover advantage” when making inroads into other service industries such as education, legal services, creative industries etc. Given the state of development in the services sector in the region, and the fast changing technology that makes services increasingly tradable, Singapore could still extract considerable value by merely moving closer to the global efficiency frontiers in the service sector without necessarily engaging in “frontier-pushing” innovations. More than the manufacturing sector, the growth of the services sector is influenced by changes in the regulatory policy. A lighter regulatory approach could make a big difference. The healthcare industry is one example. In recent years, the growth of Singapore as a regional medical hub has been hampered by a shortage in the supply of doctors and restrictions on the registration of foreign doctors. This has resulted in high private medical costs and an opportunity for some other cities in the region including Bangkok (Thailand) and Malacca (Malaysia) to vie for a slice of the pie.⁹⁰

The country’s entrepreneurial base needs to be enhanced. The number of individuals involved in R&D work has increased significantly over the past few years, in large part because of the inflows of foreign researchers. But how this will translate to greater output remains to be seen. Over the past three years, there was also a significant increase in the number of patents filed in Singapore (Figure 43). However, most of the patents were filed by non-Singapore residents (e.g. 7,340 out of 7,580 in 2002). In Taiwan, for instance, domestic residents filed 24,846 patents in 2002 compared with 20,196 patents filed by foreigners. The trend is similar for trademark registration. Singapore’s ranking in the Global Entrepreneur Monitor actually fell in 2003. It was ranked 15th in a group of 22 OECD/East Asian

⁸⁷ Tan, Kim-Song, 2005. p. 18

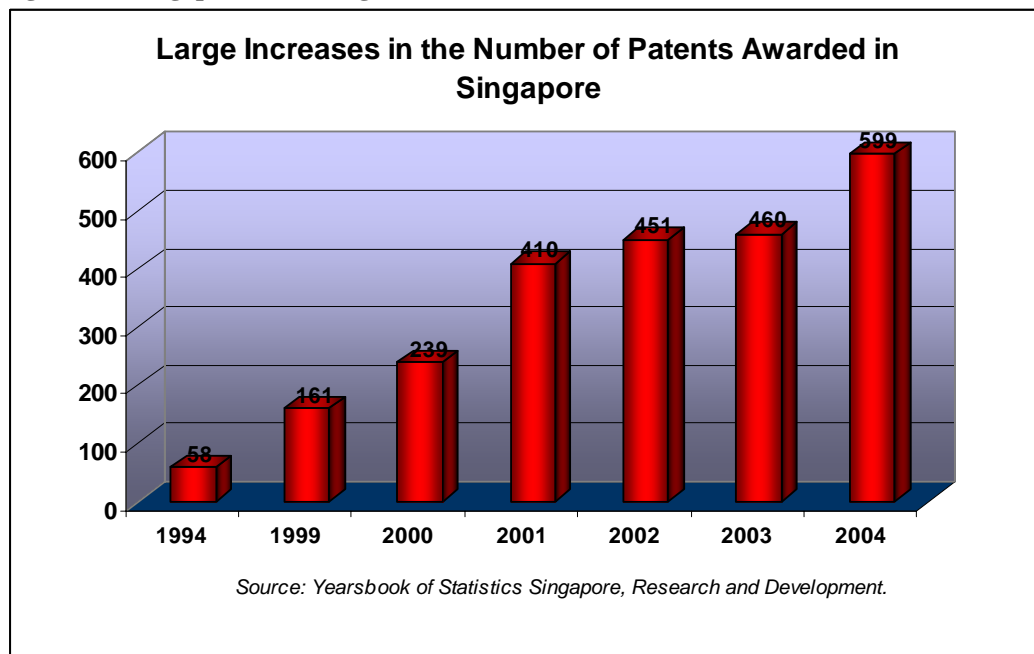
⁸⁸ Hwa, Ko Kheng, 2003.

⁸⁹ Tan, Kim Song, 2005.

⁹⁰ Ibid.

countries, compared with 11th a year earlier. In order to reverse these trends, Singapore's needs to develop entrepreneurs that are keen on commercializing their findings.⁹¹

Figure 43: Singapore increasing its innovation record



The industry focus of Singapore's innovation efforts could be difficult to define due to the country's market structure. It would be advantageous to focus on innovation in the high-tech manufacturing sector, an area in which Singapore has already built up a certain capacity for innovation. To capitalize on the increasing returns and agglomeration effects in innovation activities, deeper resource specialization is often necessary. However, investment in any particular industry must be sizeable enough for increasing returns to kick in. A diffused approach may not be effective in the end. However, concentration of resources in a few industries in accordance with the economy's perceived comparative advantage may require a lot more winner-picking and entail more risks than what the government is comfortable with. "Over-specialization" in production could result in growth patterns which may be too volatile for a small city-state. Already, "over-reliance" on the electronic industry has led to much wilder swings in GDP growth in Singapore in recent years. In this context, Singapore does face more constraints than its potential rivals in the region such as Hong Kong, Seoul and Shanghai in terms of the strategy it can pursue and the risks it can take.⁹²

The government should encourage the private sector to bear the bulk of innovation projects. The government will need to be willing to spread its resources over a wide range of industries, with the understanding that only a certain fraction of the investments will bear fruit. To compensate for its limited insight in the working of the market forces, the government often tries to bring in private sector participation, both to share the investment risk and to provide the discipline needed to guide and develop the business. The government could mitigate the risk it faces by encouraging as much private sector participation as possible and by monitoring the performance of its investments closely and frequently.

⁹¹ Ibid.

⁹² Ibid.

The Singaporean government needs to loosen its regulatory grip on the economy in order to foster a more risk taking entrepreneurial population. Too many rules and too harsh a stigma for non-conformist behaviors are said to have hindered Singaporeans' ability to innovate or to think independently. The society's intolerance for failure is also seen as a further hindrance to entrepreneurship. As part of the efforts to encourage innovation, there have been some attempts in recent years to relax the regulatory environment and government control over the social and political lives of the population. Committees were set up to identify areas where the government may be able to lighten rules and regulations so as to make it easier for individuals to start and operate businesses. Schools are revamping their curricula to inculcate a stronger entrepreneurial mindset in the students.⁹³ Changing the culture and mindset of the population to one that is more open-minded and thus, entrepreneurial will allow Singaporeans to take bigger risks in education, innovation, and business practices.

Education Issues

Tertiary education has been assigned a high priority in recent years in order to develop the human skills necessary to facilitate the country's emerging R&D efforts. Education in Singapore is highly subsidized and constitutes the second largest item of government expenditure. The country has transformed its education system into one that is industrially targeted, able to provide the higher technical skills as well as the worker training needed for high-technology production. In the process, the government has exercised control over curriculum content and quality, and ensured its relevance to the activities being produced. Manpower planning is effected through detailed quotas on the number of students to be admitted to specific programs (law, medicine, architecture, civil engineering, computer engineering, etc) at the tertiary institutions.

In July 2001, the country announced its incentive of about US\$285 million in financial support to talented undergraduate science scholars throughout their doctorates. The purpose is to ensure a steady supply of local research scientists to fuel growth in engineering and the sciences. In 2004, the government announced plans to devolve greater operational and financial autonomy to the three universities and put in place a Quality Assurance Framework for Universities to track quality enhancement in the universities. Apart from formal education, the government also directed considerable effort towards developing the industrial training system, now considered one of the best in the world for high technology production. In addition, a new agency, the Singapore Workforce Development Agency, was established in 2003 with the specific purpose of enhancing workforce skills through developing a comprehensive, market-driven and performance-based adult continuing education and training framework.⁹⁴

The government is heavily encouraging research within universities through a variety of mechanisms. Funding for research programs and graduate studies has risen substantially, especially in selected areas such as life sciences, information technology, communications and management studies etc. There is also aggressive recruitment of research faculty from abroad and greater research collaboration with reputable universities outside Singapore. The government, in an effort to transform the country into a regional education hub, is allocating a large amount of resources to the R&D efforts in the tertiary educational sector to enhance its research and innovation capacity.

Government grants have helped attract foreign universities to establish in Singapore. Government grants were given to set up joint research centers between the local and reputable foreign universities to fund collaborative projects between them. Nine world class universities offering courses in Singapore, ranging from MIT, Wharton, Johns Hopkins, Shanghai Jiaotong University, and INSEAD, and Chicago

⁹³ Ibid.

⁹⁴ Tan, Kim-Song, 2005.

Graduate School of Business, have set up their Asia campuses in Singapore.⁹⁵ More resources are also channeled to specific areas of study seen to be closely linked to the government's blueprint of an innovation-based economy: life sciences, entrepreneurial studies, communications etc.

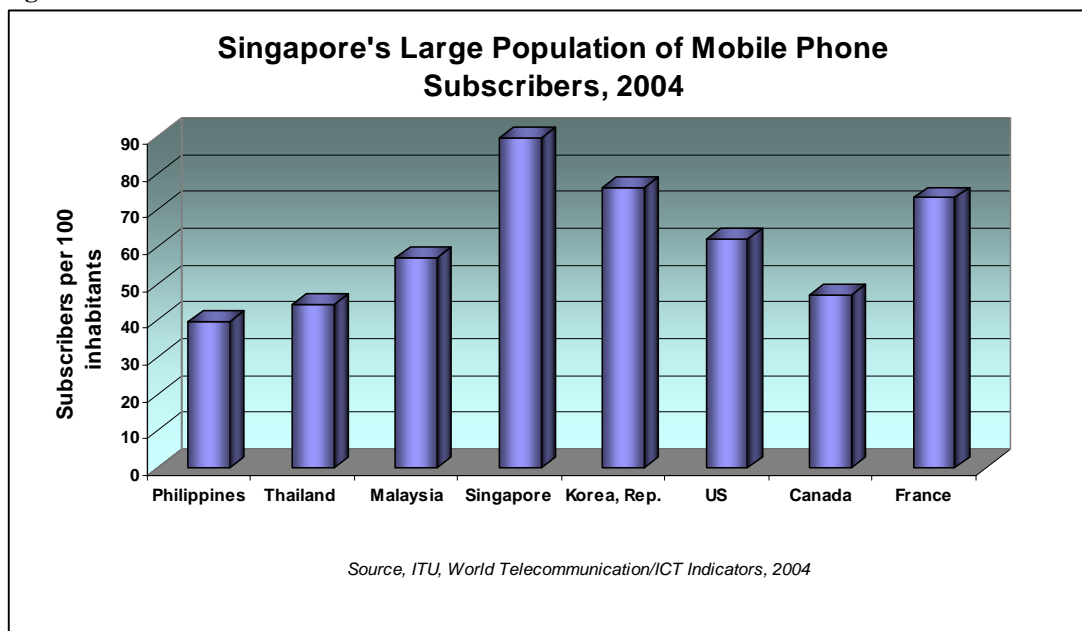
A key element of this drive for research excellence is the attraction of top researchers from abroad. Rules and regulations regarding granting of licenses for private educational institutions, programs that can be offered and intake of foreign students have been rapidly liberalized. This is aimed at building up a critical mass of educational service providers to cater to the rising demand in the region for quality education at all levels, from secondary school to tertiary and post-graduate levels.⁹⁶

Information Infrastructure

Singapore's information infrastructure has managed to connect a large percentage of the population through its commitment to liberalization and competition. The government has implemented policies to develop an information communications sector and has aspirations for Singapore to be the information hub for the region. The state owned monopoly, Singapore Telecoms, was partially privatized through listing on the stock exchange in 1993 to help realize greater efficiency. Market liberalization and a pro-competition framework were established, with regulatory functions performed by the InfoComm Development Authority (IDA).

Competition has lowered prices and spurred demand in the telecoms sector. As of September 2003, the mobile phone penetration rate in Singapore had reached 82 percent, the highest in Asia (Figure 44). The Singapore ONE project, launched by the government in 1998, provides broadband infrastructure of high capacity networks and switches, with the goal of making broadband access available to 99 percent of the population. Between 2000 and 2002, the household and corporate broadband penetration rates grew from 8 percent to 24 percent and from 15 percent to 41 percent, respectively. By June 2003, the household broadband penetration rate had increased to 31percent, in step with the IDA's target of 50 percent by 2006.⁹⁷

Figure 44: Telecom liberalization has resulted in mass access



⁹⁵ Hwa, Ko Kheng, 2003.

⁹⁶ Tan, Kim-Song, 2005.

⁹⁷ Ibid.

Singapore has been effective in incorporating IT into schools through a uniform teacher training system offered by the MOE. The National Institute of Education (NIE) is the sole teacher training institution in Singapore responsible for producing teachers effective in preparing students for knowledge for development. The programs are conducted at the diploma, degree, masters, and PhD levels. The MOE launched the IT Master plan for Education in April 1997 to effectively infuse ICT into education. This is a five year S\$2 billion plan that aimed to set out a blueprint for the use of IT in schools, and to provide access to an IT enriched school environment for every child.

At each phase of the implementation, each primary school was provided with an initial student-computer ration of 6.6:1, and spent about 10 percent of its curriculum time on IT based learning. Secondary and junior colleges started with 5:1 and 10 percent respectively for the student-computer ration and curriculum time.

The Master plan provides for the eventual targets of a student-computer ration of 2:1 and 30 percent IT based learning curriculum time. To facilitate the move towards an ICT enriched environment, NIE has adopted 'blackboard' as its entry level course delivery system, which provides the basis upon which the various e-learning models used by NIE can be built. The templates provide an easy entry to online course development for staff members using online teaching for the first time.⁹⁸ The program has been effective in preparing teachers in incorporating IT learning into their curriculums and thus, producing an IT literate population.

The Singapore government was also one of the first in the world to implement an e-government system. The Ge-BIZ portal on the e-government site was the world's first Internet-based government procurement system. At the e-Citizen centre, Singaporeans can obtain information and bid for certificates to register a vehicle, file their taxes, download forms to file for bankruptcy, register a marriage, baby, car or a pet, apply for a passport, housing or utilities, check their provident fund accounts or their child's school registration status, etc.⁹⁹

What can Sri Lanka learn from Singapore's innovation strategy?

Sri Lanka should strengthen its R&D system and cultivate innovation in its universities. Singapore recognized, early on, that it needed to develop a powerful innovation sector in order to remain competitive in the knowledge economy. The country moved quickly to address the KE pillars and brought in international experience and funding wherever possible. Sri Lanka could acquire some of these strategies in its development by encouraging a culture of innovation and more stringent protection of property rights. The country should also invest more heavily in university and private sector R&D. At the moment, the country's education system deters innovation. Students are generally not encouraged to conduct or promote research and even children in school are not encouraged to ask questions.

Singapore has been able to combat a demotivating research environment by investing more focus in creating an innovation culture through attracting the right type of people through projects like 'One North' (see Box 9) that enhance research communities. Sri Lanka could devote more effort to creating stronger research communities on a smaller scale, encouraging researchers to interact with each other and get excited about the prospects of innovation and commercialization by building links with the private sector.

⁹⁸ Cheah, H.M. and T.S. Koh. 2002.

⁹⁹ Ibid.