CHAPTER ONE

INTRODUCTION

Science and Technology Policy in Malaysia

High priority was accorded to the promotion of science, research and technological innovation, as an essential part of the Malaysian Government's development strategy to maintain high rates of growth and improve living standards. This is critical as science and technology provides the means for economic advancement and enhances international competitiveness of the economy. From the science and technology (S&T) perspective four groups of technologies would be required to meet these socio-political objectives (Omar, 1993). They are:

1. Technologies for satisfying basic needs such as food and shelter.
2. Technologies for a better quality of life such as health care, communication and transport, protection of the environment and stabilization of population size.
3. Technologies for wealth creation and maintenance of industrial competitiveness.
4. Technologies for governance appropriate for the need of government in the high-technology age.

During the Sixth Malaysia Plan period (1991-1995), considerable attention was given to effecting organisational, management and strategic changes in line with the efforts of the Government to increase technological capability and make public sector research and development (R&D) programs more demand-oriented and relevant to industry. The goals of the national S&T policy was to ensure continuous scientific and technological

developments that support and sustain high rates of economic growth, accelerate overall industrial development and lay the foundation for the attainment of a scientific and technologically advanced society by the year 2020. It was recognized that Malaysia must keep abreast with rapid advances in new technologies and move into intensive application of the emerging new generation of technologies in order to promote innovation-oriented industries and services, as they are the growth areas of the future. In line with this, the Government continued to place high priority on innovation-driven and technology-led industrial development. The thrust for S&T development under the Seventh Malaysia Plan (1996-2000) is to meet the objectives of productivity-driven growth and competitiveness. The development of Malaysia in the long-term depends on the increased use of technology, knowledge and skills to enhance industrial competence and productivity, as well as improve standards of living. Greater emphasis is placed on increasing indigenous innovation capability, and accelerating the strategic development of industrial technology. The focus is to provide an enabling environment for technological development, with proper balance between the supply and demand side initiatives for technology upgrading. The emphasis is to enhance technology infrastructure and strengthen demand for, and capacity to use, technology at the firm level. The country supports R&D and technology that promote growth, enhance industrial efficiency, productivity and competitiveness, generate homegrown technology with its own brands of goods and services and improve the quality of life. In order to support the implementation of the technology-based industrial strategies, several advanced technologies are being promoted. Developments in these areas, both domestically and internationally, are expected to create new investment opportunities for the economy as a

whole and for local industry in particular. One of these core technologies is information technology and communications, which includes high performance computing, networking infrastructure, communications, digital imaging, multimedia, high definition display, high density storage, software, and simulation and modeling.

Information Technology in Malaysia

The fruits of research and development (R&D) in electronics, especially semiconductors, have given birth to what we know of as the age of Information Technology (IT), which Malaysia like the rest of the world are highly subjected to and dependent upon. Computers and communications is the main driving force for shifting Malaysia's society in such directions. In discussing science and technology and their impact upon our future, the role of electronics and its applications in computers and communications cannot be overemphasized. Dr. Mahathir Mohamad mentioned that "Already Malaysians are among the biggest users of computers in the region. Computer literacy is essential if we want to progress and develop." (Yukio, 1993). Malaysia is highly credited not only for high usage of computers but also for a very high level of computer literacy. By the year 2020, Malaysia expects to prepare herself for the research and development, production which emphasizes the application of IT or computer software and the integration, interface, and application of such technology into the nation's needs. The issue is how to use computer hardware to develop Malaysia into an information-rich and knowledge-intensive country. While progress and even breakthroughs are being achieved in efficiency, cost, performance, size and weight of hardware, the know-how of utilising the hardware, that is, software, does not synchronize. The development of softwares cannot be achieved by

simply transplanting systems developed by other countries into the Malaysian climate. The software must be custom-tailored in accordance to each country's different operating systems, customs and culture. In this context the capability of developing such softwares or systems and high-speed digital communication networking has become priority areas in Malaysia. The systematic development of computer technology and IT becomes apparently more important and necessary in order to move the manufacturing industries from labor-intensive to computer-aided manufacturing and eventually to high technology manufacturing industries. The following engineering disciplines are needed (Yukio, 1993):

1. Computer software development: System analysts, computer programmers.
2. Computer hardware development: Computer designers, computer maintenance and repairs, manufacturers and designers of chips.
3. Computer-aided manufacturing: Engineering designers using computer-aided design or CAD; engineering personnel using computer-aided manufacturing or CAM; and computer-aided design and manufacturing or CADAM.
4. Material technologist: Material – its properties and applications (research and development).
5. Industrial designers.
6. Robotic engineering: Robotic designers, robotic repairs and maintenance, robotic applications.
7. Industrial engineers.

IT played a significant role in national development, particularly in improving efficiency, productivity and competitiveness. The critical role of information in investment decision-making and global competition has thrust IT into the forefront of economic development. IT has been recognized as a strategic enabling tool to support the growth of the Malaysian economy as well as enhance the quality of life of the population. During the Sixth Malaysia Plan period, both the public and private sectors undertook investments in computer hardware and software to facilitate the use of IT in providing goods and services more effectively. The development of IT infrastructure, such as the telecommunications network as well as IT related services and training, was expanded in tandem with the demand for such facilities and services brought about by the increased investment in IT. Investment in IT grew rapidly at an average rate of 24 per cent per annum from RM1.3 billion in 1990 to RM3.8 billion in 1995. The number of personal computers (PCs) also increased substantially from 160,000 units in 1990 to 310,000 units in 1995 (*Seventh Malaysia Plan 1996-2000*, 1996).

The current economic slowdown and the need to improve the competitiveness of exports necessitate a greater role for S&T, in particular R&D, which will help revitalize the industrial and agriculture sectors as well as develop further the services sector. High technology and strategic R&D programs that would augment overall productivity, increase the local content and capacity of industry as well as the technological capability of the country are introduced. Malaysia is preparing itself to be part of the Information Age in the new millennium where IT and multimedia will be the strategic enabling tools for the creation of a knowledge-based and civil society. The thrust of IT during the

Seventh Plan period would be to develop and expand the requisite IT infrastructure as well as instill an IT culture among the people to be more receptive to new living and working lifestyles emanating from an information-rich society. The economic slowdown does not, however, deter Government's efforts to transform the country into a knowledge-base economy. IT permeates all sectors and enhances their respective contributions to growth. Investment in IT expanded at a rate of 8.4 per cent per annum during the first three years of the Seventh Plan (1996-1998), increasing from RM3,800 million in 1995 to RM4,840 million in 1998 (*Mid-Term Review of the Seventh Malaysia Plan 1996-2000*, 1999).

Realizing the important role of IT as a catalyst for national development, the Malaysian Government has initiated the construction of the Multimedia Super Corridor (MSC) spanning Kuala Lumpur to the new KL International Airport (KLIA) at Sepang. The Corridor is supported by the provision of world-class physical and information infrastructure (*Seventh Malaysia Plan 1996-2000*, 1996) and created as a greenfield hub in order to provide the environment for the introduction and synergistic expansion of IT-related multimedia industries (*Mid-Term Review of the Seventh Malaysia Plan 1996-2000*, 1999). The Government developed KLIA and the new administrative center at Putrajaya equipped with state-of-the-art communications technology and IT infrastructure. The private sector, especially world-class multimedia companies, are also encouraged to locate themselves in the Corridor to undertake remote manufacturing as well as introduce high value-added IT goods and services, thereby enabling Malaysia to become a regional IT hub.

Table 1.2: Ranking and Percentage Share of Publication on S&T by ASEAN Countries

Country	1984-1989		1990-1994	
	Rank	Share (%)	Rank	Share (%)
Singapore	40	0.09	41	0.17
Thailand	42	0.07	44	0.09
Malaysia	44	0.05	46	0.07
Philippines	45	0.04	47	0.04
Indonesia	46	0.02	48	0.03

(Note: A total of 50 countries are in the rank)
(Source: *Second European Report on S&T Indicators – 1997*, pg. 117, Table 2c.1)

Table 1.3: Average Annual Growth Rate of Publication Output in ASEAN Countries

Country	1980-1985 (%)	1984-1989 (%)	1990-1995 (%)
Singapore	15.80	10.52	14.23
Indonesia	7.34	4.85	7.74
Malaysia	3.78	4.58	7.41
Thailand	3.88	5.38	3.88
Philippines	2.13	1.95	-1.37

(Source: *Second European Report on S&T Indicators-1997*, pg.117, Table 2c.1)

- expand and upgrade the communications infrastructure to increase accessibility;
- review laws and regulations to promote the growth of electronic communities and the development of a continuous learning environment;
- promote the development of e-commerce, indigenous contents and the local IT industry, especially the software and knowledge products industries, to generate new growth opportunities; and
- review and improve the national innovation systems to generate R&D output capable of driving the knowledge economy (*Mid-Term Review of the Seventh Malaysia Plan 1996-2000*, 1999).

Overview of National Research and Development

Assembling data from the four governmental documents, i.e., *1994 Malaysian Science and Technology Indicators Report*, *1996 Malaysian Science and Technology Indicators Report*, *1994 National Survey of Research and Development*, and *1996 National Survey of Research and Development (Revised Version)*, Table 1.1 shows the main fields of research of government agencies and research institutes (GRI), private sector, institutions of higher learning (IHL) and non-profit organizations (NPO) during 1994 and 1996. At the national level, five fields grew faster than average in the number of researchers in each main field of research between 1992 and 1994. They were earth sciences, information technology, engineering sciences, biological sciences and agricultural sciences (*1994 Malaysian Science and Technology Indicators Report*, 1996).

In 1994, among the major universities in Malaysia, Universiti Kebangsaan Malaysia has the largest number of researchers in the fields of engineering, chemical and marine sciences. Universiti Putra Malaysia led others in a number of fields including agricultural sciences, biological sciences and earth sciences. Universiti Malaya had the largest number of researchers in the fields of physical sciences, applied sciences and technologies and medical and health sciences as well as social development and community services. Universiti Utara Malaysia, however, had the most researchers in the information and computers and social sciences. Universiti Teknologi Malaysia dominated in energy supply during this year (*1994 National Survey of Research and Development*, 1996). In 1996, Universiti Teknologi Malaysia had the largest number of researchers in the field of applied sciences and technologies, material and engineering sciences. Universiti Putra Malaysia led others in a number of fields including agricultural sciences, biological sciences and earth sciences. Universiti Malaya, on the other hand, had the largest number of researchers in the fields of chemical sciences. Universiti Sains Malaysia has the largest group involve in medical and health sciences as well as information, computer and communication technology (*1996 National Survey of Research and Development (Revised Version)*, 1998).

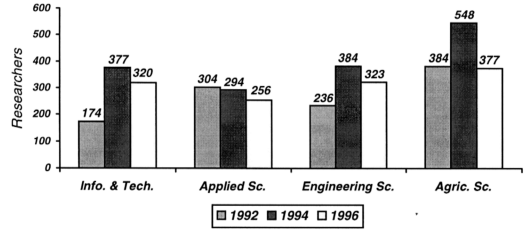
Figure 1.1 shows researchers by main field of research during 1992 and 1996. Agricultural Science seems to be the main priority, which in not surprising since Malaysia is still a highly agriculture-based economy. The trend is, however, shifting towards information technology and engineering science. This indicates that the government is changing its priority towards a more information-based economy with

high value added technology (*1996 Malaysian Science and Technology Indicators Report*, 1998).

Table 1.1: Comparison of Sectoral Research by Year (Top 3 Fields)

Sectors	1994		1996	
	Field of Research	Number of Researchers (%)	Field of Research	Expenditure (%)
GRI	Agricultural Sciences	51	Agricultural Sciences	53.2
	Applied Sciences and Technologies	8.4	Biological Sciences	14.4
	Information, Computer and Communication Technologies	4	Social Sciences	6.1
Private	Information Technology	30	Agricultural Sciences	28
	Engineering Science	26	Engineering Sciences	21
	Applied Sciences and Technologies	17	Applied Sciences and Technologies	16
IHL	Biological Sciences	24	Medical and Health Sciences	25
	Agricultural Sciences	17	Social Sciences	14.6
	Applied Sciences and Technologies	9	Biological Sciences	12.6
NPO	Social Sciences	56	N.A.	N.A.

Figure 1.1: Researchers by Main Field of Research (Top 4 Sciences)



(Source: *1996 Malaysian Science and Technology Indicators Report*, 1998, p.12, Figure 2.3)

Malaysia has been producing a considerable number of publications on S&T, which are internationally recognized. Malaysia's publications on S&T are ranked in 50 top leading countries publication output in the world. From 1984-1989, Malaysia ranked number 44 out of 48 leading countries with 0.05% share of publication output in the world. From 1990-1995, Malaysia's percentage publication output increased to 0.07% and ranked number 46 out of 50 leading countries in the world (see Table 1.2).

In terms of average annual growth rate of the world's share in publication output, Malaysia's average annual growth rate for publication output is 4%, 5% and 7% for 1980-1985, 1986-1989 and 1990-1995, respectively. The ranking is shown in Table 1.3. Singapore is ahead of other ASEAN nations, registering 16% in average annual growth rate of the share in the world's publication output. Asian countries posted quite remarkable growth against their European and North American counterparts in the annual average growth rate of the share in the world's publication; while South Korea was ranked first, Turkey third and Taiwan fourth.

Malaysia's scientific publications have also been cited 510 times in 1993, which was second to Thailand, which recorded 1,368 times (*1996 Malaysian Science and Technology Indicators Report*, 1998).

Table 1.2: Ranking and Percentage Share of Publication on S&T by ASEAN Countries

Country	1984-1989		1990-1994	
	Rank	Share (%)	Rank	Share (%)
Singapore	40	0.09	41	0.17
Thailand	42	0.07	44	0.09
Malaysia	44	0.05	46	0.07
Philippines	45	0.04	47	0.04
Indonesia	46	0.02	48	0.03

(Note: A total of 50 countries are in the rank)
(Source: *Second European Report on S&T Indicators – 1997*, pg. 117, Table 2c.1)

Table 1.3: Average Annual Growth Rate of Publication Output in ASEAN Countries

Country	1980-1985 (%)	1984-1989 (%)	1990-1995 (%)
Singapore	15.80	10.52	14.23
Indonesia	7.34	4.85	7.74
Malaysia	3.78	4.58	7.41
Thailand	3.88	5.38	3.88
Philippines	2.13	1.95	-1.37

(Source: *Second European Report on S&T Indicators-1997*, pg.117, Table 2c.1)

Statement of Problems

In the new Millennium, new challenges and opportunities exist simultaneously. This is also the last year of the Seventh Malaysia Plan, 1996-2000. By the end of the Plan period, the Second Outline Perspective Plan would have been completed. It is the time that each fixed socio-economic objective in all areas, either of long-term, mid-term or short-term form, will be fully achieved. To summarize those past experience in order to look forward to the future is absolutely necessary. This study intends to analyze international academic publication productivity in the fields of computer science and information technology by Malaysian scholars during the period, 1990-1998.

Objective of the Study

The specific objective of the study is to seek and reveal the following factors:

1. To ascertain the total number of papers published in the field of computer science and information technology available through selected international databases during the period 1990-1998,
2. To identify the channels of research communication used by Malaysian authors to publish their research findings for the period under study,
3. To find out the authors involved in the published works retrieved,
4. To ascertain the main subjects of research in the fields of computer science and information technology covered by the published works retrieved,
5. To identify the country distribution of channels used to publish as indicated by published works retrieved,
6. To ascertain the characteristics of references cited by the works retrieved.

Research Questions

1. What are the total number and spread of publication in computer science and information technology?
2. Who are the active Malaysian contributors?
3. What was the affiliate status of authors?
4. What were the main channels of research publication?
5. What were the areas research upon?

Importance of Study

The results of this study would (a) present an overview of the current status of publication productivity of Malaysian computer science and information technology researchers internationally for the period 1990-1998, and (b) identify the main interests of academic activity of these experts.

Limitations

Because time, manpower and financial resource is constrained, the investigation was restricted to only three CD-ROM databases, i.e., *INSPEC*, *COMPENDEX*, and *IEE/IEEE Electronic Library*. Furthermore, due to the incomplete subscription of CD-ROMs in the University of Malaya Library, some data may have been missed.