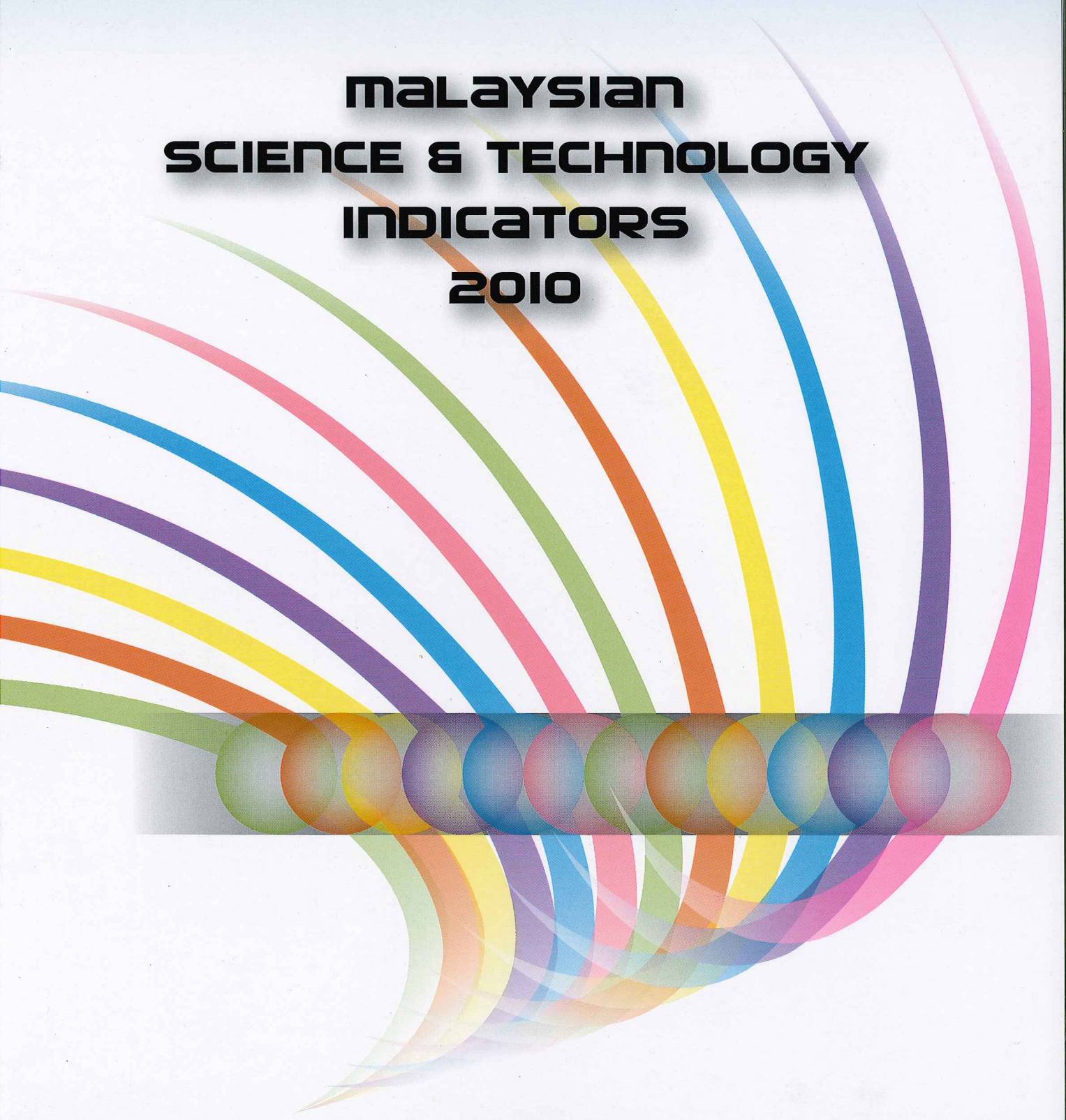
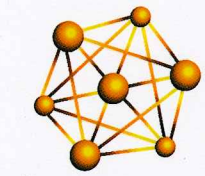
MALAYSIAN SCIENCE & TECHNOLOGY INDICATORS 2010



MINISTRY OF SCIENCE, TECHNOLOGY AND INNOVATION
MALAYSIA



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- Malaysian Examinations Syndicate (MES)
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- Ministry of Higher Education (MOHE)
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THE RESEARCH TEAM

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Editor	: Prof. Dr. Ratnawati Mohd Asraf

- EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This section presents the highlights of the various chapters in the Malaysian Science and Technology Indicators 2010 Report.

Education in S&T

- From 2005 to 2009, Additional Mathematics recorded the number of highest registrations compared to the other subjects in the Science stream at the SPM level. Throughout the same period, there was an overall decrease in the number of students registered for all the science courses at the STPM level. At the matriculation level, more than 90.0% of the students enrolled in the programme passed in science in 2009.

- There is an overall increase in students' enrolment and graduations in S&T at the undergraduate and postgraduate levels in public institutions. In general, students' enrolment in S&T at the undergraduate and postgraduate levels in public institutions is also higher than private institutions.

- At the undergraduate level, females outnumber males in all fields of study in 2008 and 2009 with the exception of the Technical field. However, males outnumber females in enrolment in PhD programmes.

Human Resource in S&T

- The human resource involved in R&D has shown an increasing trend for the period 2000-2008. The total headcount for R&D personnel increased from 23,262 in 2000 to 29,945 in 2008, while the FTE of R&D personnel increased from 10,059.7 in 2000 to 15,221.7 in 2008.

- The decomposition of human resource by sector shows a significant difference between the private and public sectors in 2006 and 2008. The headcount of private sector R&D personnel dropped by 68.0%, from 7,025 in 2006 to 2,249 in 2008, while the FTE for the private sector decreased from 5,627.8 to 2,003.9. The FTE for the IHLs, on the other hand, increased by 87.7%, from 5,438.0 to 10,208.8.

- The participation of women in R&D has also increased, from 9,127 in 2006 to 12,011 in 2008.

Public Sector Support for R&D

- The government has provided numerous grants and incentives for research and development in science and technology. The positive response observed from the public as well as the private research institutions or companies reflects their awareness of the existence of these programmes and their keen interest in being involved in R&D activities.

- However, the demand has, most of the time, exceeded the supply of such grants, given the fact that the number of applications have been, most of the time, found to be much higher than the allocations could allow.

Research and Development

- Throughout the years, Malaysia's total R&D expenditure (GERD) has been on an increasing trend. However, it dropped drastically (by 52.8%), from RM 3.6 billion in 2006 to RM 1.7 billion in 2008. The GERD/GDP ratio, a measure of research intensity, dropped from the average of 0.65% in the six year period of 2002-2006 to 0.24% in 2008.

- Analysis by sector shows that the decrease in GERD and GERD/GDP ratio is because of the sharp drop in GERD for the private sector, which declined from RM 3.1 billion in 2006 to RM 535.5 million in 2008. On the other hand, the GERD for the IHLs and GRIs was RM 772.9 million and RM 431.3 million respectively in 2008, which is greater than their GERD in 2006, which was RM 360.8 million and RM 189.5 million, respectively.

- The poor response rate by both the public and private sectors on the NSRD 2008 leaves cause for concern that the survey may not have managed to capture the true R&D expenditure, and that the R&D expenditure in Malaysia is actually much greater than that reported in the survey.

Innovation in the Private Sector

- Between 2005 and 2008, 51.5% of the Malaysian companies surveyed reported that they carried out innovation activities, and a total of RM 410.0 million was spent on innovation in that period. When compared with international countries, Malaysia was ranked 24th on Innovation Competitiveness in the GCI 2010-2011, and 26th on global competitiveness. On the WCY 2010, however, Malaysia was ranked 12th on Innovative Capacity and 10th on world competitiveness.

- When comparing the companies according to ownership, firm size, and turnover, the results of the 2005-2008 survey showed that a higher percentage of innovations were conducted by foreign controlled companies (61.9%), as shown in, large companies (74.3%), followed by small companies (64.3%), and companies with turnovers of over RM 1.0 million.

- On the factors hampering innovation, the majority of the companies cited high innovation cost (40.4%), high cost of finance (40.0%), high risk (32.5%), and lack of appropriate sources of finance (29.1%) as being the major factors. This is followed closely by their perceptions of the market being dominated by established firms (29.6%) and the lack of qualified personnel (28.1%).

Intellectual Property Rights and Balance in Royalties and Licensing Fees

- The increase in the number of patents filed and granted in Malaysia has been impressive. The number of patents filed rose significantly from 262 in 1986 to 5,737 in 2009, while the number of patents granted increased from 6 in 1988 to 3,468 in 2009. In 2009, both patents filed and granted registered positive growth of 6.2% and 35.4%, respectively.

- Patents filing and grants have been dominated by non-Malaysians. The shares of patent filed and owned by foreigners in 2009 were 78.5% and 92.2%, respectively. On the other hand, the number of patent applications made by Malaysians has increased notably, from 864 in 2008 to 1,234 applications in 2009. The share of local patent applications rose steadily from 2.2% in 1987 to 3.3% in 2000, and increased further to 21.5% in 2009.

- Since 2006, local patent applications by universities and research institutes registered a notable increase, largely contributed by the support provided by the government in financing R&D activities. The number of patents filed by universities increased from 1 in 2000 to 42 in 2009. In terms of the share in total local applications, university patent filing share rose from 0.5% in 2000 to 3.4% in 2009, peaking in 2007 at 4.8%. Applications from research institutes are more notable, increasing from 13 in 2000 (representing 6.3% of total local applications) to 148 in 2009 (12.0%).

- Malaysia has consistently experienced deficits in the balance of payments for royalties and licensing fees. The receipts have been small, but rose gradually from RM 68.1 million in 2001 to RM 192.9 million in 2004, and then increased notably to RM 656.0 million and RM 937.0 million in 2008 and 2009, respectively. However, this is far less than the payment made by Malaysia for the usage of imported technology and intellectual property rights. The payments for royalties and licensing fees increased from RM 2,379.0 million in 2001 to RM 3,368.3 million and RM 3,988.0 million in 2004 and 2009, respectively.

- The largest recipient of royalties and licensing fees from Malaysia is the United States, with a 26.5% share of the total payments in 2009. This is followed by Singapore, accounting for 15.7% of the total payments (RM 626.0 million), Japan 14.5% (RM 579.0 million), the UK 12.1% (RM 483.0 million), and Switzerland 4.6% (RM 183.0 million).

- In the professional services, Malaysia has been experiencing persistent deficits. The deficits in the contract and professional services trade widened from RM 0.6 billion in 2001 to RM 2.7 billion in 2005, and expanded further to RM 3.6 billion in 2009. The deficits in this account peaked in 2003 and 2004, registering a deficit of RM 5.1 billion and RM 4.7 billion, respectively.

ICT in Malaysia

- The indicators for ICT infrastructure and access showed increasing penetration rates for cellular telephones and internet access, while that of the DEL showed a consistent decline over the years. The penetration rate for cellular telephones grew by 42.2% from 74.1 per 100 inhabitants at end-2005 to 105.4 per 100 inhabitants at end-2009.

- The broadband penetration rate has also shown an encouraging performance, from 0.2 per 100 households at end-2005 to 31.7 per 100 households at end-2009—in line with the government's efforts to improve ICT infrastructure so as to increase its adoption and reduce the digital divide in the country. Meanwhile, the penetration rate for DEL showed a consistent declining trend to 44.0 per 100 households at end 2009 from 49.5 per 100 households in 2005 due to the increased reliance on cellular telephones and Internet as media of communication.

- The ICT sector benefited from the government's efforts to aggressively promote ICT adoption in its economic and social agenda, particularly the National Broadband Initiatives, which has set the target for the household broadband penetration rate at 50.0% by 2010, and to 75.0% by 2015 under the 10MP.
- ICT spending in Malaysia grew by 5.0%, to RM 44.9 billion in 2009 and is expected to register a higher growth at 6.0% to RM 48.43 billion in 2010.
- The key sectors in ICT spending are: the government sector; the telecommunications sector; and the financial services industry. A total of RM 20.0 billion has been allocated during the 10MP for further development of the ICT sector.

Biotechnology

- The total number of participants in biotechnology has increased to 219 in 2009, with a total expenditure of RM 445.0 million, where 80.0% is funded by the public sector.
- Biotechnology firms focused on healthcare, industrial and agricultural biotechnology while RIs and IHLs participated almost equally in agricultural, healthcare, industrial and other sectors in biotechnology.
- The revenues from biotechnology increased from RM 418.0 million to RM 1.2 billion in 2009.

Trade in Technology

- In 2009, the high and medium-high technology industry together contribute about 50.0% of Malaysia's total manufacturing exports.
- The high-technology industry exports have been consistently dominated by two industrial sub-sectors: office, accounting and computing machinery, and radio, television and communications equipment, contributing to 86.6% of the total high-technology manufacturing exports in 2009.
- Malaysia has consistently exported more high-technology products than it imported but registered a *persistent deficit* in medium high-technology products trade. The trade surplus in high-technology products declined from RM 84.5 billion in 2007 to RM 81.9 billion in 2008 and RM 60.8 billion in 2009. Trade deficit in medium high-technology products reduced slightly from RM 45.4 billion in 2007 to RM 41.8 billion in 2008, and dropped drastically to RM 18.4 billion in 2009.
- In 2008, Malaysia was ranked eighth in the list of top exporters of high-technology in the world. The US Science and Engineering Indicators (2008) ranked Malaysia first in the list of potential future high-technology exporters for smaller developing countries for the years 2005 and 2007.

Publications and Citations (Bibliometrics)

- The number of S&T articles and citations for authors affiliated with Malaysian institutions in international peer-reviewed journals has been increasing at a very rapid rate for the period 2000 to 2009. In 2009, 5,985 articles in S&T and 1,776 in the social sciences were published by authors affiliated with institutions in Malaysia, far greater than those for the year 2000, when there were 1,048 articles in S&T and 94 articles in the social sciences published. This means that the average annual growth of Malaysia's S&T article output for the period 2000-2009 is 52.3%, and is the highest in the world.

- S&T article outputs for the ASEAN region are led by Singapore and Thailand. With the rapid growth, Malaysia's article output in 2009 is higher, for the first time, than that of Thailand. However, even with the rapid growth, Malaysia's share of the world's article output is only 0.5% in 2009.

- The National Higher Education Strategic Plan, which called for the establishment of Apex and Research Universities, has helped to increase the article output and the number of citations for Malaysia.

Public Awareness of S&T

- Malaysians, throughout the years, have reported themselves as being between slightly to moderately interested in the S&T issues surveyed. The level of public interest in most of these issues is varied across the years surveyed, with the exception of their interest in *environmental pollution,* which displays a gradual decline. On the other hand, there is an increase in the percentage of respondents reporting to be interested in *space exploration, the use of nuclear power to generate power,* and *economy & commerce.*

- Throughout the years, Malaysians have perceived themselves as having between a *poor* and *average* knowledge of S&T. In the 2008 survey, however, the majority of the respondents reported themselves as having a *weak* knowledge of the issues surveyed.

- The results also show that in terms of attitude towards S&T, Malaysians have been consistently positive. From 1998 to 2004, more than 60.0% of Malaysians felt that S&T has positive effects on *public health, individual enjoyment of life, standard of living,* and *working conditions.* In 2008, 73.8% of Malaysians agreed that scientific research brings more positive than negative effects. 84.3% agreed that *S&T improves the quality of our lives* and 79.8% agreed that *S&T is very important for the progress of our nation.*

- The 2008 survey also found that Malaysians' level of understanding of S&T varies according to the issues. In 2008, more Malaysians answered correctly the items that have been taught in school such as, *"The earth travels around the sun"* (72.6%) and *"Plants produce the oxygen that we use for breathing"* (76.4%). 81.1% of the Malaysian public also answered correctly the item, *"Smoking causes lung cancer"*.

- Malaysia also generally lags behind the USA, Europe, and South Korea on their understanding of S&T. However, it should be mentioned that on the item, *"The earth travels around the sun"*, 70.3% of the Malaysians responded correctly, surpassing the Americans (56.0%), Europeans (65.0%) and Indians (68.5%), and are outperformed only by South Koreans (88.5%), while on the item, *"The earth takes 365 days to complete its rotation around the sun"*, 65.6% of Malaysians responded correctly, outperforming the Americans by 10.5% and the Indians by 24.6%.

Recent Advancements in the Energy Sector

- A major challenge in the energy sector in Malaysia is to be able to meet the energy supply-demand mismatch as energy demand grew at a higher rate of 28.0% compared to energy supply at 25.7% over the 2003-2007 period.

- Malaysia has embarked on several initiatives to promote efficient utilisation of energy and elimination of wasteful non-productive patterns of energy consumption. According to the Energy Commission, the electricity intensity ratio for Malaysia remained at a high level of around 0.175 MWh/GDP in 2009, reflecting consistently inefficient electricity usage in the country.

- Specific measures have been implemented in the 9MP to promote efficient energy usage, with additional initiatives are introduced in the 10MP. This includes specific initiatives to achieve the objective of energy efficiency in the residential, industrial, township and building sectors.

- The concern for energy security has also expedited the need to step up the R&D activities to explore renewable energy sources, which received substantial focus in the 10MP. It is targeted that renewable energy would contribute about 5.5% of Malaysia's total electricity supply by 2015.

CHAPTER 1
- INTRODUCTION

CHAPTER 1

INTRODUCTION

1.0 PREAMBLE

Malaysia has undergone a rather remarkable transformation since independence in 1957, emerging from a poor country to an upper middle-income country by the end of the 20th century. However, the factor driven growth strategies that were successful in transforming Malaysia from a poor country, reliant on rubber and tin at independence, into a diversified upper middle-income economy, are no longer appropriate to transform Malaysia into a high income country by 2020. Over the last decade, Malaysia's momentum of growth has been noticeably slow, while the growth rates of several countries in the region have improved. In addition, the latest 2010-2011 Global Competitiveness Index not only shows Malaysia's overall competitiveness ranking to decline to the 26th place from the 24th place in 2009, but that she also only ranks 40th in technological readiness, although 25th on the innovation and sophistication factors.

In 10MP (2011-2015), it is acknowledged that Malaysia's economy risks not only getting caught in a middle-income trap, "being neither a low cost imitator nor a high value add innovator," but also of being squeezed in the middle between faster growing developing nations at one end and by developed nations expanding into new markets at the other end. Vietnam, for example, is already near the take-off stage and could technologically leapfrog over Malaysia. The Republic of Korea, which started with a lower Gross National Income (GNI) per capita in 1970 of US$ 260 compared to Malaysia's US$ 380, has transformed its economy to move far ahead of Malaysia by 2009 with a GNI per capita of US$ 21,530, almost triple that of Malaysia's, of US$ 6,760.

Recognising the fact that maintaining the status quo will only put Malaysia at risk of continuously being overtaken by other countries, the Malaysian government has embarked on strategies towards a transformational shift to higher value-added and knowledge intensive activities. These activities have to be accompanied by productivity growth, which will be achieved through high-skilled human capital, adoption of new technologies, and development of entrepreneurship to drive innovation and creativity. The 10MP (2011-2015) gives special emphasis on the so-called 'enablers' of productivity, specifically skills development of the existing work force to facilitate industries to move up the value chain, investment promotion towards investment quality (as opposed to just quantity), which support higher value added activities and diffusion of technology, and increasing public investment into the enablers of innovation, particularly R&D and venture capital funding. The New Economic Model, which was recently announced on 30th March 2010, also indirectly presents a similar emphasis through its eight Strategic Reform Initiatives.

In this regard, the Second National Science and Technology Policy that was launched in 2003 to replace the first National Science and Technology Policy of 1986, now has a bigger role in setting out the path for science and technology (S&T) to be the engine for the country's future growth and competitiveness. The Second National Science and Technology Policy attempts to address the gaps in the national innovation system and focuses on strengthening research and technological capacity and capability with emphasis on commercialisation of research outputs, strengthening institutional framework, and management of S&T. Central to all these strategic thrusts is to bring the government, industries, universities and public research institutions together in a synergistic partnership. It aims at increasing R&D spending to at least 1.5% of the Gross Domestic Product (GDP) and at achieving a competent work force of at least 60 RSEs (researchers, scientists and engineers) per 10,000 labor force by 2010, so as to enhance national capacity in R&D and national capability in S&T respectively. There are seven key priority areas that the Second National Science and Technology Policy seeks to address, which have a strong influence on the innovation system, namely:

- Strengthening research and technological capacity and capability;
- Promoting commercialisation of research outputs;
- Developing human resource capacity and capability;
- Promoting a culture for science, innovation and techno-entrepreneurship;
- Strengthening institutional framework and management for S&T and monitoring of S&T policy implementation;
- Ensuring widespread diffusion and application of technology, leading to enhanced market-driven R&D to adapt and improve technologies; and
- Building competence for specialisation in key emerging technologies.

This 2010 Science and Technology Indicators Report presents an assessment of the S&T status in Malaysia for the past two years using a range of indicators, hence simultaneously providing an evaluation on the extent of the success of the Second National Science and Technology Policy in achieving its objectives, specifically on R&D capacity and S&T capability. It reveals the strengths and weaknesses of S&T development in Malaysia, which are necessary information for the formulation of new and improved national S&T policies, in line with the 10MP and the New Economic Model to transform the country into a high-income nation by 2020.

1.1 HOW THE REPORT WAS PREPARED

The indicators presented in this report are based on surveys conducted by MASTIC and other secondary sources of data either published or obtained directly from various ministries and government agencies. Hence, the original sources should be referred to with regard to details on the methodology employed in generating the indices. The principal sources of information employed in this 2010 Science and Technology Indicators Report are shown in **Table 1.1.**

Table 1.1: Principal References Employed in Preparation of Malaysia Science and Technology Indicators 2010 Report

Chapter	Title	Principal Source of Information
2	Education in Science and Technology	• Ministry of Education (MOE) • Ministry of Higher Education (MOHE) • Malaysian Examination Syndicate (MES)
3	Human Resource in Research and Development	• Final Draft of National Survey of Research and Development 2008 • IMD World Competitiveness Yearbook
4	Public Sector Support for Research and Development in Science and Technology	• Ministry of Science, Technology and Innovation (MOSTI) • Malaysian Technology Development Corporation (MTDC) • Small and Medium Industries Development Corporation (SME Corp) • Malaysian Life Science Capital Fund (MLSCF) • Malaysia Biotechnology Corporation Sdn Bhd • Malaysia Communications and Multimedia Commission (MCMC) • Lembaga Hasil Dalam Negeri (LHDN) • Multimedia Development Corporation (MDeC) • Malaysian Industry Development Authority (MIDA)

Table 1.1: Principal References Employed in Preparation of Malaysia Science and Technology Indicators Report 2010 (Continued)

Chapter	Title	Principal Source of Information
5	Research and Development for Science and Technology	• Final Draft of National Survey on Research and Development 2008
6	Innovation in Private Sector	• Global Innovation Index (GII) • Ministry of Science, Technology and Innovation (MOSTI)
7	Intellectual Property Rights and Balance in Royalties and Licensing Fees	• Intellectual Property Corporation of Malaysia (MyIPO) • United States Patent and Trademark Office (USPTO)
8	Information and Communication Technology in Malaysia	• International Data Corporation (IDC) • Tenth Malaysia Plan • Information Economy Report • Multimedia Development Corporation (MDeC) • Malaysian Communication and Multimedia Commission (MCMC)
9	Biotechnology	• Malaysia Biotechnology Corporation Sdn Bhd • Technology Park Malaysia (TPM) • National Biotechnology Division (BIOTEK) • Malaysian Biotech Information Centre (MABIC)
10	Trade in High-Technology Products and Professional Services	• Department of Statistic (DOS) • Bank Negara Malaysia (BNM)
11	Bibliometrics	• Bibliometrics Study 2008, MOSTI
12	Public Awareness of Science and Technology in Malaysia	• Survey on Public Awareness, Knowledge and Attitudes towards STI 2008
13	Recent Advancement in the Energy Sector	• Ministry of Energy, Green Technology and Water (KeTTHA) • Malaysia Green Technology Corporation (Green Tech Malaysia) • Malaysian Nuclear Agency

1.2 ORGANISATION OF THE REPORT

The report consists of this introductory chapter followed by 12 core chapters on the specific areas and a final chapter that provides the conclusion and the way forward. Preceding these chapters, there will also be an Executive Summary that provides an overview of the findings of this report. The chapters are as follows:

Chapter 1	:	Introduction
Chapter 2	:	Education in Science and Technology
Chapter 3	:	Human Resource in Research and Development
Chapter 4	:	Public Sector Support for Research and Development in Science and Technology
Chapter 5	:	Research and Development for Science and Technology
Chapter 6	:	Innovation in the Private Sector
Chapter 7	:	Intellectual Property Rights and Balance in Royalties and Licensing Fees
Chapter 8	:	Information and Communications Technology in Malaysia
Chapter 9	:	Biotechnology
Chapter 10	:	Trade in High-Technology Products and Professional Services
Chapter 11	:	Bibliometrics
Chapter 12	:	Public Awareness of Science and Technology in Malaysia
Chapter 13	:	Recent Advancements in the Energy Sector
Chapter 14	:	Conclusion and the Way Forward

CHAPTER 2
- EDUCATION IN SCIENCE & TECHNOLOGY

CHAPTER 2

EDUCATION IN SCIENCE & TECHNOLOGY

2.0 INTRODUCTION

The Malaysian government has always regarded S&T as an important national agenda. In order for Malaysia to be a developed country, and in order for her to maintain a competitive edge and reap the benefits of a knowledge-based economy, it is important that we not only keep abreast of developments in S&T, but also strive to be at the forefront of these developments. This, however, requires that we create the conditions that are conducive for the growth of S&T. Given the importance of S&T, the National Science and Technology Policy was implemented (and currently, the Second National Science and Technology Policy) to promote the culture of science, innovation, and techno-entrepreneurship, among Malaysians. Among the specific initiatives proposed by the Second National Science and Technology Policy is to develop the needed human resource in S&T and to ensure that our system of education helps us to fulfil this aim.

The Malaysian education system encompasses education beginning from pre-school to university. Pre-tertiary education (pre-school to secondary education) is the responsibility of the Ministry of Education (MOE), while tertiary or higher education is under the purview of the Ministry of Higher Education (MOHE). The Malaysian education system begins streaming students into science and arts-related subjects at the upper secondary school level. This continues to the pre-tertiary or matriculation level, and to the tertiary education level, which includes programmes at the Certificate, Diploma, Bachelor's, Master's, and Doctorate levels.

This chapter presents an overview of the state of education in science and technology (S&T) in Malaysia, from the upper secondary school level to the tertiary level. Data obtained from both the public and private educational institutions are used to draw comparisons on students' enrolment and graduations at different levels of higher education. The data presented cover at least a two-year period, if not longer, to observe possible patterns or trends. An analysis will then be made, with the aim of assessing the state of science and technology education in this country. Data in this chapter are obtained from three main sources, the Ministry of Education (MOE), Ministry of Higher Education (MOHE), and the Malaysian Examinations Syndicate (MES).

This chapter is organised into five sections. The first section presents data on Science and Technology (S&T) subjects at the upper secondary school level and matriculation level. The second and third section compares the statistics on enrolment and graduations between S&T and non-S&T courses at the undergraduate and postgraduate degree levels in both public and private educational institutions. The third section also includes the statistics on enrolment and graduation at the Diploma and Certificate level programmes at private institutions. The fourth section examines the enrolment and graduation between males and females in different fields of study at the undergraduate and postgraduate degree levels in public educational institutions, while final section concludes the chapter with a brief discussion on the salient features of the data before ending with some recommendations for education in S&T for the future.

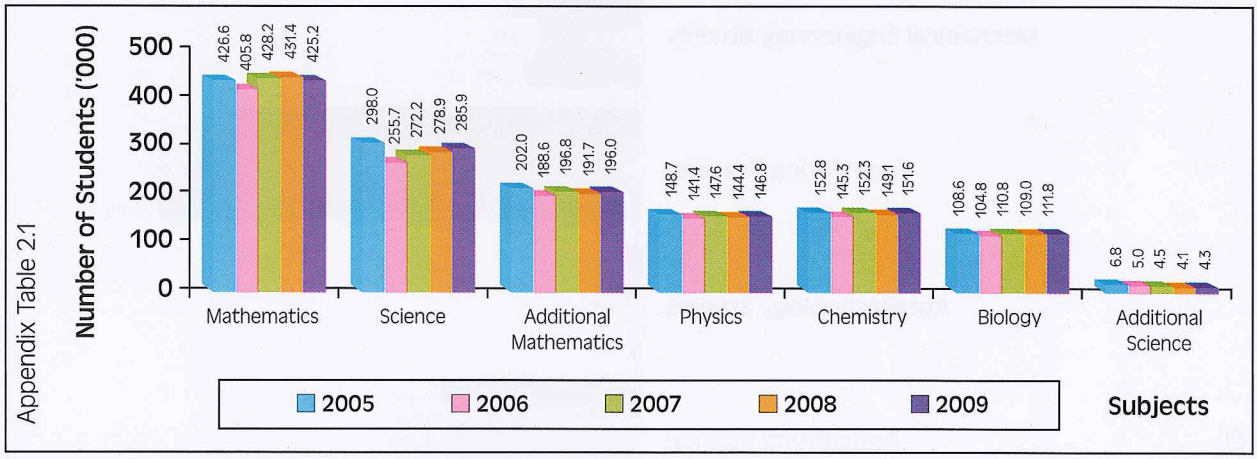
2.1 EDUCATION IN SCIENCE, MATHEMATICS, AND TECHNOLOGY AT THE SECONDARY AND MATRICULATION LEVEL

This section discusses education in Science, Mathematics, and Technology at the secondary level, namely, the *Sijil Pelajaran Malaysia* (SPM) and *Sijil Tinggi Pelajaran Malaysia* (STPM) examinations, and the pre-university level, commonly known as the Matriculation level. The statistics that are presented include the number of students registered for Science and Mathematics subjects for the SPM and STPM examinations, the number of students registered in science courses, and the percentage of students who passed in Science at the Matriculation level.

2.1.1 Science, Mathematics and Technical Subjects at the SPM Level

Figure 2.1 shows that from 2005-2009, more than 400,000 students registered for mathematics every year. This is followed quite closely by science, where between 250,000 to almost 300,000 students registered. This is to be expected, as mathematics is a general subject, taken by all students in Form Four and Form Five. Of the subjects taken by students in the science stream, additional mathematics has the highest registration, followed closely by physics and chemistry, where around 150,000 students registered. With the exception of 2006, where there was a slight drop in registration for mathematics, science, and additional mathematics, the number of students registered for these courses has been relatively constant.

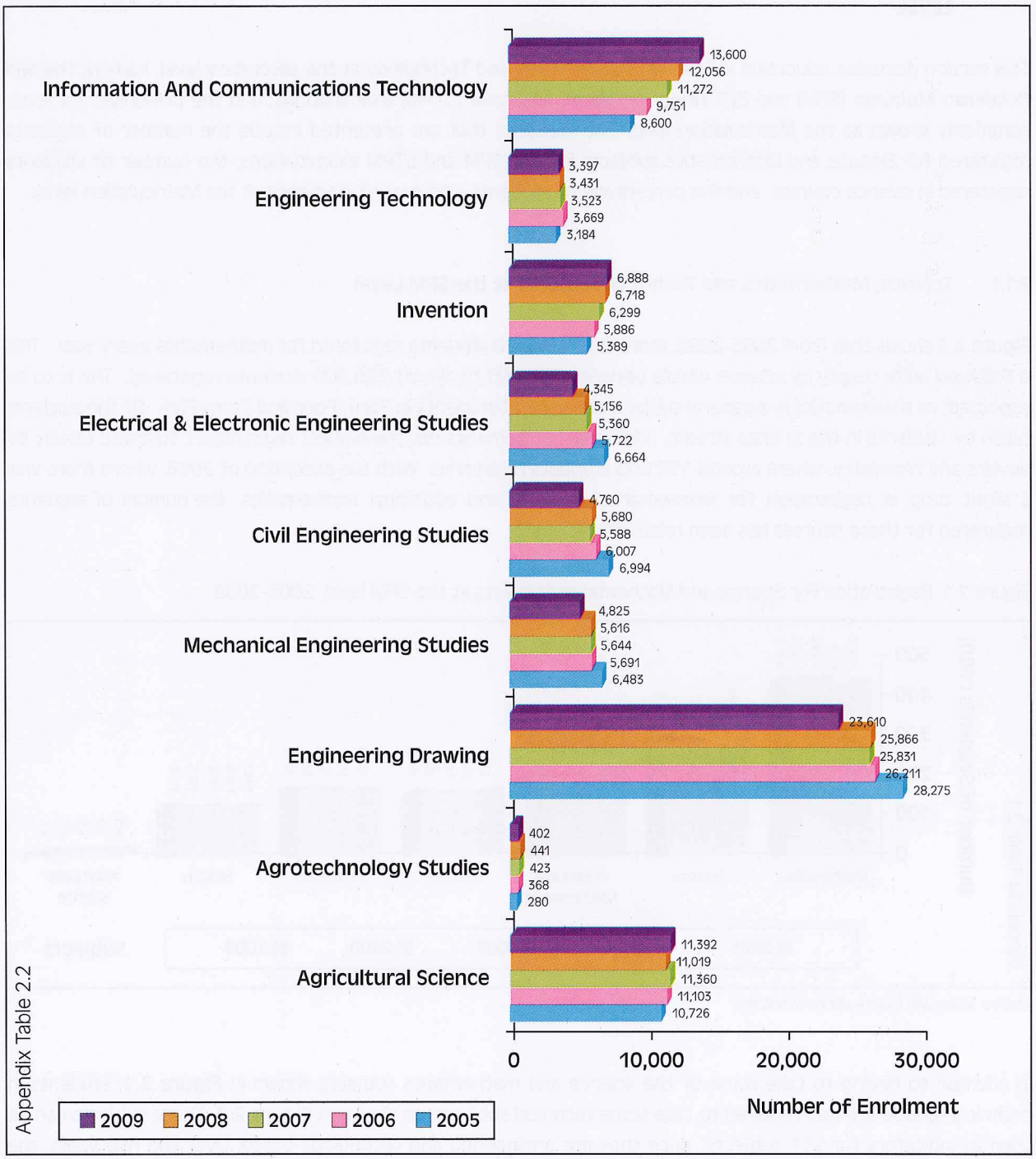
Figure 2.1: Registration for Science and Mathematics Subjects at the SPM level, 2005-2009



Source: Malaysian Examinations Syndicate

In addition to having to take some of the science and mathematics subjects shown in **Figure 2.1**, students in technical schools are also required to take some technical subjects, as shown in **Figure 2.2**. These subjects can be used as indicators for S&T subjects, since they are engineering and technology-based. Over the five years, the highest number of registrations are recorded for engineering drawing, with more than 20,000 students. This is because it is a required subject for engineering-stream students. Meanwhile, the number of students registered for agricultural science and engineering technology has remained relatively constant, while there seems to be a gradual decline in all engineering studies subjects. A steady increase is experienced by the subjects, Inventions, and Information and Communications Technology (ICT) over the years. The subject, Agrotechnology Studies, received the lowest number of registrations in the five years, suggesting the need to make students more aware of the subject and to make the subject more appealing for students. The increase in interest in ICT is encouraging, given its importance in our country's economy.

Figure 2.2: Registration for Technical Subjects at the SPM level, 2005-2009

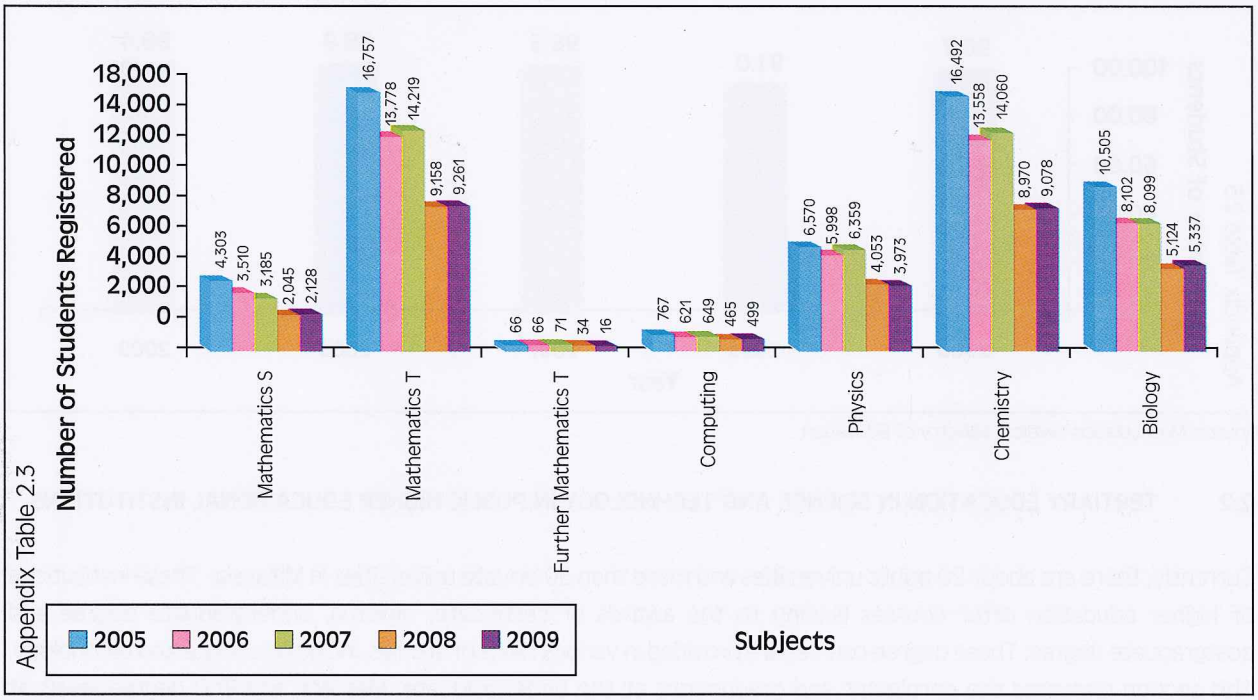


Source: Malaysian Examinations Syndicate

2.1.2 Science, Mathematics, and Technology Subjects at the STPM Level

From 2005 to 2009, Mathematics T and Chemistry are two courses that have the highest number of students registered, followed, a distant second, by biology. Not as many students registered for Physics and Mathematics S, and even fewer registered for computing. The subject that has the least number of students registered is Further Mathematics T **(Figure 2.3).** The data also show that from 2005 to 2009, there has been an overall decrease in the total number of students registered for all the science courses at the STPM level **(Table 2.1).**

Figure 2.3: Registration for Science and Mathematics Subjects at the STPM level, 2005-2009



Source: Malaysian Examinations Syndicate

Table 2.1: Total Registration for Science at the STPM Level, 2007-2009

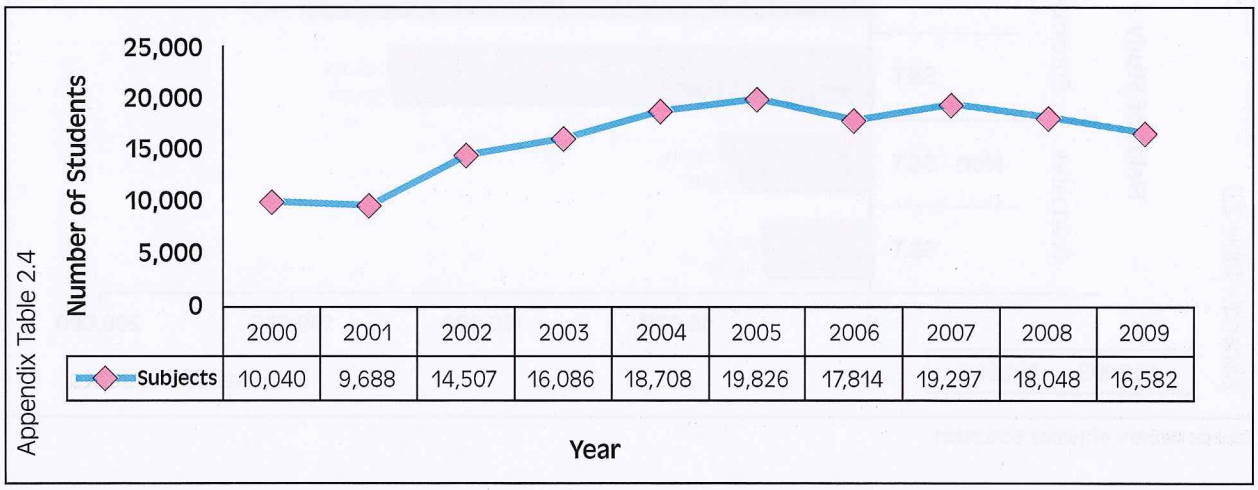
Total Number of Science Stream Students Registered at the STPM Level	2007	2008	2009
	14,235	9,093	9,205

Source: Malaysian Examinations Syndicate

2.1.3 Education in Science and Technology at the Matriculation Level

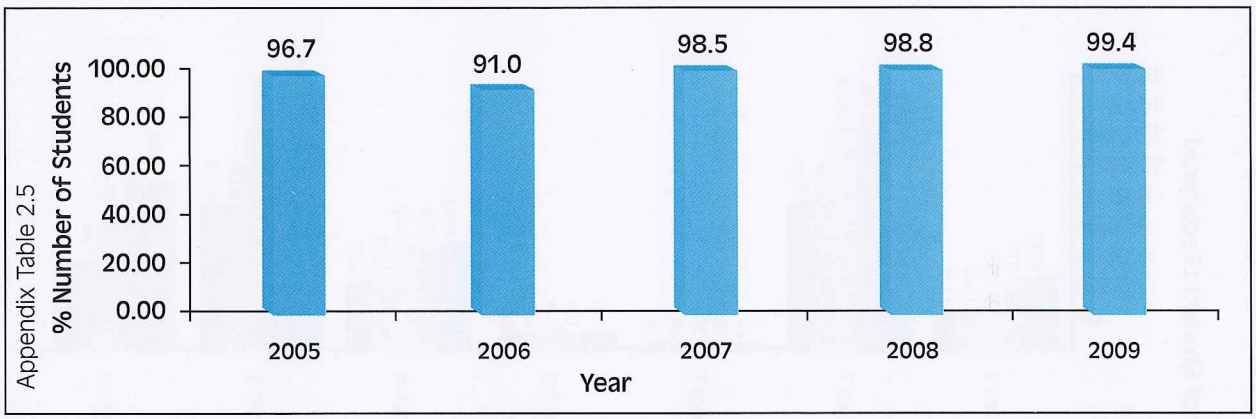
As shown in **Figure 2.4**, the number of students registered for science subjects has been on an increasing trend from 2000 to 2009, with the exception of 2006 and 2009, where the registration dropped by almost 2,000 compared to the years before. The percentage of students who passed Matriculation in Science is also high. With the exception of 2006, the percentage of students who passed is almost 100.0% **(Figure 2.5)**.

Figure 2.4: Registration for Matriculation for Science Subjects, 2000-2009



Source: Matriculation Division, Ministry of Education

Figure 2.5: Percentage of Students Who Passed Matriculation in Science, 2005-2009



Source: Matriculation Division, Ministry of Education

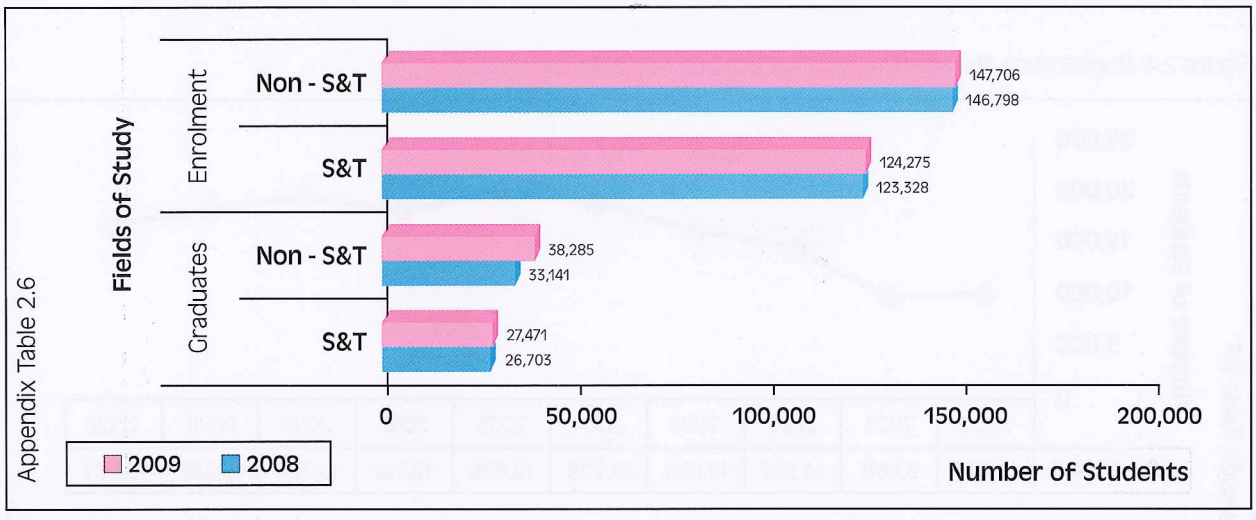
2.2 TERTIARY EDUCATION IN SCIENCE AND TECHNOLOGY IN PUBLIC HIGHER EDUCATIONAL INSTITUTIONS

Currently, there are about 20 public universities and more than 30 private universities in Malaysia. These institutions of higher education offer courses leading to the awards of certificate, diploma, undergraduate degree and postgraduate degree. These degree courses are provided in various fields of studies, including science and technology. This section discusses the enrolment and graduations at the undergraduate, Masters, and PhD degree levels at public and private institutions, and the enrolment and graduations at the Certificate and Diploma levels at private institutions.

2.2.1 Enrolment and Graduations in First Degree Courses at Public Higher Educational Institutions by Field of Studies

As shown in **Figure 2.6**, there is a slight increase in students' enrolment and graduations in both Science & Technology (S&T) and non-science & Technology (non-S&T) courses from 2008 to 2009. However, the enrolments for non-science courses exceed the enrolments for science courses by more than 20,000. Consistent with the figures for enrolment, the number of graduates in non-science courses exceeds those in the science courses.

Figure 2.6: Students' Enrolment and Graduation in First Degree Courses at Public Higher Educational Institutions by Field of Study, 2008-2009

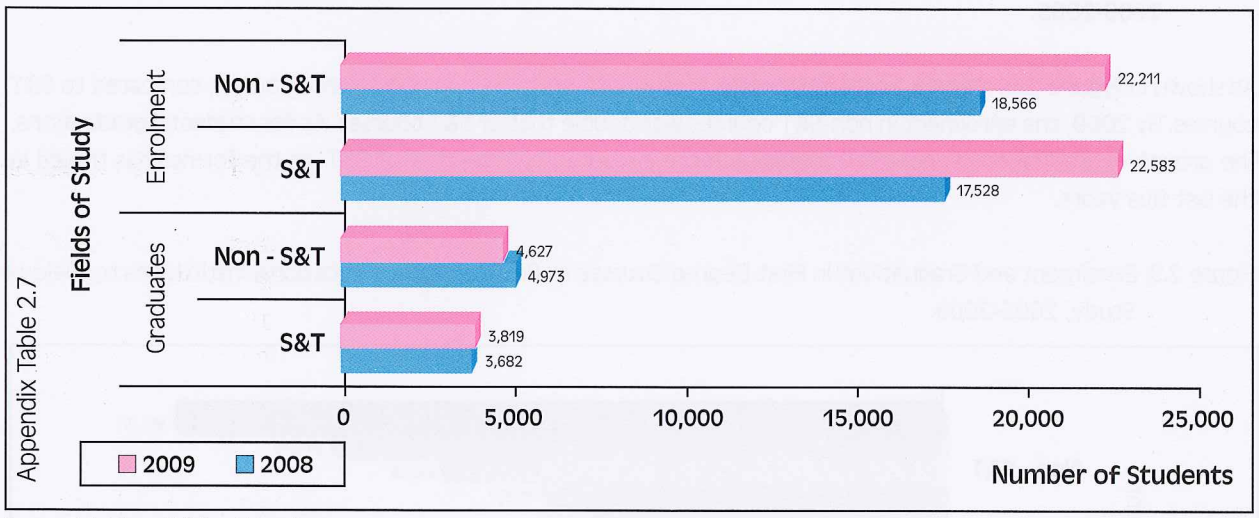


Source: Ministry of Higher Education

2.2.2 Enrolment and Graduation for Master's Degree Courses at Public Higher Educational Institutions

As illustrated in **Figure 2.7**, there was a sharp rise in the enrolment in the Master's degree programmes for both S&T and non-S&T courses from 2008 to 2009. The enrolment in S&T courses increased by more than five thousand from 2008 to 2009 while that for the non-S&T courses increased by about three thousand. A different pattern is displayed in students' graduation, where graduation in non-S&T programmes declined by 7.0%, while graduations in S&T Master's programmes increased by 3.7%.

Figure 2.7: Enrolment and Graduations in Master's Degree Programmes at Public Higher Educational Institutions by Field of Study, 2008-2009

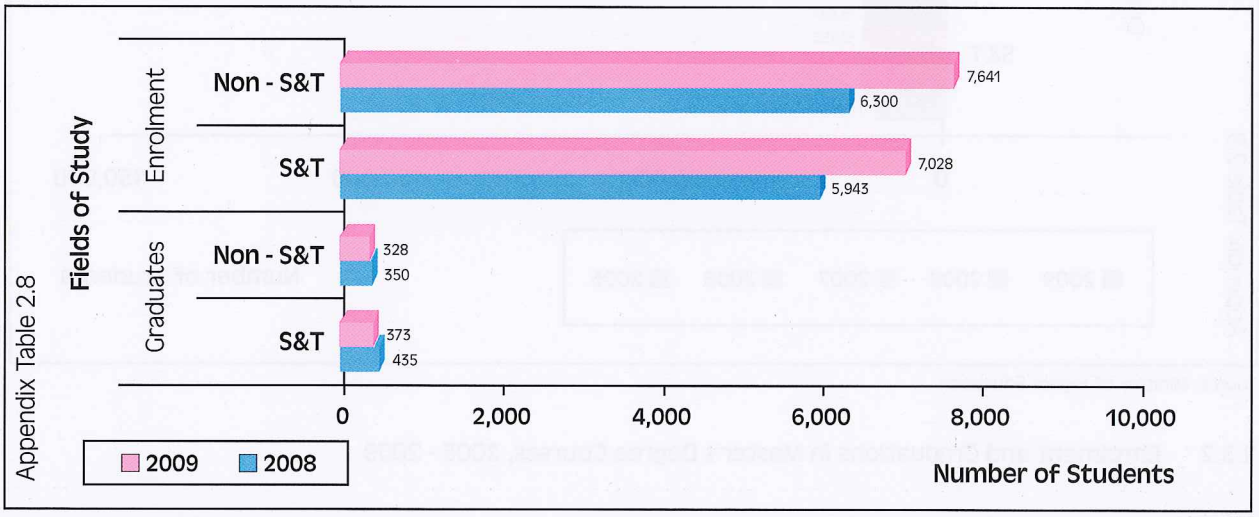


Source: Ministry of Higher Education

2.2.3 Enrolment and Graduations in Doctoral Degree Courses

In 2009, more than 7,000 students registered for S&T and non-S&T courses, a higher enrolment for both courses compared to the previous year **(Figure 2.8)**. For graduations however, S&T courses recorded a higher number of graduations compared to non-S&T courses.

Figure 2.8: Enrolment and Graduations in Doctoral Degree Programmes at Public Higher Educational Institutions by Field of Study, 2008-2009



Source: Ministry of Higher Education

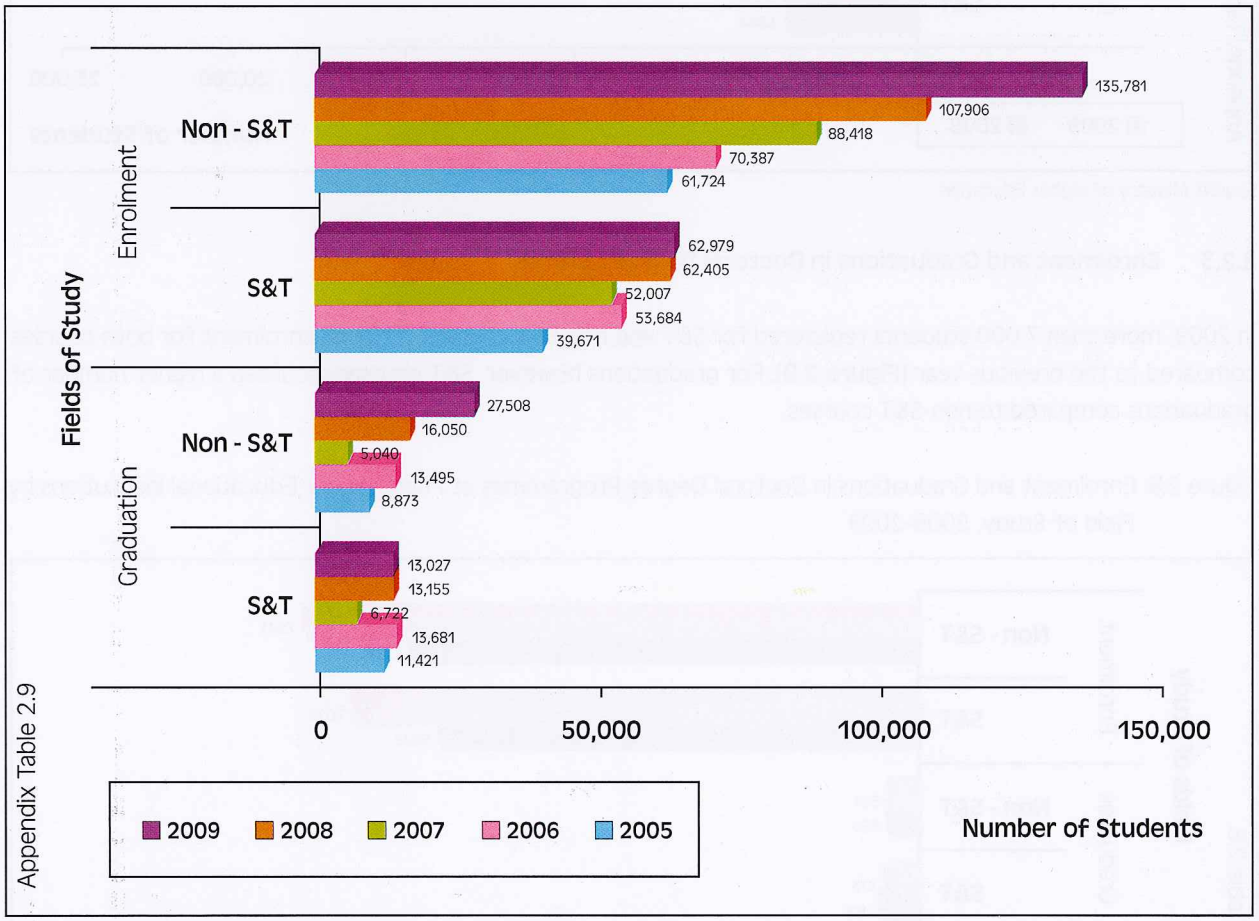
2.3 TERTIARY EDUCATION AT PRIVATE HIGHER EDUCATIONAL INSTITUTIONS

Private higher educational institutions provide a substantive contribution to higher education in this country. This consists of private universities such as the Multimedia University, the University Kuala Lumpur, and Universiti Teknologi Petronas. The size of enrolment and graduations in these institutions is quite substantial and encouraging, particularly at the First degree level. This section presents data on students' enrolment and graduations at the Certificate, Diploma, Bachelor's, Master's and PhD levels by field of studies from 2005 to 2009.

2.3.1 Enrolment and Graduations in First Degree courses at Private Higher Educational Institutions, 2005-2009.

As shown in **Figure 2.9**, there is a steady increase in students' enrolment in non-science courses compared to S&T courses. By 2009, the enrolment in non-S&T courses was double that of S&T courses. As for students' graduations, the growth in graduations in non-S&T courses is more encouraging than that of S&T, as the former has tripled in the last five years.

Figure 2.9: Enrolment and Graduations in First Degree Courses at Private Higher Educational Institutions by Field of Study, 2005-2009

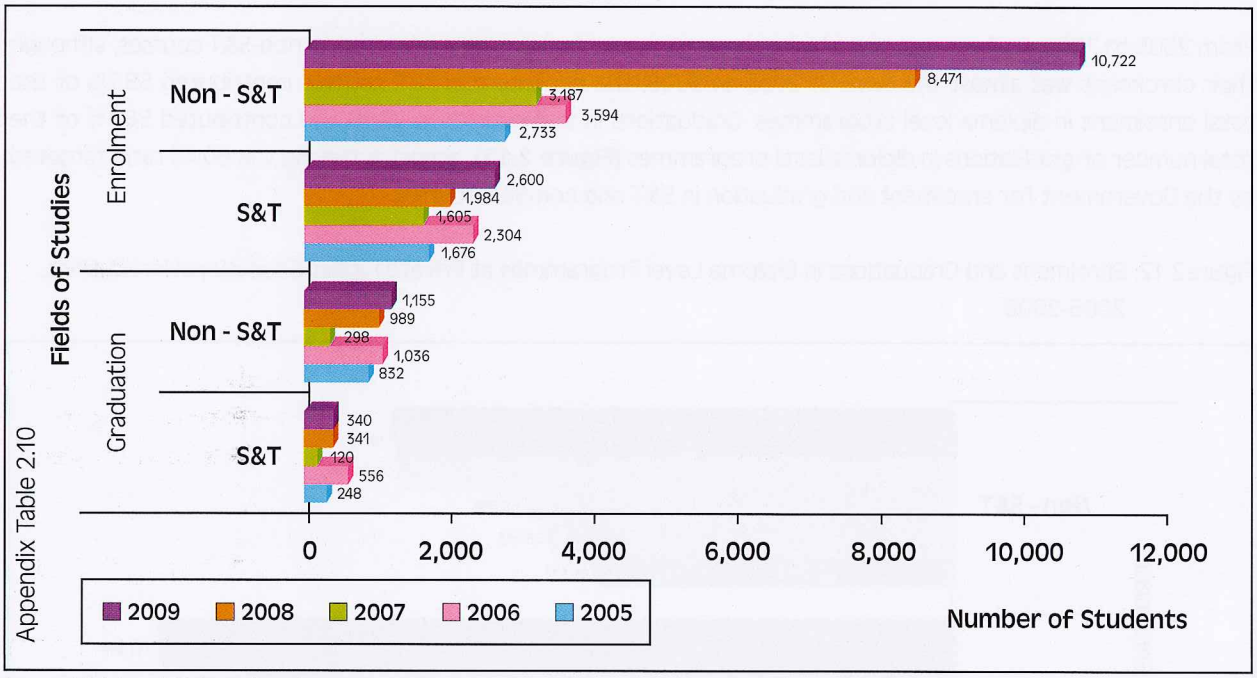


Source: Ministry of Higher Education

2.3.2 Enrolment and Graduations in Master's Degree Courses, 2005 - 2009

As shown in **Figure 2.10**, enrolments in the fields of non-science far outnumber those in S&T. By 2009, the enrolment in non-S&T programmes had almost quadrupled that of 2005, and was four times higher than the enrolment in S&T programmes in 2009.

Figure 2.10: Enrolment and Graduations in Master's Degree Courses at Private Higher Educational Institutions, 2005-2009

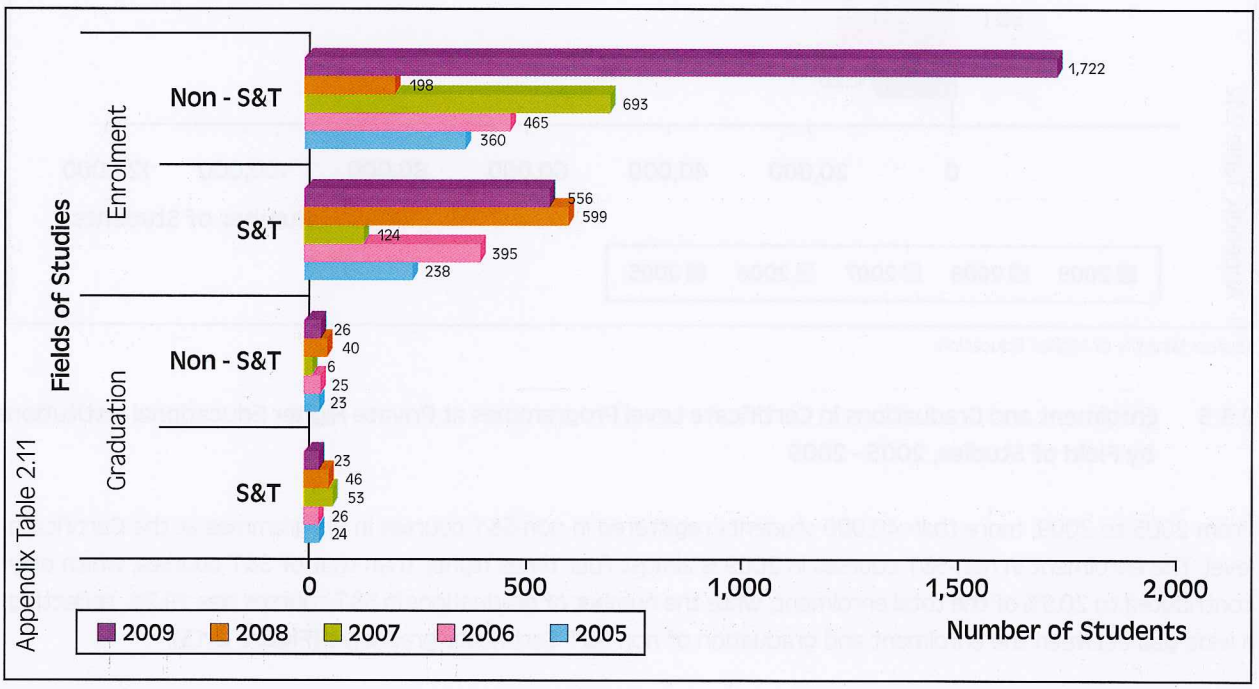


Source: Ministry of Higher Education

2.3.3 Enrolment and Graduations in Doctoral Degree Courses at Private Higher Educational Institutions, 2005-2009

As shown in **Figure 2.11**, the enrolment in non-S&T and S&T courses fluctuated throughout the five-year period. Enrolment in non-S&T courses was highest in 2009, with 1,722 students, while enrolment in S&T courses dropped 7.2% in 2009. The number of graduations at the Doctoral degree level declined by almost 43.0% from 2008 to 2009. By 2009, the number of graduations in S&T (23) and non-S&T (26) courses was almost equal.

Figure 2.11: Enrolment and Graduations in Doctoral Degree Courses at Private Higher Educational Institutions, 2005-2009

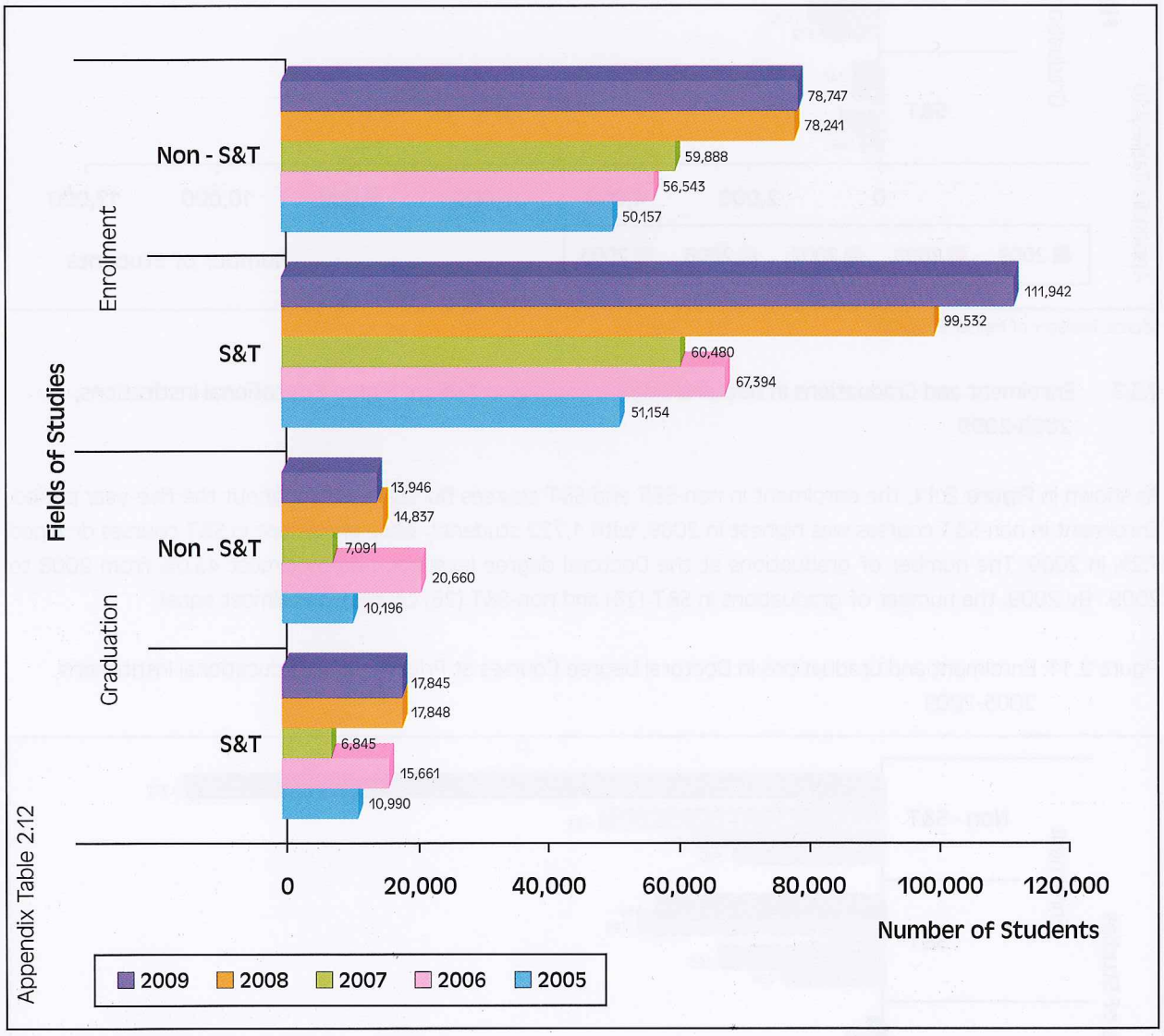


Source: Ministry of Higher Education

2.3.4 Enrolment and Graduations in Diploma Level Programmes at Private Higher Educational Institution 2005 - 2009

From 2005 to 2009, S&T courses saw a higher increase in enrolment when compared to non-S&T courses, although their enrolment was almost the same in 2005. In 2009, the enrolment in S&T courses contributed 58.7% of the total enrolment in diploma level programmes. Graduations in S&T courses in 2009 also contributed 56.1% of the total number of graduations in diploma level programmes **(Figure 2.12)**, almost achieving the 60:40 ratio targeted by the Government for enrolment and graduation in S&T and non-S&T courses.

Figure2.12: Enrolment and Graduations in Diploma Level Programmes at Private Higher Educational Institutions, 2005-2009

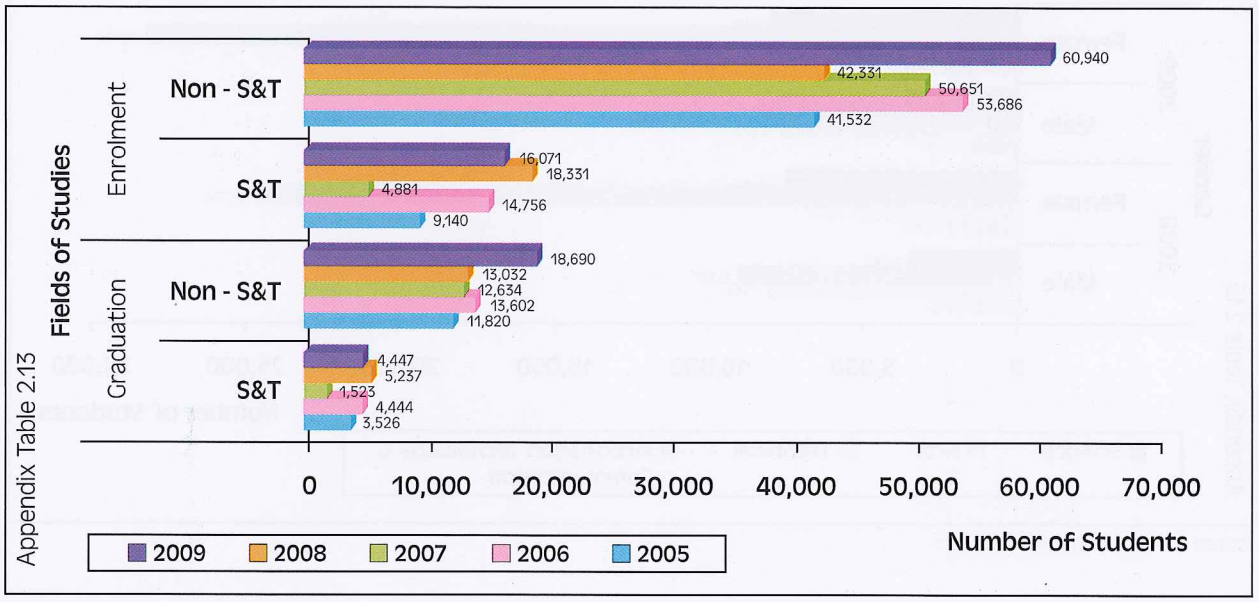


Source: Ministry of Higher Education

2.3.5 Enrolment and Graduations in Certificate Level Programmes at Private Higher Educational Institutions by Field of Studies, 2005 - 2009

From 2005 to 2009, more than 40,000 students registered in non-S&T courses in programmes at the Certificate level. The enrolment in non-S&T courses in 2009 is almost four times higher than that of S&T courses, which only contributed to 20.9% of the total enrolment, while the number of graduations in S&T courses was 19.2%, reflecting a wide gap between the enrolment and graduation of non-S&T Certificate graduates **(Figure 2.13)**.

Figure 2.13: Enrolment and Graduations in Certificate Level Programmes at Private Higher Educational Institutions by Field of Studies, 2005-2009



Source: Ministry of Higher Education

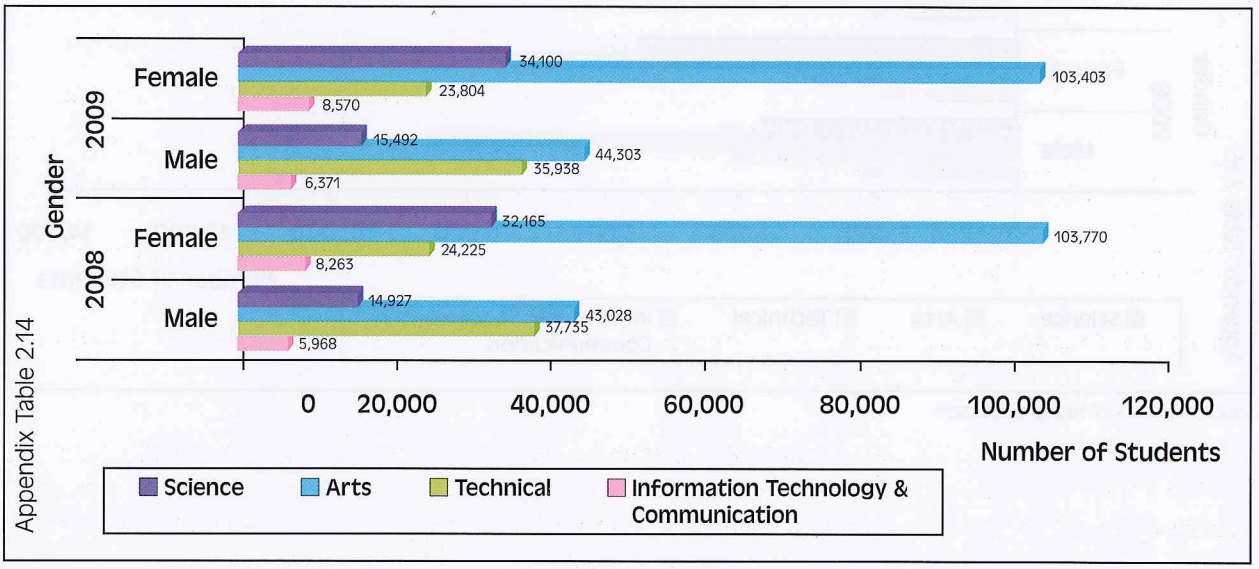
2.4 COMPARISONS BETWEEN GENDER

This section compares students' enrolment and graduations in different fields of studies in tertiary education between male and female students from 2008 to 2009.

2.4.1 Gender Comparison for Enrolment and Graduations in First Degree Courses in Public Educational Institutions from 2008 to 2009

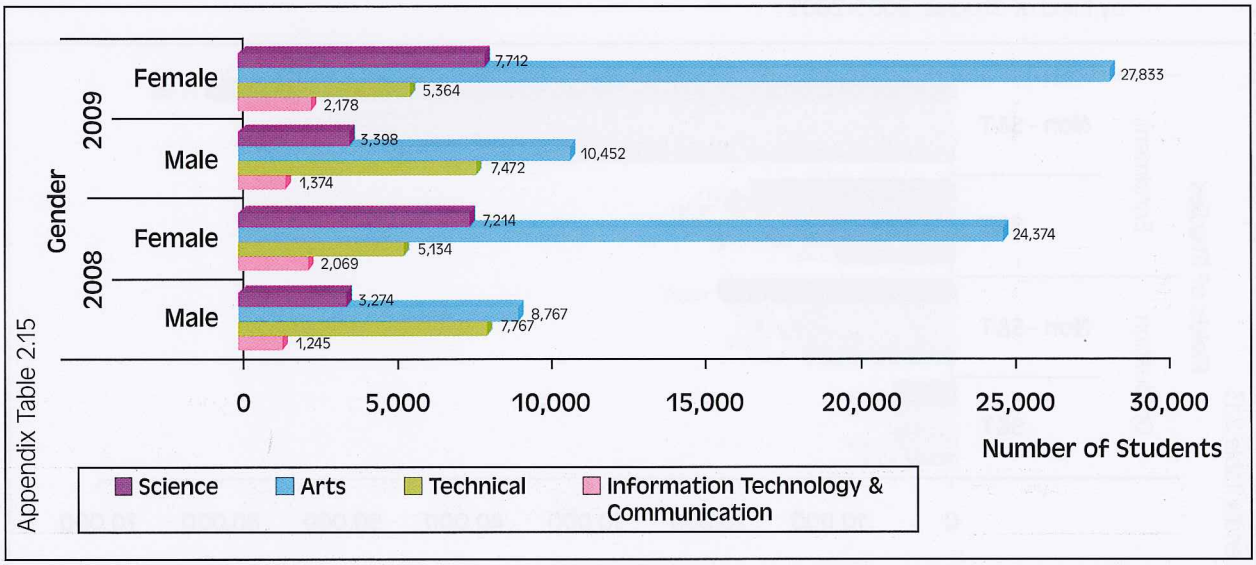
As can be seen from **Figure 2.14**, females outnumber males in all fields of study in 2008 and 2009 by 27.8% and 25.7% respectively, with the exception of the Technical field. An overall increase in male and female graduations from 2008 to 2009 can be observed in almost all fields, with the exception of male graduations in the Technical field, which suffered a decline of 295 students **(Figure 2.15)**.

Figure 2.14: Gender Comparison for Students' Enrolment in First Degree Level in Public Institutions, 2008-2009



Source: Ministry of Higher Education

Figure 2.15: Gender Comparison for Students' Graduations in First Degree Level in Public Institutions, 2008-2009

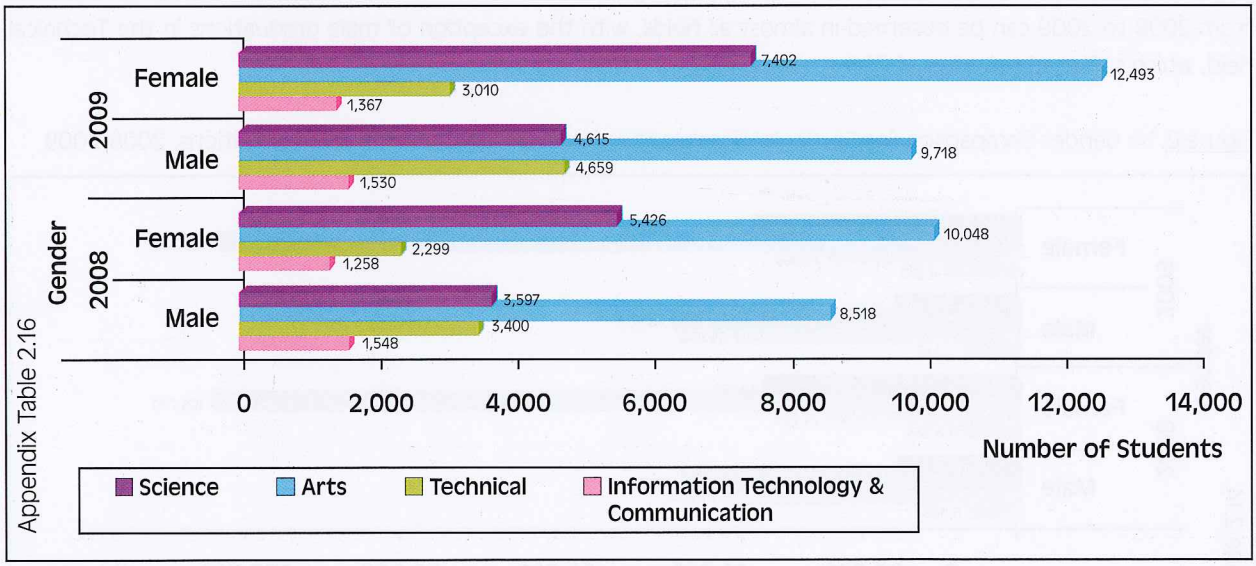


Source: Ministry of Higher Education

2.4.2 Gender Comparison for Students' Enrolment and Graduations at the Master's Degree Level in Public Institutions from 2008 – 2009

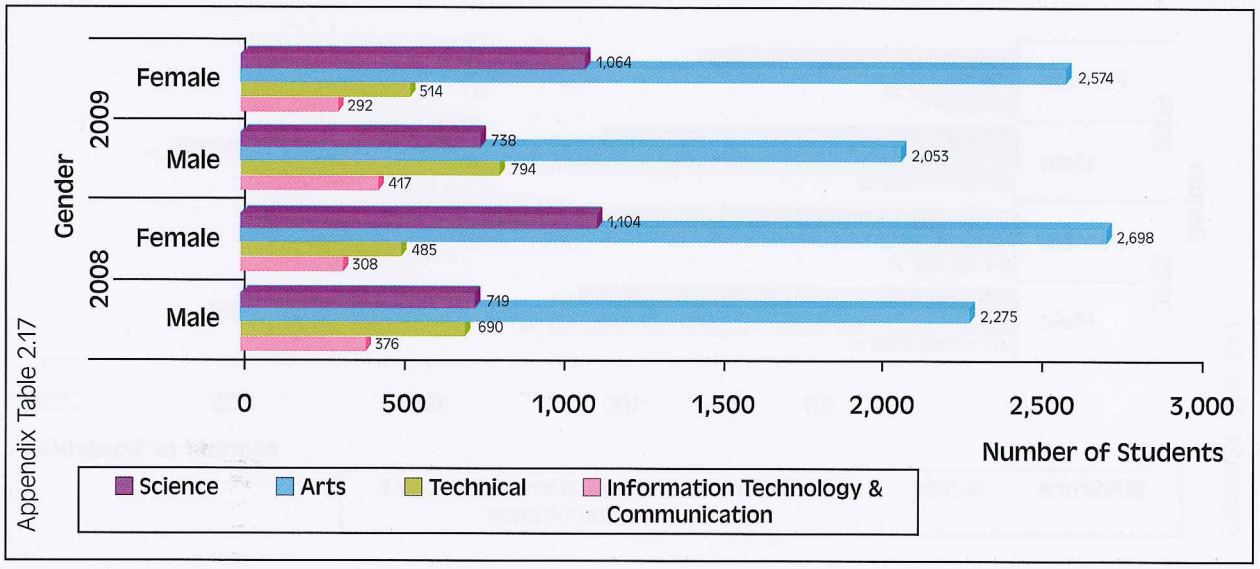
Figure 2.16 shows that female enrolment outnumber male enrolment in Science and Arts, but male enrolment slightly exceeds female enrolment in Technical subjects and IT&C, in both 2008 and 2009. For graduations at the Master's degree level, there is a decrease in enrolment in the Arts courses for male and females graduates from 2008 to 2009 **(Figure 2.17)**. The total number of female Master's graduates in Science, Technical subjects, and IT&C also decreased from 2008 to 2009, while the total number of male Master's graduates increased in the Science and Technical fields by 22.1% and 27.0%, respectively.

Figure 2.16: Gender Comparison for Students' Enrolment in Master's Degree Level in Public Institutions, 2008-2009



Source: Ministry of Higher Education

Figure 2.17: Gender Comparison for Students' Graduations in Master's Degree Level in Public Institutions, 2008-2009

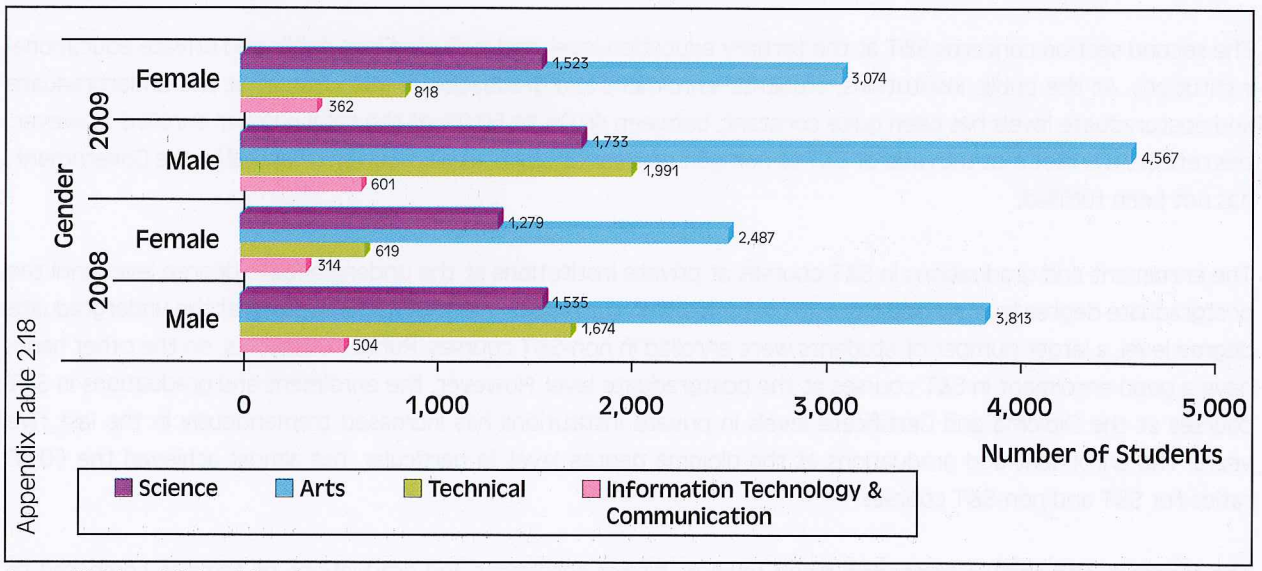


Source: Ministry of Higher Education

2.4.3 Gender Comparison for Students' Enrolment and Graduations at the PhD Level in Public Institutions, 2008 – 2009

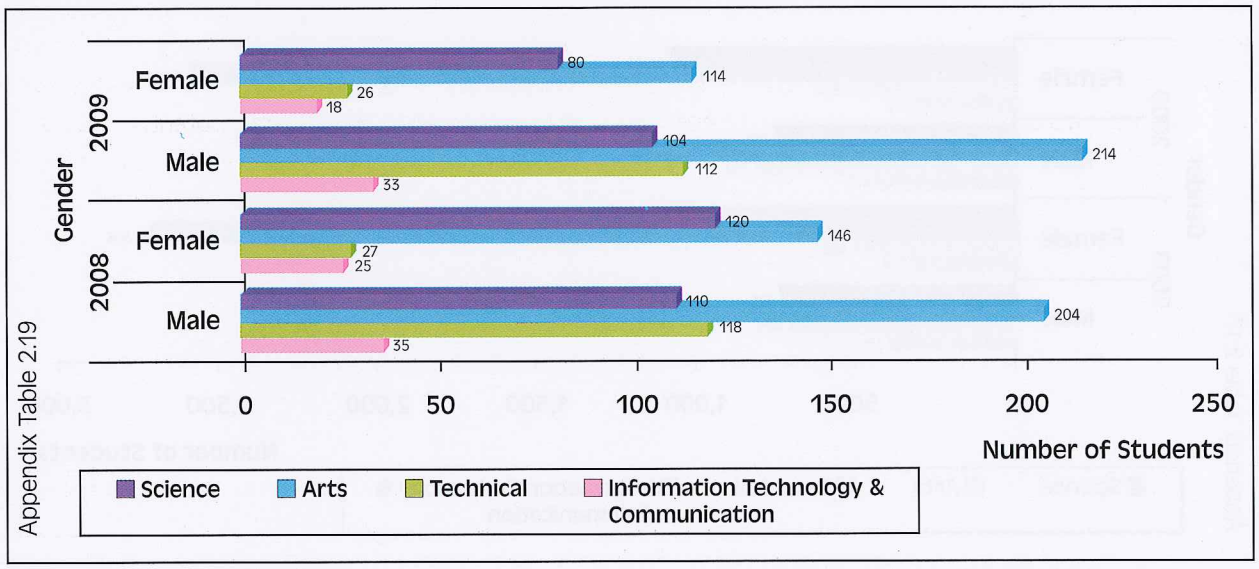
Figure 2.18 presents the total number of students' enrolment and graduations at the PhD level between males and females in public institutions from 2008 to 2009. Interestingly, the males outnumber females in enrolment in PhD programmes in both years. There is also an increase across all fields for both genders throughout the two-year period. For both 2008 to 2009, males also outnumber females in almost all fields, except for Science in 2008 **(Figure 2.19)**.

Figure 2.18: Gender Comparison for Students' Enrolment in PhD Level in Public Institutions, 2008-2009



Source: Ministry of Higher Education

Figure 2.19: Gender Comparison for Students' Graduations at the PhD Level in Public Institutions, 2008-2009



Source: Ministry of Higher Education

2.5 CONCLUSION

The data on the total number of students who registered for the SPM show that slightly less than half were in the science stream, as reflected in the distribution of Science and Mathematics subjects such as Physics, Chemistry, Biology, and Additional Mathematics. For the STPM, the number of students who registered for Science, Mathematics, and Technology subjects decreased due to the decrease in the number of students in the science stream **(Table 2.1).** By 2009, the total number of students in the science stream at the STPM level was only 16.5% of the total number of students that registered for the STPM. However, this was compensated by the increase in the number of students who registered for science subjects at the Matriculation level and the increase in the students' passing rate in Science, which was almost 100.0% in 2009.

The second section concerns S&T at the tertiary education level, and is divided into public and private educational institutions. At the public institutions, students' enrolment and graduation in S&T courses at the undergraduate and postgraduate levels has been quite constant, between 40.0% to 50.0% of the total number enrolled. However, this reflects the fact that the ratio of S&T to non-S&T courses of 60:40, as has been emphasised by the Government, has not been fulfilled.

The enrolment and graduations in S&T courses at private institutions at the undergraduate degree level until the postgraduate degree level ranged from 20.0% to 46.0%. In the private institutions particularly, at the undergraduate degree level, a larger number of students were enrolled in non-S&T courses. Public institutions, on the other hand, have a good enrolment in S&T courses at the postgraduate level. However, the enrolment and graduations in S&T courses at the Diploma and Certificate levels in private institutions has increased tremendously in the last five years. The enrolment and graduations at the diploma degree level, in particular, has almost achieved the 60:40 ratios for S&T and non-S&T courses.

The statistics also show a noticeable trend towards higher enrolment and graduations of females compared to males in public educational institutions in the undergraduate and Master's Degree courses. Female students also dominate in Science and Information Technology & Communication, while technical subjects are dominated by male students in most of the degree programmes. However, the enrolment and graduations at the PhD level display a different trend, where the male students outnumber the female students in all fields.

The data presented in the preceding sections clearly indicate that much can be done to improve education in S&T. Effort should be made to increase student enrolment in the science stream at the upper secondary and matriculation levels as these students will proceed to join S&T courses at the tertiary education level. R&D in the public institutions is quite promising based on the positive growth in enrolment in postgraduate S&T courses, but private institutions should also be more involved in improving their postgraduate programmes to help develop potential scientists, researchers, and innovators. Only with greater involvement from the different sectors can Malaysia's aspirations be realised.

CHAPTER 3
- HUMAN RESOURCE IN RESEARCH & DEVELOPMENT

CHAPTER 3

HUMAN RESOURCE IN RESEARCH AND DEVELOPMENT

3.0 INTRODUCTION

The concern over the middle income trap, where a middle-income country is neither able to compete technologically with high-income countries, nor compete in terms of cost with low-income countries has forced the Malaysian government to rethink its development policies. The New Economic Model (NEM) and the 10MP have stressed the importance of the enablers of innovation to enable us to break free from the trap. Among the emphases of the 10MP is the focus on skills development, especially in terms of up-skilling the existing workforce to facilitate industries to move up the value chain and to improve physical and non-physical resources for Research & Development (R&D). In addition, the Malaysia Higher Education Plan 2007-2010 has also set targets for human resource in R&D and the higher education sector at 100 researchers, scientists, and engineers (RSE) per 10,000 workforce and 100,000 PhDs by the year 2020.

This chapter reports on human resource for R&D. Malaysia's aggregate R&D activities, and the decomposition of the R&D activities by Institutions of Higher Learning (IHLs), Government Research Institutes (GRIs), and the private sector (or business enterprise) are presented. The data used for the analysis in this chapter are mainly from the Final Draft of National Survey of Research and Development 2008 (NSRD 2008) and the UNESCO Institute for Statistics.

The National Survey of Research and Development (NSRD) are administered once every two years. It provides statistics and information on the status, development, and trend of R&D activities in Malaysia for the IHLs, GRIs, and the private sector. The definition of indicators and the methodologies adopted in the NSRD are based on the OECD Frascati Manual.

The NSRD collects information on R&D activities using two methods: (a) online survey, and (b) mail survey. For the public sector (IHLs and GRIs), the survey was conducted online. A preliminary survey was conducted before the online survey. The intent of the preliminary survey is to obtain information on the number of R&D projects that had been carried out by the GRIs and IHLs in 2008. The preliminary survey showed that GRIs and IHLs had conducted 1,181 and 10,406 projects respectively. However, only 70.0% of the project leaders responded to the online survey. For the private sector, data were collected using the mail survey. A preliminary survey to identify the number companies involved in R&D projects involved the development of a comprehensive list of companies based on the list of (a) companies that had participated in the NSRD 2008, (b) companies provided by the Small and Medium Industries Development Corporation (SME Corp), and (c) government-led companies. A total of 2,890 questionnaires were mailed to the companies and a total of 231 companies responded to the survey but only 164 of the companies reported that they conducted R&D activities in 2008. This leaves cause for concern that the survey may not have managed to capture the true R&D expenditure and human resource involved in R&D.

3.1 HUMAN RESOURCE IN R&D

At the aggregate level, the number of R&D personnel involved, or headcount, and the amount of time they devote to R&D activities during the year, or the full time equivalent (FTE), has been increasing steadily for the eight year period from 2000 to 2008. However, the figures are still far behind the targets set by the Malaysia Higher Education Plan 2007-2010, of 100 RSE per 10,000 workforce and 10,000 PhDs by 2020.

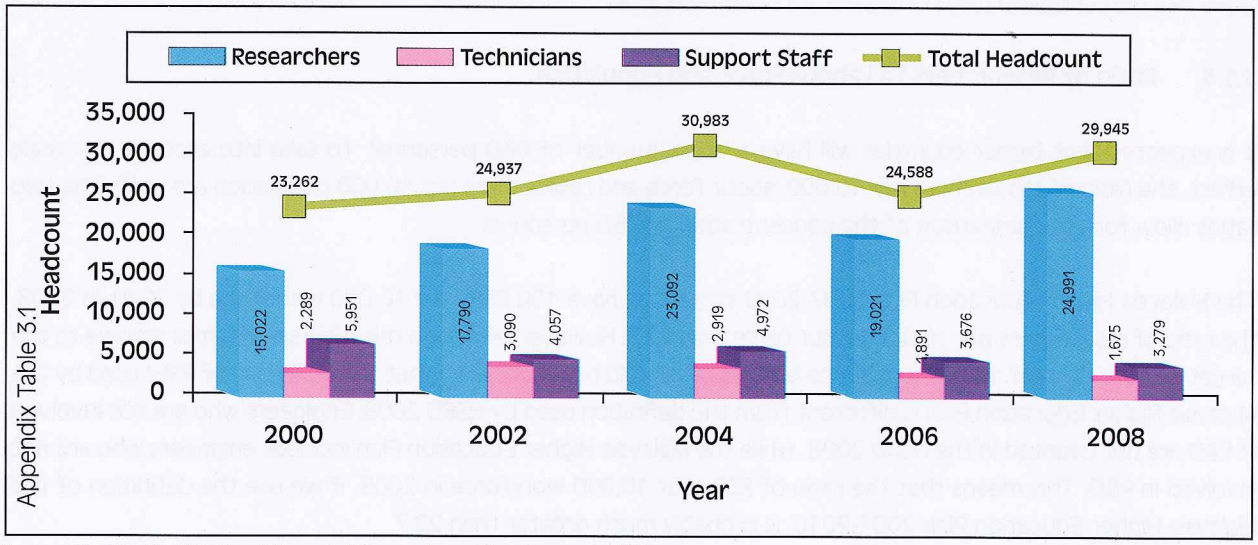
3.1.1 Headcount

From 2000-2008, the headcount of R&D personnel increased by 28.7%, from 23,262 personnel in 2000, to 29,945 personnel in 2008. The maximum number of R&D personnel for the period was in 2004, where 30,983 personnel were involved in R&D activities. Except for a small decrease in 2006, the headcount of R&D personnel has been increasing from year to year.

R&D personnel includes researchers, technicians, and support staff. In 2008, there were 24,991 researchers. However, there is a decreasing trend in the number of support staff and technicians. The number of support staff declined from a high of 5,951 in 2000 to a low of 3,279 in 2008; a decrease of 44.9%. There was also a decrease in the number of technicians. In 2002, there were 3,090 technicians, while in 2008, there were 1,675 technicians, a decrease of 45.8% **(Figure 3.1).**

The contrasting trend in the number of researchers, technicians, and support staff is rather surprising because it is expected that the increase in the number of researchers should be followed by an increase in the number of technicians and support staff who will assist the researchers. This suggests that a significant portion of R&D activities which used to be handled by technicians and support staff are now being handled by the researchers.

Figure 3.1: Headcount of R&D Personnel, 2000-2008



Source: Final Draft of National Survey of Research and Development 2008

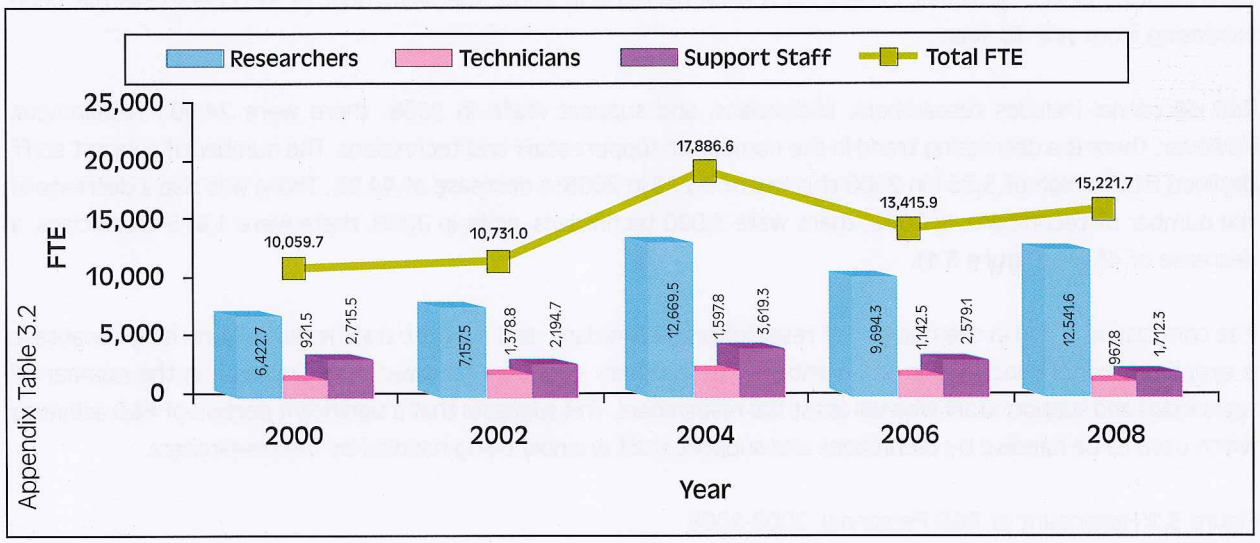
3.1.2 Full Time Equivalent (FTE)

Except for 2006, where there was a slight decrease, the FTE for R&D personnel has been on an uptrend. The FTE increased by 51.3% for the eight year period, from 10,059.7 in 2000 to 15,221.7 in 2008. The total FTE for 2004 was the maximum for the period 2000-2008 **(Figure 3.2).**

Decomposition of the FTE shows that in 2008 the FTE for researchers was 12,541.6, almost double that for researchers in 2000, which was 6,422.7. Overall, the FTE for researchers was trending upward, and increased by 95.3% for the period. In contrast, the FTE for technicians and support staff was 967.8 and 1,712.3, respectively in 2008—the minimum for the period.

Similar to the headcount for R&D personnel, the contrasting trend in the FTE for researchers, technicians, and support staff is surprising because it is expected that the trend should be similar; that is, an increase in the number of hours spent by researchers in R&D activities should be followed by an increase in the number of hours technicians and support staff spend on R&D activities.

Figure 3.2: FTE of R&D Personnel, 2000-2008



Source: Final Draft of National Survey of Research and Development 2008

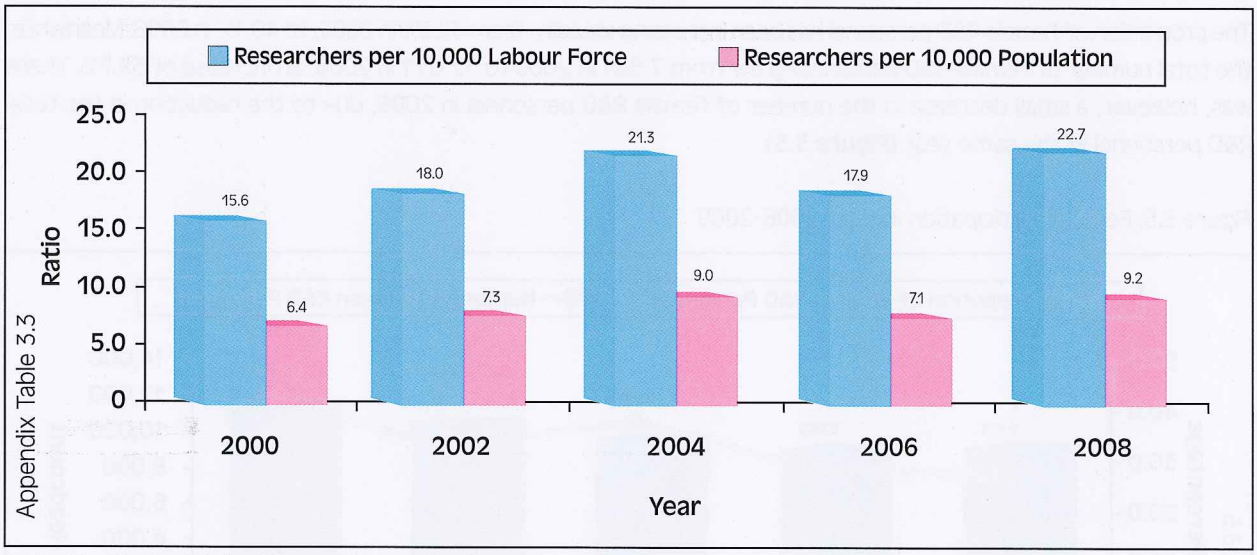
3.1.3 Ratio of Researchers to Labour Force and Population

It is expected that bigger countries will have a larger number of R&D personnel. To take into account this scale effect, the ratio of researchers per 10,000 labour force and researchers per 10,000 population are used. The two ratios allow for the comparison of the concentration of R&D personnel.

The Malaysia Higher Education Plan 2007-2010 targets to have 100 RSEs per 10,000 workforce by 2020. In 2008, the ratio of researchers per 10,000 labour force, was 22.7. However, although this ratio seems small relative to the target of 100 RSEs per 10,000 workforce by 2020, it should be emphasised that the definition of RSEs used by the Malaysia Higher Education Plan is different from the definition used by NSRD 2008. Engineers who are not involved in R&D are not counted in the NSRD 2008, while the Malaysia Higher Education Plan includes engineers who are not involved in R&D. This means that the ratio of RSEs per 10,000 workforce in 2008, if we use the definition of the Malaysia Higher Education Plan 2007-2010, is probably much greater than 22.7.

The ratio of researchers per 10,000 labour force and per 10,000 population have both been increasing since 2000, except for a small decrease in 2006. In 2000, the ratio of researchers per 10,000 labour force was 15.6 while the ratio of researchers per 10,000 population was 6.4. The two ratios grew by approximately 43.8% for the eight year period, showing that the increase in the number of researchers is faster than the increase in Malaysia's labour force and population **(Figure 3.3).**

Figure 3.3: Ratio of Researchers to Labour Force and Population, 2000-2008



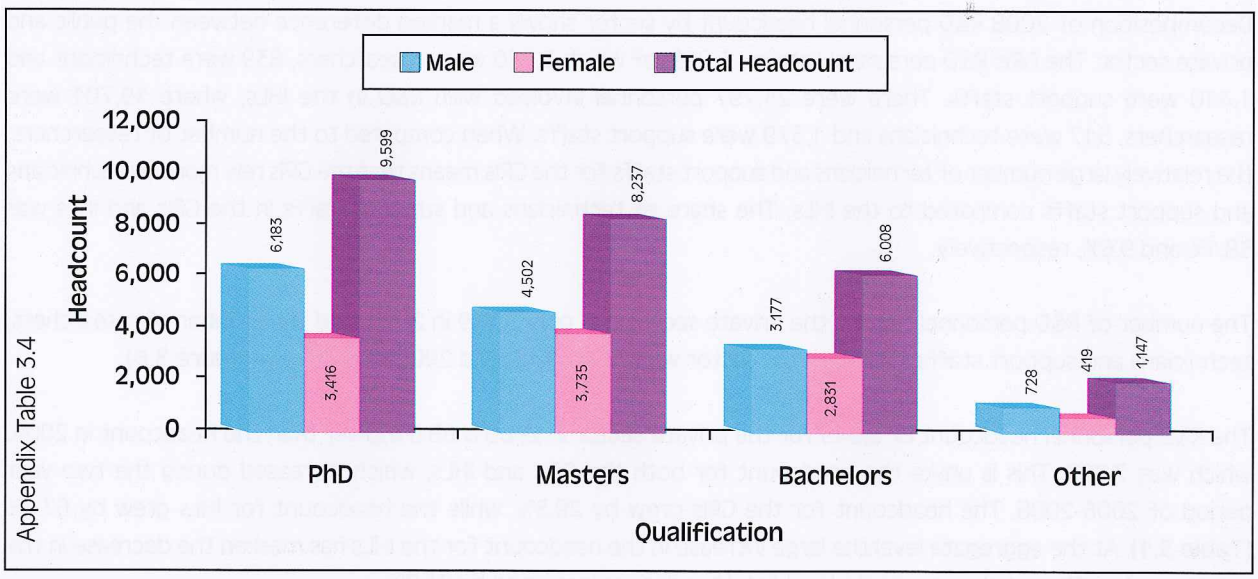
Source: Final Draft of National Survey of Research and Development 2008

3.1.4 Researcher Qualifications

The Malaysia Higher Education Plan 2007-2010 targets to have 100,000 PhDs by 2020. In 2008, the number of researchers with PhD qualifications was 9,599, of which 6,183 were males, and 3,416 were females. It should be noted that not all Malaysians with PhD qualifications were involved in R&D activities (R&D activities is as defined by the Frascati Manual). So, the number of Malaysians with PhD qualifications is much higher than 9,599.

There were 8,237 researchers with Master's degree qualifications, and 6,088 with a Bachelors' degree qualifications in 2008. The headcount for male researchers with Master's degree qualifications was 4,502, and the headcount for females was 3,735. The headcount for male and female researchers with a Bachelor's degree was similar, at 3,177 and 2,831 respectively **(Figure 3.4).**

Figure 3.4: Headcount of Researcher by Gender and Qualifications, 2008

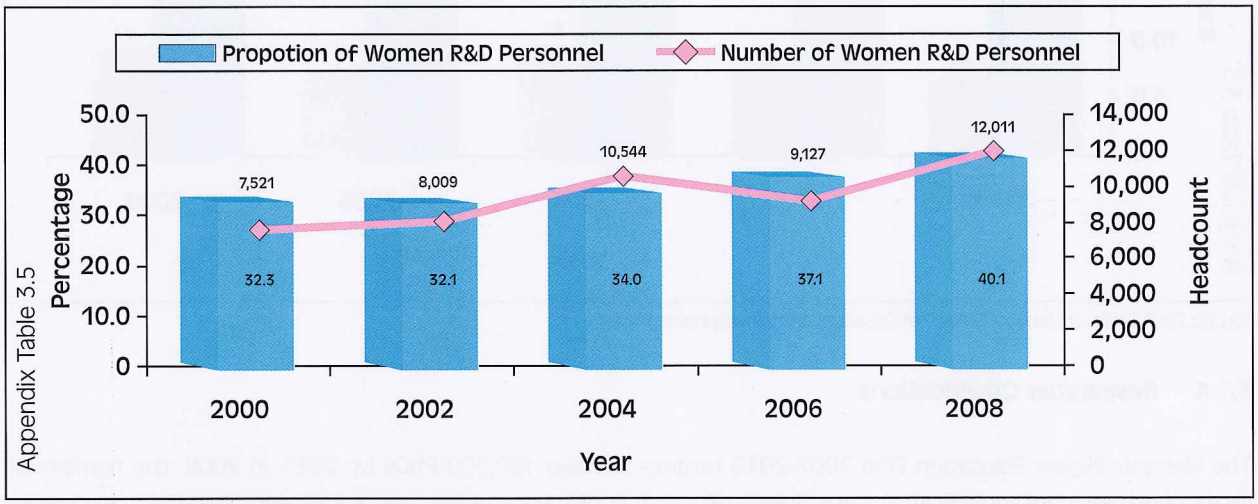


Source: Final Draft of National Survey of Research and Development 2008

3.1.5 Female Participation in R&D

The proportion of female R&D personnel has been increasing steadily, from 32.3% in 2000, to 40.1% in 2008. Meanwhile, the total number of female R&D personnel grew from 7,521 in 2000 to 12,011 in 2008, an increase of 59.7%. There was, however, a small decrease in the number of female R&D personnel in 2006, due to the reduction in the total R&D personnel in the same year **(Figure 3.5)**.

Figure 3.5: Female Participation in R&D, 2008-2009



Source: Final Draft of National Survey of Research and Development 2008

3.2 HUMAN RESOURCE IN R&D BY SECTOR

In general, there has been an uptrend for the headcount and FTE of R&D personnel at the aggregate level. However, the trends for the different sectors differ from that of the aggregate level.

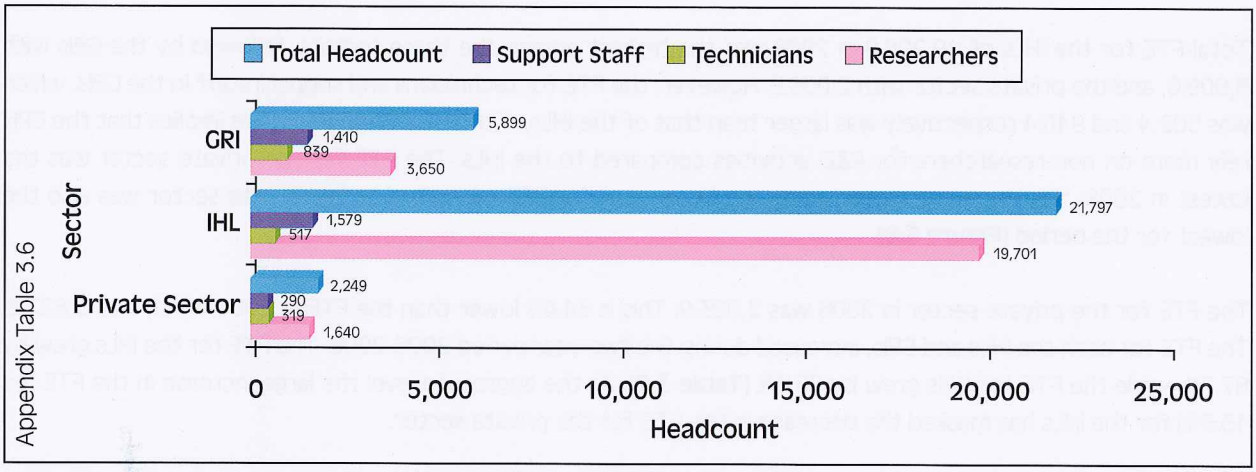
3.2.1 Headcount by Sector

Decomposition of 2008 R&D personnel headcount by sector shows a marked difference between the public and private sector. The GRIs R&D personnel totalled 5,899, of which 3,650 were researchers, 839 were technicians and 1,410 were support staffs. There were 21,797 personnel involved with R&D in the IHLs, where 19,701 were researchers, 517 were technicians and 1,579 were support staffs. When compared to the number of researchers, the relatively large number of technicians and support staffs for the GRIs means that the GRIs rely more on technicians and support staffs compared to the IHLs. The share of technicians and support staffs in the GRIs and IHLs was 38.1% and 9.6%, respectively.

The number of R&D personnel serving the private sector was only 2,249 in 2008, and the number of researchers, technicians and support staffs in the private sector was 1,640, 319, and 290, respectively **(Figure 3.6)**.

The R&D personnel headcount of 2,249 for the private sector in 2008 is 68.0% lower than the headcount in 2006, which was 7,025. This is unlike the headcount for both the GRIs and IHLs, which increased during the two year period of 2006-2008. The headcount for the GRIs grew by 29.5%, while the headcount for IHLs grew by 67.6% **(Table 3.1)**. At the aggregate level the large increase in the headcount for the IHLs has masked the decrease in the private sector; thus at the aggregate level total headcount increased by 21.8%.

Figure 3.6: Headcount by Sector, 2008



Source: Final Draft of National Survey of Research and Development 2008

Table 3.1: Headcount by Sector, 2006 and 2008

Sector	2006	2008	Growth (%)
GRI	4,556	5,899	29.5
IHL	13,007	21,797	67.6
Private Sector	7,025	2,249	-68.0
Total Headcount	24,588	29,945	21.8

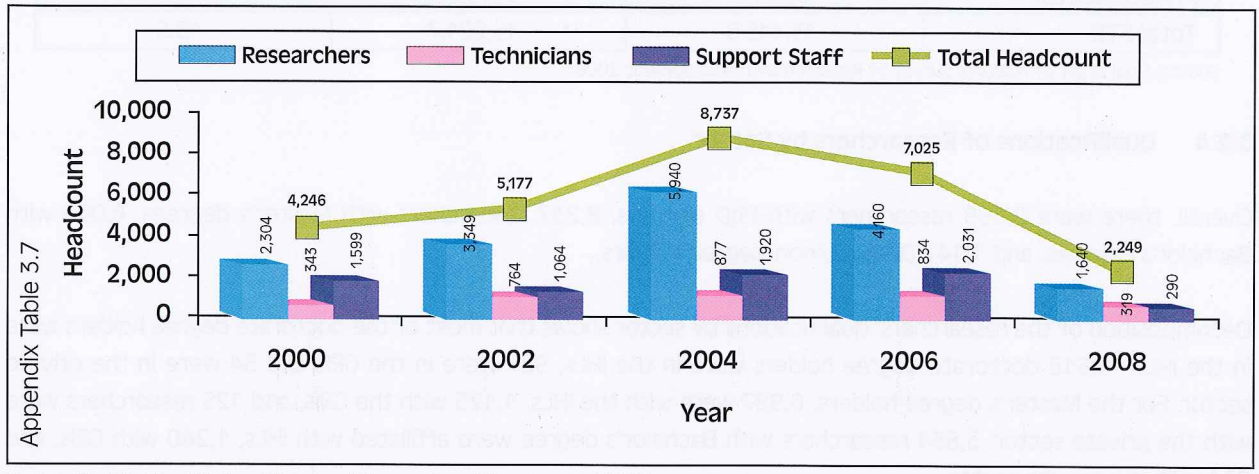
Source: Final Draft of National Survey of Research and Development 2008

3.2.2 Private Sector Headcount

Figure 3.7 shows the patterns for the total headcount of researchers, technicians, and support staff for the private sector. The total headcount for R&D personnel reached a maximum of 8,737 in 2004; this is in sharp contrast to the headcount of 2,249 in 2008.

Similar to the R&D activities for Science and Technology **(Chapter 5)**, among the reasons for the sharp contrast in the number of R&D personnel between 2006 and 2008 for the private sector is the very low response rate for the NSRD 2008; hence the number R&D personnel reported may not reflect the actual headcount of R&D personnel in Malaysia.

Figure 3.7: Private Sector Headcount, 2000-2008



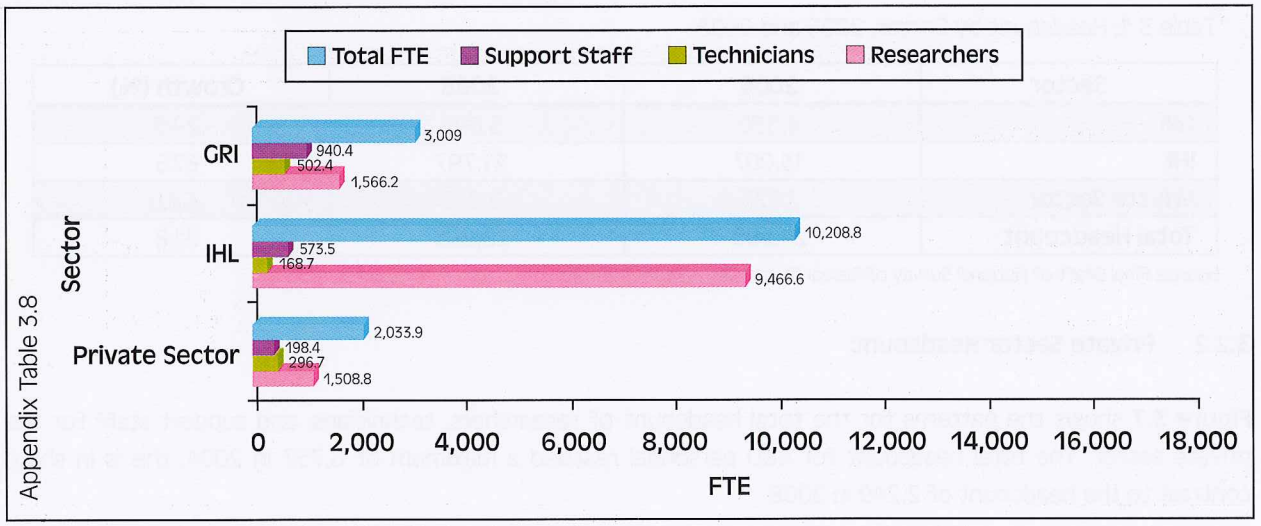
Source: Final Draft of National Survey of Research and Development 2008

3.2.3 FTE by Sector

Total FTE for the IHLs of 10,208.8 in 2008 was the highest among the three sectors, followed by the GRIs with 3,009.0, and the private sector with 2,003.9. However, the FTE for technicians and support staff in the GRIs, which was 502,4 and 940.4 respectively was larger than that of the IHLs, with 168.7 and 573.5. This implies that the GRIs rely more on non-researchers for R&D activities compared to the IHLs. The FTE for the private sector was the lowest in 2008; this should be expected as the headcount for R&D personnel in the private sector was also the lowest for the period **(Figure 3.8)**.

The FTE for the private sector in 2008 was 2,003.9. This is 64.4% lower than the FTE in 2006 which was 5,627.8. The FTE for both the IHLs and GRIs, increased during the two year period 2006-2008. The FTE for the IHLs grew by 87.7%, while the FTE for GRIs grew by 28.0% **(Table 3.2)**. At the aggregate level the large increase in the FTE (by 13.5%) for the IHLs has masked the decrease in the FTE for the private sector.

Figure 3.8: FTE by Sector and R&D Personnel, 2008



Source: Final Draft of National Survey of Research and Development 2008

Table 3.2: FTE by Sector, 2006 and 2008

Sector	2006	2008	Growth (%)
IHL	5,438.0	10,208.8	87.7
GRI	2,350.1	3,009.0	28.0
Private Sector	5,627.8	2,003.9	-64.4
Total FTE	13,415.9	15,221.7	13.5

Source: Final Draft of National Survey of Research and Development 2008

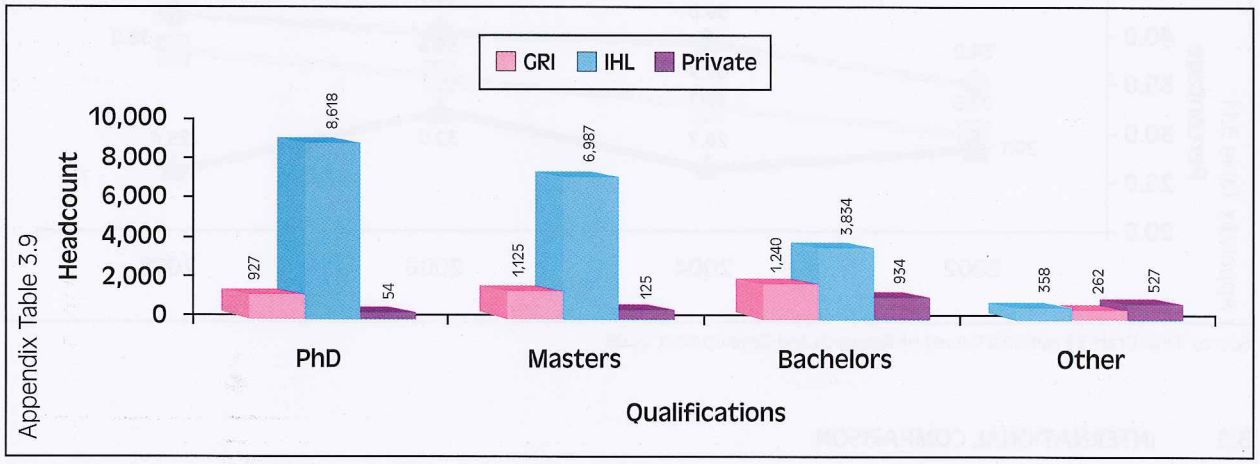
3.2.4 Qualifications of Researchers by Sector

Overall, there were 9,599 researchers with PhD degrees, 8,237 researchers with Master's degrees, 6,008 with Bachelor's degrees, and 1,147 Diploma/non-degree holders.

Decomposition of the researchers' qualifications by sector shows that most of the doctorate degree holders were in the IHLs. 8,618 doctorate degree holders were in the IHLs, 927 were in the GRIs and 54 were in the private sector. For the Master's degree holders, 6,987 were with the IHLs, 1,125 with the GRIs, and 125 researchers were with the private sector. 3,834 researchers with Bachelor's degree were affiliated with IHLs, 1,240 with GRIs, and 934 with the private sector.

In terms of qualifications, the main contrast between the private and public sector is that unlike the public sector, a majority of the researchers in the private sector do not hold a higher degree.

Figure 3.9: Qualifications of Researchers by Sector, 2008

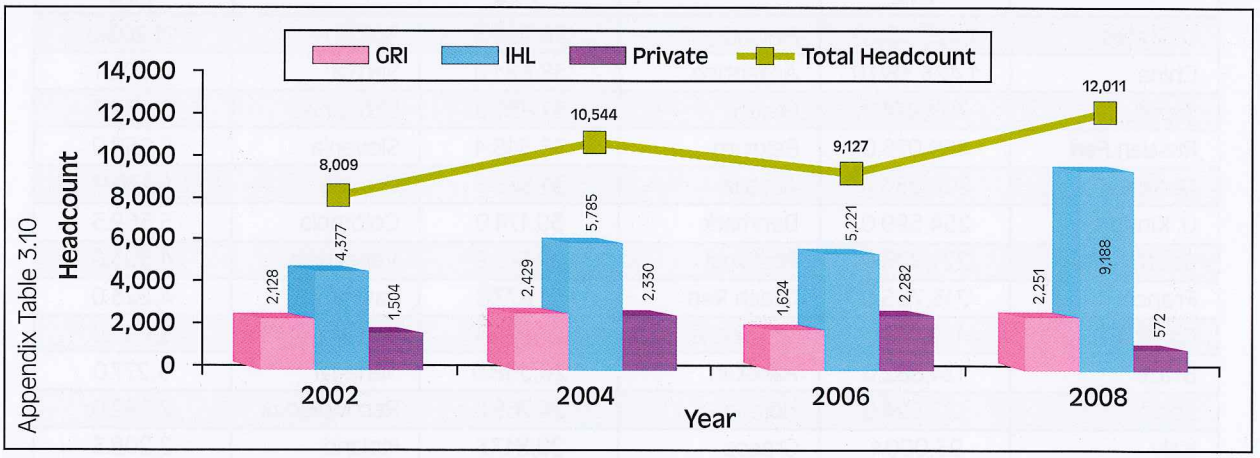


Source: Final Draft of National Survey of Research and Development 2008

3.2.5 Women Participation by Sector: Headcount

The total number of female R&D personnel in 2008 was 12,011, a 50.0% increase compared to the headcount of 8,009 in 2000. The largest increase in the number of female R&D personnel was for the IHLs, where it jumped from 5,221 in 2006 to 9,188 in 2008, an increase of 76.0% **(Figure 3.10).** The number of women R&D personnel in the GRIs for the period 2002-2006 averaged at around 2,000, as was the case for the private sector. However, there was a sharp decrease in the headcount of women R&D personnel in the private sector in 2008, which is a function of the decrease in total private R&D personnel.

Figure 3.10: Women Participation by Sector: Headcount, 2002-2008

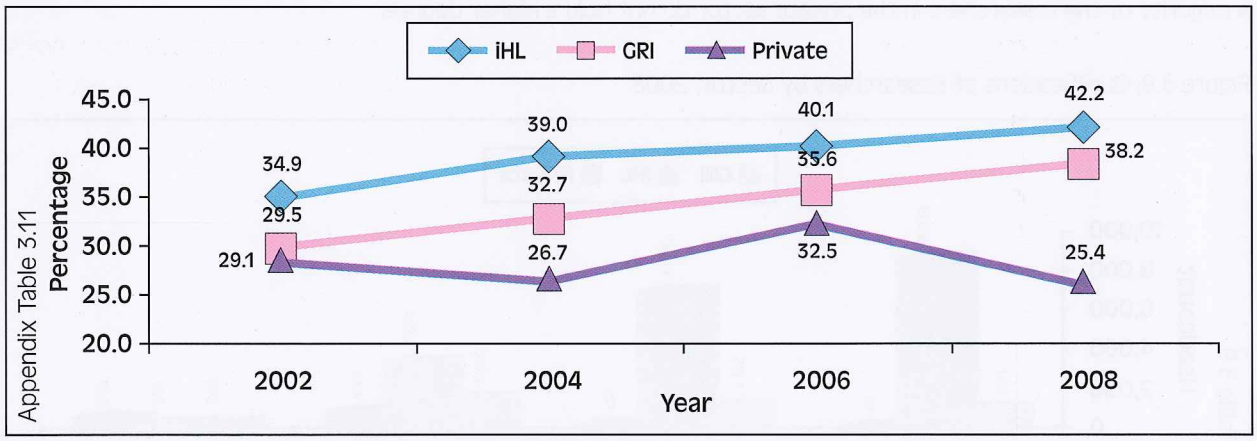


Source: Final Draft of National Survey of Research and Development 2008

3.2.6 Share of Female R&D Personnel Headcount

The share of female R&D personnel headcount for the GRIs and IHLs for the period 2002-2008 has shown an increasing trend; unlike that of the private sector, which did not show a significant change. The share of headcount for female R&D personnel in the IHLs increased from 34.9% in 2002 to 42.2% in 2008, while that of the GRIs increased from 29.5% in 2002 to 38.2% in 2008. The share of female R&D personnel headcount for the private sector is lower than that of the public sector, and has fluctuated at around 25.4%.

Figure 3.11: Share of Female R&D Personnel Headcount, 2002-2008



Source: Final Draft of National Survey of Research and Development 2008

3.3 INTERNATIONAL COMPARISON

3.3.1 FTE of Researchers

Table 3.3 shows that the FTE (the number of hours spent on R&D) of researchers is concentrated in the developed countries such as the US, with an FTE of 1,425,550.0. This is followed closely by China, with an FTE of 1,423,380.0. Malaysia's researcher FTE of 12,541.6 is comparable to those of Bulgaria, Slovakia, and Ireland. However, Singapore, even with a significantly smaller population compared to Malaysia, has a researcher FTE of more than 2 times that of Malaysia; showing that it has a greater density of researchers.

Table 3.3: FTE of Researchers

Country	Researchers' FTE	Country	Researchers' FTE	Country	Researchers' FTE
U. States	1,425,550.0	Finland	38,999.5	Bulgaria	11,203.0
China	1,423,380.0	Argentina	38,681.0	Serbia	8,806.1
Japan	709,974.0	Mexico	37,930.0	Lithuania	8,489.0
Russian Fed	469,076.0	Belgium	36,318.4	Slovenia	6,250.0
Germany	290,853.0	Austria	31,675.6	Croatia	6,129.0
U. Kingdom	254,599.0	Denmark	30,174.0	Colombia	5,569.5
South Korea	221,928.0	Portugal	28,175.9	Venezuela	4,503.0
France	215,755.0	Czech Rep	27,877.8	Latvia	4,223.0
Canada	139,011.0	Singapore	27,301.4	Estonia	3,690.0
Brazil	124,882.0	Pakistan	26,338.0	Senegal	3,277.0
Spain	122,624.0	Norway	24,769.0	Rep Moldova	2,592.0
Italy	93,000.1	Greece	20,817.3	Iceland	2,208.3
Australia	87,139.6	South Africa	19,320.3	Luxenbourg	2,200.6
Ukraine	67,492.5	Romania	18,808.0	Ethiopia	1,615.0
Poland	61,395.3	Hong Kong	18,326.0	Madagascar	937.0
Iran	50,546.0	New Zealand	18,300.0	Equador	924.0
Netherlands	49,726.0	Hungary	17,391.0	Cyprus	799.0
Turkey	49,667.9	Ireland	12,668.7	Bos an Herz	745.2
Egypt	49,363.0	**Malaysia**	**12,541.6**	Malta	494.0
Sweden	47,775.0	Slovakia	12,354.2	Panama	480.0

Source: UNESCO Institute for Statistics and Final Draft of National Survey of Research and Development 2008

3.3.2 Researchers per Million Population

The number of researchers per million population measures the concentration of researchers in a country. It helps to compare research intensity among countries with different populations. In 2008, Malaysia had 924.6 researchers per million populations. This is comparable to Egypt and Brazil, with 1,198.4 and 1,049.0, respectively. However, it is still far behind leading developed countries such as Norway and Sweden, which 8,845.1 and 7,982.4 researchers per million populations, respectively, and among the developed East Asian countries such as Singapore, Japan, and South Korea, with 7,059.1, 6,934.2, and 6,027.6 researchers per million population, respectively **(Table 3.4).**

Table 3.4: Researchers per Million Population

Country	Researchers per Million Population	Country	Researchers per Million Population	Country	Researchers per Million Population
Iceland	12,913.1	Slovenia	4349.0	Armenia	1,339.0
Finland	10,111.1	Czech Rep.	4142.7	Egypt	1,198.4
Norway	8,845.1	Lithuania	3990.6	Montenegro	1,080.6
Sweden	7,942.4	Slovakia	3591.8	Brazil	1,049.0
Denmark	7,895.4	Latvia	3448.0	**Malaysia**	**924.6**
New Zealand	7,083.5	Hungary	3295.2	South Africa	815.2
Singapore	7,059.1	Russian Fed.	2767.7	Costa Rica	489.7
Japan	6,934.2	Poland	2551.4	Bos and Herz	781.5
Austria	6,451.2	Croatia	2508.3	Kazakhtan	747.9
U. Kingdom	6,218.6	Malta	2455.0	Senegal	732.3
South Korea	6,027.6	Belarus	1953.4	Rep Moldova	725.5
Germany	5,316.6	Cyprus	1941.1	Mongolia	666.3
Luxembourg	5,199.6	Bulgaria	1713.1	Trin and Tob	477.3
Estonia	5,083.2	Ukraine	1703.0	Cuba	467.3
Belgium	4,869.3	Argentina	1495.3	Kyrgyzstan	380.5
Portugal	4,834.4	Serbia	1436.4	Pakistan	310.3
Spain	4,680.7	Romania	1433.1	Colombia	270.9
Ireland	4,450.1	Turkey	1396.7	Tajikistan	191.2
France	4,432.4	Azerbaijan	1358.0	Venezuela	188.8

Source: UNESCO Institute for Statistics and Final Draft of National Survey of Research and Development 2008

3.3.3 Percentage of Women Researchers

The percentage of women researchers is the highest in Latvia, followed by Azerbaijan, Kazakhstan, and Venezuela. With regard to Malaysia, the percentage of women researchers (41.6%) in 2008 is better than that of the newly developed East Asian countries such as Singapore (27.4%), South Korea (14.9%) and Japan (13.0%) as well as that of many developed countries such as the United Kingdom (36.6%), Sweden (34.5%), Norway (33.3%), and Finland (31.5%). A high percentage of women researchers are found in the East European countries.

Table 3.5: Percentage of Women Researchers

Country	Pecentage of Women Researchers	Country	Pecentage of Women Researchers	Country	Pecentage of Women Researchers
Latvia	52.4	Belarus	43.3	Sweden	34.5
Azerbaijan	52.0	Slovakia	42.3	Hungary	33.5
Kazakhtan	52.0	Russian Fed.	41.8	Norway	33.3
Venezuela	51.9	**Malaysia**	**41.6**	Panama	32.7
Argentina	51.5	Cent Afr. Rep	41.5	Cyprus	32.6
Lithuania	50.4	Montenegro	41.3	Ireland	32.0
Mongolia	48.1	Uganda	41.0	Guatemala	31.7
Brazil	18.0	South Africa	40.3	Finland	31.5
Serbia	47.0	Costa Rica	40.0	Belgium	31.1
Bulgaria	46.8	Poland	39.9	El Salvador	31.0
Cuba	46.0	Trin and Tob	38.0	Denmark	30.2
Rep Moldova	45.1	Iceland	37.8	Czech Rep	28.3
Ecuador	44.9	Spain	37.0	Singapore	27.4
Armenia	44.7	Turkey	36.7	Pakistan	27.3
Romania	44.7	U. Kingdom	36.6	Austria	26.4
Croatia	44.6	Colombia	36.4	Malta	25.5
Estonia	44.3	Egypt	36.2	Luxembourg	24.1
Ukraine	43.9	Madagascar	35.2	Germany	23.2
Kyrgyztan	43.7	Kuwait	35.2	South Korea	14.9
Portugal	43.4	Slovenia	34.9	Japan	13.0

Source: UNESCO Institute for Statistics and Final Draft of National Survey of Research and Development 2008

3.4 CONCLUSION

Human resource in R&D in Malaysia has shown continual improvement for the period 2000-2008. This is evident in the headcount, FTE, and qualifications of the R&D personnel. The participation of women in R&D has also increased throughout the period. On the international front, the headcount and FTE of R&D personnel in Malaysia is comparable to that of other developing countries. However, Malaysia is behind many newly developed East Asian countries such as Singapore and South Korea; and these countries have surpassed many established developed countries. The increase in human resource for R&D may be a reason these countries achieve the developed country status.

Decomposition of the R&D personnel by sector shows a significant difference between 2006 and 2008 for the private sector and the IHLs. The headcount and FTE of R&D personnel for the private sector dropped by 68.0% and 64.4% respectively, while the headcount and FTE for the IHLs increased by 67.6 % and 87.7% respectively for the two year period.

The poor response rate for the NSRD 2008, especially for the private sector, may be one of the reasons for the precipitous drop in the headcount and FTE for the R&D personnel in the private sector. This means that the R&D data reported in 2008 may not reflect the true state of R&D activities in Malaysia. Other possible reasons for the drop may be the fact that the increase in oil prices and the global economic uncertainty due to the financial crisis in 2008 forced firms to reduce their R&D expenditure in order to reduce their overall cost to be competitive.

CHAPTER 4
- PUBLIC SECTOR SUPPORT FOR RESEARCH AND DEVELOPMENT IN SCIENCE & TECHNOLOGY

CHAPTER 4

PUBLIC SECTOR SUPPORT FOR RESEARCH AND DEVELOPMENT IN SCIENCE AND TECHNOLOGY

4.0 INTRODUCTION

Public sector support for R&D in S&T activities in high technology sectors in Malaysia has been provided since the 1980s with the launching of the Intensification of Research in Priority Areas (IRPA) grant managed by the Ministry of Science, Technology, and Environment (MOSTE) in 1988. Under the Seventh Malaysia Plan, the grant was extended to the private sector via three schemes to enhance the competencies of Malaysian firms, namely, the Industrial R&D Grant Scheme (IGS) (launched in 1997, but discontinued in 2005), the Multimedia Super Corridor (MSC) Malaysia R&D Grant Scheme (MGS), and the Demonstrator Application Grant Scheme (DAGS). In 1997, other grants were also established, such as the Technical Acquisition Fund (TAF) and Commercialisation of R&D Fund (CRDF), administered by the Malaysian Technology Development Corporation (MTDC) to promote the commercialisation of local research results, introduce strategic technologies, and manufacture products widely used as industrial inputs. In 2002, four new schemes were introduced to further enhance R&D and S&T activities, namely, the Technology Acquisition Fund for Women (TAF-W, later known as TAF 2), the E-Manufacturing Grant, the Grant for RosettaNet Standard Implementation for SMEs, and the Grant for Upgrading Engineering Design Capabilities. Later, under the Ninth Malaysia Plan, MOSTI introduced the ScienceFund, TechnoFund, InnoFund, e-Content and DAGS Roll Out aimed at financing projects from the research and development to the commercialisation phase. As of December 2009, a total of 3,421 R&D projects have benefited from these grants during the period of the Ninth Malaysia Plan.

Apart from the various non-fiscal incentives above, Malaysia also provides a number of fiscal incentives to promote R&D in the form of tax exemption for the promotion of exports of goods and services with value-added element, as well as double deduction for R&D expenses. Studies have shown that R&D tax incentives can be an effective instrument for inducing a certain degree of private sector research. Depending on their design, tax incentives can increase private research spending by an amount equal to the loss in tax revenue on average. Most studies also find that social returns to such fiscal incentives far outweigh private returns, hence, making the incentive a viable option to promote R&D[1].

This chapter describes the various public sector support programmes and incentives for R&D undertaken through MOSTI and the designated agencies, such as the Multimedia Development Corporation (MDeC), the Malaysian Technology Development Corporation (MTDC), and the Malaysian Industrial Development Authority (MIDA). It also presents the trends and patterns in the performance of existing incentive programmes over the years covered in this Report. However, this chapter does not purport to be all inclusive of the funds made available by the Malaysian government and it includes only funds for which data are available. The next section presents the trends for S&T related grant schemes, followed by the section on double deduction for tax, and R&D investment incentives.

[1]OECD, "Tax Incentives for Research and Development: Trends and Issues," Organisation for Economic Cooperation and Development (http://www.oecd.org/dataoecd/12/27/2498389.pdf)

4.1 APPLICATION AND APPROVAL FOR S&T-RELATED GRANT SCHEMES

The spectrum of public funding and the stage in which each falls into from the initial stage of creation to the final stage of commercialisation is shown in **Figure 4.1**. At the initial stage of the spectrum, i.e., the 'Creation' stage, MSC Malaysia offers the following grants to individuals and early-startup companies:

- The MSC Malaysia Pre-Seed Fund Programme, initiated in the Ninth Malaysia Plan to address the funding gap at pre-seed stage and is expected to boost the development of commercially viable ICT projects and kick off a chain reaction in the creation of new local K-SMEs in ICT.

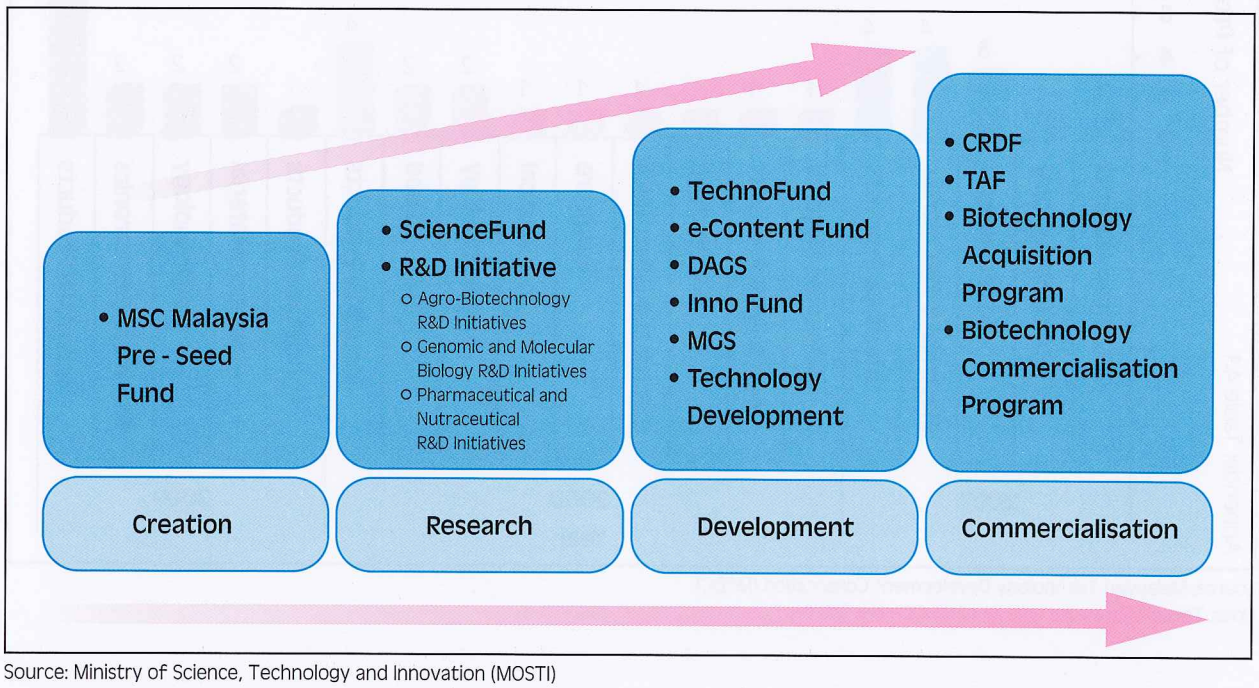
- The ICONedu (Online Education Content Creation Grant) for the local SMEs and technopreneurs who want to be innovative and commercially focused on putting their educational projects up for online consumption.

- The ICONity (Online Social and Community Content Creation Grant) for the development of social and community content platforms and eco-systems by Malaysians.

This section examines the performance of grant schemes from the research to the commercialisation stage of the spectrum, namely:

- Technology Acquisition Fund (TAF);
- Commercialisation of R&D Fund (CRDF);
- Demonstrator Application Grant Scheme (DAGS);
- MSC Malaysia R&D Grant Scheme (MGS);
- Industrial Technical Assistance Fund (ITAF);
- Biotechnology R&D Grant Scheme; and
- Support for R&D Institutions of Higher Learning
    - ScienceFund
    - TechnoFund
    - Spectrum Research Collaboration Program (SRCP)

Figure 4.1: The Spectrum of Public Funding of Research, Development, and Commercialisation



Source: Ministry of Science, Technology and Innovation (MOSTI)

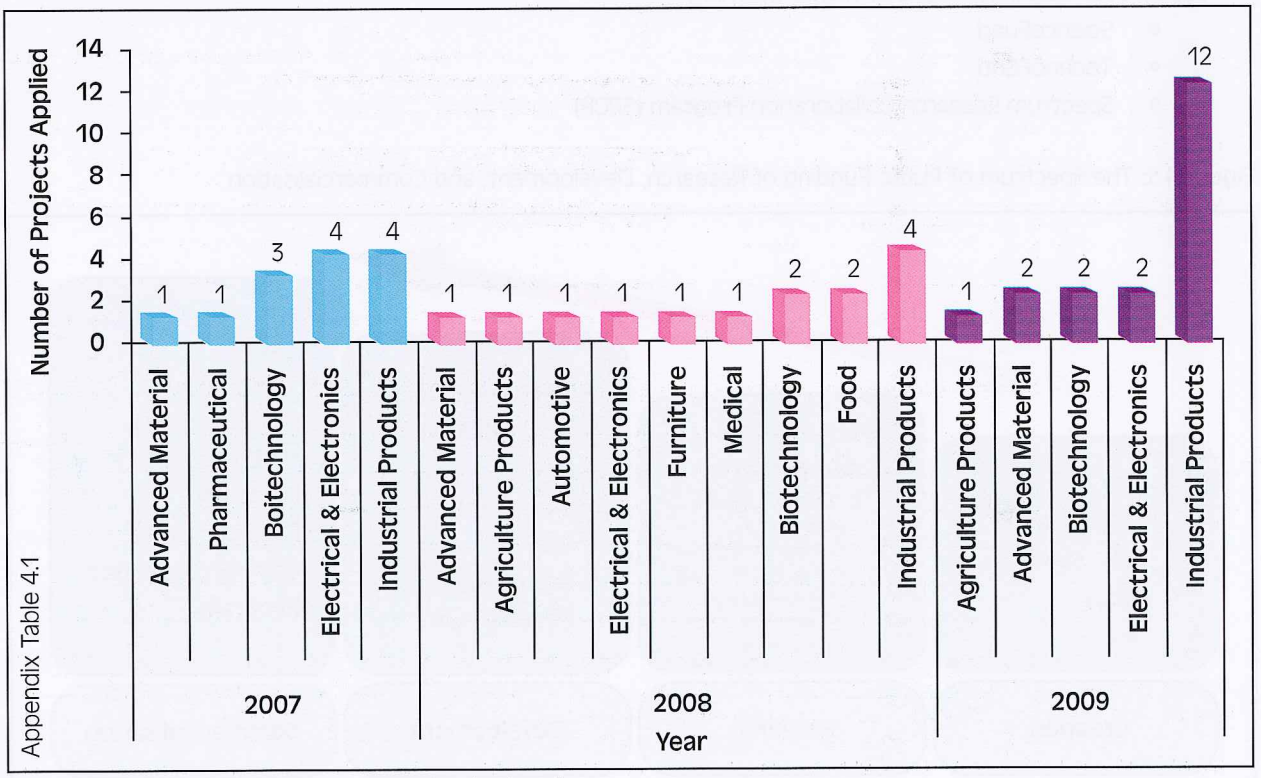
4.1.1 Technology Acquisition Fund (TAF)

The Technology Acquisition Fund (TAF) is a scheme to facilitate the acquisition of foreign strategic and relevant technologies for immediate incorporation into the company's manufacturing activity. A maximum of 50.0%, or RM 2.0 million partial grants, whichever is lower, is provided to eligible Malaysian companies to acquire new technology and enhance their technological capabilities and production processes. The TAF is administered by the Malaysian Technology Development Corporation (MTDC), and covers the following activities:

- Purchase of high technology equipment and machinery;
- Technology licensing;
- Acquisition of patent rights, prototypes, and designs;
- Training in foreign companies for high technology; sourcing of experts; and
- Organising of seminars on technology by industry associations

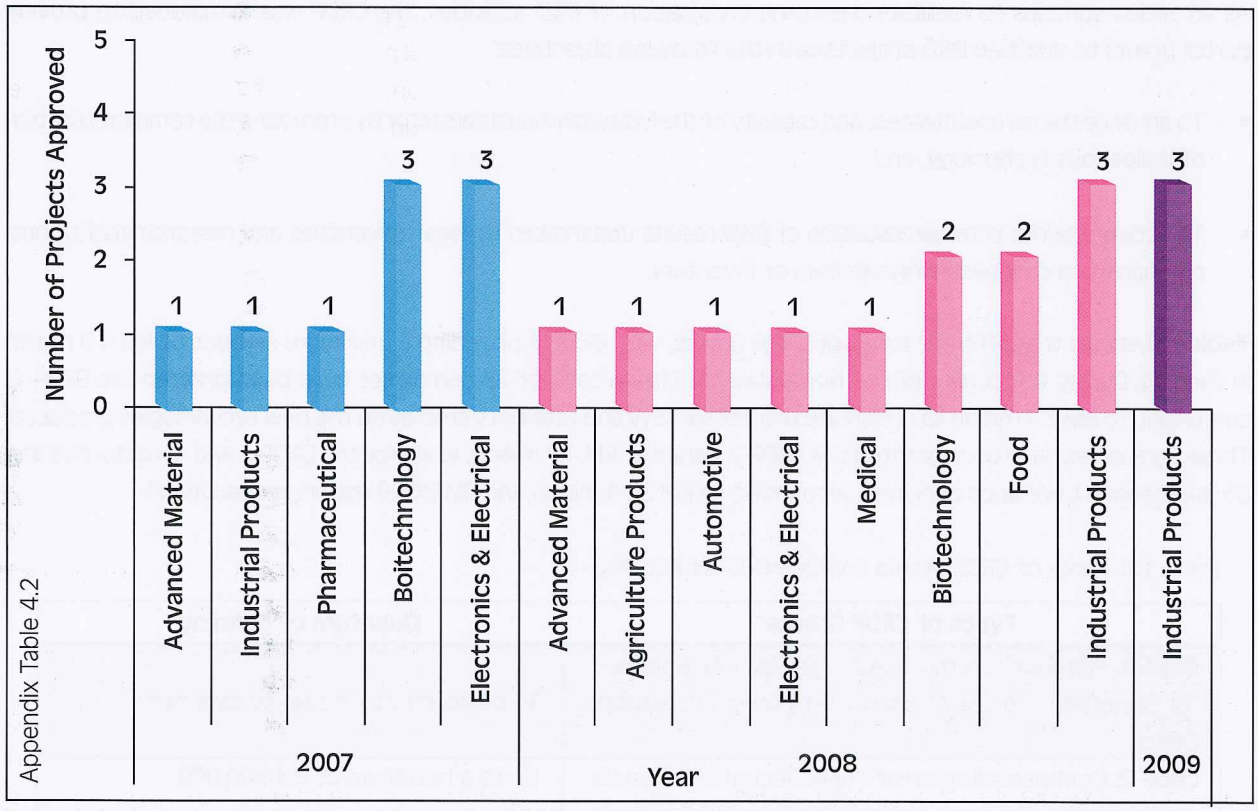
Figures 4.2 and **4.3** show the number of projects applied and approved for TAF by the industrial sector from 2007 to 2009. The annual number of applications increased gradually from one year to another, from 13 and 14 in 2007 and 2008, respectively, to 19 applications in 2009. Applications from industrial products remain relatively higher than those from other sectors, and it surged to 12 applications in 2009. A similar trend is found for the approved TAF applications, with industrial products leading the way, except for 2007 where biotechnology and electrical & electronics had the highest approved applications. During the Ninth Malaysia Plan period of 2006-2010, a total of 30 companies have been granted the TAF, amounting to RM 42.1 million, with biotechnology and industrial products clusters being the leading recipients in terms of value **(Table 4.1).**

Figure 4.2: Number of Projects that Applied for the Technology Acquisition Fund (TAF) by the Industrial Sector, 2007-2009



Source: Malaysian Technology Development Corporation (MTDC)
Note: These figures are true as of 25 October 2010

Figure 4.3: Number of Projects Approved for the Technology Acquisition Fund (TAF) by the Industrial Sector, 2007-2009



Source: Malaysian Technology Development Corporation (MTDC)
Note: Figures for 2009 are based on the number of applications currently being processed and are true as of 25 October 2010.

Table 4.1: Number of TAF Approved Projects and Approved Grant Amount under the Ninth Malaysia Plan, 2006-2010

Technology Industry / Cluster	Number of Companies		Approved Amount (RM million)	
Agriculture Products	3	10.0%	2.9	6.9%
Advanced Material	1	3.3%	2.4	5.8%
Automotive	2	6.7%	2.2	5.3%
Bio-technology	6	20.0%	10.0	23.8%
Electrical & Electronics	6	20.0%	7.6	18.0%
Food	3	10.0%	0.8	2.0%
Industrial Product	3	10.0%	9.7	23.1%
Machinery	1	3.3%	0.9	2.3%
Medical	1	3.3%	2.4	5.6%
Metal Based	1	3.3%	0.3	0.6%
Miscellaneous	2	6.7%	2.2	5.2%
Pharmaceutical	1	3.3%	0.6	1.5%
Total	30	100.0%	42.1	100.0%

Source: Malaysian Technology Development Corporation (MTDC)
Note: These figures are true as of 1 December 2010.

4.1.2 Commercialisation of R&D Fund (CRDF)

As an added stimulus to facilitate the commercialisation of R&D activities, the CRDF was established to provide partial grants to qualified R&D projects with the following objectives:

- To enhance the competitiveness and capacity of the Malaysian industrial sector by promoting the commercialisation of indigenous technology, and
- To accelerate the commercialisation of R&D results undertaken by local universities and research institutions, companies, and individual researchers or inventors.

Table 4.2 shows the different types of CRDF grants, with CRDF 4 providing a maximum amount of RM 4.0 million in funding. During the course of the Ninth Malaysia Plan, a total of 23 companies have been granted the CRDF 1, amounting to RM 2.1 million to undertake market surveys and feasibility studies on the new technologies produced. Three companies have been granted the CRDF 2 valued at RM 1.2 million, while for the CRDF 3 and 4, thirty-five and 85 applications have been approved amounting to RM 26.4 million and RM 248.8 million, respectively[2].

Table 4.2: Types of CRDF Grants and Quantum of Funding

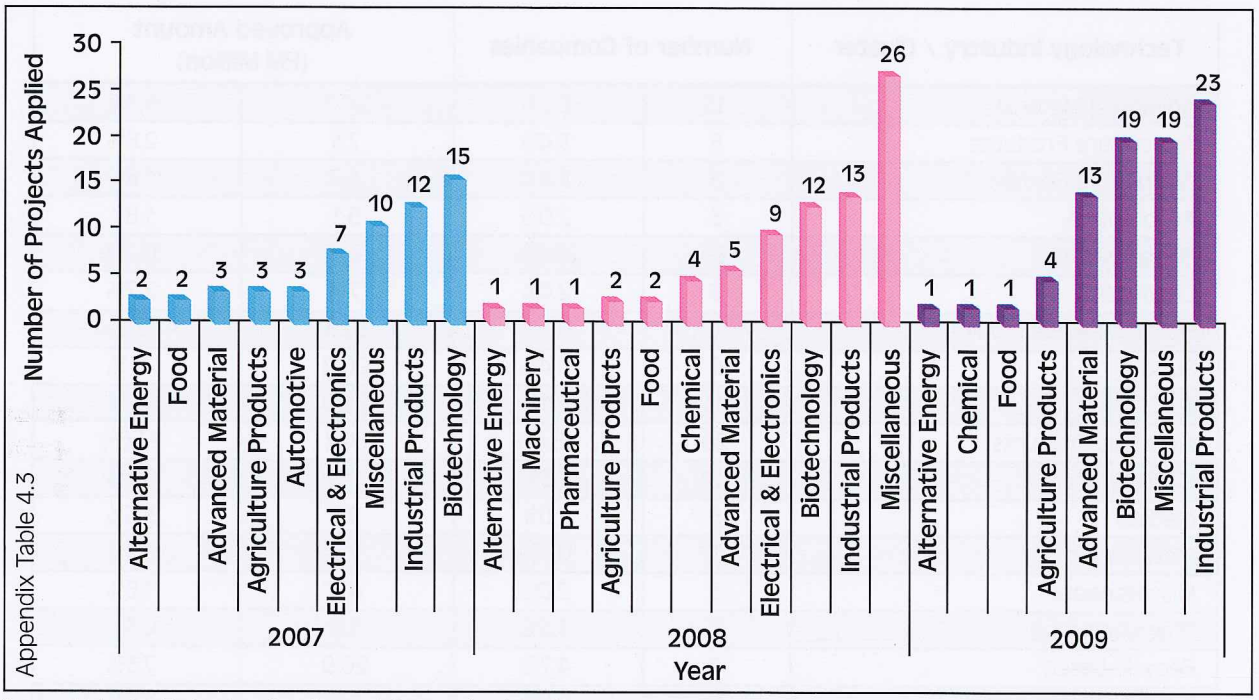
Types of CRDF Grants	Quantum of Funding
CRDF 1: Feasibility Study on Public Sector R&D Results for University / Research Institution's Commercialisation Office.	To be approved on case to case basis
CRDF 2: Commercialisation of Public Sector R&D Results via University /Research Institution's Spin-Off Company.	Up to a maximum of RM 500,000
CEDF 3: Commercialisation of Public Sector R&D Results via Start-up Company.	Up to a maximum of 70.0% or RM 500,000 whichever is lower
CRDF 4(a): Commercial Production of any Locally Generated R&D Results by SMEs.	Up to a maximum of 70.0% or RM 4 million whichever is lower
CRDF 4 (b): Commercial Production of Public Sector R&D Results Undertaken by Large Corporations.	Up to a maximum of 60.0% or RM 4 million whichever is lower
CRDF 4 (c): Commercial Production of Public Sector R&D Results Undertaken by Public Listed Companies.	Up to a maximum of 50.0% or RM 4 million whichever is lower

Source: http://www.mtdc.com.my/index.php?page=grants/index&mod=3&id=crdf_1
http://www.mtdc.com.my/index.php?page=grants/index&mod=3&id=crdf_2
http://www.mtdc.com.my/index.php?page=grants/index&mod=3&id=crdf_3
http://www.mtdc.com.my/index.php?page=grants/index&mod=3&id=crdf_4

The total number of applications for the CRDF stood at 214 for the period 2007-2009, while a total of 112 have been approved during the same period, a large improvement compared to the numbers recorded for 2005-2006 **(Figures 4.4** and **4.5)**. The highest number of approved applications are mainly in industrial products, biotechnology, advanced materials, electrical & electronics, and miscellaneous products. The figures also show a gradual increase in the number of applications for funding between 2007 and 2009, with the total number of applications of 57, 76, and 81 for the years 2007, 2008, and 2009, respectively. However, even though the number of projects approved increased slightly from 42 in 2007 to 48 in 2008, the number declined by more than half, to only 22 projects in 2009. This is due to the overwhelming number of applications received, resulting in the allocation being fully utilised. Hence, the MTDC had subsequently closed the CRDF effective 22 January 2010, and no new applications were accepted from the said date. A total of 149 companies have been granted the CRDF during the Ninth Malaysia Plan period of 2006-2010, with the biotechnology cluster being the lead recipient followed by industrial products, electrical & electronics, advanced materials, and ICT **(Table 4.3)**.

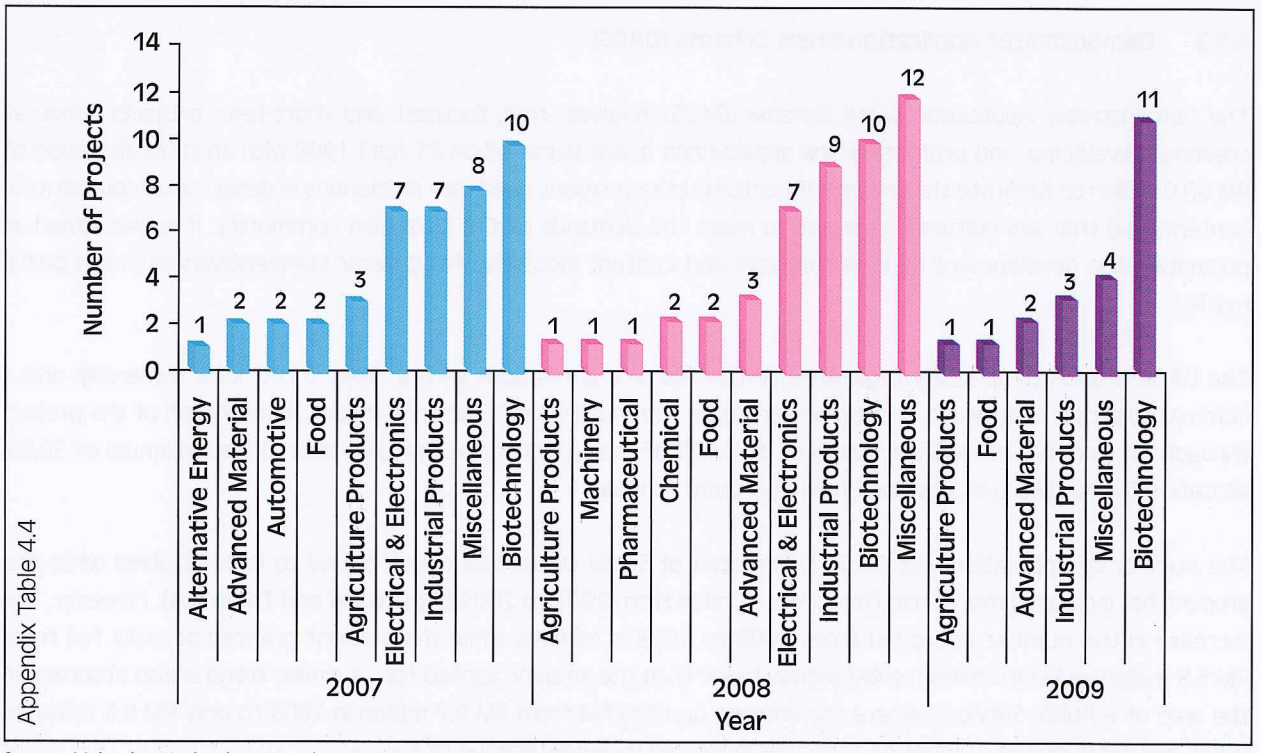
[2] Malaysian Technology Development Corporation (MTDC)

Figure 4.4: Number of Projects that Applied for Funds from the Commercialisation of R&D Fund (CRDF), 2007-2009



Source: Malaysian Technology Development Corporation (MTDC)
Note: These figures are true as of 25 October 2010.

Figure 4.5: Number of Projects Granted for Commercialisation of R&D Fund (CRDF), 2007-2009



Source: Malaysian Technology Development Corporation (MTDC)
Note: These figures are true as of 25 October 2010.

Table 4.3: Number of CRDF Approved Projects and Approved Grant Amount under the Ninth Malaysia Plan, 2006-2010

Technology Industry / Cluster	Number of Companies		Approved Amount (RM Million)	
Advanced Material	13	8.7%	26.7	9.3%
Agriculture Products	5	3.4%	7.3	2.6%
Alternative Energy	5	3.4%	4.7	1.6%
Automotive	3	2.0%	5.1	1.8%
Biotechnology	38	25.5%	52.5	18.4%
Chemicals	3	2.0%	7.7	2.7%
Electrical & Electronics	16	10.7%	37.5	13.1%
Food	8	5.4%	20.2	7.1%
ICT	11	7.4%	20.0	7.0%
Industrial Products	28	18.8%	61.7	21.6%
Machinery	2	1.3%	0.5	0.2%
Medical	3	2.0%	9.3	3.3%
Metal Based	1	0.7%	2.7	0.9%
Miscellaneous	3	2.0%	4.7	1.6%
Pharmaceutical	2	1.3%	1.5	0.5%
Recycle-based	7	4.7%	20.9	7.3%
Sand & Mineral based	1	0.8%	2.8	1.0%
Total	149	100.0%	285.6	100.0%

Source: Malaysian Technology Development Corporation (MTDC)
Note: These figures are true as of 1 December 2010.

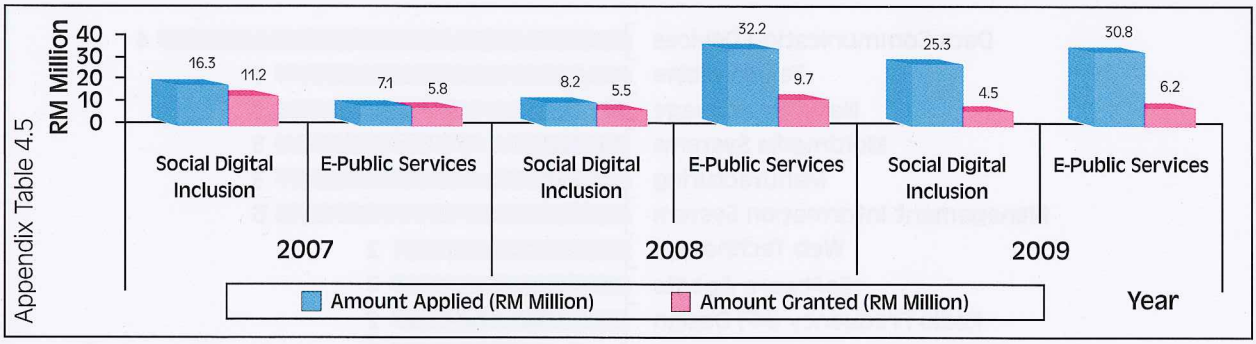
4.1.3 Demonstrator Application Grant Scheme (DAGS)

The Demonstrator Application Grant Scheme (DAGS) involves small, focused, and short-term projects aimed at creating, developing, and promoting new applications. It was launched on 21 April 1998 with an initial allocation of RM 50.0 million to facilitate the growth of bottom-up innovations which are indigenous in design, that contain local content, and that are culturally relevant to meet the demands of the Malaysian community. It is also aimed at promoting the development of local software and content industries for greater competitiveness in the global market.

The DAGS is open to all locally registered companies or organisations with at least 51.0% local ownership and a committed project champion. It must demonstrate community participation in the implementation of the project throughout its entire duration. A maximum of 70.0% of the approved total project cost with a maximum of 30.0% allocation for hardware is provided under this grant scheme.

The number of applications for DAGS in the area of Social Digital Inclusion is found to have doubled while the amount has increased more than four times in value from 2008 to 2009 **(Figure 4.6** and **Table 4.4).** However, the increase in the number approved from 2008 to 2009 is minimal while the amount granted actually fell from RM 5.5 million to RM 4.6 million, substantially lower than the amount applied for. A similar trend is also observed in the area of E-Public Services, where the amount granted fell from RM 9.7 million in 2008 to only RM 6.5 million in 2009, even though the number of approvals increased minimally from 4 to 5.

Figure 4.6: Amount Approved for DAGS Applications, 2008-2009



Source: Ministry of Science, Technology and Innovation (MOSTI)
Note: These figures are true as of 12 November 2010.

Table 4.4: Number of Project Applications and Approvals for DAGS, 2008-2009

Industry	Social Digital Inclusion			E-Public Services		
	2007	2008	2009	2007	2008	2009
No of Applications	5	4	8	3	7	7
Amount Applied (RM Million)	16.3	8.2	25.3	7.1	32.2	30.8
No of Approvals	5	2	3	3	4	5
Amount Granted (RM Million)	11.2	5.5	4.5	5.8	9.7	6.2

Source: Ministry of Science, Technology and Innovation (MOSTI)
Note: These figures are true as of 12 November 2010.

4.1.4 MSC Malaysia Research & Development Grant Scheme (MGS)

The MGS is a scheme administrated by the Multimedia Development Corporation (MDeC), offered to locally-owned or joint-venture MSC Malaysia status companies to develop ICT and multimedia technologies which would contribute to the overall development of the MSC. It is aimed at encouraging and establishing vibrant R&D activities by local companies leading to innovative ICT/multimedia products that possess significant commercial potential. It is also aimed at increasing the creation of Intellectual Property (IP) that enables companies to compete globally, and at strengthening the R&D capabilities of Malaysian knowledge workers.

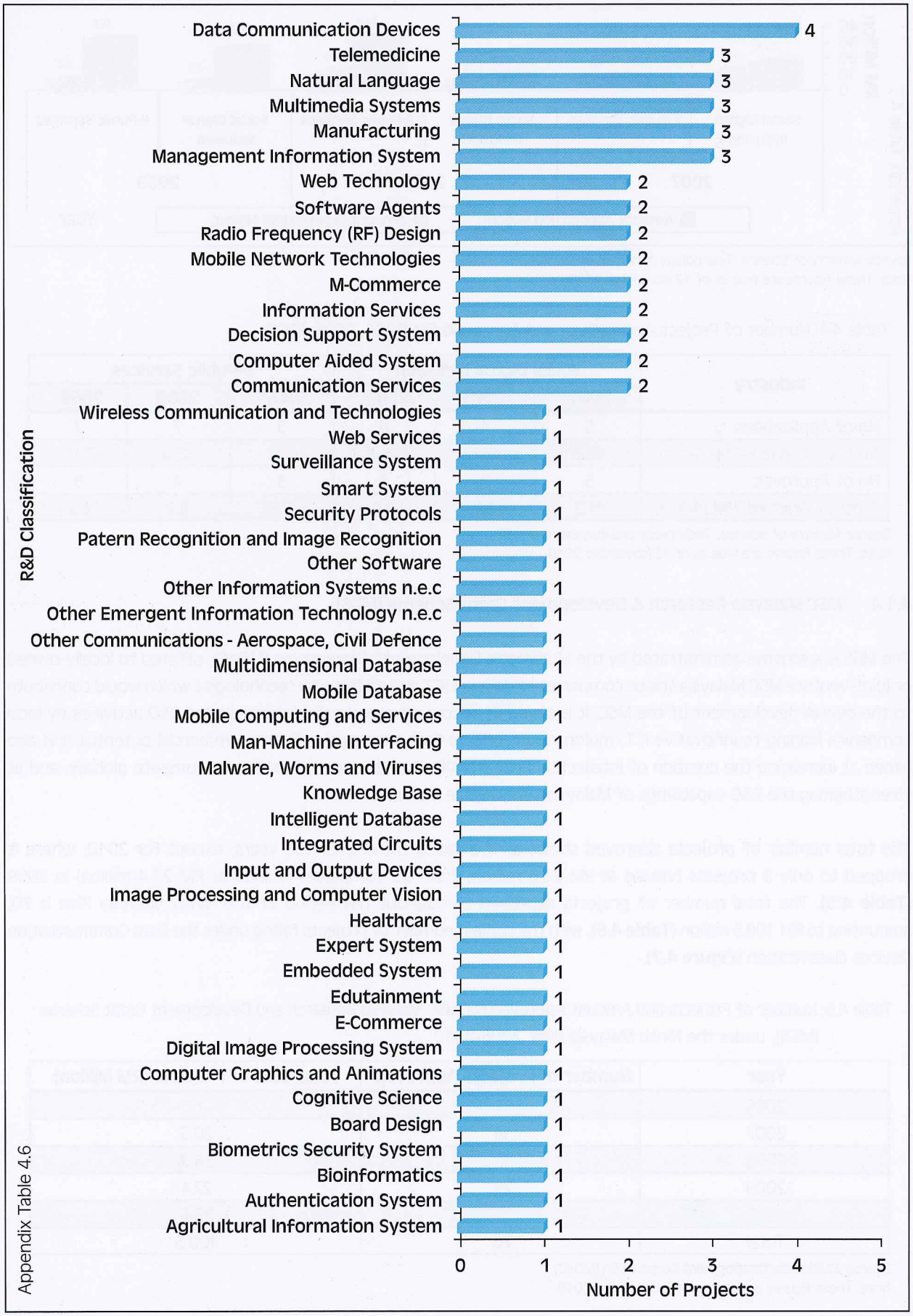
The total number of projects approved shows an increasing trend over the years, except for 2010, where it dropped to only 9 projects (valued at RM 26.6 million) from 29 companies (valued at RM 27.4 million) in 2009 **(Table 4.5)**. The total number of projects approved throughout the period of the Ninth Malaysia Plan is 70, amounting to RM 100.5 million **(Table 4.5)**, with the highest number of projects falling under the Data Communication Devices classification **(Figure 4.7)**.

Table 4.5: Number of Projects and Amount Approved for MSC Malaysia Research and Development Grant Scheme (MGS), under the Ninth Malaysia Plan, 2006-2010

Year	Number of Projects Approved	Total Cost of Projects (RM Million)
2006	0	0
2007	14	20.3
2008	18	26.2
2009	29	27.4
2010	9	26.6
Total	70	100.5

Source: Multimedia Development Corporation (MDeC)
Note: These figures are true as of 2 December 2010.

Figure 4.7: Number of MGS Projects under the Ninth Malaysia Plan, 2006-2010 by the MRDCS



Source: Multimedia Development Corporation (MDeC)
Note: These figures are true as of 2 December 2010.

4.1.5 Industrial Technical Assistance Fund (ITAF)

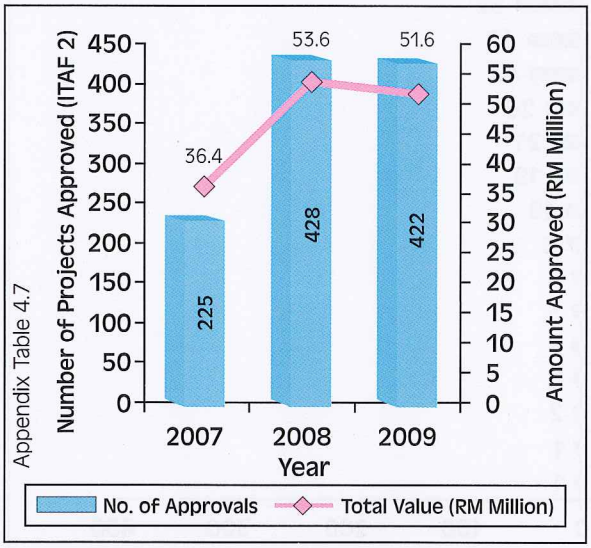
The Industrial Technical Assistance Fund (ITAF) was established in 1990 with an initial allocation of RM 50.0 million to assist small and medium enterprises (SMEs) to become technologically proficient as well as cost competitive. The grant is in the form of matching grants where 50.0% of the project cost is borne by the government and the remainder is borne by the applicant. Four categories of this fund have been established to address the specific requirements of SMEs as shown in **Table 4.6.**

Table 4.6: Types of ITAF Grants and Quantum of Funding

Types of ITAF Grants	Quantum of Funding
ITAF 1: Assistance for studies in business planning, technology and market development.	Up to a maximum of RM 40,000
ITAF 2: Assistance to improve and upgrade existing product, product design and processes.	Up to a maximum of RM 500,000
ITAF 3: Assistance for productivity and quality improvement and to achive international quality standards and certification.	Up to a maximum of RM 250,000
ITAF 4: Assistance for market development.	Implemented by Malaysia External Trade Development (MATRADE) effective 1 January 2002

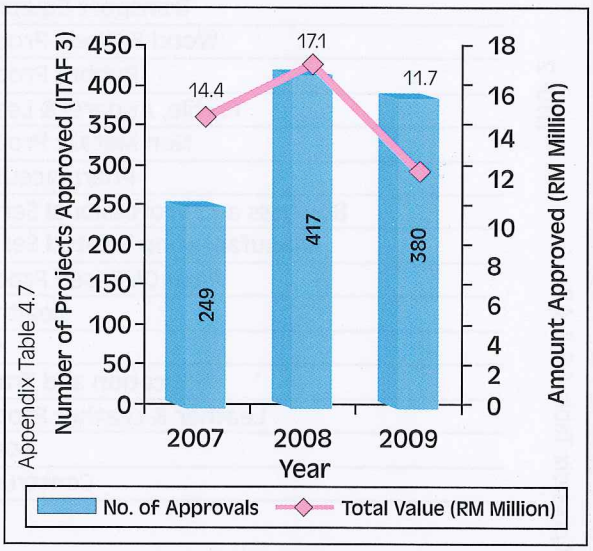
The number of projects approved under ITAF 2 experienced a surge from only 225 in 2007 to almost double the amount (428) in 2008, after which it dropped to 422 in 2009. The amount approved shows a similar trend **(Figure 4.8).** For ITAF 3, the number of approved projects also increased from 2007 to 2008, but experienced quite a significant decline in 2009 to only 380 from 417 the previous year **(Figure 4.9).** The amount approved shows a sharper decline from RM 17.1 million in 2008 to only RM 11.7 million in 2009. Most of the projects approved under ITAF 2 and ITAF 3 were from the food & beverages, electrical & electronics, mineral products, plastic products, and machinery and engineering, as indicated in **Figures 4.10** and **4.11.**

Figure 4.8: Number of Projects and Amount Approved under Matching Grant for Product and Process Improvement (ITAF 2), 2007-2009



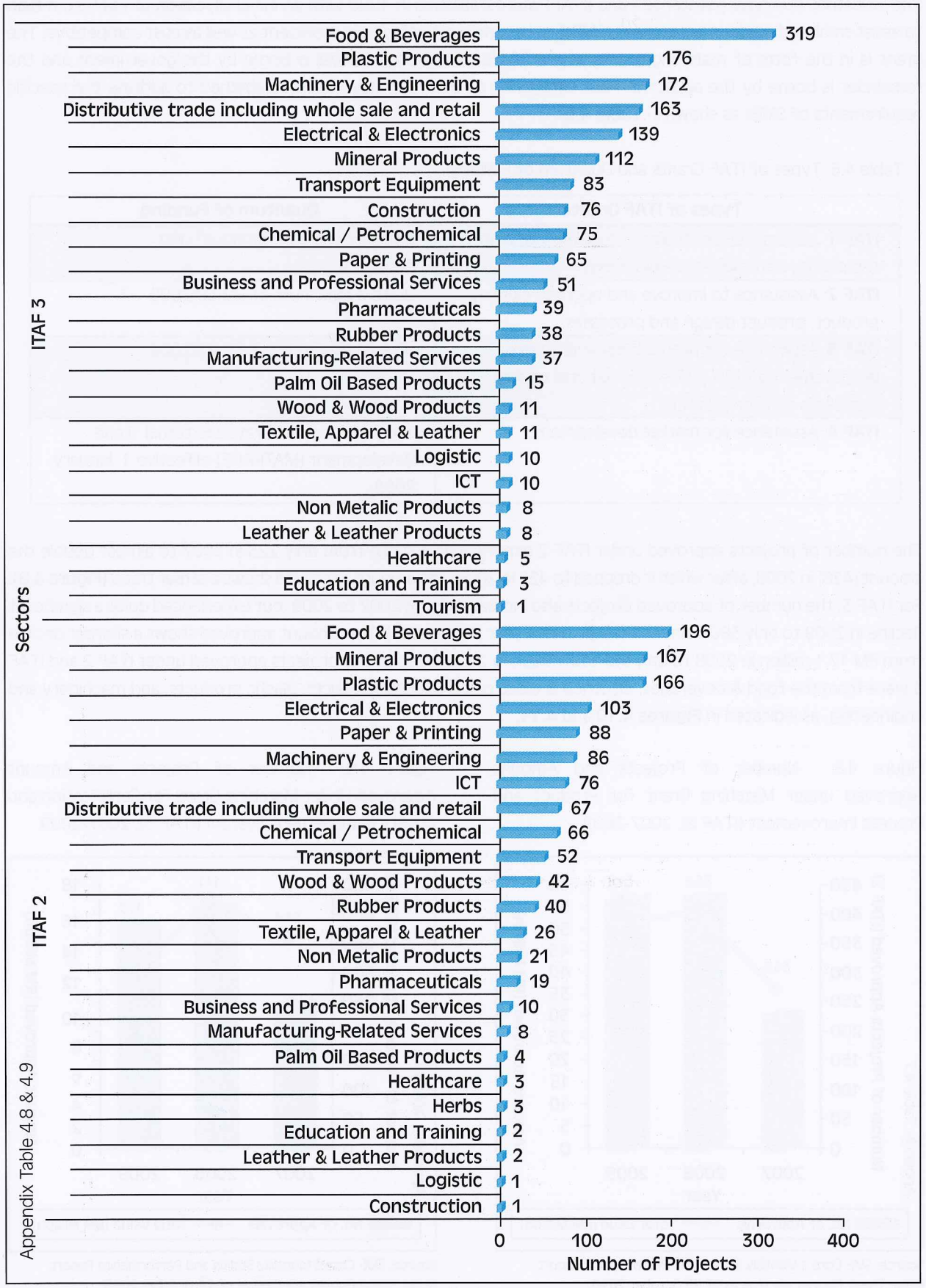
Source: SME Corp's Monthly Status and Performance Report
Note: These figures are true as of 25 October 2010.

Figure 4.9: Number of Projects and Amount Approved Under Matching Grant for Certification and Quality Management System (ITAF 3), 2007-2009



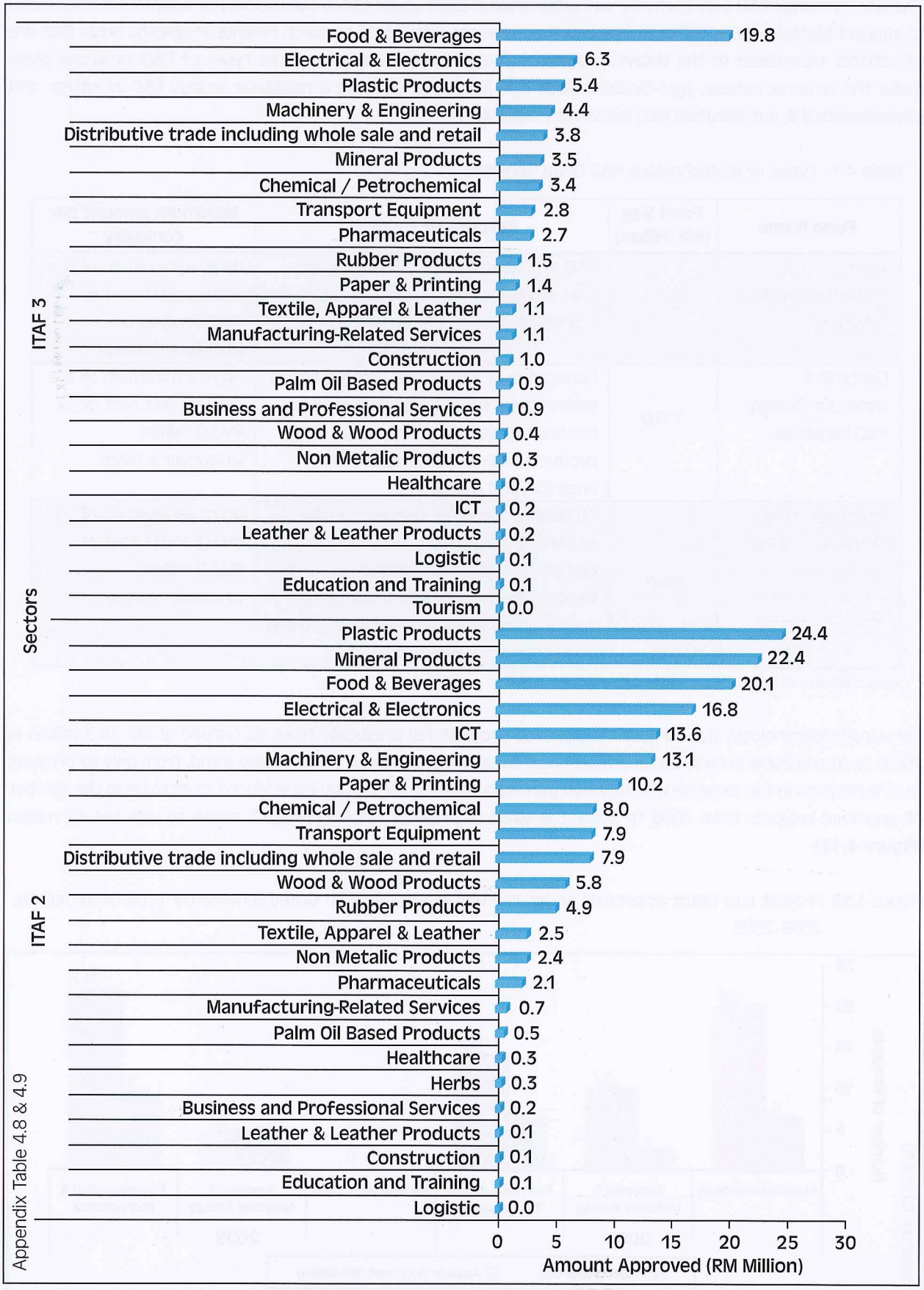
Source: SME Corp's Monthly Status and Performance Report
Note: These figures are true as of 25 October 2010.

Figure 4.10: Cumulative Approvals under the Matching Grant for Product and Process Improvement (ITAF 2) and Matching Grant for Certification and Quality Management System (ITAF 3) by Sector, 2005-2009



Source: SME Corp's Monthly Status and Performance Report
Note: These figures are true as of 25 October 2010.

Figure 4.11: Cumulative Amount Approved under the Matching Grant for Product and Process Improvement (ITAF 2) and Matching Grant for Certification and Quality Management System (ITAF 3) by Sector, 2007-2009



Source: SME Corp's Monthly Status and Performance Report
Note: These figures are true as of 25 October 2010.

4.1.6 Biotechnology R&D Grant Scheme

The Biotechnology R&D Grant Scheme was established in 2001 under the National Biotechnology Directorate (NBD) to support biotechnology R&D activities and the commercialisation of research findings in specific areas that are of national importance to the Malaysian biotechnology industry. There are three types of R&D initiatives given under this scheme, namely, agro-biotechnology R&D initiatives, genomic & molecular biology R&D initiatives, and pharmaceutical & nutraceutical R&D initiatives **(Table 4.7)**.

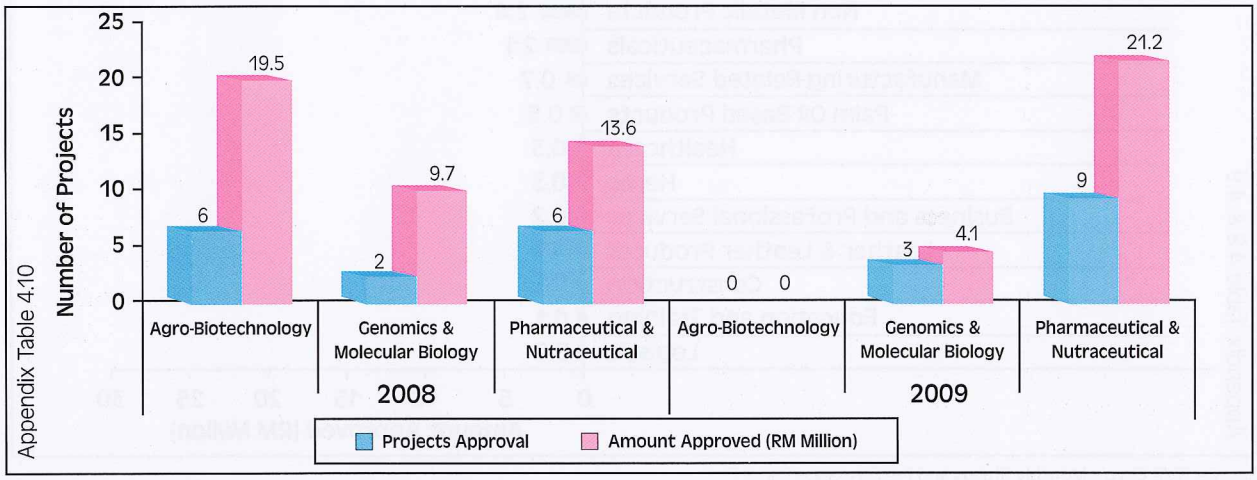
Table 4.7: Types of Biotechnology R&D Grant Schemes

Fund Name	Fund Size (RM Million)	Purpose of funding	Maximum amount per company
Agro - Biotechnology R&D Initiatives	80.0	R&D in strategic areas of agro-biotech that will lead to modernisation and transformation of the agricultural sector.	Up to a maximum of the total project cost or RM2.5 million, whichever is lower.
Genomic & Molecular Biology R&D Initiatives	100.0	Generation of intellectual properties and technologies for application in modern bio-manufacturing of high value products such as biocatalysts, fine chemical, and diagnostics.	Up to a maximum of the total project cost or RM5.0 million, whichever is lower.
Pharmaceutical & Nutraceutical R&D Initiatives	90.0	To develop 'proof of concept' products or service developed by local scientist to comply with the international standards imposed by the regulatory authorities, such as good research practice (GRP) and good laboratory practice (GLP).	Up to a maximum of the total project cost or RM5.0 million, whichever is lower.

Source: Ministry of Science, Technology and Innovation (MOSTI)

For agro-biotechnology, the number of approved projects fell drastically from six (valued at RM 19.5 million in 2008) to zero in 2009. In contrast, pharmaceutical & nutraceutical shows an increasing trend, from only six projects to nine projects in the same period. Although genomics & molecular biology experienced an increase in the number of approved projects from 2008 to 2009, the value of projects fell from RM 9.7 million to only RM 4.2 million **(Figure 4.12)**.

Figure 4.12: Project and Grant Approvals under the Biotechnology R&D Grant Scheme by Type of Initiatives, 2008-2009



Source: Ministry of Science, Technology and Innovation (MOSTI)
Note: These figures are true as of 12 November 2010.

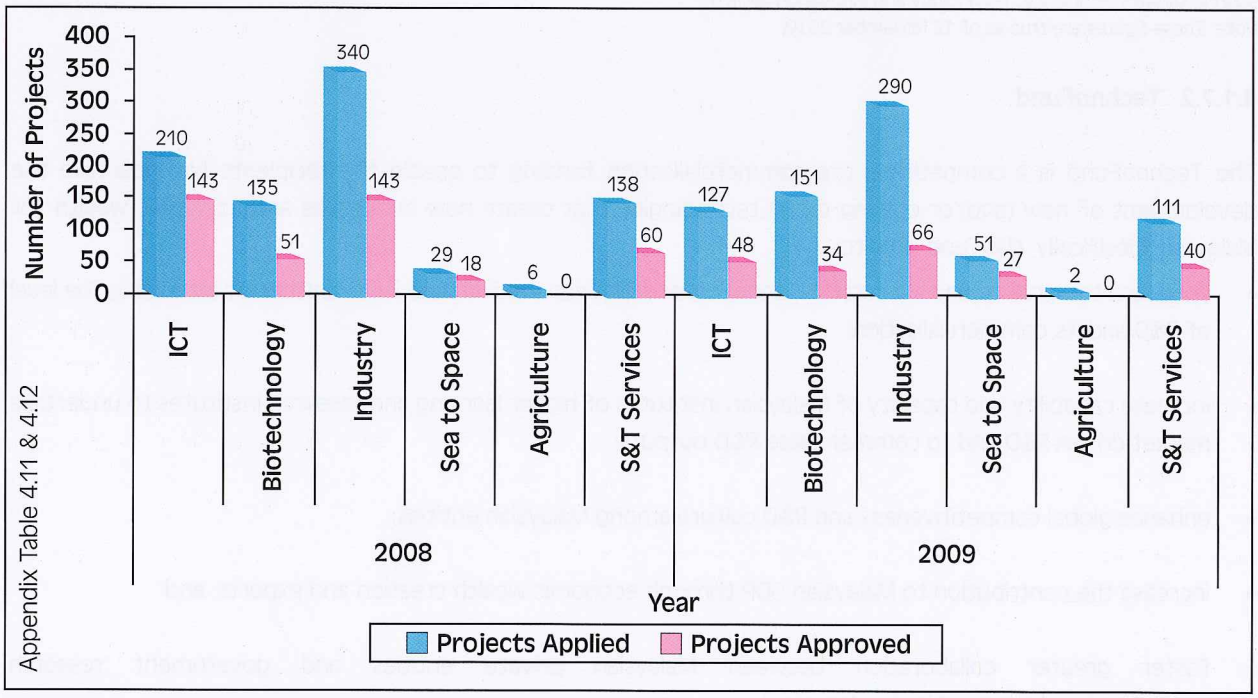
4.1.7 Support for R&D in Institutions of Higher Learning (IHL)

4.1.7.1 ScienceFund

The ScienceFund is a grant provided to eligible entities to undertake R&D projects that can acquire and generate new knowledge in strategic basic and applied sciences. The fund has the objectives of supporting R&D projects that can develop new products or processes necessary for further development and commercialisation in specific research clusters (RC); generating science-based knowledge through research, and enhancing skills as well as expertise among researchers in Malaysia. The outcome of research under ScienceFund that has commercial potential can be considered for additional funding under the TechnoFund.

The strategic basic research, or experimental or theoretical work to be undertaken under the ScienceFund should be primarily focused towards acquiring new knowledge directed into specified broad areas that are expected to lead to useful discoveries. On the other hand, the applied research to be undertaken should be directed towards acquiring new knowledge for a specific application up to the development of laboratory scale prototype. The ScienceFund has a ceiling value up to RM 500,000 per proposal, and it focuses on five main clusters, namely, Information and Communications Technology (ICT), Biotechnology, Industry, Sea to Space, and Science & Technology core.

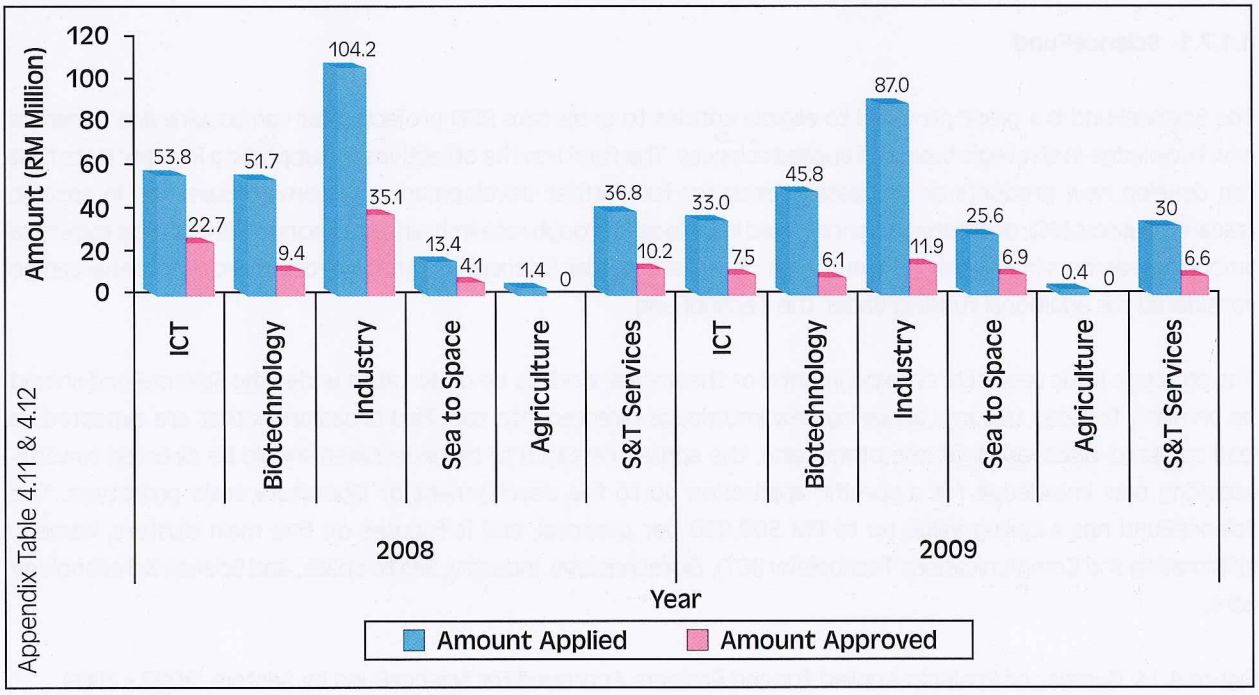
Figure 4.13: Number of Projects Applied for and Projects Approved for ScienceFund by Sectors, 2008 - 2009



Source: Ministry of Science, Technology and Innovation (MOSTI)
Note: These figures are true as of 12 November 2010.

The total number of projects applied for in 2009 was 732, down from 858 in 2008 **(Figure 4.13)**, while the number of projects approved fell even more sharply to only 215 in 2009 from a high of 415 in the previous year. The declining trend is experienced in all the sectors, except for the Sea to Space sector, which saw an increase in the number of projects approved from 2008 to 2009. The largest decline is seen in the ICT sector, where the number of approved projects in 2008 was 143 (with a value of RM 22.7 million) to only 48 in 2009 (with a value of RM 7.5 million). The Industry sector is also observed to have undergone a similar decline in both the number of projects and the amount approved in these two years **(Figure 4.14)**.

Figure 4.14: Amount Applied for and Amount Approved for ScienceFund by Sectors, 2008 & 2009



Source: Ministry of Science, Technology and Innovation (MOSTI)
Note: These figures are true as of 12 November 2010.

4.1.7.2 TechnoFund

The TechnoFund is a competitive, pre-commercialisation funding to enable the recipients to undertake the development of new (and/or cutting edge) technologies that create new businesses and economic wealth for Malaysia. Specifically, the fund aims to:

- stimulate the growth and successful innovation of Malaysian medium and large entities by increasing the level of R&D and its commercialisation;
- increase capability and capacity of Malaysian institutes of higher learning and research institutes to undertake market driven R&D and to commercialise R&D outputs;
- enhance global competitiveness and R&D culture among Malaysian entities;
- increase the contribution to Malaysian GDP through economic wealth creation and exports; and
- foster greater collaboration between Malaysian private entities and government research institutes/institutions of higher learning.

The fund focuses on six subpriority technology areas of ICT, biotechnology, advanced materials, advanced manufacturing, nanotechnology, and renewable energy. It consists of two types of funds as follows:

Type A: Pre-commercialisation

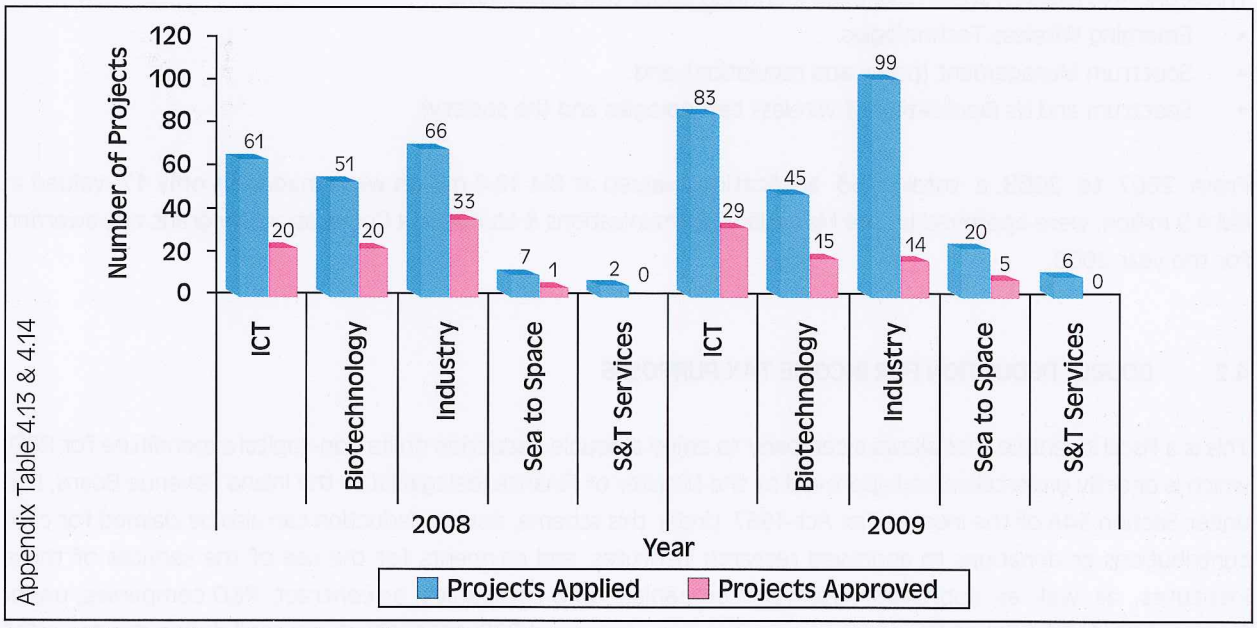
- Pre-commercialisation activities comprise the development (up-scaling) of commercial ready prototype/ pilot plant/ clinical trial/ field trial for demonstration and testing purposes but not for commercial exploitation.

Type B: IP Acquisition

- Type B comprises the acquisition of IP (academic/laboratory scale prototype) from overseas or local sources for further development (up-scaling) up to pre-commercialisation stage. The IP acquired must be an outright purchase (IP licensing is not allowed)

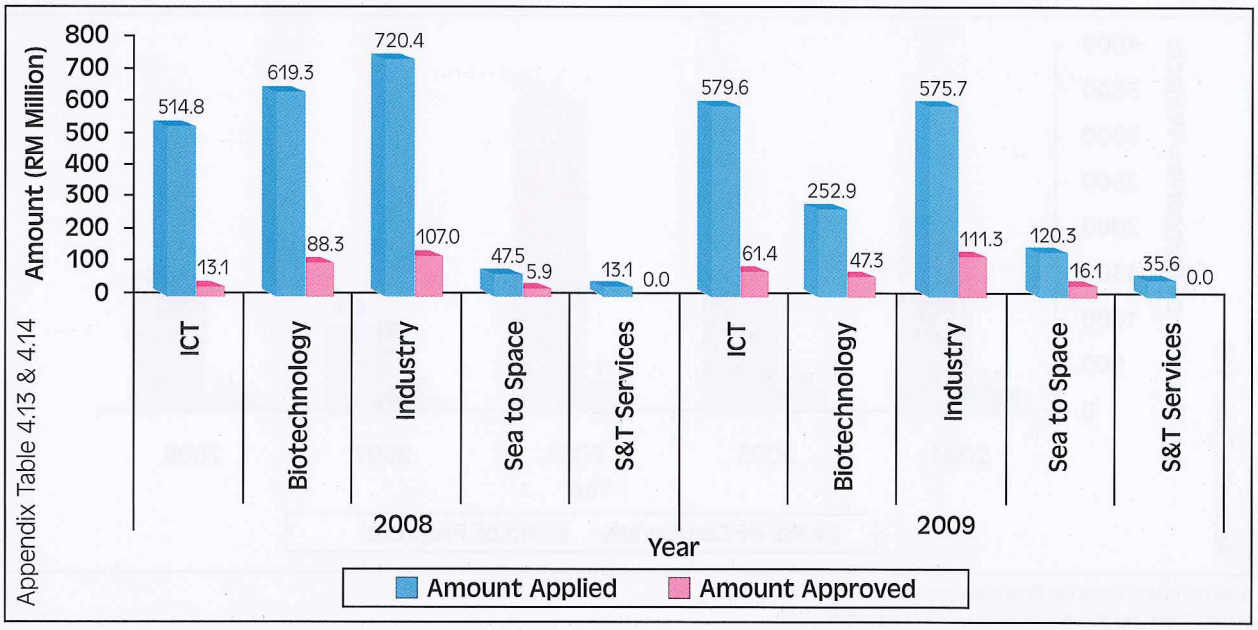
Except for Biotechnology, all sectors show an increase in the number of projects applied for and approved between 2008 and 2009 (**Figures 4.15** and **4.16**). For ICT, however, although the number of projects approved increased from 20 to 29 in the same period, the amount approved suffered a decline from RM 76.1 million to RM 61.4 million.

Figure 4.15: Number of Projects Applied for and Projects Approved for TechnoFund by Sector, 2008 & 2009



Source: Ministry of Science, Technology and Innovation (MOSTI)
Note: These figures are true as of 15 November 2010.

Figure 4.16: Amount Applied for and Amount Approved for TechnoFund by Sector, 2008 & 2009



Source: Ministry of Science, Technology and Innovation (MOSTI)
Note: These figures are true as of 12 November 2010.

4.1.7.3 Spectrum Research Collaboration Program (SRCP)

In view of the rapid advancement in wireless communications, which requires more radio spectrum, the Malaysian Communications and Multimedia Commission (MCMC) and designated Institutions of Higher Learning (IHLs) have agreed to work in a collaborative framework to provide a more efficient spectrum management that is much needed in the field. Under this collaborative framework, the Spectrum Research Collaboration Program (SRCP) was established to improve the administrative, regulatory, and technical expertise of frequency management, by promoting and funding research on spectrum related matters. Malaysia's IHLs in the public and private sectors are eligible to participate in the SRCP. Other organisations that are interested to participate will need to form collaborative partnerships with IHLs, with the latter being the lead partner.

Three priority research areas have been identified under this programme:

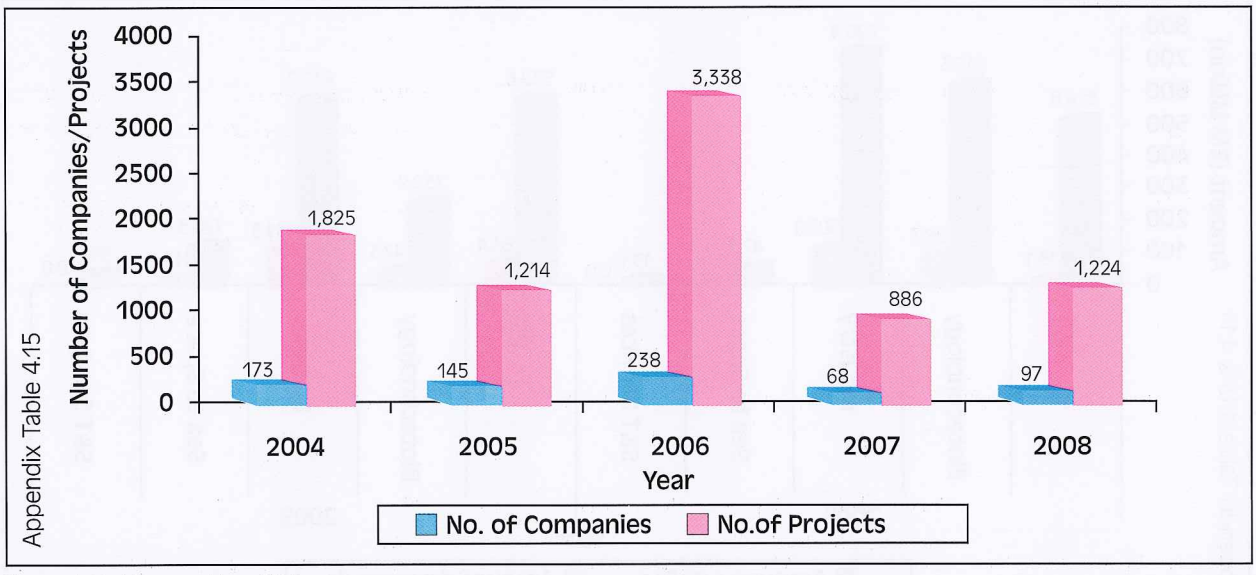
- Emerging Wireless Technologies;
- Spectrum Management (policy and regulation); and
- Spectrum and Us (application of wireless technologies and the society).

From 2007 to 2008, a total of 53 applications valued at RM 18.4 million were made but only 17, valued at RM 4.9 million, were approved by the Malaysian Communications & Multimedia Commission. No grant was awarded for the year 2009.

4.2 DOUBLE DEDUCTION FOR INCOME TAX PURPOSES

This is a fiscal incentive that allows a company to enjoy a double deduction on its non-capital expenditure for R&D, which is directly undertaken and approved by the Minister of Finance (delegated to the Inland Revenue Board, IRB) under Section 34A of the Income Tax Act 1967. Under this scheme, double deduction can also be claimed for cash contributions or donations to approved research institutes, and payments for the use of the services of these institutes, as well as approved research companies, R&D companies, or contract R&D companies, under Section 34B (1) (b) & (c) of the same Income Tax Act. Approved R&D expenditure incurred during the tax relief period for companies granted Pioneer Status can be accumulated and deducted after the tax relief period.

Figure 4.17: Number of Projects and Companies that Claimed for Deduction of R&D Expenditure, 2004-2008



Source: Inland Revenue Board Malaysia
Note: These figures are true as of 16 November 2010.

Table 4.8: Number of Projects Approved and the Estimated Amount of Deduction for R&D, 2004-2008

Year	Number of Projects	Estimated Amount of Deduction (RM Million)
2004	1,825	499.5
2005	1,214	467.1
2006	3,338	963.8
2007	886	267.8
2008	1,224	587.0

Source: Inland Revenue Board Malaysia
Note: These figures are true as of 16 November 2010.

As shown in **Figure 4.17**, the number of companies that benefited from the double deduction for R&D has increased from 68 in 2007 to 97 in 2008. A similar trend is observed for the number of projects, increasing from 886 to 1,224 in the two years. However, these figures are significantly lower than those of 2006, where the number of companies that claimed for double deductions was 238 while the number of projects was 3,338. Hence, as expected, the estimated amount of deduction for R&D at RM 267.8 million and RM 587.0 million for the years 2007 and 2008 **(Table 4.8)**, respectively, are also significantly lower than that in 2006, at RM 963.8 million.

The industrial sector remains the leading recipient of double deductions for R&D in both 2007 and 2008. In 2007, IT/Telecommunication took the lead, making up 45.7% of the total estimated amount, but the sector fell to the automobile sector in 2008 **(Figure 4.18)**. Other major recipients for both years are transportation and electrical products.

4.3 R&D INVESTMENT INCENTIVES

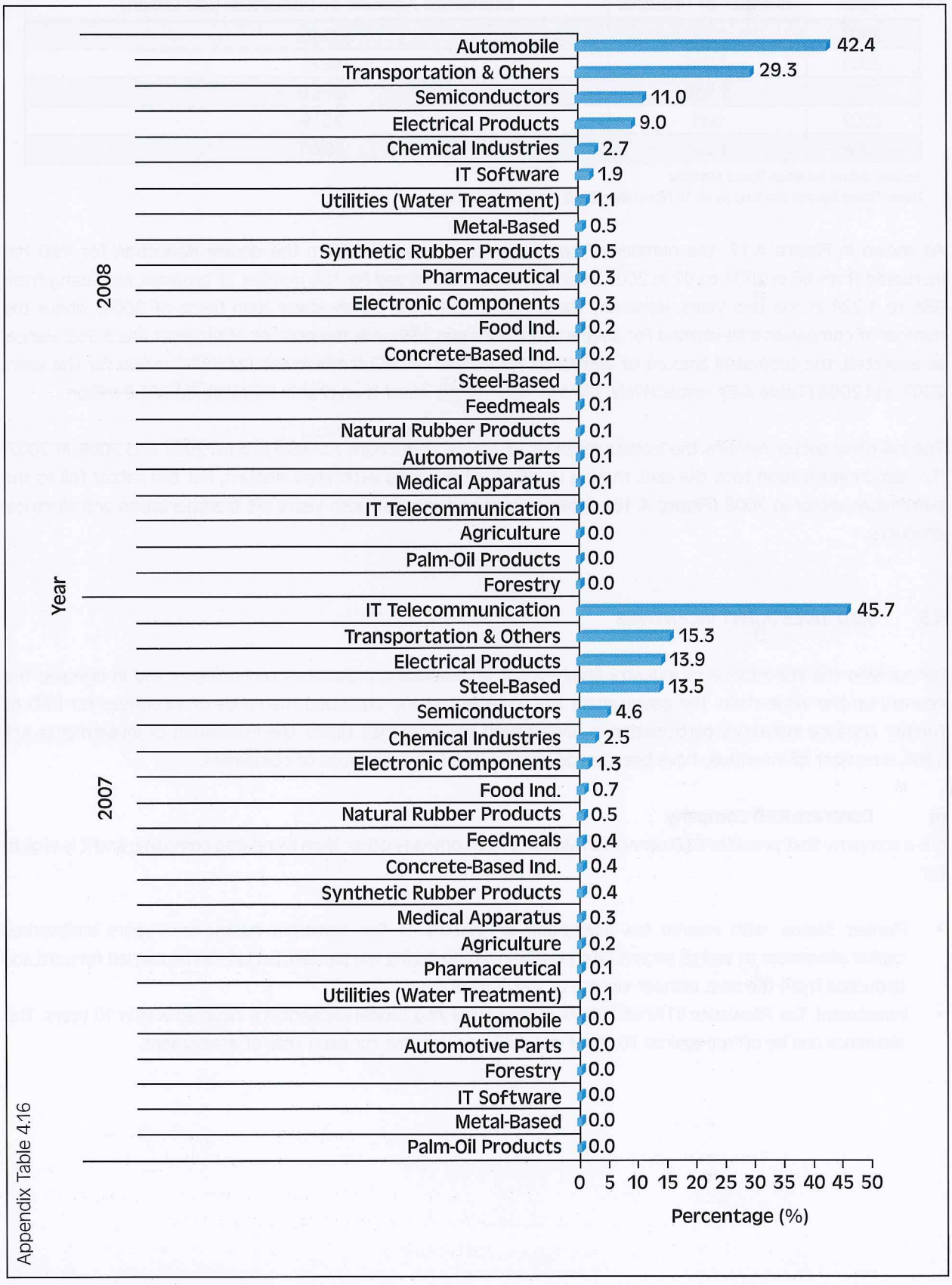
Recognising the importance of industry involvement in developing indigenous technologies and in bringing the country up the value-chain, the government has, in recent years, expanded the range of incentives for R&D to further enhance industry's participation in undertaking R&D activities. Under the Promotion of Investments Act 1986, a number of incentives have been introduced for the following types of companies:

(i) Contract R&D Company

It is a company that provides R&D services in Malaysia to a company other than its related company, and it is eligible for:

- Pioneer Status, with income tax exemption of 100.0% of the statutory income for 5 years. Unabsorbed capital allowances as well as accumulated losses incurred during the pioneer period can be carried forward and deducted from the post pioneer income of the company; or
- Investment Tax Allowance (ITA) of 100.0% on the qualifying capital expenditure incurred within 10 years. The allowance can be offset against 70.0% of the statutory income for each year of assessment.

Figure 4.18: Leading Recipients of Double Deduction for R&D Expenditure by Industrial Sector, 2007 & 2008



Source: Inland Revenue Board Malaysia
Note: These figures are true as of 16 November 2010.

(ii) R&D Company

It is a company that provides R&D services in Malaysia to its related company or to any other company. It is eligible for an ITA of 100.0% on the qualifying capital expenditure incurred within 10 years. The allowance can be offset against 70.0% of the statutory income for each year of assessment. Should the R&D company choose not to avail itself of the allowance, its related companies can enjoy double deduction for payments made to the R&D company for services rendered.

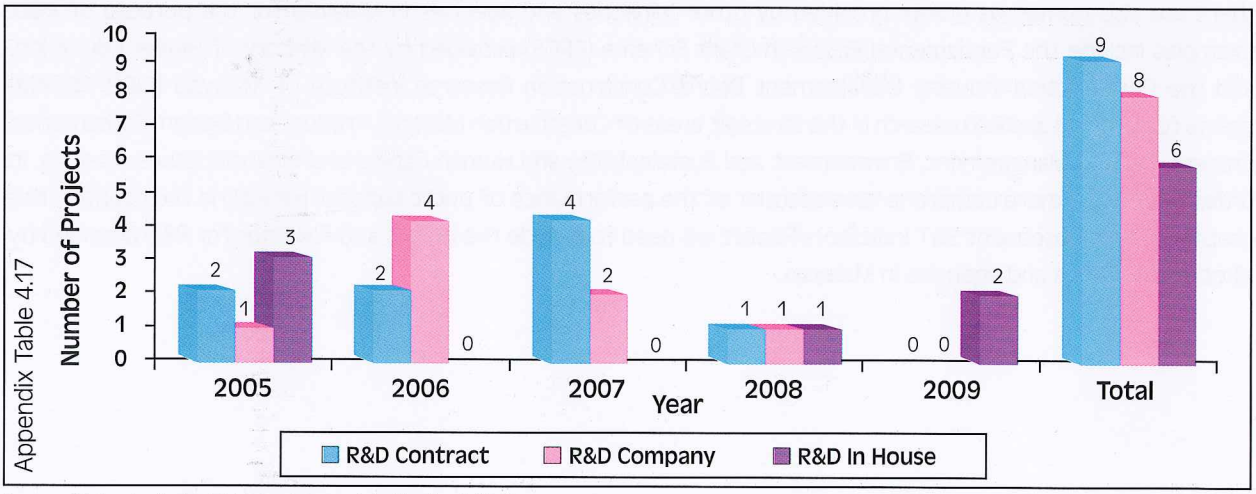
(iii) In House Research

A company that undertakes in-house R&D to further its business can apply for an ITA of 50.0% of the qualifying capital expenditure incurred within 10 years. The company can offset the allowance against 70.0% (100.0% for promoted areas) of its statutory income for each year of assessment.

For all the three types of arrangements, any unutilised allowances of the ITA can be carried forward to subsequent years until fully utilised. To further strengthen Malaysia's foundation for more integrated R&D, companies which carry out design development and prototyping as independent activities are also eligible for incentives.

Figure 4.19 reveals contract R&D companies as being the highest recipients of the incentives over the period 2005-2009, followed by R&D companies and in-house R&D. The number of recipient companies is found to be highest for the years 2005 to 2007 at six for each year. A total of 23 companies have benefited from the incentives over the period of 5 years.

Figure 4.19: Number of R&D Projects by Type of Incentives, 2005-2009



Source: Malaysian Industrial Development Authority (MIDA)
Note: These figures are true as of 25 October 2010.

4.4 CONCLUSION

As acknowledged in the 10MP, funding is critical to innovation, but requires government support in its early stages of development and commercialisation, as markets frequently do not supply the volume of capital to these areas. Hence, the continuous provision of the various grants and incentives to promote R&D activities is pertinent, especially in high technology sectors in Malaysia, in tandem with the government's objective to bring Malaysia up the value chain to become a high income developed nation by 2020.

From the trends in the various schemes and incentives discussed earlier, the positive response observed from both the public as well as the private research institutions or companies reflects their awareness of the existence of these programmes and their keen interest in being involved in R&D activities. However, the demand has, most of the time, exceeded the supply of such grants, given the fact that the number of applications have been, most of the time, found to be much higher than the allocations could allow. Hence, these allocations for the grants are quickly exhausted, resulting in a situation where many applications had to be turned down. In order to improve this situation, the allocations for the various funds need to be increased in order to allow for more companies as well as public universities and research institutes to benefit in developing new technologies and in promoting their research outputs.

As a related issue, although a number of specialized incentives to promote the development of indigenous technologies have already been introduced, most of the existing funds are still focused on only acquiring and adopting foreign technologies. In order for Malaysia to avoid being trapped into becoming mainly a 'technology adopter' rather than a 'technology creator', additional funds, schemes, and incentives need to be established to encourage and accelerate the development of indigenous technologies for the country's long-term international competitiveness.

In line with the above needs, under the Tenth Malaysia Plan, the government has stated its commitment to provide a larger pool of funds for venture capital, especially on a *Mudharabah* basis (risk sharing), through co-investment with private sector funds. The government targets to increase the Gross Expenditure on R&D (GERD) in the 10MP period with a higher ratio of private sector R&D expenditure.

As mentioned earlier, this chapter covers the various grants and schemes for R&D managed by MOSTI. However, there are also numerous grants provided by other ministries and agencies in Malaysia for the purpose of R&D. Examples include the Fundamental Research Grant Scheme (FRGS) provided by the Ministry of Higher Education, and the Construction Industry Development Board/Construction Research Institute of Malaysia (CIDB/CREAM) grants focusing on applied research in the strategic areas of Construction Material, Product and Design, Construction Process, Project Management, Environment and Sustainability; and Human Capital and Financial Issues. As such, in order to obtain a more comprehensive account of the performance of public support for R&D in the country, this chapter in the subsequent S&T Indicators Report will need to include the grants and fundings for R&D provided by all other ministries and agencies in Malaysia.

CHAPTER 5
- RESEARCH AND DEVELOPMENT (R&D) FOR SCIENCE AND TECHNOLOGY

CHAPTER 5

RESEARCH AND DEVELOPMENT (R&D) FOR SCIENCE AND TECHNOLOGY

5.0 INTRODUCTION

Malaysia's economic growth has been driven predominantly by factor (capital, energy and labour) accumulation. However, a factor driven model of growth is not sustainable. This model is also inconsistent with the economic structure required for a high-income economy based on higher value-added activities. A transformational shift to higher value-added activities requires high productivity growth. Hence, under the 10MP special emphasis is given to the enablers of productivity. Among the initiatives introduced to increase productivity is the initiative to increase public investment into the enablers of innovation, particularly research and development (R&D) and venture capital funding (EPU, 2010).

This chapter reports Malaysia's aggregate R&D activities, and decomposition of R&D activities by the Institutions of Higher Learning (IHLs), Government Research Institutes (GRIs), and the private sector (or business enterprise). The data used for the analysis in this chapter are mainly from the NSRD 2008 and the UNESCO Institute for Statistics.

The NSRD, administered once every two years, provides statistics and information on the status, development, and trend of R&D activities in Malaysia, especially among institutions of higher learning (IHLs), government research institutes (GRIs), and the private sector. The definition of indicators and methodologies adopted in the NSRD are based on the OECD Frascati Manual.

The NSRD collects information on R&D activities using two methods: (a) online survey, and (b) mail survey. For the public sector (IHLs and GRIs), the survey was conducted online. A preliminary survey was conducted before the online survey. The intent of the preliminary survey is to obtain information on the number of R&D projects that had been carried out by the GRIs and IHLs in 2008. The preliminary survey showed that GRIs and IHLs had conducted 1,181 and 10,406 projects, respectively. However, only 70.0% of the project leaders responded to the online survey. For the private sector, data were collected using the mail survey. A preliminary survey was conducted to identify the number of companies involved in R&D projects. This led to the development of a comprehensive list of companies based on the list of (a) companies that had participated in the NSRD 2006, (b) companies provided by the Small and Medium Industries Development Corporation (SME Corp), and (c) government-led companies. A total of 2,890 questionnaires were mailed to the companies but only 231 companies returned the questionnaires, and of these, only 164 reported that they conducted R&D activities in 2008.

The expenditure data reported in the NSRD 2008 are in nominal Ringgit Malaysia (RM); hence, most of the analyses conducted in this chapter do not take into account inflation. However, this should not be a major problem since the analyses cover a relatively short period (2000-2008). Furthermore, Malaysia's inflation rate is relatively small, at about four percent per year for the period reported.

5.1 OVERVIEW OF R&D IN MALAYSIA

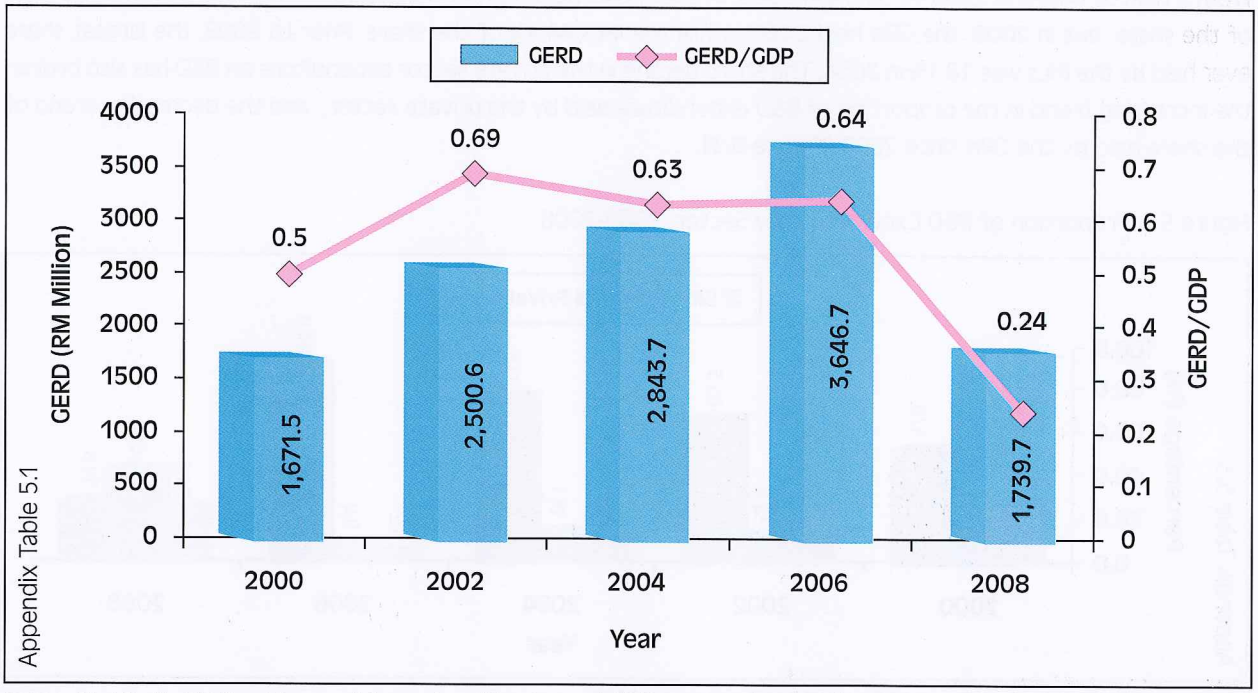
Malaysia's GERD in 2008 was RM 1.7 billion, a sharp drop from a high of RM 3.6 billion in 2006. This breaks the trend of increasing GERD since 2000. Taking into account inflation (approximately 4.0% per year for the period), Malaysia's real GERD in 2008 is lower than the real GERD for 2000 (Nominal GERD in 2000 was approximately RM 1.7 billion) **(Figure 5.1)**.

Similarly, the measure of research intensity—GERD/GDP ratio—also decreased. In 2008, the research intensity ratio was 0.24%, while the average GERD/GDP for the period 2002-2006 was 0.64%. The GERD/GDP ratio for 2008 is also about half the ratio for 2000, which was 0.50% **(Figure 5.1)**.

Among the reasons that might explain the decrease in GERD and GERD/GDP are the global uncertainty due to the rapid increase in oil prices, and the global financial crisis in 2008, which have affected Malaysia's economy. The increase in oil prices in 2008 increased production costs, and hence firms were forced to reduce their expenditure on R&D in order to reduce overall cost and be competitive. Uncertainty in the global economy because of the global financial crisis, which started in the U.S.A., forced firms to be vigilant with their spending and investments especially those that provide returns only in the long term, such as investments on R&D. In fact, the OECD Science, Technology, and Industry Scoreboard 2009 indicated that on average, companies in the US stock market report a reduction in their R&D expenditure by about 7.0%.

However, the global financial crisis and the oil crisis alone may not be able to explain the drastic drop in Malaysia's GERD by more than half. Another important consideration is the poor response rate by both the public and private sectors on the NSRD 2008. As mentioned in the Introduction, the response rate for the public sector was 70.0%, while for the private sector, out of 2,890 companies to which the questionnaires were mailed, a total of 231 companies responded to the questionnaire, but only 164 of the companies reported that they conducted R&D. This leaves cause for concern that the survey may not have managed to capture the true R&D expenditure, and that the R&D expenditure in Malaysia is actually much greater than that reported in the survey.

Figure 5.1: Malaysia's GERD and GERD/GDP Ratio, 2000-2008

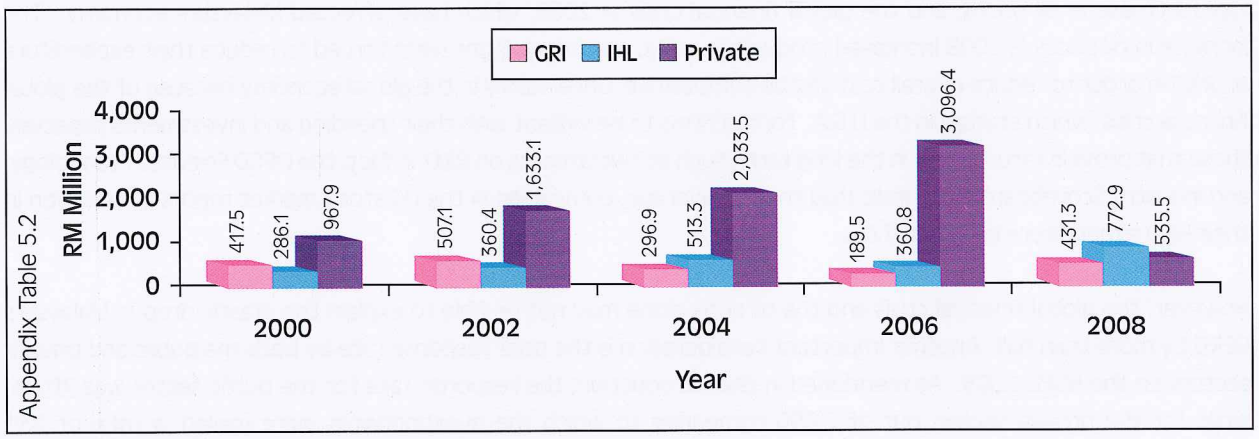


Source: Final Draft of National Survey of Research and Development 2008

5.1.1 R&D Expenditure by the Private and Public Sectors

Decomposition of the GERD by sector shows that the decrease in total GERD and GERD/GDP ratio is because of the sharp drop in GERD for the private sector as shown in **Figure 5.2**. The GERD for the private sector declined from a high of RM 3.1 billion in 2006 to a low of RM 535.5 million in 2008. The unusually low expenditure on R&D breaks the trend of Malaysia's increasing GERD since 2000 for the private sector, which has always had the lion's share of the nation's GERD. The GERD for the GRIs and IHLs was RM 431.3 million and RM 772.9 million, respectively in 2008, which is greater than their GERD in 2006, which was RM 189.5 million and RM 360.8 million, respectively. Both the GRIs and IHLs more than doubled their GERD from that of 2006; however, the increase, though large, was not enough to overcome the sharp drop in the GERD for the private sector.

Figure 5.2: R&D Expenditure by Sector, 2000-2008

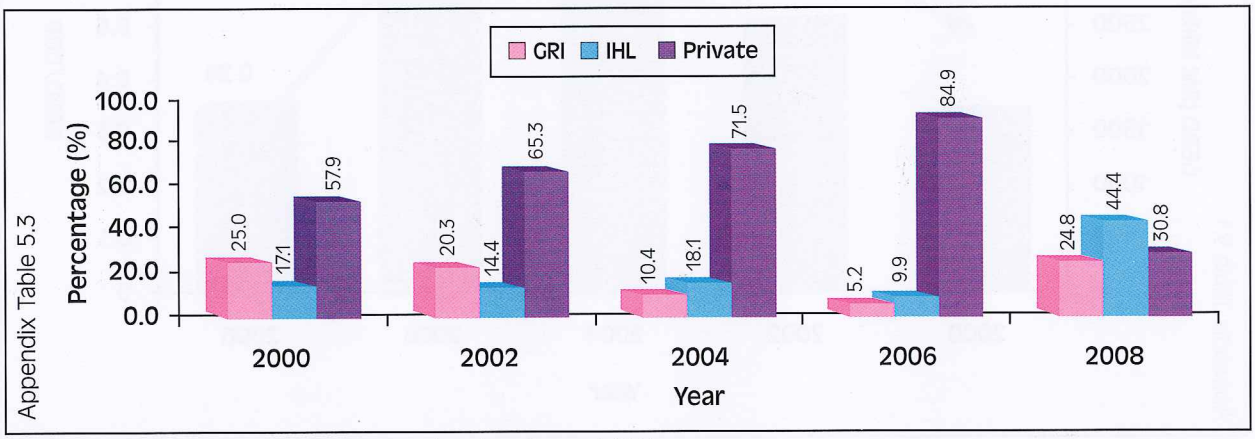


Source: Final Draft of National Survey of Research and Development 2008

5.1.2 Proportion of R&D Expenditure by Sector

The private sector's share of total GERD has been well above 50.0% for the period 2000-2006; however, it declined from a high of 84.9% in 2006 to 30.8% in 2008. In 2006, GRIs held 5.2% of Malaysia's GERD share and the IHLs 9.9% of the share, but in 2008, the GRIs held 24.8%, while the IHLs 44.4% of the share. Prior to 2008, the largest share ever held by the IHLs was 18.1% in 2004. The sharp decline in the private sector expenditure on R&D has also broken the increasing trend in the proportion of R&D expenditure held by the private sector, and the decreasing trend of the share held by the GRIs since 2000 **(Figure 5.3).**

Figure 5.3: Proportion of R&D Expenditure by Sector, 2000-2008

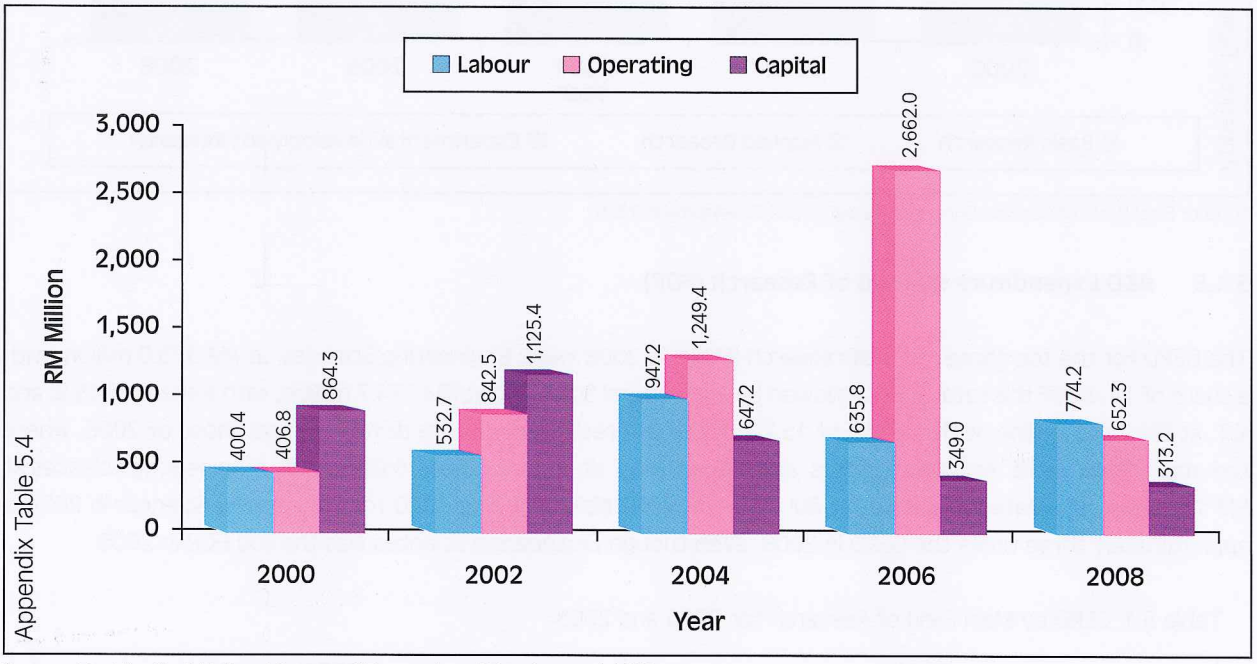


Source: Final Draft of National Survey of Research and Development 2008

5.1.3 R&D Expenditure by Type of Cost

Figure 5.4 shows R&D expenditure by type of cost, which is divided into labour, operating, and capital cost. Operating expenditure in 2008 was RM 652.3 million, a significant drop compared to 2006, which was RM 2.7 billion. Labour and capital expenditure do not record a significant change, registering RM 774.2 million and RM 313.2 million in 2008 respectively, compared to RM 635.8 million and RM 349.0 million in 2006. Unlike the period from 2000-2006, where the expenditure on labour is the lowest, in 2008, the expenditure on labour is the highest. This anomaly may be due to the fact that a large amount of investments on R&D were reduced in 2008, and hence most of the R&D expenditure went to the maintainance of the existing R&D personnel. It may also be explained by the fact that with the increase in R&D funding for the GRIs and IHLs, more researchers were hired to carry out the research activities.

Figure 5.4: R&D Expenditure by Type of Cost, 2000-2008

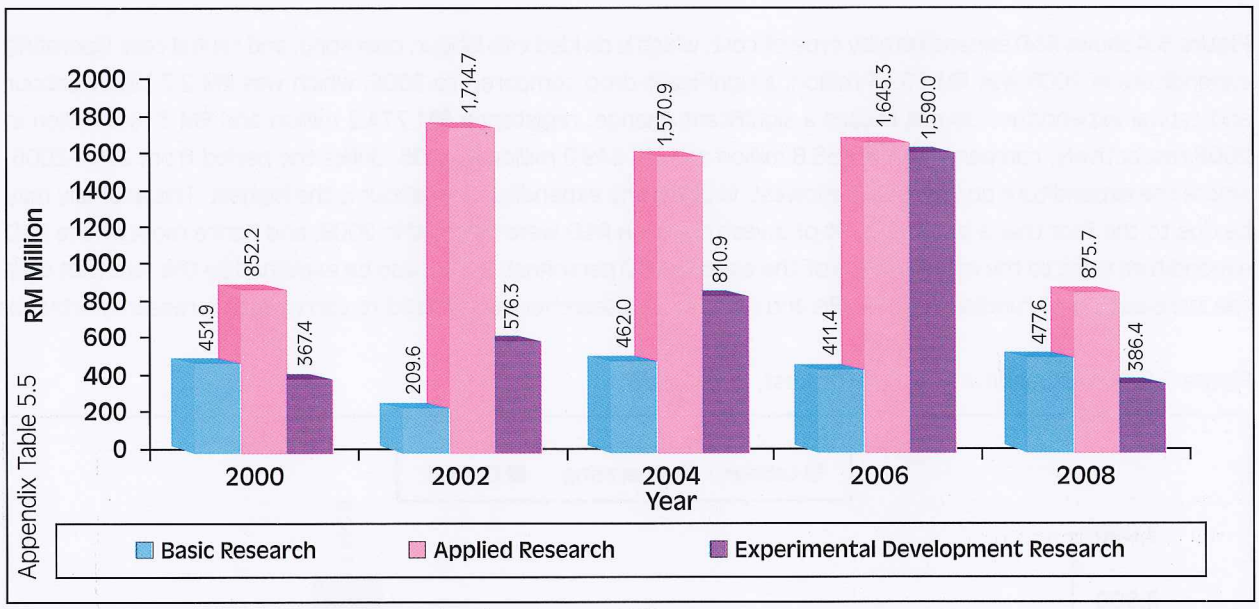


Source: Final Draft of National Survey of Research and Development 2008

5.1.4 R&D Expenditure by Type of Research

Figure 5.5 illustrates R&D expenditure by type of research. R&D expenditure on basic research, applied research, and experimental development research in 2008 was RM 477.6 million, RM 875.7 million, and RM 386.4 million respectively. The expenditure on basic research is approximately similar to that of the previous years, because unlike applied research and experimental development research, most of the basic research is done by the IHLs. The impact of the rise in oil prices and the global financial crisis on the IHLs is not as severe as that on the private sector because the funding for the IHLs is mostly from the federal government. Meanwhile, the private sector and the GRIs have mostly concentrated on applied and experimental development research, because it does not take as long to get the returns, compared to basic research, which takes a much longer time, and where the spillover effect is very large.

Figure 5.5: R&D Expenditure by Type of Research, 2000-2008



Source: Final Draft of National Survey of Research and Development 2008

5.1.5 R&D Expenditure by Field of Research (FOR)

The GERD for the top three fields of research (FORs) in 2008 were: Engineering Sciences, at RM 373.0 million, with a share of 21.4% of the total GERD; followed by Agricultural Sciences , at RM 274.7 million, with a share of 15.8; and ICT, at RM 264.5 million, with a share of 15.2%. The top three main FORs are different from those of 2006, where the main FORs were Applied Sciences and Technology at RM 1.2 billion; followed by Engineering Sciences at RM 1.1 billion; and Material Sciences at RM 364.9 million **(Table 5.1).** The GERD for Engineering Sciences in 2006 is approximately three times the GERD in 2008, even though Engineering Sciences was the top FOR in 2008.

Table 5.1: GERD by Main Field of Research for 2006 and 2008

2008			2006		
FOR	GERD (RM Million)	Share (%)	FOR	GERD (RM Million)	Share (%)
Engineering Sciences	373.0	21.4	Applied Sciences and Technology	1,265.0	34.8
Agricultural Sciences	274.7	15.8	Engineering Sciences	1,175.4	32.3
ICT	264.5	15.2	Material Sciences	364.9	10.0

Source: Final Draft of National Survey of Research and Development 2008 and National Survey of Research and Development 2006

5.1.6 R&D Expenditure by Socio-Economic Objectives (SEO)

The GERD for the top three socio-economic objectives (SEO) in 2008 were Natural Sciences, Technologies, and Engineering (NSTE) at RM 536.2 million, with a share of 30.8% of the GERD; followed by Plant Production and Plant Primary Products (PPPP), at RM 249.8 million, with a share of 14.4%; and Manufacturing, at RM 235.7 million, with a share of 13.6% of the GERD. The top three SEOs for 2008 are different from those of 2006, where the main SEO was Manufacturing at RM 2.3 billion; followed by NSTE at RM 289.2 million; and Transportation at RM 214.0 million **(Table 5.2).**

Table 5.2: GERD by Social-Economic Objectives for 2006 and 2008

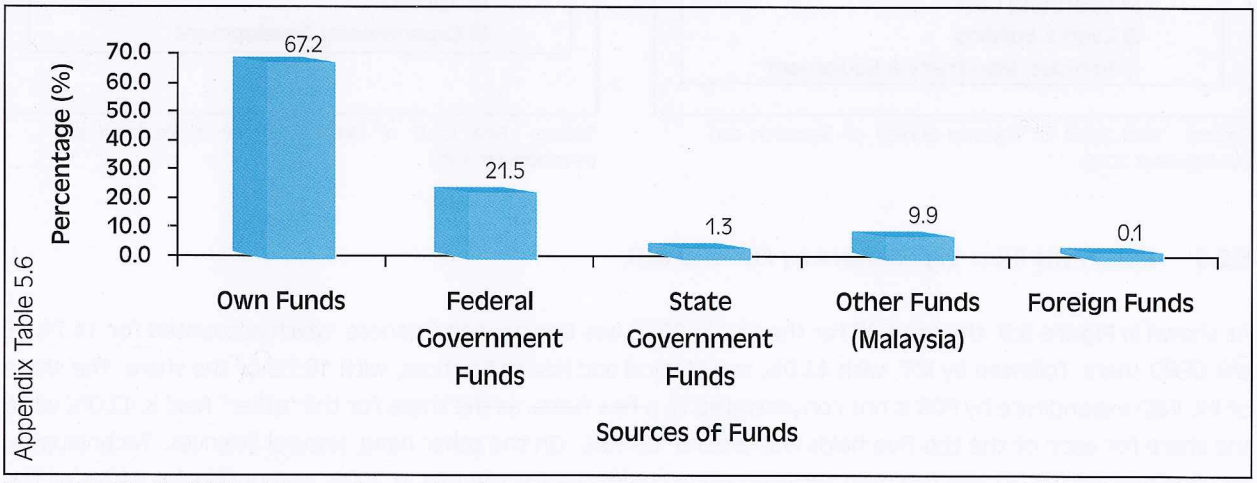
2008			2006		
SEO	GERD (RM Million)	Share (%)	SEO	GERD (RM Million)	Share (%)
NSTE	536.2	30.8	Manufacturing	2,294.7	63.1
Plant Production and Plant Primary Products	249.8	14.4	NSTE	289.2	8.0
Manufacturing	235.7	13.6	Transport	214.0	5.9

Source: Final Draft of National Survey of Research and Development 2008 and National Survey of Research snd Development 2006

5.1.7 Sources of Funds for R&D Expenditure

The main source of funds for R&D expenditure in 2008 was the institution's own funds, which amounted to 67.2% of the share, followed by funding from the federal government (21.5%), and state government funds, with 1.3% of the share. Other sources of funds within Malaysia accounted for 9.9%, while foreign funds only accounted for 0.1% of the share. It should be stressed, however, that GRIs' and IHLs' budget allocations are mostly from the federal government, and hence GRIs' and IHLs' own funds are, in actuality, federal government funds.

Figure 5.6: Sources of Funds, 2008



Source: Final Draft of National Survey of Research and Development 2008

5.2 R&D ACTIVITIES IN THE IHLs

As shown in **Figure 5.2**, expenditure on R&D in the IHLs has been increasing since 2000, and their expenditure on R&D has been greater than that of the GRIs since 2004. However, the amount of R&D expenditure by the IHLs is still small compared to the private sector, except for the anomaly in 2008.

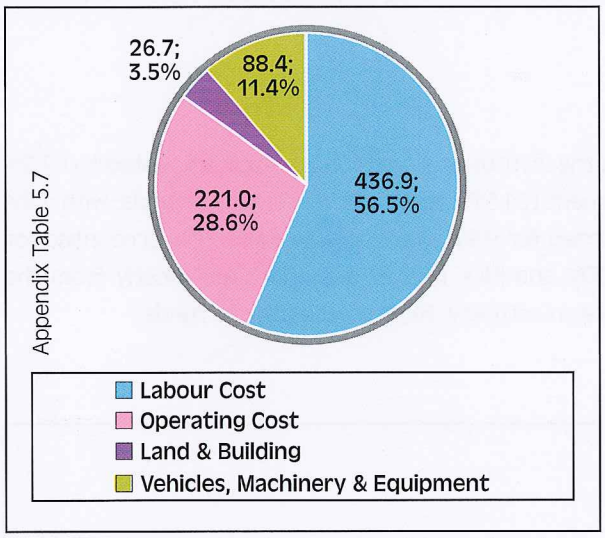
5.2.1 R&D in the IHLs: Expenditure by Type of Costs

Most of the R&D expenditure for the IHLs in 2008 was on the payment for labour, at RM 436.9 million, with a share of 56.5% of the total expenditure. Operating cost was RM 221.0 million, with a share of 28.6%, and expenditure on capital (Vehicles, Machinery and Equipment, and Land and Building) accounted for 14.9% of the share, amounting to RM 115.1 million **(Figure 5.7).**

5.2.2 R&D in the IHLs: Expenditure by Type of Research

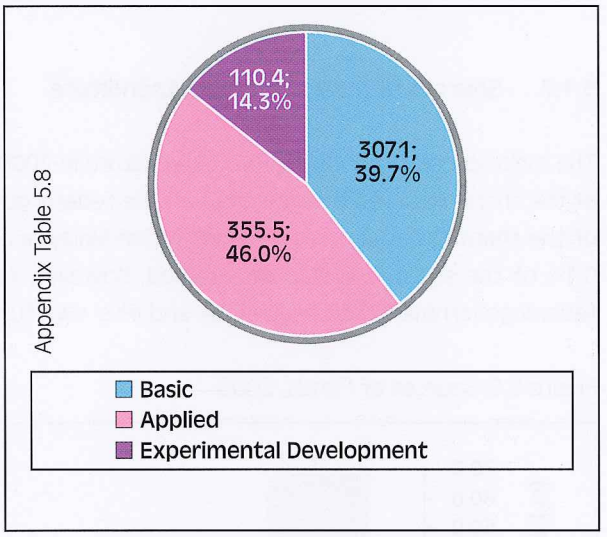
Figure 5.8 shows the expenditure by type of research for the IHLs. From the total of RM 477.6 million spent on basic research for Malaysia in 2008 **(Figure 5.5)**, RM 307.1 million of the expenditure came from the IHLs. The IHLs also spent RM 355.5 million on applied research, but only RM 110.4 million on experimental development research. This is unlike the private sector and the GRIs, where usually, a smaller portion of the expenditure is spent on basic research.

Figure 5.7: R&D in the IHLs: Expenditure (RM Million; Percentage) by Type of Costs, 2008



Source: Final Draft of National Survey of Research and Development 2008

Figure 5.8: R&D in the IHLs: Expenditure (RM Million; Percentage) by Type of Research, 2008

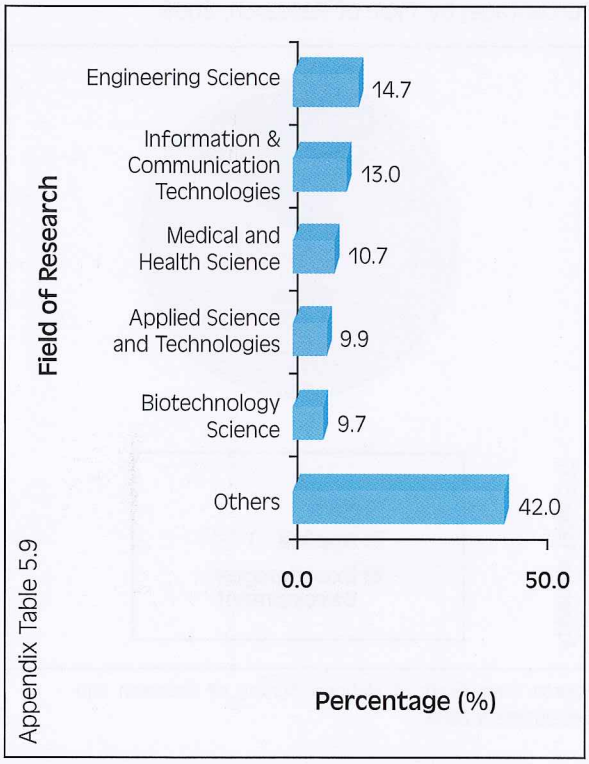


Source: Final Draft of National Survey of Research and Development 2008

5.2.3 R&D in the IHLs: Expenditure by FOR and SEO

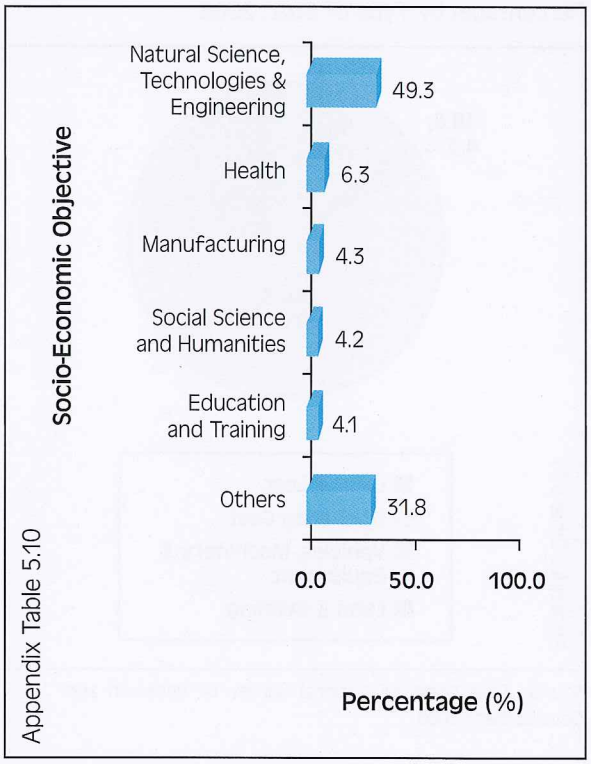
As shown in **Figure 5.9**, the top FOR for the IHLs in 2008 was Engineering Sciences, which accounted for 14.7% of the GERD share, followed by ICT, with 13.0%, and Medical and Health Sciences, with 10.7% of the share. The share of IHL R&D expenditure by FOR is not concentrated to a few fields, as the share for the "other" field is 42.0%, while the share for each of the top five fields was around 10-15%. On the other hand, Natural Sciences, Technologies, and Engineering (NSTE) was the main socio-economic objective for the IHLs in 2008, accounting for 49.3% of the GERD, followed by Health with 6.3%, and Manufacturing, with a 4.3% share **(Figure 5.10).** Unlike the expenditure for FOR, where the shares are relatively equal among the fields, for the SEO, the share is concentrated on NSTE.

Figure 5.9: R&D in the IHLs: Expenditure by FOR, 2008



Source: Final Draft of National Survey of Research and Development 2008

Figure 5.10: R&D in the IHLs: Expenditure by SEO, 2008



Source: Final Draft of National Survey of Research and Development 2008

5.3 R&D ACTIVITIES IN GRIs

Similar to the IHLs, the GERD for GRIs increased from 2006 to 2008. However, it is still smaller than the GERD for the private sector as well as the GERD for 2000 and 2002, at RM 417.5 million and RM 507.1 million respectively **(Figure 5.2).**

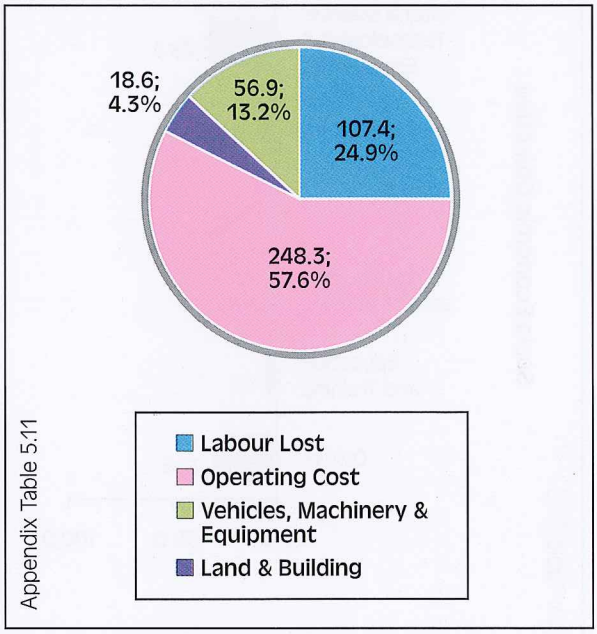
5.3.1 R&D in the GRIs: Expenditure by Type of Cost

The main expenditure for the GRIs in 2008 was on operating cost, at RM 248.3 million, accounting for 57.6% of the total R&D expenditure; this is followed by labour cost, at RM 107.4 million, accounting for 24.9% of the total share. R&D expenditure by the GRIs is unlike that of the IHLs, where the main expenditure is on the cost for labour **(Figure 5.11).**

5.3.2 R&D in the GRIs: Expenditure by Type of Research

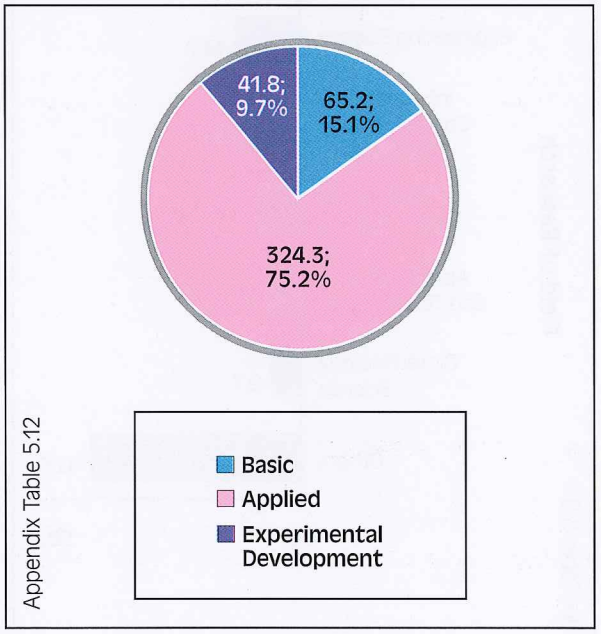
In 2008, RM 324.3 million was spent on applied research, accounting for 75.2% of the GRI's total expenditure on R&D, while RM 65.2 million was spent on basic research, accounting for 15.1% of the GERD by the GRIs. This is in contrast to the IHLs, where 39.7% of their R&D expenditure was on basic research **(Figure 5.12).**

Figure 5.11: R&D in the GRIs: Expenditure (RM Million; Percentage) by Type of Cost, 2008



Source: Final Draft of National Survey of Research and Development 2008

Figure 5.12: R&D in the GRIs: Expenditure (RM Million; Percentage) by Type of Research, 2008



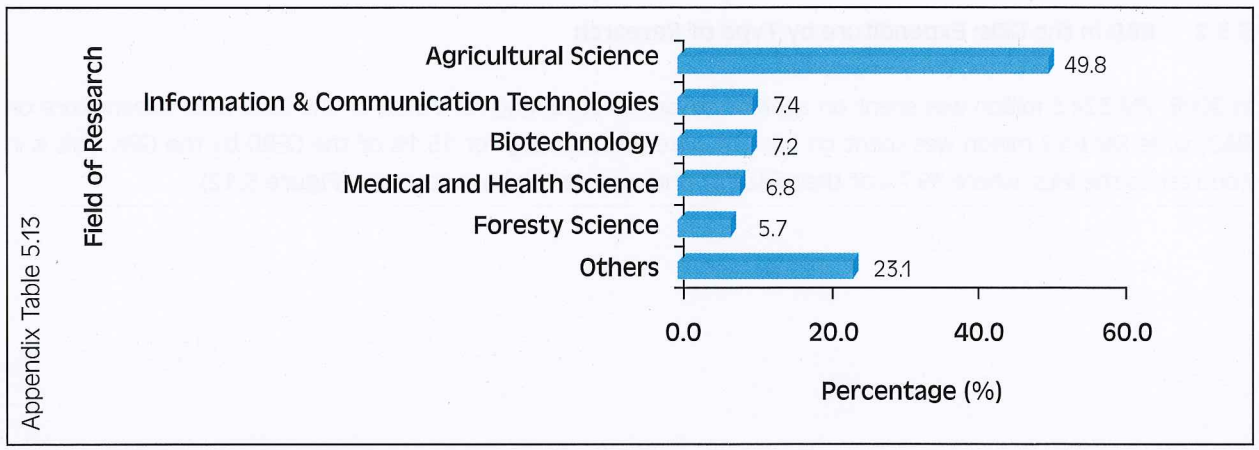
Source: Final Draft of National Survey of Research and Development 2008

5.3.3 R&D in the GRIs: Expenditure by FOR and SEO

In 2008, the field of Agricultural Sciences held 49.8% of R&D expenditure by FOR, followed by ICT with 7.4%, Biotechnology with 7.2%, Medical and Health Sciences with 6.8%, and Forestry Sciences with 5.7%. Expenditure in the top five fields amounted to 76.9% of total expenditure by FOR. For three consecutive years (2004, 2006 and 2008), Agricultural Science was the top FOR in terms of expenditure **(Figure 5.13).**

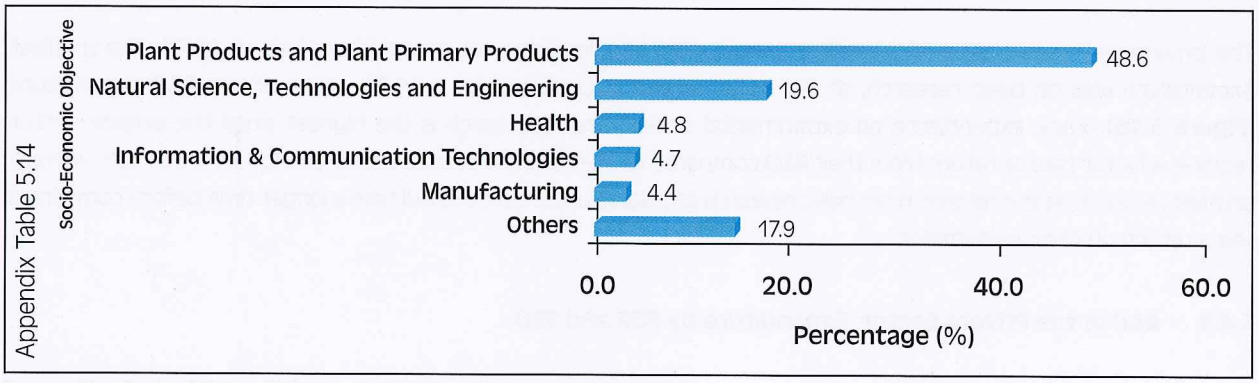
The top five SEO in 2008 were Plant Products and Plant Primary Products, with 48.6% of the share; followed by Natural Sciences, Technologies and Engineering, with 19.6%; Health, with 4.8%; Information and Communication Services (ICS), with 4.7%; and Manufacturing, with 4.4%. Expenditure in the top five SEO accounted for 82.1% of total expenditure by SEO. For two consecutive years (2006 and 2008), Natural Sciences, Technologies & Engineering and Plant Production and Plant Primary Products were the top expenditure according to SEO **(Figure 5.14).**

Figure 5.13: R&D in the GRIs: Expenditure by FOR, 2008



Source: Final Draft of National Survey of Research and Development 2008

Figure 5.14: R&D in the GRIs: Expenditure by SEO, 2008



Source: Final Draft of National Survey of Research and Development 2008

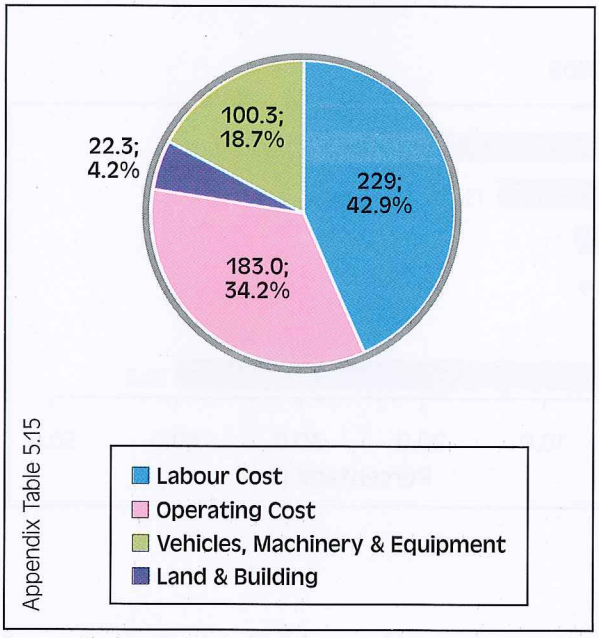
5.4 R&D ACTIVITIES IN THE PRIVATE SECTOR

With the exception of 2008, the private sector R&D expenditure has been increasing throughout the years, and the private sector has always had the lion's share of the country's GERD. It had a share of 57.9% of the total R&D expenditure in 2000, and peaked at 84.9% in 2006 **(Figure 5.2).**

5.4.1 R&D in the Private Sector: Expenditure by Type of Cost

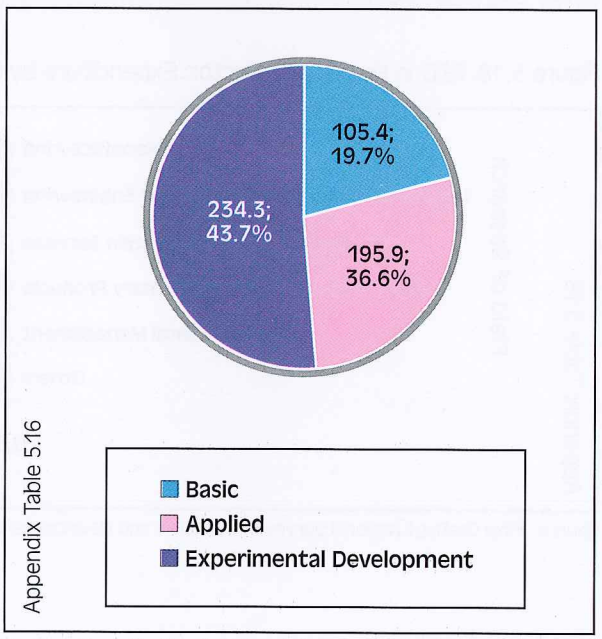
Similar to the IHLs, the main cost for the private sector was labour, at RM 229.9 million, a share of 42.9%, followed by operating cost at RM 183.0 million, with a share of 34.2%. Capital expenditure, which includes expenditure for land and building, vehicles, machinery, and equipment, amounts to RM 122.6 million, with a share of 22.9% **(Figure 5.15).**

Figure 5.15: R&D in the Private Sector: Expenditure (RM Million; Percentage) by Type of Cost, 2008



Source: Final Draft of National Survey of Research and Development 2008

Figure 5.16: R&D in the Private Sector: Expenditure (RM Million; Percentage) by Type of Research, 2008



Source: Final Draft of National Survey of Research and Development 2008

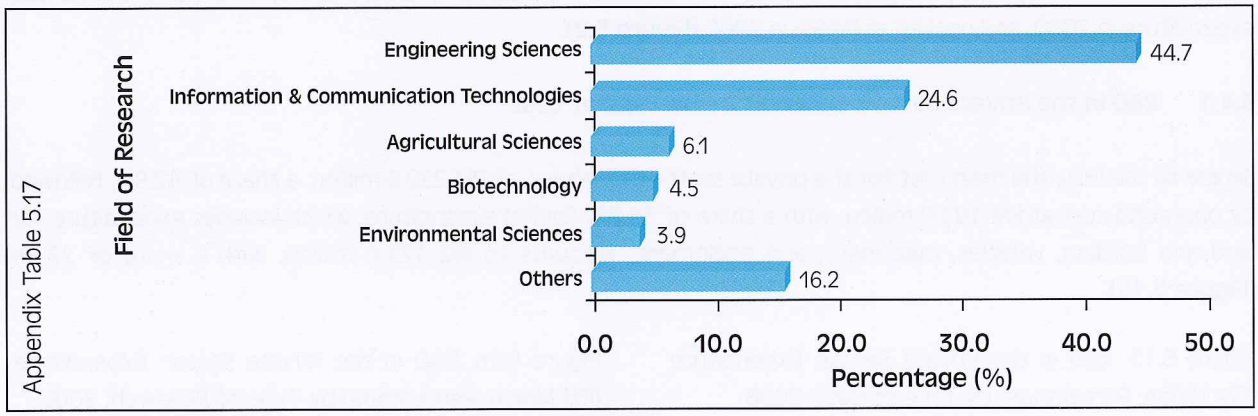
5.4.2 R&D in the Private Sector: Expenditure by Type of Research

The private sector spent RM 234.3 million on experimental development research, a share of 43.7%. The smallest expenditure was on basic research, at RM 105.4 million, accounting for a 19.7% share of the R&D expenditure **(Figure 5.16).** Their expenditure on experimental development research is the highest since the private sector requires a faster rate of return from their R&D compared to the IHLs. The private sector cannot afford to concentrate on basic research as the returns from basic research are highly uncertain, and will take a longer time before companies see a return on their investment.

5.4.3 R&D in the Private Sector: Expenditure by FOR and SEO

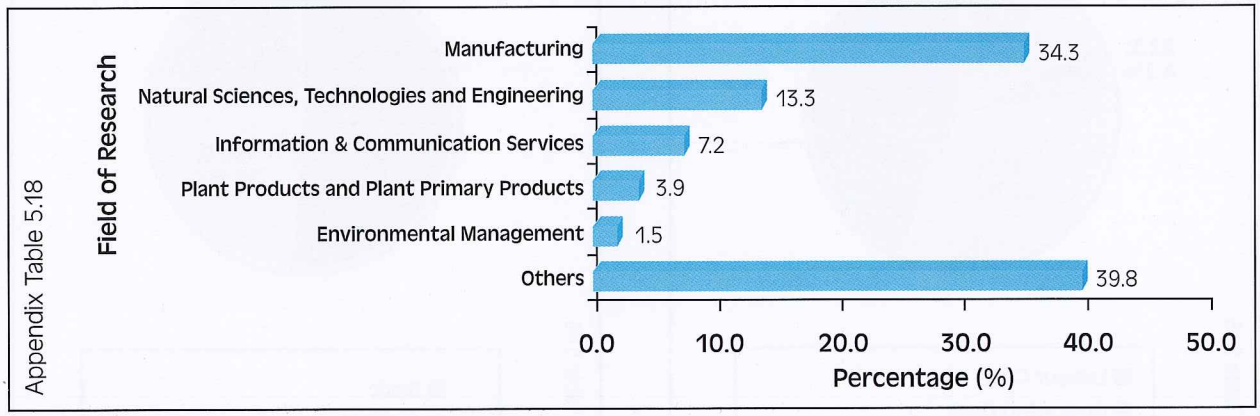
In the private sector in 2008, the largest proportion of the R&D expenditure by FOR was held by Engineering Sciences (44.7%), followed by ICT (24.6%), and Agricultural Sciences (6.1%) **(Figure 5.17).** On the other hand, the top five expenditures by SEO for the private sector in 2008 were Manufacturing, with a 34.3% share, followed by NSTE (13.3%), ICS (7.2%), Plant Production and Primary Products (3.9%), and Environmental Management (1.5%).

Figure 5.17: R&D in the Private Sector: Expenditure by FOR, 2008



Source: Final Draft of National Survey of Research and Development 2008

Figure 5.18: R&D in the Private Sector: Expenditure by SEO, 2008



Source: Final Draft of National Survey of Research and Development 2008

5.5 INTERNATIONAL COMPARISON

Malaysia's GERD/GDP ratio of 0.24% in 2008 is small. It is similar to countries such as Azerbaijan and Ethiopia. The top three countries in terms of research intensity are Israel, Sweden and South Korea with a GERD/GDP ratio of 4.74%, 3.68% and 3.47%, respectively. These countries' GERD/ GDP ratio is 20 times greater than Malaysia's. In fact, Malaysia's research intensity in 2008 is smaller than that of many developing Asian countries such as China, India, and Pakistan, at 1.49%, 0.80%, and 0.67%, respectively, and even more so when compared to many East Asian developed countries such as Singapore, South Korea, and Japan, which have GERD/GDP ratios of 2.61%, 3.47% and 3.45%, respectively **(Table 5.3)**. This is in contrast to Malaysia's average GERD/GDP ratio of 0.65% for the period 2002-2006, which placed Malaysia at the same level as India and Pakistan. However, it is important to stress that making a comparison at this stage is not very meaningful, given the fact that the GERD/GDP ratio of 0.24 is most likely the result of the poor response rates to the National R&D 2008 survey in the public and private sectors, and hence may not reflect the country's true R&D expenditure.

Table 5.3: GERD/GDP Ratio (%)

Country Name	R&D per GDP (%)	Country Name	R&D per GDP (%)	Country Name	R&D per GDP (%)
Israel	4.74	China	1.49	Poland	0.57
Sweeden	3.68	Slovenia	1.48	Moldova	0.55
South Korea	3.47	Ireland	1.34	Romania	0.54
Finland	3.47	Spain	1.28	Argentina	0.51
Japan	3.45	New Zealand	1.26	Greece	0.50
Iceland	2.81	Portugal	1.19	Bulgaria	0.48
United States	2.67	Montenegro	1.18	Slovak Rep.	0.46
Singapore	2.61	Russian	1.12	Cyprus	0.45
Denmark	2.57	Estonia	1.12	Cuba	0.44
Germany	2.55	Belarus	0.97	Uganda	0.41
Austria	2.52	Hungary	0.97	Serbia	0.34
France	2.10	Croatia	0.93	Kyrgyz Rep.	0.25
Canada	2.03	Ukraine	0.87	**Malaysia**	**0.24**
Belgium	1.91	Lithuania	0.83	Egypt	0.23
U. Kingdom	1.84	India	0.80	Mongolia	0.23
Netherlands	1.75	Turkey	0.71	Armenia	0.21
Luxembourg	1.69	Pakistan	0.67	Kazakhstan	0.21
Norway	1.67	Latvia	0.63	Azerbaijan	0.18
Czech Rep	1.59	Malta	0.60	Ethiopia	0.17

Source: UNESCO Institute of Statistics
Note: R&D per GDP are for 2007, except for Malaysia where the ratio is for 2008.

5.6 CONCLUSION

Malaysia's R&D activities in 2008 dropped precipitously compared to 2006. The GERD dropped by 52.8%, from RM 3.6 billion in 2006 to RM 1.7 billion in 2008. The GERD/GDP ratio, a measure of research intensity, dropped from the average of 0.65% in the six year period of 2002-2006 to 0.24% in 2008. However, it should be stressed that the sharp drop in GERD and GERD/GDP may be due to the decrease in declared R&D expenditure, instead of actual R&D activities and expenditure by the public and private sectors. The response rate for the NSRD 2008 especially for the private sector, was poor; hence the R&D data reported may not reflect the true state of R&D activities in Malaysia. Other possible reasons for the drop may be the fact that the increase in oil prices and the global economic uncertainty due to the financial crisis in 2008 forced firms to reduce their R&D expenditure in order to reduce their overall cost to be competitive.

CHAPTER 6
- INNOVATION IN THE PRIVATE SECTOR

CHAPTER 6

INNOVATION IN THE PRIVATE SECTOR

6.0 INTRODUCTION

It is widely accepted that innovation plays a central role in economic development. Innovation has perhaps become the most important source of competitive advantage in advanced economies, as innovation can improve the productivity of nations and increase their rate of economic growth. Through innovation, firms can improve their performance by increasing demand and by reducing costs. Innovation resulting in a new product or process can also be a source of market advantage for the firm, and increase its competitiveness. Innovations that result in changes in organisational methods can also improve the efficiency and quality of their operations, and hence increase demand or reduce costs[1]. Hence, it is important to know where we stand with regard to innovation so that steps can be taken to improve our competitive advantage.

This chapter discusses innovation in the private sector in Malaysia, and is based primarily on the data from the Fifth National Survey of Innovation (NSI-5) as described in the *National Survey of Innovation 2005-2008 Report.* In the section on International Comparisons, the discussion on the Global Competitiveness Index is based on the data and information from the Global Competiveness Report 2010-2011 (GCR 2010-2011) and the Malaysia Productivity Corporation (MPC), while the discussion on Malaysia's ranking in the World Competitiveness Yearbook 2010 (WCY 2010) is based on the data obtained from the WCY 2010 and Malaysia in the World Competitiveness Yearbook 2010.

This chapter is organised into five sections. The first section discusses innovation in the private sector, which includes both the manufacturing and the services sector. The second section discusses innovation in the manufacturing sector, while the third section discusses innovation in the services sector. The fourth section discusses where Malaysia stands with regard to innovation when compared with International countries. The conclusion is presented in the final section.

6.1 OVERVIEW OF INNOVATION IN THE PRIVATE SECTOR

This section presents an overview of innovation in the Private Sector, which includes the manufacturing sector as well as the services sector. It is important to note that this is the first time in which the National Survey of Innovation has included the services sector in its survey. This move is pertinent and timely, given the fact that Malaysia's services sector was the largest contributor to the GDP in 2009, accounting for 57.6% of Malaysia's GDP[2]. This is also in line with the recommendations of the Oslo Manual 2005, which provides guidelines for the study and survey of innovations in the business enterprise sector, and which also, for the first time, has included the services sector in its conception of business enterprise.

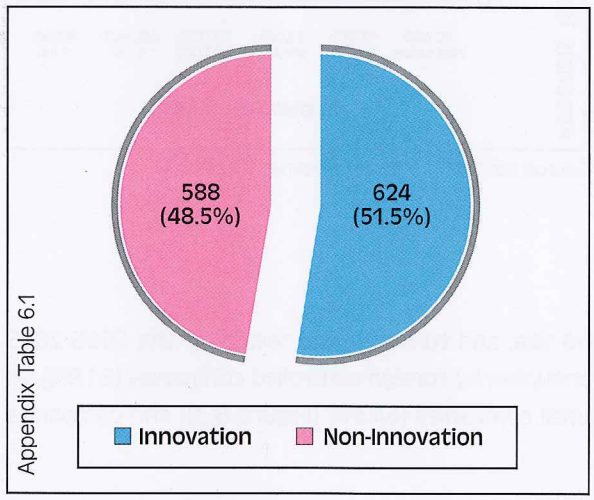
[1] Oslo Manual (2005): Guidelines for collecting and interpreting Innovation Data.

[2] Economic Report 2010/2011, Ministry of Finance Malaysia

6.1.1 Level of Innovation

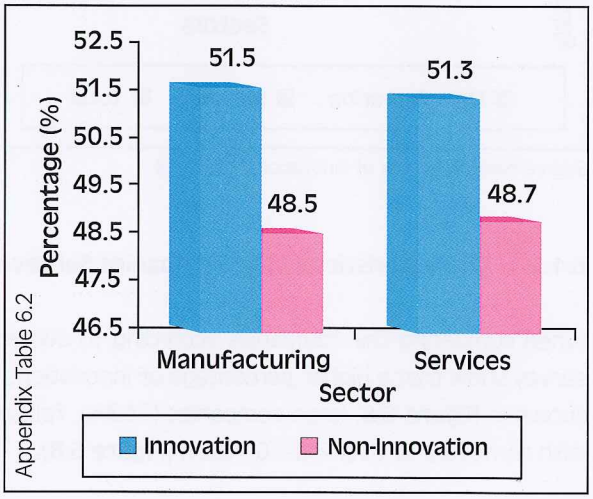
As stated in the Oslo Manual, one of the most important indicators of innovation in a country is the number or percentage of companies that carry out innovation. In the NSI-5 (2005-2008 Survey), 624 companies (51.5%) surveyed reported that they carried out innovation activities while 48.5% or 588 companies were non-innovating **(Figure 6.1)**. The percentage of innovating and non-innovating companies is quite similar for both sectors, where 51.5% of the firms in the Manufacturing Sector reported that they carried out innovations; while 51.3% of those in the Services Sector reported doing so **(Figure 6.2).** Another important indicator is the number of innovations carried out. During the period 2005-2008, the majority (31.7%) of the companies carried out 1 or 2 innovations, while 23.6% carried out 3-4 innovations. 8.0% of the companies carried out more than 10 innovations **(Figure 6.3)**.

Figure 6.1: Percentage and Number of Innovative Companies, 2005-2008



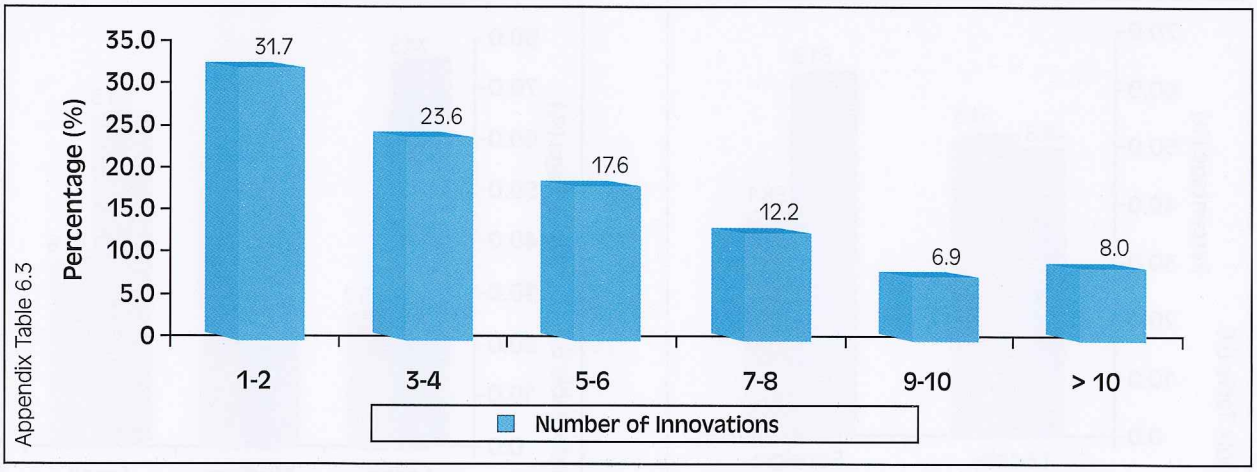
Source: National Survey of Innovation 2005-2008

Figure 6.2: Innovation in the Manufacturing and Services Sector, 2005-2008



Source: National Survey of Innovation 2005-2008

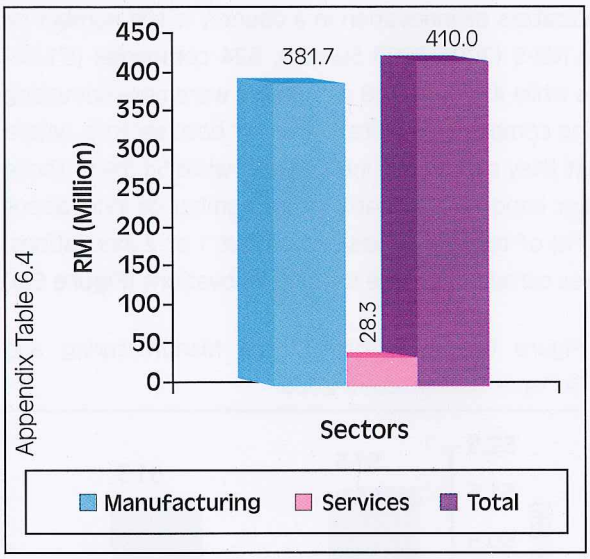
Figure 6.3: Number of Innovations, 2005- 2008



Source: National Survey of Innovation 2005-2008

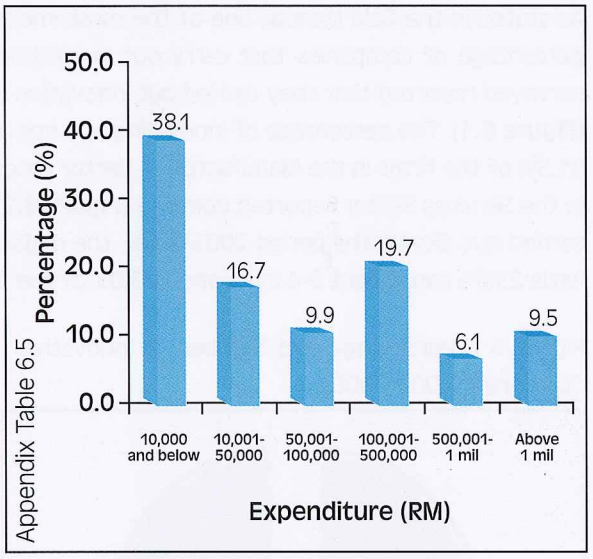
In terms of the expenditure on innovation activities, which is another important indicator of innovation, a total of almost RM 410.0 million was spent on innovation activities from 2005-2008; RM 381.7 million in the manufacturing sector, and RM 28.3 million in the services sector **(Figure 6.4)**. The majority of the companies (38.1%) spent RM 10,000 and below, while 19.7% spent between RM 100,001 to RM 500,000. 9.5% of the companies spent more than RM 1.0 million on innovation activities **(Figure 6.5)**.

Figure 6.4: Expenditure of Innovating Companies by Sector, 2005-2008



Source: National Survey of Innovation 2005-2008

Figure 6.5: Percentage of Innovating Companies by Expenditure, 2005-2008

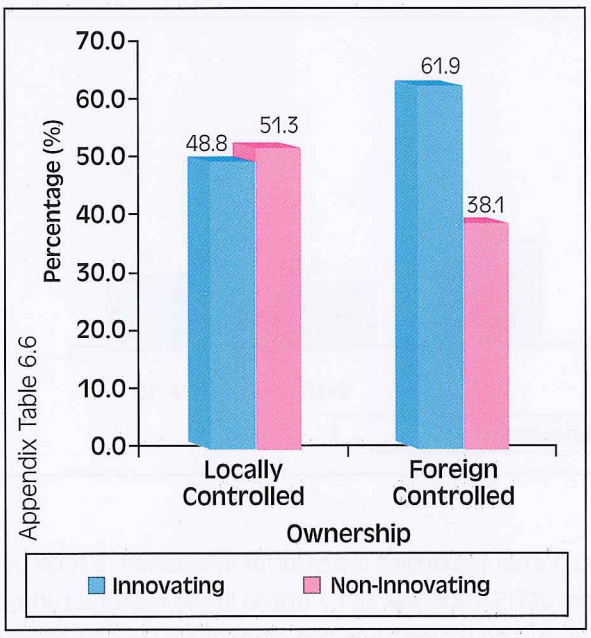


Source: National Survey of Innovation 2005-2008

6.1.2 Characteristics of the Companies Surveyed

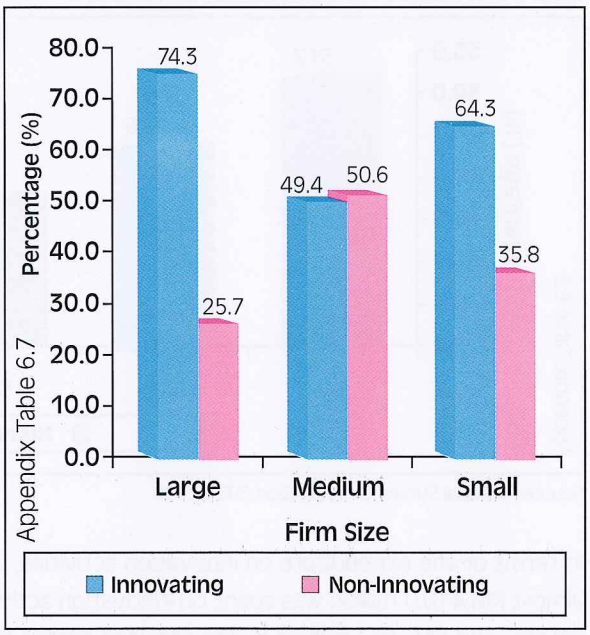
When comparing the companies according to ownership, firm size, and turnover, the results of the 2005-2008 survey show that a higher percentage of innovations were conducted by foreign controlled companies (61.9%), as shown in **Figure 6.6**, large companies (74.3%), followed by small companies (64.3%) **(Figure 6.7)**, and companies with turnovers of over RM 1.0 million **(Figure 6.8).**

Figure 6.6: Local and Foreign Ownership Companies, 2005-2008



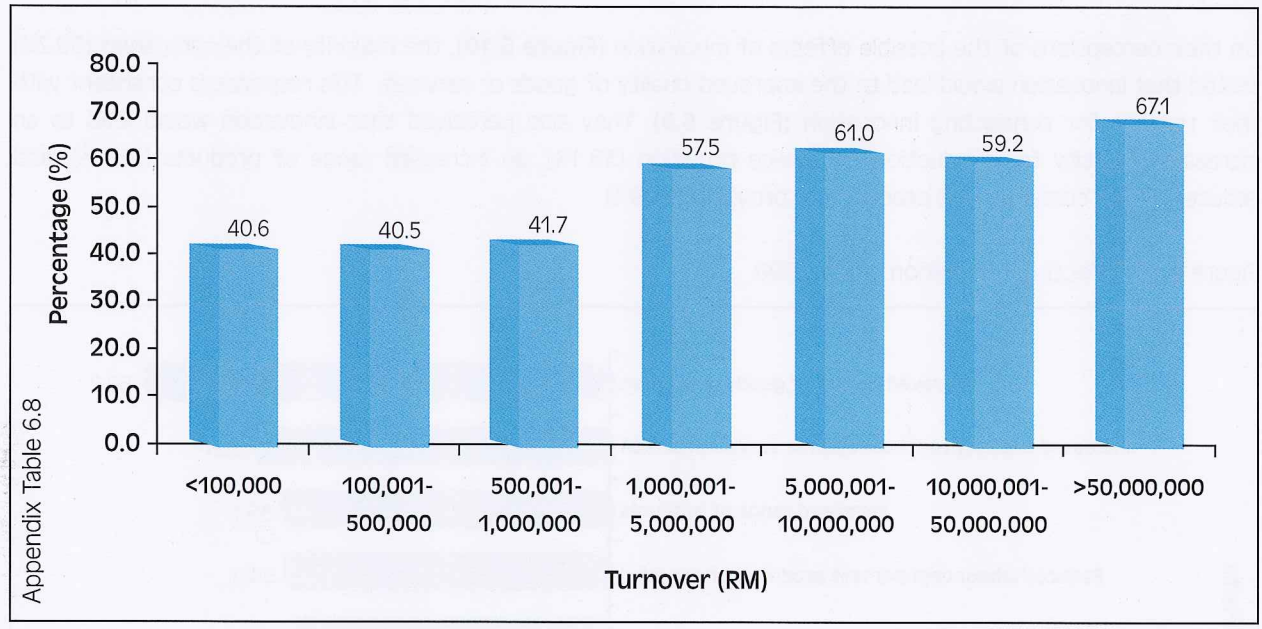
Source: National Survey of Innovation 2005-2008

Figure 6.7: Innovating and Non-Innovating Companies According to Firm Size, 2005-2008



Source: National Survey of Innovation 2005-2008

Figure 6.8: Percentage of Innovating Firms by Turnover, 2005-2008

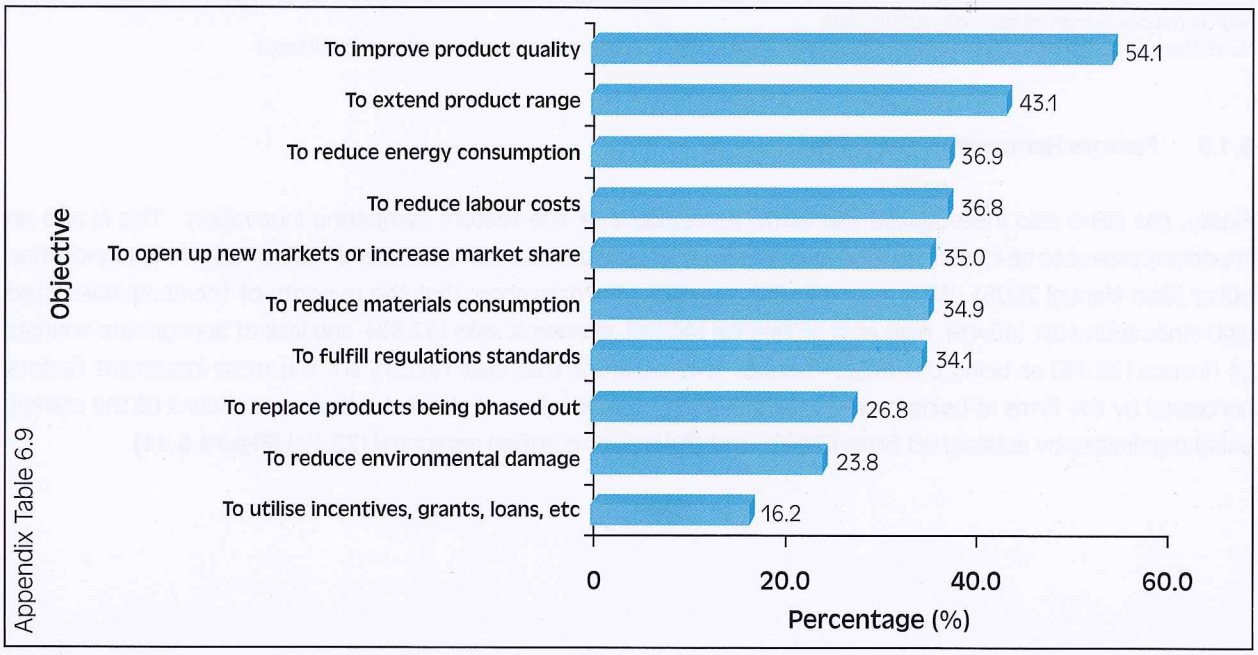


Source: National Survey of Innovation 2005-2008

6.1.3 Objectives of Innovation Activities

The NSI-5 also asked the companies to list the reasons, in order of importance, as to why they undertook innovation activities. According to the Oslo Manual 2005, identifying the companies' motives for innovating and their importance is helpful when we would like to examine the forces that drive innovation activity, such as competition and opportunities for entering new markets. To this question, the respondents stated that the most important reasons for undertaking innovation are to improve product quality and to extend their product range. This is followed by the need to reduce energy consumption and labour costs, and to open up new markets or to increase market share **(Figure 6.9)**.

Figure 6.9: Objectives of Innovation Activities, 2005-2008



Source: National Survey of Innovation 2005-2008
Note: The graph shows the percentage of respondents that rated the above reasons as being of high importance.

6.1.4 Effects of Innovation

On their perceptions of the possible effects of innovation **(Figure 6.10)**, the majority of the companies (50.2%) stated that innovation would lead to the improved quality of goods or services. This response is consistent with their reasons for conducting innovation **(Figure 6.9)**. They also perceived that innovation would lead to an increased capacity for production or service provision (38.1%), an increased range of products (35.1%), and reduced labour costs per unit produced or provided (34.9%).

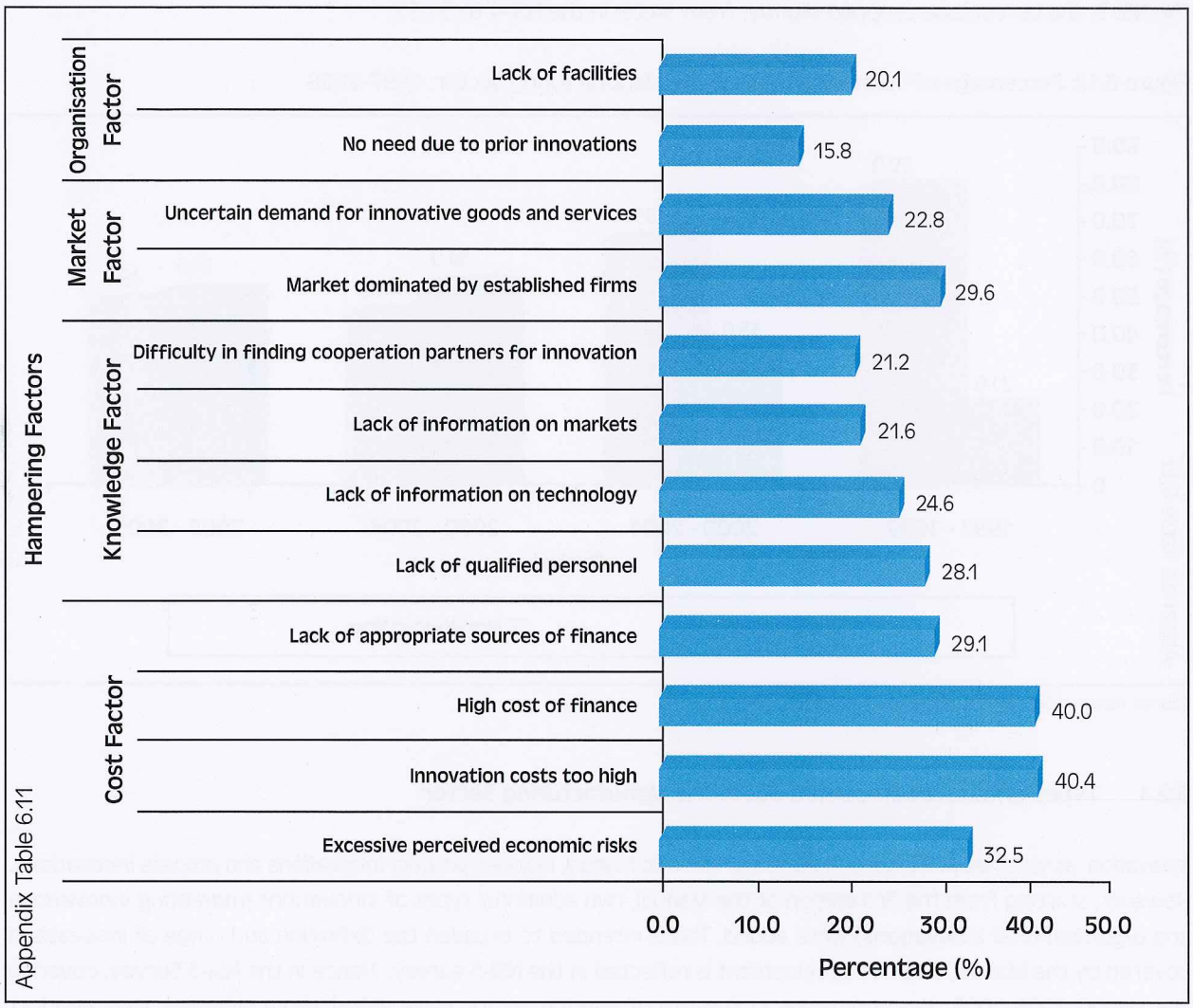
Figure 6.10: Effects of Innovation, 2005-2008

Source: National Survey of Innovation 2005-2008
Note: The graph shows the percentage of respondents that rated the above reasons as being of high importance.

6.1.5 Factors Hampering Innovation

Finally, the NSI-5 also investigated the firm's perceptions of the factors hampering innovation. This is also an important aspect to be investigated because it can provide information on a number of issues relevant for innovation policy (Oslo Manual 2005). With regard to this question, the data show that the majority of the companies cited high innovation cost (40.4%), high cost of finance (40.0%), economic risks (32.5%), and lack of appropriate sources of finance (29.1%) as being the major factors. It is apparent that cost factors are the most important factors perceived by the firms as being barriers to innovation. This is followed closely by their perceptions of the market being dominated by established firms (29.6%) and the lack of qualified personnel (28.1%) **(Figure 6.11)**.

Figure 6.11: Factors Hampering Innovation, 2005-2008



Source: National Survey of Innovation 2005-2008

6.2 INNOVATION IN THE MANUFACTURING SECTOR

The manufacturing sector is an important contributor to Malaysia's economic growth and development. In 2009, the manufacturing sector accounted for 26.6% of Malaysia's GDP[3]. It was also the leading sector, in terms of contribution to total exports, and accounted for 72.2% share of Malaysia's total exports[4] in 2009. Although the manufacturing sector experienced a decrease in growth in 2008 and 2009 due to the economic downturn, it posted a sterling performance in the first six months of 2010, surging at 16.4%[5]. The challenge for the Malaysian manufacturing sector in the next few years will be how to maintain its competitiveness in the local and global trade environment that is becoming increasingly competitive. To meet this challenge, the manufacturing sector needs to plan for and carry out innovation, which has been identified as being essential to competitiveness. This section presents a summary of innovation in Malaysia's manufacturing sector, describing the percentage of companies carrying out innovation, the types of innovation carried out, the support received, as well as the output of innovation.

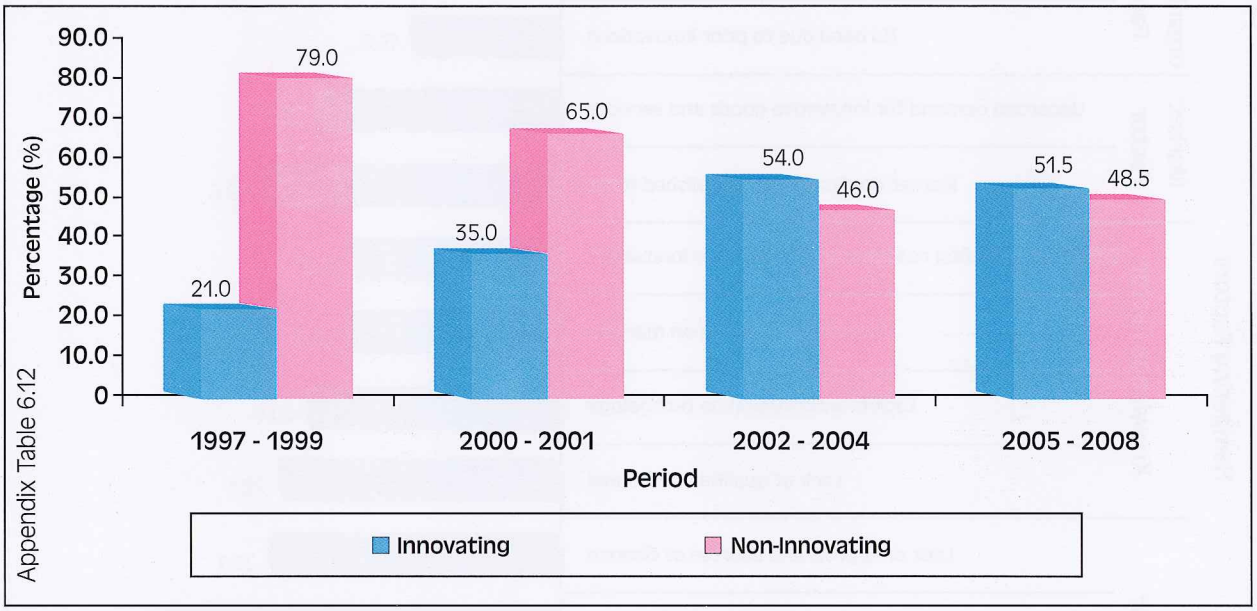
[3] Economic Report 2010/2011, Ministry of Finance Malaysia

[4] MATRADE, Media Conference on Malaysia's Trade Performance March 2009 by the Minister of International Trade and Industry. http://www.matrade.gov.my/cms/content.jsp?id=com.tms.cms.article.Article_hide_MTS_Mar_09

[5] Economic Report 2010/2011, Ministry of Finance Malaysia

As shown in **Figure 6.12**, the percentage of innovating firms has increased steadily in the last decade. However, in the NSI-5, the percentage dropped slightly, from 54.0% in the NSI-4 to 51.5%.

Figure 6.12: Percentage of Innovating Firms in the Manufacturing Sector, 1997-2008



Source: National Survey of Innovation 2005-2008

6.2.1 Types of Innovation carried out in the Manufacturing Sector

Innovation, as specified in the second edition of the Oslo Manual, included *product innovations* and *process innovations.* However, starting from the 3rd edition of the Manual, two additional types of innovations *(marketing innovations* and *organisational innovations)* were added. This is intended to broaden the definition and range of innovations covered by the Manual, and this development is reflected in the NSI-5 survey. Hence in the NSI-5 Survey, covering the period 2005-2008, the companies in the manufacturing sector were asked about whether they conduct *marketing* and *organisational innovations,* in addition to *product* and *process innovations*, as has been done in previous surveys.

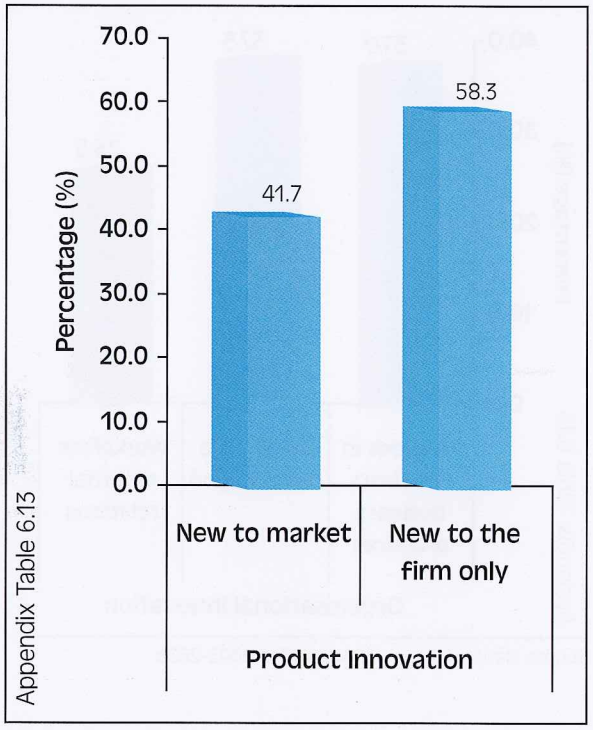
6.2.1.1 Product Innovation

In terms of product innovation, which, according to the Oslo Manual (2005) is "the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses" (pg 48), the majority of the companies (58.3%) reported introducing products that are new to the firm, while only 41.7% introduced products new to the market **(Figure 6.13)**.

6.2.1.2 Process Innovation

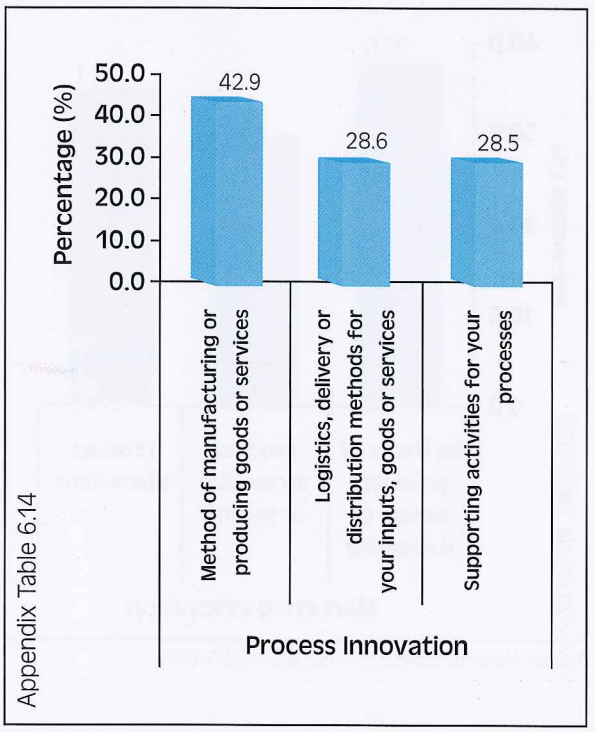
In terms of *process innovation*, which is defined by the Oslo Manual (2005) as the implementation of a new or significantly improved production or delivery method, including significant changes in techniques, equipment and/or software, the majority of the companies (42.9%), innovated in terms of improved methods of manufacturing and producing goods **(Figure 6.14)**. Only 28.6% innovated in terms of logistics, delivery, or distribution methods for their inputs, goods, and services, while 28.5% innovated in terms of supporting activities for their processes.

Figure 6.13: Product Innovation in the Manufacturing Sector, 2005-2008



Source: National Survey of Innovation 2005-2008

Figure 6.14: Process Innovation in the Manufacturing Sector, 2005-2008



Source: National Survey of Innovation 2005-2008

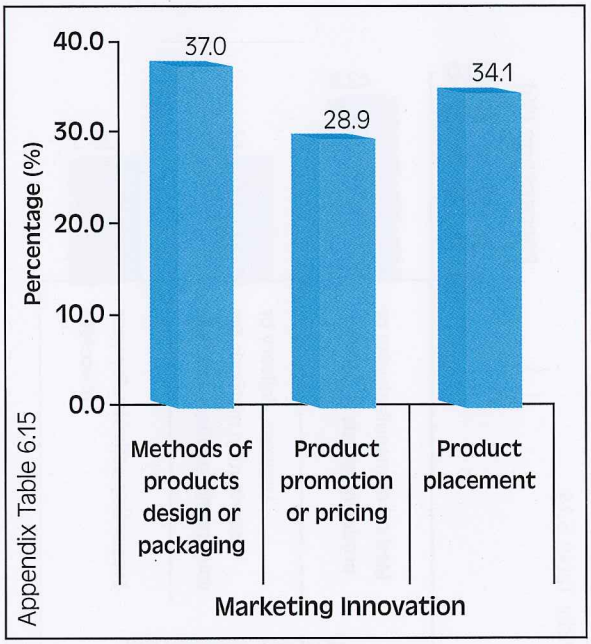
6.2.1.3 Marketing Innovation

The innovating companies surveyed also carried out *marketing innovation*, which is defined by the Oslo Manual (2005) as "the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion, or pricing" (pg. 49). The NSI-5 Survey found that the highest occurrence of innovation **(Figure 6.15)** was in the area of product packaging (37.0% of the firms) followed by product placement (34.1% of the firms) and product promotion or pricing (28.9% of the firms).

6.2.1.4 Organisational Innovation

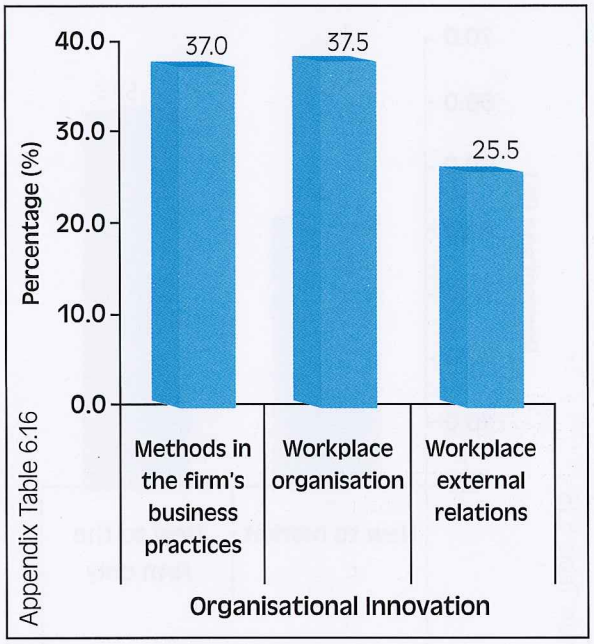
Finally, the companies were also asked whether they conducted *organisational innovation*, which the Oslo Manual (2005) defines as "the implementation of a new organisational method in the firm's business practices, workplace organisation, or external relations". As shown in **Figure 6.16**, the majority of the firms carried out innovations in the workplace (37.5%) and methods in the firm's business practices (37.0%). Only 25.5% of the companies reported conducting innovations pertaining to external relations.

Figure 6.15: Marketing Innovation in the Manufacturing Sector, 2005-2008



Source: National Survey of Innovation 2005-2008

Figure 6.16: Organisational Innovation in the Manufacturing Sector, 2005-2008

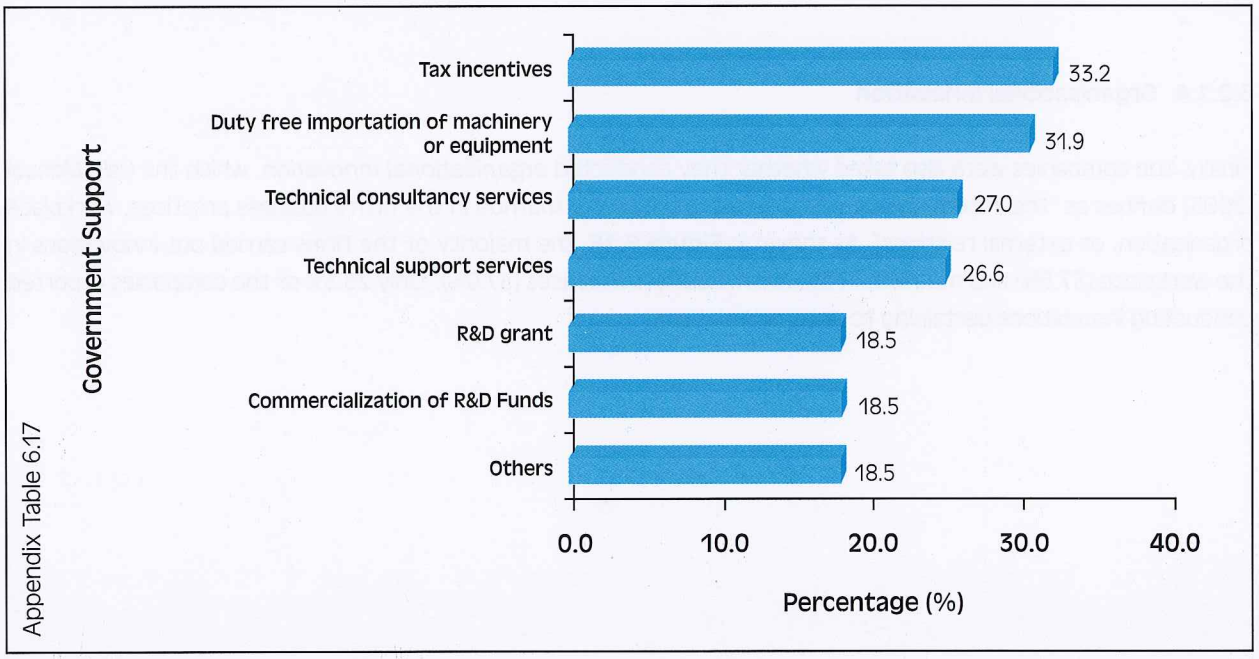


Source: National Survey of Innovation 2005-2008

6.2.2 Government Support for Innovation

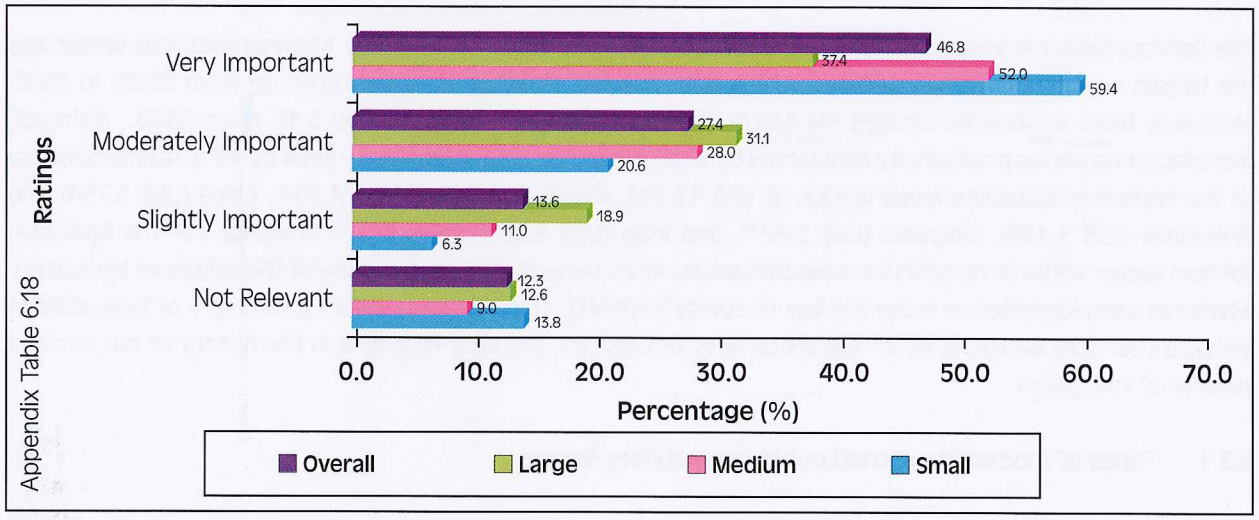
The manufacturing companies were also surveyed on the extent of government support that they received. As shown in **Figure 6.17**, tax incentives (33.2%), followed by duty-free importation of machinery or equipment (31.9%) were reported as being the most utilized government support. Technical consultancy services (27.0%) and technical support services (26.6%) come in as a close second. The majority of the companies, regardless of size, rated government support as being very important for innovation activities **(Figure 6.18)**.

Figure 6.17: Types of Government Support for Innovation, Manufacturing Sector, 2005-2008



Source: National Survey of Innovation 2005-2008
Note: The graph shows the percentage of respondents that received the above government support.

Figure 6.18: Usefulness of Government Support and Assistance in Manufacturing Sector, 2005-2008



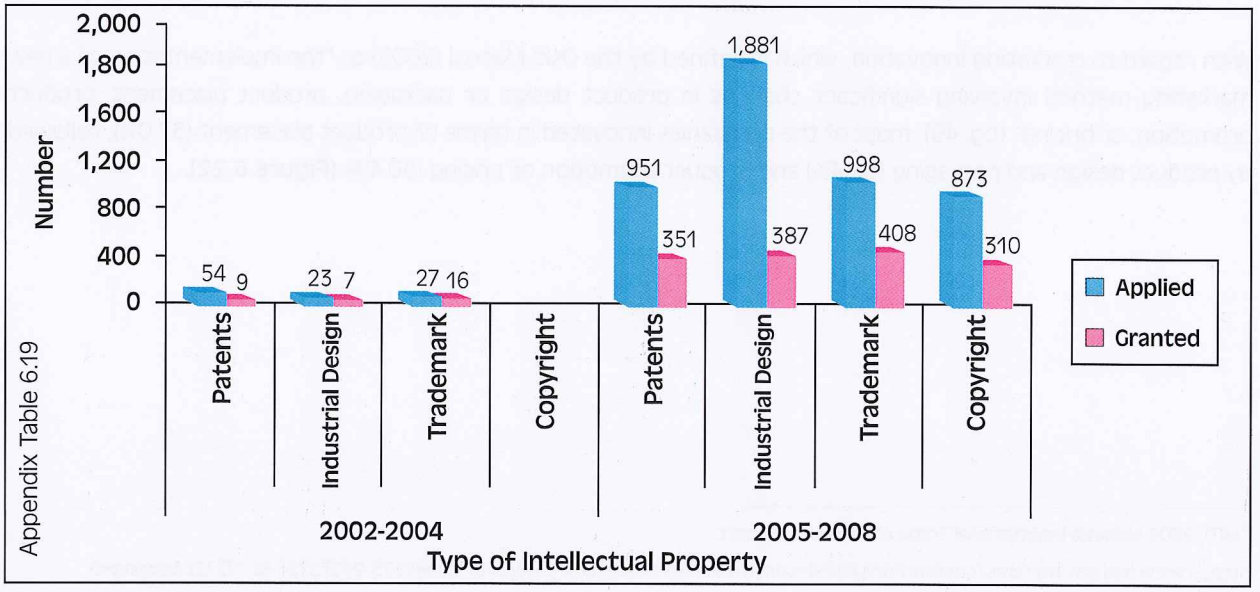
Source: National Survey of Innovation 2005-2008

6.2.3 Intellectual Property

The impact of innovation can be measured by the number of patents, industrial designs, trademarks, and copyrights applied for and granted, although the Oslo Manual (2005) provides a cautionary note that not all the results of innovations are patented. Be that as it may, statistics on the applications for various types of intellectual property and the number granted are somewhat useful as an indicator of innovation activities. This section describes the applications for Intellectual Property as well as the number granted in the Manufacturing Sector.

As shown in **Figure 6.19**, the number of intellectual property applied for and granted have increased tremendously in the period 2005-2008 when compared to the period 2002-2004. The number of patents, trademarks, and copyrights applied for increased manyfold when compared to the 2002-2004 period, from 54 to 951 patents, and from 27 to 998 trademarks. However, the most dramatic increase in applications was for industrial design, which rose dramatically from 23 in 2002-2004 to 1,881 in the period 2005-2008. No data were available for the applications for copyrights in the period 2002-2004, but in 2005-2008, there were 873 applications for copyrights. However, as **Figure 6.19** shows, despite the large number of intellectual property filed, the number that was actually granted was far less.

Figure 6.19: Intellectual Property Applied for and Granted in the Manufacturing Sector, 2002-2008



Source: National Survey of Innovation 2005-2008

6.3 INNOVATION IN THE SERVICES SECTOR

The Services Sector is a very strong and important sector in the nation's economy. Malaysia's services sector was the largest contributor to the GDP in 2009, accounting for 57.6% of Malaysia's GDP, up from 55.2% in 2008. Malaysia's trade in services totalled RM 195.0 billion in 2009, decreasing only by 3.4% from 2008. Although manufacturing sector productivity contracted by 8.6%, services sector productivity grew by 1.7%, maintaining one of the highest productivity levels in Asia, at US$ 12,793, ahead of Thailand (US$ 4,596), China (US$ 3,734), the Philippines (US$ 3,192), Indonesia (US$ 2,471), and India (US$ 2,051)[6]. Hence, the challenge for the Malaysian services sector will be to maintain its competitiveness, which necessitates the fostering of the culture of innovation, which has been identified as being the key to competitiveness. This section presents a summary of innovation in Malaysia's services sector, in which the sector was included for the very first time in the history of our national surveys of innovation.

6.3.1 Types of Innovation carried out in the Services Sector

As in the manufacturing sector, the companies in the services sector were asked whether they conducted product, process, marketing, and organisational innovation from 2005-2008, as recommended by the 3rd Edition of the Oslo Manual (2005).

6.3.1.1 Product Innovation

In terms of *product innovation*, which, according to the Oslo Manual (2005) is "the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses" (pg 48), 54.7% of the firms innovated in terms of products new to the firm, while 45.3% introduced products that are new to the market **(Figure 6.20)**.

6.3.1.2 Process Innovation

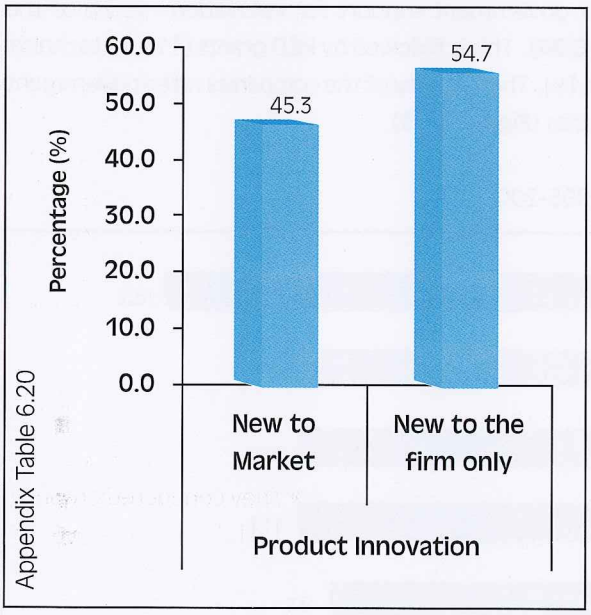
In terms of *process innovation*, which is defined by the Oslo Manual (2005) as the implementation of a new or significantly improved production or delivery method, including significant changes in techniques, equipment and/or software, 36.0% of the companies innovated in terms of the method of manufacturing or producing goods and services, 34.8% in terms of supporting activities for their process, while 29.2% in terms of logistics, delivery, or distribution methods for their inputs, goods, or services. **(Figure 6.21).**

6.3.1.3 Marketing Innovation

With regard to marketing innovation, which is defined by the Oslo Manual (2005) as "the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion, or pricing" (pg. 49), most of the companies innovated in terms of product placement (37.0%), followed by product design and packaging (32.4%) and product promotion of pricing (30.4%) **(Figure 6.22)**.

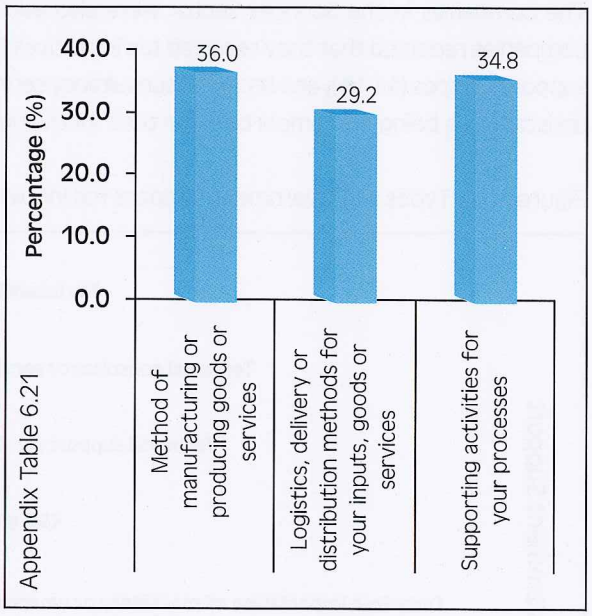
[6] MITI, 2009 Malaysia International Trade and Industry Report.
http://www.miti.gov.my/cms/contentPrint.jsp?id=com.tms.cms.article.Article_5d0fe1bf-c0a81573-272f272f-8e19372c&paging=0

Figure 6.20: Product Innovation in the Services Sector, 2005-2008



Source: National Survey of Innovation 2005-2008

Figure 6.21: Process Innovation in the Services Sector, 2005-2008

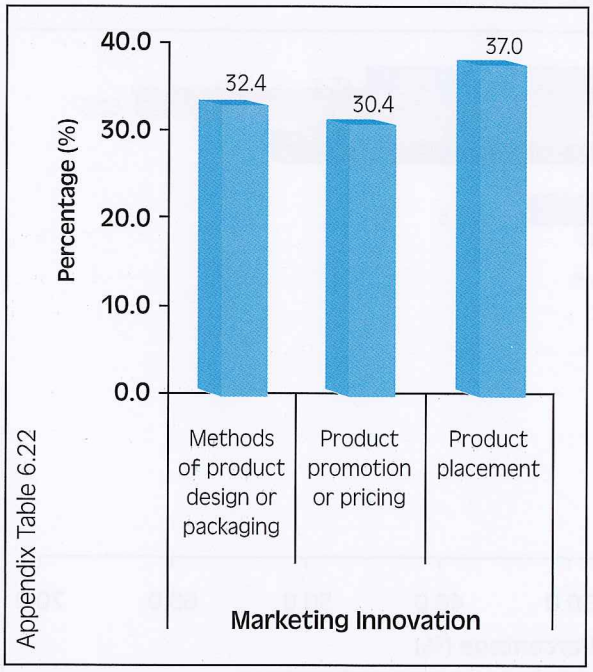


Source: National Survey of Innovation 2005-2008

6.3.1.4 Organisational Innovation

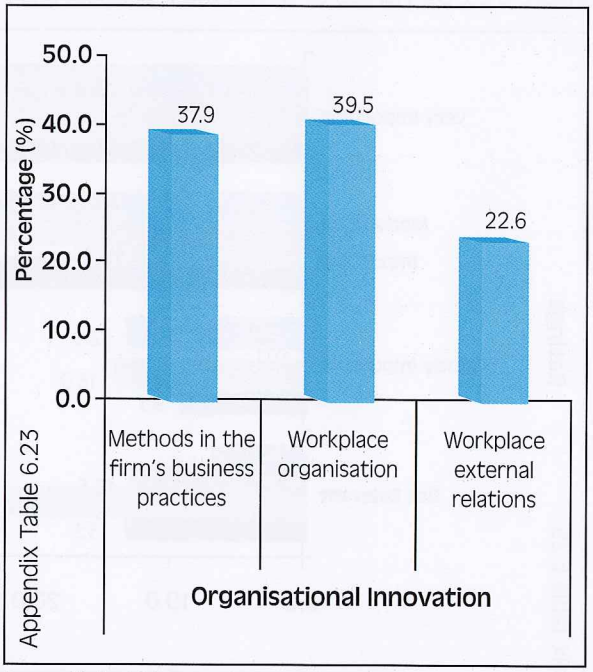
Finally, in terms of organisational innovation, which the Oslo Manual (2005) defines as "the implementation of a new organisational method in the firm's business practices, workplace organisation, or external relations", 39.5% of the companies conducted innovations in their workplace organisations, 37.9% introduced new methods in their firm's business practices, while 22.6% innovated in terms of their workplace relations **(Figure 6.23)**.

Figure 6.22: Marketing Innovation in the Services Sector, 2005-2008



Source: National Survey of Innovation 2005-2008

Figure 6.23: Organisational Innovation in the Services Sector, 2005-2008

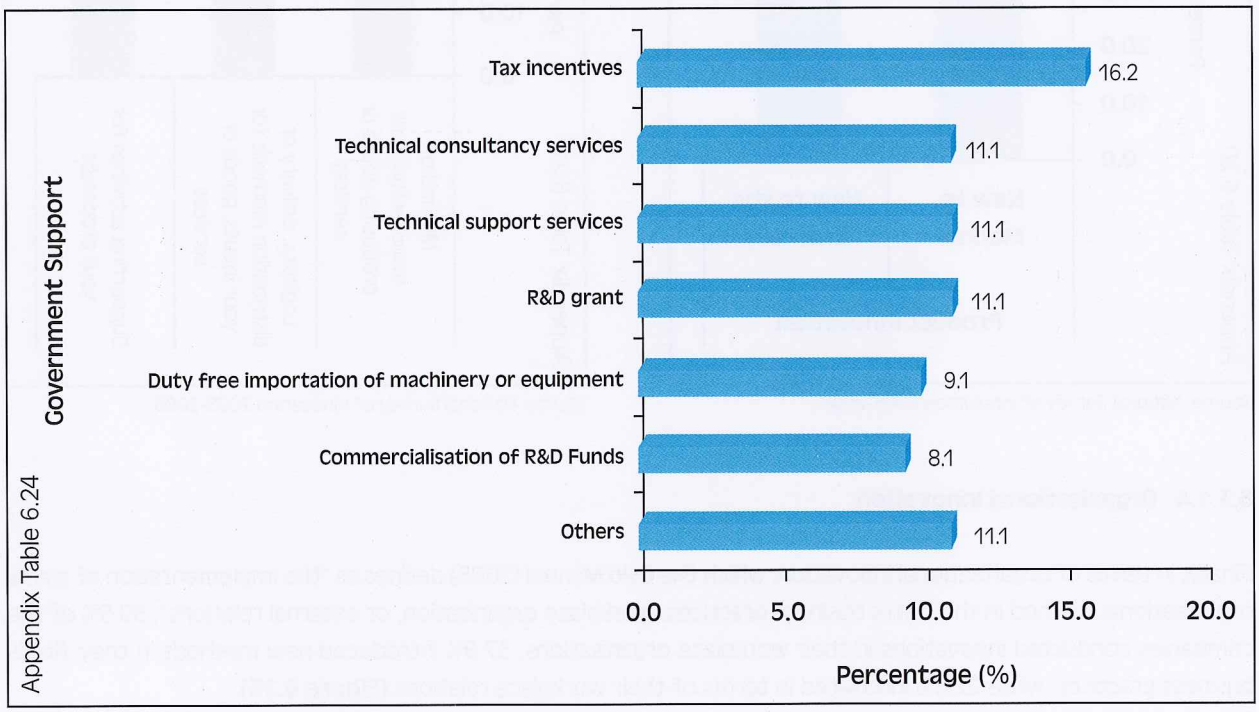


Source: National Survey of Innovation 2005-2008

6.3.2 Government Support for Innovation

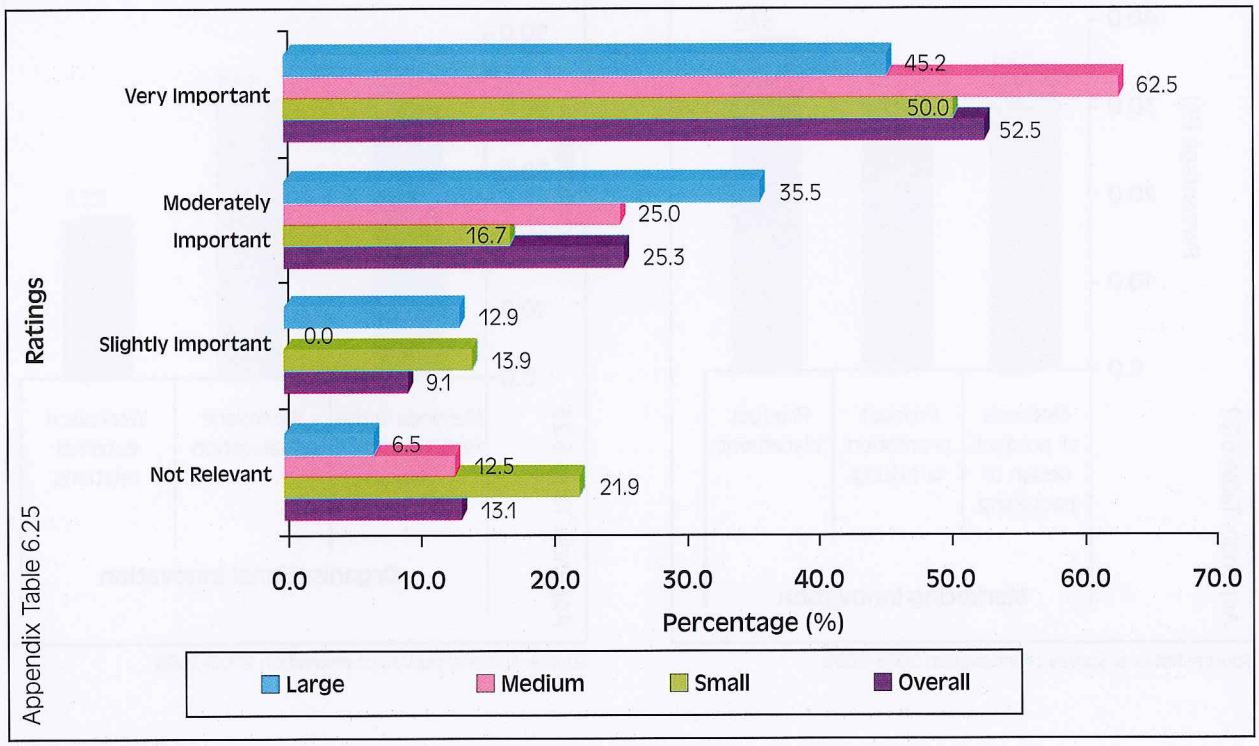
The companies in the Services Sector were also asked about government support for innovation. 16.2% of the companies reported that they received tax incentives **(Figure 6.24)**. This is followed by R&D grants (11.1%), technical support services (11.1%), and technical consultancy services (11.1%). The majority of the companies rated government assistance as being very important for their innovation activities **(Figure 6.25)**.

Figure 6.24: Types of Government Support for Innovation, 2005-2008



Source: National Survey of Innovation 2005-2008
Note: The graph shows the percentage of respondents that received the above government support.

Figure 6.25: Usefulness of Government Support and Assistance, 2005-2008



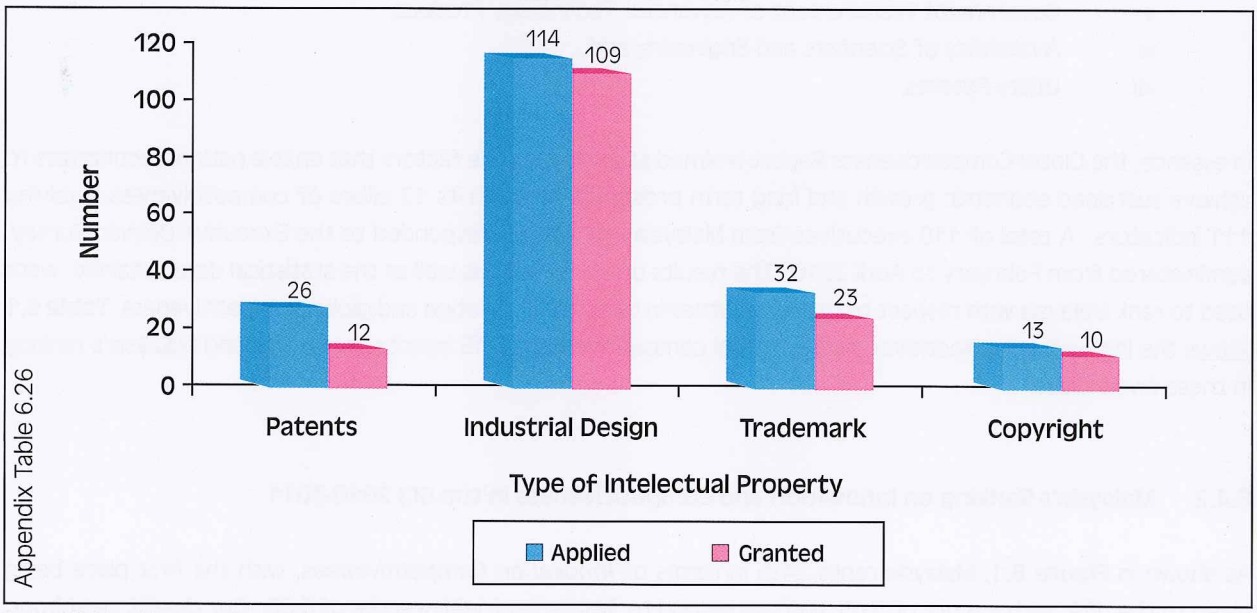
Source: National Survey of Innovation 2005-2008

6.3.3 Intellectual Property

As mentioned in **Section 6.2.3**, the impact of innovation can be measured by the number of patents, industrial designs, trademarks, and copyrights applied for and granted, although the Oslo Manual (2005) provides a cautionary note that not all the results of innovations are patented. This section describes the applications for Intellectual Property as well as the number granted in the Services Sector.

In the period 2005-2008, the intellectual property that received the most applications was industrial design (114), followed by trademarks (32), patents (26), and copyrights (13). As would be expected, the number of intellectual property granted was less than that applied for.

Figure 6.26: Intellectual Property Applied for and Granted in the Services Sector, 2005-2008



Source: National Survey of Innovation 2005-2008

6.4 INTERNATIONAL COMPARISONS

This section compares Malaysia's performance on innovation and competitiveness with that of other countries through the following indices:

i. The Global Competitiveness Index
ii. The World Competitiveness Yearbook

This will be followed by a discussion on the difference in ratings that Malaysia received on innovation in the above two indices and on world competitiveness.

6.4.1 The Global Competitiveness Index

According to the Global Competitiveness Report 2010 – 2011, published by the World Economic Forum (WEF), the Global Competitiveness Index (GCI) is a highly comprehensive index for measuring *national competitiveness, defined as the set of institutions, policies, and factors that determine the level of productivity of a country,* which, in turn, sets the sustainable level of prosperity that can be earned by an economy. In addition, the level of productivity also determines the *rates of return* obtained by investments (physical, human, and technological) in an economy. The Report asserts that because the rates of return are "the fundamental drivers of the growth rates of the economy, a more competitive economy is one that is likely to grow faster in the medium to long run" (pg. 4).

The Global Competitiveness Index for 2010-2011 (GCI 2010-2011) was calculated based on publicly available, statistical data from 139 countries as well as the annual Executive Opinion Survey, conducted by the WEF. The calculation of the index is based on 30.0% statistical data (encompassing 32 criteria) and 70.0% survey data (encompassing 79 criteria), and is based on 12 pillars: institutions, infrastructure, macroeconomic environment, health and primary education, higher education and training, goods market efficiency, labour market efficiency, financial market development, technological readiness, market size, business sophistication, and innovation, which, in turn, comprises the following seven elements :

i. Capacity for Innovation;
ii. Quality of Scientific Research Institutions;
iii. Company Spending on R&D;
iv. University – Industry Collaboration in R&D;
v. Government Procurement of Advanced Technology Product;
vi. Availability of Scientists and Engineers; and
vii. Utility Patents.

In essence, the Global Competitiveness Report is aimed at examining the factors that enable national economies to achieve sustained economic growth and long term prosperity through its 12 pillars of competitiveness involving 111 indicators. A total of 110 executives from Malaysian companies responded to the Executive Opinion Survey, administered from February to April 2010. The results of the survey, as well as the statistical data obtained, were used to rank Malaysia with respect to other countries in terms of innovation and global competitiveness. **Table 6.1** shows the innovation competitiveness and global competitiveness of 15 selected countries and Malaysia's ranking in these two indices.

6.4.2 Malaysia's Ranking on Innovation and Competitiveness in the GCI 2010-2011

As shown in **Figure 6.1**, Malaysia ranks 24th in terms of *Innovation Competitiveness,* with the first place being given to the USA, with a score of 5.65, and the second to Switzerland, with a score of 5.60. Our closest neighbour, Singapore, is ranked 9th, while Indonesia and Thailand are ranked 36th and 52nd, respectively. Malaysia's score on innovation competitiveness, together with her scores on the 11 other pillars, led her to be ranked 26th on global competiveness, two points below the GCI 2009-2010 ranking. On global competitiveness as discussed in the GCI Report 2010-2011, Switzerland is ranked first, followed by Sweden, Singapore, the United States, Germany, and Japan. Saudi Arabia, which was ranked 28th in the GCI 2009-2010, is now ranked 21st, while China is ranked 27th, Thailand 38th, and Indonesia 44th, up ten notches from 2009.

Table 6.1: Ranking of Selected Countries According to the GCI 2010-2011 and the GCI 2009-2010

No.	Country / Economy	IC		GCI 2010-2011		GCI 2009-2010	
		Rank	Score	Rank	Score	Rank	Score
1	Switzerland	2	5.60	1	5.63	1	5.60
2	Sweden	5	5.45	2	5.56	4	5.51
3	Singapore	9	5.04	3	5.48	3	5.55
4	United States	1	5.65	4	5.43	2	5.59
5	Germany	8	5.19	5	5.39	7	5.37
6	Japan	4	5.52	6	5.37	8	5.37
7	Canada	21	4.41	10	5.30	9	5.33
8	United Kingdom	11	4.87	12	5.25	13	5.19
9	Australia	14	4.65	16	5.11	15	5.15
10	Saudi Arabia	28	3.92	21	4.95	28	4.75
11	**Malaysia**	**24**	**4.10**	**26**	**4.88**	**24**	**4.87**
12	China	26	3.92	27	4.84	29	4.74
13	Brunei Darussalam	69	3.08	28	4.75	32	4.64
14	Thailand	52	3.34	38	4.51	25	4.84
15	Indonesia	36	3.71	44	4.43	54	4.26

Source: GCI Report 2010 – 2011
Note: GCI : Global Competitiveness Index; IC: Innovation Competitiveness

According to the Malaysia Productivity Corporation (MPC)[7], Malaysia's ranking on global competitiveness, at the 26th position, is essentially the result of unfavourable assessment in the Executive Survey Report, particularly in terms of the respondents' perceptions of the business costs of terrorism, where we are ranked 103rd (down from 97th) and reliability of police services (50th, down from 48th). We also did not fare very well in terms of the business costs of crime and violence as perceived by the respondents (ranked 93rd) as well as organised crime (ranked 77th). The other factors that affected Malaysia's competitiveness performance are technological readiness, health and primary education, as well as labour market efficiency. With regard to technological readiness, Malaysia was assessed rather unfavourably in terms of *internet users* (at 57.6 per 100 population, ranked 39th), *broadband internet subscribers* (at 6.1 per 100 population, ranked 62nd) and *FDI and technology transfer*, ranked 16th. In terms of education, Malaysia is perceived to be weak in the primary education enrollment rate of 96.1%, ranked at 47th (compared to countries such as Japan, New Zealand, United Kingdom, and Canada which had close to 100.0% enrollment in primary education), and the secondary school enrollment rate of 68.2%, ranked 99th.

Hence, these were the weaknesses (among other factors and criteria) that caused our ranking to fall to the 26th position. However, despite the areas of weaknesses as assessed by the GCR 2010-2011 Malaysia is ranked in the 1st place in the Legal Rights Index, together with Hong Kong and Singapore. We are also ranked 4th on our Strength of Investor Protection. These high rankings are due to the reforms that Malaysia introduced in recent years, including the establishment of Intellectual Property Courts, the passing of an Anti-Competition Law, and a prospective review of the Arbitration Act and the Legal Profession Act[8]. The overall quality of education in Malaysia has also improved, such as the quality of mathematics and science education, ranked 31st (GCR2009-2010: 34th), internet access in schools, ranked 36th (GCR2009-2010: 40th), and quality of primary education, ranked 30th (GCR2009-2010: 31st).

[7]Performance of Malaysia in the Global Competitiveness Report 2010-2011, a publication of the MPC

[8]Global Competitiveness Report (GCR) 2010-2011: The Way Forward by Dato' Sri Mustapa Muhamed
http://www.mpc.gov.my/home/index.php?kod1=k&kod2=news&item=000030&sstr_lang=en&t=3

The GCR 2010-2011 also stresses that Malaysia does have a well-developed financial market (ranked 7th) and an efficient goods market (ranked 27th). Malaysia does relatively well in the more complex categories, namely business sophistication (25th) and innovation (24th), which, according to the report, matter the most for advanced economies, as this augurs well for the future. Finally, the GCR 2010-2011 also states that Malaysia remains the most competitive country among the 29 countries in the Efficiency-driven stage (Stage 2) of development, being ranked 8th among 22 Asia Pacific countries ahead of China, Brunei, Thailand, Indonesia, India, Vietnam, and the Philippines **(Table 6.2)** and second out of 8 countries in ASEAN **(Table 6.3)**.

Table 6.2: The GCI 2010–2011 Rankings for Asia-Pacific Countries

Country / Economy	GCI 2010-2011		Country / Economy	GCI 2010-2011	
	Rank	Score		Rank	Score
Singapore	1	5.48	Indonesia	12	4.43
Japan	2	5.37	India	13	4.33
Hong Kong SAR	3	5.27	Vietnam	14	4.27
Taiwan, China	4	5.21	Sri Lanka	15	4.25
Australia	5	5.11	Philippines	16	3.96
Korea Rep.	6	4.93	Mongolia	17	3.75
New Zealand	7	4.92	Bangladesh	18	3.64
Malaysia	**8**	**4.88**	Cambodia	19	3.63
China	9	4.84	Kygryz Republic	20	3.49
Brunei Darussalam	10	4.75	Pakistan	21	3.48
Thailand	11	4.51	Nepal	22	3.34

Source: Performance of Malaysia in the Global Competitiveness Report 2010-2011, MPC

Table 6.3: The GCI 2010–2011 Rankings for ASEAN Countries

Country / Economy	GCI 2010-2011	
	Rank	Score
Singapore	1	5.48
Malaysia	**2**	**4.88**
Brunei Darussalam	3	4.75
Thailand	4	4.51
Indonesia	5	4.43
Vietnam	6	4.27
Philippines	7	3.96
Cambodia	8	3.63

Source: Performance of Malaysia in the Global Competitiveness Report 2010-2011, MPC

6.4.3 The World Competitiveness Yearbook

The IMD World Competitiveness Yearbook (WCY) often considered as being a worldwide reference point on the competitiveness of nations ranks and analyzes a nation's economy in terms of how it manages the totality of its resources and competencies to increase the prosperity of its population. Published since 1989, it purports to be one of the most renowned studies comparing the competitiveness of 57 economies (for 2010) on the basis of 392 criteria, two thirds of which are addressed by hard data, and one-third of which are answered by the IMD's executive opinion survey. The WCY divides the national environment into four main factors, each with five sub-factors:

1) **Economic Performance**
(Domestic economy, international trade, international investment, employment, and prices)

2) **Government Efficiency**
(Public finance, fiscal policy, institutional framework, business legislation, and societal framework)

3) **Business Efficiency**
(Productivity, labor market, finance, management practices, attitudes and values)

4) **Infrastructure**
(Basic infrastructure, technological infrastructure, scientific infrastructure, health and environment, and education)

The 20 sub-factors above comprise a total of 392 criteria that are then used to calculate the overall competitiveness ranking.

6.4.4 Malaysia's Ranking on Innovative Capacity in the WCY 2010

One of the criteria in the World Competitiveness Yearbook is *Innovative Capacity,* where respondents are asked to judge the innovative capacity of firms in generating new products and processes. As shown in **Table 6.4**, Malaysia was rated highly on this item, and was ranked 12th, behind countries such as Israel (ranked 1st), the USA (ranked 2nd), Switzerland, Taiwan, Germany, Sweden, Japan, and Korea. Indeed, on this index, Singapore is ranked 18th, with a score of 6.48. The favourable assessment that Malaysia received on Innovative Capacity is in line with the Malaysian government's emphasis on innovation and creativity to achieve growth, and the declaration of 2010 as the Innovation Year.

Table 6.4: Malaysia's Ranking on Innovative Capacity in the WCY 2010

Country / Economy	Rank	Score	Country / Economy	Rank	Score
Israel	1	8.22	Korea	11	6.92
USA	2	8.02	**Malaysia**	**12**	**6.89**
Switzerland	3	7.91	Ireland	13	6.77
Austria	4	7.25	United Kingdom	14	6.72
Taiwan	5	7.16	Netherlands	15	6.64
Germany	6	7.16	Finland	16	6.61
Sweden	7	7.07	Canada	17	6.56
Japan	8	7.02	Singapore	18	6.48
Denmark	9	7.00	Norway	19	6.64
Iceland	10	6.94	France	20	6.38

Source: World Competitiveness Yearbook 2010

6.4.5 Malaysia's Ranking on Competitiveness in the WCY 2010

Malaysia's ranking on the Innovative capacity of firms, as well as her ranking on the other 392 criteria has led her to be ranked 10th in the WCY 2010 (up eight places from her 18th position in 2009), behind Singapore (ranked 1st), Hong Kong (2nd), the USA (3rd), Switzerland, Australia, Sweden, Canada, Taiwan, and Norway. The USA has lost its leading position as being the most competitive nation in the WCY. Indeed, in the WCR 2010, Asian economies such as Singapore, Hong Kong, Taiwan, and Malaysia, are seen as being among the most competitive economies **(Table 6.5).**

Table 6.5: The WCY Scoreboard 2010 Overall Ranking

Countries	2010		2009	
	Index	Rank	Index	Rank
Singapore	100.000	1	95.740	3
Hong Kong	99.357	2	98.146	2
USA	99.091	3	100.000	1
Switzerland	96.126	4	94.163	4
Australia	92.172	5	88.934	7
Sweden	90.893	6	90.520	6
Canada	90.459	7	88.708	8
Taiwan	90.441	8	75.390	23
Norway	89.987	9	86.604	11
Malaysia	**87.228**	**10**	**77.162**	**18**
Israel	80.327	17	73.425	24
China Mainland	80.182	18	76.595	20
United Kingdom	76.808	22	76.069	21
Thailand	73.233	26	70.762	26
Japan	72.093	27	78.242	17

Sources: WCY 2009, WCY 2010

Malaysia's ranking on the WCY is based on her performance on the four competitiveness factors, on which she has made remarkable improvements when compared to the previous years. For example, Malaysia has been ranked 9th on government efficiency, up ten places from her 19th position in 2009; 4th on business efficiency, up 9 notches from her 13th position in 2009; 8th on economic performance, from the 9th position in 2009; and infrastructure factors, 25th (up from the 26th position in 2009) **(Table 6.6)**.

Table 6.6: Malaysia's Competitiveness Ranking on the WCY, 2006-2010

		WCY 2010 (n=58 economies)	WCY 2009 (n=57 economies)	WCY 2008 (n=55 economies)	WCY 2007 (n=55 economies)	WCY 2006 (n=53 economies)
Overall Scoreboard	Rank	10	18	19	23	22
	Index	87.228	77.162	73.199	74.091	70.080
Economic Performance	Rank	8	9	8	12	10
Government Efficiency	Rank	9	19	19	21	19
Business Efficiency	Rank	4	13	14	15	19
Infrastructure	Rank	25	26	25	26	27

Sources: WCY 2009, WCY 2010

Malaysia's performance on the four competitiveness factors has also led her to be ranked 5th among the Asia Pacific countries **(Table 6.7)**, surpassing China, New Zealand, Korea, Thailand, Japan, India, and Indonesia; and second in ASEAN **(Table 6.8)**.

Table 6.7: The World Competitiveness Scoreboard 2010 (12 selected Asia-Pacific countries)

Countries	2010		2009		2008	
	Index	Rank	Index	Rank	Index	Rank
Singapore	100.000	1	95.740	2	99.330	1
Hong Kong	99.357	2	98.146	1	94.964	2
Australia	92.172	3	88.934	3	83.500	3
Taiwan	90.441	4	75.390	8	77.359	4
Malaysia	**87.228**	**5**	**71.162**	**6**	**73.199**	**7**
China Mainland	80.182	6	76.595	7	73.758	5
New Zealand	78.531	7	79.621	4	73.374	6
Korea	76.249	8	68.408	10	58.884	11
Thailand	73.233	9	70.762	9	63.096	9
Japan	72.093	10	78.242	5	70.028	8
India	64.567	11	66.454	11	60.625	10
Indonesia	60.745	12	55.479	12	41.520	13

Sources: WCY 2009, WCY 2010

Table 6.8: The World Competitiveness Scoreboard 2010 (ASEAN)

Countries	2010		2009		2008	
	Index	Rank	Index	Rank	Index	Rank
Singapore	100.000	1	95.740	1	99.330	1
Malaysia	**87.228**	**2**	**71.162**	**2**	**73.199**	**2**
Thailand	73.233	3	70.762	3	63.096	3
Indonesia	60.745	4	55.479	4	41.520	5
Philipines	56.526	5	54.490	5	50.478	4

Sources: WCY 2009, WCY 2010

6.4.6 The Difference in the Rankings

As seen in the preceeding discussion, Malaysia has been ranked quite differently on innovation and on competitiveness in the GCI 2010-2011 and the WCY 2010. On *Innovation Competitiveness* in the GCI, she has been ranked 24th out of 139 countries, and on her performance on global competitiveness, she has been ranked 26th. On the WCY 2010, on the other hand, Malaysia has been ranked 12th on *Innovative Capacity*, and 10th on World Competitiveness. The question that naturally arises is why there is such a big discrepancy in our ranking on the two indices.

One explanation for this lies in the different methodologies adopted by the GCI and the WCY. The GCI uses 30.0% statistical data and 70.0% survey data, while the reverse is true for the WCY. Two thirds of the calculation of the competitiveness index in the WCY is based on hard data, and one-third on the IMD's executive opinion survey. Hence, the GCI contains a higher percentage of data based on the perceptions of respondents as opposed to the WCY. For its assessment of Malaysia, for example, the World Economic Forum, which publishes the GCI reports, drew on the responses of 110 executives from various companies operating in Malaysia. Hence, since the opinions of the respondents constitute 70.0% of the calculation towards the index, the index is highly affected by their perceptions of the various aspects on which Malaysia is assessed.

6.5 CONCLUSION

Between 2005 and 2008, 51.5% of the Malaysian companies surveyed reported that they carried out innovation activities, and a total of RM 410.0 million was spent on innovation in that period. When compared with international countries, Malaysia was ranked 24th on Innovation Competitiveness in the GCI 2010-2011, and 26th on global competitiveness. On the WCR 2010, however, Malaysia was ranked 12th on Innovative Capacity and 10th on world competitiveness.

Malaysia's ranking on the GCI is not dismally low, given the fact that she has been ranked 24th on innovation and 26th on competitiveness out of 139 countries. In fact, it is heartening to note that Malaysia has been consistently at the top quartile of the overall rankings for the past few years. Indeed, according to the GCI 2010-2011, although Malaysia has slid from 24th to 26th in the rankings, she has a well-developed financial market (7th) and an efficient goods market (27th). The Report also states that Malaysia does relatively well in the more complex categories, which matter the most for advanced economies, namely business sophistication (25th) and innovation (24th), "boding well for the future" (p. 41).

In looking at Malaysia's ranking on the GCI, it should be remembered that the countries which are ranked higher than Malaysia are mainly developed countries with high GDP per capita and which are in the innovation stage of development. Hence, given the fact that Malaysia is still a developing country, we may consider that we have done relatively well on this index. Finally, it should also be remembered that the rankings of countries may differ on different indices—as apparent in our more favourable ranking on the WCR 2010—as different indices use different methodologies in the calculation of their respective indices. Be that as it may, we should not be complacent with our relatively decent ranking on the GCI and our more favourable ranking on the WCY, and should strive, instead, to improve our performance even further, and continue our efforts at innovation such that it would be our source of competitive advantage, and subsequently, increase our rate of economic growth.

CHAPTER 7
- INTELLECTUAL PROPERTY RIGHTS AND BALANCE IN ROYALTIES AND LICENSING FEES

CHAPTER 7

INTELLECTUAL PROPERTY RIGHTS AND BALANCE IN ROYALTIES AND LICENSING FEES

7.0 INTRODUCTION

Technological capability is built either by the innovation of a new technology or by acquiring technology through technology transfers, purchasing the required technology, and the appropriation of disembodied technologies through foreign direct investments (FDIs). An important indicator of innovation is patents, a property rights granted to inventors to exclude other parties from using, copying, or distributing the invention without the permission of the inventor for a period of time, commonly for 20 years. It is important to note that not all inventions are patented and not all patents are commercialised.

Most of the technologies required for industrial development are patented, and the majority of these patents are owned by big business corporations in developed countries. The technical know-how and operational aspects of the patented technology normally remain as an industrial secret of the owner. The patent owners will not release this know-how to maintain their technological edge and also to avoid the possibility of 'copying' by their competitors. Nevertheless, owners of patented technology are willing to disclose their knowledge on the condition that their technology is transferred with their permission and that they are rewarded in the form of licensing fees and royalties.

This chapter is arranged into three sections. The first section discusses intellectual property in Malaysia, focusing on the trends in patent applications and grants, trademarks registrations and grants, industrial design applications, and registrations of geographical indications. It also analyses the trends in global patenting activities. The second section evaluates the trends in payments, receipts, and balance in royalties and licensing fees in Malaysia and the world. The last section provides the conclusion of this chapter.

7.1 INTELLECTUAL PROPERTY

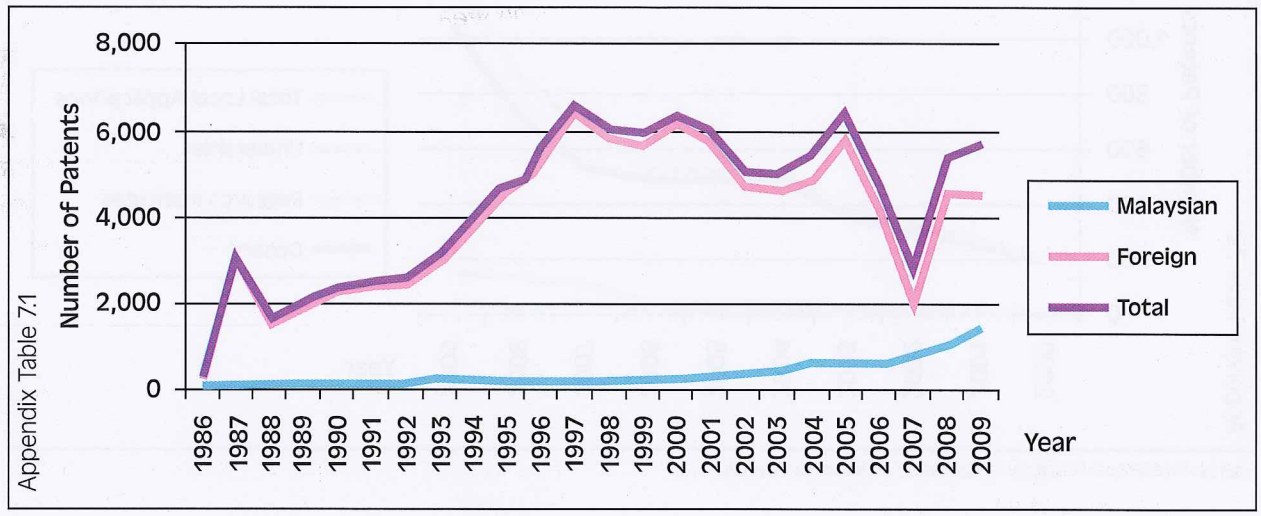
Intellectual property consists of patents, utility innovations, copyrights, trademarks and service marks, industrial designs, geographical indications, and layout designs for integrated circuits. Malaysia is a member of the World Intellectual Property Organisation (WIPO), Trade Related Intellectual Property Rights (TRIPS) under the auspices of the World Trade Organisation (WTO), and a signatory to the Paris Convention and Berne Convention that governs the intellectual property rights. Malaysia's intellectual property rights protection level is at par with the international standard.

This section presents the trends in the application and granting of patent and utility innovations, trademarks, industrial design, and geographical indications in Malaysia. Data on intellectual property in Malaysia are obtained from the Malaysian Intellectual Property Office (MyIPO) while the data on global patenting activities is obtained from the website of the World Intellectual Property Organisation (WIPO). A discussion on global trends in patenting activities is presented to provide international comparisons.

7.1.1 Patents and Utility Innovations

A patent is defined as "the right to secure the enforcement power of the state in excluding unauthorised persons, for a specified number of years, from making commercial use of a clearly identified invention" (Machlup,1958)[1]. For an invention to be protected by a patent, it must provide a novel solution to a technological problem, involve an inventive step and be industrially applicable (Blakeney, 1996)[2]. Since the enactment of the Patent Act in 1983, the number of patent filings and grants has increased substantially. The number of patents filed rose from 262 in 1986 to 2,305 in 1990 and increased further to 5,737 in 2009 **(Figure 7.1)**. The trends in the total and foreign applications show an upward trend until 2005.

Figure 7.1: Patent Applications by Ownership, 1986-2009



Source: Intellectual Property Corporation of Malaysia (MyIPO)

In 2007, the total number of patent applications registered a sharp decline of 50.6%, from 4,800 applications in 2006 to 2,372 in 2007 **(Table 7.1)**. The drop is caused by the drastic fall in foreign applications, which declined from 4,800 in 2006 to 1,702 in 2007 (a decline of 60.1%). The total number of patents filed increased from 5,403 in 2008 to 5,737 in 2009, registering a moderate growth of 6.2% in 2009 (2008: 127.8%).

Table 7.1: Patent and Utility Innovations Filed, 2007- 2009

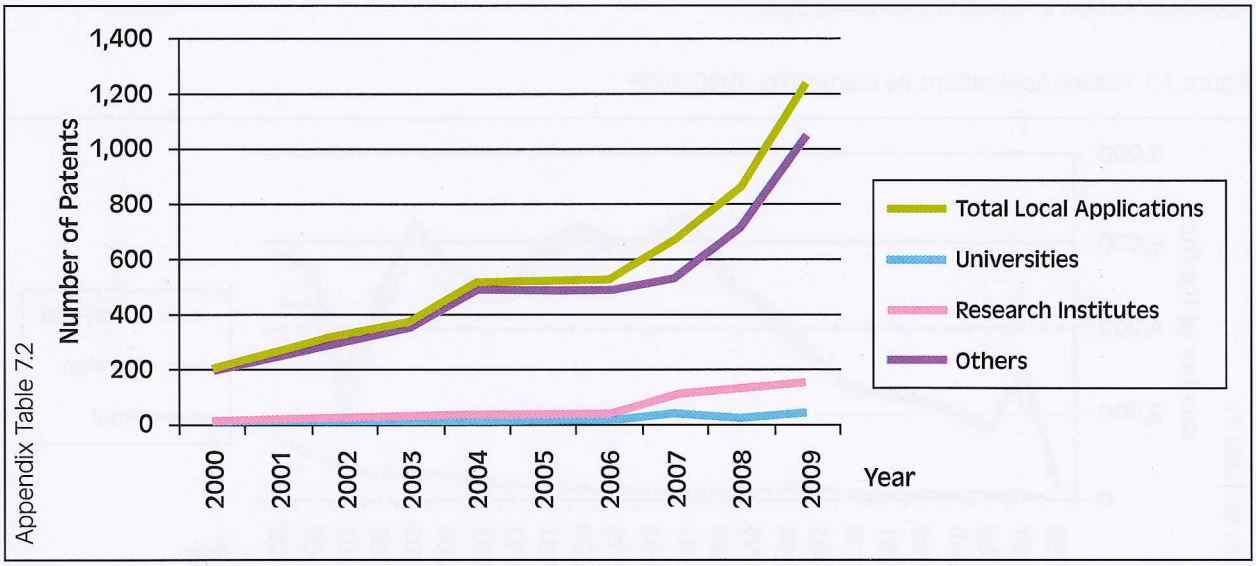
Year	Malaysian	% Share	Foreign	% Share	Total	% Change
2007	670	28.0	1,702	72.0	2,372	-50.6
2008	864	16.0	4,539	84.0	5,403	127.8
2009	1,234	21.5	4,503	78.5	5,737	6.2

Source: Intellectual Property Corporation of Malaysia (MyIPO)

[1]Machlup, F. (1958), An Economic Review of the Patent System, Washington. D.C.: US Government Printing Office
[2]Blakeney M. (1996), Trade Related Aspects of Intellectual Property Rights: A Concise Guide to the TRIPS Agreement, Sweet and Maxwell: London

Figure 7.1 and **Table 7.1** show that the patent applications in Malaysia have been dominated by non-Malaysians, where 78.5% of the applications in 2009 were made by foreign patent owners. Nevertheless, the number of patent applications made by Malaysians has increased notably from 864 in 2008 to 1,234 applications in 2009. The share of local patent applications rose steadily from 2.2% in 1987 to 4.6% in 2000, and increased further to 11.1% in 2006. By 2007, the share jumped to 28.0%. However, the share declined to 16.0% in 2008 and 21.5% in 2009 **(Table 7.1)**.

Figure 7.2: Patent Applications by Locals, Universities, and Research Institutes, 2000-2009



Source: Intellectual Property Corporation of Malaysia (MyIPO)

Since 2006, local patent applications by universities and research institutes registered a notable increase, largely contributed by the support provided by the government in financing R&D activities **(Figure 7.2)**. The number of patents filed by universities increased from 1 in 2000 to 42 in 2009. In terms of the share in total local applications, university patent filing share rose from 0.5% in 2000 to 3.4% in 2009, peaking in 2007 at 4.8% **(Table 7.2)**. Applications from research institutes are more notable, increasing from 13 in 2000 (representing 6.3% of total local applications) to 148 in 2009 (12.0%).

Table 7.2: Local Patent Applications by Type of Applicants, 2000-2009

Years	Total Local Applications	Applications from Universities	% Share	Applications from Research Institutes	% Share	Applications from Others	% Share
2000	206	1	0.5	13	6.3	192	93.20
2001	271	4	1.5	18	6.6	249	91.88
2002	322	5	1.6	21	6.5	296	91.93
2003	376	4	1.1	20	5.3	352	93.62
2004	522	1	0.2	35	6.7	486	93.10
2005	522	8	1.5	36	6.9	478	91.57
2006	531	9	1.7	36	6.8	486	91.53
2007	670	32	4.8	107	16.0	531	79.25
2008	864	21	2.4	132	15.3	711	82.29
2009	1,234	42	3.4	148	12.0	1,044	84.60

Source: Intellectual Property Corporation of Malaysia (MyIPO)

The trend in patents granted is the same as that for patent applications, but grew at a slower pace compared to patent applications. The total number of patents granted increased from 6 in 1988 to 518 in 1990, and further rose to 3,468 in 2009. Patent grants in 2008 plummeted to 2,242 from 6,983 in 2007, registering a decline of 67.9% (the decline in patent application during the same time is -50.6%). **Table 7.3** shows that the number of patents granted registered a notable increase of 35.4% in 2009.

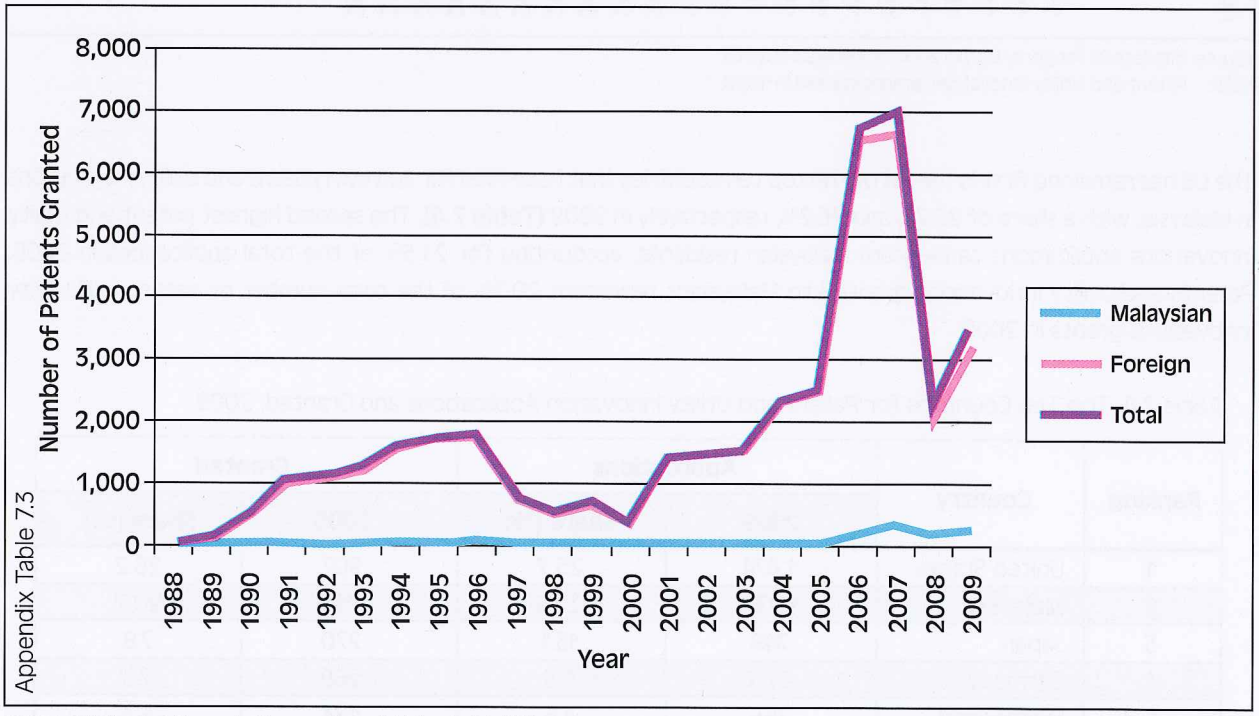
Table 7.3: Patent and Utility Innovations Granted, 2007 and 2009

Year	Malaysian	% Share	Foreign	% Share	Total	% Change
2007	338	4.8	6,645	95.2	6,983	3.5
2008	198	8.8	2,044	91.2	2,242	-67.9
2009	270	7.8	3,198	92.2	3,468	35.4

Source: Intellectual Property Corporation of Malaysia (MyIPO)

Table 7.3 also shows that 92.2% of the total patents granted in 2009 are owned by foreigners. Indeed, this has been the trend in the ownership of patents in Malaysia **(Figure 7.3)**. However the ownership of patents by locals has shown a notable increase after 2005.

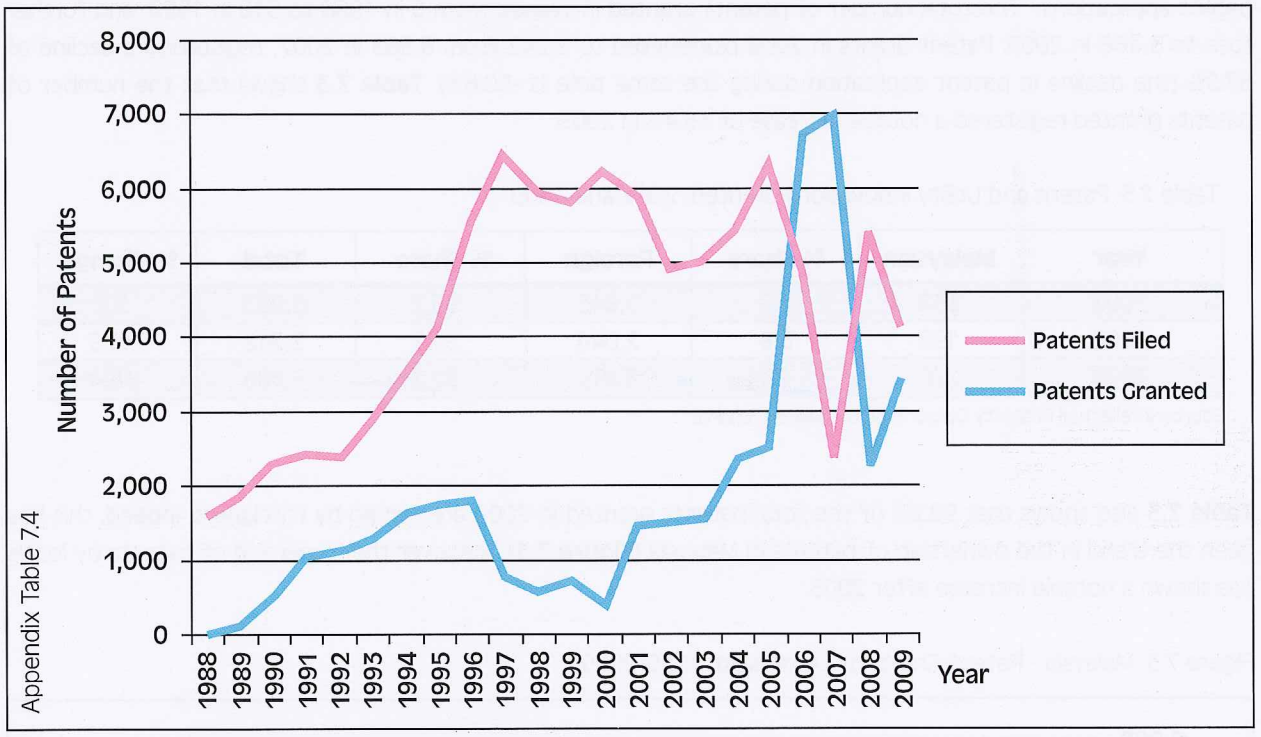
Figure 7.3: Malaysia - Patent Grants by Ownership, 1988-2009



Source: Intellectual Property Corporation of Malaysia (MyIPO)

The gap between patent applications and patents granted has narrowed over the years **(Figure 7.4)**. This improvement is contributed by the introduction of the modified examination for patent applications filed through the overseas patent office. The time frame for patent application approval improved further with the corporatisation of the IP Office in 2003, where special measures were introduced to clear the backlog of patent applications. As a result of these changes, the number of patents granted exceeded patent filing by 2006. The volatility in the number of patents applied for and granted is greater in the period between 2006 and 2009.

Figure 7.4: Total Patents and Utility Innovations Applied for and Granted 1988-2009



Source: Intellectual Property Corporation of Malaysia (MyIPO)
Note: Patent and Utility Innovations grants started in 1988

The US has remained first in the list of the top ten countries that have filed for and own patent and utility innovations in Malaysia, with a share of 25.7% and 26.2%, respectively in 2009 **(Table 7.4).** The second highest patent and utility innovations applications came from Malaysian residents, accounting for 21.5% of the total applications in 2009. Patents and utility innovations granted to Malaysians represent 20.7% of the total number of patent and utility innovations grants in 2009.

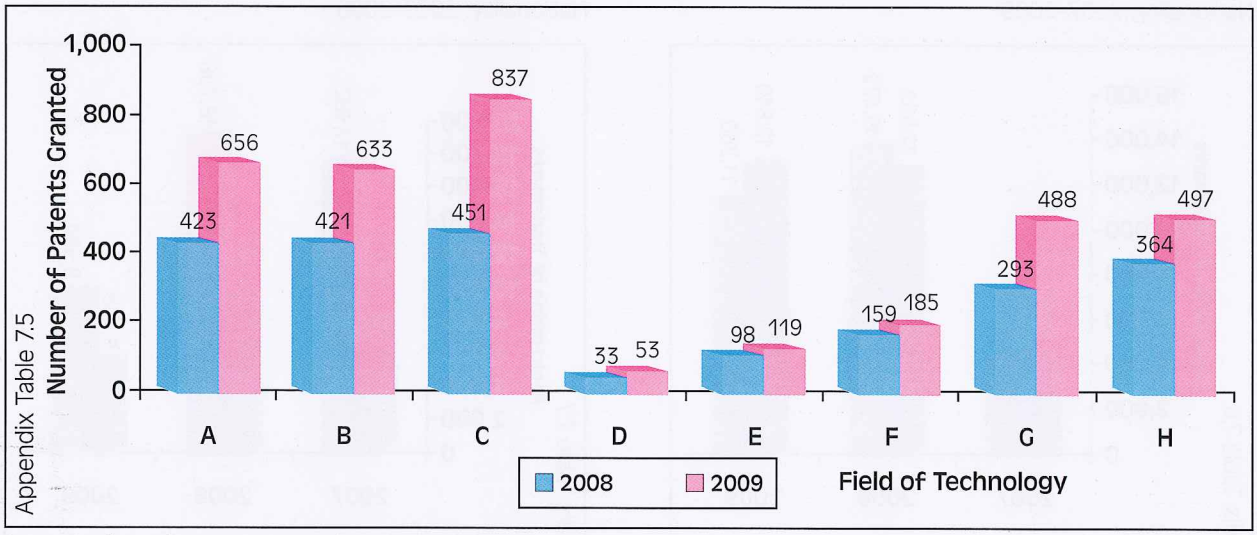
Table 7.4: Top Ten Countries for Patent and Utility Innovation Applications and Granted, 2009

Ranking	Country	Applications		Granted	
		2009	Share (%)	2009	Share (%)
1	United States	1,474	25.7	907	26.2
2	**Malaysia**	**1,234**	**21.5**	**719**	**20.7**
3	Japan	749	13.1	270	7.8
4	Germany	375	6.5	269	7.8
5	Switzerland	265	4.6	183	5.3
6	United Kingdom	237	4.1	168	4.8
7	France	203	3.5	165	4.8
8	Netherlands	182	3.2	153	4.4
9	Sweeden	123	2.1	112	3.2
10	South Korea	113	2.0	61	1.8

Source: Intellectual Property Corporation of Malaysia (MyIPO)

The number of patents granted to all fields of technology registered an increase in 2009 **(Figure 7.5)**. Chemistry and the metallurgy division registered the highest number of patents granted (837), followed by human necessities (656), performing operations and transporting (633), electricity (497), and physics (488).

Figure 7.5: Patents Granted According Field of Technology, 2008 and 2009



Source: Intellectual Property Corporation of Malaysia (MyIPO)

Note : International Patent Classification (IPC)

Section A : Human Necessities
Section B : Performing Operations; Transporting
Section C : Chemistry ; Metallurgy
Section D : Textiles ; Paper
Section E : Fixed Constructions
Section F : Mechanical Engineering; Lighting; Heating; Weapons
Section G : Physics
Section H : Electricity

7.1.2 Trademarks

Trademark applications and registrations dropped significantly in 2009 **(Table 7.5)**. Trademark applications declined from 26,034 in 2008 to 24,070 in 2009 (-7.5%) while trademark registrations fell from 27,847 in 2008 to 14,972 in 2009 (-46.2%).

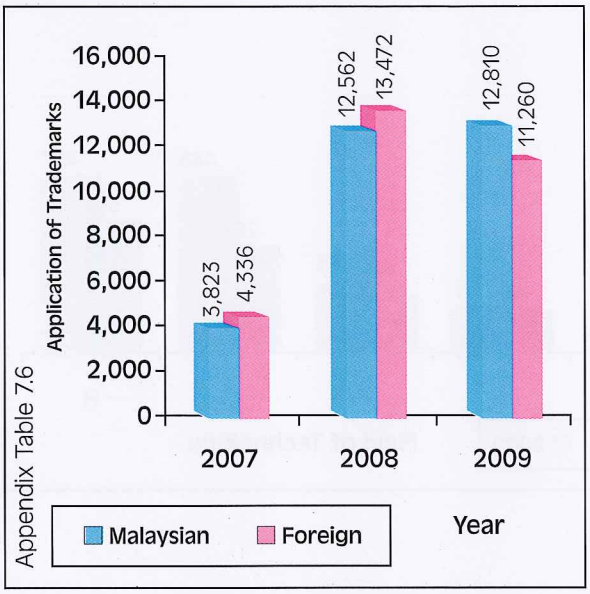
Table 7.5: Application for and Registration of Trademarks, 2008 and 2009

Year	Applications	Registrations
2008	26,034	27,847
2009	24,070	14,972
Annual Change (%)	-7.5	-46.2

Source: Intellectual Property Corporation of Malaysia (MyIPO)

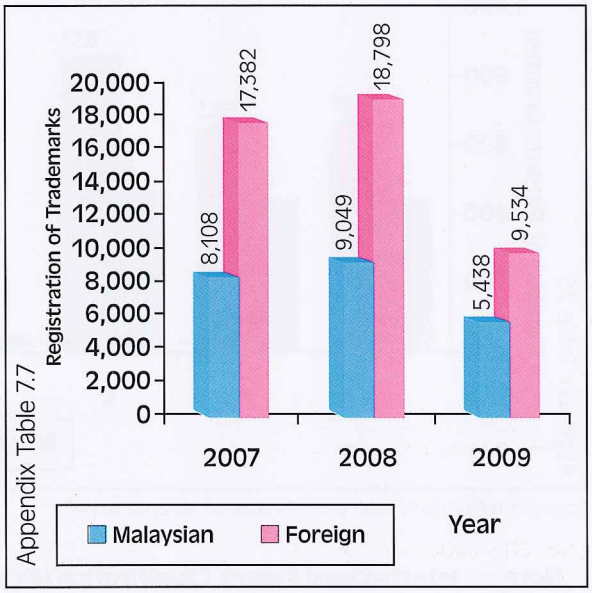
In 2009, Malaysian trademark applications constitute 53.2% of the total applications (2008: 48.3%). The total number of applications by Malaysians, however, increased slightly from 12,562 in 2008 to 12,810 in 2009. Applications by foreigners fell by 16.4% to 11,260 in 2009 **(Figure 7.6)**. In terms of the registration of trademarks however, foreign registrations exceeded local trademark registrations **(Figure 7.7)**. In 2009, foreign registrations constituted 63.7% of the total trademark registrations (2008: 67.5%). Foreign registration of trademarks declined significantly by 49.3%, from 18,798 in 2008 to 9,534 in 2009. Meanwhile, local registrations fell by 39.9%, from 9,049 in 2008 to 5,438 in 2009.

Figure 7.6: Application of Trademarks According to Nationality, 2007-2009



Source: Intellectual Property Corporation of Malaysia (MyIPO)

Figure 7.7: Registration of Trademarks According to Nationality, 2007-2009



Source: Intellectual Property Corporation of Malaysia (MyIPO)

Table 7.6 shows that Malaysia had the highest share of trademark applications and registrations in 2009 (53.2% and 36.3% respectively). This is followed by the USA (9.3% and 14.2% respectively) and Japan (5.8% and 9.3% respectively). Other countries in the list are Switzerland, Germany, the United Kingdom, Singapore, China, France and Australia.

Table 7.6: Top Ten Countries for Trademark Applications and Registrations, 2009

Ranking	Application			Registration		
	Country	2009	Share (%)	Country	2009	Share (%)
1	**Malaysia**	**12,810**	**53.2**	**Malaysia**	**5,438**	**36.3**
2	USA	2,245	9.3	USA	2,120	14.2
3	Japan	1,399	5.8	Japan	1,385	9.3
4	Switzerland	872	3.6	Germany	724	4.8
5	Germany	848	3.5	United Kingdom	606	4.0
6	United Kingdom	729	3.0	France	507	3.4
7	Singapore	727	3.0	Switzerland	495	3.3
8	China	636	2.6	Singapore	471	3.1
9	France	421	1.7	China	339	2.3
10	Australia	300	1.2	Australia	279	1.9

Source: Intellectual Property Corporation of Malaysia (MyIPO)

7.1.3 Industrial Designs

The application of industrial designs recorded a notable increase since the Industrial Designs Act 1996 took effect in 1999. It increased steadily from 268 applications in 1999 to 1,607 in 2005 before declining to 1,544 in 2006 **(Table 7.7)**. The number of applications registered a decline of 13.9%, from 1,702 in 2008 to 1,465 in 2009. Foreign industrial design applications constituted 52.3% of the total applications in 2009 (2008: 63.0%).

Table 7.7: Application of Industrial Designs, 1999-2009

Year	Malaysia	Share (%)	Foreign	Share (%)
1999	111	41.4	157	58.6
2000	286	29.6	679	70.4
2001	465	43.8	597	56.2
2002	502	43.2	660	56.8
2003	624	47.1	700	52.9
2004	520	35.6	941	64.4
2005	633	39.4	974	60.6
2006	616	39.9	928	60.1
2007	774	40.3	1,146	59.7
2008	630	37.0	1,072	63.0
2009	699	47.7	766	52.3

Source: Intellectual Property Corporation of Malaysia (MyIPO)

The registration of industrial designs also showed a similar trend **(Table 7.8)**. The share of foreign industrial design registration is much higher, constituting 66.9% of the total registration in 2009 (2008: 60.9%).

Table 7.8: Registrations of Industrial Designs, 1999-2009

Year	Malaysia	Share (%)	Foreign	Share (%)
1999	0	0	0	0
2000	73	26.0	208	74.0
2001	199	23.9	635	76.1
2002	274	39.0	429	61.0
2003	573	37.0	974	63.0
2004	602	47.3	671	52.7
2005	314	40.4	463	59.6
2006	700	38.9	1,100	61.1
2007	597	35.7	1,076	64.3
2008	580	39.1	903	60.9
2009	529	33.1	1,067	66.9

Source: Intellectual Property Corporation of Malaysia (MyIPO)

7.1.4 Geographical Indications

The Geographical Indications Act 2000 provides protection to goods based on where the location of the goods are produced, where a given quality, reputation, or other characteristic of the goods is essentially attributable to their geographical areas. By 2009, 12 products were given geographical indication protection in Malaysia **(Table 7.9)**.

Table 7.9: Geographical Indications in Malaysia, 2009

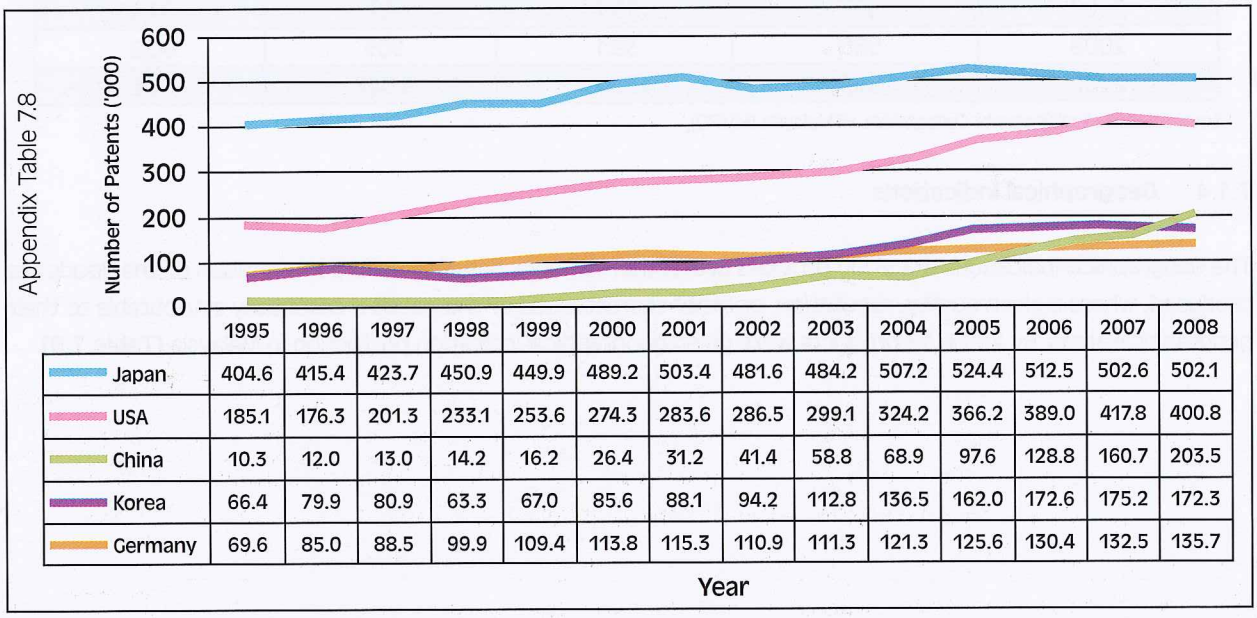
No.	Geographical Indication
1.	Sarawak Pepper
2.	Sabah Tea
3.	Borneo Virgin Coconut Oil
4.	Tenom Tea
5.	Sabah Seaweed
6.	Bario Rice
7.	Buah Limau Bali Sungai Gedung
8.	Pisco
9.	Scotch Whisky
10.	Sarawak Beras Biris
11.	Sarawak Beras Bajong
12.	Kuih Lidah Kampung Berundung Papar

Source: Intellectual Property Corporation of Malaysia (MyIPO)

7.1.5 Trends in Global Patent Applications and Grants

Overall patent applications across the world recorded positive growth since the 1980s. In 2008, the total number of patent applications filed stood at around 1.91 million, and registered a 2.6% increase over 2007 (WIPO, 2010). Japan, the US, China, Korea, and Germany are the top five countries in terms of patent applications in the world, accounting for 74.1% of total patent applications in 2008. Between 1995 and 2008, Japan Patent Office received the largest number of applications **(Figure 7.8)**. Japan accounted for 26.3% of total patent applications in 2008. The second largest patent applications originated from USPTO (US Patent and Trademark Office), representing 21.0% of total applications in 2008. The number of patent applications filed with the patent office of China (SIPO) saw a significant increase over the years, overtaking Germany in 2007 and Korea in 2008 to become the third largest country in patent applications in 2008, and peaking up fast to be at par with the US and Japan. In 2008, filings from SIPO accounted for 10.7% of total applications.

Figure 7.8: Total Patent Applications in the Top Five Countries ('000), 1995-2008

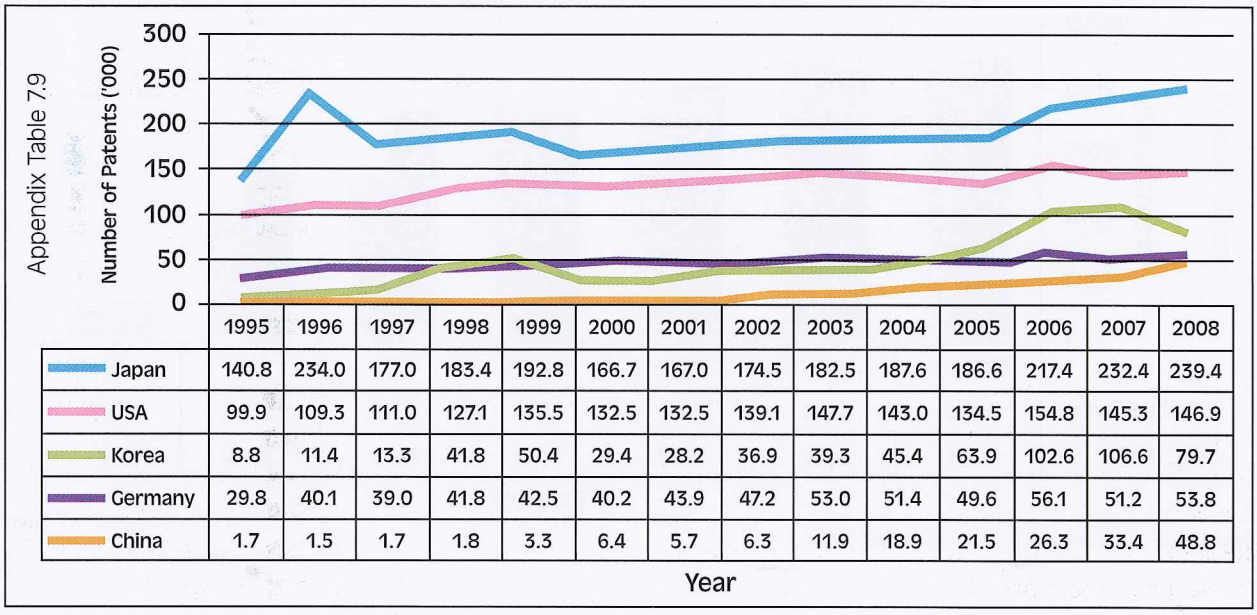


	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Japan	404.6	415.4	423.7	450.9	449.9	489.2	503.4	481.6	484.2	507.2	524.4	512.5	502.6	502.1
USA	185.1	176.3	201.3	233.1	253.6	274.3	283.6	286.5	299.1	324.2	366.2	389.0	417.8	400.8
China	10.3	12.0	13.0	14.2	16.2	26.4	31.2	41.4	58.8	68.9	97.6	128.8	160.7	203.5
Korea	66.4	79.9	80.9	63.3	67.0	85.6	88.1	94.2	112.8	136.5	162.0	172.6	175.2	172.3
Germany	69.6	85.0	88.5	99.9	109.4	113.8	115.3	110.9	111.3	121.3	125.6	130.4	132.5	135.7

Source: WIPO Statistics Database, September 2010

The trend in patents granted show greater volatility compared to patent applications, reflecting the effectiveness and variation in institutional capacity of patent offices in respective countries. In 2008, 777,600 patents were granted, representing a 0.6% increase from 2007 (WIPO, 2010). The trend in patents granted is the same for patent applications, except for a drastic fall in the number of patents granted by the Korean Intellectual Property Office in 2008 (by 25.2%) and a slower growth in patent grant compared to patent filing in China **(Figure 7.9)**. Japan remained the largest country granting patents, representing 30.8% of total patents granted in the world in 2008. The second largest office granting patents was the US, followed by Korea, Germany, and China.

Figure 7.9: Total Patent Grants in Top Five Countries ('000), 1995-2008

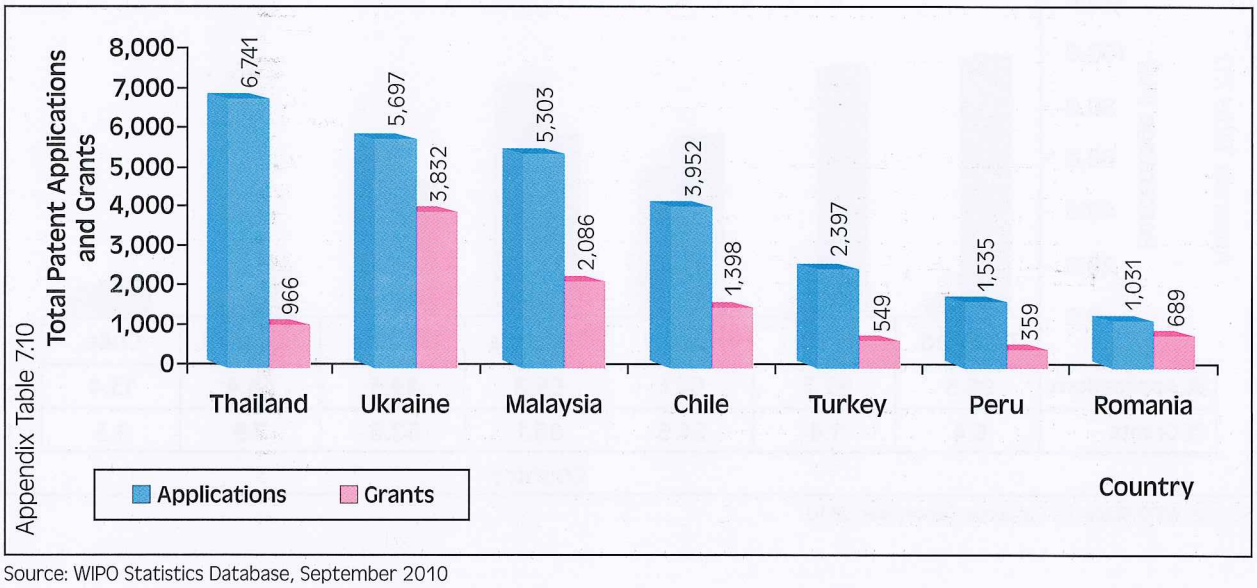


	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Japan	140.8	234.0	177.0	183.4	192.8	166.7	167.0	174.5	182.5	187.6	186.6	217.4	232.4	239.4
USA	99.9	109.3	111.0	127.1	135.5	132.5	132.5	139.1	147.7	143.0	134.5	154.8	145.3	146.9
Korea	8.8	11.4	13.3	41.8	50.4	29.4	28.2	36.9	39.3	45.4	63.9	102.6	106.6	79.7
Germany	29.8	40.1	39.0	41.8	42.5	40.2	43.9	47.2	53.0	51.4	49.6	56.1	51.2	53.8
China	1.7	1.5	1.7	1.8	3.3	6.4	5.7	6.3	11.9	18.9	21.5	26.3	33.4	48.8

Source: WIPO Statistics Database, September 2010

Figure 7.10 shows the total number of patent applications and patents granted for selected middle income countries in 2008. The largest number of patent applications come from Thailand, (6,741) followed by the Ukraine (5,697), Malaysia (5,303), Chile (3,952), Turkey (2,397), Peru (1,535), and Romania (1,031). In terms of patent grants, the highest ranking countries are the Ukraine, with 3,832 patents granted, followed by Malaysia (2,086), Chile (1,398), Thailand (966), Romania (689) and Turkey (549).

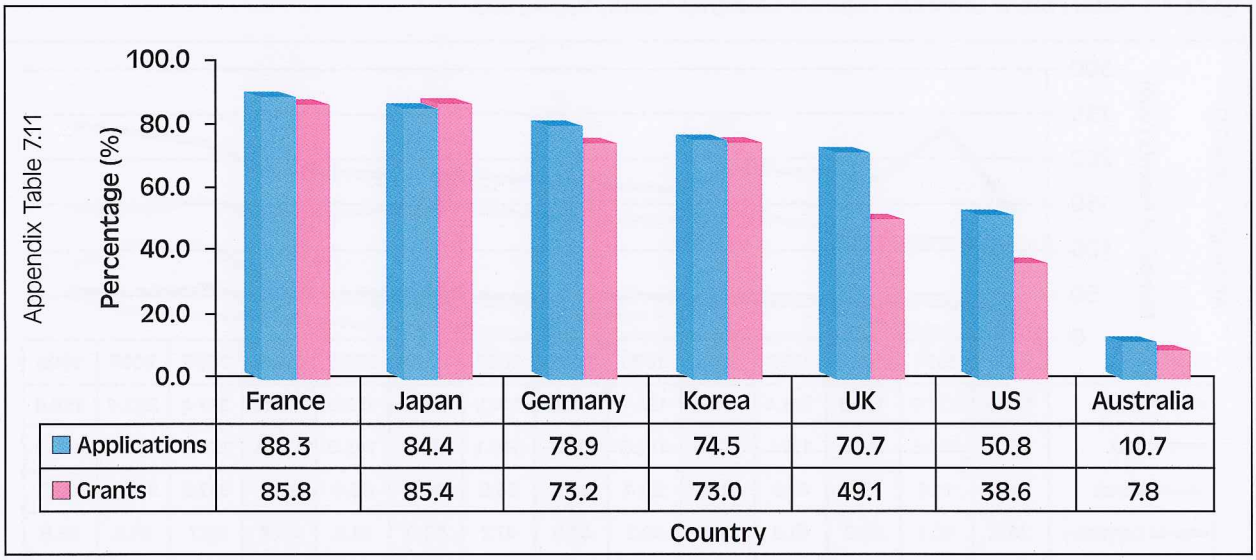
Figure 7.10: Total Patent Applications and Grants in Selected Middle Income Countries, 2008



Source: WIPO Statistics Database, September 2010

Figure 7.11 and **Figure 7.12** show the share of patents filed and granted to residents in selected developed and middle income countries respectively. In all the developed countries selected except Australia, residents had a substantial share of the patents filed and granted. The largest share of resident's ownership of patents filed and granted is in France, registering 88.3% and 85.8% respectively. In the UK, the gap between patents filed and granted is significant in 2008, where applications by residents constituted 70.7% of total applications, in contrast to only 49.1% patents granted.

Figure 7.11: Patent Applications and Grants by Residents in Selected Developed Countries, 2008 (share of total %)

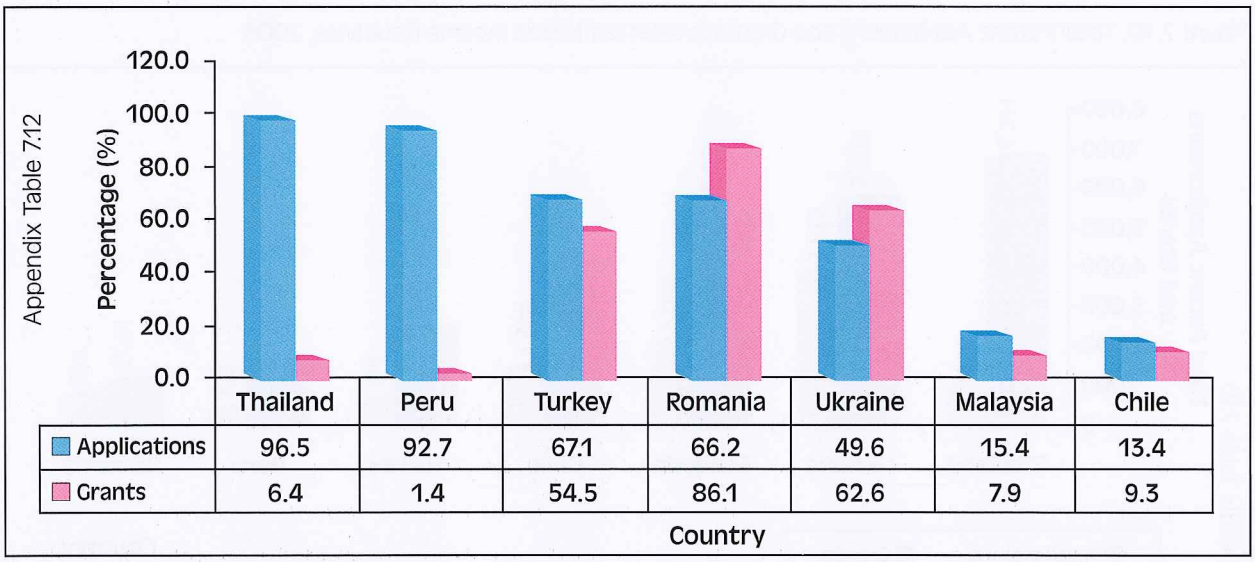


	France	Japan	Germany	Korea	UK	US	Australia
Applications	88.3	84.4	78.9	74.5	70.7	50.8	10.7
Grants	85.8	85.4	73.2	73.0	49.1	38.6	7.8

Source: WIPO Statistics Database, September 2010

In contrast, the experience of most developing countries show that the majority of the patents are filed by and granted to non-residents. **Figure 7.12** shows that Malaysia and Chile have very low patent applications by residents compared to Thailand, Peru, Turkey, Romania, and the Ukraine. The gap between patent applications and grants is apparent in Thailand and Peru, where applications by residents in these countries constitute 96.5% and 92.7% respectively, while the share of patent grants are only 6.4% and 1.4%, respectively.

Figure 7.12: Patent Applications and Grants by Residents in Selected Middle Income Countries, 2008 (share of total %)

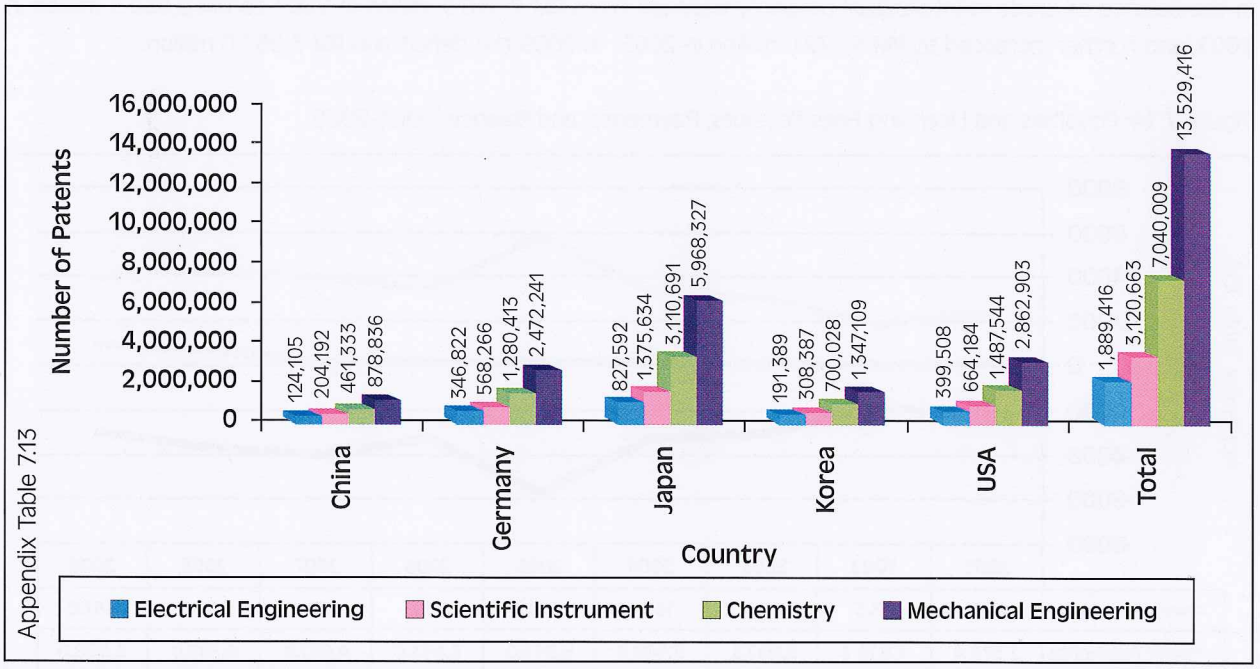


	Thailand	Peru	Turkey	Romania	Ukraine	Malaysia	Chile
Applications	96.5	92.7	67.1	66.2	49.6	15.4	13.4
Grants	6.4	1.4	54.5	86.1	62.6	7.9	9.3

Source: WIPO Statistics Database, September 2010

The technology areas that registered the largest number of patent applications in 2007 were computer technology, electrical machinery, and telecommunications (WIPO, 2010). Between 2003 and 2007, the fields of technologies that recorded patent application growth of more than 5.0% are electrical machinery (9.0%), telecommunications (7.3%), digital communications (9.6%), computer technology (11.0%), IT methods for management (10.5%), scientific measurement (8.1%), food chemistry (7.0%), surface technology and coating (7.2%), chemical engineering (9.2%), environmental technology (5.8%), and engines, pumps and turbines (6.1%)[3]. Fields of technologies that experience a decline in patent applications during the same period were analysis of biological methods (-1.6%), biotechnology (-1.5%) and textiles and paper machines (-0.2%).

Figure 7.13: Patent Applications by Major Field of Technology in Five Top Countries, 2003-2007



Source: WIPO Statistics Database, September 2010
Note: Total for five countries.

Figure 7.13 shows the number of patents filed in four major economies according to fields of technologies. Between 2003 and 2007, the highest number of patent applications was registered in mechanical engineering, followed by chemistry, scientific instruments, and electrical engineering, whereas Japan leads in all fields of technologies.

7.2 ROYALTIES AND LICENSING FEES

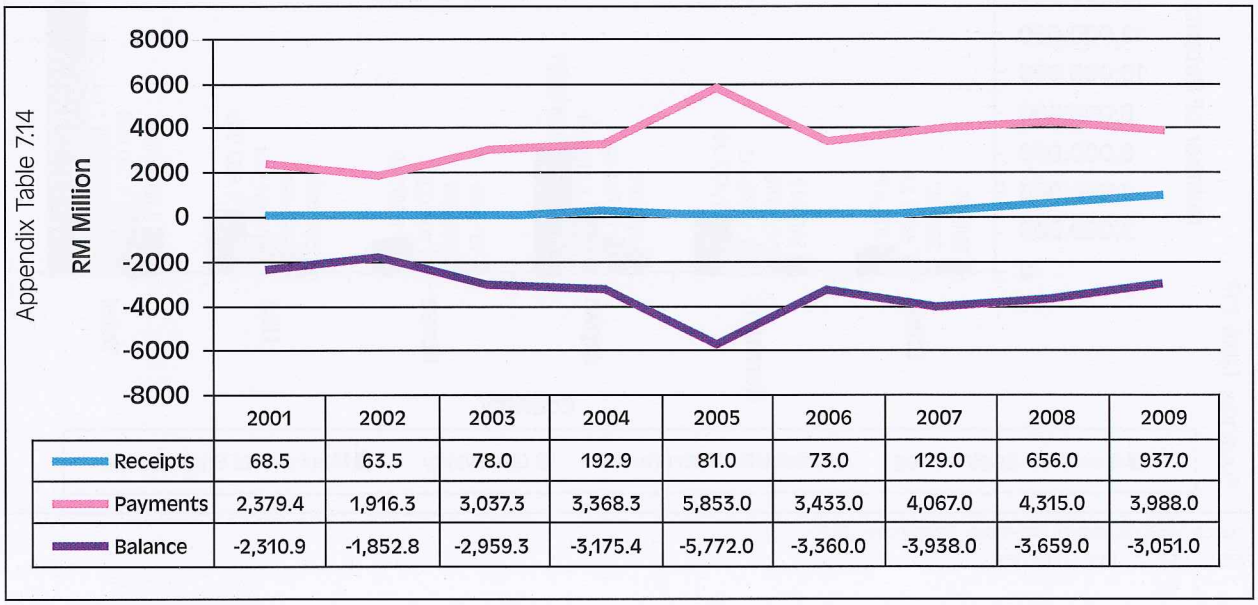
This section analyses the trends in total receipts and payments of royalties and licensing fees in Malaysia and in the world. Royalties and licensing fees represent revenues and payments for intellectual property trade. The owners of intellectual property rights commonly license or franchise their propriety technologies, patented or unpatented techniques, formulas, processes and products, trademarks, service marks, distribution rights and other IP rights to another party locally or internationally and charge fees or royalty for its transactions and usage. Most developing countries are net importers in the intellectual property trade. Data for Malaysia were obtained from Bank Negara Malaysia while the analysis on the trends in the global receipts and payments of royalties and licensing fees relies on data extracted from the World Bank Statistical Database.

[3]Based on data obtained from Table A.6.1, World Intellectual Property Indicators 2010, WIPO: Geneva

7.2.1 Trends in Royalties and Licensing Fees

As we have seen in the earlier sections, Malaysia's intellectual property rights are mostly owned by foreigners, which essentially means that Malaysia is a net importer in intellectual property trade. The payments for royalties and licensing fees have been consistently higher than receipts, hence contributing to persistent deficits in intellectual property trade. The receipts from licensing intellectual property have been small, but rose gradually from RM 68.5 million in 2001 to RM 192.9 million in 2004, and then increased notably to RM 656.0 million and RM 937.0 million in 2008 and 2009 respectively **(Figure 7.14)**. However, this is far less than the payment made by Malaysia for the usage of intellectual property rights. The payments for royalties and licensing fees increased from RM 2,379.4 million in 2001 to RM 3,368.3 million and RM 3,988.0 million in 2004 and 2009 respectively. As a result, the deficit in the balance of trade in intellectual property widened from RM 2,310.9 million in 2001 to RM 2,959.3 million in 2003, and further increased to RM 5,772.0 million in 2005. In 2009 the deficit was RM 3,051.0 million.

Figure 7.14: Royalties and Licensing Fees Receipts, Payments, and Balance, 2001-2009

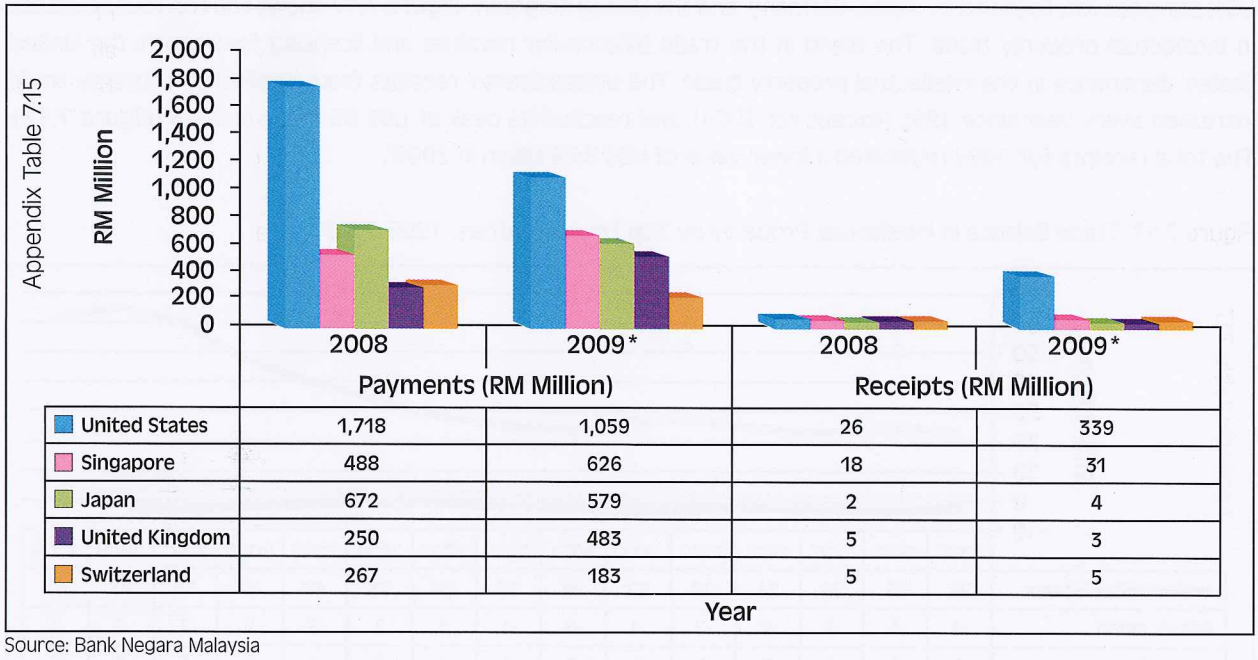


	2001	2002	2003	2004	2005	2006	2007	2008	2009
Receipts	68.5	63.5	78.0	192.9	81.0	73.0	129.0	656.0	937.0
Payments	2,379.4	1,916.3	3,037.3	3,368.3	5,853.0	3,433.0	4,067.0	4,315.0	3,988.0
Balance	-2,310.9	-1,852.8	-2,959.3	-3,175.4	-5,772.0	-3,360.0	-3,938.0	-3,659.0	-3,051.0

Source: Bank Negara Malaysia
Note: Data for 2009 is preliminary.

The largest recipient of royalties and licensing fees from Malaysia is the United States, with a 27.0% share of the total payments in 2009 **(Figure 7.15)**. This is followed by Singapore, accounting for 16.0% of the total payments (RM 626 million), Japan 15.0% (RM 579 million), the UK 12.0% (RM 483 million), and Switzerland 5.0% (RM 183 million).

Figure 7.15: Malaysia Royalty Receipts and Payments by Country, 2008-2009



	Payments (RM Million)		Receipts (RM Million)	
	2008	2009*	2008	2009*
United States	1,718	1,059	26	339
Singapore	488	626	18	31
Japan	672	579	2	4
United Kingdom	250	483	5	3
Switzerland	267	183	5	5

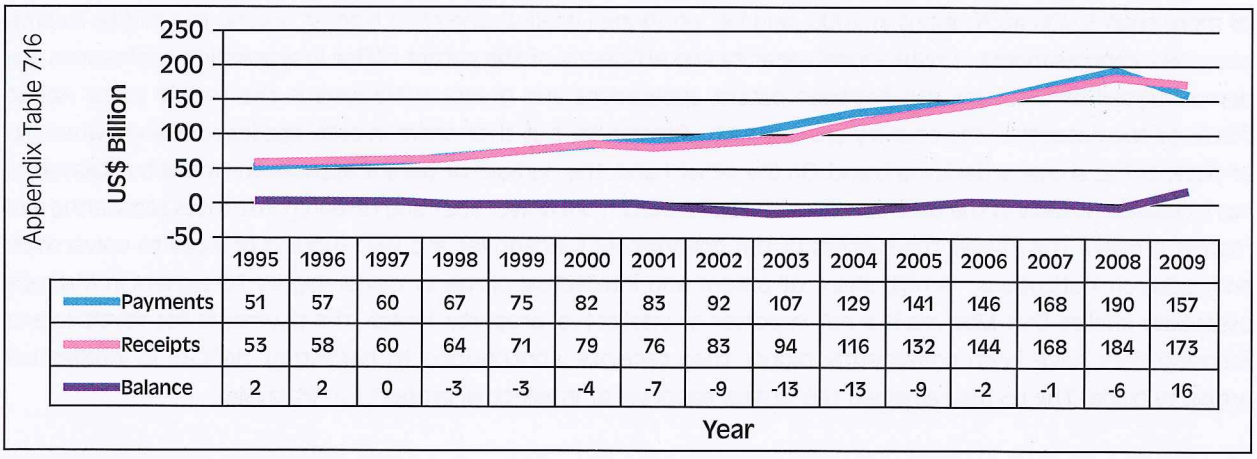
Source: Bank Negara Malaysia
*Note: Data for 2009 is preliminary.

The United States is also the largest importer of intellectual property rights from Malaysia, amounting to a 36.0% share of total royalties and licensing fees receipts in 2009. Royalties and licensing fees receipts from Singapore accounted for 3.0%, while other countries contributed negligibly to the total receipts of royalties and licensing fees.

7.2.2 Global Royalties and Licensing Fees Receipts and Payments

World total receipts and payments of royalties and licensing fees generated from intellectual property experienced significant expansion since the 1990s. Total payments increased 3-fold; from US$ 51 billion to US$ 157 billion in 2009, while the receipts increased more than 3-fold; from US$ 53 billion to US$ 173 billion during the same period **(Figure 7.16)**. The trade balance in intellectual property recorded a small surplus in 1995 and 1996, and from 1998 onwards, the payments exceeded the receipts. The deficits reached its high in 2003 and 2004, registering a net payment of US$ 13 billion. In 2009, however, global intellectual property trade recorded a surplus of US$ 16 billion.

Figure 7.16: Global Receipts, Payments and Balance of Trade in Intellectual Property, 1995-2009

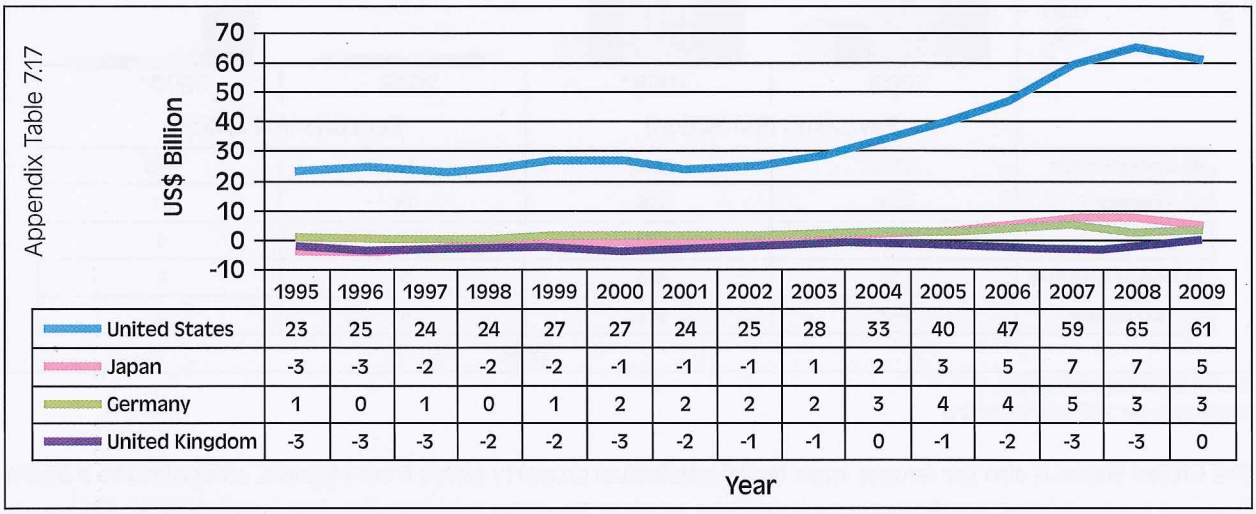


	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Payments	51	57	60	67	75	82	83	92	107	129	141	146	168	190	157
Receipts	53	58	60	64	71	79	76	83	94	116	132	144	168	184	173
Balance	2	2	0	-3	-3	-4	-7	-9	-13	-13	-9	-2	-1	-6	16

Source: World Bank Statistical Database

Developed countries remained the largest net exporters and importers of royalties and fees in the world, with the US leading the list, followed by Japan, Germany, and the United Kingdom. **Figure 7.17** shows the top four countries in intellectual property trade. The trend in the trade balance for royalties and licensing fees shows the United States' dominance in the intellectual property trade. The United States' receipts from intellectual property trade increased every year since 1995 (except for 2001), and reached its peak of US$ 65 billion in 2008 **(Figure 7.17)**. The total receipts for 2009 registered a lower value of US$ 84.4 billion in 2009[4].

Figure 7.17: Trade Balance in Intellectual Property by Top Four Countries, 1995-2009



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
United States	23	25	24	24	27	27	24	25	28	33	40	47	59	65	61
Japan	-3	-3	-2	-2	-2	-1	-1	-1	1	2	3	5	7	7	5
Germany	1	0	1	0	1	2	2	2	2	3	4	4	5	3	3
United Kingdom	-3	-3	-3	-2	-2	-3	-2	-1	-1	0	-1	-2	-3	-3	0

Source: World Bank Statistical Database

The United States' trade surplus in royalties and licensing fees has been far larger than any other country in the world **(Figure 7.17)**. The US has been experiencing a surplus since 1995, and it increased sharply after 2002. The surplus rose from US$ 23 billion in 1995 to US$ 40 billion in 2005, and further increased to US$ 61 billion in 2009. About 75.0% of these receipts involved the transactions of intellectual property between US companies and their affiliates abroad (US Science and Engineering Indicators, 2008). Japan registered a surplus in intellectual property trade only after 2003, while Germany recorded a gradual and slow increase in surplus every year since 1999. The United Kingdom on the other hand, is a net importer of intellectual property.

7.3 CONCLUSION

Overall, patent applications and grants in Malaysia have registered a positive growth since the enactment of the Patent Act in 1983. Malaysia has made its mark in terms of patent applications and grants globally, recording a total of more than 5,000 applications in 2008, and has positioned itself as the third highest among the middle income countries. Improvements in institutional capacity and efficiency of the patent office in processing applications are demonstrated by a smaller gap between patent applications and grants in Malaysia in the recent years. About 75.0% of the patents in the country are owned by foreigners, but their share in total applications and ownership of patents has shown a declining trend. On the other hand, the number of patent applications made by Malaysians has increased notably in the past decade with applications from universities and research institutes registering the fastest growth. This implies the success of the government's incentives and R&D funding granted to universities and research institutions. A high share of patent and intellectual property ownership by foreigners in Malaysia essentially implies that Malaysia is a net importer of intellectual property. Hence, the payments for royalties and licensing fees have been consistently higher than receipts, contributing to persistent deficits in intellectual property trade. The US has remained the largest exporter of intellectual property to Malaysia.

[4]Data obtained from World Bank Statistical Database.

CHAPTER 8
- INFORMATION AND COMMUNICATIONS TECHNOLOGY IN MALAYSIA

CHAPTER 8

INFORMATION AND COMMUNICATIONS TECHNOLOGY IN MALAYSIA

8.0 INTRODUCTION

Malaysia's determination to achieve a developed nation status by 2020 has brought along with it higher requirements for Information and Communications Technology (ICT) in all the critical aspects of the economy. Indeed, in the 10MP, the ICT sector has been identified as one of the New Key Economic Areas to steer the country's transformation towards a high income and innovation driven economy. With increasing attention geared towards the sector, along with the converging trend in the industries due to digitalisation, the sector is expected to gain further significance in the Malaysian economy with its share of total GDP to increase to around 10.2% in 2015 from 9.8% in 2009.

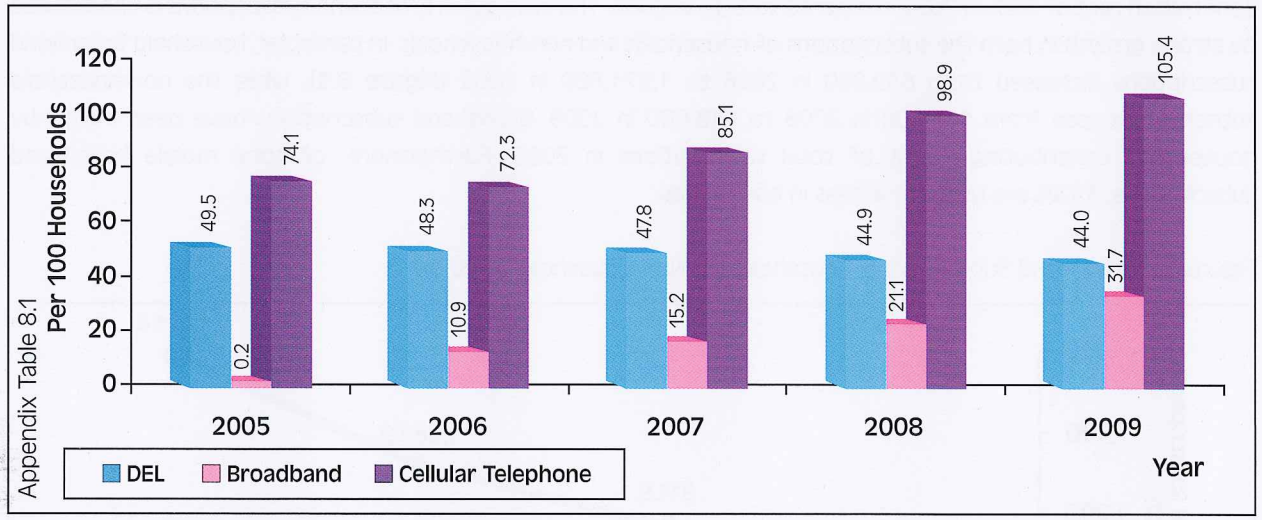
This chapter analyses the recent developments in the ICT sector in Malaysia by focusing on its infrastructure and access, current trends in the ICT industry including the development of e-commerce, and the various funding supports and expenditure on the sector. The chapter ends with some international comparisons on ICT adoption in various countries and a conclusion.

8.1 ICT INFRASTRUCTURE AND ACCESS

The ICT infrastructure and access in Malaysia can be analysed based on the penetration rates for the Direct Exchange Lines (DEL), cellular telephones, and internet access. In general, the indicators showed increasing penetration rates for cellular telephones and internet access, while that of the DEL showed a consistent decline over the years **(Figure 8.1)**. The penetration rate for cellular telephones, in particular, breached the 100 level in 2009, growing at a double digit rate of 42.2% from 74.1 per 100 inhabitants at end 2005 to 105.4 per 100 inhabitants at end 2009. Consistent with the sustained household income amid the relatively stable economic situation, and coupled with the increasing popularity of cellular telephones as a telecommunication channel, total cellular telephone subscriptions are expected to increase further, thus pushing the penetration rate further to around 108.9 per 100 inhabitants by end 2010.

The trend in internet access in Malaysia has been encouraging. This is in line with the government's efforts to improve ICT infrastructure so as to increase its adoption and reduce the digital divide in the country. Consequently, the broadband penetration rate has shown an encouraging performance, from 0.2 per 100 households at end 2005 to 31.7 per 100 households at end 2009. It is encouraging to note that due to the sustained high broadband subscriptions, particularly by the household sector, the country's broadband penetration rate has surpassed the 2010 target set by the government under the National Broadband Initiatives at 50 per 100 households. Meanwhile, amid the increased reliance on cellular telephones and internet as media of communication, the penetration rate for DEL showed a consistent declining trend to 44.0 per 100 households at end 2009 from 49.5 per 100 households in 2005.

Figure 8.1: Penetration Rates for DEL, Cellular Telephones and Broadband in Malaysia, 2005 – 2009

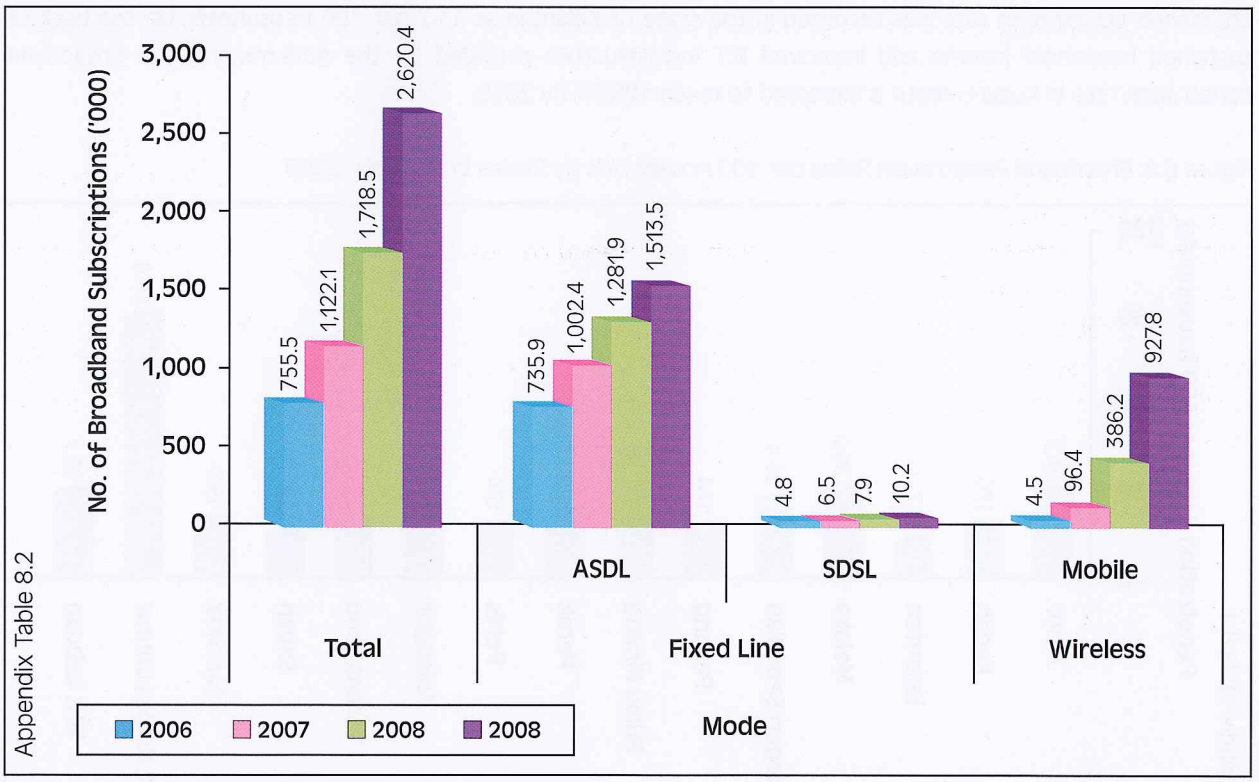


Source: Malaysian Communications and Multimedia Commission

8.1.1 Modes of Internet Access in Malaysia

Internet access in Malaysia is mainly in the form of fixed line (comprising predominantly Asymmetric Digital Subscriber Line (ADSL) and Symmetric Digital Subscriber Line (SDSL) and wireless (predominantly mobile). For fixed line, subscriptions of ADSL rose steadily to 1,513,500 at end of 2009 from 735,900 in 2006, while subscription of SDSL rose to 10,200 in 2009 from 4,800 in 2006 **(Figure 8.2)**. As for wireless, total subscription staged an impressive performance to 927,800 in 2009, from a mere 4,500 in 2006. In total, broadband subscriptions staged an impressive growth of around 250%, from 755,500 in 2006, to 2,620,400 in 2009.

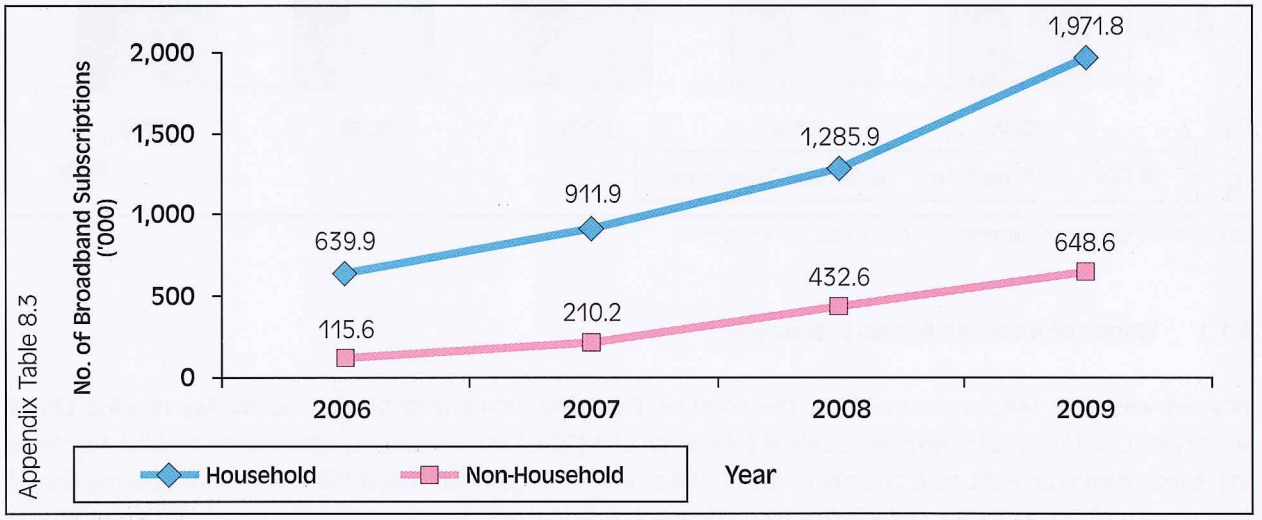
Figure 8.2: Modes of Internet Access in Malaysia, 2006 – 2009



Source: Malaysian Communications and Multimedia Commission

Due to the encouraging performance of internet subscriptions, Malaysia recorded a higher population broadband penetration rate of 9.2% in 2009 compared to 2.8% in 2006. The increase in broadband subscriptions is contributed by strong growth in both the subscriptions of households and non-households. In particular, household broadband subscriptions increased from 639,900 in 2006 to 1,971,800 in 2009 **(Figure 8.3)**, while the non-household subscriptions rose from 115,600 in 2006 to 648,600 in 2009. Broadband subscriptions have been mainly by households, contributing 75.4% of total subscriptions in 2009. Furthermore, of total mobile broadband subscriptions, 39.4% are used for access in households.

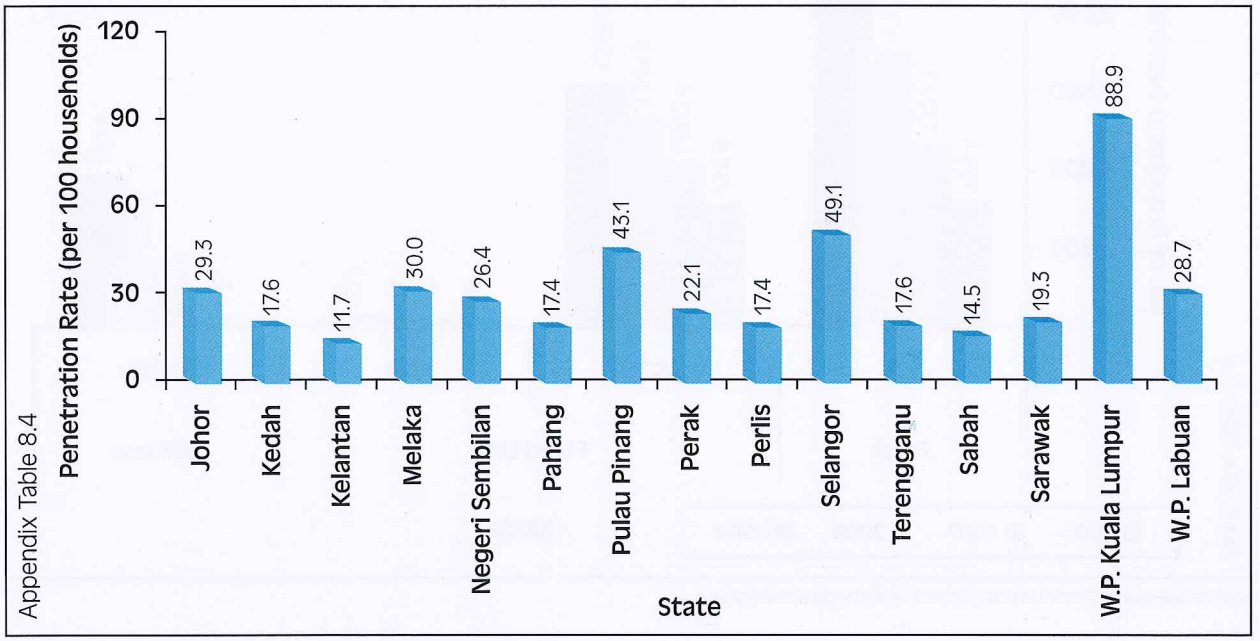
Figure 8.3: Broadband Subscriptions: Household and Non-Household, 2006-2009



Source: Malaysian Communications and Multimedia Commission

Over the years, the household broadband penetration rate has registered a steady increase to 31.7 per 100 households in 2009, from 15.2 in 2007. Penetration rate was the highest in Kuala Lumpur, at 88.9 per 100 households, followed distantly by Selangor at 49.1 per 100 households, and Penang at 43.1 per 100 households **(Figure 8.4)**. The lowest broadband penetration rate was recorded in the state of Kelantan at 11.7 per 100 households. On the back of sustained household income and improved ICT infrastructure provided by the government, the broadband penetration rate in Kuala Lumpur is expected to reach 100.0% by 2010.

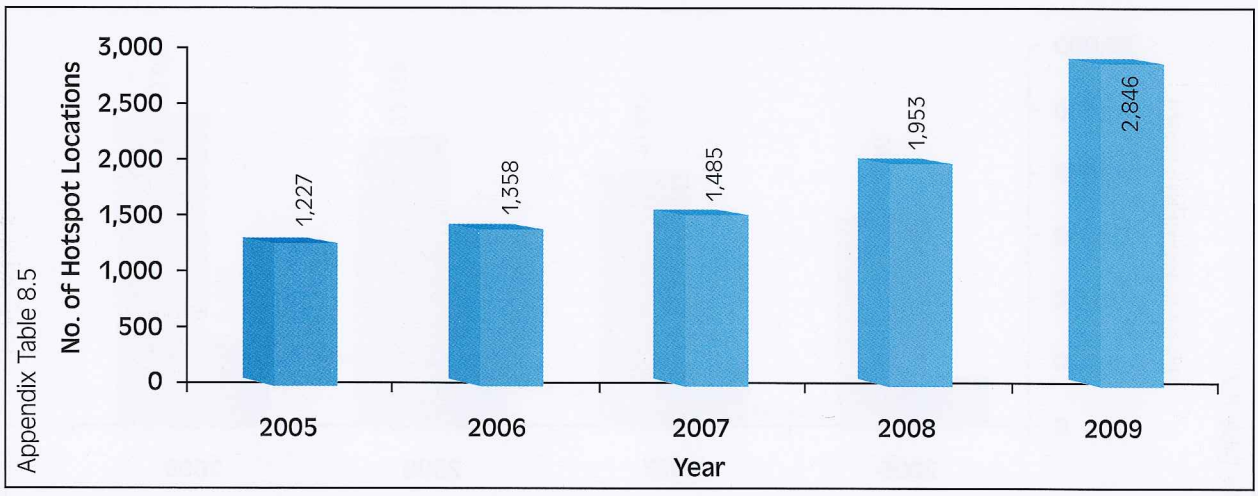
Figure 8.4: Broadband Penetration Rates per 100 Households by States in Malaysia, 2009



Source: Malaysian Communications and Multimedia Commission

Hotspots and WiFi continued to gain popularity among internet users in Malaysia. Hotspot locations have registered a steady increase from 1,227 in 2005 to 2,846 in 2009, of which more than 50.0% of the hotspot locations were in Kuala Lumpur (617) and Selangor (844) **(Figure 8.5)**. With the increasing hotspot locations, hotspot subscriptions rose dramatically from 20,300 in 2005 to 375,500 in 2009, while the more recent WiFi broadband subscription is making a strong presence, with 263,900 subscriptions in 2009.

Figure 8.5: Number of Hotspot Locations in Malaysia, 2005 – 2009

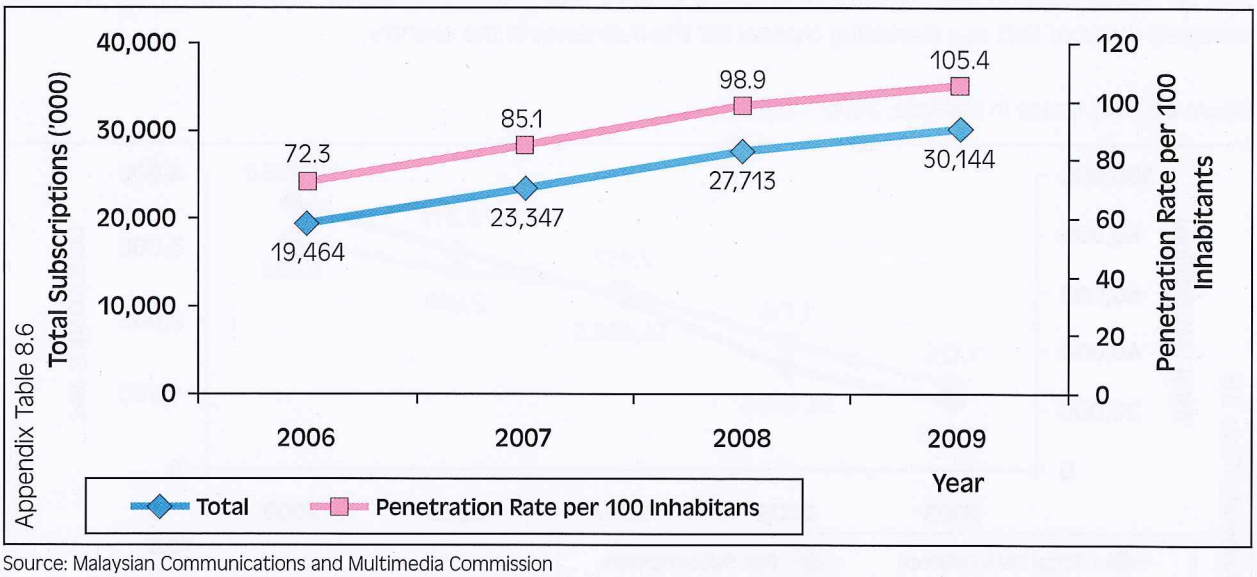


Source: Malaysian Communications and Multimedia Commission

8.1.2 Cellular Telephones in Malaysia

Cellular telephones have become a major form of telecommunication in Malaysia as reflected by several indicators. Total subscriptions of cellular telephones in the country have recorded a phenomenal increase, from 19,464,000 in 2006 to 30,144,000 in 2009, or a growth of about 50.0% over the period **(Figure 8.6)**. In line with this trend, the cellular telephone penetration rate has breached the 100 mark in 2009, indicating multiple subscriptions per household. In particular, the cellular telephone penetration rate rose from 72.3 per 100 inhabitants in 2006 to 105.4 per 100 inhabitants in 2009. Indeed, with the declining costs of communication using cellular telephones, the increasing trend in the penetration rate is expected to be sustained in the future.

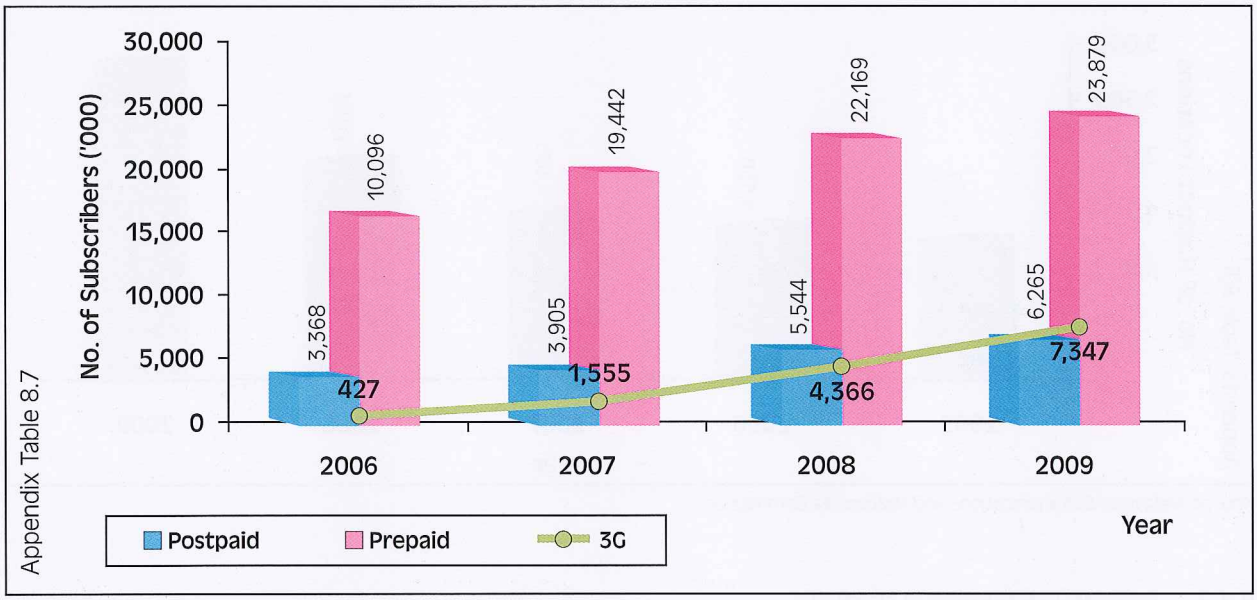
Figure 8.6: Cellular Telephone Subscriptions and Penetration Rates in Malaysia, 2006 – 2009



Source: Malaysian Communications and Multimedia Commission

Of the total cellular telephone subscriptions, 79.2% (or 23,879,000) are prepaid services, while the 20.8% (or 6,265,000) are postpaid services **(Figure 8.7)**. The relative popularity of prepaid services compared to postpaid services can be attributed to the innovative payment plans by the service providers that enable competitive rates, and thus lower costs to the subscribers. Meanwhile, the 3G subscriptions surged from 427,000 in 2006 to 7,347,000 in 2009, reflecting increased product sophistication, in line with ICT advancement.

Figure 8.7: Cellular Telephones and 3G Subscriptions in Malaysia, 2006 – 2009

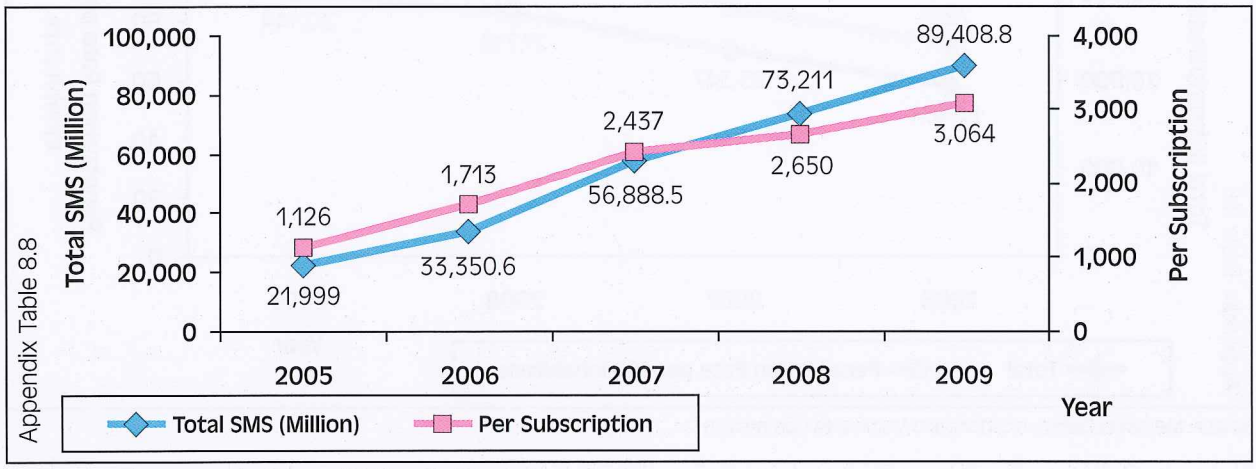


Source: Malaysian Communications and Multimedia Commission

Further breakdown of cellular telephone penetration rate by states show that four states have penetration rates of more than 100.0% in 2008, namely Kuala Lumpur (151.8%), Melaka (102.7%), Penang (101.4%) and Johor (101.3%). States that have the lowest penetration rates are Sabah and Terengganu at 58.5% and 62.6%, respectively.

In line with the increasing importance of cellular telephones as a telecommunication channel in the country, the use of short message services (SMS) showed a phenomenal increase. A total of 89,408.8 million SMS were transferred in 2009 compared with 21,999.0 million in 2005, or an equivalent of 3,064 SMS per subscription compared to 1,126 SMS per subscription in the corresponding period **(Figure 8.8)**. The high usage of SMS is also in line with the increased usage of SMS as a marketing channel for the businesses in the country.

Figure 8.8: SMS Usage in Malaysia, 2005 – 2009

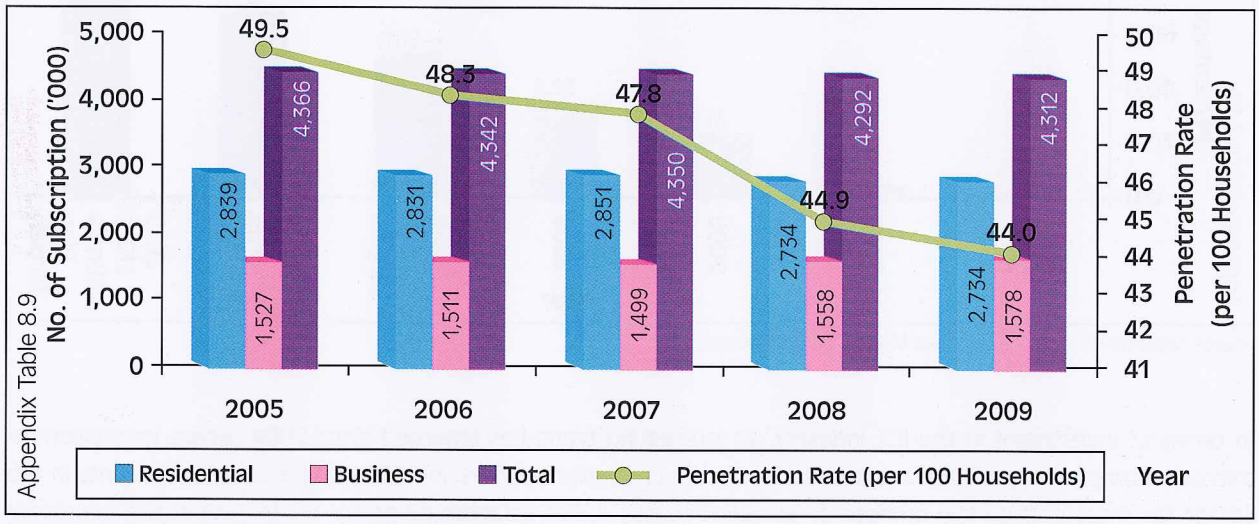


Source: Malaysian Communications and Multimedia Commission

8.1.3 Direct Exchange Lines in Malaysia

Subscriptions of DEL has continued its downward trend in the post-2000 period amid the increasing importance of cellular telephones and internet services as major forms of telecommunication in Malaysia. In particular, DEL subscriptions per 100 households has further declined to 44.0% in 2009, from around 50.0% in 2005 **(Figure 8.9)**. In contrast, DEL connection for businesses has shown a steady increase over the years. In particular, the number of business subscriptions increased slightly to 1,578,000 in 2009, from 1,527,000 in 2005. In view of this offsetting effect, total subscriptions of DEL for Malaysia has been consistently around the 4,312,000 level in 2009.

Figure 8.9: DEL Penetration Rates in Malaysia, 2005 – 2009



Source: Malaysian Communications and Multimedia Commission

The decline in the overall DEL penetration rate in Malaysia was contributed by lower DEL penetration rates across all states in the country, except for Selangor. Kuala Lumpur showed a glaring decline in DEL penetration rate to 31.9% in 2009, from 68.5% in 2006. As for Selangor, the sustained trend in the DEL penetration rate in the state is attributable to the stable DEL subscriptions by the business sector amid the stable economic environment.

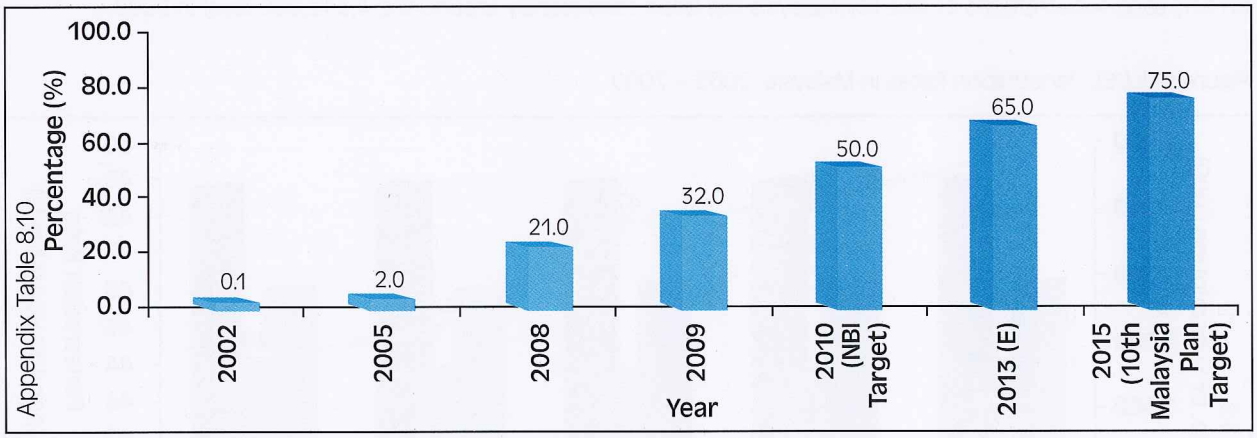
8.2 THE ICT INDUSTRY

The Malaysian ICT industry recorded a slower growth of 5.0% in 2009 compared to 7.0% in 2008 on the back of weak demand in the aftermath of the global financial crisis. However, the ICT sector is expected to accelerate in 2010 and beyond, fuelled by higher spending in hardware as the government embarks on the programs and initiatives of the 10MP. The higher growth projection is also based on a more favourable external environment following the expected recovery in the US and sustained robust performance of the Chinese economy. As such, total IT spending is estimated to be higher, at US$ 6.0 billion in 2010 compared to US$ 5.4 billion in 2009 (Economist Intelligence Unit).

On the domestic front, several factors contributed positively to the performance of the ICT sector, which has benefitted tremendously from the government's efforts to aggressively promote ICT adoption in its economic and social agenda. In particular, the National Broadband Initiatives has set the target for the household broadband penetration rate at 50.0% by 2010, and further, to 75.0% by 2015 under the 10th MP **(Figure 8.10)**. In achieving this target, the High Speed Broadband and Broadband to General Population initiatives have been rolled-out by the government, resulting in a great boost in the ICT industry. Other factors include increasing demand for ICT consumer products, sustained growth in the sector in particular, the financial services sector, growth in online and mobile applications, and other related broadband services and applications.

In addition, the various incentives by the government to promote ICT adoption and reduce the digital divide in the country such as providing income tax relief on broadband subscription, loans to Government employees to purchase PCs, and netbook schemes to university students, have also contributed positively to the performance of the industry. Among the major telecommunications service providers that are involved in the provision of broadband services are TM, Time dotCom, Maxis Communication Bhd, Jaring and PenangFON (for Penang).

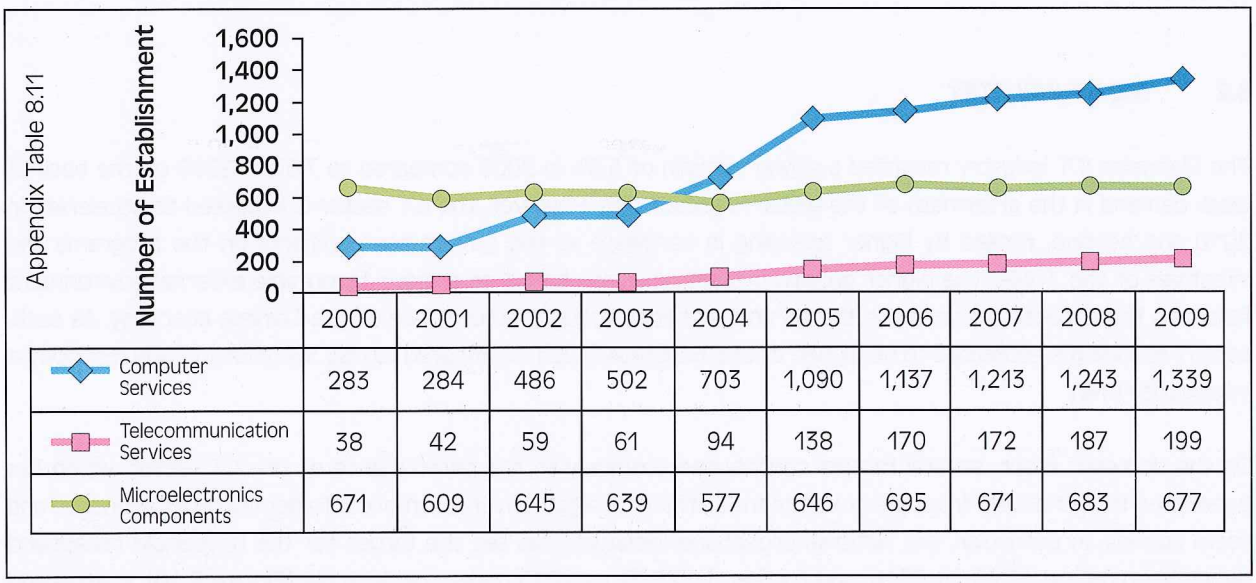
Figure 8.10: Projections for Household Broadband Penetration Rates in Malaysia, 2002 – 2015



Source: Malaysian Communications and Multimedia Commission

In terms of investment in the ICT industry, an interesting trend has emerged since 2004, where investment in microelectronics components is surpassed by that in computer services. In 2009, of the total investments in the sector (as measured by the number of establishments), 1,339 establishments (or 60.4%) are in the computer services components, 677 establishments (or 30.6%) are in microelectronics, and 199 establishments (or 9.0%) are in telecommunications services **(Figure 8.11)**. The increasing importance of investment in the computer services components is in line with the current emphasis on the ICT applications in the economy which, in particular, involve activities such as IT/computing, hardware consultancy, software consultancy and maintenance and repair services.

Figure 8.11: Investment in the ICT Industry by Type, 2000 – 2009



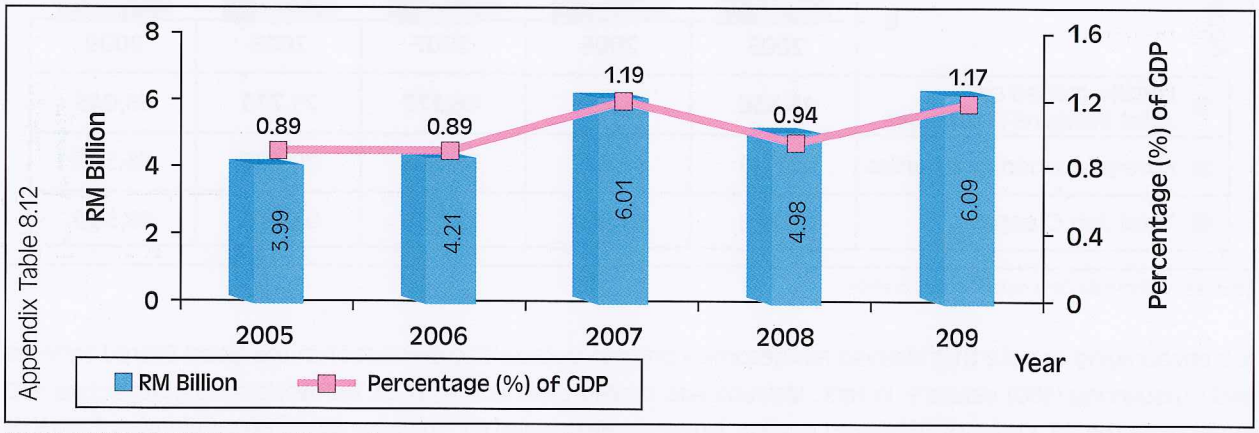
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Computer Services	283	284	486	502	703	1,090	1,137	1,213	1,243	1,339
Telecommunication Services	38	42	59	61	94	138	170	172	187	199
Microelectronics Components	671	609	645	639	577	646	695	671	683	677

Source: Ang, C. J., Yew, O. K., and Ramasamy, R. (2010). Enhancing competitiveness of the ICT industry, ICT Strategic Review 2010/2011, MOSTI/PIKOM

8.2.1 Multimedia Super Corridor (MSC) Malaysia

A major contributing factor to the encouraging performance of the ICT industry can largely be attributed to the government's effort to implement the MSC Malaysia initiatives. The initiatives which were embarked in 1996 have started to bear fruits and indeed, are currently spearheading the ICT industry and contributing positively to the overall economy. In the past five years, the contribution of the MSC Malaysia status companies to the country's total GDP has increased gradually from RM 3.99 billion (or 0.89% of GDP) in 2005 to RM 6.09 billion (or 1.17% of GDP) in 2009 **(Figure 8.12)**.

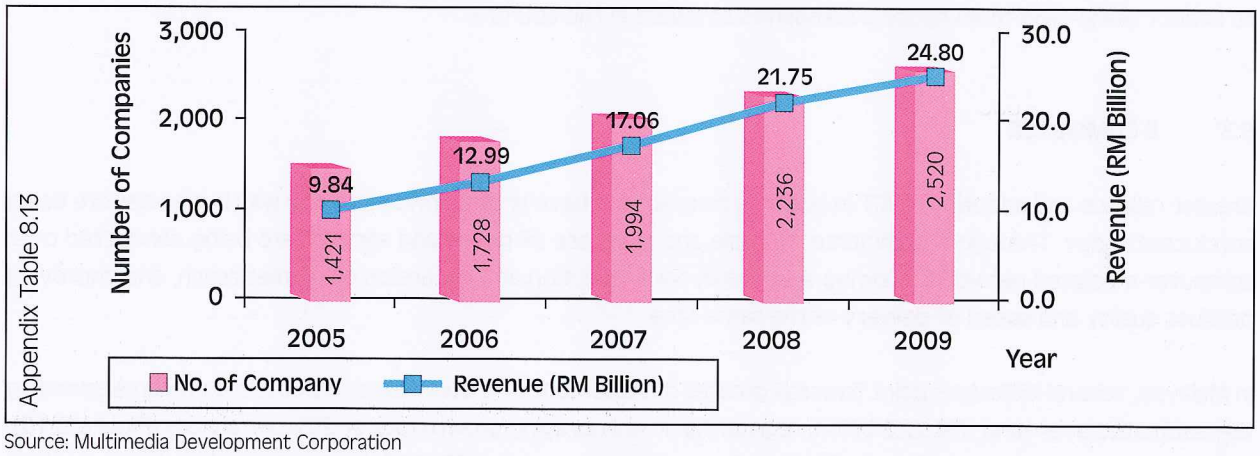
Figure 8.12: MSC Malaysia Companies' Contribution to GDP, 2005-2009



Source: Multimedia Development Corporation

Reflecting increased adoption of high multimedia technologies in production and process development, the number of companies granted the MSC Malaysia status have quadrupled from 429 companies in 2000 to 2,520 companies in 2009, comprising of 1,952 (or 77.4%) are locally-owned and/or joint-venture companies, and 568 (or 22.6%) are foreign-owned companies. Total revenue generated by these companies surged by 152.0%, reaching RM 24.80 billion at end-2009 from RM 9.84 billion at end-2005 **(Figure 8.13)**. Of total sales in 2009, RM 17.65 billion (or 71.2%) is for the local market, while the remaining RM 7.15 billion (or 28.8%) is for the export market.

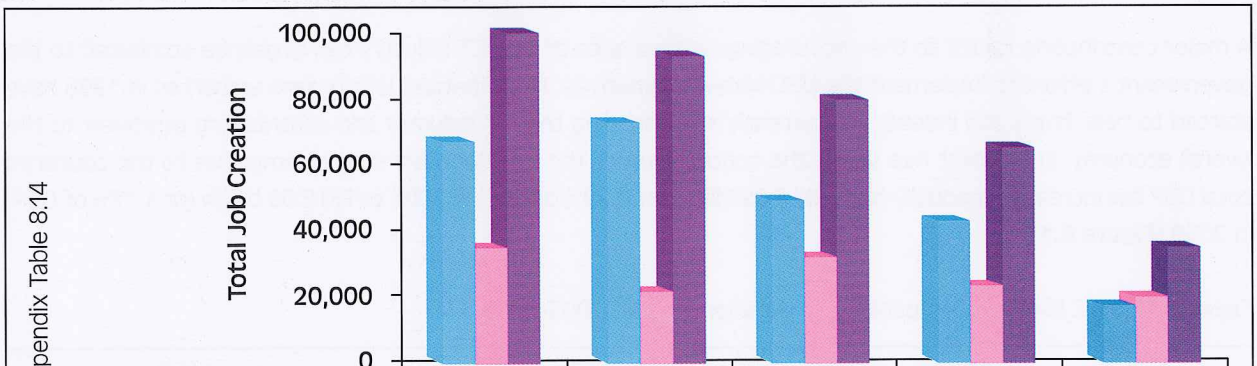
Figure 8.13: MSC Malaysia Companies: Number of Companies and Revenue, 2005-2009



Source: Multimedia Development Corporation

The MSC Malaysia status companies have also contributed towards providing employment opportunities in the country. Total job creation of these companies reached 99,590 workers in 2009, of which 66,043 jobs (or 66.3%) are contributed by the locally-owned and/or joint-venture companies **(Figure 8.14)**. In 2009, the Shared Services and Outsourcing cluster was the largest employment generator, contributing 38.2% of the total employment generated during the year, followed by the InfoTech cluster (27.8%), Institutions of Higher Learning (IHLs) cluster (26.7%), Creative Multimedia cluster (7.1%), and Incubator cluster (0.2%). Additionally, the R&D expenditure of the MSC Malaysia status companies has reached RM 1.5 billion at end 2009 compared to RM 0.57 billion in 2005.

Figure 8.14: MSC Status Companies: Job Creation, 2005-2009



	2005	2006	2007	2008	2009
Locally-owned or Joint-Venture Companies	15,530	41,897	48,277	71,775	66,043
Foreign-owned Companies	18,321	22,010	30,728	20,426	33,547
Total Job Created	33,851	63,907	79,005	92,201	99,590

Sources: Multimedia Development Corporation

It is encouraging to note that Malaysia has become a premier outsourcing destination in the global Shared Services and Outsourcing (SSO) industry. In fact, Malaysia was ranked third in the list of the world's most attractive SSO location by the AT Kerney's Offshore Location Attractiveness Index for the past six consecutive years (2004 to 2009). The country also ranked high and gained recognition in several other SSO lists and international reports including that of KPMG's New Emerging Destinations 2009, Gartner's Preferred Data Center Location 2008, and Deloitte's Asian Advantage in the Outsourcing Revolution 2005.

According to Frost & Sullivan, the global SSO industry is estimated to grow by 15.0% per annum, with a market size of approximately US$ 1,430.0 billion by end 2009. Within Malaysia, the SSO industry is estimated at US$ 1.1 billion in 2009, mainly in Business Process Outsourcing (BPO), Systems Integration, and IT Consulting. Major verticals in SSO spending in the country remain the Government sector, the Financial Services Industry, and manufacturing. The SSO industry has benefited substantially from the MSC Malaysia initiatives, which provide numerous incentives to attract world-class multi-national companies to invest in the country.

8.3 E-COMMERCE

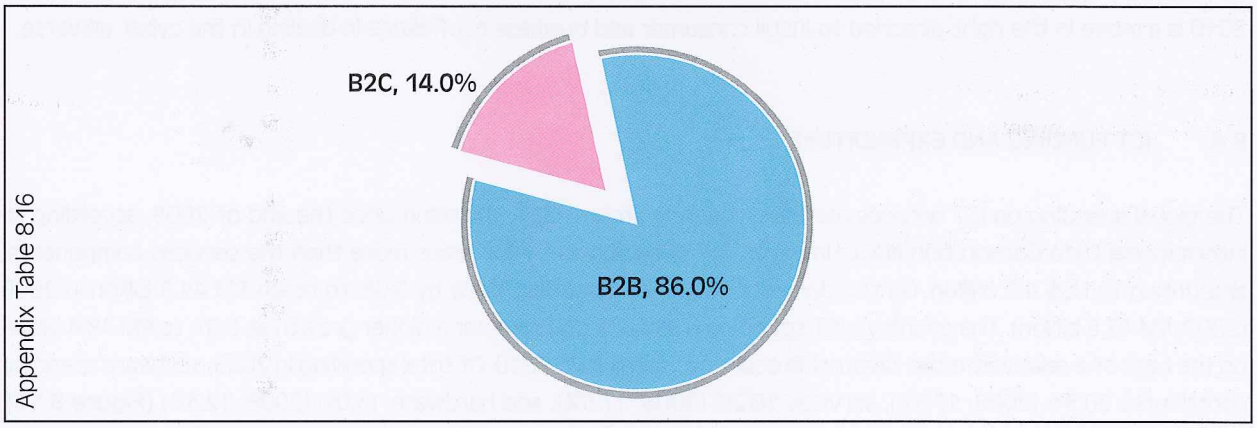
Greater reliance and adoption of ICT in business transactions have greatly influenced the way businesses are being conducted today. Through e-commerce, the sale and purchase of goods and services are being conducted over computer-mediated networks, allowing substantial cost reduction and expansion of market reach, and improving product quality and speed of delivery at the same time.

In Malaysia, several indicators point towards greater development of e-commerce. In 2009, e-commerce spending was estimated at around US$ 22.2 billion, registering an encouraging growth rate at 29% per annum **(Figure 8.15).** By 2013, e-commerce spending in Malaysia is expected to reach US$ 64.2 billion. According to an analysis conducted by Frost & Sullivan, of the total e-commerce spending amounting to US$ 11.1 billion in 2006, Business to Business (B2B) spending comprised a large proportion, accounting for 86.0%, while Business to Customers (B2C) spending contributed a mere 14.0% **(Figure 8.16)**. Based on a survey by Nielsen Company in 2007, 39.0% of Malaysians made purchases online, while 70.0% of Malaysian internet users had the experience of making online purchases.

Figure 8.15: Total e-Commerce Spending in Malaysia, 2005 – 2013

Source: E-commerce adoption in Malaysia, ICT Strategic Review 2010/2011, MOSTI/PIKOM

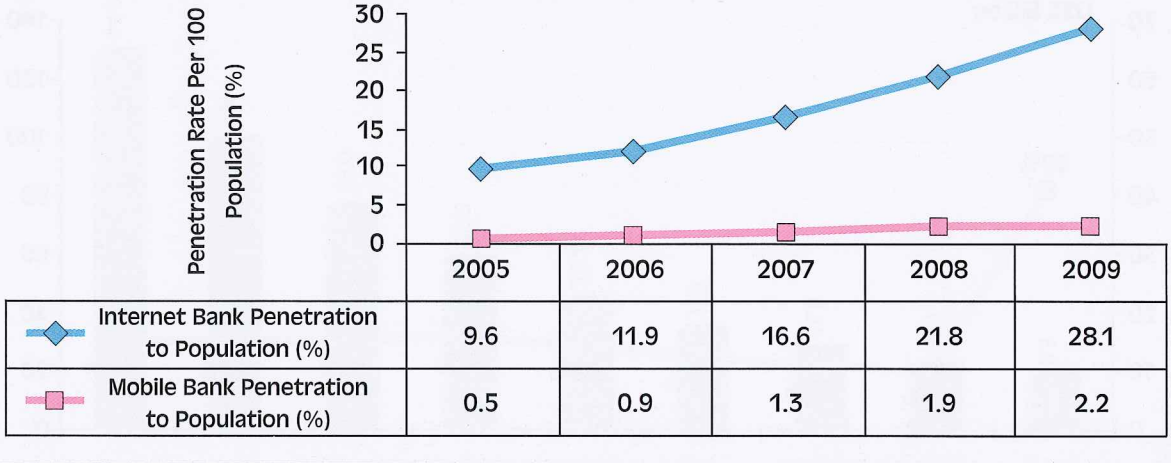
Figure 8.16: Total e-Commerce Spending by Type in Malaysia in 2006



Source: E-commerce adoption in Malaysia, ICT Strategic Review 2010/2011, MOSTI/PIKOM

An area in which e-commerce has been highly adopted in this country is the banking sector, as indicated by the internet and mobile banking penetration rates. In 2009, the internet banking penetration rate reached 28.1 per 100 population, from 9.6 per 100 population in 2005 **(Figure 8.17)**. The more recent mobile banking services has started to increase its presence with its penetration rate at 2.2 per 100 population in 2009 compared to 0.5 per 100 population in 2005. Collectively, 20 million e-banking services were recorded in 2008, which include activities such as inquiries, bill payments, fund transfers, credit card payments, insurance, and share investing. The government's consistent promotion of e-services such as e-procurement, e-filing, and e-refund have also contributed positively to the development of e-commerce in the country. According to the Special Task Force to Facilitate Business (or PEMUDAH), 118 government agencies offered a total of 278 e-payment services as at December 2009.

Figure 8.17: Internet and Mobile Banking Penetration Rates in Malaysia: 2005 – 2009



Appendix Table 8.17

	2005	2006	2007	2008	2009
Internet Bank Penetration to Population (%)	9.6	11.9	16.6	21.8	28.1
Mobile Bank Penetration to Population (%)	0.5	0.9	1.3	1.9	2.2

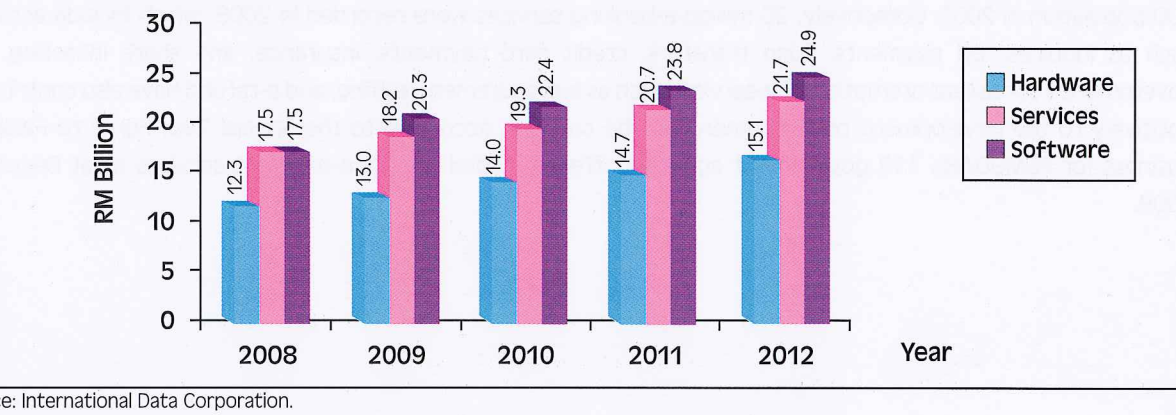
Source: Abdul Wahab, A., Saleh, S., and Abdul Razak, M. (2010). Uptake of e-commerce in Malaysia, ICT Strategic Review 2010/2011, MOSTI/PIKOM

The prospects for e-commerce in Malaysia are bright in view of the encouraging current trend in e-commerce spending and adoption as well as the continuous support by the government. Despite the vast opportunities and benefits of e-commerce, there remain several issues that need to be further refined, including authenticity, safe payment options, and service quality. More importantly is the issue of security, which is highly critical in ensuring confidence in dealing within the cyber-universe. In this regard, the introduction of the Personal Data Protection Act 2010 is a move in the right direction to instill consumer and business confidence in dealing in the cyber universe.

8.4 ICT FUNDING AND EXPENDITURE

The global spending on ICT services has been lingering around US$ 1.0 trillion since the end of 2009, according to International Data Corporation (IDC). However, ICT spending was four times more than the services components, amounting to US$ 4.0 trillion. On the domestic front, ICT spending grew by 5.0% to reach RM 44.9 billion in 2009 (2008: RM 42.8 billion). The country's ICT spending is expected to register a higher growth at 6.0% to RM 48.4 billion on the back of a relatively more favourable economic scenario in 2010. Of total spending in 2009, software spending contributes 20.3% (2008: 17.5%), services 18.2% (2008: 17.5%), and hardware 13.0% (2008: 12.3%) **(Figure 8.18)**. Key sectors in ICT spending are the government sector (mainly in education, e-government projects, and the development of corridor projects); the telecommunications sector (mainly in high-speed broadband and WIMAX infrastructure); and the financial services industry (in developing the ICT base for Islamic banking and finance).

Figure 8.18: ICT Spending in Malaysia, 2008-2012



Appendix Table 8.18

Source: International Data Corporation.

In terms of funding, the creation of the "Facilitation Fund", amounting to RM 20.0 billion in the 10th MP, is expected to provide substantial catalyst for further development of the ICT sector **(Table 8.1)**. In particular, the fund is intended to facilitate Private Finance Initiative (PFI) as part of the government's continuous efforts to promote public-private partnerships in projects with high ICT infrastructure requirements, particularly the HSBB Initiatives, which cost approximately RM 11.3 billion over a span of 10 years. Other public projects with high ICT requirements include the biotechnology clusters in Iskandar Malaysia and the upgrading of the traffic infrastructure system around KL Sentral. The specific type of government grants for the development of the ICT industry is given in **Table 8.1** below.

Table 8.1: Types of Government Grants Applicable for the ICT Sector

Ministry	Funding Nomenclature	Funding Focus	Agency Responsible	Focus Area
MOSTI	ScienceFund	Basic Research	MOSTI	General
	TechnoFund	Technology	MOSTI	General
	InnoFund	Innovation	MOSTI	General Community Innovation Fund (CIF) Enterprise Innovation Fund (IEF)
	e-Content Fund	Content Development	MOSTI	ICT
	Demonstrator Application Grant Scheme (DAGS)	Proof-of-Concept	MOSTI	ICT
	MSC Malaysia Research & Developement Grant Scheme (MGS)	Research & Development	MDeC	ICT
	MSC Malaysia Intellectual Property Programme	Intellectual Property Rights (IPR) Development	MDeC	ICT
	MSC Malaysia Pre-seed Fund	Idea Generation	MDeC	ICT
	Commerciallisation of Research Development Funding (CRDF)	Commerciallisation of R&D Result	MTDC	General CRDF 1 CRDF 2 CRDF 3 CRDF 4a CRDF 4b CRDF 4c
MITI	Technology Acquisition Fund (TAF)	Strategic Technology Acquisition	MTDC	General TAF 1 TAF 2
	Market Development Grant (MDG)	Market Development	MATRADE	General
	Brand Promotion Grant (BPG)	Branding	MATRADE	General
	Service Export Fund	Export Promotion	MATRADE	General
MOF	Cradle Investment Programme (CIP)	Idea Generation	Cradle Fund Sdn Bhd / MOF	General

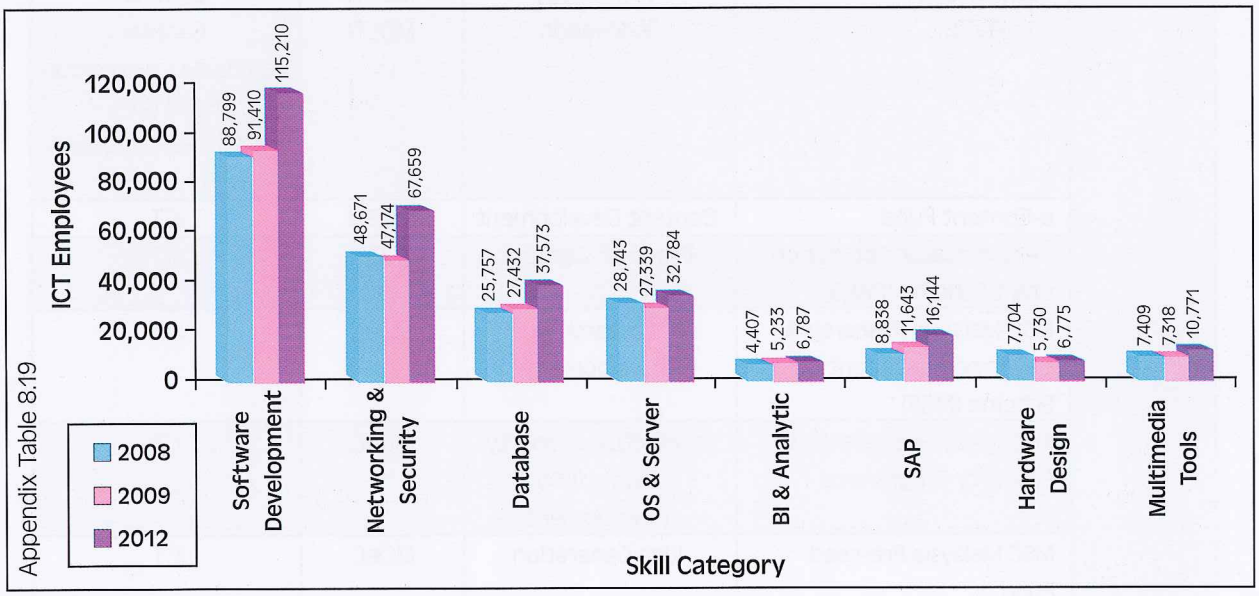
Source: Ramasamy, Ramachandran. (2009). Provision of ICT Grants in Malaysia, ICT Strategic Review 2009/2010, PIKOM/MOSTI
Note: The funds listed were only for 9MP period.

8.5 WORKFORCE IN ICT

In 2010, labour requirement in the ICT industry is expected to reach 800,000 workers, from 365,000 workers in 2005. In tandem with the rapid expansion of the sector, the requirements for labor in the ICT sector will continue to expand as well.

Further breakdown of the demand analysis suggests that the specific category of skills needed are in the areas of software development, networking and security, database, OS and server, BI and analytics, SAP, hardware design, and multimedia tools **(Figure 8.19)**. In particular, the software development category requires the greatest demand, contributing 40.9% of the total demand for ICT employees in 2009. Going into 2012, ICT workers in the areas of multimedia tools, networking and security, and SAP are expected to be highly sought-after as the demand for ICT workers in these skill categories are estimated to grow by 13.8%, 12.8% and 11.5%, respectively.

Figure 8.19: ICT Employee Strength by Skill Categories in Malaysia, 2008-2012



Source: Malaysia ICT Human Capital Study, MDeC. Frost & Sullivan

8.6 INTERNATIONAL COMPARISONS

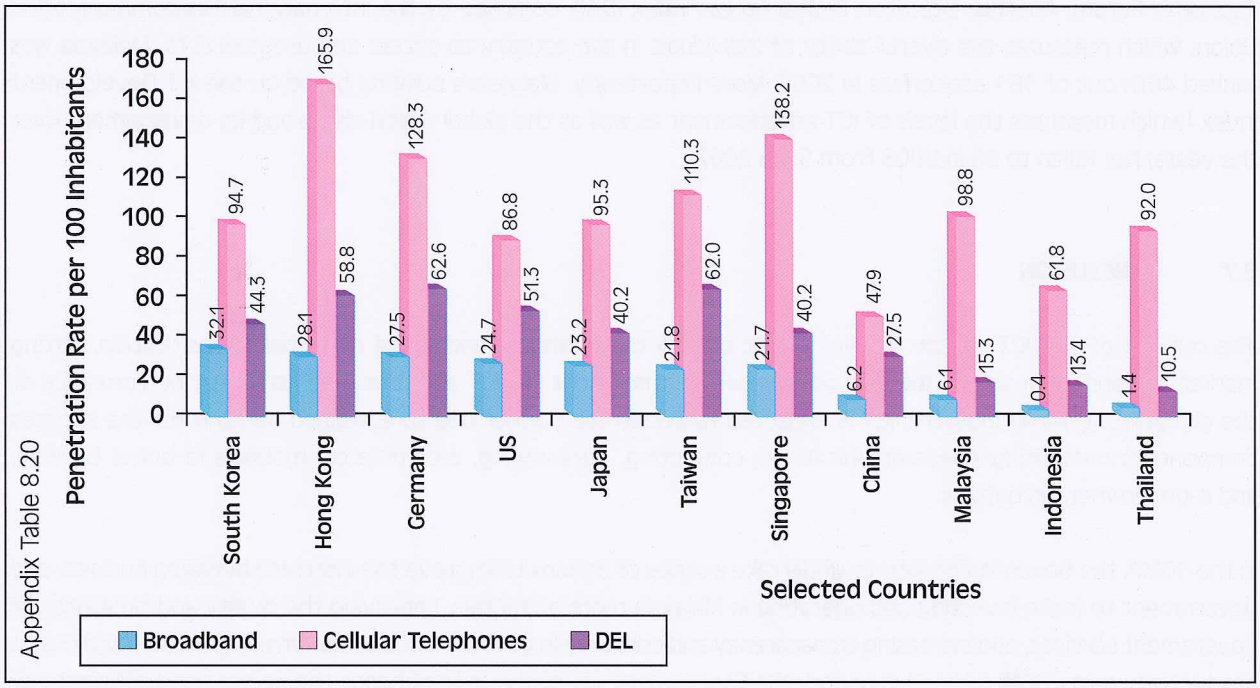
This section discusses how Malaysia fares in ICT adoption and access when compared with other countries. The comparison would also allow for the estimation of the potential development of ICT in the country. The comparisons of the penetration rates for broadband, cellular telephones, and DEL is provided in **Figure 8.20**.

With regard to broadband penetration rate in 2008, Malaysia (6.1%) ranked second after Singapore (21.7%) among the ten ASEAN economies. When compared with the largest ten trading partners, Malaysia was the third last, with South Korea, Hong Kong, Germany, the USA, and Japan being the top five countries having the highest broadband penetration rate in 2008.

In terms of cellular telephone penetration rate, among the ten ASEAN economies, Malaysia also ranked second (98.9%) after Singapore (138.2%) in 2008. This is followed closely by Brunei (95.9%), Thailand (92.0%), and Vietnam (80.4%). The rest of the ASEAN economies have cellular telephones penetration rates of below 80.0%. When compared with its largest ten trading partners, Malaysia fares well, being ranked fifth after Hong Kong (165.9%), Singapore (138.2%), Germany (128.3%), and Taiwan (110.3%).

Lastly, in terms of the DEL penetration rate, compared to the ten ASEAN economies, Malaysia ranked fourth after Singapore (40.2%), Vietnam (33.1%), and Brunei (19.9%) in 2008. However, when compared with its 10 biggest trading partners, Malaysia falls to the eighth place.

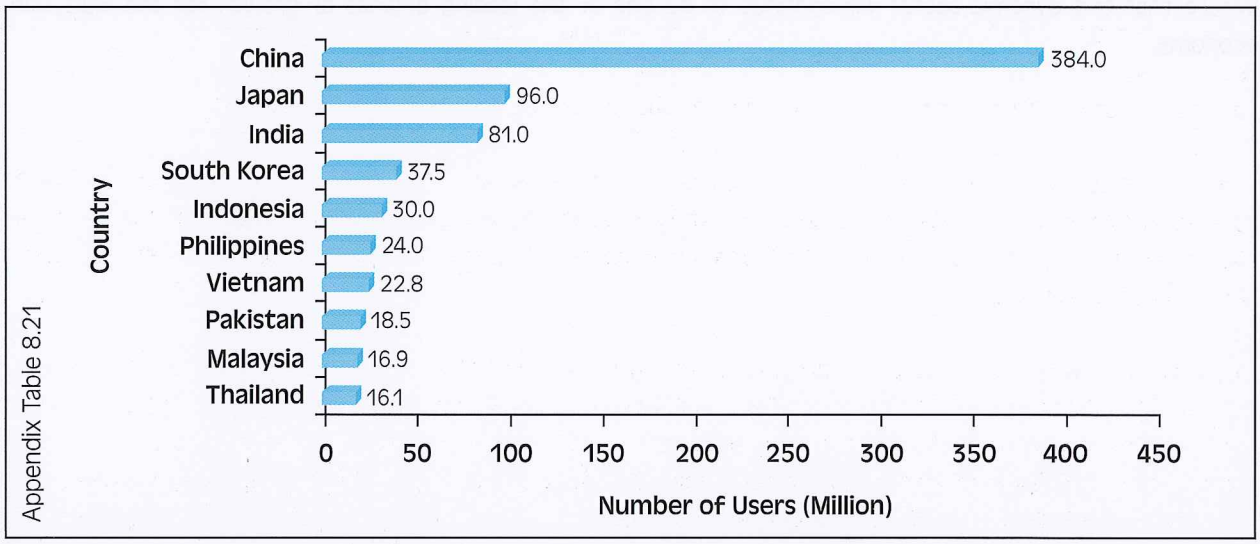
Figure 8.20: Penetration Rates per 100 Inhabitants for Broadband, Cellular Telephones, and DEL in Selected Countries, 2008



Source: Malaysian Communications and Multimedia Commission

In addition to the penetration rates for broadband, cellular telephones, and DEL discussed above, another indicator for ICT adoption in a country is the internet usage among the population. In 2009, it was estimated that there were 1.8 billion internet users worldwide, with the Asian region contributing around 57.6% of the total internet users. Indeed, Malaysia is one of the top ten Asian countries with regard to internet usage, with an estimated 16.9 million internet users in 2009 **(Figure 8.21)**.

Figure 8.21: Top 10 Countries in Internet Usage in Asia, 2009



Source: www.internetworldstats.com/stat3.htm Estimated Internet Users in Asia 764,435,900 for 2009

Several ICT-related indices suggest that ICT has a great potential to be further developed in Malaysia. In terms of the e-readiness ranking which assesses a country's readiness to increase the adoption of ICT (based on ICT infrastructure and the ability of the consumers, businesses, and the government to adopt ICT to their advantage) Malaysia was ranked 38th in 2009 (2008: 34th) out of 69 countries, based on a survey conducted by the Economist Intelligence Unit. The Networked Readiness Index (NRI), which indicates the inclination to exploit the opportunities, offered by ICT, Malaysia ranked 27th out of 115 countries in 2009 based on a survey conducted by the World Economic Forum. Another indicator, Digital Access Index (DAI), compiled by the International Telecommunication Union, which measures the overall ability of individuals in the country to access and use new ICTs, Malaysia was ranked 46th out of 181 economies in 2002. More importantly, Malaysia's position based on the ICT Development Index (which measures the levels of ICT advancement as well as the global digital divide and its development over the years) has fallen to 56 in 2008 from 52 in 2007.

8.7 CONCLUSION

The outlook of the ICT sector remains bright due to the continued increased customer sophistication, strong market demand, high and continuous government commitment for ICT adoption, and its robust performance at the global front. As an industry, ICT is expected to accelerate further due to sustained demand for the services components comprising telecommunications, computing, outsourcing, e-commerce, mobile and online banking, and e-government initiatives.

In the 10MP, the Government aims to undertake a series of actions to improve the interface between business and government to make investing and operating in Malaysia more attractive. Improving the quality and timeliness of government services, and increasing transparency and certainty in government decision-making will yield significant productivity gains. During the Plan period, the Government will continue to enhance the delivery and efficiency of services to business by leveraging ICT. Some of these initiatives include the MyGovXchange for business, SSM Enterprise Services Gateway, and National Single Window (NSW) for trade.

Despite this, there remain several challenges that could hinder the healthy growth of the ICT sector in Malaysia. At the industry level, major issues include the inadequate scope for e-services and content development activities, and lack of strong global brands for Malaysian ICT products and services. At the structural level, the country is still struggling with the persistently wide information, knowledge, and technology gaps as well as the poor broadband services. There are also concerns on the lack of policy and market research and knowledge management system, and insufficient market driven or commercial R&D. In view of this, pro-active strategies need to be undertaken to ensure that this dynamic sector will continue to be one of the leading engines of growth for the Malaysian economy.

CHAPTER 9
- BIOTECHNOLOGY

CHAPTER 9

BIOTECHNOLOGY

9.0 INTRODUCTION

Biotechnology was identified as one of the core technologies in the 8th Malaysian Plan (8MP) (2001 – 2005) that would assist the nation in realising its aspiration of becoming an industrialised country by 2020. Hence, the National Biotechnology Policy (NBP) was launched in 2005 so that a clear framework for the industry's development could be established through three phases: Capacity Building (2006 – 2010), Science to Business (2011 – 2015), and Global Business (2016 – 2020) (Reported in Malaysian Biotechnology Statistical Indicators 2010). The three phases is a strategic framework to be implemented over fifteen years, which aims at long-term growth. The NBP focuses on the following nine areas: healthcare, agricultural and industrial biotechnology, R&D acquisition, human capital development, financial infrastructure, legal and regulatory framework, strategic development, and government support. However, the NBP uses biotechnology to further develop three main sectors from the nine areas namely, healthcare, agricultural biotechnology, and industrial biotechnology.

In assisting and monitoring the biotechnology industry development, Malaysia established the National Biotechnology Division (BIOTEK) in 2005, a government agency under the Ministry of Science, Technology and Innovation (MOSTI), to spearhead the biotechnology missions and visions of the country.

The purpose of this chapter is to discuss the status of the progress and development of biotechnology in Malaysia, in terms of the sector participants, expenditure and allocation, revenues, collaboration projects approved, patents applied for and granted, and research publications. It also includes comparisons of global performance in the biotechnology sector. Data in this chapter are mainly sourced from the Malaysia National Biotechnology Division (BIOTEK).

9.1 SECTOR PARTICIPANTS

This section presents data on the number of firms engaged in biotechnology activities, whether to produce goods or services, and/or to conduct biotechnology research and development (R&D). Biotechnology sectors include healthcare, agricultural and industrial biotechnology, and other areas (consumer goods such as cosmetics, marine biotechnology, food and beverage, waste management, services, and bioinformatics). Most biotechnology firms, research institutes (RIs), and institutions of higher learning (IHLs) are involved in more than one sector.

Figure 9.1 presents the estimated number of biotechnology firms, RIs, and IHLs in the Malaysian biotechnology sector in 2008 and 2009, while **Figure 9.2** shows the estimated number of dedicated biotechnology firms and dedicated biotechnology R&D firms, which increased by 22.7% and 19.3% respectively in 2009. As can be observed from the total number of participants in Malaysian biotechnology, which is estimated at 219 in 2009, biotechnology in Malaysia is still in its early stages[2] of development. Meanwhile, **Figure 9.3** shows the breakdown in the number of participants in each biotechnology sector for firms, RIs, and IHLs in 2009. According to the MBSI 2010, 109 biotechnology firms were involved in healthcare, followed closely by the industrial and agricultural sectors.

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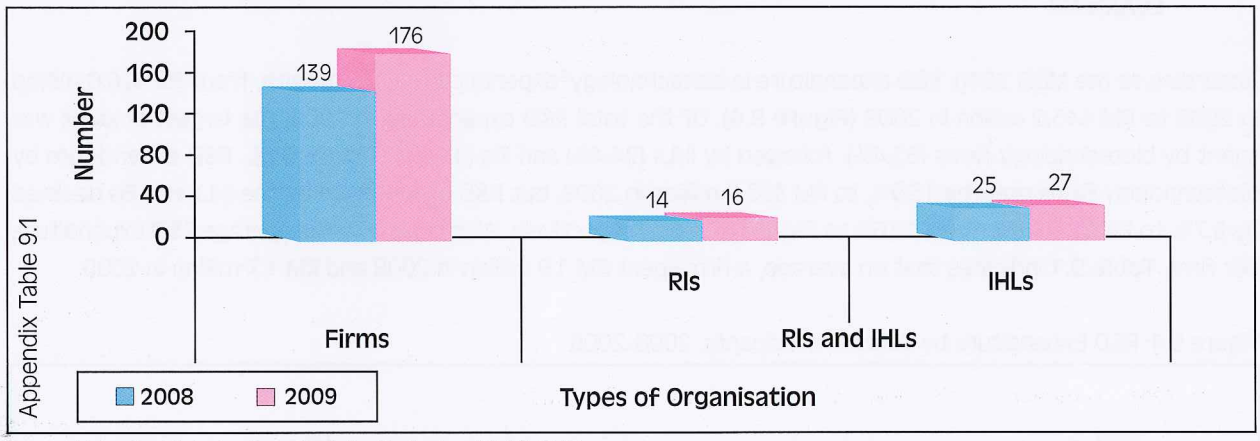
[1] According to Malaysian Biotechnology Statistical Indicators (MBSI) 2010, the Organisation for Economic Co-operation and Development's (OECD) defined a dedicated biotechnology firm as a firm that is involved in at least 75.0% biotechnology activities, while biotechnology R&D firms devote 75.0% of their total R&D to biotechnology R&D.

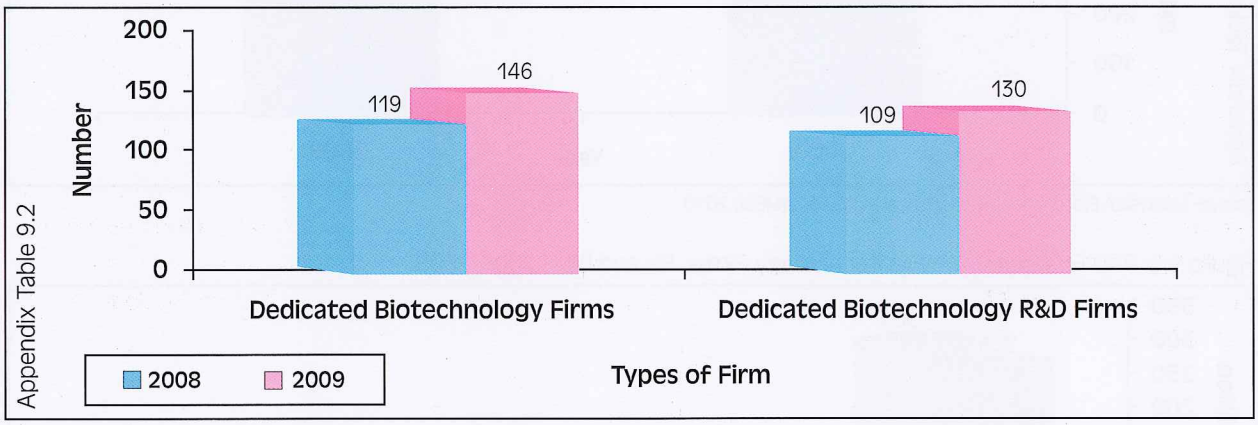
[2] This is based on the procedures carried out by the MBSI 2009-2010 Survey to determine the number of participants in biotechnology in Malaysia.

Figure 9.1: Total Number of Biotechnology Firms, RIs and IHLs in Biotechnology, 2008-2009



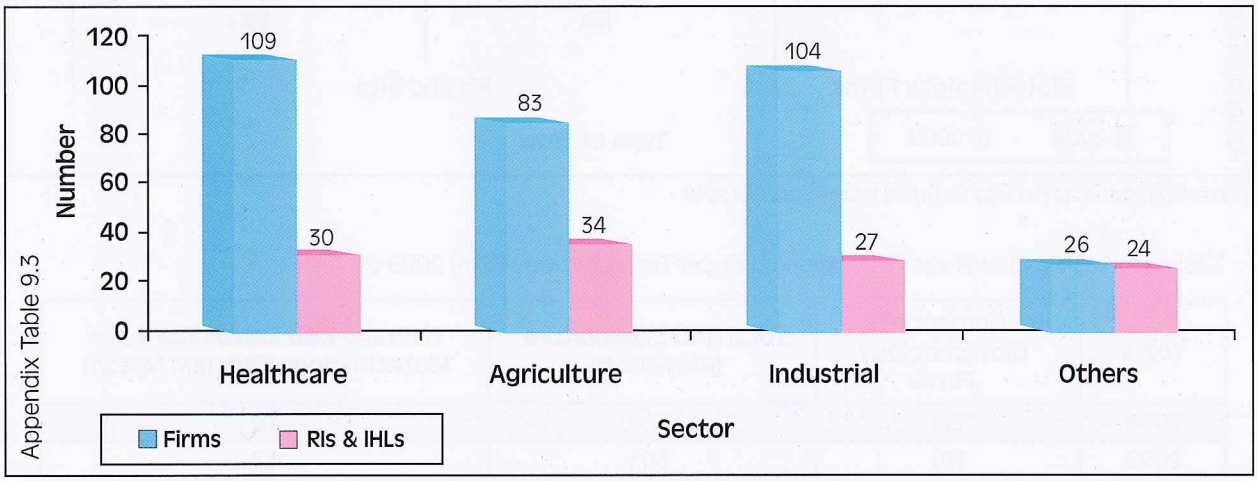
Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

Figure 9.2: Total Number of Dedicated Biotechnology Firms and Dedicated Biotechnology R&D Firms, 2008-2009



Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

Figure 9.3: Number of Participants in each Sector for Biotechnology Firms, RIs and IHLs, 2009

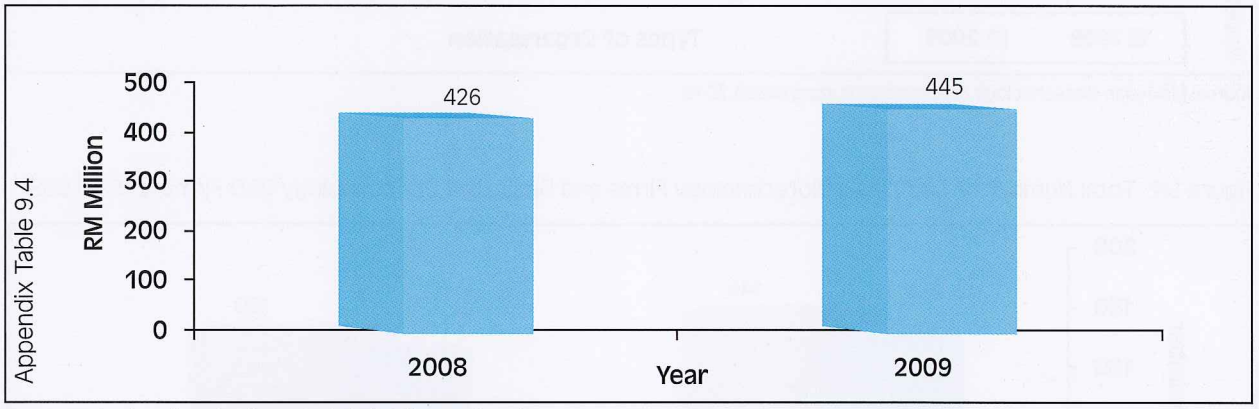


Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

9.2 R&D EXPENDITURE BY BIOTECHNOLOGY FIRMS, RESEARCH INSTITUTES AND INSTITUTIONS OF HIGHER LEARNING

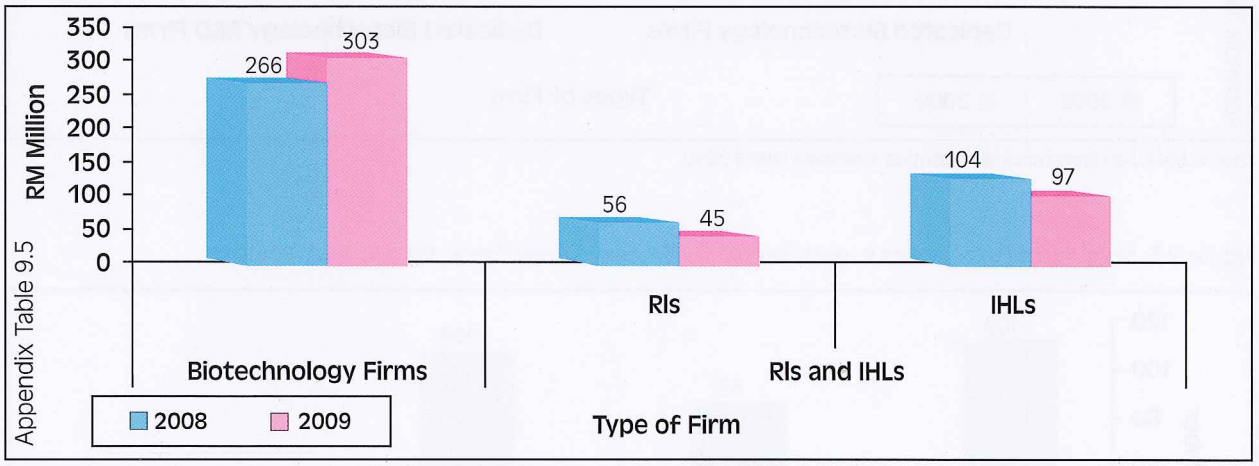
According to the MBSI 2010, R&D expenditure in biotechnology[3] experienced a 4.5% growth, from RM 426.0 million in 2008 to RM 445.0 million in 2009 **(Figure 9.4)**. Of the total R&D expenditure in 2008, the largest amount was spent by biotechnology firms (62.4%), followed by IHLs (24.4%) and RIs (13.1%) **(Figure 9.5)**. R&D expenditure by biotechnology firms grew by 13.9%, to RM 303.0 million in 2009, but R&D expenditure by the IHLs and RIs declined by 6.7%, to RM 97.0 million and 19.6% to RM 45.0 million, respectively. With regard to the average R&D expenditure per firm, **Table 9.1** indicates that on average, a firm spent RM 1.9 million in 2008 and RM 1.7 million in 2009.

Figure 9.4: R&D Expenditure by Sector Participants, 2008-2009



Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

Figure 9.5: R&D Expenditure by Biotechnology Firms, RIs and IHLs, 2008-2009



Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

Table 9.1: Total and Average R&D Expenditure per Biotechnology Firm, 2008-2009

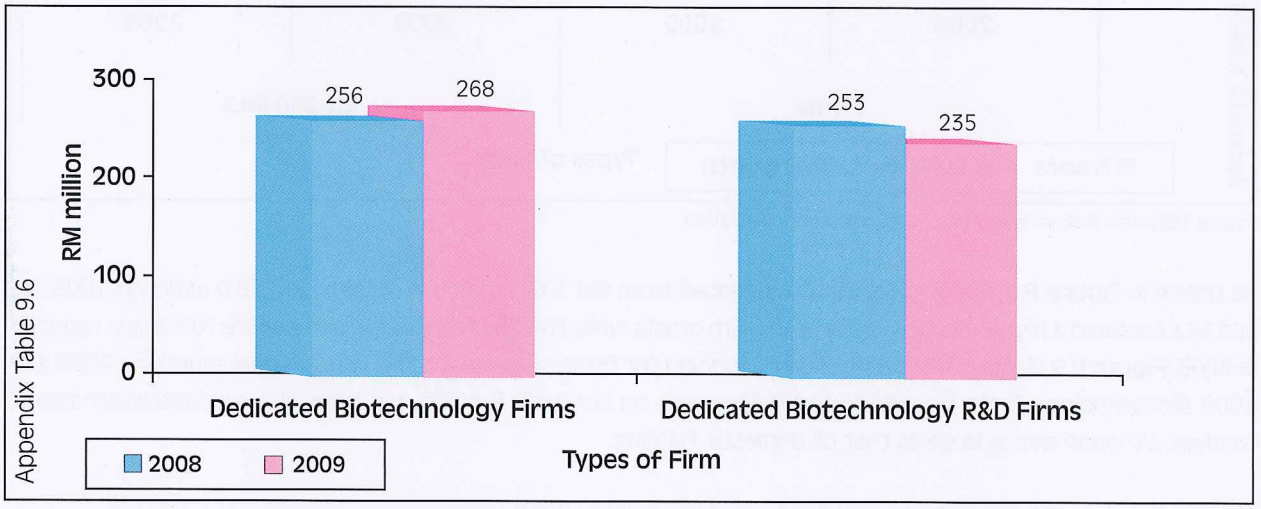
Years	Number of Biotechnology Firms	Total R&D Expenditure (RM Million)	Average R&D Expenditure per Biotechnology Firm (RM Million)
2008	139	266	1.9
2009	176	303	1.7

Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

[3]Due to the low overall response rate of 55.0% obtained in the Malaysian Biotechnology Survey 2009-2010 (as was reported in the MBSI Report 2010), the reported figures for biotechnology R&D expenditure are probably underestimates of the actual biotechnology R&D expenditure in Malaysia.

As for the R&D expenditure of dedicated biotechnology and R&D firms, **Figure 9.6** shows that the expenditure grew by 4.7%, from RM 256.0 million to RM 268.0 million, while the expenditure of dedicated biotechnology R&D firms dropped by 7.1% in 2009. The average R&D expenditure per dedicated firm was RM 2.2 million in 2008 and RM 1.8 million in 2009 **(Table 9.2)**, while that of dedicated R&D firms was RM 2.3 million in 2008 and RM 1.8 million in 2009 **(Table 9.3)**.

Figure 9.6: R&D Expenditure by Dedicated Biotechnology Firms and Dedicated Biotechnology R&D Firms, 2008-2009



Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

Table 9.2: Total and Average R&D Expenditure by Dedicated Biotechnology Firms, 2008-2009

Years	Number of Dedicated Biotechnology Firms	Total Biotechnology R&D Expenditure (RM Million)	Average Biotechnology R&D Expenditure per Dedicated Biotechnology Firm (RM Million)
2008	119	256	2.2
2009	146	268	1.8

Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

Table 9.3: Total and Average R&D Expenditure by Dedicated Biotechnology R&D Firms, 2008-2009

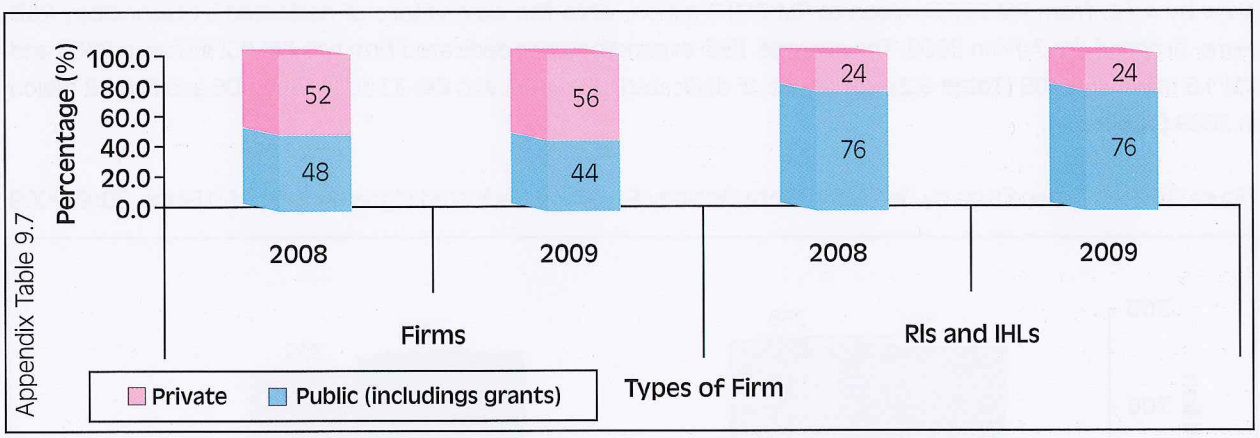
Years	Number of Dedicated Biotechnology R&D Firms	Total Biotechnology R&D Expenditure (RM Million)	Average Biotechnology R&D Expenditure per Dedicated Biotechnology R&D Firm (RM Million)
2008	109	253	2.3
2009	130	235	1.8

Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

9.3 FUNDING FOR BIOTECHNOLOGY SECTOR PARTICIPANTS

Figure 9.7 presents the distribution of funding from public and private sources for firms, RIs, and IHLs from 2008 to 2009. Slightly more than half of the funding for firms was sourced from the private sector, while most (76%) of the funding for RIs and IHLs for both years came from public or government funds. The proportion of funding for firms from private sources increased by 7.7% while there was no change in the proportion of funding from public and private sources for the RIs and IHLs in 2008 and 2009.

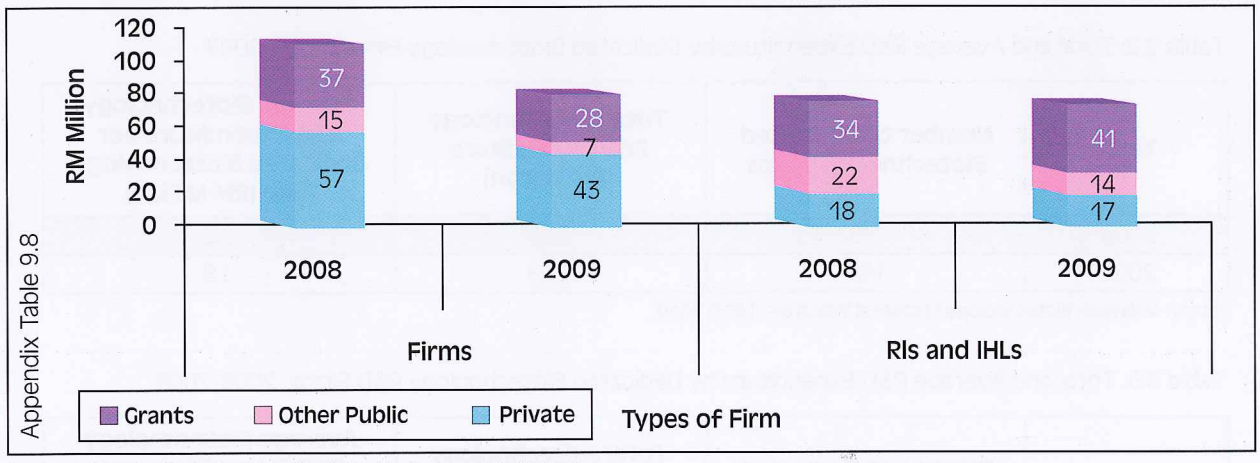
Figure 9.7: Share of Funding by Source for Firms, RIs, and IHLs, 2008-2009



Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

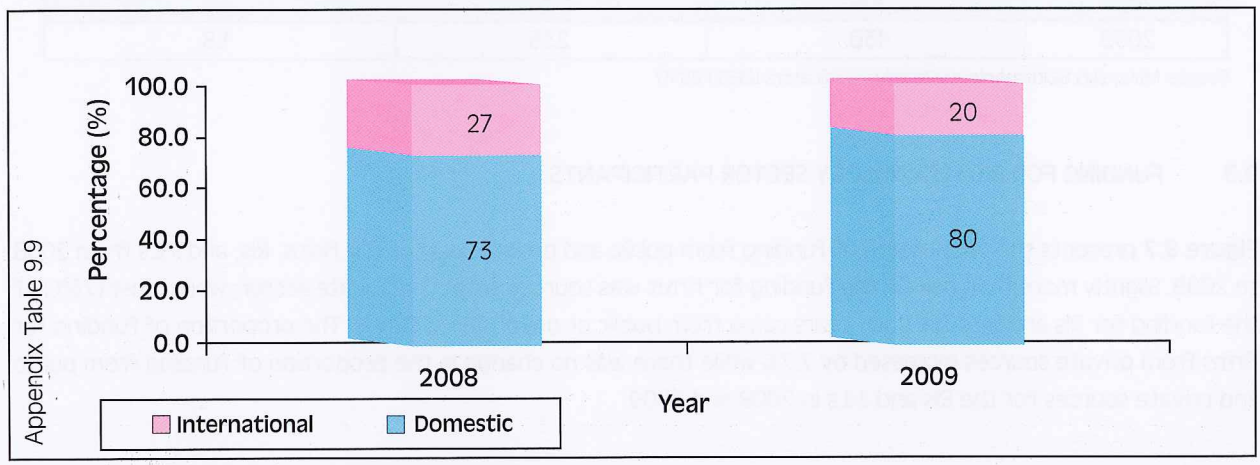
As shown in **Figure 9.8**, funding for firms decreased from RM 109.0 million in 2008 to RM 78.0 million in 2009. RIs and IHLs received a higher portion of funding from grants while funding from public and private funds was reduced in 2009. **Figure 9.9** displays the distribution of funding for firms by domestic and international sources in 2008 and 2009. Biotechnology firms, RIs, and IHLs relied primarily on domestic funding, but firms also received international funding, although not as large as that of domestic funding.

Figure 9.8: Value of Funding by Source for Firms, RIs, and IHLs, 2008-2009



Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

Figure 9.9: Share of Funding Sourced Domestically and Internationally by Biotechnology Firms, 2008-2009



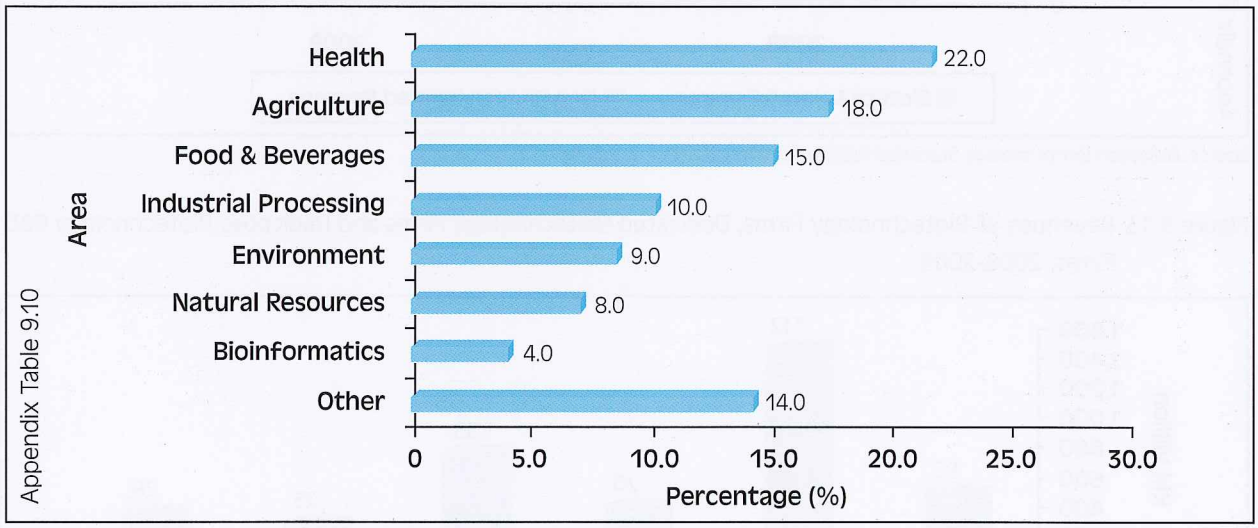
Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

9.4 TECHNOLOGY APPLICATION

Technology application is used by biotechnology firms to develop products such as those in healthcare, and agricultural and industrial biotechnology. As reported in the Malaysian Biotechnology Statistical Indicators 2009 (MBSI 2009), most firms are involved in applied technology such as bioprocessing and biotechnology fermentation, cell/tissue culture, DNA/RNA synthesis, and genomics. In addition to bioprocessing technology, RIs and IHLs are also involved in proteins and other molecular technology.

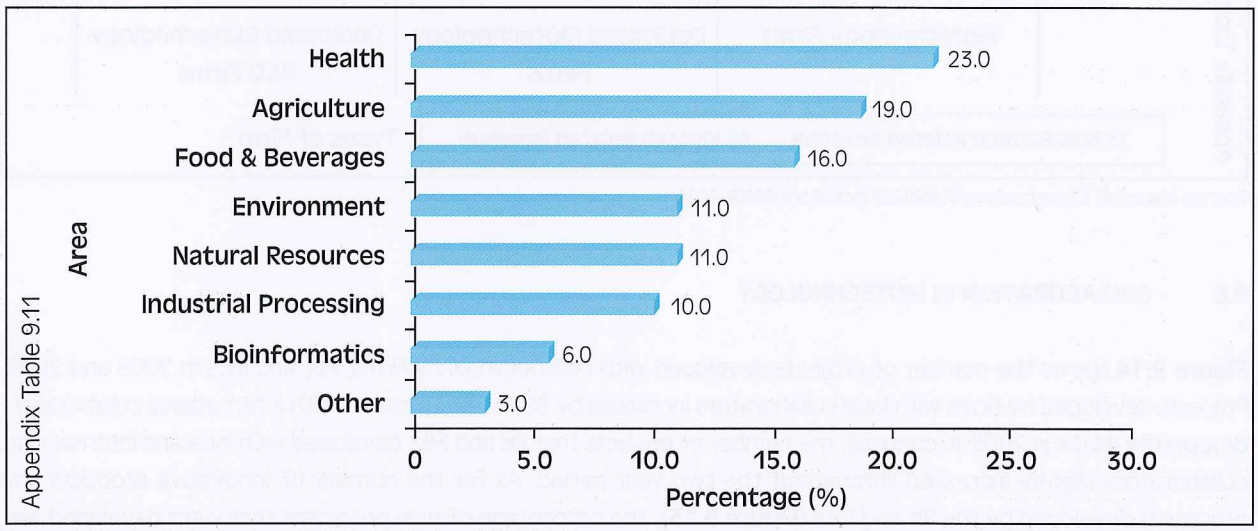
Figure 9.10 shows the percentage of firms that were involved in the development of products according to areas in 2009. 22.0% of the biotechnology firms developed products in healthcare, followed closely by agriculture, food and beverage, and other biotechnology areas. Bioinformatics was the least developed sector by firms, at only 4.0%. As for the percentage of dedicated biotechnology firms that were involved in the development of products by areas, a similar pattern is shown in **Figure 9.11** for healthcare, agricultural biotechnology, and food and beverage. Dedicated firms differed, however, in the least developed sectors, which were other biotechnology areas, at 3.0%, followed closely by Bioinformatics, at 6.0%.

Figure 9.10: Percentage of Firms Developing Products for Customers by Area, 2009



Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

Figure 9.11: Percentage of Dedicated Biotechnology Firms Developing Products for Customers by Area, 2009

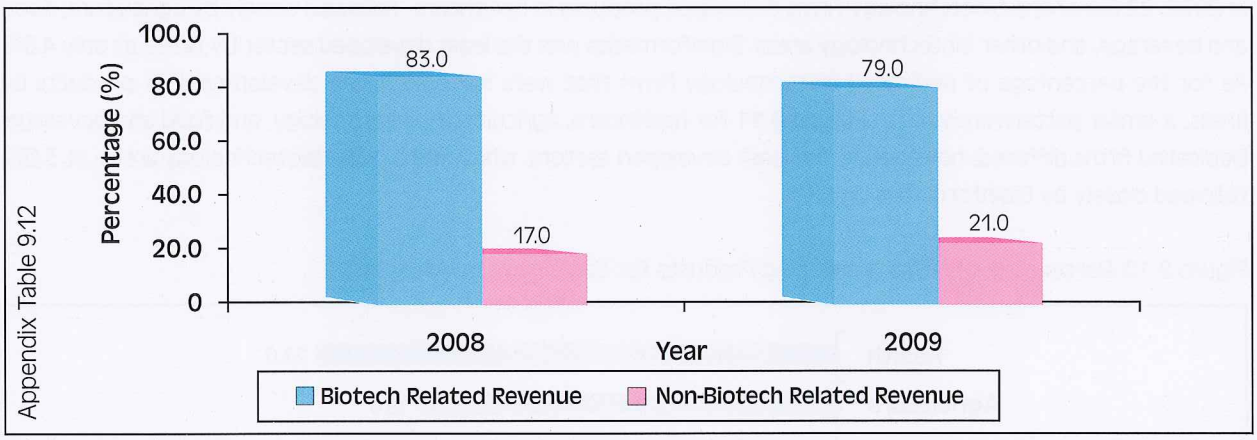


Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

9.5 BIOTECHNOLOGY SECTOR REVENUES

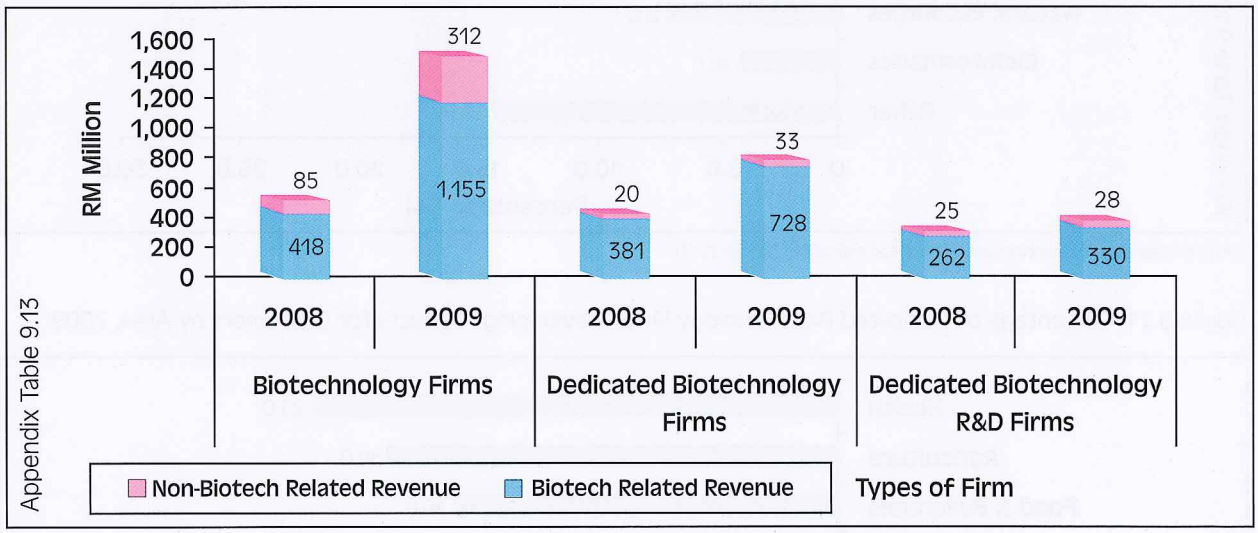
Figure 9.12 presents the breakdown of revenues of biotechnology firms from biotechnology and non-biotechnology related activities from 2008 to 2009. The revenues from biotechnology activities increased sharply, almost threefold, from RM 418.0 million to RM 1,155.0 million in just over a two year period **(Figure 9.13)**. The revenues of dedicated biotechnology firms increased two fold; from RM 381.0 million in 2008 to RM 728.0 million in 2009, while the revenues of dedicated biotechnology R&D firms increased by 26.0%. **(Figure 9.13).**

Figure 9.12: Share of Revenues Generated by Firms through Biotechnology Activities, 2008-2009



Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

Figure 9.13: Revenues of Biotechnology Firms, Dedicated Biotechnology Firms and Dedicated Biotechnology R&D Firms, 2008-2009

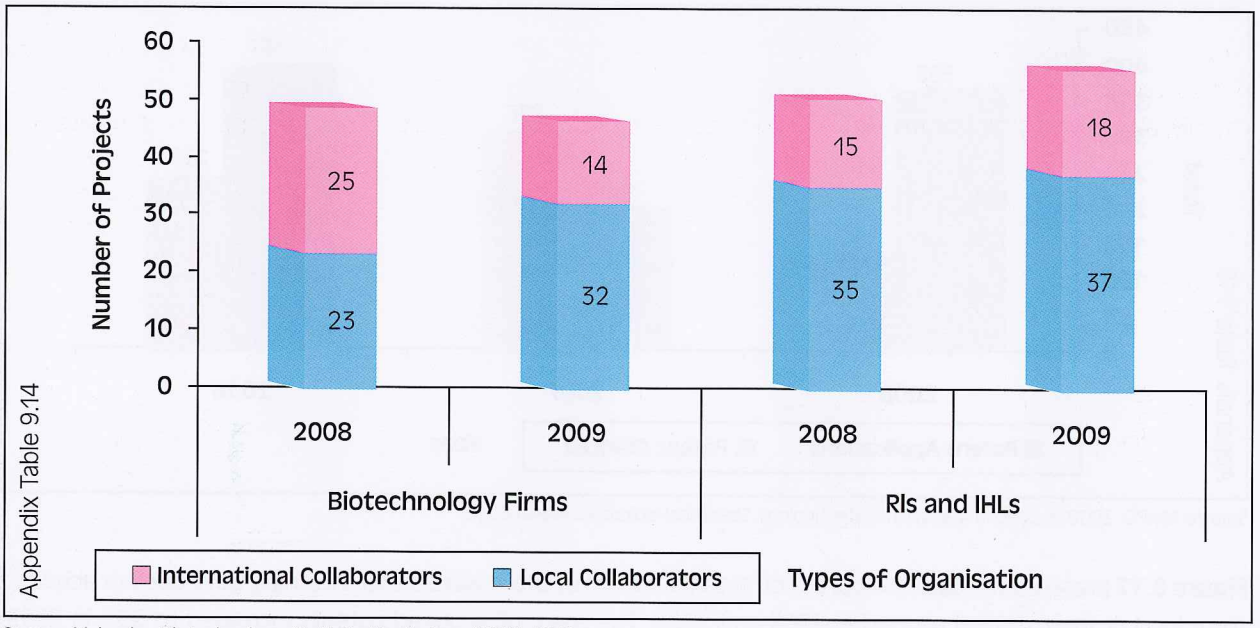


Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

9.6 COLLABORATION IN BIOTECHNOLOGY

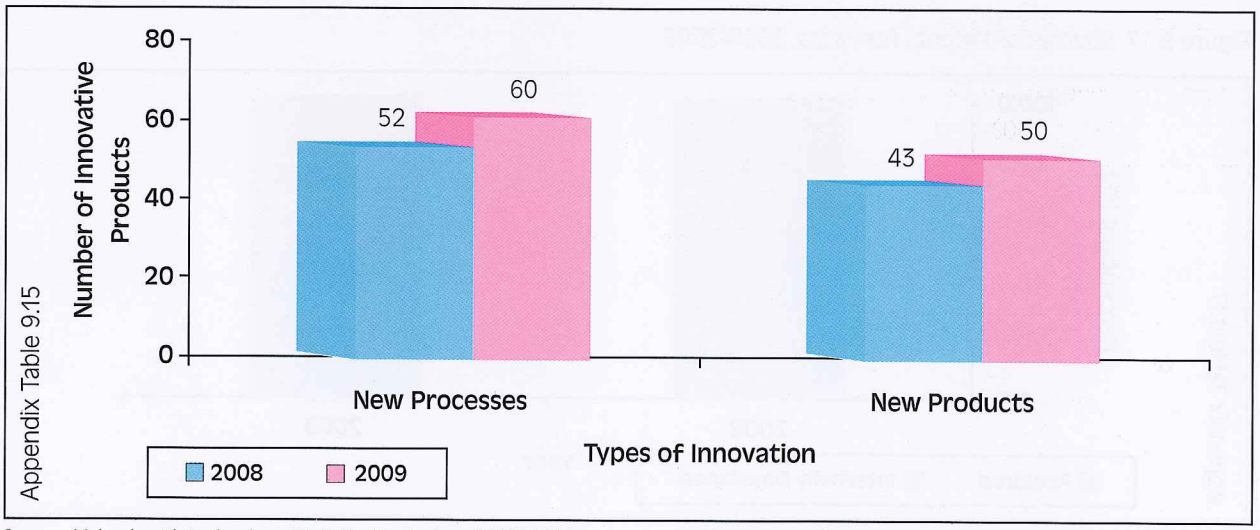
Figure 9.14 shows the number of projects developed with collaborators by firms, RIs, and IHLs in 2008 and 2009. Projects developed by firms with local collaborators increased by 39.1%, but projects with international collaborators dropped by 44.0% in 2009. In contrast, the number of projects that RIs and IHLs developed with local and international collaborators slightly increased throughout the two year period. As for the number of innovative products and processes developed by the RIs and IHLs **(Figure 9.15)**, the percentage of new processes that were developed was slightly higher than the new products, but their growth were almost similar, at 15.4% and 16.3%, respectively in 2009.

Figure 9.14: Number of Projects Developed with Collaborators by Biotechnology Firms, RIs and IHLs, 2008-2009



Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

Figure 9.15: Number of Innovative Products and Processes Developed by RIs and IHLs, 2008-2009



Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

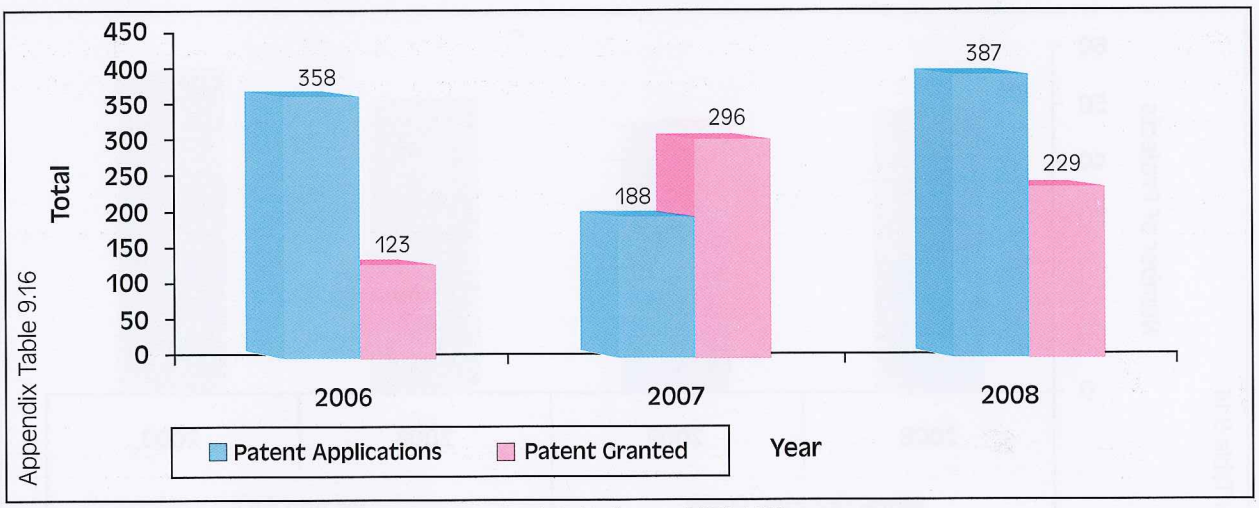
9.7 PATENTS AND RESEARCH OUTPUT

The number of patents applied for and approved, as well as research publications are considered as indicators of innovation in the biotechnology sector.

9.7.1 Biotechnology Patents

Figure 9.16 shows a sharp drop of almost 50.0% in the total number of patents applied for in 2007, before it doubled to 387 in 2008. As for the total number of patents granted, there is an increase of more than 100.0% from 2006 to 2007 before it slightly declined in 2008.

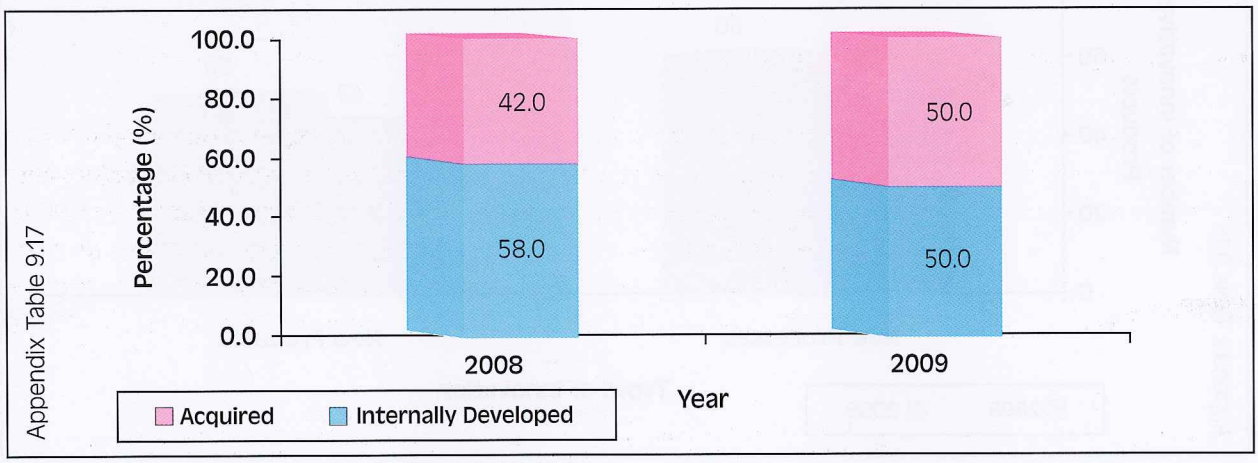
Figure 9.16: Patent Applications and Patents Granted, 2006-2008



Source: MyIPO, 2009 as cited in Malaysian Biotechnology Statistical Indicators (MBSI) 2010

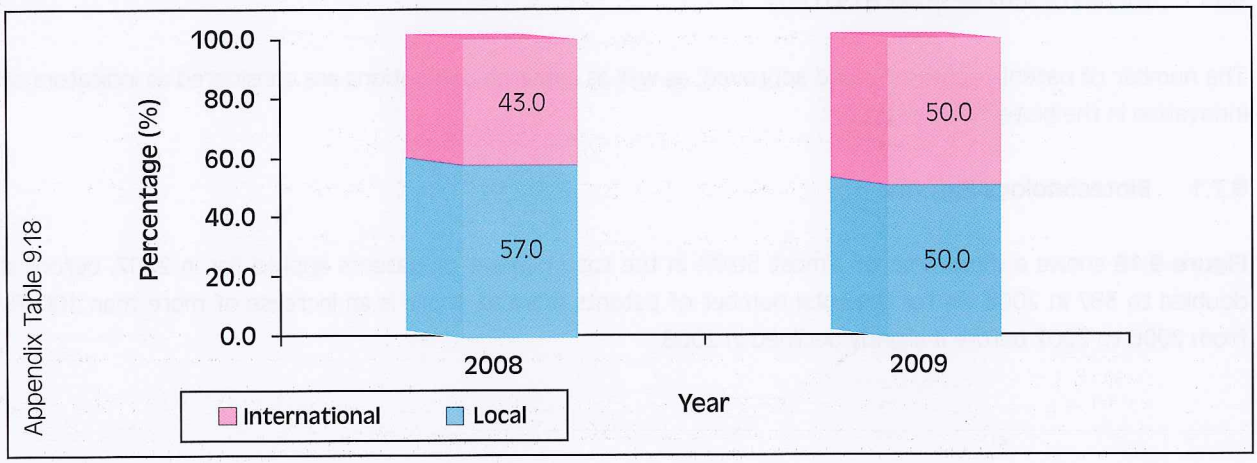
Figure 9.17 presents the data on sources of patents for firms, which were either internally developed or acquired from local or international sources in 2008 and 2009. The share of acquired patents increased to 50% in 2009, equal to that of internally developed patents. **Figure 9.18** shows that the proportion of the patents sourced internationally rose from 43.0% to 50.0%, while patents sourced locally declined to 50.0%.

Figure 9.17: Sources of Patents for Firms, 2008-2009



Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

Figure 9.18: Sources of Patents Acquired by Firms, 2008-2009

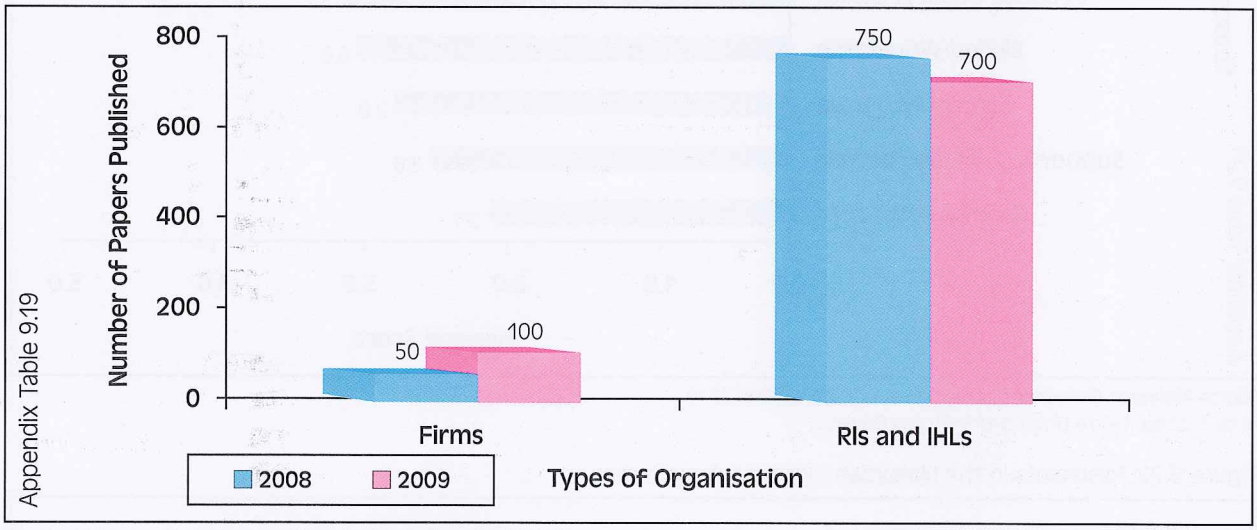


Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

9.7.2 Research Publications in Biotechnology

Figure 9.19 shows that more than 1,450 papers were published by RIs and IHLs in 2008 and 2009, about ten times more than those published by firms. This is expected, since publications are usually based on R&D activities, which is the main focus of RIs and IHLs.

Figure 9.19: Number of Papers Published Related to Biotechnology by Firms, RIs and IHLs, 2008-2009

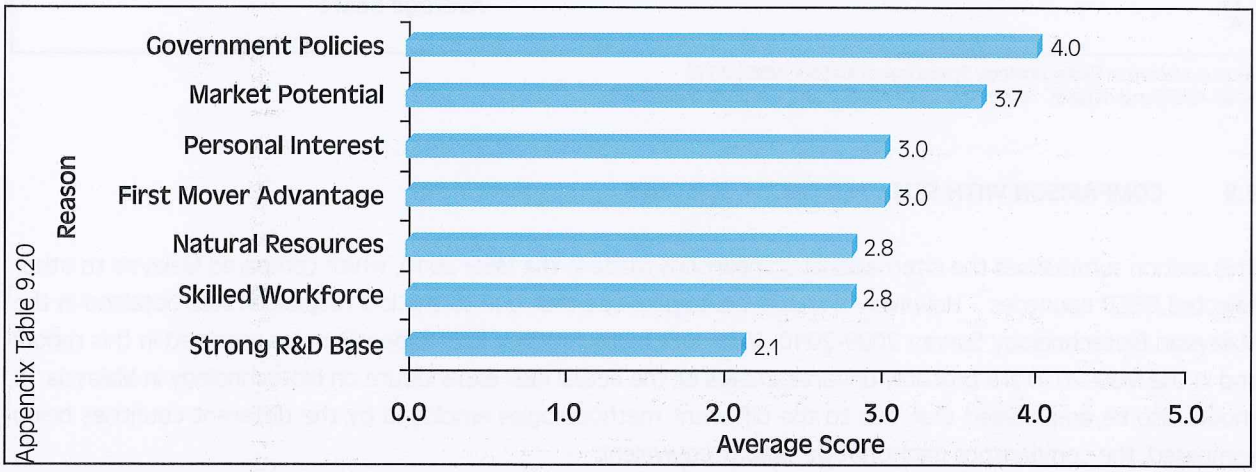


Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010

9.8 DRIVERS FOR THE BIOTECHNOLOGY SECTOR

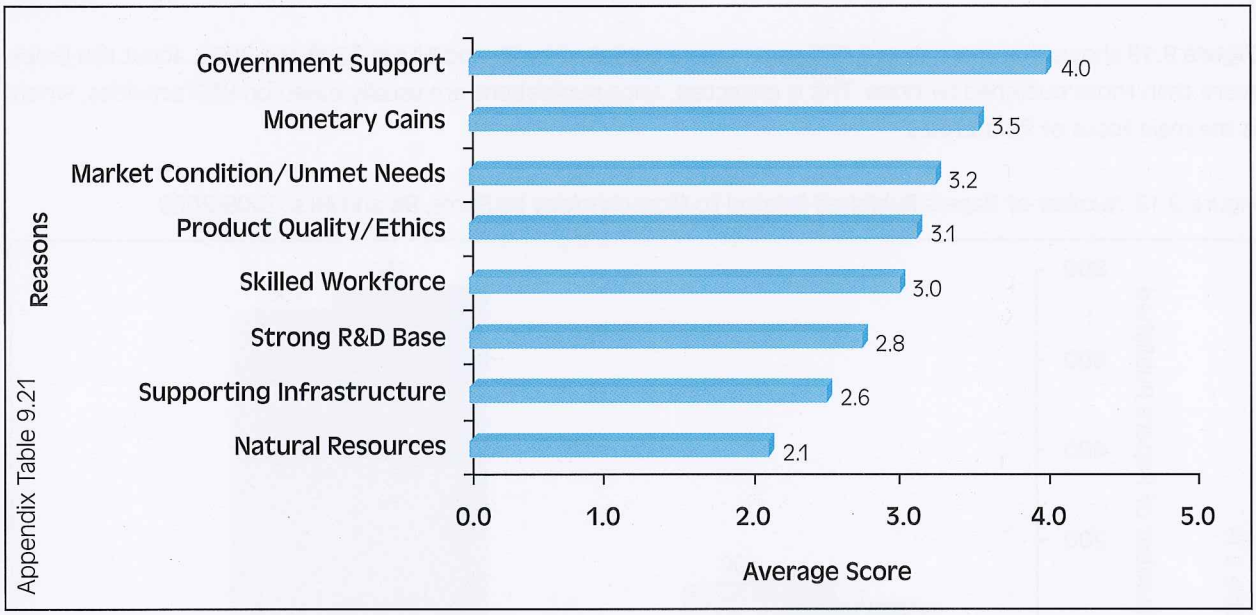
Some of the important reasons that encouraged participation in the Malaysian biotechnology sector (as indicated by the average scores received on each item by the respondents) were the specific government policies that support biotechnology as well as its market potential **(Figure 9.20)**. Some key drivers for the biotechnology sector were government support (since biotechnology is a new area that needs to be developed), monetary gains, and market conditions **(Figure 9.21)**. On the restraints that hindered growth in biotechnology, limited capital was viewed as the main restraint, besides the lack of infrastructure and the high cost involved in the sector **(Figure 9.22)**.

Figure 9.20: Reasons Provided by Respondents for Venturing into the Biotechnology Sector in Malaysia



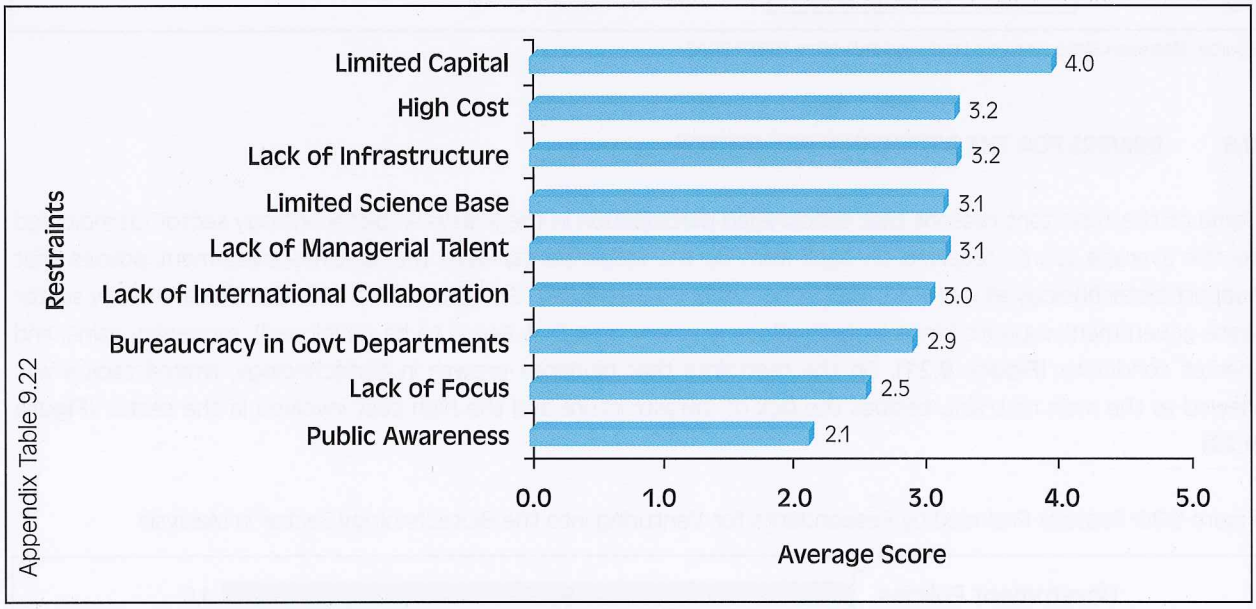
Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010
Note: Scoring: 1=Low Driver and 5=Strong Driver. The number of responses for each reason is: Government Policies (45), Market Potential (33), Natural Resources (27), Personal Interest (21), Skilled Workforce (18), R&D base (13), First Mover Advantage (7)

Figure 9.21: Key Drivers for the Malaysian Biotechnology Sector



Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010
Note: Scoring: 1=Low Driver and 5=Strong Driver.

Figure 9.22: Restraints in the Malaysian Biotechnology Sector



Source: Malaysian Biotechnology Statistical Indicators (MBSI) 2010
Note: Additional dataset. Score: 1 = Low Restraint and 5 = Strong Restraint.

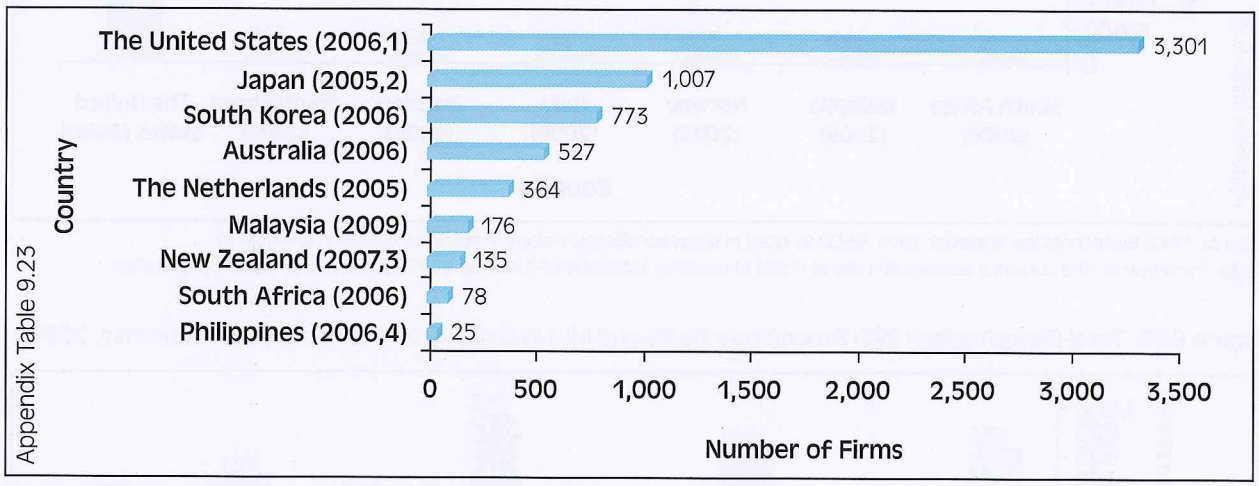
9.9 COMPARISON WITH SELECTED OECD COUNTRIES

This section summarises the International Comparisons made in the MBSI 2010, which compared Malaysia to other selected OECD countries[4]. However, it should be emphasised that due to the low response rates obtained in the Malaysian Biotechnology Survey 2009-2010, Malaysia's biotechnology R&D expenditure as reported in this report and in the MBSI 2010 are probably underestimates of the actual R&D expenditure on biotechnology in Malaysia. It should also be emphasised that due to the different methodologies employed by the different countries being compared, the comparisons might not be exactly equivalent.

[4]The MBSI 2010 used data in the 2009 OECD report.

Figure 9.23 shows that the United States has the largest number of firms, followed by Japan and South Korea. These countries, including Australia and the Netherlands, have developed the biotechnology industry much earlier than Malaysia. **Figure 9.23** also shows that Malaysia has more biotechnology firms than New Zealand, South Africa and the Philippines, which indicates that the biotechnology industry is growing quite rapidly in Malaysia.

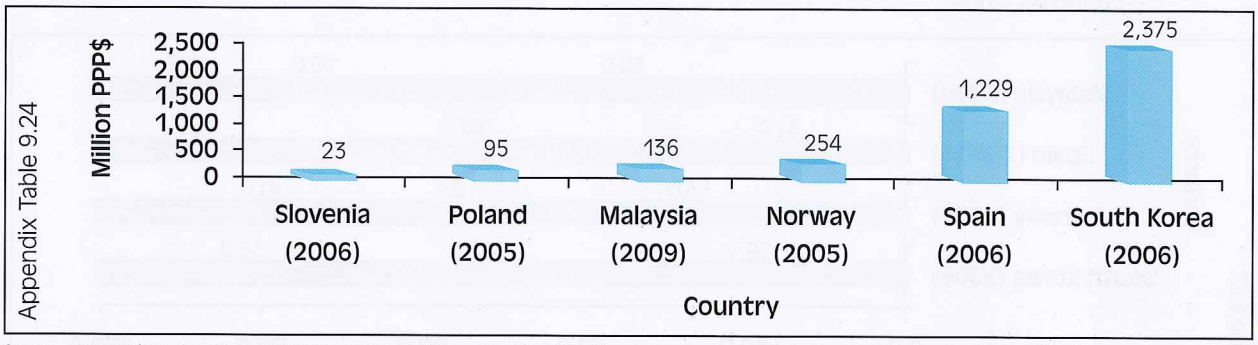
Figure 9.23: Number of Biotechnology Firms in Malaysia and Selected OECD Countries



Source: OECD Biotechnology Statistics 2009 OECD, as cited in Malaysian Biotechnology Statistical Indicators (MBSI) 2010
Note: The United States and the Netherlands also included the number of biotechnology R&D firms in this data[5].
(1) Number of Biotechnology R&D firms are used for the United States and the Netherlands.
(2) Overestimate of true number. Includes firms that are only active in traditional biotechnology. May include firms that are active in biotechnology but which do not develop biotechnology innovation.
(3) Probably overestimate of the true number.
(4) Probably underestimate of the true number.

On the total biotechnology R&D expenditure, **Figure 9.24** shows that Malaysia has a lower R&D expenditure compared to South Korea, Spain and Norway. However, R&D expenditure in Malaysia is slightly higher than Poland and is almost six times higher than Slovenia. With regard to the total biotechnology R&D expenditure by firms, **Figure 9.25** shows that biotechnology firms in Malaysia have a higher R&D expenditure than South Africa at 92 million PPP$ (Purchasing Power Parity), but a lower biotechnology R&D expenditure than the rest of the selected OECD countries shown. Meanwhile, the R&D expenditure on biotechnology by RIs in South Korea and Spain amounted to more than 500 million PPP$, while Malaysia's expenditure is twice higher than Norway **(Figure 9.26)**. For biotechnology R&D expenditure by IHLs, Malaysia's is the lowest when compared to South Korea, Spain, and Norway. The figures show that South Korea is a good benchmark for the biotechnology industry due to its achievement in the area.

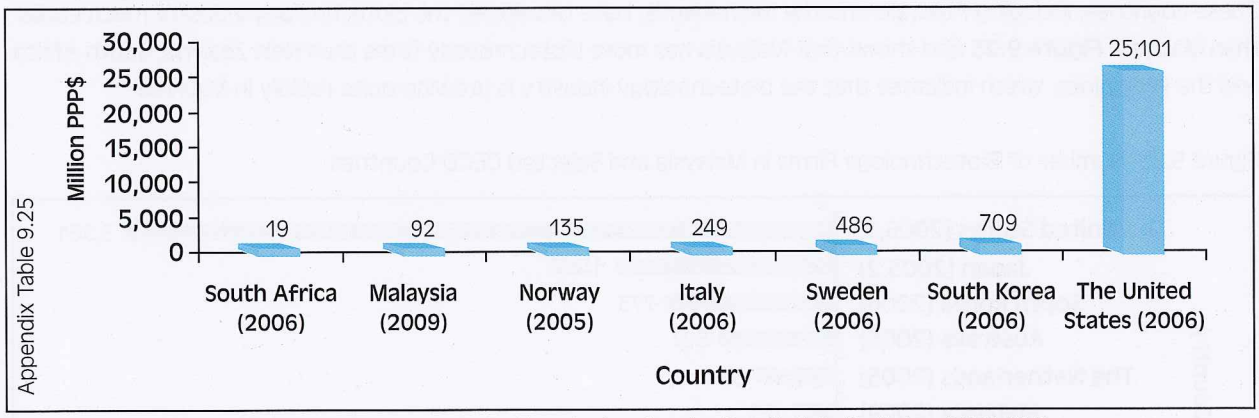
Figure 9.24: Total Biotechnology R&D Expenditure in Malaysia and Selected OECD Countries



Source: OECD Biotechnology Statistics 2009, OECD as cited in Malaysian Biotechnology Statistical Indicators (MBSI) 2010
Note: The currency conversion rate of .305 id used for RM/USD PPP$. This translates to RM 445 million.

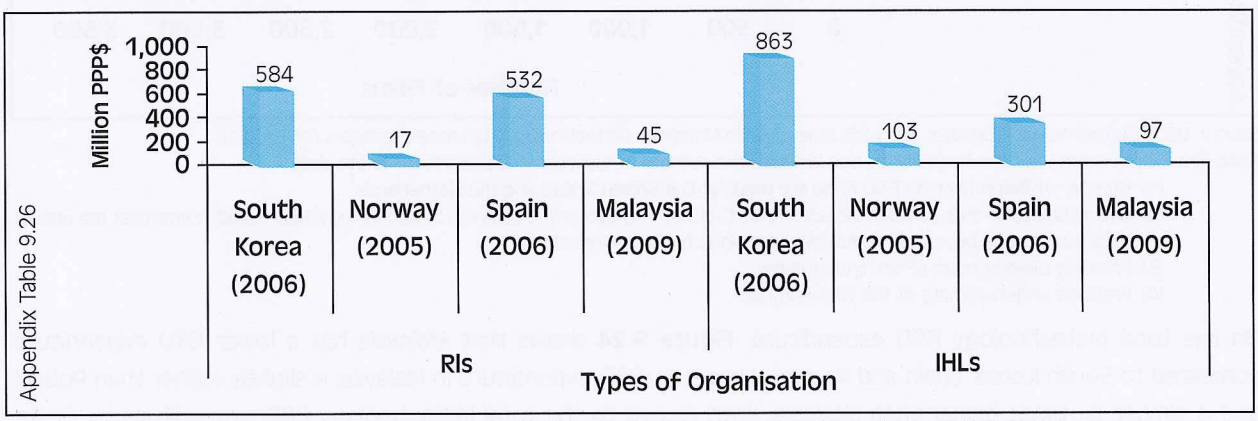
[5]The Biotechnology firms that are presented in Figure 9.24 may include firms that are also involved in traditional biotechnology (biotechnologies that may differ from the OECD list-based definition of biotechnology techniques published in OECD (2005), A Framework for Biotechnology Statistics, OECD, Parisas cited in OECD Biotechnology Statistics 2009, OECD). For the OECD list-based definition.

Figure 9.25: Total Biotechnology R&D Expenditure by Firms in Malaysia and Selected OECD Countries



Source: OECD Biotechnology Statistics 2009, OECD as cited in Malaysian Biotechnology Statistical Indicators (MBSI) 2010
Note: For Malaysia, the currency conversion rate of 0.305 id used for RM/USD PPP$. Hence, 92 PPP$, translates to RM 303.0 million.

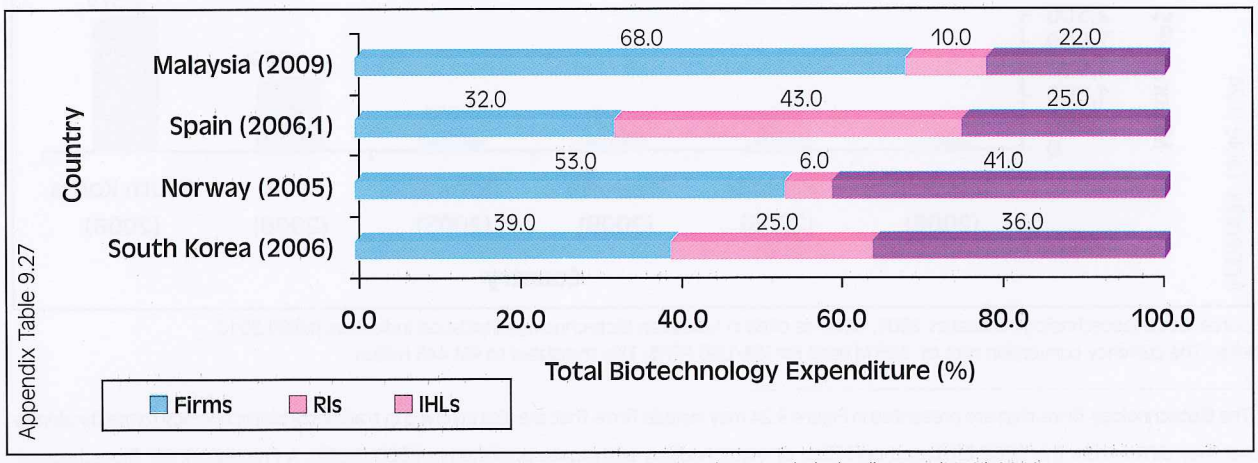
Figure 9.26: Total Biotechnology R&D Expenditure by RIs and IHLs in Malaysia and Selected OECD Countries, 2009



Source: OECD Biotechnology Statistics 2009, OECD as cited in Malaysian Biotechnology Statistical Indicators (MBSI) 2010
Note: Definition of RIs and IHLs between countries may differ.

As shown in **Figure 9.27**, firms contribute to the bulk of Malaysia's biotechnology expenditure, at 68.0% of the total. Expenditure by Malaysian firms is almost double that of the expenditure by firms in Spain and South Korea. However, the expenditure by Malaysian RIs and IHLs, constituting 32.0% of the total, is almost half of the expenditure by the RIs and IHLs in South Korea and Spain.

Figure 9.27: Percent of Total Biotechnology Expenditure by Sector Participants in Malaysia and Selected OECD Countries, 2009



Source: OECD Biotechnology Statistic 2009, OECD as cited in Malaysian Biotechnology Statistical Indicators (MBSI) 2010

9.10 CONCLUSION

The biotechnology industry in Malaysia is still in the early stages of development, but there is still a lot of opportunity for growth and expansion. Currently, there are 219 participants in the industry, focusing mainly on healthcare and industrial and agricultural biotechnology, with a total R&D expenditure (in 2009) of RM 445.0 million. The biotechnology industry is still highly dependent on public and local funding, and requires support to move towards commercialisation if higher revenues are to be generated. Although almost RM 1.2 billion was generated in 2009, it was largely contributed by the domestic market. Hence, there is a need to expand the biotechnology industry by venturing into the international market. One of the strategic ways to be competitive internationally is to form collaborations with foreign firms, RIs and IHLs. This will encourage further growth and also generate more innovative products and processes. Given the fact that the biotechnology industry is still in its infancy, it can be said that it has achieved quite a good level of success, and will continue to grow given adequate support, proper infrastructure, and supportive laws and policy.

CHAPTER 10
- TRADE IN HIGH-TECHNOLOGY PRODUCTS & PROFESSIONAL SERVICES

CHAPTER 10

TRADE IN HIGH-TECHNOLOGY PRODUCTS AND PROFESSIONAL SERVICES

10.0 INTRODUCTION

High-technology manufacturing products are one of the main outcomes of R&D and innovation. The demanding effects of globalisation and the concern to remain competitive in the global economy have driven countries to actively pursue high-technology manufacturing and knowledge-intensive service oriented industrialisation strategies. These sectors have become increasingly important, and are a key part of the economic growth of developed and emerging economies. The United States, the EU, Japan, China and Taiwan are the major producers and exporters of high-technology products in the world.

High technology products or services refer to the products or services that embody advanced technologies and that have a high level of R&D intensity. High technology industries, on the other hand, are defined by the Organisation for Economic Co-operation and Development (OECD) by comparing industry R&D expenditures or the number of technical people employed with industry production or value added. High-technology industries, according to the OECD, also include the manufacture of aircraft and spacecraft; pharmaceuticals; office, accounting, and computing machinery; radio, television, and communications equipment; and medical, precision, and optical instruments. This report includes the medium-high technology manufacturing sector under the high-technology industry category. The OECD classification of the medium-high technology industry includes electrical machinery and apparatus, motor vehicles, trailers and semi-trailers, chemicals (excluding pharmaceuticals), machinery and equipment, and railroad and transport equipment.

Trade in skilled and professional services is another important indicator to measure the strength of science and technology-based industries and services in a country. In recent decades, cross border movements of skilled labourers and professional experts have increased significantly as countries move up the technological ladder in both the goods and services sectors.

This chapter uses data from three key sources. For the analysis on Malaysian high and medium-high technology manufacturing industries, data were obtained from the Malaysia External Trade Development Corporation (MATRADE) database, which relies on data sourced from the World Trade Atlas. These data, however, are in US$, and therefore they were converted to Malaysian Ringgit using the annual average US Dollar exchange rates obtained from the US Federal Reserve Statistical Release. The discussion on global trade and international comparisons in high-technology products uses data obtained from the US Science and Engineering Indicators 2010 Report[1]. Data is maintained in US$ for international comparisons. Data for professional services were provided by Bank Negara Malaysia.

This chapter is organised into six sections. The first and second sections discuss the trend in Malaysia's high and medium-high technology industries exports and imports, respectively. The third section evaluates the trade balance of the high and medium-high technology industries in Malaysia.

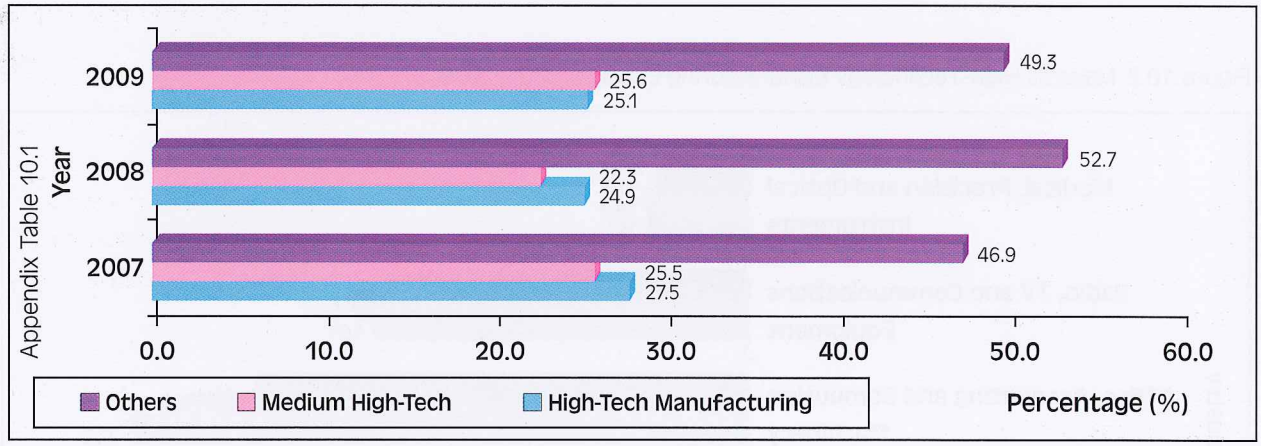
[1]The US Science and Engineering Indicators Report is published by the US National Science Board. The report provides quantitative information on the U.S. and international science and engineering enterprise.

The fourth section presents the global patterns and trends in high-technology products trade by examining the performance of the key exporters and importers of advanced technology products in the world. The trade balance of the major players in the global trade of high-technology products is also analysed. Section five discusses the payments and receipts of professional services trade in Malaysia, while the conclusion is presented in the final section.

10.1 MALAYSIAN HIGH AND MEDIUM HIGH-TECHNOLOGY EXPORTS

The high and medium-high technology industries together contribute close to 50.0% of Malaysia's total manufacturing exports, reflecting the importance of the industry to the Malaysian economy. In 2009, the shares of these industries in total manufacturing exports were 25.1% (2008: 24.9%) and 25.6% (2008: 22.3%), respectively **(Figure 10.1).**

Figure 10.1: Malaysian Composition of Manufacturing Exports by Technology Intensity, 2007- 2009



Source: Retrieved from the World Trade Atlas Database

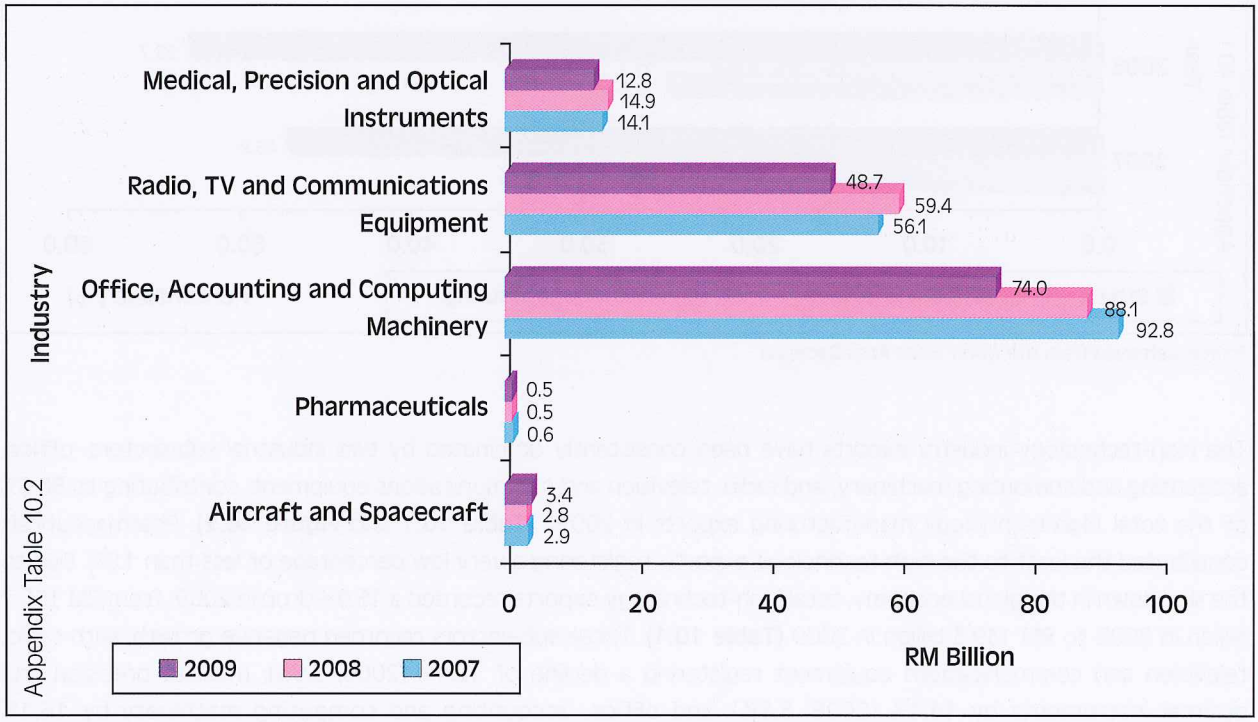
The high-technology industry exports have been consistently dominated by two industrial sub-sectors: office, accounting and computing machinery, and radio, television and communications equipment, contributing to 86.6% of the total high-technology manufacturing exports in 2009 **(Table 10.1** and **Figure 10.2).** Pharmaceuticals contributed the least to the high-technology exports, registering a very low percentage of less than 1.0%. Due to the slowdown in the global economy, total high-technology exports recorded a 15.9% drop in 2009; from RM 165.7 billion in 2008 to RM 139.3 billion in 2009 **(Table 10.1)**. Three sub-sectors recorded negative growth, with radio, television and communications equipment registering a decline of 18.1% (2008: 5.9%); medical, precision and optimal instruments by 14.1% (2008: 5.5%); and office, accounting and computing machinery by 16.1% (2008: -5.1%). The sectors that have registered positive growth are aircraft and spacecraft (22.6%) and pharmaceuticals (11.7%).

Table 10.1: High-Technology Manufacturing Exports by Industrial Sub-Sectors, 2007-2009

Industry	RM Million	% Share	RM Million	% Share	RM Million	% Share	Growth Rate %	
	2007		2008		2009		2008	2009
Office, Accounting and Computing Machinery	92,827.0	55.0	88,105.0	52.2	73,958.9	52.2	-5.1	-16.1
Radio, Television and Communications Equipment	56,132.6	33.2	59,429.8	35.2	48,694.6	34.4	5.9	-18.1
Medical, Precision and Optical Instruments	14,130.5	8.4	14,908.8	8.8	12,805.8	9.0	5.5	-14.1
Aircraft and Spacecraft	2,913.1	3.1	2,760.4	3.5	3,382.9	4.1	-5.2	22.6
Pharmaceuticals	564.1	0.3	450.4	0.3	503.1	0.4	-20.1	11.7
Total High-Tech Industry	166,567.3	100.0	165,654.4	100.0	139,345.3	100.0	-0.5	-15.9

Source: Retrieved from the World Trade Atlas Database

Figure 10.2: Malaysia High-Technology Manufacturing Exports, 2007-2009



Source: Retrieved from the World Trade Atlas Database

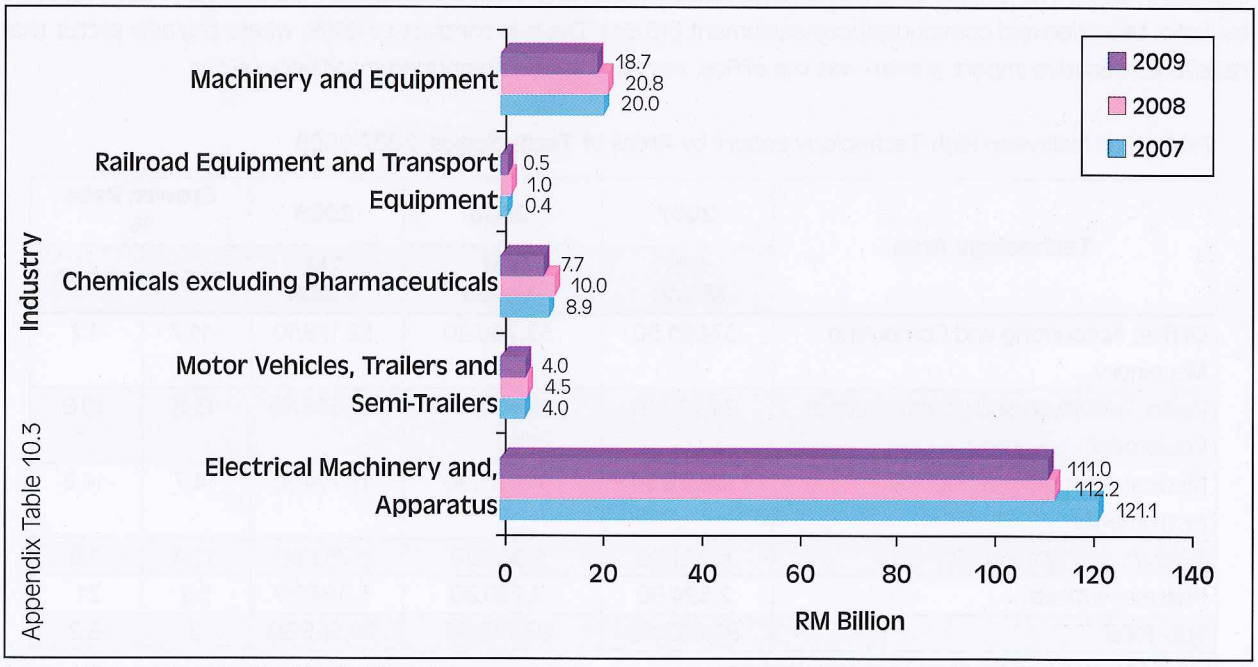
Table 10.2 and **Figure 10.3** show the medium-high technology manufacturing exports for 2007 to 2009. The electrical machinery and apparatus sector is the major contributor to the medium-high technology manufacturing exports, accounting for 78.2% of total manufacturing exports in 2009. The medium-high technology exports registered a 4.4% decline in 2009 (2008: -3.8%); from RM 148.4 billion in 2008, to RM 141.9 billion in 2009 **(Table 10.2).** All industrial sub-sectors producing medium-high technology products experienced negative growth in their exports in 2009, with a notable decline recorded by the railroad equipment industry (51.7%) and the chemicals industry (22.8%). This is in contrast to the export performance in 2008, where these industries experienced positive growth of 140.9% and 12.4%, respectively.

Table 10.2: Medium-High Technology Manufacturing Exports by Industrial Sub-Sectors, 2007-2009

Industry	RM Million	% Share	RM Million	% Share	RM Million	% Share	Growth Rate %	
	2007		2008		2009		2008	2009
Electrical Machinery and Apparatus	121,078.80	78.4	112,183.50	75.6	110,999.40	78.2	-7.3	-1.1
Machinery and Equipment	19,987.40	12.9	20,772.90	14	18,679.20	13.2	3.9	-10.1
Chemicals excluding Pharmaceuticals	8,928.30	5.8	10,032.20	6.8	7,745.90	5.5	12.4	-22.8
Motor Vehicles, Trailers and Semi-Trailers	3,989.20	2.6	4,481.80	3	4,000.10	2.8	12.3	-10.7
Railroad Equipment and Transport Equipment	404.7	0.3	974.8	0.7	471	0.3	140.9	-51.7
Total	154,388.30	100	148,445.10	100	141,895.70	100	-3.8	-4.4

Source: Retrieved from the World Trade Atlas Database

Figure 10.3: Malaysia Medium-High Technology Manufacturing Exports, 2007-2009

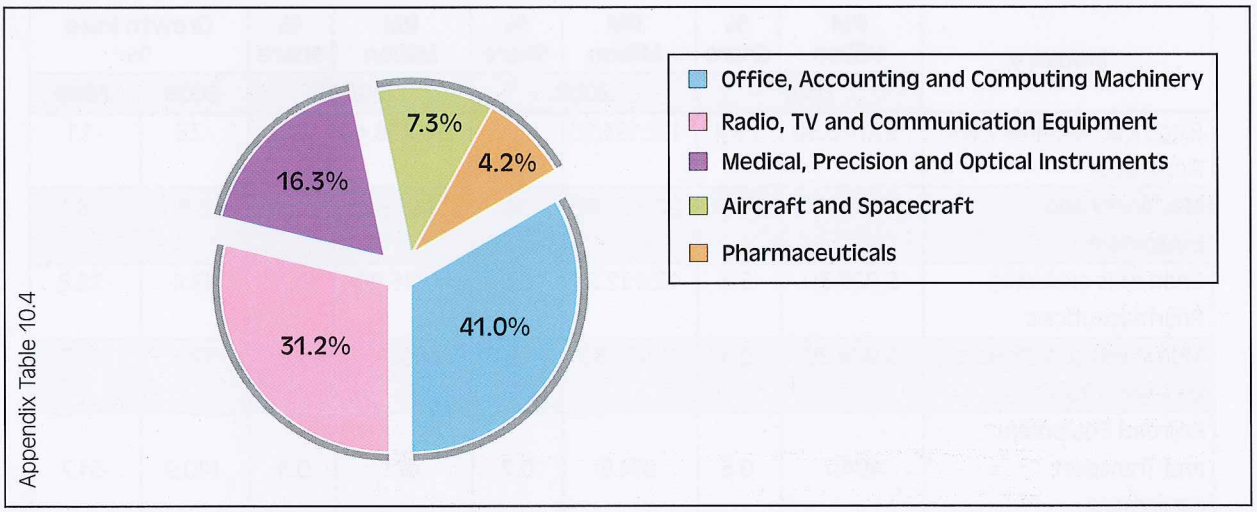


Source: Retrieved from the World Trade Atlas Database

10.2 MALAYSIAN HIGH AND MEDIUM-HIGH TECHNOLOGY IMPORTS

Malaysia's import of high-technology products in 2009 totalled RM 78.6 billion (2008: RM 83.7 billion) and accounted for 18.0% of total manufacturing imports **(Figure 10.4** and **Table 10.3)**. The import of office machinery represented 41.0% of the total high-technology import followed by telecommunications equipment (31.2%), medical instruments (16.3%), aircraft and spacecraft products (7.3%), and pharmaceuticals (4.2%).

Figure 10.4: High-Technology Import Share by Technology Areas, 2009



Source: Retrieved from the World Trade Atlas Database

Imports of high-technology products experienced a 6.2% drop in 2009 compared to a 2.0% growth in 2008 **(Table 10.3).** Pharmaceutical imports grew by 21.0% in 2009 (2008: 5.2%) while all other sub-sectors recorded a lower value of imports in 2009. The largest drop was experienced by medical, precision and optical instruments (14.2%) followed by radio, television and communications equipment (10.8%). This is in contrast to 2008, where the only sector that registered negative import growth was the office, accounting, and computing machinery sector.

Table 10.3: Malaysian High-Technology Import by Areas of Technologies, 2007-2009

Technology Area	2007	2008	2009	Growth Rate %	
	RM Million	RM Million	RM Million	2008	2009
Office, Accounting and Computing Machinery	37,081.30	32,730.20	32,178.10	-11.7	-1.7
Radio, Televisyen and Communicatios Equipment	24,222.10	27,506.70	24,544.40	13.6	-10.8
Medical, Precision and Optical Instruments	12,972.30	14,883.90	12,774.10	14.7	-14.2
Aircraft and Spacecraft	5,221.80	5,868.20	5,763.90	12.4	-1.8
Pharmaceuticals	2,594.80	2,730.80	3,304.90	5.2	21
Sub-Total	82,092.40	83,719.80	78,565.30	2	-6.2

Source: Retrieved from the World Trade Atlas Database

In 2009, the total import of medium-high technology products was RM 160.3 billion, 15.8% lower than imports in 2008 (RM 190.3 billion). Its share in total manufacturing imports declined from 39.8% in 2007 to 36.5% in 2008, and remains stable at 36.7% in 2009 **(Table 10.4)**.

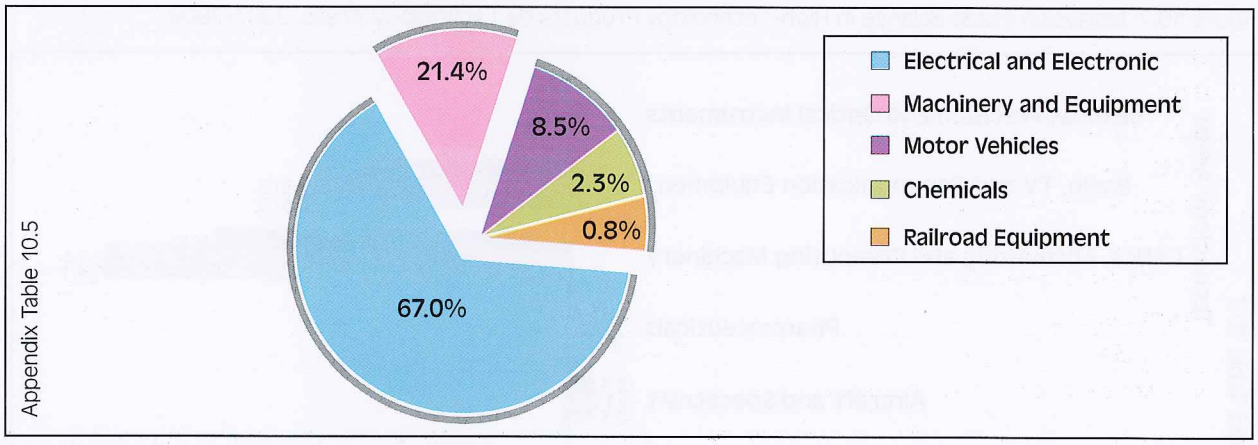
Table 10.4: Malaysian Medium-High Technology Import by Areas of Technologies, 2007-2009

Technology Area	2007		2008		2009		Growth Rate	
	RM Million	% Share	RM Million	% Share	RM Million	% Share	2008	2009
Electrical Machinery and Apparatus	146,846.7	73.5	134,016.4	70.4	107,448.2	67.0	-8.7	-19.8
Machinery and Equipment	37,881.2	19.0	38,755.1	20.4	34,254.9	21.4	2.3	-11.6
Motor Vehicles, Trailers and Semi-Trailers	11,063.4	5.5	13,421.7	7.1	13,571.7	8.5	21.3	1.1
Chemicals excluding Pharmaceuticals	3,823.9	1.9	3,641.8	1.9	3,646.1	2.3	-4.8	0.1
Railroad Equipment and Transport Equipment	134.7	0.1	436.8	0.2	1,341.6	0.8	224.3	207.1
Sub-Total	199,749.8	100.0	190,271.8	100.0	160,262.5	100.0	-4.7	15.8
Share in Total Manufacturing Imports	-	39.8	-	36.5	-	36.7	-	-

Source: Retrieved from the World Trade Atlas Database

Electrical and electronics imports constitute 67.0% of total medium-high technology imports in 2009 **(Figure 10.5)**, while machinery and equipment accounted for 21.4%, motor vehicles (8.5%), chemicals (2.3%), and railroad equipment (0.8%).

Figure 10.5: Medium High-Technology Import Share by Technology Areas, 2009



Source: Retrieved from the World Trade Atlas Database

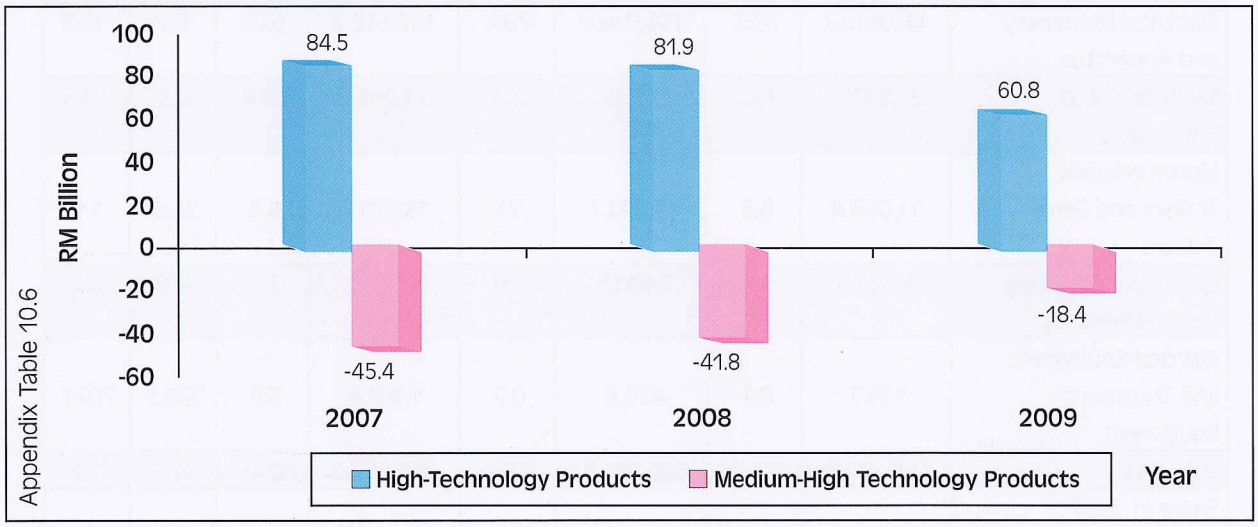
Railroad equipment imports grew significantly by 224.3% and 207.1% in 2008 and 2009 respectively. Motor vehicle imports increased modestly at 1.1% in 2009 compared to 21.3% in 2008. Electrical and electronics registered negative growth in 2008 and 2009, declining by 8.7% and 19.8% respectively.

10.3 MALAYSIAN TRADE BALANCE IN HIGH AND MEDIUM-HIGH TECHNOLOGY INDUSTRIES

Malaysia has consistently exported more-high technology products than it imported but registered a persistent deficit in medium-high technology products trade. Analysis on the trade balance shows that there is a steady contraction in both the surplus as well as the deficit in high and medium-high technology trade, mainly due to the slowdown in international trade. The trade surplus in high-technology products declined from RM 84.5 billion in -

2007 to RM 81.9 billion and RM 60.8 billion in 2008 and 2009 respectively **(Figure 10.6)**. The trade deficit in medium-high technology products reduced slightly from RM 45.4 billion in 2007 to RM 41.8 billion in 2008, and dropped drastically to RM 18.4 billion in 2009.

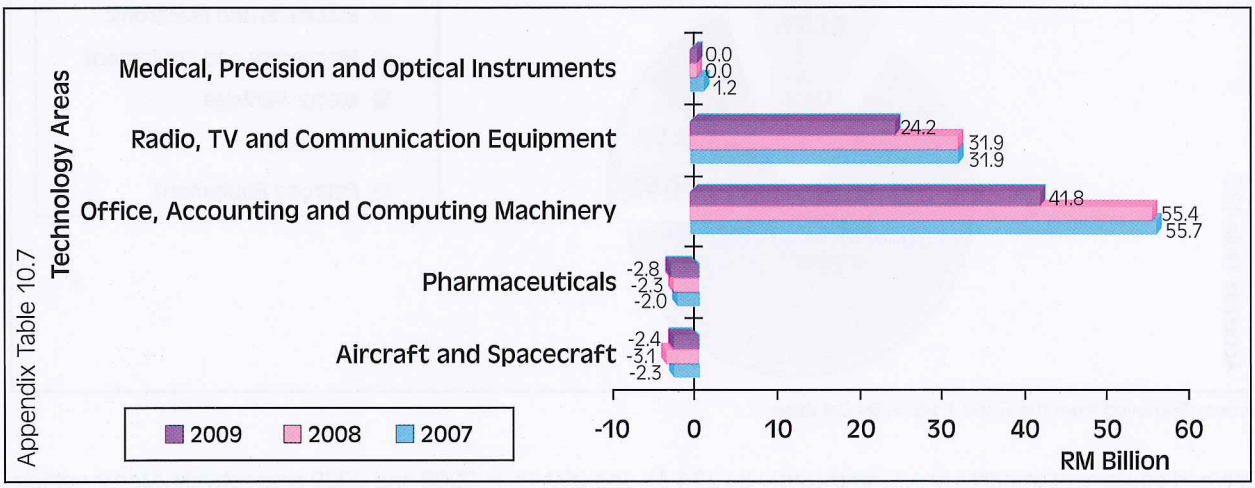
Figure 10.6: Malaysian Trade Balance in High and Medium-High Technology Products, 2007-2009



Source: Retrieved from the World Trade Atlas Database

Surplus in trade in high-technology products is mainly contributed by two sectors: radio, television and communications equipment; and office, accounting and computing machinery products **(Figure 10.7)**. In 2009, the surplus in radio, television and communication equipment was RM 24.2 billion (2008: RM 31.9 billion) while office, accounting and computing machinery products registered a RM 41.8 billion surplus (2008: RM 55.4 billion). Areas of technologies that have registered a deficit trade balance are pharmaceuticals and aerospace.

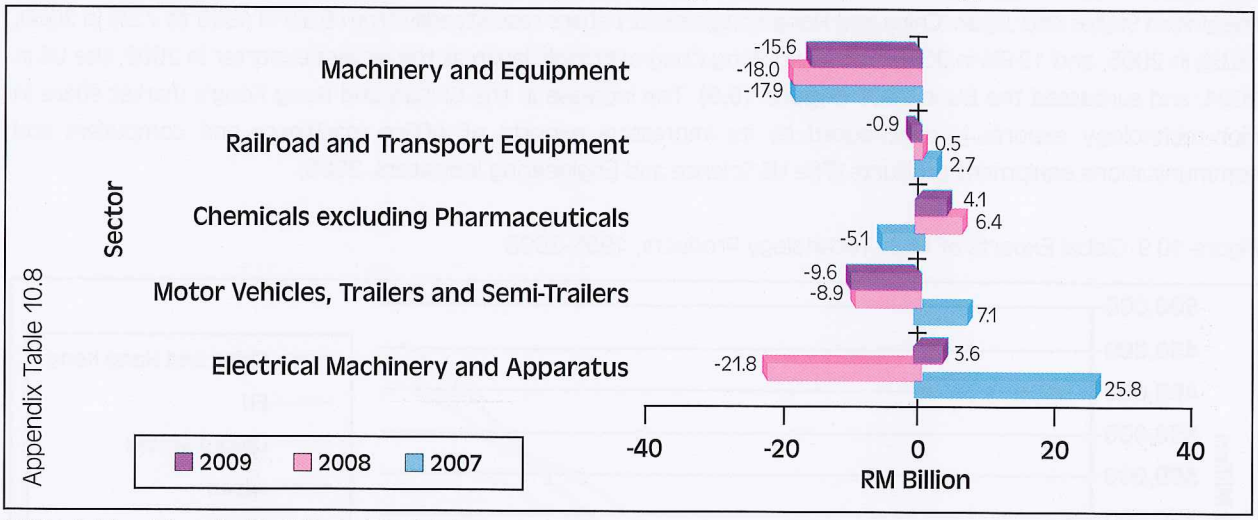
Figure 10.7: Malaysian Trade Balance in High-Technology Products by Technology Areas, 2007-2009



Source: Retrieved from the World Trade Atlas Database

Figure 10.8 shows persistent trade deficit in the medium-high technology industry, which was contributed mainly by machinery and equipment products. This sub-sector recorded a deficit of RM 17.9 billion and RM 18.0 billion in 2007 and 2008, respectively, higher than the deficit of RM 15.6 billion in 2009. The electrical machinery and apparatus sub-sector had mixed performance, experiencing a notable 21.8% fall in 2008. However, by 2009 the sector had turned around to record a 3.6% growth. Other sub-sectors experienced similar fluctuations in trade balance.

Figure 10.8: Malaysian Trade Balance in Medium High-Technology Products by Technology Areas



Source: Retrieved from the World Trade Atlas Database

10.4 GLOBAL TRADE IN HIGH-TECHNOLOGY PRODUCTS

The growth of global trade (exports plus imports) in high-technology products has been impressive, surging from US$ 1.5 trillion in 1995 to US$ 4.6 trillion in 2008[2]. Global exports of high-technology products increased threefold, from US$ 732.4 billion in 1995 to US$ 2.3 trillion in 2008 **(Table 10.5)**.

Table 10.5: Global Exports of High-Technology Products, Selected Years (1995-2008), US$ Million

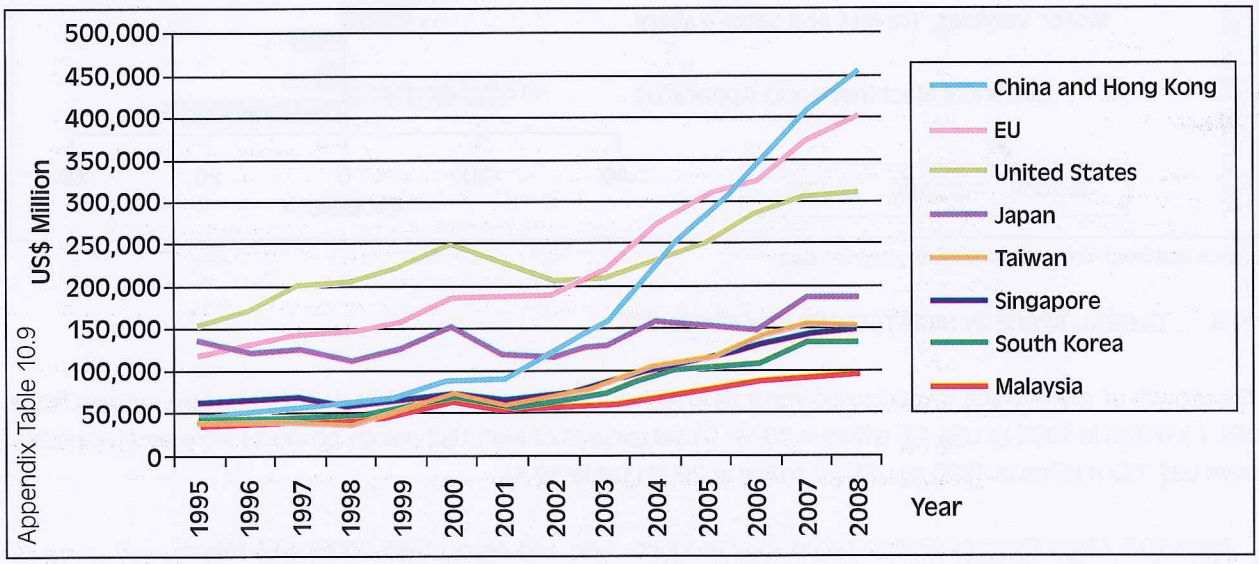
Ranking Based on Total Export for 2008	Region / Country	1995	2000	2005	2008
1	China and Hong Kong	45,352	87,535	281,201	455,008
2	EU (excluding intra-EU)	119,631	181,223	306,737	398,625
3	United States	155,622	249,695	251,941	312,107
4	Japan	134,836	151,309	153,938	185,661
5	Taiwan	37,444	752,502	115,040	152,126
6	Singapore	62,163	76,830	111,319	151,227
7	South Korea	37,960	66,327	104,031	136,202
8	**Malaysia**	**36,832**	**61,621**	**77,457**	**96,035**
9	Latin America	15,822	46,890	56,649	81,351
10	Thailand	14,132	21,761	32,361	45,862
11	Philipines	5,159	28,753	29,252	36,726
12	Middle East	4,510	10,950	14,152	19,806
13	Indonesia	2,868	8,668	8,523	11,565
14	India	1,283	2,061	4,987	9,583
15	Vietnam	36	974	1,136	1,965
16	World	732,410	1,159,889	1,698,339	2,294,633

Source: The US Science and Engineering Indicators 2010

[2] Calculated based on data obtained from the US Science and Engineering Indicators 2010 Report. Intra-EU trade and trade between China and Hong Kong are excluded. Note that China and Hong Kong are treated as a single country.

The world's largest exporter of high-technology products in 2008 was China and Hong Kong, followed by the EU, the United States and Japan. China and Hong Kong's export share rose steadily from 6.2% in 1995 to 7.5% in 2000, 16.6% in 2005, and 19.8% in 2008. China and Hong Kong overtook Japan as the largest exporter in 2002, the US in 2004, and surpassed the EU in 2006 **(Figure 10.9)**. The increase in the China's and Hong Kong's market share in high-technology exports is contributed by its impressive exports of office machinery and computers and communications equipment products (The US Science and Engineering Indicators, 2008).

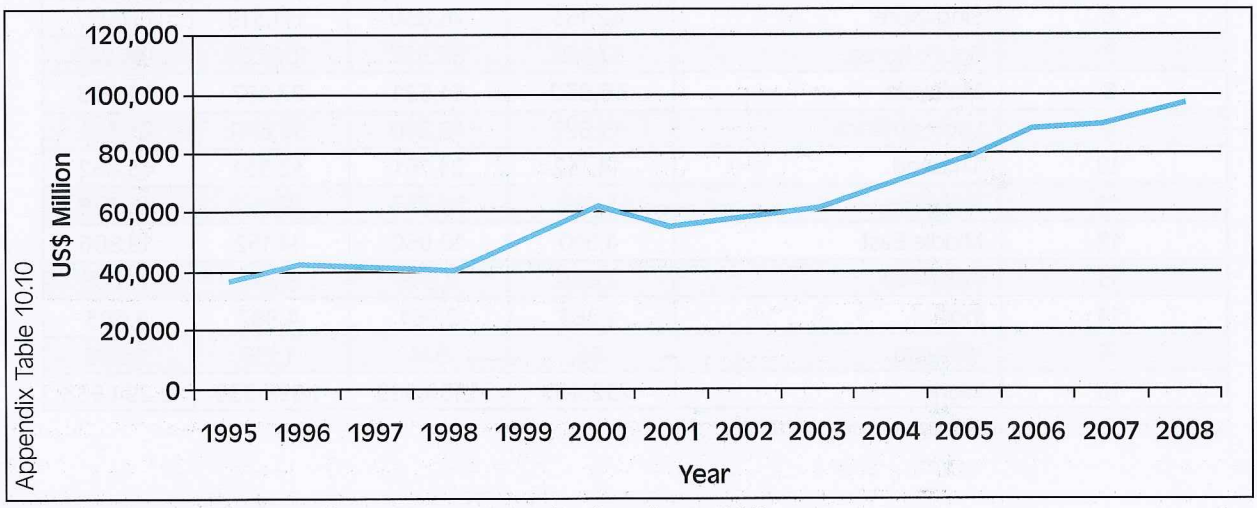
Figure 10.9: Global Exports of High-Technology Products, 1995-2008



Source: Based on data extracted from the US Science and Engineering Indicators, 2010

In 2008, Malaysia ranked eighth in the list of top exporters of high-technology in the world **(Table 10.5)**. Among the ASEAN countries, Malaysia is behind Singapore but far ahead of other ASEAN member countries. Malaysia's export of high-technology products experienced a significant increase, rising from US$ 36.8 million in 1995 to US$ 96.0 million in 2008. **Figure 10.10** shows that Malaysia's export of high-technology products has been trending upward since 1995.

Figure 10.10: Malaysian Exports of High Technology Products, 1995-2008



Source: Based on data extracted from the US Science and Engineering Indicators, 2010

Malaysia's international competitiveness in international high-technology trade has improved over the years. The US Science and Engineering Indicators 2008 ranked Malaysia first in the list of potential future high-technology exporters for smaller developing countries for the years 2005 and 2007 **(Table 10.6)**. The ranking has improved from the third position in 1999 and 2002.

Table 10.6: Ranking of Future High-Technology Export Potential for Smaller Developing Countries, 1996-2007

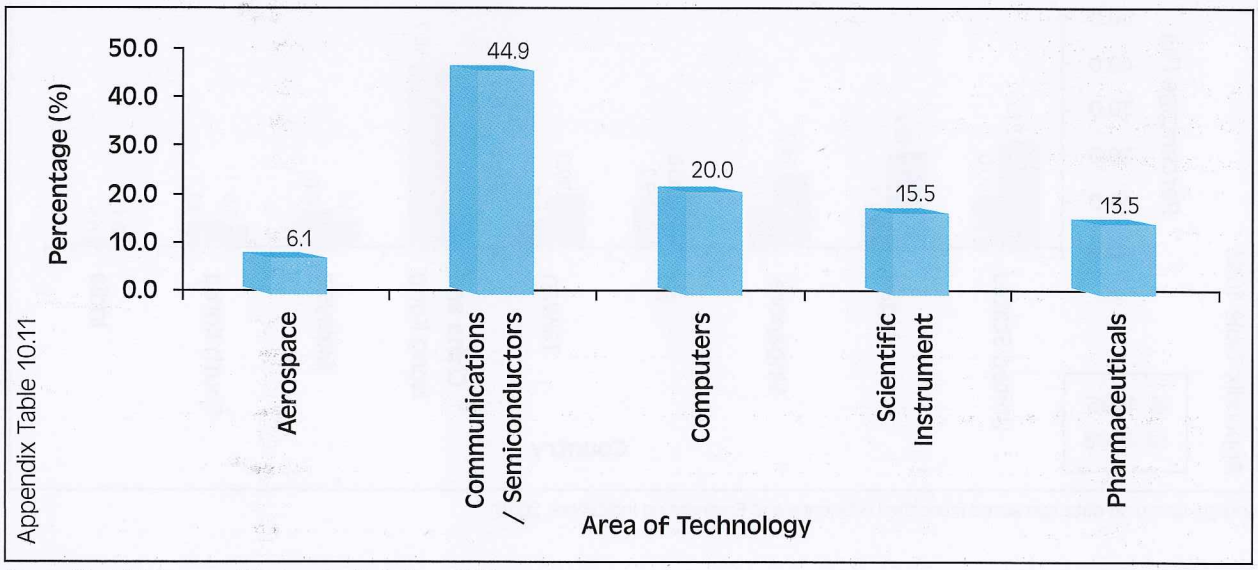
Country	1996	1999	2002	2005	2007
Malaysia	**2**	**3**	**3**	**1**	**1**
Poland	3	3	2	3	2
Hungary	4	1	1	2	3
Thailand	5	7	7	6	4
South Africa	6	5	5	5	5
Argentina	7	6	6	7	6
Philipines	1	4	4	4	7
Venezuela	8	8	8	8	8

Source: The US Science and Engineering Indicators, 2008

Note: The ranking is based on simple average of raw scores of four component indicators, i.e. national orientation, socioeconomic infrastructure, technological infrastructure and productive capacity. Individual countries' scores are then scaled to U.S. overall score. National orientation composed of an investment risk index, and questions addressing national strategy, implementation, entrepreneurship, and attitudes toward technology. Socioeconomic infrastructure composed of educational attainment and questions on national policies toward multinational investment and capital mobility. Technological infrastructure composed of number of scientists employed in R&D, electronic data processing purchases, and questions on technical training and education, industrial R&D, and technological mastery. Productive capacity composed of electronics production, and questions on supply of skilled labor and indigenous component supply and management capability.

An analysis of the trade patterns of the five categories of high-technology products **(Figure 10.11)** shows that the world export value was greatest in communications and semiconductors (44.9% of the total) followed by computers (20.0%), scientific instruments (15.5%), pharmaceuticals (13.5%), and aerospace (6.1%)[3].

Figure 10.11: Distribution of Global Exports of High-Technology Products by Area of Technology, 2008 (% Share of Total High-Technology Products)

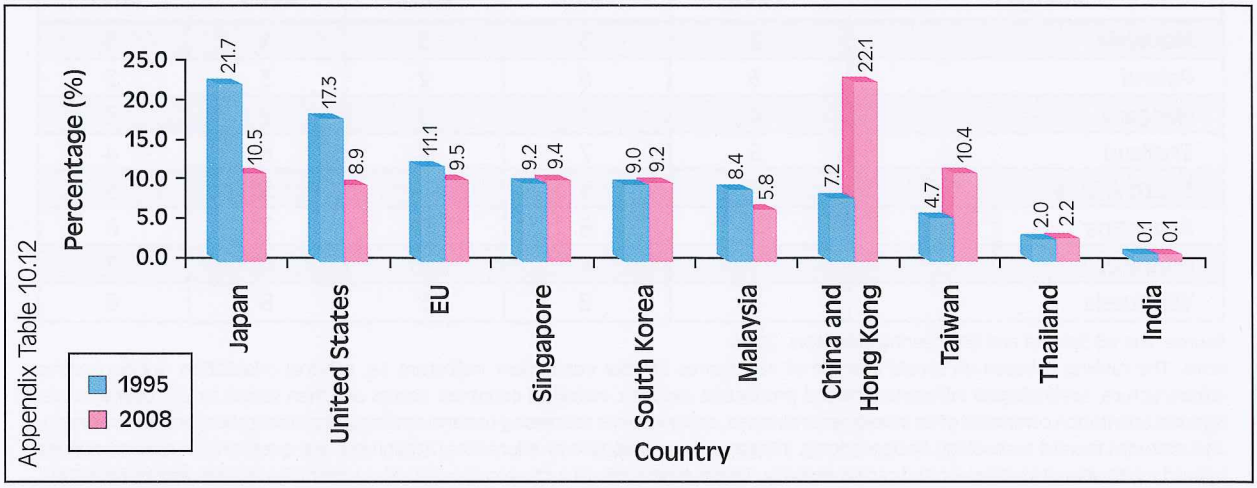


Source: The US Science and Engineering Indicators, 2010

The trend in the export performance of the five high-technology products by countries and regions shows an interesting pattern **(Figure 10.12)**. China and Hong Kong's market shares in communications and semiconductors products jumped from 7.2% in 1995 to 22.1% in 2008, making China and Hong Kong the largest exporters of these products in the world. As a result, the market share of other key exporters dwindled. The most notable is Japan's market share, which declined from 21.7% in 1995 to 10.5% in 2008, and the US from 17.3% to 8.9%. Malaysia's market share declined only marginally, by 2.6%.

[3] The US Science and Engineering Indicators 2010

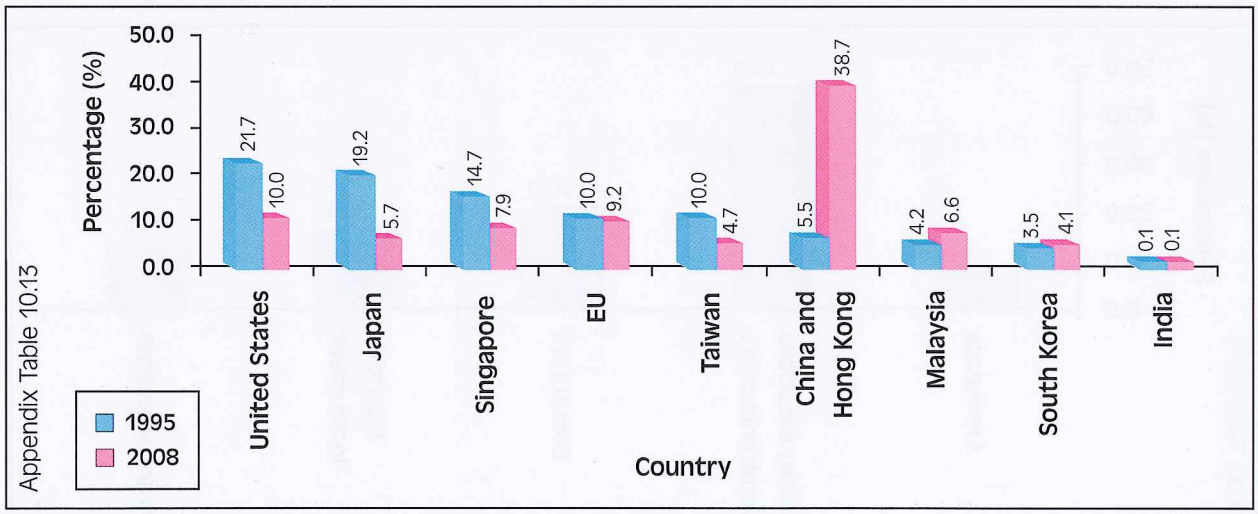
Figure 10.12: Global Export Market Share in Communications and Semiconductors Products for Selected Countries, 1995 and 2008



Source: Based on data extracted from the US Science and Engineering Indicators, 2010

A similar trend is observed in the computers and office machinery sector. China and Hong Kong's share in global exports increased sharply from 5.5% in 1995 to 38.7% in 2008 **(Figure 10.13)**. Consequently, the market of share of the US and Japan declined from 21.7% to 10.0% and 19.2% to 5.7%, respectively during the same period. Malaysia and South Korea registered positive growth where the share rose from 4.2% to 6.6% and 3.5% to 4.1%, respectively.

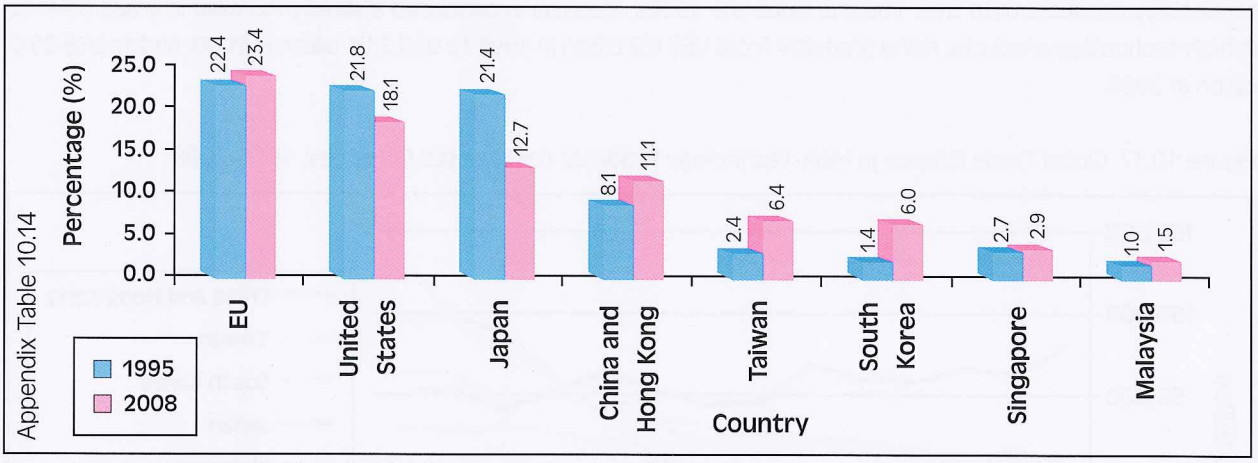
Figure 10.13: Global Export Market Share in Computers and Office Machinery Products for Selected Countries, 1995 and 2008



Source: Based on data extracted from the US Science and Engineering Indicators, 2010

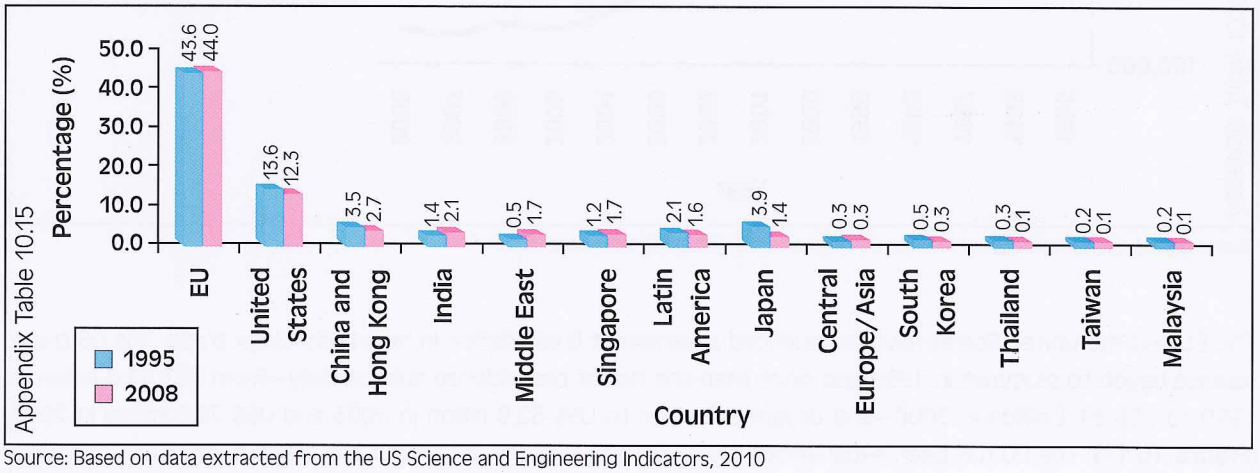
In scientific instruments and pharmaceutical products, the EU holds strong market shares of 23.4% and 44.0%, respectively in 2008 **(Figure 10.14** and **Figure 10.15)**. Other key exporters of scientific instruments in 2008 are the United States (18.1%), Japan (12.7%) and China and Hong Kong (11.1%). Malaysia's share in this sector is negligible, with a share of 1.5% in 2008 **(Figure 10.14)**. As for pharmaceuticals, another major exporter is the United States, holding a market share of 12.3% in 2008. Developing countries such as India, the Middle East, and Singapore recorded an increase in the global pharmaceutical export market share. Malaysia's share is very small and declined from 0.2% in 1995 to 0.1% in 2008 **(Figure 10.15)**.

Figure 10.14: Global Export Market Share in Scientific Instruments and Measuring Equipment Products for Selected Countries, 1995 and 2008



Source: Based on data extracted from the US Science and Engineering Indicators, 2010

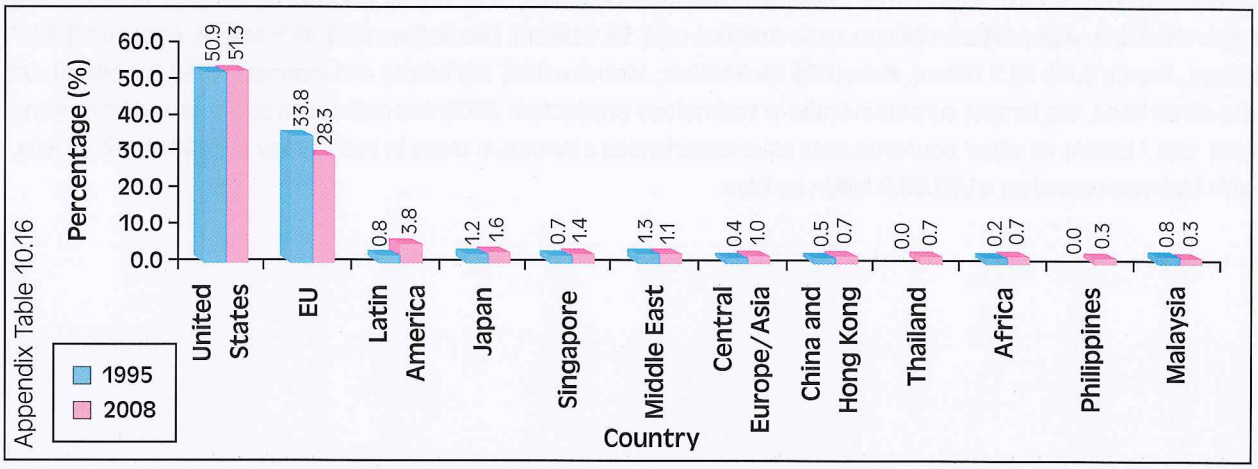
Figure 10.15: Global Export Market Share in Pharmaceutical Products for Selected Countries



Source: Based on data extracted from the US Science and Engineering Indicators, 2010

The aerospace export market is dominated by the EU and the US, with market shares of 28.3% and 51.3% respectively in 2008 (Figure 10.16). Other countries and regions that have recorded an increase in their market share in this industry between 1995 and 2008 are Latin America (from 0.8% to 3.8%), Japan (1.2% to 1.6%), and Singapore (0.7% to 1.4%). Malaysia's market share reduced from 0.8% to 0.3%.

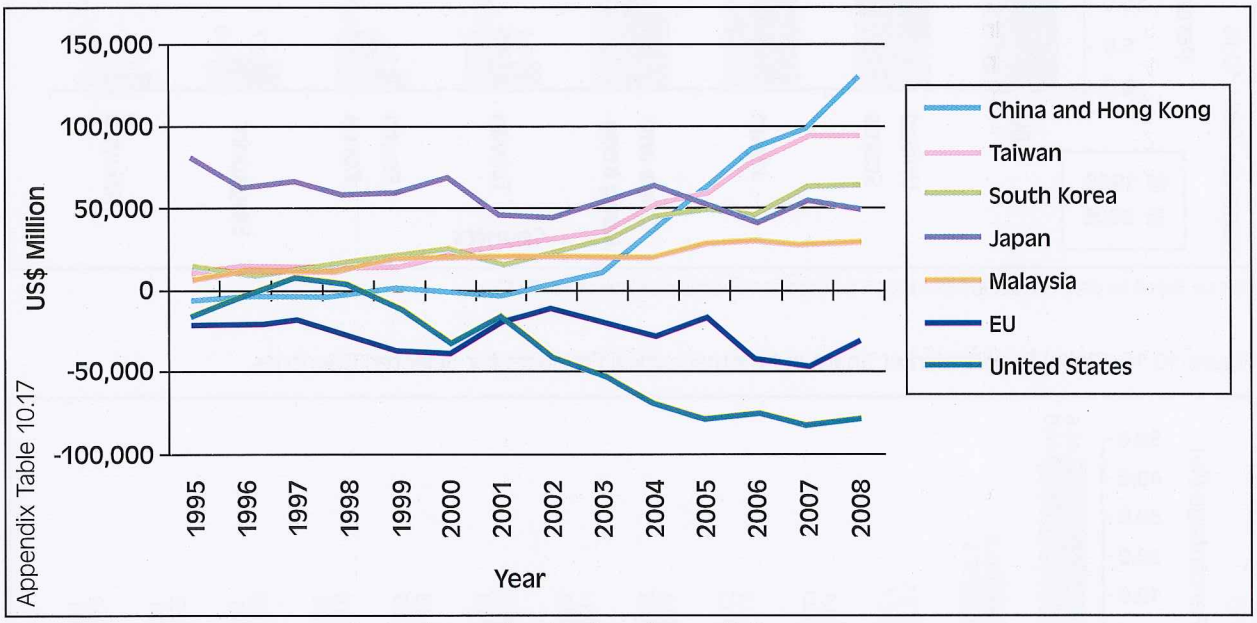
Figure 10.16: Global Export Market Share in Aerospace Products for Selected Countries, 1995 and 2008



Source: Based on data extracted from the US Science and Engineering Indicators, 2010

China and Hong Kong's trade surplus began to surge in 2002; increasing from US$6.6 billion in 2002 to US$ 128.7 billion in 2008 **(Figure 10.17)**. Taiwan, South Korea, Japan, and Malaysia have consistently exported more high-technology products than their imports since the 1990s. Malaysia experienced a steady increase in trade balance in high-technology products, rising gradually from US$ 8.2 billion in 1995 to US$ 21.1 billion in 2000, and to US$ 29.0 billion in 2008.

Figure 10.17: Global Trade Balance in High-Technology Products for Selected Countries, 1995-2008

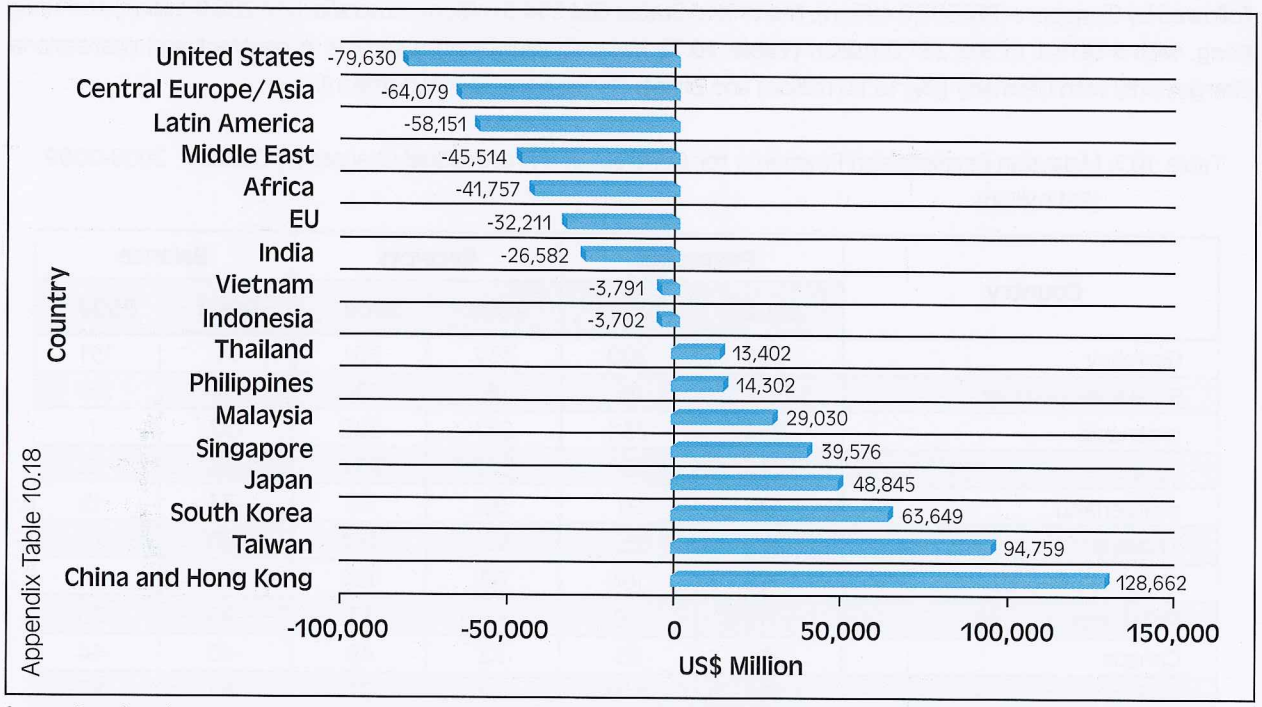


Source: Based on data extracted from the US Science and Engineering Indicators, 2010

The EU and the United States have experienced a persistent trade deficit in high-technology trade. The US trade balance began to plummet in 1999 and since then the deficit has widened substantially—from US$ 11.0 billion in 1999 to US$ 31.1 billion in 2000—and dropped further to US$ 52.9 billion in 2003 and US$ 79.6 billion in 2008 **(Figure 10.17)**. The EU has been experiencing trade deficit since the 1990s but the trade balance has remained stable, registering a deficit of US$ 22.3 billion in 1995 and US$ 32.2 billion in 2008. For both the US and the EU, the increasing amount of imports in ICT products have been the cause of trade deficit in high-technology products. The import of ICT products surged mainly because of rising domestic demand for ICT products and the relocation of production centres of ICT products to developing countries, especially Asia (The US Science and Engineering Indicators, 2010).

Figure 10.18 shows that the biggest deficit in trade in technology products in 2008 was experienced by the US, amounting to US$ 79.6 billion. Other countries that have registered a deficit in trade in technology products are Central Europe/Asia (US$ 64.1 billion), Latin America (US$ 58.1 billion), Middle East (US$ 45.5 billion), Africa (US$ 41.7 billion), the EU (US$ 32.2 billion), India (US$ 26.6 billion), Vietnam (US$ 3.8 billion) and Indonesia (US$ 3.7 billion). On the other hand, the largest surplus in trade in technology products in 2008 was registered by China and Hong Kong (US$ 128.7 billion). All other countries that have experienced a surplus in trade in technology in 2008 are from Asia, with Malaysia recording a US$ 29.0 billion surplus.

Figure 10.18: Global Trade Balance for High-Technology Products, 2008



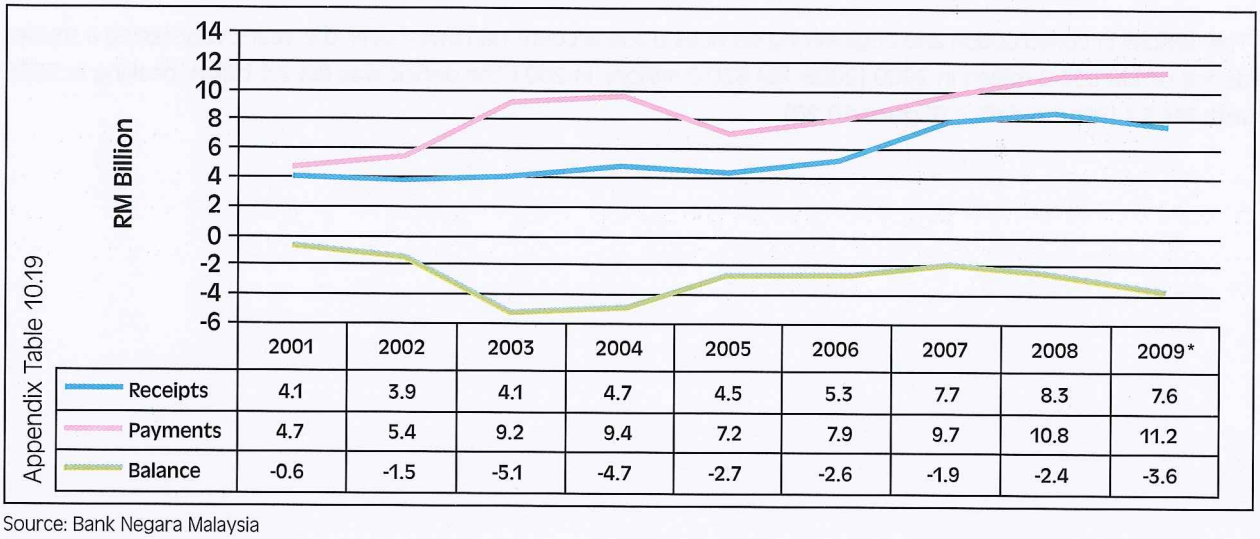
Source: Based on data extracted from the US Science and Engineering Indicators, 2010

10.5 RECEIPTS AND PAYMENTS FOR PROFESSIONAL SERVICES TRADE

This section examines the trend in the payments and receipts of the Malaysian professional services trade. Bank Negara Malaysia divides this transaction into two areas, contract and professional charges and construction and engineering.

Malaysia, essentially, is a net importer of professional services, implying dependence on foreign technologies and expertise. The contract and professional charges payments exceed receipts for all years, thus contributing to persistent deficits in contract and professional charges account balance **(Figure 10.19)**. The deficits, in fact, widened from RM 0.6 billion in 2001 to RM 2.7 billion in 2005, and increased further to RM 3.6 billion in 2009. The deficits in this account peaked in 2003 and 2004, registering a deficit of RM 5.1 billion and RM 4.7 billion, respectively.

Figure 10.19: Malaysian Receipts and Payments for Contract and Professional Charges, 2001-2009



	2001	2002	2003	2004	2005	2006	2007	2008	2009*
Receipts	4.1	3.9	4.1	4.7	4.5	5.3	7.7	8.3	7.6
Payments	4.7	5.4	9.2	9.4	7.2	7.9	9.7	10.8	11.2
Balance	-0.6	-1.5	-5.1	-4.7	-2.7	-2.6	-1.9	-2.4	-3.6

Source: Bank Negara Malaysia
* Note: Data for 2009 is preliminary

Deficits in contract and professional charges in 2009 is the largest with the United Kingdom (RM 825.0 million), followed by Singapore (RM 607.0 million), the United States (RM 534.0 million), Australia, (RM 288.0 million) and Hong Kong, with a deficit of RM 257.0 million **(Table 10.7)**. Malaysia registered a surplus in contract and professional charges only with Germany (RM 131.0 million) and Brunei Darussalam (RM 98.0 million).

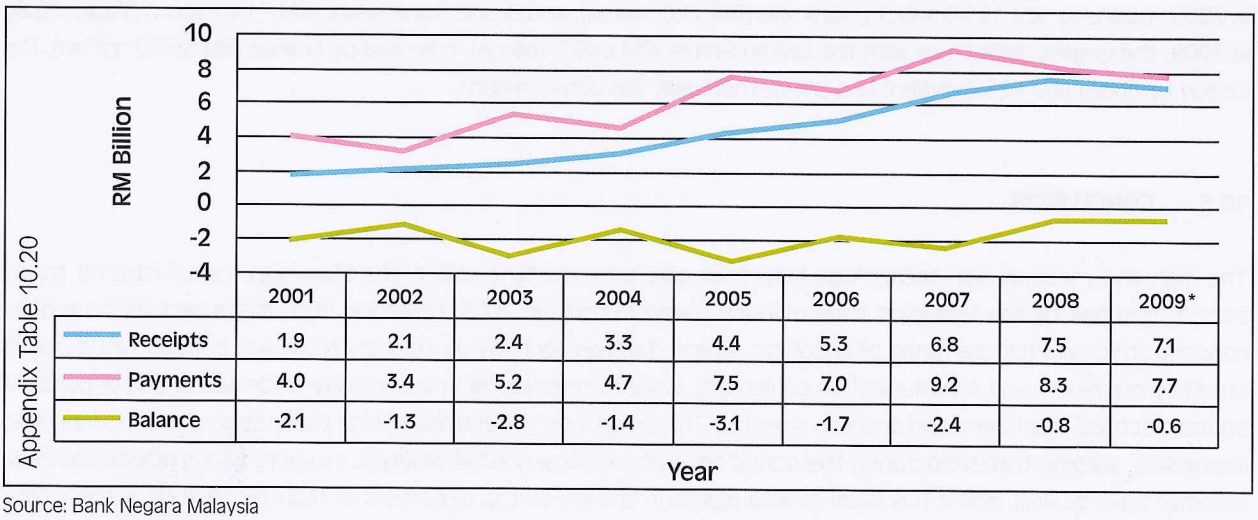
Table 10.7: Malaysian Receipts and Payments for Contract and Professional Charges by Country, 2008-2009 (RM million)

Country	Payments		Receipts		Balance	
	2008	2009*	2008	2009*	2008	2009*
Germany	261	200	332	331	71	131
Brunei Darussalam	27	26	45	124	18	98
Indonesia	254	230	217	223	-37	-7
Japan	305	269	272	257	-33	-12
Switzerland	171	97	98	78	-73	-19
Thailand	178	157	100	132	-78	-25
Republic of Korea	189	160	82	134	-107	-26
Philippines	115	99	55	73	-60	-26
Canada	92	93	52	49	-40	-44
Taiwan	136	149	79	92	-57	-57
France	128	121	128	50	0	-71
India	264	210	93	90	-171	-120
Sweeden	89	394	193	196	104	-198
Netherlands	313	337	174	132	-139	-205
China	407	366	107	112	-300	-254
Hong Kong	624	700	632	443	8	-257
Australia	583	586	328	298	-255	-288
United States	2,086	2,149	2,022	1,615	-64	-534
Singapore	2,106	2,116	1,381	1,509	-725	-607
United Kingdom	1,145	1,427	669	602	-476	-82
Others	1,295	1,315	994	1,063	-301	-2525
Total	**10,767**	**11,201**	**8,054**	**7,605**	**-2,713**	**-3,596**

Source: Bank Negara Malaysia
* Note: Data for 2009 is preliminary

The deficits in construction and engineering services trade account narrowed over the years, registering a smaller deficit of RM 633.0 million in 2009 (2008: RM 820.0 million). In 2001 the deficit was RM 2.1 billion, peaking in 2005 with RM 3.1 billion in deficit **(Figure 10.20)**.

Figure 10.20: Malaysian Receipts and Payments for Construction and Engineering, 2001-2009



Appendix Table 10.20

	2001	2002	2003	2004	2005	2006	2007	2008	2009*
Receipts	1.9	2.1	2.4	3.3	4.4	5.3	6.8	7.5	7.1
Payments	4.0	3.4	5.2	4.7	7.5	7.0	9.2	8.3	7.7
Balance	-2.1	-1.3	-2.8	-1.4	-3.1	-1.7	-2.4	-0.8	-0.6

Source: Bank Negara Malaysia
* Note: Data for 2009 is preliminary

Table 10.8: Malaysian Receipts and Payments for Construction and Engineering by Country, 2008 and 2009 (RM Million)

Country	Payments		Receipts		Balance	
	2008	2009*	2008	2009*	2008	2009*
Singapore	1,973	1,249	947	1,377	(1,026)	128
Indonesia	95	97	351	222	256	125
Australia	156	116	240	207	84	91
Brunei Darussalam	13	21	96	92	83	71
Myanmar	1	1	1	1	-	-
Bahrain	4	18	13	14	9	-4
Democratic People of Korea	1	4	-	-	-1	-4
Republic of Korea	125	95	99	87	-26	-8
Japan	758	283	198	271	-560	-12
Panama	21	31	26	12	5	-19
Switzerland	169	135	102	112	-67	-23
Canada	35	101	13	30	-22	-71
Hong Kong	403	244	422	165	19	-79
China	276	185	137	101	-139	-84
Germany	512	280	238	173	-274	-107
Italy	132	635	180	527	48	-108
Thailand	112	241	222	117	110	-124
Netherlands	687	619	560	452	-127	-167
United Kingdom	382	474	154	249	-228	-225
France	395	350	59	45	-336	-305
United States	893	1,255	562	606	-331	-649
Others	1,067	1,143	2,708	2,037	1,641	-894
Total	**8,297**	**7,705**	**7,477**	**7,027**	**-820**	**-633**

Source: Bank Negara Malaysia
* Note: Data for 2009 is preliminary

Malaysia is a net exporter of construction and engineering services to Singapore, with a surplus of RM 128.0 million in 2009, Indonesia (RM 125.0 million), Australia (RM 91.0 million), and Brunei Darussalam (RM 71.0 million) **(Table 10.8)**. In 2009, the largest deficit was with the United States (RM 649.0 million), followed by France (RM 305.0 million), the United Kingdom (RM 225.0 million) and the Netherlands (RM 225.0 million).

10.6 CONCLUSION

The high and medium-high technology industries play an important role in the Malaysian manufacturing trade, constituting half of the Malaysian total manufacturing exports in 2009. However, both these sectors have been concentrating on a narrow range of products, where the high-technology industry trade was concentrated mainly on office machinery and communication equipment, while the medium high-technology trade was largely dependent on the electrical machinery and apparatus sector. The growth of global trade in high technology products has been impressive, surging threefold during the period between 1995 and 2008. Malaysia's export performance has been commendable as well, and it has been ranked eighth in the list of top exporters of high-technology in the world, and fifth in Asia. Malaysia's international competitiveness in international high-technology trade has improved over the years, and she has been identified as the best potential exporter of high-technology products among small developing countries. However, Malaysia is a net importer of professional services due to dependence on foreign technologies and expertise.

CHAPTER II
- BIBLIOMETRICS

CHAPTER 11

BIBLIOMETRICS

11.0 INTRODUCTION

Academic and research institutions are key contributors to scientific and technological development. These institutions develop researchers and engineers, and generate new knowledge, ideas, and technology. Among the output measures for academic and research institutions are the number of articles published, whether the articles are published in high impact journals, and the number of times the articles are cited.

This chapter analyses the current performance and trends in the production and citation of peer-reviewed S&T articles for Malaysian institutions, specifically, Institutions of Higher Learning (IHLs) and Government Research Institutes (GRIs). Regional and global trends in article production and citations are analysed to measure Malaysia's competitiveness in S&T. The focus of this chapter is the 10-year period from 2000 to 2009.

The SCOPUS database was used to derive information on publications and citations for authors affiliated with Malaysian institutions. The number of articles in the database analysed totalled 11.0 million, of which 10.0 million were S&T articles and 1.3 million were social science articles. S&T articles are defined as articles in the field of the life sciences, the physical sciences, and the health sciences.

Article output or publication is defined as an article published in the peer-reviewed literature. Notes, conference papers, or reviews are not included. The report excludes conference papers as they are usually exploratory studies that will end up as articles in international peer-reviewed journals; hence, their exclusion will reduce the double counting of publications. Reviews and notes are excluded as the reviewing process, if any, is usually less rigorous. The definition of article output, and hence the data used, is not quite comparable with the data presented in the S&T indicators 2008, which include conference papers, reviews, and notes from the SCOPUS database.

Earlier issues of the S&T Indicators also used the Science Citation Index and the Social Science Citation Index (SCI and SSCI) database, which are also not quite comparable to SCOPUS. The advantage of using the SCOPUS database is that it covers substantially more journals compared to the SCI/SSCI database (Bosman *et al.* 2006).

As the data are derived mainly from the SCOPUS database, the number of articles and citations will underestimate the actual article output by authors affiliated with Malaysian institutions, as many publications by Malaysian authors may not be covered by SCOPUS.

Even though one of the output measures for academic and research institutions is the number of articles published in internationally recognised peer-reviewed literature—which is also a measure of the progress in building the S&T base underlying indigenous technology—it should be noted that counts of published articles are not strictly equivalent to research activity. Rather, such published articles constitute the production of publicly available, research-based, and codified knowledge for the international research community.

Finally, it should be mentioned that the number of citations received by the published articles, although not perfect, is also an important output measure for academic and research institutions as it quantifies the transfer and utilisation of knowledge. More often than not, a frequently cited paper has a greater influence on subsequent research activities than a research paper with fewer or no citations. The relative number of citations is also often considered a proxy measure of visibility within the research community.

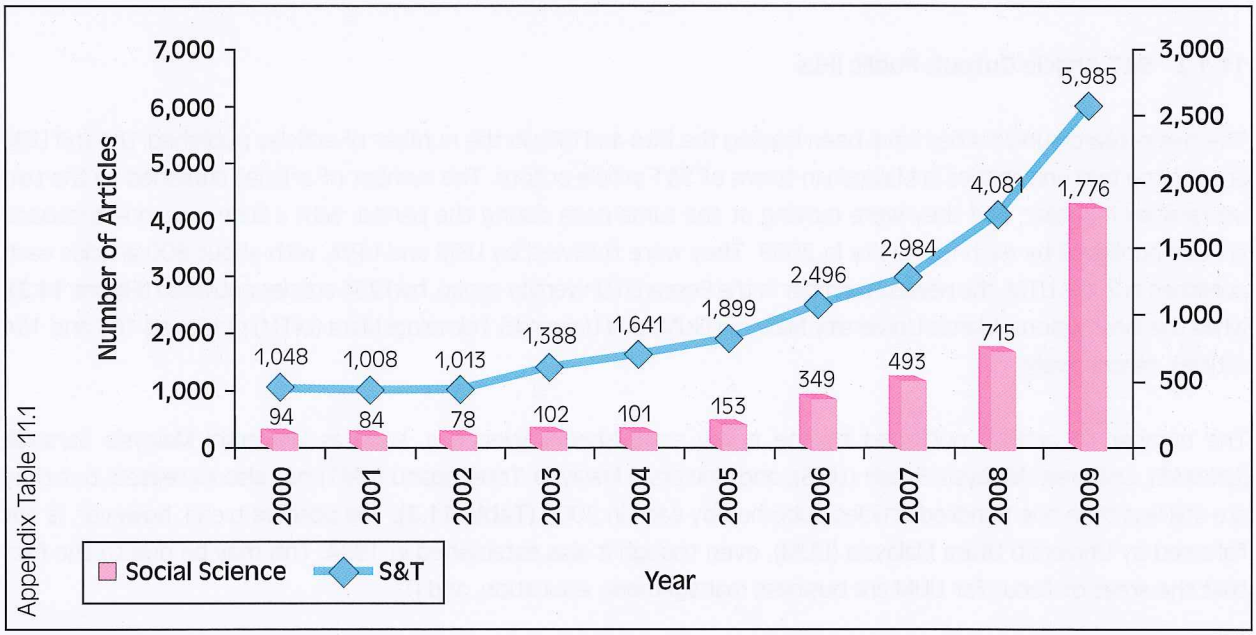
The data show that the number of S&T articles and citations for authors affiliated with Malaysian institutions in international peer-reviewed journals has been increasing at a very rapid rate for the period 2000 to 2009. However, even with the rapid increase in publications, Malaysia's share of the world's S&T articles is negligible with about 0.1% in 2000 and 0.5% in 2009. In the South East Asian region, Malaysia is still behind Singapore, but it has been able to catch up with Thailand in terms of the quantity of publications in 2009. If this growth can be maintained, it is possible that Malaysia's S&T article output will be greater than Singapore's in a few years.

11.1 ARTICLE OUTPUT BY AUTHORS AFFILIATED WITH INSTITUTIONS IN MALAYSIA

11.1.1 Overview

In 2009, 5,985 articles in S&T and 1,776 in the social sciences were published by authors affiliated with institutions in Malaysia **(Figure 11.1)**. These numbers are far greater than those for the year 2000, when there were 1,048 articles in S&T and 94 articles in the social sciences published. Articles in S&T and the social sciences by authors affiliated with Malaysian institutions grew at a very rapid rate during the period of 2000-2009. The number of articles in S&T grew by 471.1%, from approximately 1,000 articles in 2000 to approximately 6,000 in 2009, an average annual growth of 52.3%; while those in the social sciences grew by 1,789.4%, from 94 in 2000 to 1,776 in 2009 **(Table 11.1)**, an average annual growth of 198.8%. Hence, the growth in publications by authors affiliated with institutions in Malaysia is indeed impressive. However, it should be mentioned that as a share of world publications, the number of articles published for both S&T and the social sciences is still negligible. Globally, about 1.3 million articles were published, and recorded in the SCOPUS database for 2009.

Figure 11.1: S&T and Social Sciences Articles, 2000-2009



Source: Bibliometric Study 2008, MOSTI

Table 11.1: Average Annual Growth of S&T and Social Sciences Articles, 2000-2009

Country	S&T	Social Science
2000	1,048	94
2009	5,985	1,776
Growth (%)	471.1	1,789.4
Average Annual Growth (%)	52.3	198.8

Source: Bibliometric Study 2008, MOSTI

The rapid growth of articles published can be attributed, among others, to the Ministry of Higher Education's (MOHE) National Higher Education Strategic Plan. Among the goals of the Strategic Plan is to have Institutions of Higher Learning (IHLs) in Malaysia ranked in the top 50 world universities' ranking by the year 2020. The plan also calls for the establishment of Apex and Research Universities, which require Malaysian researchers to publish regularly in recognised and agreed upon, international, high impact refereed journals.

Competition among Malaysian universities to achieve Apex and Research University status has also helped to encourage researchers in Malaysian universities to publish in international peer-reviewed journals, as one of the criteria for a Research University is the number of publications in high impact journals. Currently, Universiti Sains Malaysia (USM) is the only university that has been granted Apex University status, while Universiti Malaya (UM), Universiti Kebangsaan Malaysia (UKM), Universiti Putra Malaysia (UPM), and most recently, Universiti Teknologi Malaysia (UTM), have been granted Research University status. USM, in addition to being granted Apex University Status, was also granted Research University Status.

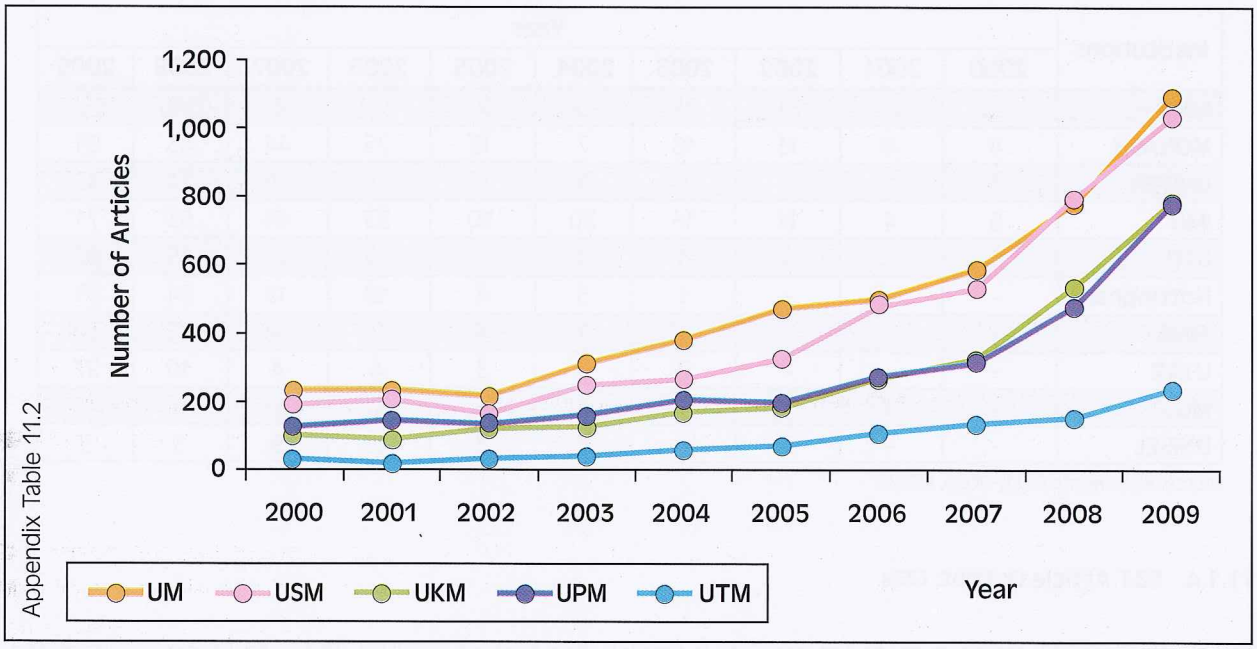
The growth in the number of articles published can also be traced to the establishment of new IHLs, both public and private. For instance, Universiti Malaysia Terengganu (UMT) and Universiti Malaysia Kelantan (UMK) were established in 2007. Several college universities, such as Kolej Universiti Teknikal Kebangsaan Malaysia (KUTKM), were upgraded to university status. Finally, the establishment of local campuses by foreign universities, such as Monash University and the University of Nottingham, has also helped to increase the number of researchers, and hence articles, by Malaysian IHLs.

11.1.2 S&T Article Output: Public IHLs

The five research universities have been leading the IHLs and GRIs in the number of articles published. UM and USM are the top two universities in Malaysia in terms of S&T article output. The number of articles published by the two universities is similar, and they were moving at the same pace during the period, with a little over one thousand articles published by each university in 2009. They were followed by UKM and UPM, with about 800 articles each published in 2009. UTM, the newest member in the Research University group, had 234 articles published **(Figure 11.2)**, while the International Islamic University Malaysia (IIUM) and Universiti Teknologi Mara (UiTM) published 165 and 154 articles, respectively.

The number of articles published by the newly established universities, such as Universiti Malaysia Sarawak (UNIMAS), Universiti Malaysia Sabah (UMS), and Universiti Malaysia Terengganu (UMT) has also increased, but they are still less than one hundred articles published by each in 2009 **(Table 11.2)**. The positive trend, however, is not followed by Universiti Utara Malaysia (UUM), even though it was established in 1984. This may be due to the fact that the areas of focus for UUM are business management, education, and IT.

Figure 11.2: S&T Article Output: Research Universities, 2000-2009



Source: Bibliometric Study 2008, MOSTI

Table 11.2: S&T Article Output: Public IHLs, 2000-2009

Institutions	Year									
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
UM	232	234	215	313	379	472	502	589	777	1,094
USM	192	205	167	250	265	324	491	540	795	1,034
UKM	104	90	117	125	169	185	268	326	535	786
UPM	125	142	134	152	202	193	270	316	475	779
UTM	26	17	31	40	58	71	110	135	153	234
IIUM	1	6	5	6	18	28	69	81	110	165
UiTM	3	7	8	5	11	28	45	55	81	154
UNIMAS	14	17	16	26	16	15	30	24	52	69
UMS	-	8	6	14	22	27	29	39	41	62
UMT	-	-	-	-	-	-	-	18	19	74
UniMAP	-	-	-	-	-	-	-	4	13	33
UUM	1	2	1	3	3	-	-	2	-	14

Source: Bibliometric Study 2008, MOSTI

11.1.3 S&T Article Output: Private IHLs

Private IHLs outnumber public IHLs, but many of the private IHLs do not put an emphasis on R&D; instead, their focus is on teaching undergraduate programmes. Of the private IHLs that were given university status by the MOHE, the Multimedia University (MMU), established in 1994, has rivalled the public IHLs (which were established at around the same time) in terms of the number of S&T articles published. In 2009, authors affiliated with MMU published 182 S&T articles, more than of the number published by IIUM and UiTM. Monash University Malaysia, established in 1998, published 81 articles in 2009 **(Table 11.3)**.

Table 11.3: S&T Article Output: Private IHLs, 2000-2009

Institutions	Year									
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
MMU	26	24	31	79	100	99	181	182	188	182
MONASH	4	4	13	13	7	12	25	44	43	81
UNITEN	1	1	2	3	8	5	14	16	24	72
IMU	5	4	11	16	20	30	33	44	63	71
UTP	1	-	4	3	1	7	15	25	45	67
Nottingham	-	-	-	1	5	4	19	19	34	53
AIMST	-	-	-	1	2	4	2	4	15	30
UTAR	-	-	-	2	1	3	4	4	10	27
MUST	-	1	-	-	-	5	2	11	4	6
UNISEL	-	-	-	-	1	3	10	9	3	3

Source: Bibliometric Study 2008, MOSTI

11.1.4 S&T Article Output: GRIs

The number of S&T article outputs for the GRIs is smaller than that of the IHLs. This is to be expected, as the number of researchers from the GRIs is smaller than that of the IHLs. The GRIs are led by the Institute of Medical Research (IMR) and the Forest Research Institute of Malaysia (FRIM), producing 64 and 52 S&T articles, respectively in 2009 **(Table 11.4)**. Even though the number of S&T articles published is smaller, the growth of articles published by the IMR is comparable to that of UM, with an average annual growth rate of 39.7%.

The main difference between the GRIs and IHLs is that the GRIs specialise in specific fields of research. For example, the Malaysia Palm Oil Board (MPOB) specialises in palm oil research, while the Forest Research Institute of Malaysia (FRIM) specialises in tropical forest research.

Table 11.4: S&T Article Output: GRIs, 2000-2009

Institutions	Year									
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
IMR	14	19	20	16	16	37	33	32	42	64
FRIM	18	7	9	17	23	22	34	50	35	52
MPOB/PORIM	8	20	21	12	28	31	34	34	28	49
MARDI	4	2	1	3	3	5	6	6	12	20
SIRIM	7	9	6	4	14	14	11	10	16	14
MIMOS	-	-	1	4	5	2	4	5	9	9
RRIM	2	-	1	1	1	1	1	10	10	8
MINT	-	10	4	3	4	5	13	11	12	8

Source: Bibliometric Study 2008, MOSTI

11.1.5 S&T Article Output: Average Annual Growth (2000-2009)

The average annual growth rates of S&T articles published by the top institutions are shown in Table 11.5. The average annual growth of IIUM, UiTM, and Monash University Malaysia is far greater than the other universities. This may be due to the fact that their article output in 2000 was smaller than the Research Universities **(Table 11.2** and **Table 11.3)**.

Table 11.5: S&T Article Output: Average Annual Growth, 2000-2009

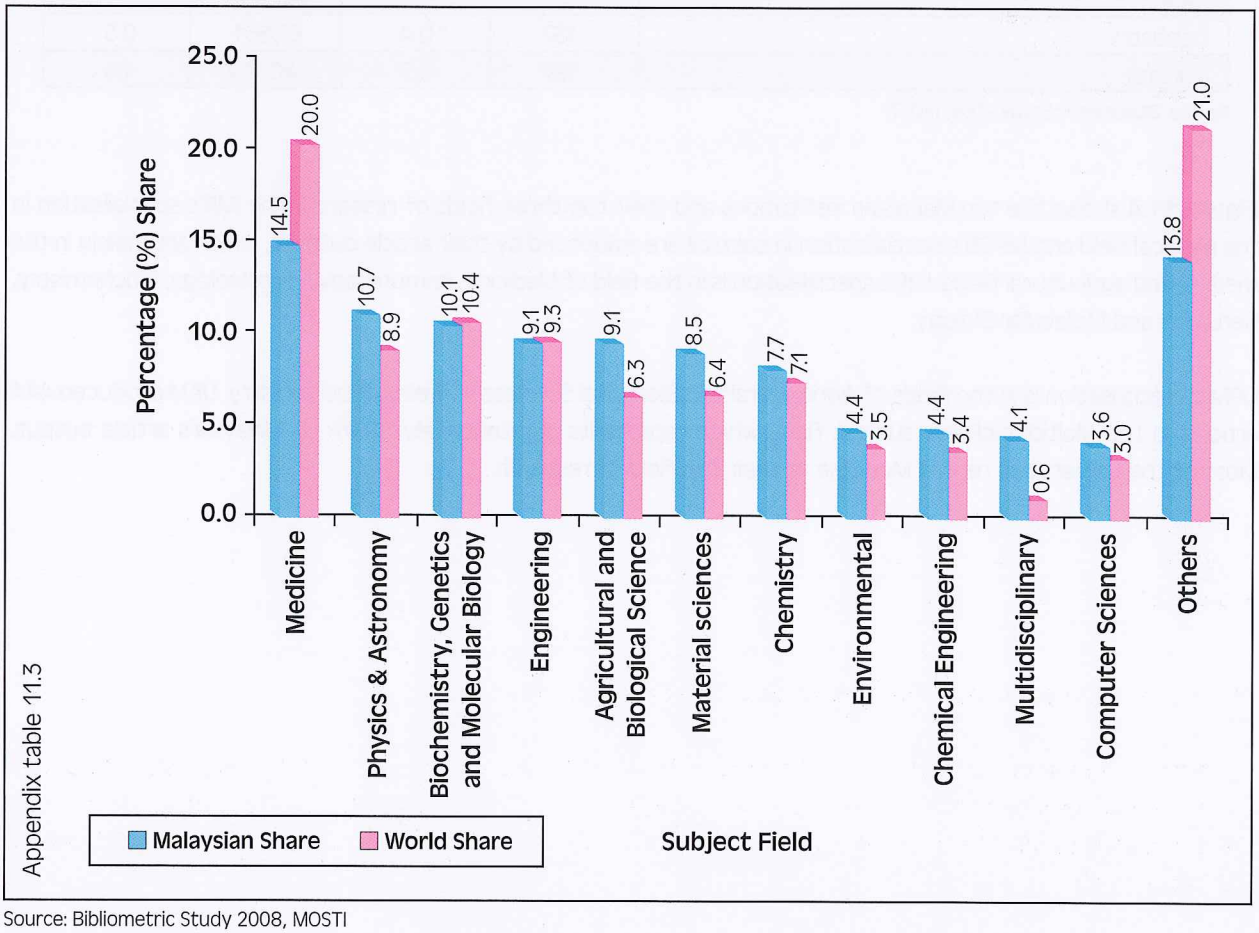
Institutions	Avg. Annual Growth (%)	Institutions	Avg. Annual Growth (%)
UM	41.3	UMS	84.4
USM	48.7	MMU	66.7
UKM	72.9	Monash	240.6*
UPM	58.1	IMR	39.7
UTM	88.9	FRIM	21.0
IIUM	331.3*	MPOB	27.8
UiTM	262.5*	MARDI	44.4
UNIMAS	43.7		

Source: Bibliometric Study 2008, MOSTI
* From 2001-2009

11.1.6 S&T Article Output by Broad Subject Field

Figure 11.3 and **Table 11.6** show the share of S&T articles by broad subject fields for Malaysia and the world. The share of publications by broad subject fields for Malaysia is similar to the world share, except for a few fields, such as Multidisciplinary Studies and Medicine, which account for 4.0% and 14.5% of the Malaysian share respectively, but 0.7% and 20.0% of the world share. The top three fields of research in Malaysia are Medicine; Physics and Astronomy; and Biochemistry, Genetics and Molecular Biology, which represents 14.5%, 10.7% and 10.1% of Malaysia's article output, respectively.

Figure 11.3: Share of S&T Article Output by Subject Field, 2000-2009



Appendix table 11.3

Source: Bibliometric Study 2008, MOSTI

Table 11.6: Share of S&T Article Output by Subject Field, 2000-2009

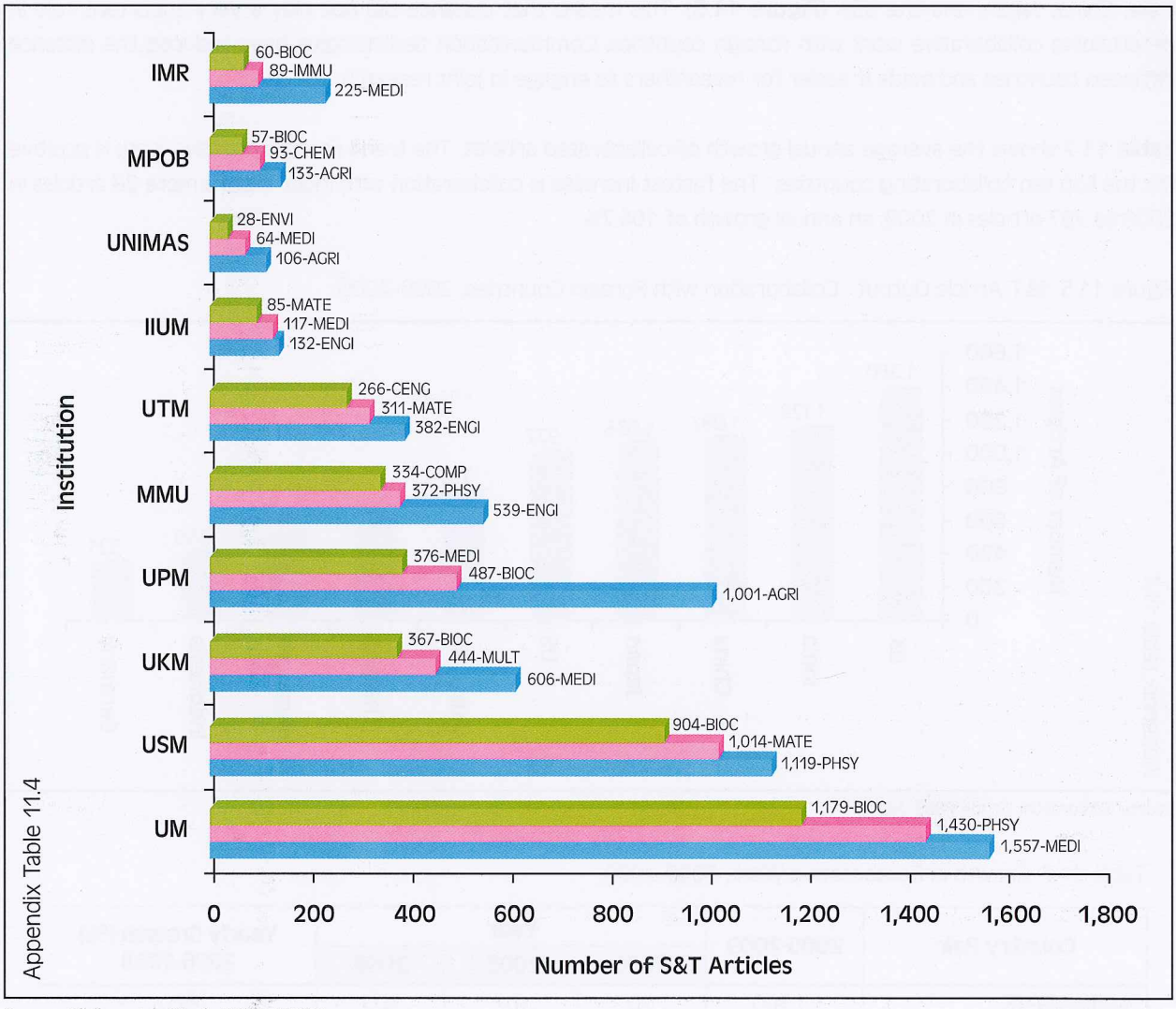
Subject	Malaysia		World	
	2000-2009	Share	2000-2009	Share
Medicine	5,450	14.5	2,935,697	20.0
Engineering	3,435	9.1	1,365,225	9.3
Biochemistry, Genetics and Molecular Biology	3,800	10.1	1,523,940	10.4
Agricultural and Biological Sciences	3,437	9.1	926,002	6.3
Physics and Astronomy	4,017	10.7	1,300,695	8.9
Chemistry	2,902	7.7	1,048,677	7.1
Material Sciences	3,232	8.6	944,528	6.4
Computer Sciences	1,359	3.6	441,560	3.0
Environmental Sciences	1,638	4.4	518,851	3.5
Chemical Engineering	1,635	4.4	492,674	3.4
Immunology and Microbiology	1,087	2.9	435,183	3.0
Pharmacology, Toxicology and Pharmaceutics	856	2.3	404,650	2.8
Mathematics	1,062	2.8	528,380	3.6
Earth and Planetary Sciences	617	1.6	571,371	3.9
Energy	551	1.5	215,405	1.5
Multidisciplinary	1,506	4.0	108,247	0.7
Decision Sciences	177	0.5	72,363	0.5
Veterinary	168	0.5	126,603	0.9
Neuroscience	150	0.4	359,330	2.5
Health Professions	172	0.5	167,436	1.1
Dentistry	137	0.4	67,861	0.5
Nursing	197	0.5	140,102	1.0

Source: Bibliometric Study 2008, MOSTI

Figure 11.4 shows the top Malaysian institutions and their top three fields of research. The IMR's specialisation in the medical field and MPOB's specialisation in palm oil are evidenced by their article outputs, which are mainly in the medical and agricultural fields. IMR's specialisation is in the field of Medicine, Immunology, Microbiology, Biochemistry, Genetics, and Molecular Biology.

UPM's specialisation is in the fields of Agricultural and Biological Sciences as well as Biochemistry. UKM produced 444 articles in the Multidisciplinary subject field, which represents approximately 30.0% of Malaysia's article output. Most of the universities record Medicine as their top field of research.

Figure 11.4: Institutions by Top Three Fields of Research, 2008



Source: Bibliometric Study 2008, MOSTI

Note: Field of Research

BIOC	: Biochemistry, Genetics and Molecular Biology
IMMU	: Immunology and Microbiology
MEDI	: Medicine
CHEM	: Chemistry
AGRI	: Agricultural and Biological Sciences
ENVI	: Environmental Sciences
MATE	: Material Sciences
ENGI	: Engineering
CENG	: Chemical Engineering
COMP	: Computer Sciences
PHYS	: Physics and Astronomy
MULT	: Multidisciplinary

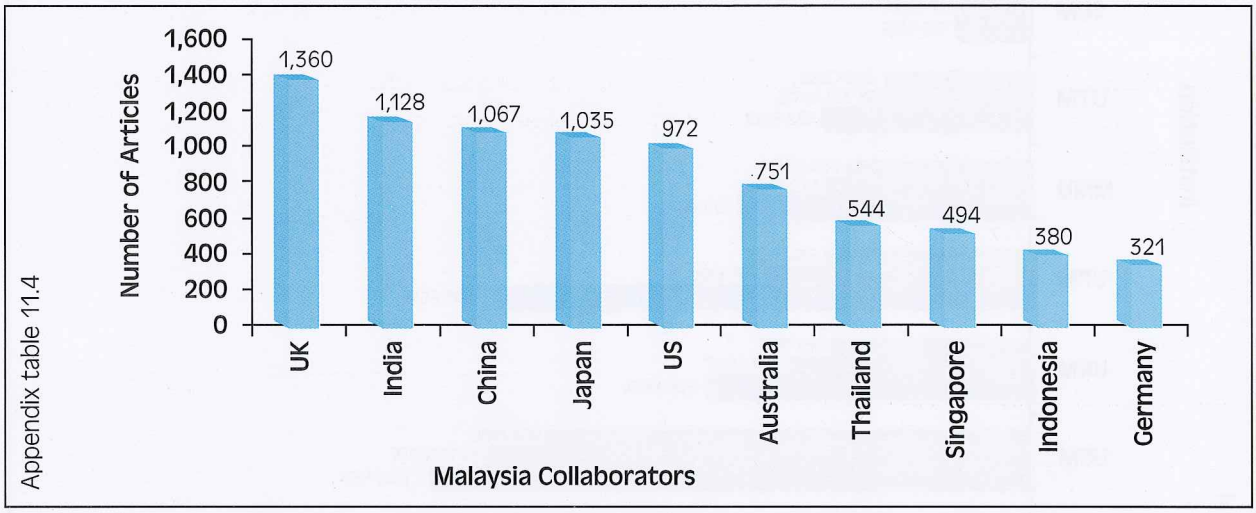
11.2 S&T ARTICLE OUTPUT: INTERNATIONAL COLLABORATION

One of the ways to transfer knowledge and technology is through collaborative work with IHLs or research institutions in foreign countries. Indeed, collaborative research has been identified as contributing to some of the highest impact activities, as collaboration provides access to a wider range of facilities and resources. Collaboration also enables researchers to participate in networks of cutting-edge and innovative activity, and provides opportunities to move further and faster by working with other leading people in the field (Adams *et al.* 2007).

The top five countries collaborating with Malaysia in the publication of articles from 2000 to 2009 are the U.K., India, China, Japan, and the USA **(Figure 11.5)**. This means that distance did not play a very important role in determining collaborative work with foreign countries. Communication technologies have reduced the distance between countries and made it easier for researchers to engage in joint research.

Table 11.7 shows the average annual growth of collaborated articles. The trend for collaborative work is positive for the top ten collaborating countries. The fastest increase is collaboration with India, from a mere 28 articles in 2000 to 297 articles in 2009; an annual growth of 106.7%.

Figure 11.5: S&T Article Output: Collaboration with Foreign Countries, 2000-2009



Source: Bibliometric Study 2008, MOSTI

Table 11.7: Growth in Collaborative Work, 2000-2009

Country Pair	2000-2009	Year			Yearly Growth (%) 2000-2009
		2000	2005	2009	
Malaysia-UK	1,360	70	107	303	37.0
Malaysia-India	1,128	28	87	297	106.8
Malaysia-China	1,067	43	166	114	18.4
Malaysia-Japan	1,035	48	103	212	38.0
Malaysia-US	972	52	84	209	33.6
Malaysia-Australia	751	40	58	191	41.9
Malaysia-Thailand	544	17	42	100	54.3
Malaysia-Singapore	494	19	50	96	45.0
Malaysia-Indonesia	380	12	30	104	85.1
Malaysia-Germany	321	11	34	71	60.6

Source: Bibliometric Study 2008, MOSTI

11.3 S&T ARTICLE OUTPUT: HIGH IMPACT JOURNALS

Publication in high impact journals is also an indicator, albeit imperfect, of whether an article, one of the outputs of research, is of high quality (Saha *et al.* 2003). However, the citation patterns, acceptance rate and impact factors vary widely across disciplines. For example, in 2006 the highest impact factor in the field of economics is 4.7, held by the Journal of Economic Literature. The top impact factor in molecular and cell biology is 47.4, held by Annual Reviews of Immunology (Althouse *et al.* 2008). The average impact factors in these fields differ six fold. Hence, to measure publication in high impact journals, this report examines publications in the top five journals by subject fields. The titles of the top five journals are reported in the **Appendix 1.**

The primary source of information for this report is the SCOPUS database, and hence, the SCImago Journal Rank Indicator (SJR) is used to measure the impact factor of a journal. The SJR was developed by SCImago from the widely known Google page rank algorithm. This indicator shows the visibility of the journals contained in the SCOPUS database from 1996. SCImago is a research group from the Consejo Superior de Investigaciones Cientificas (CSIC), University of Granada, Extremadura, Carlos III (Madrid) and Alcalá de Henares. These institutions are dedicated to information analysis, representation, and retrieval by means of visualisation techniques.

Table 11.8 reports the number of articles published in the top five journals from 2000-2009 by broad subject fields as ranked by SJR. The journal rank is comparable to those of the ISI Journal Citation Report impact factor. The number of S&T articles published by Malaysian authors and researchers in the top ranked journals is negligible. In many of the top journals, there was no article written by an author affiliated with a Malaysian institution.

The negligible share of publications in the top journals suggests that more effort is needed by the IHLs and GRIs in order to increase the number of publications in high impact journals by researchers affiliated with Malaysian institutions.

Table 11.8: Number of S&T Articles in Top Five Journals by Subject Field

Subject	Number of articles in Top 5 journals
Medicine	1
Engineering	34*
Biochemistry, Genetics and Molecular Biology	1
Agricultural and Biological Sciences	2
Physics and Astronomy	-
Chemistry	-
Material Sciences	-
Computer Sciences	3
Environmental Sciences	3
Chemical Engineering	1
Immunology and Microbiology	-
Pharmacology, Toxicology and Pharmaceutics	-
Mathematics	-
Earth and Planetary Sciences	-
Energy	34**
Multidisciplinary	19***
Decision Sciences	-
Veterinary	-
Neuroscience	-
Health Professions	-
Dentistry	4
Nursing	5

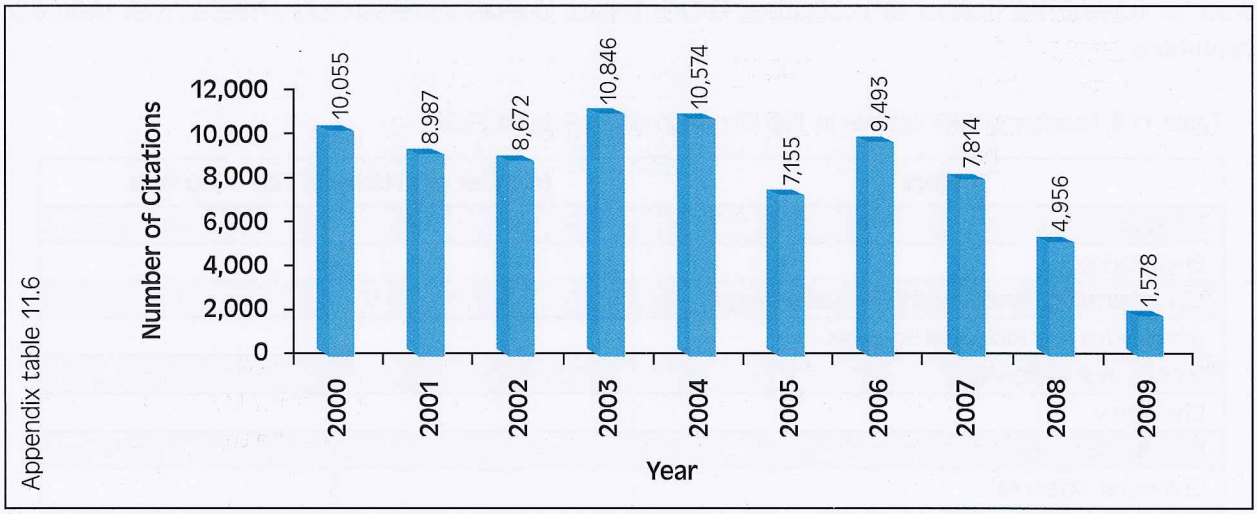
Source: Bibliometric Study 2008, MOSTI and SJR — SCImago Journal & Country Rank
Note: *32 papers in Progress in Electromagnetics Research
** 32 papers in the Journal of Power Sources
*** 19 papers in PNAS of the United States of America

11.4 CITATION OF S&T ARTICLES

The number of citations received is another way of measuring the influence and competitiveness of Malaysian S&T researchers. High citation rates indicate that an article has a greater impact on subsequent research than low citation rates, because when researchers cite the published results of previous research they are formally crediting the influence of that research on their own work. However, in comparing citation numbers, care needs to be given as citation behaviours are different for different fields.

Figure 11.6 shows the total number of citations received by articles published since 2000. The total number of accumulated citations received for the articles published is 80,130. Fewer citations were recorded for articles published in the later years as articles published in 2000 have had more time to be cited.

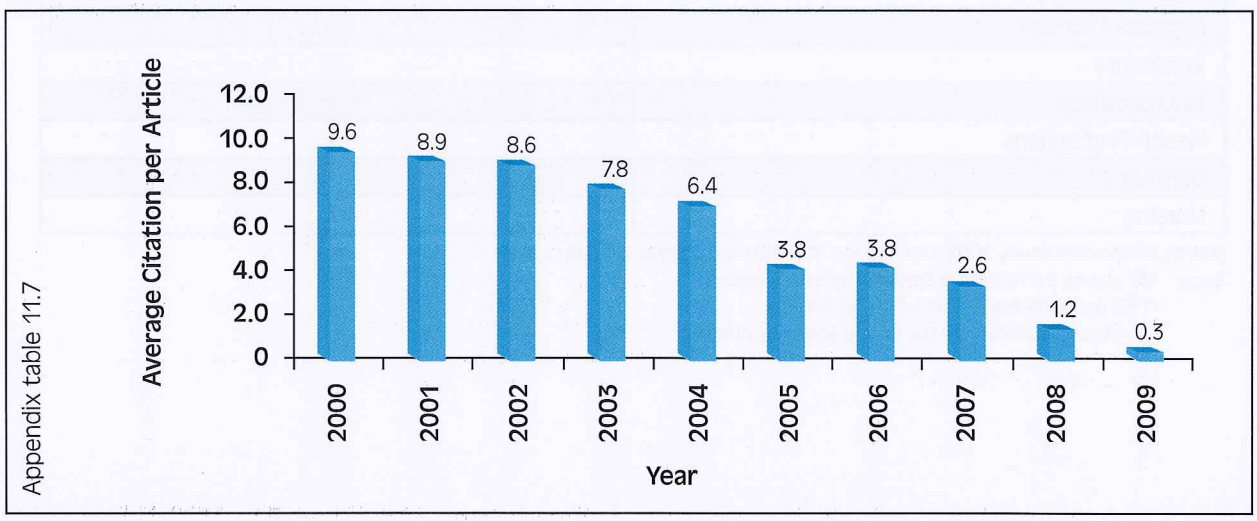
Figure 11.6: Citation of S&T Articles, 2000-2009



Source: Bibliometric Study 2008, MOSTI

Figure 11.7, on the other hand, shows the average number of citations per article for articles published for the period 2000-2009. The average number of citations per article decreased as older articles have a higher probability of being cited compared to those in the more recent years.

Figure 11.7: Average Citation per Article, 2000-2009



Source: Bibliometric Study 2008, MOSTI

The field of Medicine received the highest number of citations **(Table 11.9)**; this is a function of the number of articles published in the field. Indeed, the top three subject fields, in terms of articles published, also received the highest number of citations. On a per article basis, Environmental Sciences received the highest number of citations per article, an average of 4.9 citations per article for the period 2000-2009, followed by Biochemistry, Genetics and Molecular Biology.

Table 11.9: S&T Article Output: Citation by Selected Fields, 2000-2009

Subject	Citations	Average Citation/Article
Medicine	17,404	3.2
Biochemistry, Genetics and Molecular Biology	16,147	4.3
Agricultural and Biological Sciences	13,645	4.0
Chemistry	12,178	4.2
Material Sciences	11,020	3.4
Engineering	10,097	2.9
Physics and Astronomy	9,750	2.4
Computer Sciences	3,541	2.6
Environmental Sciences	8,027	4.9

Source: Bibliometric Study 2008, MOSTI

11.4.1 Citations by Institutions

Table 11.10 provides the number of citations for S&T articles affiliated with Malaysian IHLs and GRIs. Similar to the number of articles published, the Research Universities received the bulk of the citations for Malaysian universities: 17,024 for UM, 14,970 for USM, 6,692 for UKM and 9,489 for UPM. However, for MMU, the top private university, the number of citations (2,738) was greater than that of UTM (2,107), one of the Research Universities. Table 11.10 also shows that even though the number of S&T articles published by IIUM and UiTM is similar to MMU, the total numbers of citations they received is much smaller: 590 for IIUM and 752 for UiTM. UNIMAS and Monash University Malaysia, with a smaller number of article outputs, also received much greater citations, 1010 and 859, respectively compared to IIUM and UiTM.

Table 11.10: Number of Citations by Institutions, 2000-2009

Institution	Citations
UM	17,024
USM	14,970
UKM	6,692
UPM	9,489
MMU	2,738
UTM	2,107
UNIMAS	1,010
Monash	859
UiTM	752
IIUM	590

Source: Bibliometric Study 2008, MOSTI

11.5 INTERNATIONAL COMPARISON

The number of S&T articles published in 2000 and 2009 by country, the country's share of the world's article output, and the average annual growth of articles published for the period 2000 to 2009 are reported in **Table 11.11**. The countries reported make up approximately 82.0% (2000) and 86.0% (2009) of the share of world S&T article output. The Table shows that article output is concentrated in a relatively small number of countries. ASEAN-5 made up 0.9% percent of the world share in 2000 and 1.6% in 2009, while the U.S. made up approximately 26.1% of the world share in 2000 and declined in 2009 to 20.0%. China, meanwhile, accounts for approximately 16.0% of the world share of S&T article output in 2009.

The world average annual growth of S&T article output is 5.4%. In East Asia and South East Asia (South Korea, China, Taiwan, Malaysia, Thailand, Indonesia and Singapore) article output grew faster than the world average, with Malaysia being the fastest growing country, at 52.3%, followed by China, at 43.4%.

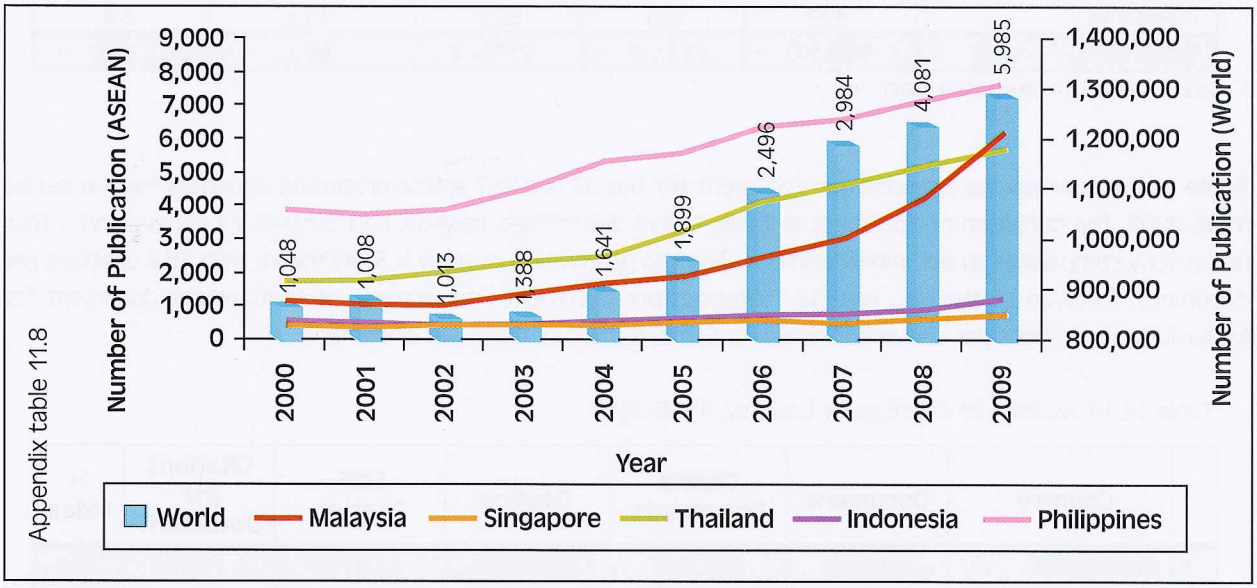
Table 11.11: S&T Article Output, Share of World Total, and Growth Rate, 2000-2009

Country	2000		2009		Average Annual Growth (%)
	Number	Share	Number	Share	
World	**862,623**		**1,278,781**		**5.4**
United States	224,865	26.1	256,045	20.0	1.5
Canada	29,817	3.5	48,456	3.8	7.0
Germany	64,490	7.5	79,114	6.2	2.5
United Kingdom	62,712	7.3	77,868	6.1	2.7
France	45,756	5.3	59,566	4.7	3.4
Italy	31,770	3.7	47,580	3.7	5.5
Spain	22,746	2.6	41,172	3.2	9.0
Netherlands	17,471	2.0	26,397	2.1	5.7
Sweden	14,519	1.7	18,386	1.4	3.0
China	**41,500**	**4.8**	**203,655**	**15.9**	**43.4**
India	20,527	2.4	45,227	3.5	13.4
Japan	79,196	9.2	79,663	6.2	0.1
South Korea	14,231	1.7	35,748	2.8	16.8
Taiwan	10,931	1.3	23,781	1.9	13.1
Australia	19,268	2.2	33,807	2.6	8.4
New Zealand	3,896	0.5	6,276	0.5	6.8
Malaysia	**1,048**	**0.1**	**5,985**	**0.5**	**52.3**
Thailand	1,709	0.2	5,651	0.4	25.6
Indonesia	498	0.1	1,091	0.1	13.2
Singapore	3,878	0.5	7,622	0.6	10.7
Philippines	434	0.1	645	0.1	5.4

Source: Bibliometric Study 2008, MOSTI

Figure 11.8 shows the trends in S&T article output for ASEAN-5 and the world. The trends have been positive. However, relative to Singapore, Thailand, and Malaysia, share of article output for Indonesia and the Philippines is small. Singapore had a 36.3% share of ASEAN-5 article output in 2009, Thailand had 26.9%, and Malaysia had a 28.5% share; while Indonesia and Philippines had a share of 5.2% and 3.1% each. The marked improvement in the number of articles published by Malaysian institutions has eaten away at Singapore's share of ASEAN's article output. In 2000, Malaysia's share was only 13.8%, while Singapore's share was 51.2% **(Table 11.12).**

Figure11. 8: S&T Article Output: ASEAN-5, 2000-2009



Source: Bibliometric Study 2008, MOSTI

Table 11.12: Shares (%) of ASEAN's S&T Article Output, 2000-2009

Year	Malaysia	Singapore	Thailand	Indonesia	Philippines
2000	13.8	51.2	22.6	6.6	5.7
2001	13.9	51.9	23.9	5.8	4.5
2002	13.3	50.8	25.7	5.1	5.2
2003	15.3	48.9	25.7	5.2	4.9
2004	15.8	51.0	24.1	5.1	4.1
2005	16.1	47.5	27.0	5.2	4.2
2006	17.6	44.5	29.0	5.0	3.9
2007	19.2	42.7	29.8	4.9	3.4
2008	22.8	40.1	29.0	4.7	3.3
2009	28.5	36.3	26.9	5.2	3.1

Source: SCOPUS, 2009

Except for the Philippines, the average annual growth rates in S&T article output for ASEAN-5 countries are greater than the world average growth **(Table 11.13)**. Malaysia's average annual increase is the largest, making it one of the top 50 article producing countries. Thailand's annual average growth is also high, at an annual growth of 25.6% the third highest after China.

Table 11.13: Growth Rate of S&T Articles Published by ASEAN Countries, 2000-2009

Country	Number of Publications			Growth 2000-2009 (%)	Average Annual Growth
	2000	2005	2009		
Malaysia	1,048	1,899	5,985	471.1	52.3
Singapore	3,878	5,605	7,622	96.5	10.7
Thailand	1,709	3,186	5,651	230.6	25.6
Indonesia	498	608	1,091	119.1	13.2
Philippines	434	501	645	48.6	5.4
World	862,513	953,075	1,277,944	48.2	5.4

Source: Bibliometric Study 2008, MOSTI

Table 11.14 provides the citations per document for the 50 top S&T article-producing countries for the period 1996-2008. The definition of document in Table 14 includes articles, reviews, and conference papers, and is thus not strictly comparable to our initial definition. The top performing country is Switzerland, with 19.4 citations per document, followed by the U.S., with 18.1 citations per document. The number of citations per document for Malaysia is 6.2 citations per document, while for China, it is 4.8 citations per document.

Table 11.14: Number of Citations by Country, 1996-2008

	Country	Document	Citable Documents	Citation	Self-Citation	Citations per Document	H Index
1	Switzerland	247,655	234,947	4,391,015	643,764	19.4	432
2	United States	4,318,928	4,052,816	75,766,251	35,474,244	18.1	1,048
3	Denmark	129,742	123,928	2,186,505	341,907	18.0	314
4	Netherlands	347,423	329,111	5,634,691	1,001,727	17.7	430
5	Sweden	250,129	240,309	4,008,063	708,092	17.0	381
6	Finland	124,445	121,124	1,800,702	322,469	15.8	281
7	Canada	630,525	599,602	8,825,916	1,803,543	15.5	495
8	U. Kingdom	1,244,316	1,134,839	18,030,898	4,476,611	15.5	636
9	Belgium	188,493	179,544	2,596,630	416,166	15.1	334
10	Israel	154,402	147,884	2,143,484	340,029	14.8	315
11	Norway	94,617	90,777	1,236,892	215,909	14.6	243
12	Austria	130,548	123,673	1,675,616	255,272	14.2	290
13	Germany	1,134,216	1,078,356	15,140,549	4,116,637	14.1	558
14	Australia	401,930	376,906	4,986,938	1,101,340	14.0	380
15	Ireland	58,545	55,123	664,497	84,077	13.8	195
16	France	824,601	781,988	10,475,265	2,511,263	13.5	510
17	New Zealand	80,299	75,790	925,791	160,983	12.9	212
18	Italy	609,192	579,114	7,169,107	1,732,478	12.9	442
19	Spain	449,406	423,791	4,623,796	1,225,409	11.6	347
20	Chile	37,347	36,482	352,382	69,866	11.3	143
21	Hong Kong	103,462	99,704	992,830	180,238	10.9	203
22	Japan	1,224,465	1,198,879	12,485,837	3,920,215	10.5	492
23	Portugal	72,826	70,910	630,969	137,362	10.5	165
24	Singapore	82,159	79,715	702,120	109,807	9.9	175

Table 11.14: Number of Citations by Country, 1996-2008 *(continue)*

	Country	Document	Citable Documents	Citation	Self-Citation	Citations per Document	H Index
25	Hungary	72,235	70,082	666,510	123,247	9.8	188
26	Greece	109,440	104,470	902,351	180,820	9.7	185
27	Argentina	73,705	71,775	622,317	144,908	9.1	158
28	South Africa	71,731	67,560	582,693	133,165	9.0	163
29	Thailand	41,892	40,906	278,002	51,460	8.7	118
30	South Korea	319,976	315,392	2,217,068	530,243	8.5	232
31	Brazil	236,703	230,272	1,614,792	517,211	8.4	219
32	Mexico	96,625	94,410	700,094	160,114	8.3	165
33	Taiwan	233,763	229,301	1,612,728	416,490	8.2	192
34	Czech Republic	93,563	91,278	649,726	165,673	7.7	168
35	Slovenia	29,493	28,922	192,212	44,163	7.4	106
36	Poland	209,744	206,235	1,317,141	373,845	7.0	213
37	Iran	68,401	66,918	261,974	109,888	6.6	83
38	Slovakia	35,274	34,417	211,727	49,365	6.4	114
39	Turkey	171,048	162,252	886,307	259,644	6.4	144
40	Bulgaria	29,893	29,399	174,697	34,490	6.2	101
41	Malaysia	29,166	28,456	122,942	23,912	6.2	85
42	India	393,536	376,276	2,107,271	729,613	6.1	206
43	Egypt	47,420	46,731	239,623	55,012	5.6	95
44	Saudi Arabia	26,763	25,588	134,758	19,320	5.4	87
45	Romania	42,320	41,858	186,021	45,957	5.2	97
46	Croatia	31,748	30,897	145,119	36,722	5.1	95
47	China	1,223,278	1,215,927	4,328,817	2,240,814	4.8	246
48	Russia	405,499	402,701	1,856,149	577,757	4.6	245
49	Pakistan	24,564	23,485	89,584	26,902	4.5	73
50	Ukraine	74,325	73,902	253,451	75,267	3.5	106

Source: SJR — SCImago Journal & Country Rank

11.6 CONCLUSION

The growth of Malaysia's S&T article output for the period 2000-2009 is very rapid. The average annual growth is approximately 52.3%; however, as a share of the world's article output, Malaysia's is considered negligible, at a mere 0.5% in 2009 and 0.1% in 2000. S&T article output for the ASEAN region is led by Singapore and Thailand for the period analysed. However, with its rapid growth, Malaysia's article output in 2009 is higher, for the first time, than that of Thailand. The global share of S&T article output, on the other hand, is concentrated in a few developed countries, together with China and India. Due to its rapid growth, China has increased its world share from approximately 5.0% in 2000 to 16.0% in 2009. However, China's average annual article growth of 43.4% is slower than Malaysia's growth of 52.3%.

The positive trend in S&T article output growth can be witnessed in both the IHLs and GRIs. While the Research Universities are the leading institutions in terms of production, newly established universities, such as the IIUM and the MMU, are quickly catching up, with much faster growth in S&T article output. The National Higher Education Strategic Plan, which called for the establishment of Apex and Research Universities, has helped to increase the article output and the number of citations for Malaysia.

CHAPTER 12
- PUBLIC AWARENESS OF SCIENCE AND TECHNOLOGY IN MALAYSIA

CHAPTER 12

PUBLIC AWARENESS OF S&T IN MALAYSIA

12.0 INTRODUCTION

The Malaysian government has always regarded S&T as an important national agenda. In order for Malaysia to be a developed country by 2020, and in order for her to maintain a competitive edge and reap the benefits of a knowledge-based economy, it is important that we not only keep abreast of developments in S&T, but also strive to be at the forefront of these developments. This, however, requires that we create the conditions that are conducive for the growth of S&T. We need to, first of all, ensure that we have provided the necessary infrastructure for Malaysians to acquire this knowledge. We also need to be conscious of the fact that in order for S&T to develop, members of the society need to realise and appreciate the importance of S&T for the betterment of society. Finally, we also need to determine where we stand with regard to the public's awareness and understanding of, interest in, and attitude towards S&T compared to other developed countries before we can consider ourselves to be a fully developed nation.

Realising the importance of society's role in the advancement of science and technology, the Malaysian Science and Technology Information Centre (MASTIC) set out to assess the public's awareness and understanding of, interest in, and attitude towards S&T. The first study on The Public's Awareness of S&T was conducted in 1994, and subsequently, in 1996, 1998, 2000, 2002, 2004, and 2008. This chapter describes the results of the 2008 survey, in which 18,447 respondents were randomly selected and stratified according to zone, location, ethnicity, gender, and age.

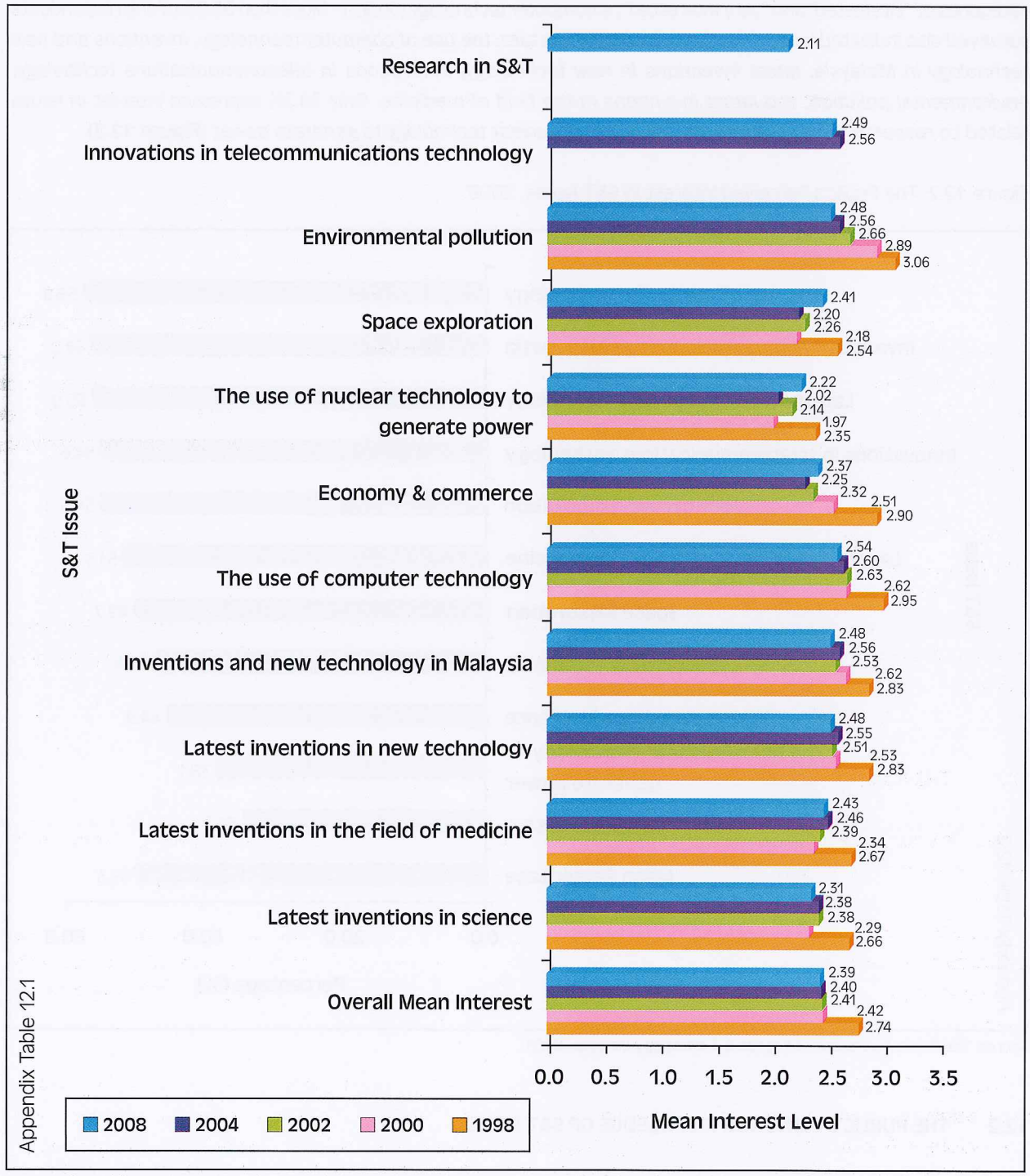
12.1 THE PUBLIC'S PERCEIVED INTEREST IN S&T ISSUES

In the 2008 survey, as in the previous surveys, perceived interest refers to what the respondent has reported to be his or her interest in S&T.

An analysis of the trends from 1998 to 2008 shows that the interest of the Malaysian public towards S&T has remained relatively constant. Throughout the years, Malaysians have been between slightly to moderately interested in S&T, as indicated by the overall mean of 2.42 for 2000, 2.41 for 2002, 2.40 for 2004, and 2.39 for 2008.

Between 1998 to 2008, the respondents reported that they were moderately interested in issues related to *space exploration, latest inventions in science, inventions and new technology in Malaysia, economy & commerce, and innovations in telecommunications technology* (**Figure 12.1**). *The use of nuclear technology to generate power,* on the other hand, generated lower levels of interest. The S&T issue that registered the highest level of interest throughout the years of the survey is *the use of computer technology.*

Figure 12.1: The Public's Perceived Interest in S&T Issues, 1998-2008

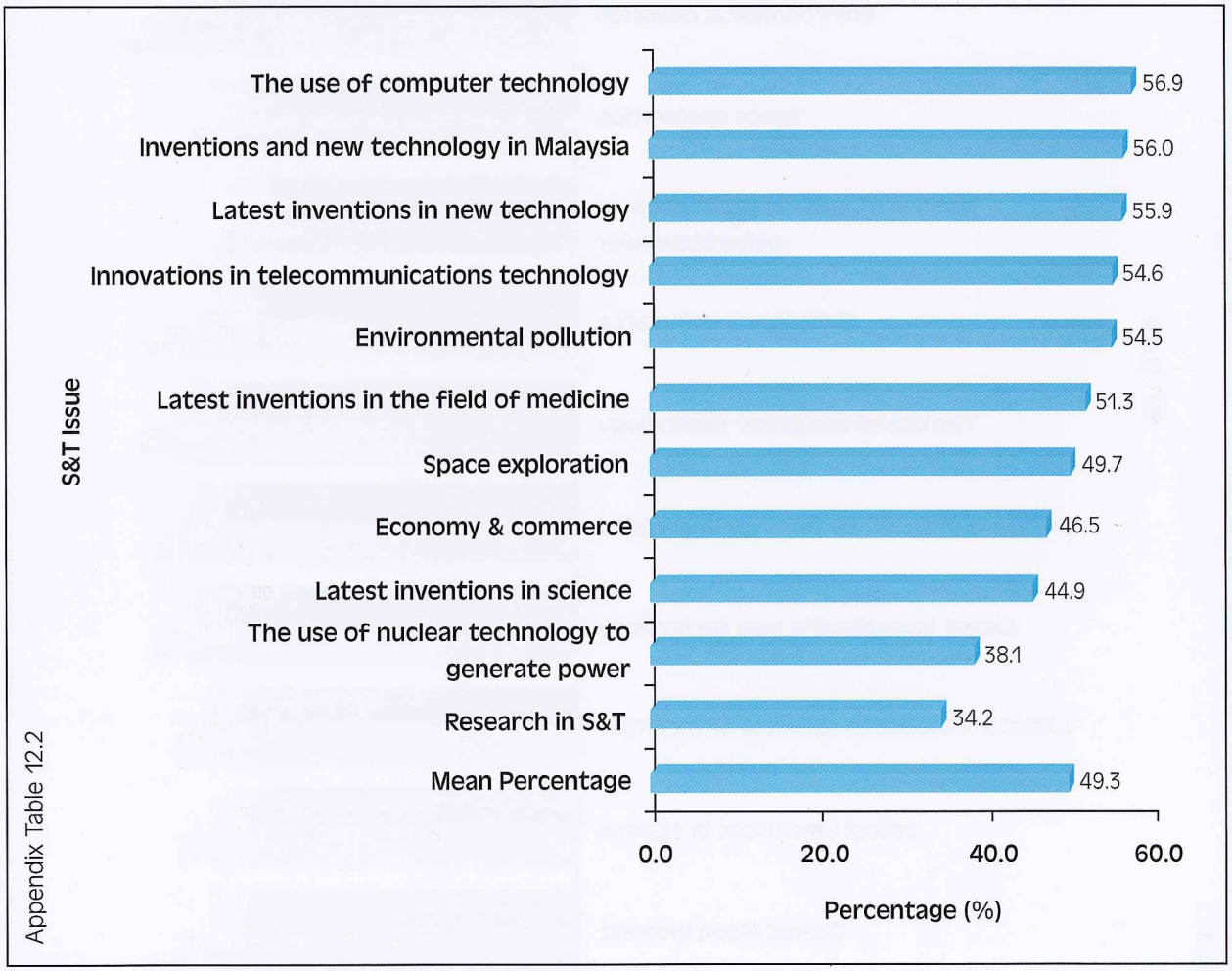


Source: The Public Awareness of Science & Technology Malaysia, 2008

The level of public interest in most of these issues is varied across the years surveyed, with the exception of the interest in *environmental pollution*, which displayed a gradual decline. On the other hand, an increase in perceived interest is seen in three issues related to *space exploration, the use of nuclear power to generate power, and economy & commerce*. It is highly likely that the increased interest in *space exploration* was stimulated by Malaysia's "National Angkasawan Programme," which was given broad coverage by the Malaysian media throughout the nation's involvement in the project between 2007 and 2008. The public's interest in the other two issues, on the other hand, could have been stimulated by the sudden oil crisis that took the world by surprise at the time the survey was conducted.

For the 2008 survey, the issue that the highest percentage of respondents expressed interest in (based on the categories of "interested" and "very interested") is *computer technology* (56.9%). More than 50.0% of the respondents surveyed also indicated interest in the following S&T issues: *the use of computer technology, inventions and new technology in Malaysia, latest inventions in new technology, innovations in telecommunications technology, environmental pollution,* and *latest inventions in the field of medicine.* Only 34.2% expressed interest in issues related to *research in S&T,* and 38.1% in the *use of nuclear technology to generate power* **(Figure 12.2)**.

Figure 12.2: The Public's Perceived Interest in S&T Issues, 2008



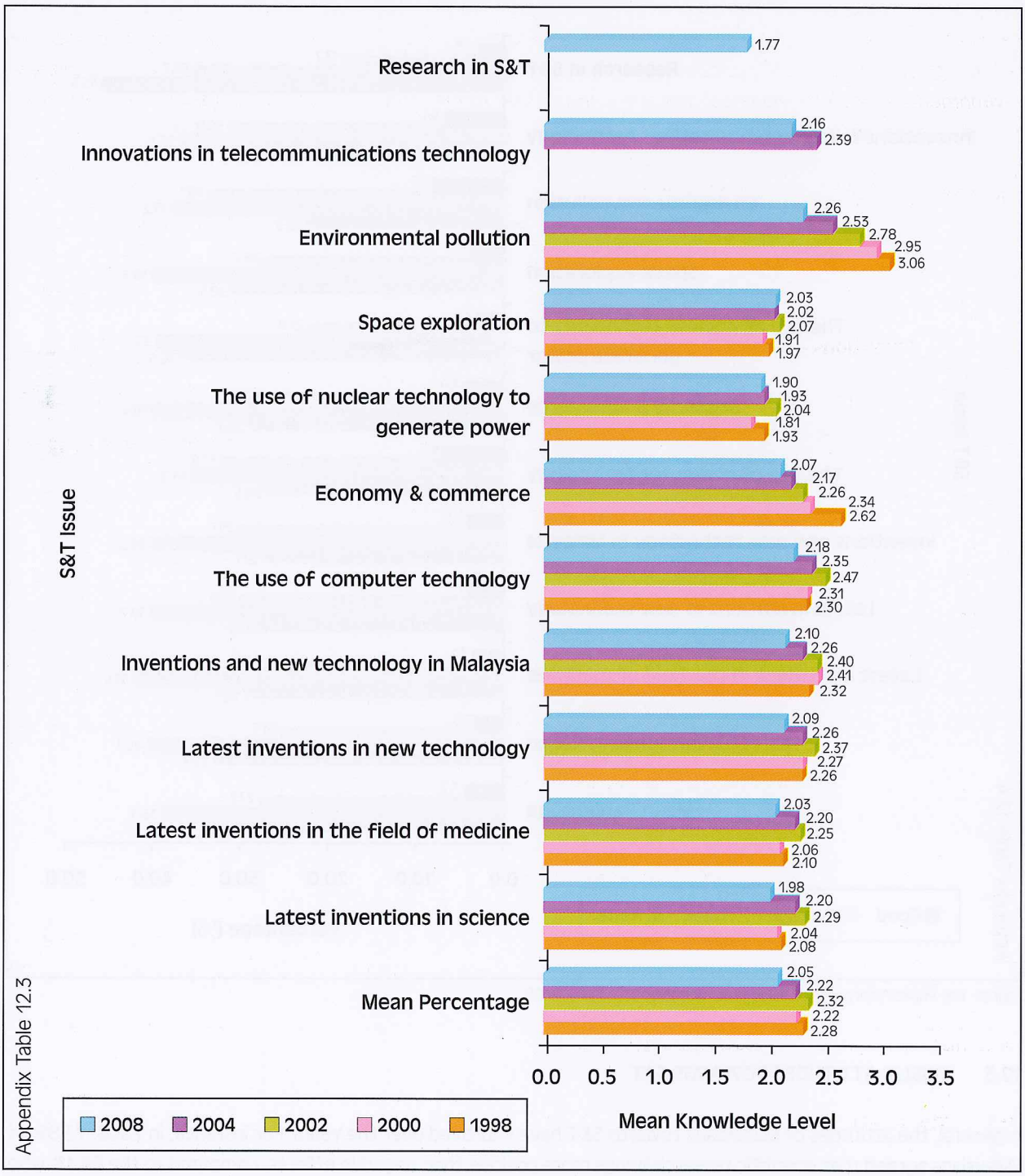
Source: The Public Awareness of Science & Technology Malaysia, 2008

12.2 THE PUBLIC'S PERCEIVED KNOWLEDGE OF S&T ISSUES

Similar to previous surveys, perceived knowledge is defined as the public's perceptions of what they know about science and technology, in which they were asked to rate their knowledge of 11 items **(Figure 12.3)** as being *"good", "average", "weak", or "none at all".*

An analysis of the trends from 1998 to 2008 indicates that Malaysians perceived themselves as having between a poor and average knowledge of S&T, as indicated by an overall mean of 2.28 for 1998, 2.22 for 2000, 2.32 for 2002, 2.22 for 2004, and 2.05 for 2008 **(Figure 12.3)**.

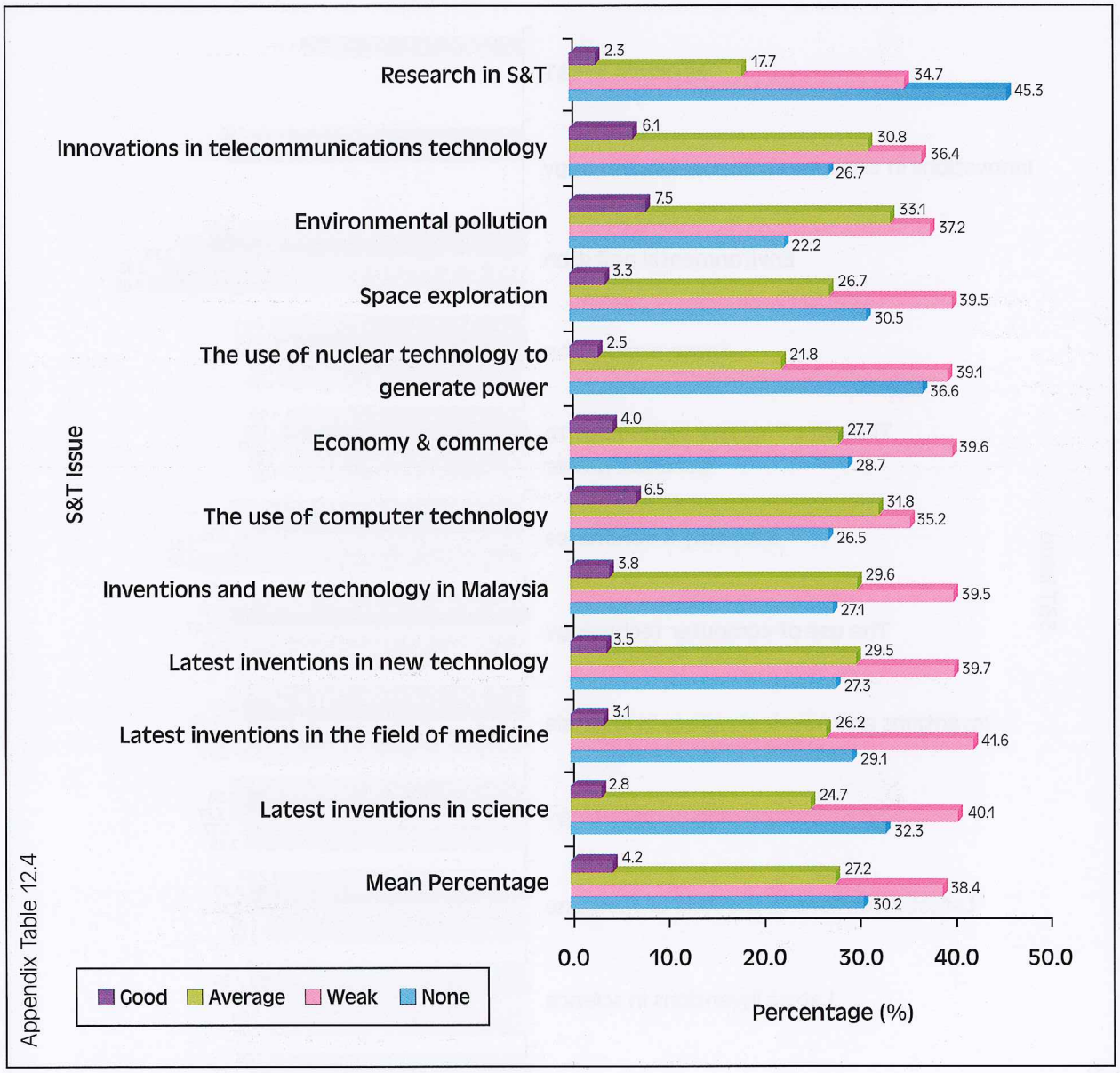
Figure 12.3: The Public's Perceived Knowledge of S&T Issues, 1998-2008



Source: The Public Awareness of Science & Technology Malaysia, 2008

In the 2008 survey the majority of the respondents perceived themselves as having a weak knowledge of the issues surveyed **(Figure 12.4)**. The highest percentage of respondents (41.6%) professed themselves as having weak knowledge of *the latest inventions in medicine* **(Figure 12.4)**, followed by *the use of nuclear technology to generate power* (39.1%), *the latest inventions in science* (40.1%), *research in science and technology* (34.7%), and *space exploration* (39.5%). The issue in which the highest percentage of respondents expressed having no knowledge of is *research in science and technology* (45.3%).

Figure 12.4: The Public's Perceived Knowledge of S&T Issues, 2008



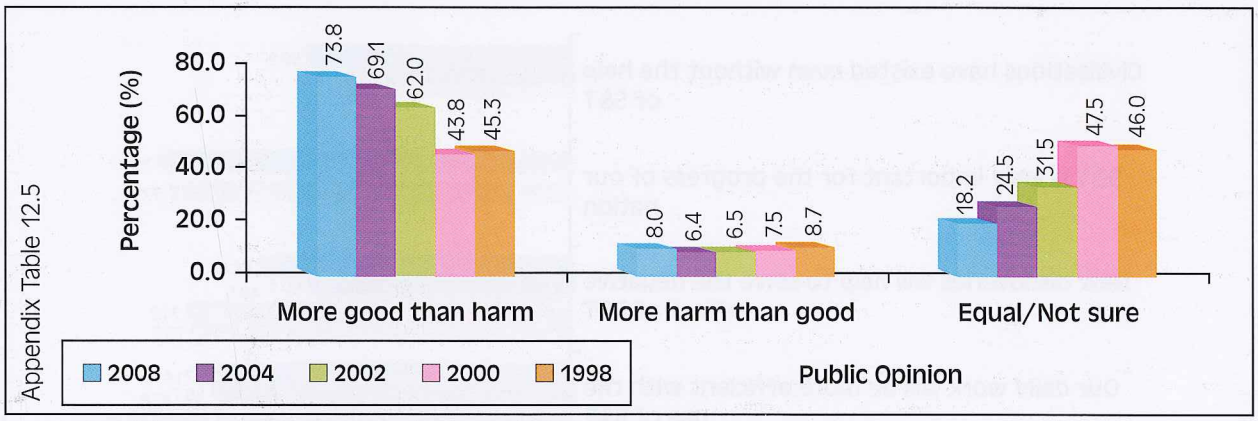
Source: The Public Awareness of Science & Technology Malaysia, 2008

12.3 PUBLIC ATTITUDES TOWARDS S&T

In general, the attitudes of Malaysians towards S&T have improved over the years. For instance, in 2008, 73.8% of Malaysians agreed that scientific research brings more positive than negative effects, compared to the 69.1% who said so in 2004, 62.0% in 2002, 43.8% in 2000, and 45.3% in 1998 **(Figure 12.5)**.

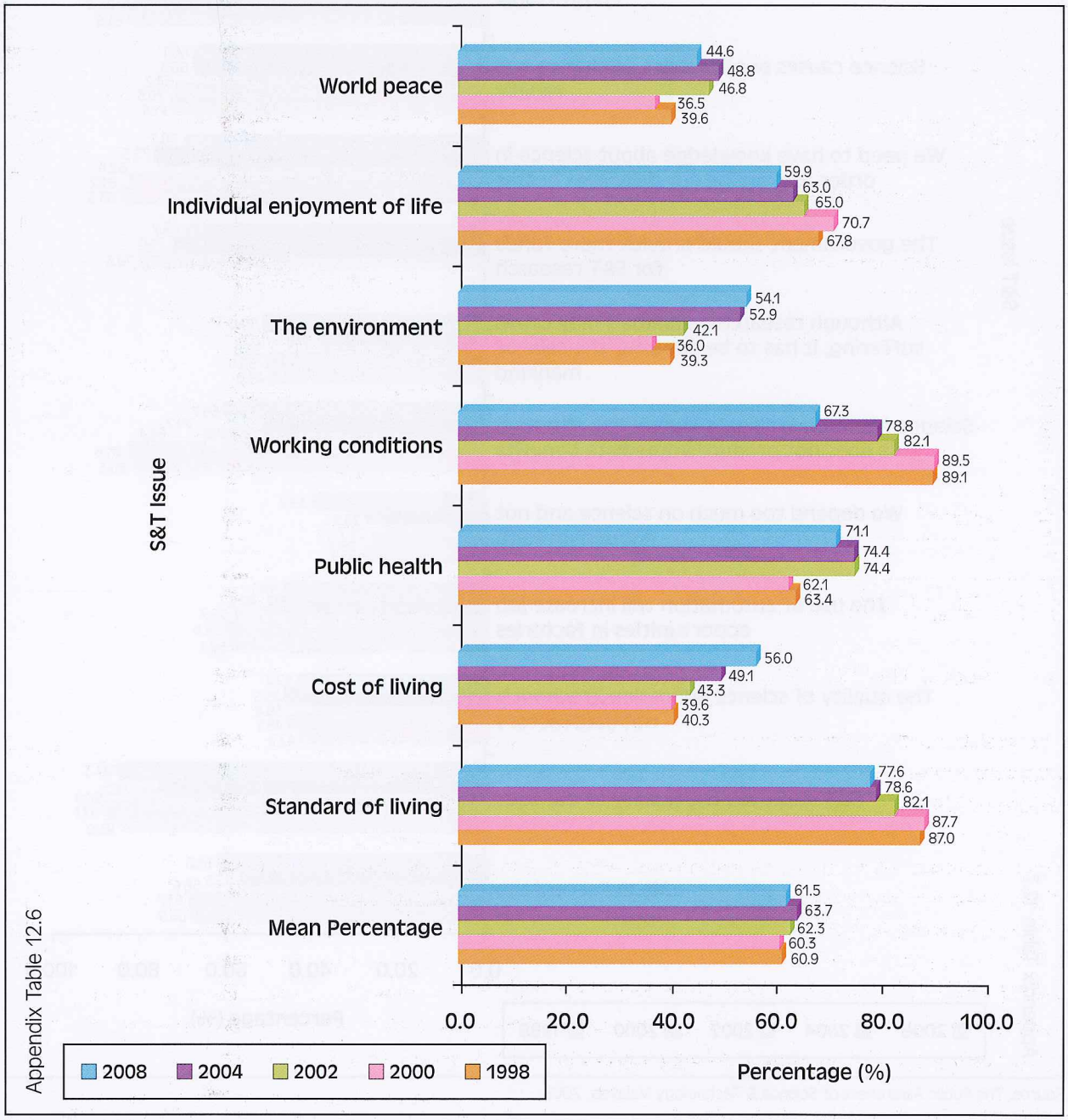
When asked to react to the statement on the effects of S&T on selected issues, 77.6% of the respondents in the 2008 survey felt that S&T has positive effects on the *standard of living, public health* (71.1%), and *cost of living* (56.0%) **(Figure 12.6)**. 67.3% agreed that S&T has positive effects on *working conditions, individual enjoyment of life* (59.9%), and *the environment* (54.1%). However, less than half of Malaysians (44.6%) perceived S&T as having a positive effect on *world peace*. The same pattern of findings can be seen in the previous Public Awareness of S&T studies. From 1998 to 2004, the majority of Malaysians (more than 60.0%) felt that S&T has positive effects on *public health, individual enjoyment of life, standard of living, and working conditions.*

Figure 12.5: Public Opinions on the Effects of S&T, 1998-2008



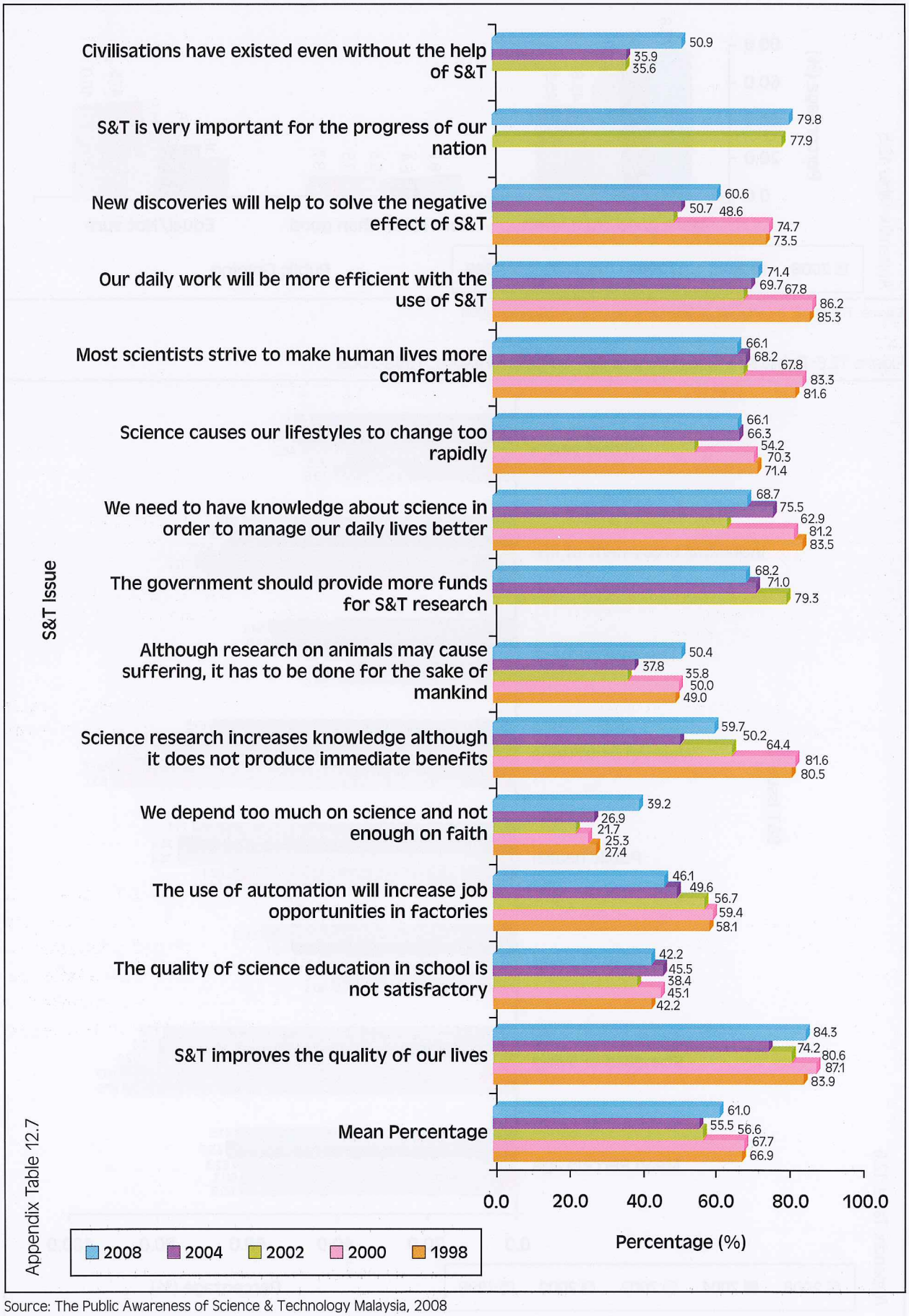
Source: The Public Awareness of Science & Technology Malaysia, 2008

Figure 12.6: Public Attitudes towards S&T on General Issues, 1998-2008



Source: The Public Awareness of Science & Technology Malaysia, 2008

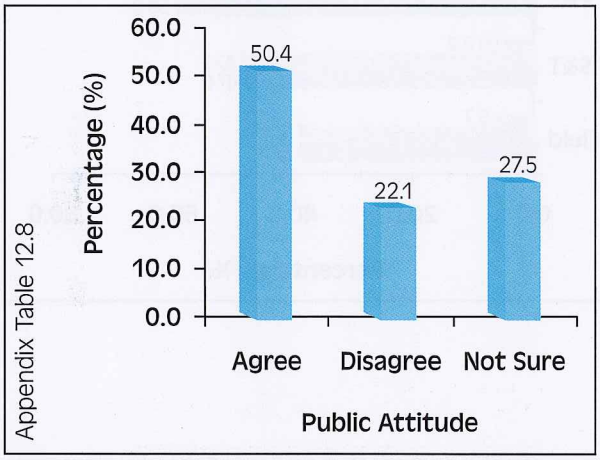
Figure 12.7: Public Attitudes towards S&T on Selected Issues, 1998-2008



Source: The Public Awareness of Science & Technology Malaysia, 2008

Another discernible pattern is that Malaysians have consistently been positive towards various S&T issues, where 84.3% agreed that *S&T improves the quality of our lives* and 79.8% agreed that *S&T is very important for the progress of our nation* **(Figure 12.7)**. In response to the statement regarding the use of animals in research, 50.4% of the respondents in 2008 agreed that *although research on animals may cause suffering, it has to be done for the sake of mankind*, while another 22.1% disagreed. This suggests that half of the Malaysian public supports scientific research. While 27.5% were unsure of how they felt about the issue **(Figure 12.8).**

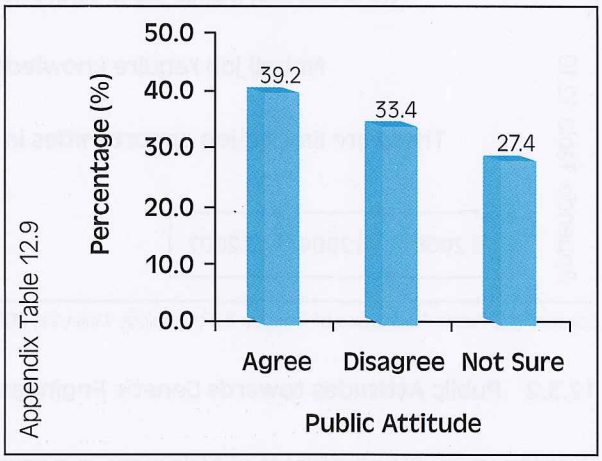
Figure 12.8: Public Attitudes towards the Use of Animals in Research, 2008



Source: The Public Awareness of Science & Technology Malaysia, 2008

Note: The graph shows the Malaysian public's response to the statement, "Although research on animals may cause suffering, it has to be done for the sake of mankind"

Figure 12.9: Public Attitudes towards S&T and Religion, 2008



Source: The Public Awareness of Science & Technology Malaysia, 2008

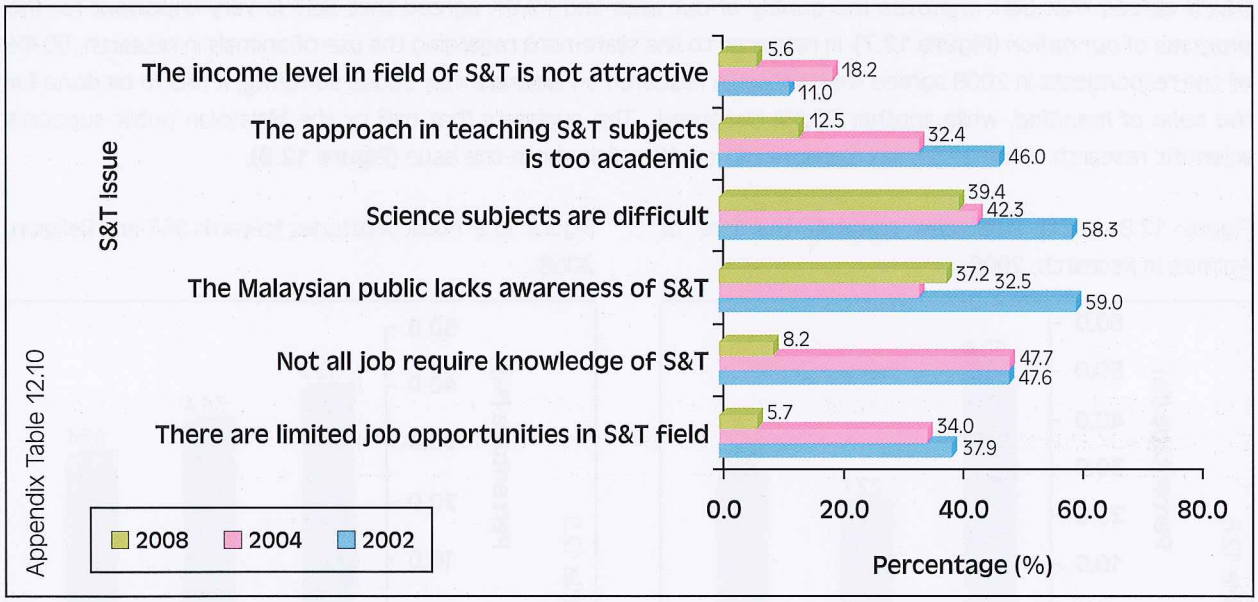
Note: The graph shows the Malaysian public's response to the statement, "We depend too much on science and not enough on faith"

Malaysians appear to be somewhat divided on the issue that involves the interplay of science and religion. 39.2% of the respondents in 2008 agreed that *we depend too much on science and not enough on faith*, 33.4% disagreed with the statement, while 27.4% **(Figure 12.9)** were unsure.

12.3.1 Opinions on Job Opportunities in S&T

The opinions of the Malaysian public were also sought on issues related to job opportunities in S&T. Some of the noteworthy findings are that only 39.4% of the Malaysian public thought that *science subjects are difficult,* and that 12.5% perceive that *the approach in teaching S&T subjects is too academic.* This suggests that special attention should be given to how science subjects should be taught in schools. In addition, 37.2% thought that *the Malaysian public lacks awareness of S&T.* On the other hand, 5.7% of the respondents felt that *there are limited job opportunities in S&T,* and 8.2% think that *not all jobs require knowledge of S&T* **(Figure 12.10)**. Finally, only 5.6% thought that *the income level in the field of S&T is not attractive.*

Figure 12.10: Public Opinions on Job Opportunities in S&T, 2002-2008

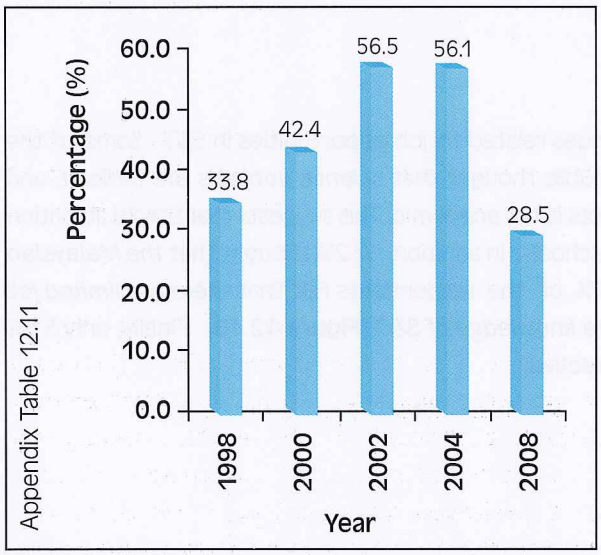


Source: The Public Awareness of Science & Technology Malaysia, 2008

12.3.2 Public Attitudes towards Genetic Engineering

Over the years, the percentage of Malaysians who have heard of *genetic engineering or cloning* steadily increased. However, in 2008, the percentage dropped to 28.5% **(Figure 12.11)**. This could be due to the fact that in the 2008 survey, the respondents were asked whether they had heard of *genetic engineering*, not *cloning*, as was the case in the previous surveys. This suggests that Malaysians may be more familiar with the term *cloning*, which was frequently discussed, several years ago, through *"Dolly"* and other examples. This may also be due to a shift in emphasis on the part of the mass media from *cloning* to other issues such as *space exploration.*

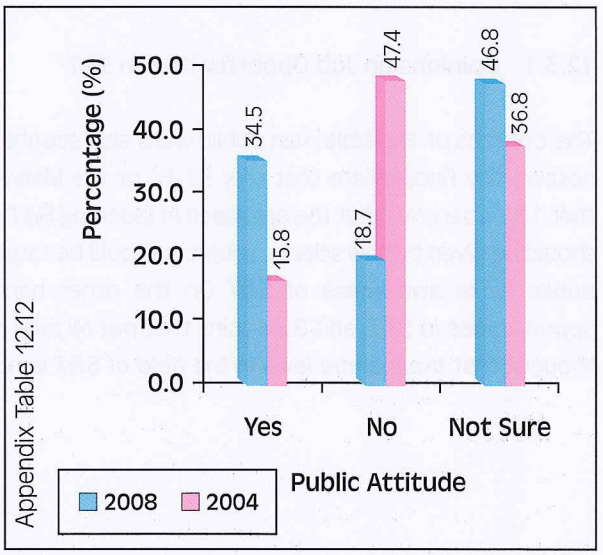
Figure 12.11: Percentage of the Malaysian Public who have heard of Genetic Engineering, 1998-2008



Source: The Public Awareness of Science & Technology Malaysia, 2008

Note: The graph shows the percentage of Malaysians who agree to the above issues

Figure 12.12: Public Attitudes towards the Implementation of Genetic Engineering or Cloning, 2004 and 2008



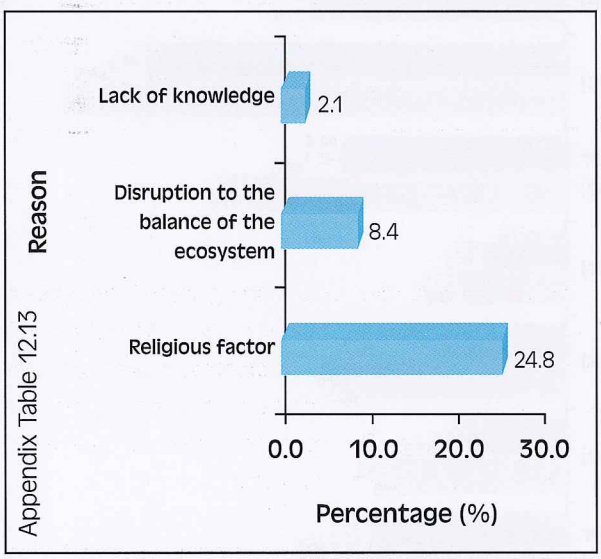
Source: The Public Awareness of Science & Technology Malaysia, 2008

Note: The graph shows the Malaysian public's response to the question "Do you agree that genetic engineering should be practiced?"

When asked whether *genetic engineering* should be practiced, 34.5% of the respondents in the 2008 survey expressed their agreement, an increase of 15.8% from the percentage of those who said so in 2004 **(Figure 12.12)**. This suggests that the Malaysian public is now becoming more receptive to changes brought about by genetic technology.

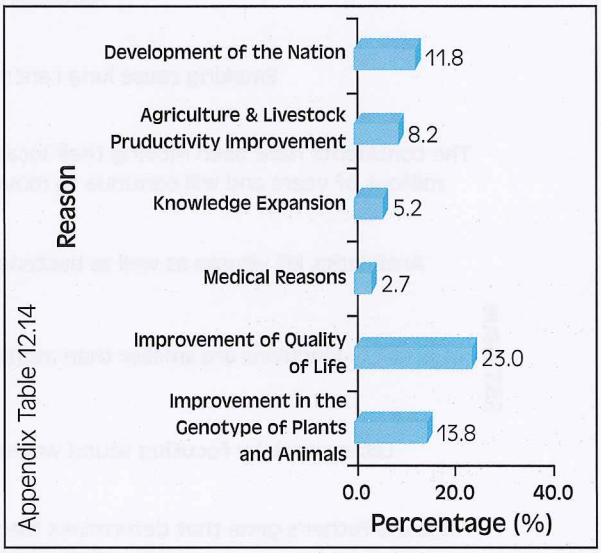
Among the reasons given by those who disagreed with the practice of *genetic engineering*, 24.8% cited religion as the reason for not agreeing with the practice **(Figure 12.13)** while 8.4% cited that genetic engineering disrupts the balance of the ecosystem. On the other hand, of those who agreed that *genetic engineering should be practiced*, 23.0% felt that it would improve the quality of life, 13.8% felt that it helps improve the genotype of plants and animals, while 11.8% felt it to be beneficial for the nation's development. Only 5.2% felt that it is important for the advancement of knowledge **(Figure 12.14)**.

Figure 12.13: Reasons for Disagreement with Genetic Engineering, 2008



Source: The Public Awareness of Science & Technology Malaysia, 2008

Figure 12.14: Reasons for Agreement with Genetic Engineering, 2008



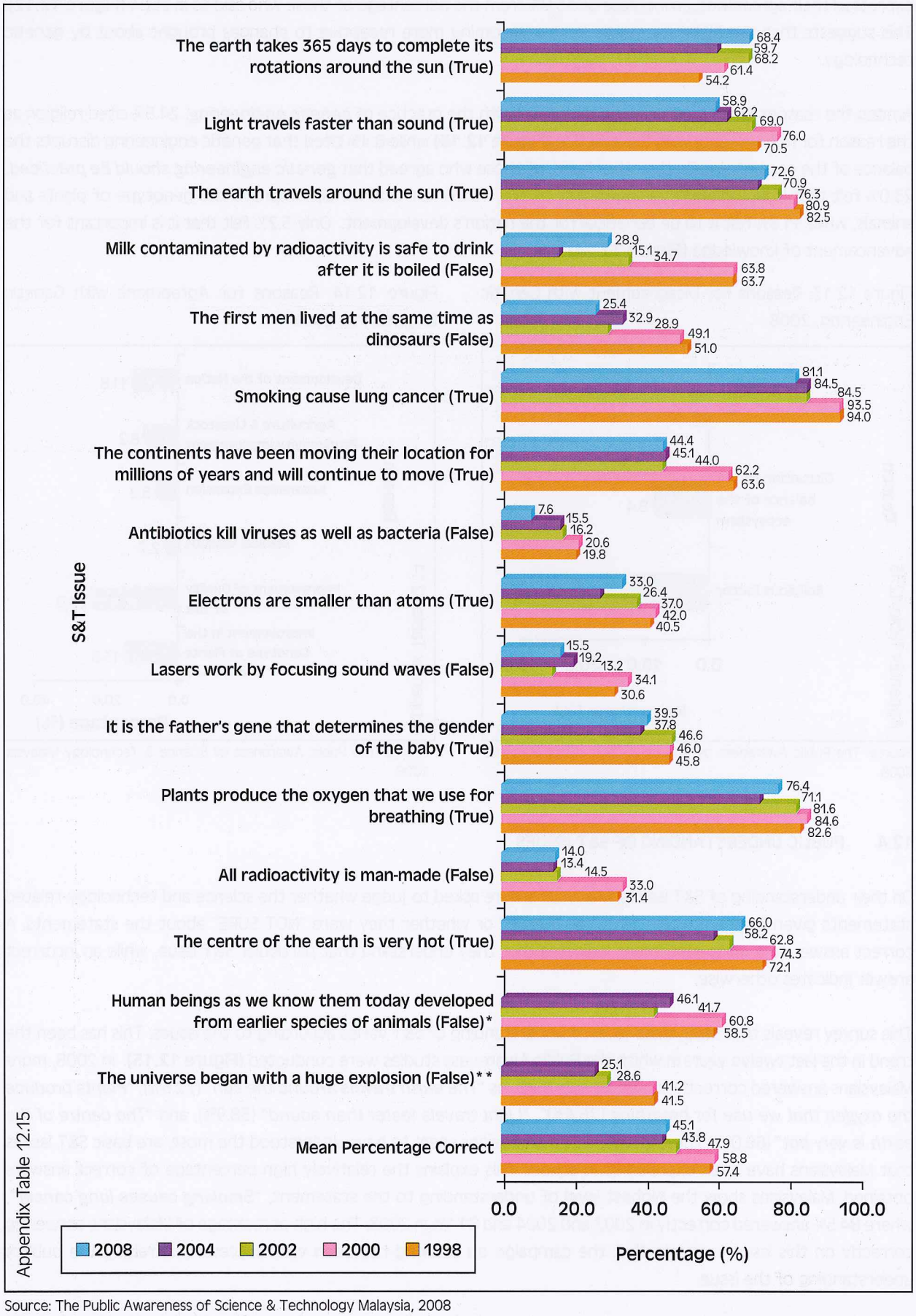
Source: The Public Awareness of Science & Technology Malaysia, 2008

12.4 PUBLIC UNDERSTANDING OF S&T ISSUES

On their understanding of S&T issues, Malaysians were asked to judge whether the science and technology-related statements given to them were "TRUE" or "FALSE" or whether they were "NOT SURE" about the statements. A correct answer to a given statement indicates that they understand that particular S&T issue, while an incorrect answer indicates otherwise.

This survey reveals that Malaysians' level of understanding of S&T varies according to the issues. This has been the trend in the last twelve years in which the Public Awareness studies were conducted **(Figure 12.15)**. In 2008, more Malaysians answered correctly to statements such, as *"The earth travels around the sun"* (72.6%), *"Plants produce the oxygen that we use for breathing* (76.4%)", *"Light travels faster than sound"* (58.9%), and *"The centre of the earth is very hot"* (66.0%). These issues, which Malaysians seem to have understood the most, are basic S&T issues that Malaysians have been exposed to in school. This explains the relatively high percentage of correct answers obtained. Malaysians show the highest level of understanding to the statement, *"Smoking causes lung cancer"*, where 84.5% answered correctly in 2002 and 2004 and 81.1% in 2008. The high percentage of Malaysians answering correctly on this issue suggests that the campaign on smoking has been very successful in raising the public's understanding of the issue.

Figure 12.15: Public Understanding of S&T Issues, 1998-2008



Source: The Public Awareness of Science & Technology Malaysia, 2008

Note: In the 2008 S&T survey, the items marked *and ** have been excluded from the calculation of the mean percentage of correct answers

On the other hand, this survey also shows that Malaysians lack understanding of the following issues, as measured by the percentage of those who correctly responded to the following items: *"Antibiotics kill viruses as well as bacteria"*, where 15.5% scored correctly in 2004 and only 7.6% in 2008; *"Milk contaminated by radioactivity is safe to drink after it is boiled"* where 28.9% of the respondents answered correctly in 2008, while 15.1% did so in 2004, *"All radioactivity is man-made"*, which was answered correctly by 14.0% of the respondents, compared to 13.4% in 2004; *"Lasers work by focusing sound waves"* which was answered correctly by 15.5% of the respondents in 2008, and *"Electrons are smaller than atoms"* which was answered correctly by 33.0% of the respondents compared to the 26.4% in 2004.

The fact that the Malaysian public did not do very well on the above issues may be explained by the fact that these issues are more specialised, and hence, obtaining correct answers to them would reflect a higher and more sophisticated understanding of S&T, which is more likely to be found among those who are truly interested in S&T and who have acquired these concepts through formal education. Nevertheless, the results show that the Malaysian public's understanding of most of these issues has improved slightly compared to the 2004 survey. The overall mean percentage of correct answers in the 2008 survey is 45.1%, compared to 43.8% in 2004. There is a marked improvement in the Malaysian public's responses to all the items, with only three exceptions: *"The first men lived at the same time as dinosaurs"* for which the percentage of correct responses declined from 32.9% in 2004 to 25.4% in 2008; *"Antibiotics kill viruses as well as bacteria"*, which declined from 15.5% in 2004 to only 7.6% in 2008; and *"Lasers work by focusing sound waves"*, which fell from 19.2% in 2004 to 15.5% in 2008.

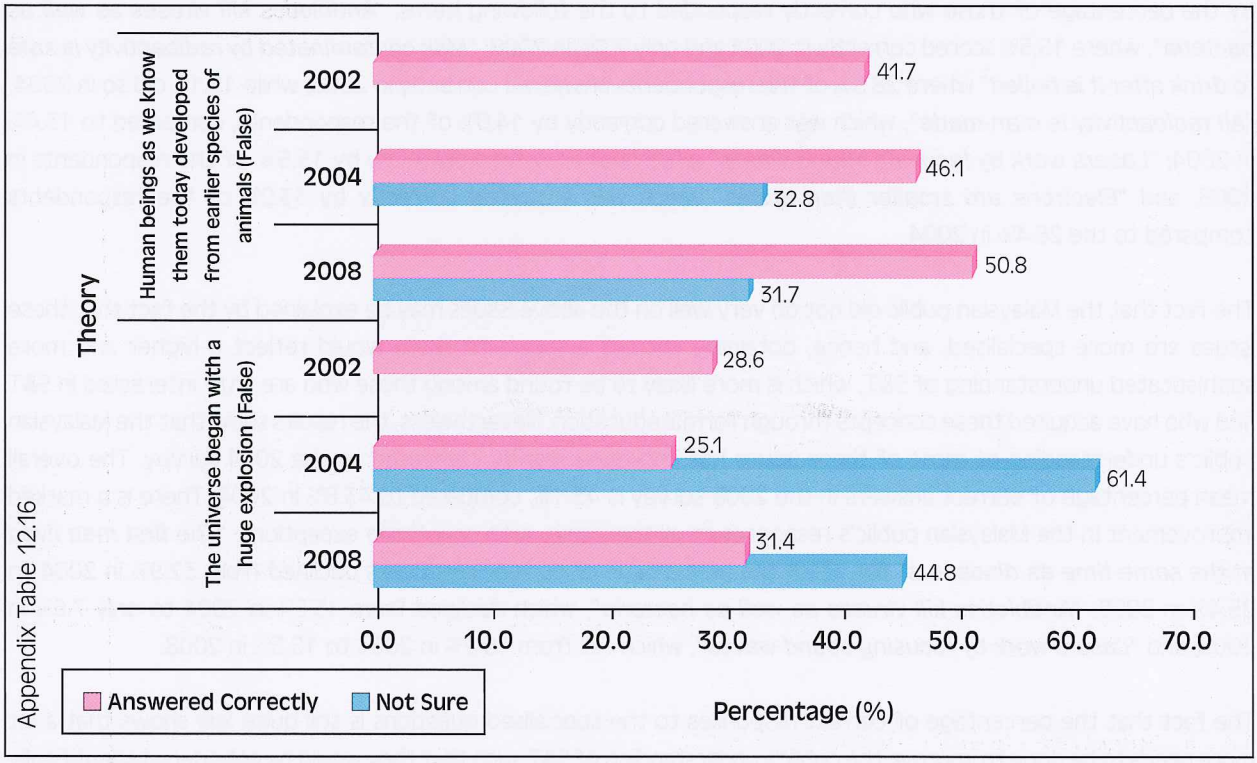
The fact that the percentage of correct responses to the specialised questions is still quite low shows that a lot more needs to be done to improve the public's understanding of S&T such that they would be considered scientifically literate. We need to look into the quality of science teaching, the appropriateness of the science curriculum, and the content of non-formal programmes, as these factors may have affected the public's interest in, and understanding of science.

12.4.1 Theories of Evolution and Big Bang

Because the statements, *"The universe began with a huge explosion"* and *"Human beings as we know them today developed from earlier species of animals"* are expressions of beliefs and philosophies rather than scientific facts, they were not included in computing the level of the Malaysian public's understanding of S&T issues. However, they were still asked to respond to these statements to record their beliefs regarding these issues. It should be noted that in the 2008 as well as the previous surveys, Malaysian scientists have regarded the two statements as FALSE, although the reverse is true in the NSF and Eurobarometer surveys.

In 2008, 31.4% of the respondents correctly answered that the statement, *"The universe began with a huge explosion"* was FALSE, while 25.1% did so in 2004, and 28.6% in 2002. It should also be pointed out that 61.4% were unsure about this statement in 2004 while only 44.8% of the respondents were unsure about it in 2008. On the statement, *"Human beings as we know them today developed from earlier species of animals"*, around 50.8% of the respondents correctly answered that it was FALSE, while 46.1% did so in 2004 and 41.7% in 2002. 31.7% of the respondents were unsure of this statement in 2008, compared to 32.8% in 2004 **(Figure 12.16)**.

Figure 12.16: Public's Understanding on Theory of Evolution and Big Bang Theory, 2002-2008



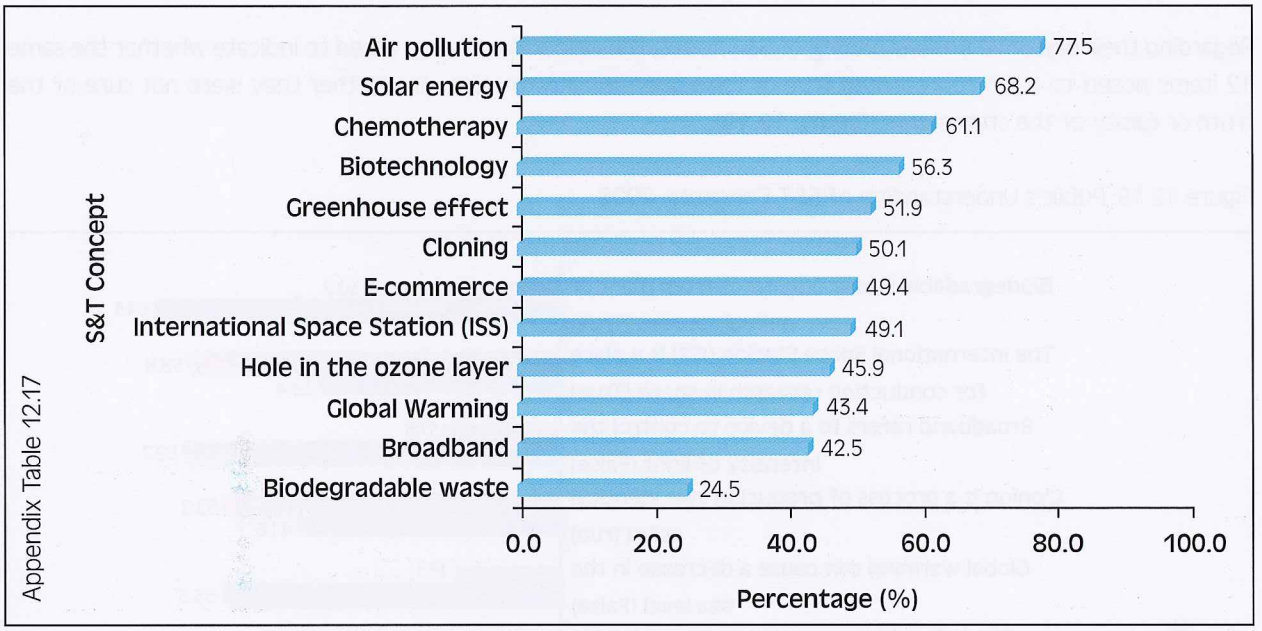
Source: The Public Awareness of Science & Technology Malaysia, 2008

It should be noted that the public's responses to the evolution and Big Bang theories do not indicate familiarity with or ignorance of scientific concepts and issues. Instead, they are statements of a person's beliefs or philosophical stand more than his or her knowledge of the concepts. In the USA, positive responses to these statements dramatically increased when the additional phrases "according to the theory of evolution", and "according to astronomers", were added to the statements about the evolution and big bang theories, respectively. This led the NSF to conclude that "these differences probably indicate that many Americans hold religious beliefs that cause them to be skeptical of scientific ideas, even when they have basic familiarity with those ideas" (NSF, 2008, 7-19). In another Muslim country, Turkey, only 27.0% of the respondents considered the statement "Man, as we know him today, originated from an earlier animal species" to be true, while 51.0% considered it false (Eurobarometer 224, p. 40).

12.4.2 Awareness of S&T Concepts

On their awareness of S&T concepts, the results indicate that more respondents have heard or read about *air pollution, solar energy, chemotherapy, biotechnology, the hole in the ozone layer* and *cloning.* In contrast, fewer respondents have heard or read about *biodegradable waste, broadband* and *global warming.* Almost half of the respondents reported being aware of the *International Space Station (ISS), cloning,* the *greenhouse effect,* and *e-commerce* **(Figure 12.17)**. With the exception of air pollution and cloning, the public's awareness of S&T issues in the 2008 survey was higher than that in the 2004 survey.

Figure 12.17: The Public's Awareness of S&T Concepts, 2008

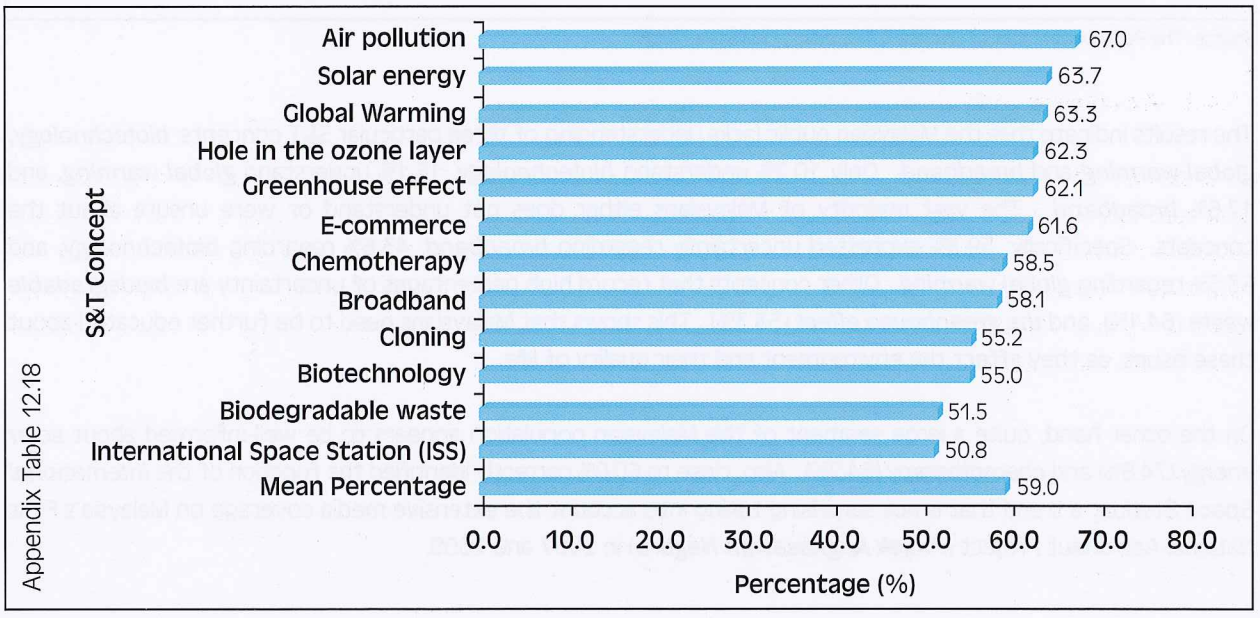


Source: The Public Awareness of Science & Technology Malaysia, 2008

12.4.3 Subjective Understanding of S&T Concepts

The Malaysian public's *subjective understanding*, or their self-assessed understanding, of S&T concepts was measured by their responses to the same 12 items shown in **Figure 12.18**. In the 2008 survey, two new items, *International Space Station (ISS)* and *biodegradable waste* were added to the original 10 items asked in the 2004 survey. On all 12 items, more than half of the respondents reported having between an average and good understanding of the S&T concepts. The issue that the highest number of respondents reported having *good* and *average* understanding of was *air pollution* (67.0%), followed by *solar energy* (63.7%), *global warming* (63.3%), *hole in the ozone layer* (62.3%) and *greenhouse effect* (62.1%). Just slightly over half of the respondents surveyed (50.8%) stated that they understood *International Space Station (ISS)*, while 51.5% reported understanding *biodegradable waste* **(Figure 12.18)**.

Figure 12.18: Public's Subjective Understanding of S&T Concepts, 2008

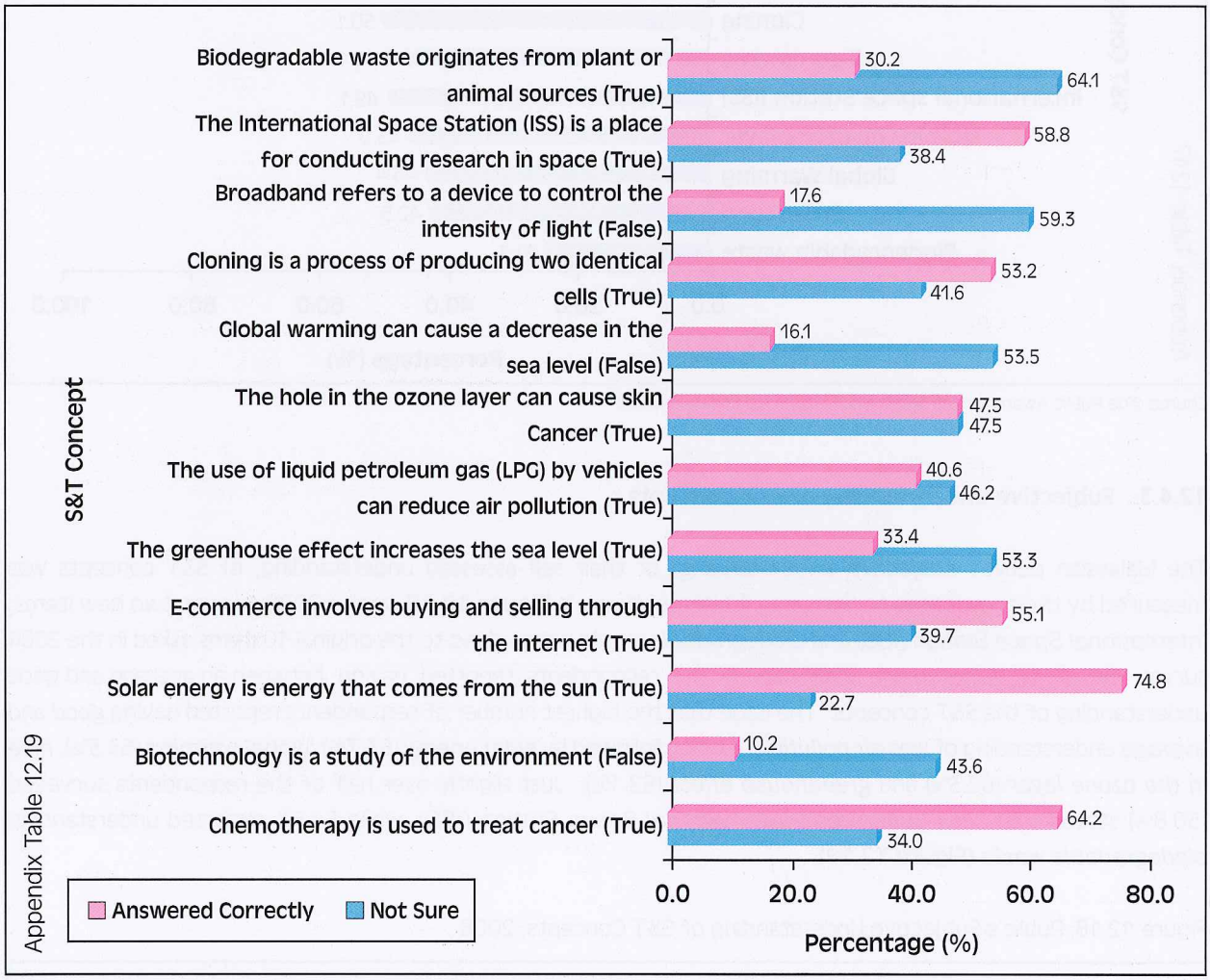


Source: The Public Awareness of Science & Technology Malaysia, 2008

12.4.4 Objective Understanding of S&T Concepts

Regarding their *objective understanding* of S&T issues, the respondents were asked to indicate whether the same 12 items posed to them represented true or false scientific information, or whether they were not sure of the truth or falsity of the statements **(Figure 12.19).**

Figure 12.19: Public's Understanding of S&T Concepts, 2008



Source: The Public Awareness of Science & Technology Malaysia, 2008

The results indicate that the Malaysian public lacks understanding of three particular S&T concepts: *biotechnology, global warming* and *broadband.* Only 10.2% understand *biotechnology,* 16.1% understand *global warming,* and 17.6% *broadband.* The vast majority of Malaysians either does not understand or were unsure about the concepts. Specifically, 59.3% expressed uncertainty regarding *broadband,* 43.6% regarding *biotechnology,* and 53.5% regarding *global warming.* Other concepts that record high percentages of uncertainty are *biodegradable waste* (64.1%), and *the greenhouse effect* (53.3%). This shows that Malaysians need to be further educated about these issues, as they affect the environment and their quality of life.

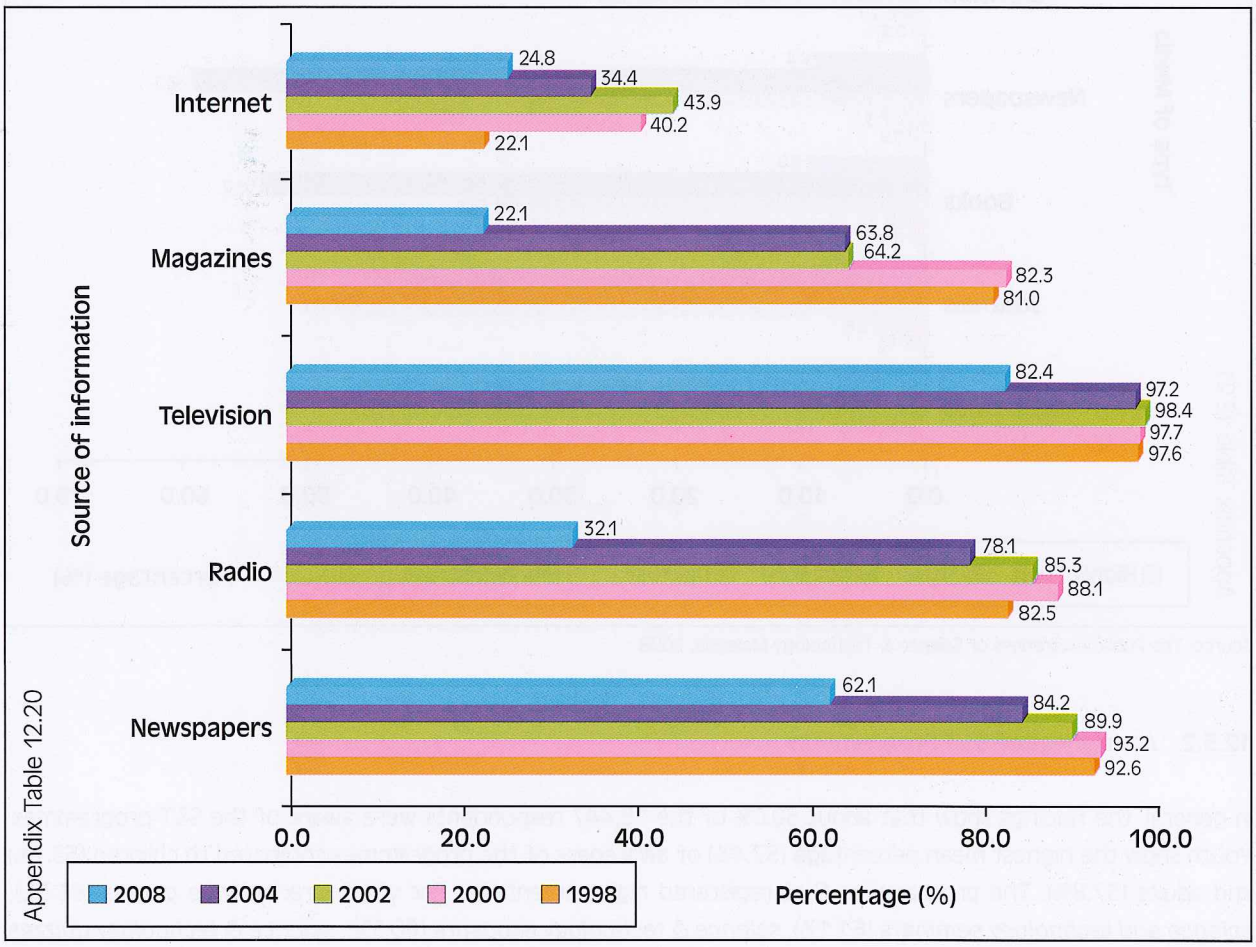
On the other hand, quite a large segment of the Malaysian population appears to be well-informed about *solar energy* (74.8%) and *chemotherapy* (64.2%). Also, close to 60.0% correctly identified the function of the *International Space Station,* a trend that is not surprising taking into account the extensive media coverage on Malaysia's First National Astronaut Project *(Projek Angkasawan Negara)* in 2007 and 2008.

12.5 INFORMATION SOURCES ON S&T, S&T PROGRAMMES, AND S&T RELATED PLACES

12.5.1 General Sources of Information on S&T

In general, Malaysians still choose the *television* (82.4%) and *newspapers* (62.1%) for their main sources of S&T news and information over other means. The *Radio* is cited as a source by only 32.1% of the respondents. *Magazines* (22.1%) and the *Internet* (24.8%) are the least preferred sources **(Figure 12.20)**.

Figure 12.20: Public Sources of Information on S&T, 1998-2008

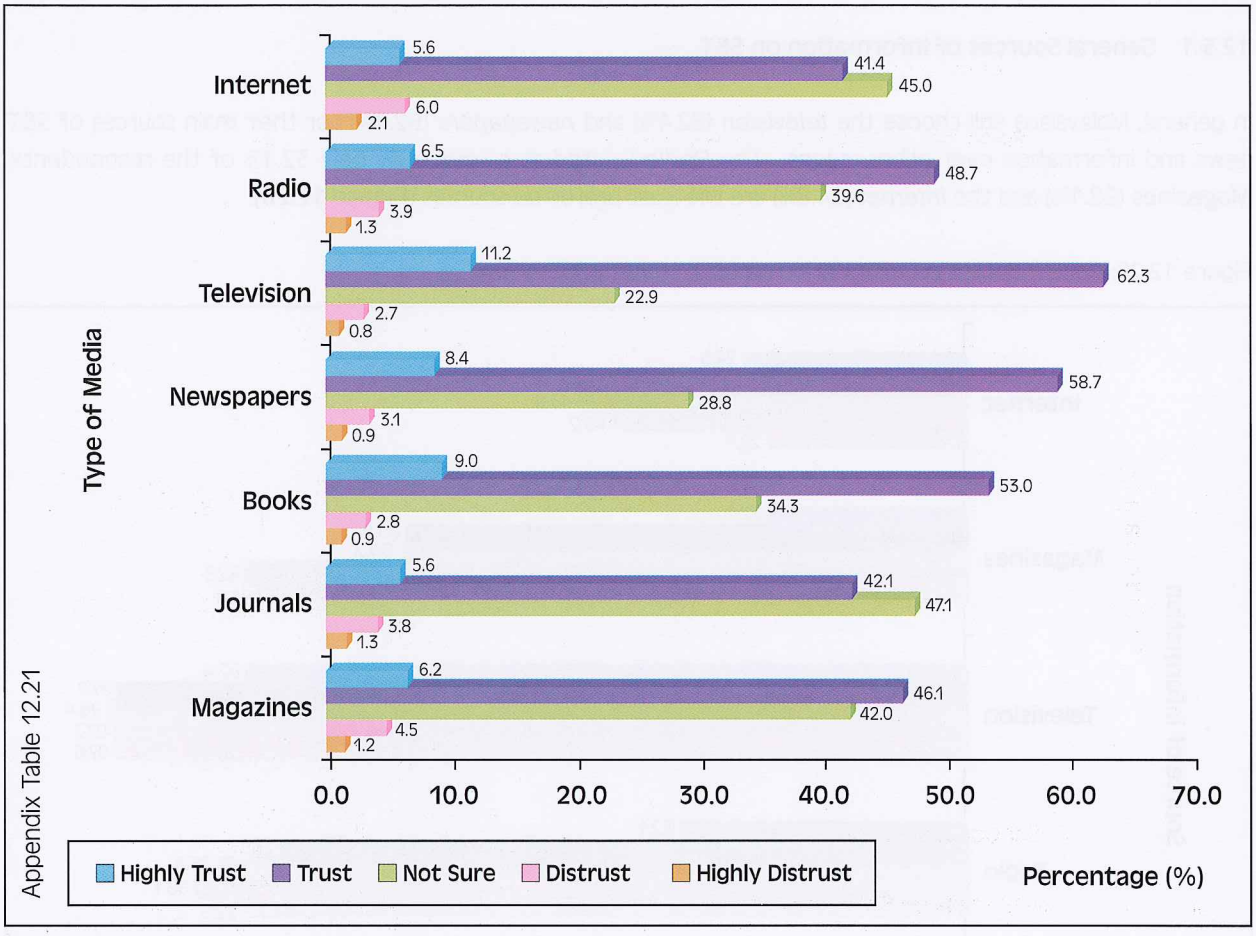


Source: The Public Awareness of Science & Technology Malaysia, 2008

The most discernible trend in 2008 is that all the media listed in the questionnaire *(television, radio, newspaper, Internet and magazines)* record a decline in the percentage of Malaysians citing them as a source of information and news for S&T. This may be explained by the inclusion of two new items in the 2008 survey *(school and books).* 16.1% relied on the school and 19.3% on books as a source of S&T information.

The results also show that, despite the current age of advanced telecommunications, relatively few Malaysians rely on the Internet for S&T information. In fact, the percentage is even smaller in the 2008 survey (24.8%) compared to the previous years, i.e. 40.2% in 2000, 43.9% in 2002 and 34.4% in 2004. The trend suggests that the Malaysian public does not capitalise on the potential of the Internet as a source of S&T information. One possible explanation for this is that there may still be a substantial proportion of Malaysian families who do not own computers or who may not have access to the Internet, especially those in the rural areas. In fact, in 2008, 51.2% of the respondents came from rural areas. It may also be due to the fact that a substantial number of Malaysians (45.0%) are wary of the Internet as being a source of reliable S&T information **(Figure 12.21)**.

Figure 12.21: Level of Trust in the Media, 2008

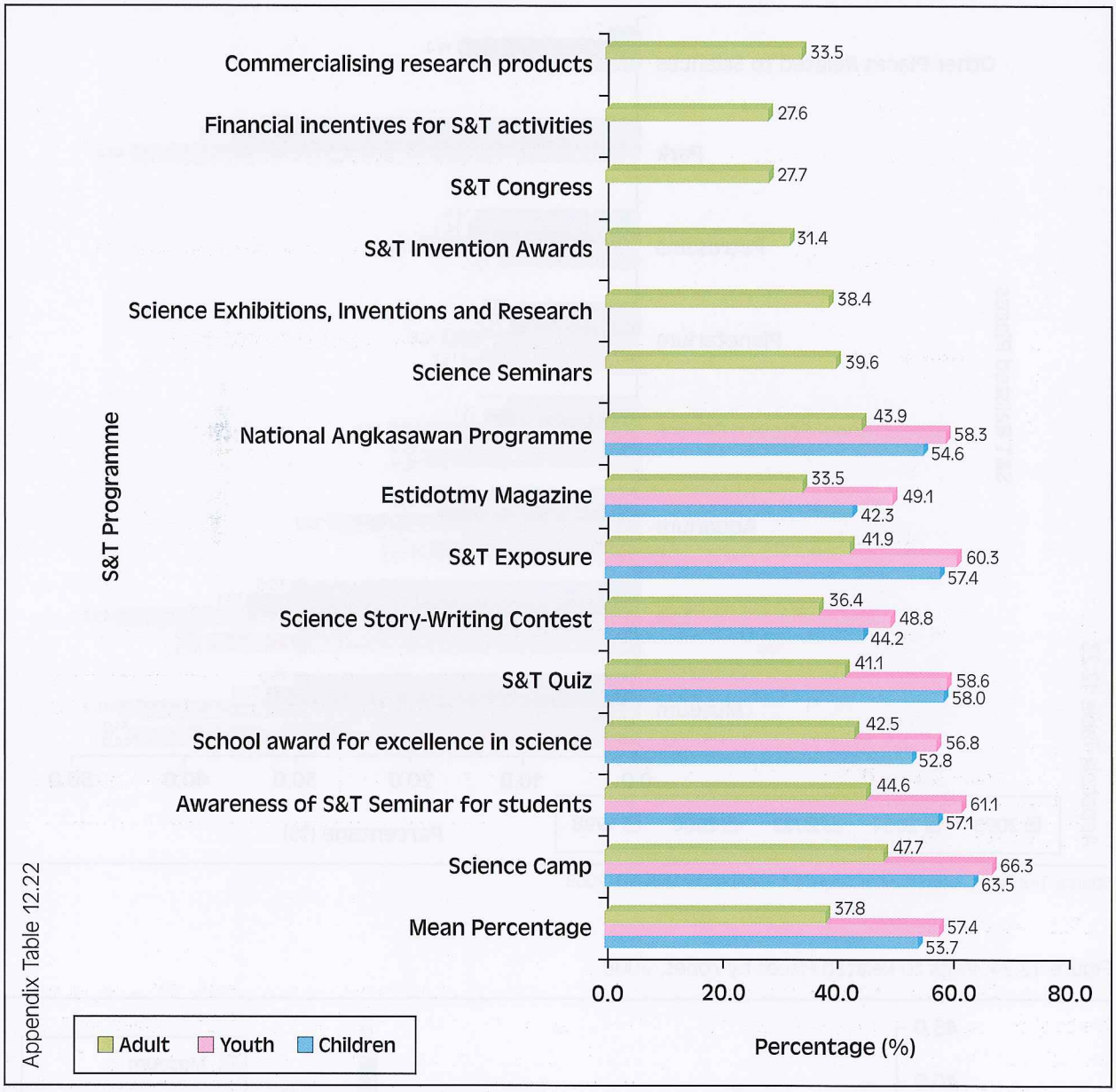


Source: The Public Awareness of Science & Technology Malaysia, 2008

12.5.2 Awareness of S&T Programmes

In general, the findings show that about 50.0% of the 18,447 respondents were aware of the S&T programmes. Youth show the highest mean percentage (57.4%) of awareness of the programmes compared to children (53.7%) and adults (37.8%). The programmes that registered high percentages for youth are: *science camps* (66.3%), *science and technology seminars* (61.1%), *science & technology exposure* (60.3%), *science & technology quizzes* (58.6%), and the *National Astronaut Project* (58.3%) **(Figure 12.22).**

Figure 12.22: Public Awareness on S&T Programmes, 2008



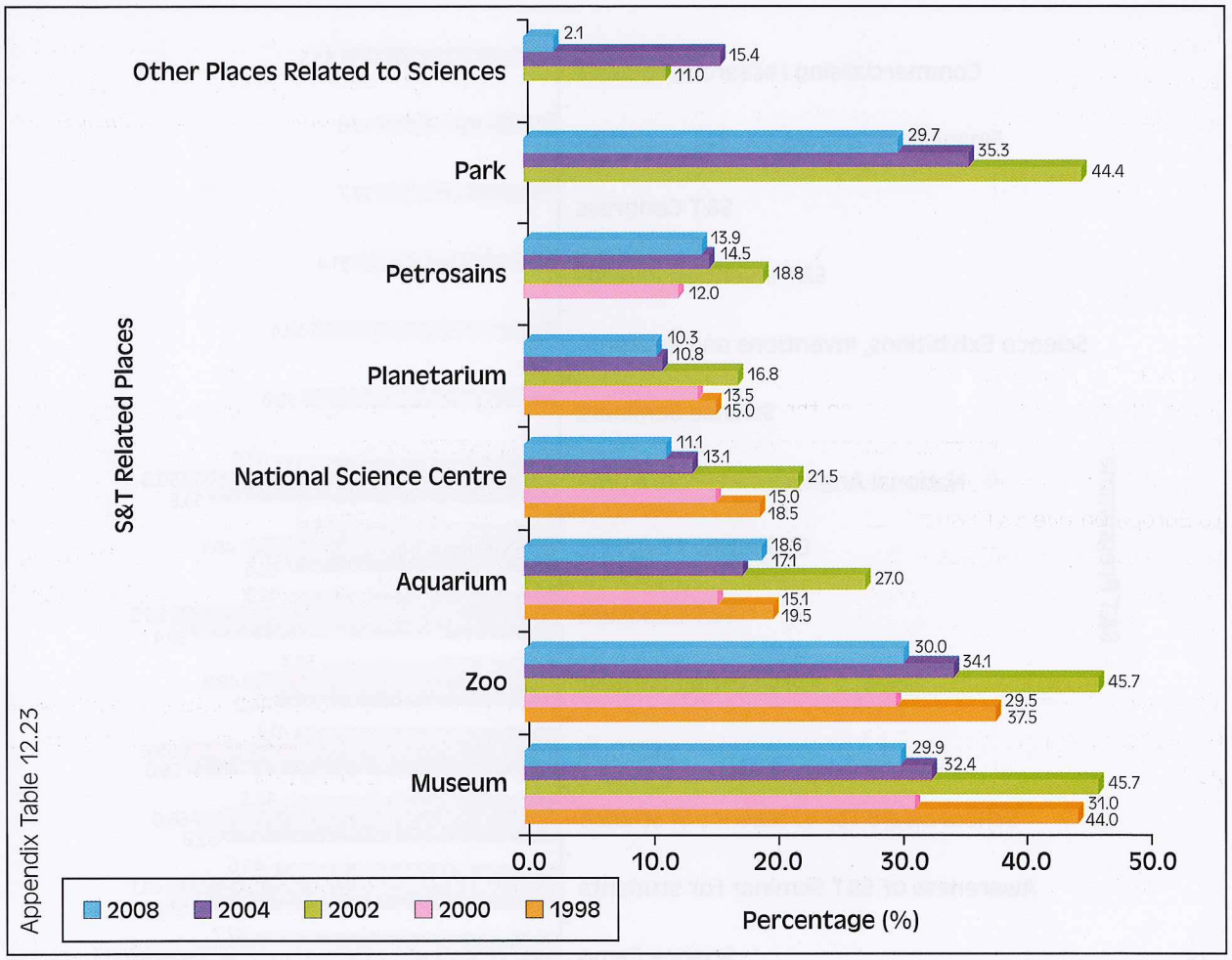
Source: The Public Awareness of Science & Technology Malaysia, 2008

Adults, on the other hand, were less aware of the programmes for youth and children, with the level of awareness falling below 50.0%. Their awareness of *commercialising research products, financial incentives for S&T activities, science technology congress, S&T invention awards, science exhibitions, inventions and research,* and *science seminars* falls in the range of 27.6% to 39.6%. The programme that the highest percentage of adults (47.7%) were aware of was the *science camp.*

12.5.3 Visits to S&T Related Places

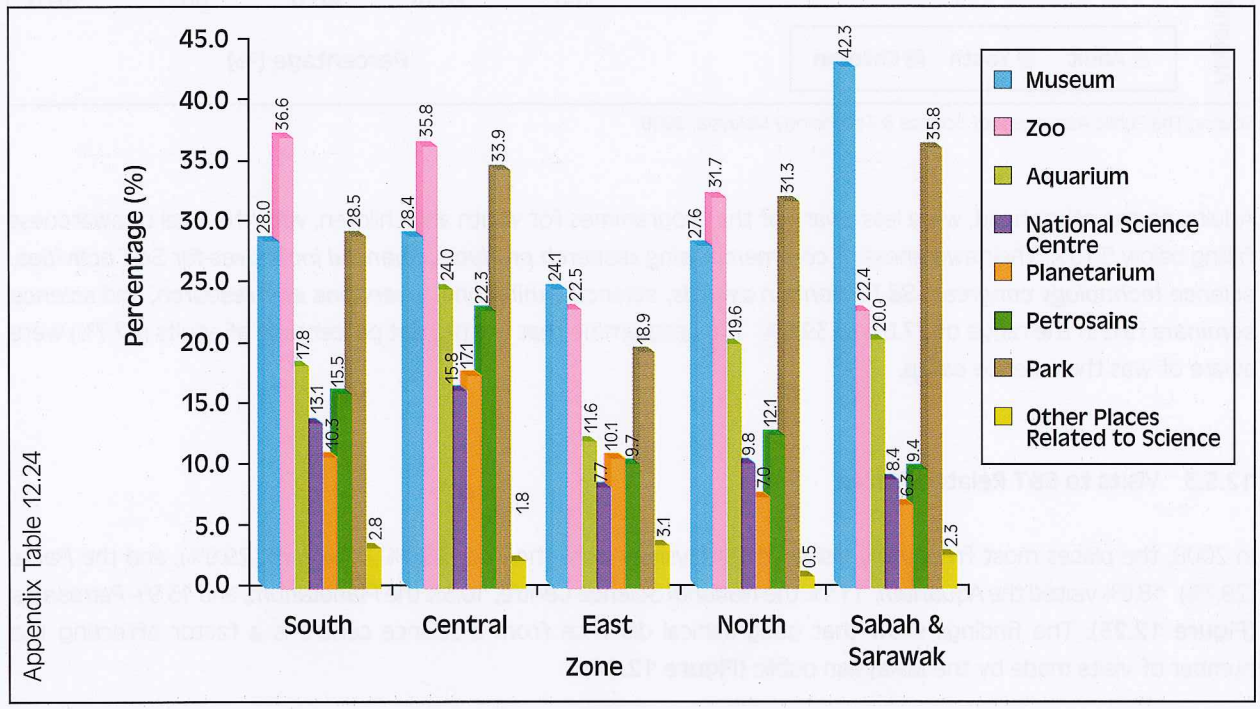
In 2008, the places most frequently visited by Malaysians were the *Zoo* (30.0%), *Museum* (29.9%), and the *Parks* (29.7%). 18.6% visited the *Aquarium,* 11.1% the *National Science Centre,* 10.3% the *Planetarium,* and 13.9% *Petrosains* **(Figure 12.23)**. The findings show that geographical distance from a science centre is a factor affecting the number of visits made by the Malaysian public **(Figure 12.24).**

Figure 12.23: Visit to S&T Related Places, 1998-2008



Source: The Public Awareness of Science & Technology Malaysia, 2008

Figure 12.24: Visits to Related Places by Zones, 2008



Source: The Public Awareness of Science & Technology Malaysia, 2008

12.6 INTERNATIONAL COMPARISON

In this section, an attempt is made to compare Malaysia with other nations on several pertinent variables regarding science and technology: public's perceived interest, perceived knowledge, actual understanding, attitude, and main sources of information. The comparisons are drawn only in as much as the international data would allow. It should be stated at the outset that the comparison with the international data on public understanding of S&T involves *only adults*, so as to be consistent with other International surveys.

12.6.1 Perceived Interest in S&T

In this section, Malaysia is compared to the USA and Europe with respect to perceived public interest in S&T. Malaysia is directly comparable to the USA on three issues **(Table 12.1)**, to which the respondents were asked to express whether they were "interested" or "very interested" in the issues. In the comparison involving the European public, two extra items *(environmental pollution* and *space exploration)* were added, making Malaysia directly comparable to Europe on five S&T issues. For the Malaysian and USA data, the response categories were identical, where the public's interest in S&T was captured using the categories of "interested" and "very interested." The European data were slightly different, where public interest in S&T was coded as "moderately interested" rather than just "interested", while very high levels of public interest were recorded using "very interested".

To allow for a meaningful comparison, the public's responses at the moderate and high interest levels were collapsed. The percentages of interested citizens for each S&T item and the mean percentages for all three nations (across three issues for the USA and across five for Europe) are presented in **Table 12.1.**

Table 12.1: Perceived Interest in S&T among the Malaysian, American and European Public

S&T Issues	Malaysia 2008			USA 2006			Europe 2005		
	% Interested	% Very Interested	% Not Interested	% Interested	% Very Interested	% Not Interested	% Interested	% Very Interested	% Not Interested
Latest inventions or new discoveries in science	40.9	4.0	37.1	40.0	47.0	10.0	48.0	30.0	20.0
Latest inventions or new discoveries in medicine	45.4	5.9	34.2	53.0	24.0	7.0	50.0	33.0	16.0
Latest inventions in new technology	49.0	6.9	29.7	48.0	15.0	*	48.0	30.0	21.0
Environmental pollution	47.3	7.1	31.7	*	*	*	49.0	38.0	12.0
Space exploration	43.1	6.6	34.7	*	*	*	23.0	*	*
Mean percentage	**45.1**	**6.1**	**33.5**	**44.7**	**34.3**	**8.5**	**43.6**	**32.8**	**17.3**

Sources: Science and Engineering Indicators 2006; Eurobarometer 2005, as cited in The Public Awareness of Science & Technology Malaysia, 2008

Note: *Data not recorded in the sources retrieved

The findings are not very encouraging. Malaysia registers lower numbers of interested citizens than the USA in all the three S&T issues compared, and Europe in four of the five issues compared. Malaysia surpasses Europe in only one issue, which is *space exploration.*

Not very many Malaysians reported being interested in new science inventions or discoveries (44.9%). In contrast, far more Americans (87.0%) and Europeans (78.0%) expressed an interest in this issue. The same is true for the latest inventions or new discoveries in medicine, where Malaysia is below the USA by 25.7% and Europe by 31.7%. However, the percentage of those who expressed interest in the latest inventions in new technology are is not very far from the USA, where we are behind by 7.1%. Likewise, a far smaller number of Malaysians expressed interest in the environment compared to Europeans. Only 54.4% of the Malaysian public expressed an interest in *environmental pollution,* 32.6% points lower than of the Europeans. Indeed, more Malaysians should be interested in and express concern about environmental issues and the environment in which they live.

The only S&T issue that sees Malaysia surpassing Europe in perceived interest is *space exploration,* where 49.7% expressed interest in the issue, 26.7% points greater than what Europe registered, which was only 23.0%. It should be noted that the wordings of the item on *space exploration* in the Malaysian S&T survey and Eurobarometer 2005 are not exactly the same (the item was worded as *space exploration* in the Malaysian survey and as *astronomy* and *space* in the Eurobarometer), but they may be used, with a certain degree of caution, to provide an approximation of the Malaysian and European public's interest in space matters. On the issue of space exploration, the *Science and Engineering Indicators 2008* reports that "interest in space exploration has consistently ranked low both in the United States and around the world. Surveys in Europe, Russia, China, and Japan document this general pattern" (MOSTI, 2008, p. 7-13).

While much of the world exhibits a lack of or a declining interest in space matters, Malaysia seems to experience a new surge of interest in this issue. The fact that almost half of the Malaysian survey respondents reported being interested in space exploration, recording a percentage which more than doubles the European percentage, is a phenomenon perhaps attributable to the recent 2007 *National Angkasawan Programme.* The extensive news and media coverage on the project has probably boosted the public's interest in space exploration. This illustrates the power of the Malaysian broadcast and print media in informing and influencing the public regarding a particular issue.

12.6.2 Perceived Knowledge of S&T

Altogether, 11 items were used to assess the Malaysian public's perceived knowledge of various S&T issues, but only four items are used for the international comparison with the USA and Europe. Of these four items, Malaysia is directly comparable to the USA on only two, *latest inventions or new discoveries in science and medicine* **(Table 12.2).**

The trends in the three nations appear to be somewhat similar. In general, most Malaysians, like most Americans and Europeans, do not rate themselves very highly on S&T knowledge—although Malaysians tend to rate themselves lower in their knowledge of S&T than their US and European counterparts. Less than 5.0% of Malaysians felt they have good knowledge of the selected S&T issues. Similarly, not quite 10.0% of the Americans and 12.0% of the Europeans felt that they are very well-informed about S&T issues. Among the four S&T issues compared, Malaysians and Europeans similarly felt least knowledgeable about scientific discoveries, and most knowledgeable about environmental pollution.

Table 12.2: Perceived Knowledge of S&T among Malaysians, Americans and Europeans (Percent)

S&T Issues	Malaysia 2008			USA 2006			Europe 2005		
	Good	Average	Weak	Very Informed	Somewhat Informed	Not Very Informed	Very Well Informed	Well Informed	Poorly Informed
Latest inventions or new discoveries in science	2.8	24.7	40.1	10.0	64.0	22.0	10.0	51.0	37.0
Latest inventions or new discoveries in medicine	3.1	26.2	41.6	9.0	67.0	19.0	11.0	59.0	28.0
Latest inventions in new technology	3.5	29.5	39.7	*	*	*	11.0	53.0	35.0
Environmental pollution	7.5	33.1	37.3	*	*	*	15.0	61.0	23.0
Mean percentage	**4.2**	**28.4**	**39.7**	**9.5**	**65.5**	**20.5**	**11.8**	**56.0**	**30.8**

Sources: 2004 Virginia Commonwealth University Life Sciences Survey; Eurobarometer 2005

12.6.3 Actual Knowledge and Understanding of S&T Issues

In the 2008 survey, 16 items were used to assess the Malaysian public's actual knowledge and understanding of S&T issues. However, only nine of the items were similar or identical to those used in international surveys, such as the National Science Foundation surveys in the USA and the Eurobarometer in Europe **(Table 12.3).**

The mean percentage of correct answers to all nine statements achieved by Malaysian adults in the present survey is 38.8%, placing Malaysia below the USA (by 23.6%), Europe (by 24.1%) and South Korea (by 20.8%). However, Malaysia is above India, leading by 6.8% (based on the mean percentages computed for the seven items on which they were identical, which comes up to 45.9% for Malaysia and 39.1% for India).

The findings also show that for 2008, Malaysians score lower on almost all S&T concepts than Americans and Europeans, except for two items: *"The earth travels around the sun"* and *"The earth takes 365 days to complete its rotation around the sun".* To the first item, 70.3% the Malaysians responded correctly, surpassing Americans (56.0%), Europeans (65.0%) and Indians (68.5%), and are outperformed only by South Koreans (88.5%). On the second item, Malaysia can only be compared to the USA and India, as the data regarding the performance of other nations on this item are not available. The figures show Malaysians outperforming the Americans by 10.6% and the Indians by 24.6% in their understanding of the earth's rotation around the sun. It should be noted that Malaysia registered higher scores than India on five of the six items compared, but on the item, *"Antibiotics kill viruses as well as bacteria"*, India outperformed Malaysia by a slight 0.8%.

Malaysians scored most poorly on three items: *"Antibiotics kill viruses as well as bacteria",* (to which only 7.2% of the Malaysian respondents responded correctly compared to 46.0% of the European respondents and 55.5% of the American respondents), *"All radioactivity is manmade",* (only 13.3% answered this item correctly compared to 59.0% of Europeans and 70.5% of Americans), and *"Lasers work by focusing sound waves"*, where only 14.5% of the Malaysian public chose the correct answer compared to 47.0% of the Americans, close to 50.0% of the Europeans and 30.0% of the South Koreans. Malaysians' low scores on these items suggest that they are acutely lacking in highly specialised science knowledge.

Table 12.3: Malaysians' Knowledge of Selected S&T Issues Compared to That of Other Countries

	Test Items	Malaysia (2004)	USA (2004)	Europe (2004)	S. Korea (2004)	India (2004)
1.	The earth travels around the sun (True)	70.3	56.0	65.0	88.5	68.5
2.	The earth takes 365 days to complete its rotation around the sun (True)	65.6	55.0	*	*	41.0
3.	The center of the earth is very hot (True)	63.8	80.0	87.0	87.0	56.5
4.	The continents have been moving their location for millions of years and will continue to move (True)	44.6	80.0	88.5	88.7	31.5
5.	It is the father's gene that determines the gender of the baby (True)	38.7	63.5	62.0	59.0	38.0
6.	Electrons are smaller than atoms (True)	30.8	54.5	46.0	46.0	30.0
7.	Lasers work by focusing sound waves (False)	14.5	47.0	49.5	30.0	*
8.	All radioactivity is manmade (False)	13.3	70.5	59.0	48.0	*
9.	Antibiotics kill viruses as well as bacteria (False)	7.2	55.5	46.0	29.5	8.0
	Mean percentage	**38.8**	**62.4**	**62.9**	**59.6**	**39.1**

Sources: Science and Engineering Indicators 2006; Eurobarometer 2005 as cited in The Public Awareness of Science & Technology Malaysia, 2008

Malaysians did not perform very well on the items, *"Electrons are smaller than atoms"* (30.8% Malaysians answered this item correctly compared to 46.0% of Europeans and 54.5% of Americans); *"It is the father's gene that determines the gender of the baby,"* (38.7% of the Malaysian respondents answered correctly compared to 62.0% of the European and 63.5% of the American respondents); and *"The continents have been moving their location for millions of years and will continue to move"* (44.6% of the Malaysians answered correctly compared to the Europeans (88.5%), the Americans (80.0%), the South Koreans (88.7%) and the Indians (31.5%)).

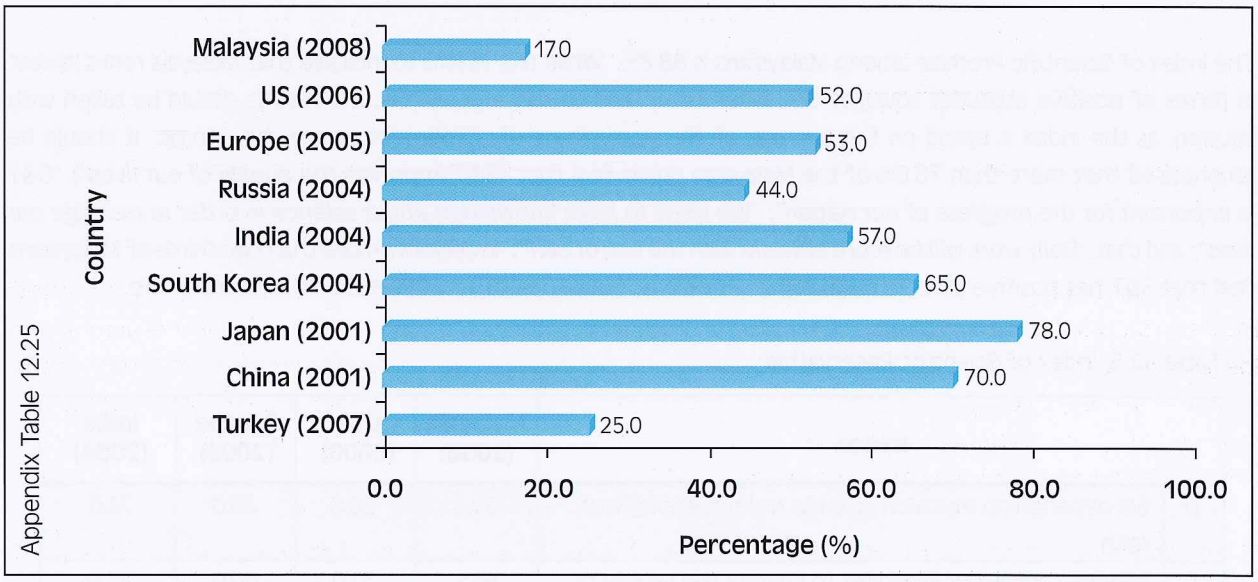
The items that Malaysians performed quite well on are, *"The earth travels around the sun," "The earth takes 365 days to complete its rotation around the sun,"* and *"The center of the earth is very hot."* On these items, more than 60.0% of the Malaysians demonstrate the correct understanding of the science concepts. Overall, Malaysians outperformed Indians on eight of the nine items of comparison, Americans on the first two, and Europeans on only the first item.

12.6.4 The Malaysian Public's Responses to the Theories of Evolution and Big Bang

Two items, *"The universe began with a huge explosion"*, and *"Human beings as we know them today developed from earlier species of animals,"* which consistently appear in *Public Understanding of S&T* surveys conducted worldwide, have not been included in the assessment of the public's understanding of S&T. This is because the two statements represent scientific theories on which scientists have differing views. In addition, the item, *"Human beings as we know them today developed from earlier species of animals,"* does not reflect science literacy, but rather, one's religious beliefs or philosophical orientation. However, the items have been included in a separate section in the present survey to enable some comparison to be drawn between the Malaysian and international public with respect to epistemological beliefs in science.

With regard to the statement, *"The universe began with a huge explosion"* not a very high percentage of the Malaysian (27.0%), American (32.0%), Russian (35.0%), or Indian (35.0%) adult public agreed with the statement. An even lower percentage of agreement (17.0%) was found among the Chinese public. The highest percentage of agreement was recorded among the South Koreans (67.0%) and Japanese (60.3%). Concerning the statement *"Human beings as we know them today developed from earlier species of animals,"* only 17.0% of the Malaysian public agreed it is TRUE **(Figure 12.25).** The majority of Malaysians (51.3%) marked this item as FALSE, which means they reject the notion that man originates from apes. In contrast, 52.0% of the Americans, 53.0% of the Europeans, 44.0% of the Russians and 57.0% of the Indians accept this notion as representing a scientific truth. Even greater acceptance of the notion is evident among oriental societies in China (70.0%), Japan (78.0%) and South Korea (65.0%). However, in Turkey where the respondents are predominantly Muslim, those who agree with human evolution constitute 25.0% **(Figure 12.25)**. Elsewhere in countries where there are large Muslim populations, those who think that Darwin's evolution theory is TRUE make up only small percentages: 8.0% in Egypt, 14.0% in Pakistan, and 16.0% in Indonesia, while those who outrightly reject the theory constitute more than 65.0%[1]. Hence, the inclination to agree with Darwin's evolution theory is noticeably less among Muslims than among the respondents of other faiths.

Figure 12.25: International Comparison of Public Agreement with the Idea *"Human Beings as We Know Them Today Developed from Earlier Species of Animals"*



Sources: Science and Engineering Indicators 2006; Eurobarometer 2005; India Science Report 2005, as cited in The Public Awareness of Science & Technology Malaysia, 2008

12.6.5 Attitudes towards S&T

The attitudes of the Malaysian public towards S&T are also compared to those of the American and European public. An Index of Scientific Promise and an Index of Scientific Reservation were first developed by the USA National Science Foundation to track trends in public attitudes towards S&T. The two indices were based on the premise that most individuals hold two primary views toward science and technology. The first view, as cited in The Public's Awareness of Science and Technology Malaysia 2000 report, represents the belief in the promise that science and technology would provide positive assessment of the likelihood of future benefits.

[1] source: *http://helios.hampshire.edu/~sahCS/Hameed- Science-Creationism.pdf*

This view is represented by specific statements. For the purpose of comparison, the Index of Scientific Promise is represented by statements A and B for Malaysia, the USA, Europe, and India **(Table 12.4)**. The second view represents personal reservations held about science and technology, which may conflict with a person's values and beliefs. This view is represented by statements D and I calculated for Malaysia, the USA, Europe, and India **(Table 12.5)**. In this survey, and in the previous Malaysian S&T awareness surveys, the two indices were calculated by taking the average percentage of adult respondents who agreed to the four items.

Table 12.4: Index of Scientific Promise

Issues		Malaysia (2008)	USA (2004)	Europe (2005)	India (2004)
A	S&T makes us healthier & our lives more comfortable	66.1	91.0	78.0	77.0
B	Our daily work will be more interesting with the use of S&T	71.4	78.5	70.0	61.0
	Mean Percentage	**68.8**	**84.8**	**74.0**	**69.0**

Sources: Science and Engineering Indicators 2006; India Science Report 2005, as cited in The Public Awareness of Science & Technology Malaysia, 2008.

The Index of Scientific Promise among Malaysians is 68.8%. While this seems to indicate that Malaysia ranks lowest in terms of positive attitudes towards S&T when compared to these countries, the results should be taken with caution, as the index is based on the average of the percentage of agreement to only two items. It should be emphasised that more than 70.0% of the Malaysian public feel that *"S&T improves the quality of our lives"; "S&T is important for the progress of our nation"; "We need to have knowledge about science in order to manage our lives";* and that *"Daily work will be more efficient with the use of S&T".* In addition, more than two thirds of Malaysians feel that S&T has positive effects on working conditions, public health, and individual enjoyment of life.

Table 12.5: Index of Scientific Reservation

Issues		Malaysia (2008)	USA (2006)	Europe (2005)	India (2004)
D	We depend too much on science and not enough on faith	39.2	56.0	40.0	74.0
I	Science causes our lifestyles to change too rapidly or Science makes our lives change too fast	66.1	31.0	60.0	75.0
	Mean Percentage	**52.7**	**43.5**	**50.0**	**74.5**

Source: Science and Engineering Indicators 2006, as cited in The Public Awareness of Science & Technology Malaysia, 2008

Based on the indices of four countries shown in **Table 12.6**, India seems to express the most reservation towards S&T. The Index of Scientific Reservation for Malaysia is almost the same as that of Europe, while the USA seems to have the least reservation towards S&T.

A sizeable portion of the Indian population (74.0%) feels that their society depends too much on science. The percentage of agreement to this statement is much lower in Malaysia (39.2%) and Europe (40.0%), which suggests that most Malaysians, as most Europeans, do not see science and religion as being in conflict. This response is encouraging, as it indicates that Malaysians have a positive attitude towards S&T. On the other hand, quite a large percentage of the Malaysian, Indian & European public feel that science changes their lives too fast. This sentiment is shared by only 31.0% of the Americans.

12.6.6 Main Sources of S&T Information

In Malaysia, the television and newspaper constitute the two most important sources of information on S&T **(Table 12.6)**, while in the USA, it is the television and Internet. However in the USA, the percentage of people accessing these sources of information is lower than the percentage registered in Malaysia. In India, people rely more on the television and radio, and less on the printed word (the newspaper, books and the Internet). The Indians also report getting S&T information from friends and relatives (11.6%). An interesting pattern shared by all three countries is that despite the rapid advances made in various fields of telecommunications and ICT technologies in the last few decades, relatively few respondents in Malaysia and the USA cited the Internet as a source of S&T. The percentage of people accessing the Internet for S&T information in Malaysia is slightly higher than that reported in South Korea (23.0%), but interestingly, the South Koreans, like the Americans, reported consulting the Internet more than the newspaper.

Table 12.6: Percentage of International Comparison on Sources of Information on S&T

Sources	Malaysia (2008)	*Malaysia (2004)	USA (2006)	India (2004)	S. Korea (2006)
Television	82.4	87.5	39.0	64.7	*
Newspaper	62.1	68.9	11.0	7.6	16.0
Radio	32.1	41.3	2.0	13.0	*
Internet	24.8	21.4	23.0	0.2	23.0

Sources: Science and Engineering Indicators 2006; India Science Report 2005, as cited in The Public Awareness of Science & Technology Malaysia, 2008

12.7 CONCLUSION

Ever since the Malaysian Public Awareness Surveys have been carried out, Malaysians have reported themselves as being moderately interested in certain S&T issues and in having a weak knowledge of S&T. In addition, while they have a good knowledge of S&T issues that are taught in school, they lack the more specialised knowledge of S&T that are important in today's society. When compared with some International countries, Malaysia generally lags behind the USA, Europe, and South Korea on their understanding of S&T. This suggests that a lot more can be done to increase the public's interest in, and knowledge of S&T such that they would be considered scientifically literate. However, in terms of attitude towards S&T, Malaysians have been consistently positive. From 1998 to 2004, more than 60.0% of Malaysians felt that S&T has positive effects on *public health, individual enjoyment of life, standard of living,* and *working conditions.* In 2008, 73.8% of Malaysians agreed that scientific research brings more positive than negative effects. 84.3% agreed that *S&T improves the quality of our lives* and 79.8% agreed that *S&T is very important for the progress of our nation.* These results are very encouraging, and underscore the need to capitalise on these aspects and continue to work towards promoting S&T thorough various programmes so that our public's attitudes towards, and consequently, understanding of S&T will continue to be enhanced.

CHAPTER 13
- RECENT ADVANCEMENTS IN THE ENERGY SECTOR

CHAPTER 13

RECENT ADVANCEMENTS IN THE ENERGY SECTOR

13.0 INTRODUCTION

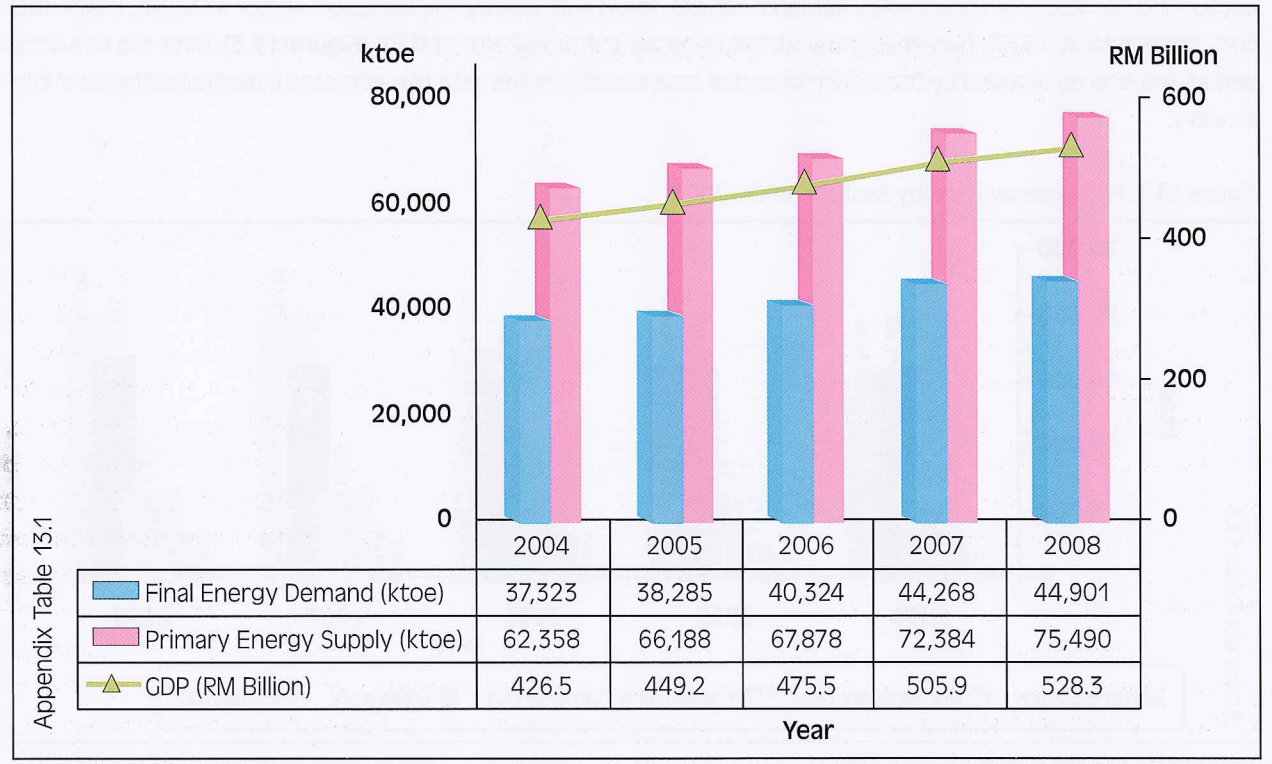
As Malaysia's economic development shifts to a higher level, the country's energy requirements also increase in tandem. Consequently, the energy sector has gained greater attention as reflected by its inclusion as one of the National Key Economic Areas in the 10MP. Continuous efforts are being implemented to ensure that policies governing the sector remain relevant and effective amid the changing requirements and increasing challenges facing the sector. In Malaysia, the government's efforts to implement policies to address the challenging issues in the energy sector are well-reflected by the various energy policies such as the National Energy Policy in 1979, National Depletion Policy in 1980, Four Fuel Diversification Policy in 1981, Renewable Energy as the Fifth Fuel Policy in 2001, National Biofuel Policy in 2005, National Green Technology Policy in 2009, New Energy Policy in 2010 and more recently, the National Renewable Energy Policy and Action Plan in 2010. In essence, the major trust of these policies has been to ensure adequate, secure, and cost-effective energy supply, which is sustainable for the country. The New Energy Policy, in particular, specifically focuses on the issue of enhancing energy security and efficiency based on five strategic pillars: first, intensify efforts to develop alternative sources of energy so as to secure and manage reliable energy supply; second, implement measures to encourage efficient energy usage by setting minimum performance standards and development of green technologies; third, adopt a market-based energy pricing mechanism in line with the strategy to rationalise energy subsidies; fourth, enhance governance in the energy sector by increasing market discipline aiming at raising productivity and efficiency; and fifth, manage the structural changes resulting from the Policy initiatives and implementations.

In view of the increasing importance of the energy sector, a separate chapter focusing on this sector is being included for the first time in this report to allow for the recent advancements in the sector to be highlighted. The next section provides a brief overview of the energy sector in Malaysia, followed by a discussion on the continuous efforts to develop renewable energy sources, the recent efforts to increase efficiency in energy usage, and the promotion of green technology adoption in the country. The chapter ends with the prospects for the industry and concluding remarks.

13.1 THE ENERGY SECTOR IN MALAYSIA – SUPPLY AND UTILISATION

In 2008, Malaysia produced a total of 75,490 kilo tonnes of oil equivalent (ktoe) of primary energy products compared to 62,358 ktoe in 2004, a growth of 21.1% over the five-year period **(Figure 13.1)**. On the demand side, final energy demand of the country rose to 44,901 ktoe in 2008 from 37,323 ktoe in 2004, registering a growth of about 20.3% over the corresponding five-year period. The double-digit growth in energy demand is in line with the rapid economic growth during the period under review. Malaysia's energy demand is expected to sustain the strong growth in line with the greater energy requirements of the country. As the final energy demand catches up with the energy supply, there is an increasing concern that if this trend continues to persist, the energy requirements of the country could not be met by the domestic energy supply. As such, a central issue in the energy sector is for Malaysia to be able to meet the challenge of addressing the supply-demand mismatch such that the country's economic growth process would not be obstructed.

Figure 13.1: Primary Energy Supply and Final Energy Demand in Malaysia, 2004-2008



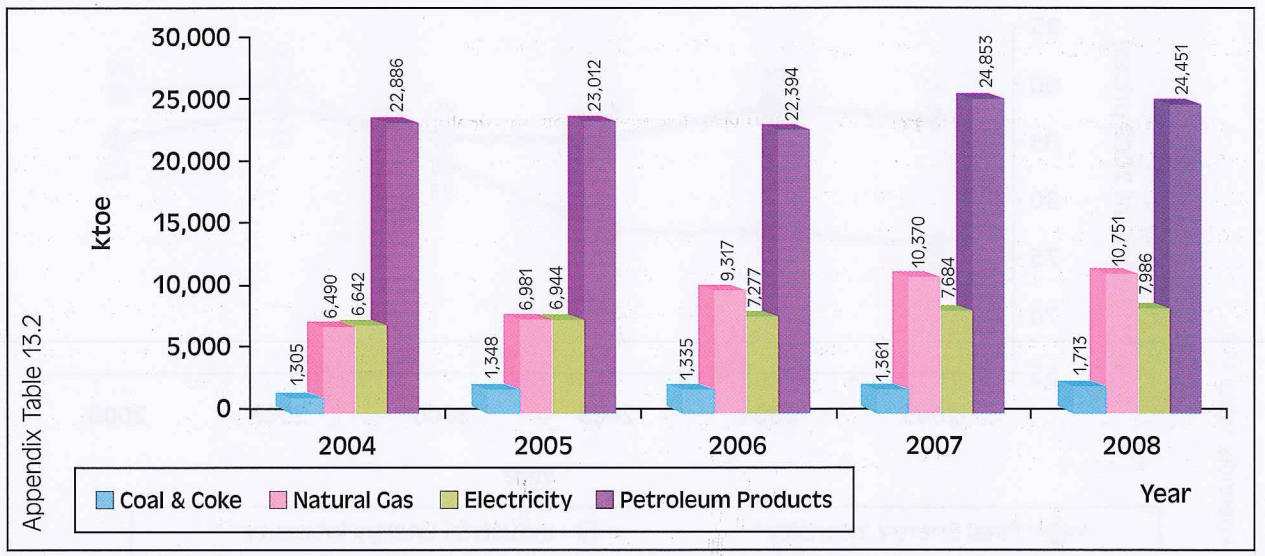
Appendix Table 13.1

	2004	2005	2006	2007	2008
Final Energy Demand (ktoe)	37,323	38,285	40,324	44,268	44,901
Primary Energy Supply (ktoe)	62,358	66,188	67,878	72,384	75,490
GDP (RM Billion)	426.5	449.2	475.5	505.9	528.3

Source: Malaysia's National Energy Balance 2008

Of the total commercial energy supply in 2008, 41.9% are sourced from natural gas, 40.4% from crude oil, 14.7% from coal and coke, and 3.0% from hydropower (NEB 2008, pg. 14). As for the final demand of commercial energy, petroleum products have consistently contributed the largest proportion, accounting for 54.5% of the 44,901 ktoe total energy demand in 2008. This is followed distantly by natural gas at 23.9% of the total demand, electricity at 17.8%, and coal and coke at 3.8% **(Figure 13.2)**. Over the years, there is a declining trend in energy demand for petroleum products, whereas the demand for natural gas continues to show a steady increase.

Figure 13.2: Final Demand of Commercial Energy by Type of Fuels, 2004-2008

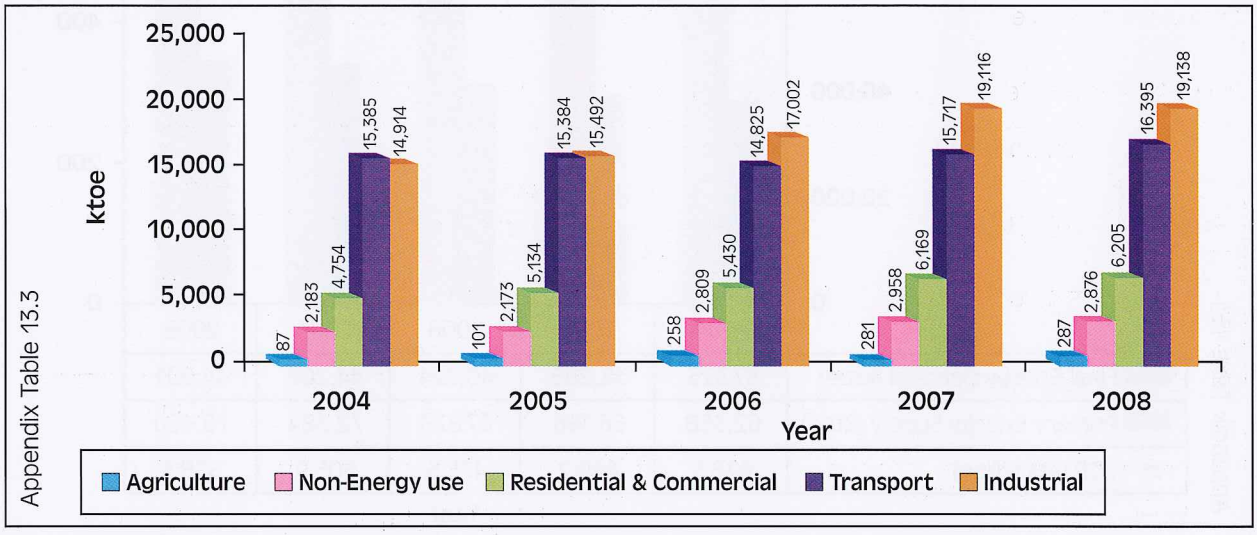


Appendix Table 13.2

Source: Malaysia's National Energy Balance 2008

In terms of final energy used by sector, the industrial sector remained the leading sector in energy consumption, accounting for 42.6% of total energy demand in 2008. This is followed by the transport sector at 36.5%, residential and commercial at 13.8%, non-energy use at 6.4%, and agricultural sector at 0.6% **(Figure 13.3).** Over the five-year period, the energy demand by the industrial sector rose steadily, in line with the increased industrial activities in the country.

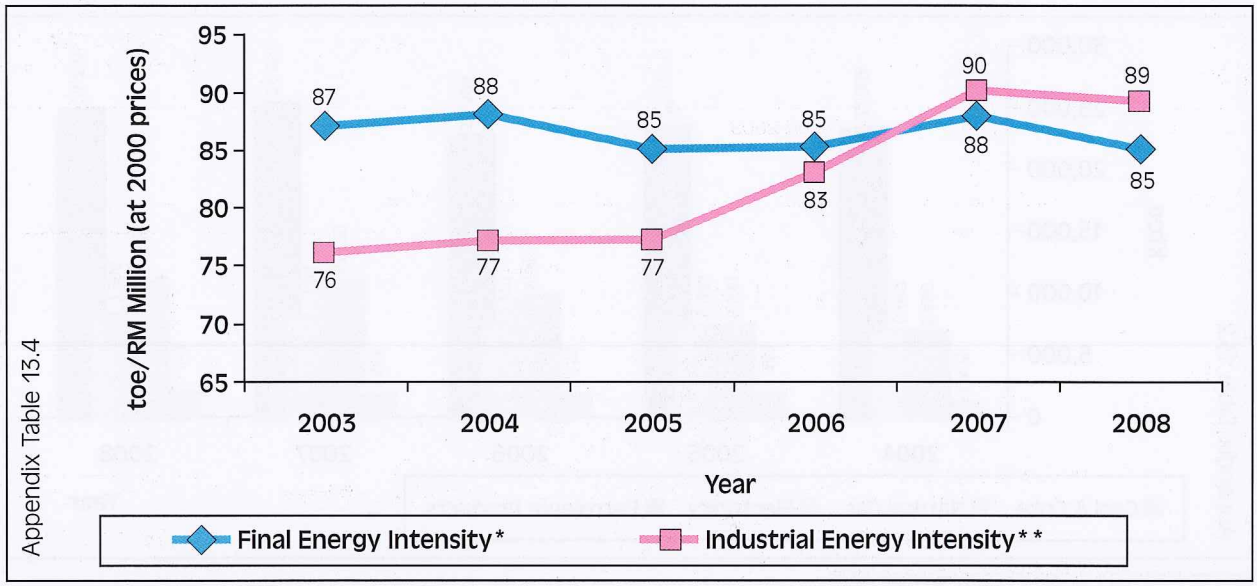
Figure 13.3: Final Energy Used by Sectors, 2004-2008



Source: Malaysia's National Energy Balance 2008

In 2000, Malaysia's total per capita energy consumption was relatively low (50.1%) compared to the world standard, but has increased to around 66.0% in 2008. As a measure of energy efficiency, the final energy intensity ratio (as measured by final energy demand divided by GDP) has remained relatively stable in the range of 85 toe/RM million to 88 toe/RM million in the period 2003 to 2008 **(Figure 13.4)**. This is in line with the final energy intensity ratio of around 88 toe/RM million by 2010 as proposed in the 9MP. The industrial energy intensity ratio (as measured by industrial energy demand divided by industrial GDP at 2000 prices), however, has edged up to 89 toe/RM million in 2008 compared to 76.0 toe/RM million in 2003.

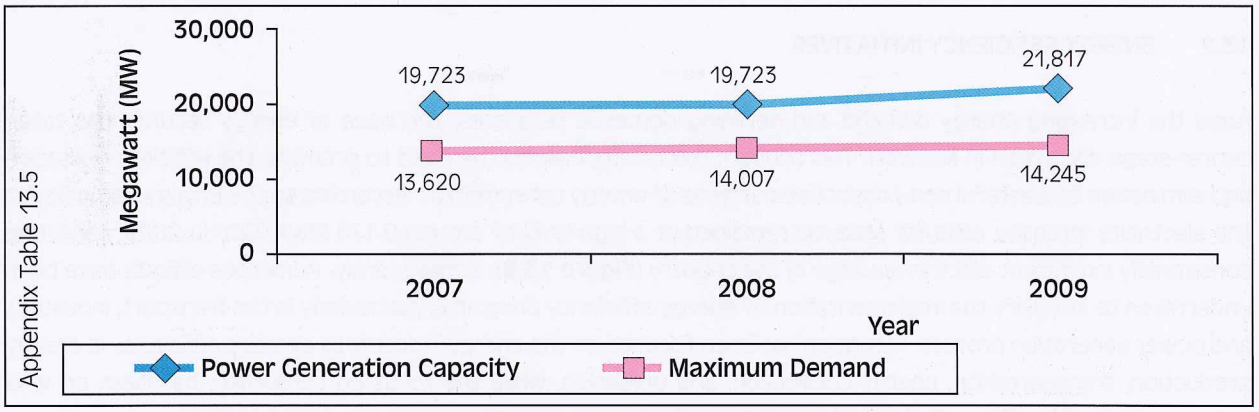
Figure 13.4: Energy Intensity Ratio in Malaysia, 2003-2008



Source: Malaysia's National Energy Balance 2008
Note: Intensity = Quantity of energy required per unit output or activity
*: Final Energy Demand/GDP at 2000 Prices
**: Industrial Energy Demand/Industrial GDP at 2000 Prices

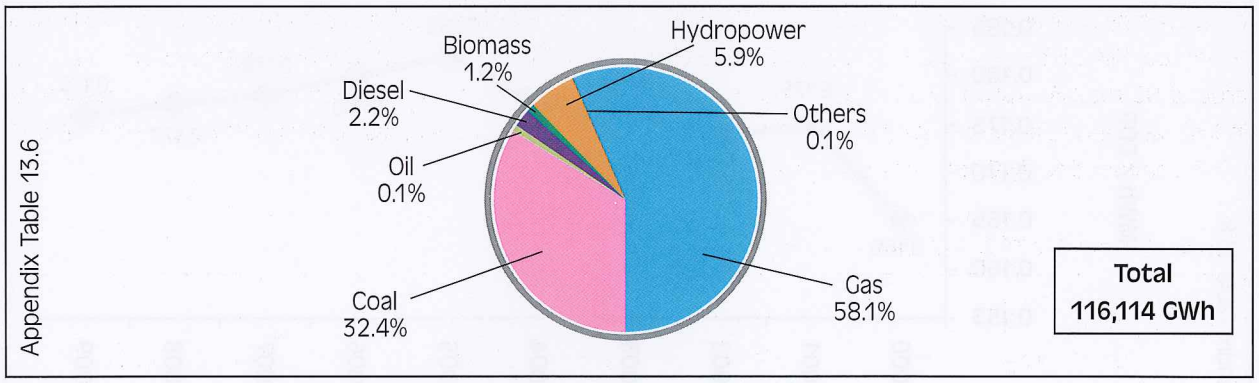
According to the Energy Commission's *Annual Report 2009,* power generation capacity connected to the Malaysian National Grid increased to 21,817 megawatt (MW) in 2009 from 19,723 MW in 2008, with a maximum demand of 14,245 MW as at August 2009, representing an increase of 1.7% from the 14,007 MW recorded in 2008 **(Figure 13.5).** Total electricity generation for 2009 was 116,114 GWh with a total consumption of 97,113 GWh or 3,570 kWh per capita. The generation fuel mix is 58.1% gas, 32.4% coal, 5.9% hydropower, and 3.6% from other forms of fuel **(Figure 13.6)**. Of the total electricity generation in 2009, independent power producers (IPPs) contribute 65.9%, followed by the government-related Tenaga Nasional Berhad (TNB) at 25.5%. The contribution of power producers to total electricity generation in Malaysia is shown in further detail in **Figure 13.7**.

Figure 13.5: Power Generation Capacity and Maximum Demand in Malaysia, 2007-2009



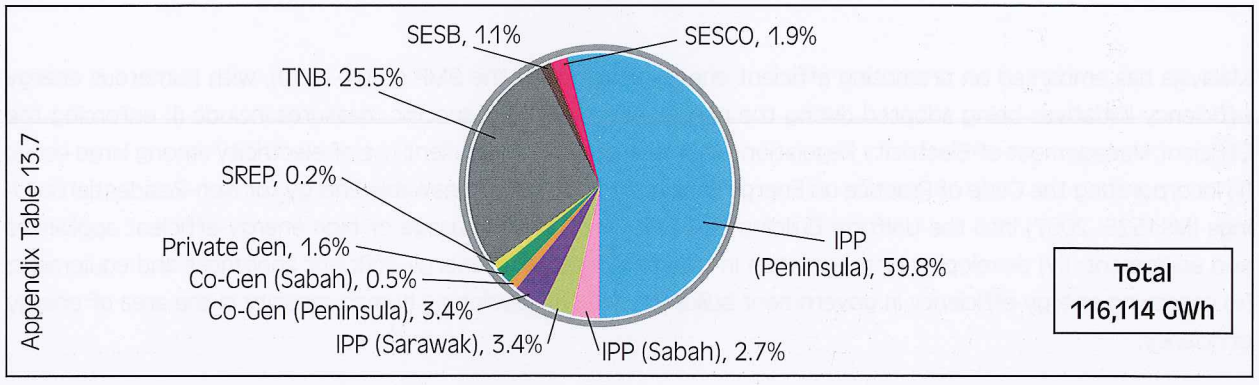
Source: Energy Commission, Malaysia. *Annual Report 2009*

Figure 13.6: Electricity Generation Mix in Malaysia, 2009



Source: Energy Commission, Malaysia. *Annual Report 2009*

Figure 13.7: Electricity Generation by Major Power Producers in Malaysia, 2009



Source: Energy Commission, Malaysia. *Annual Report 2009*

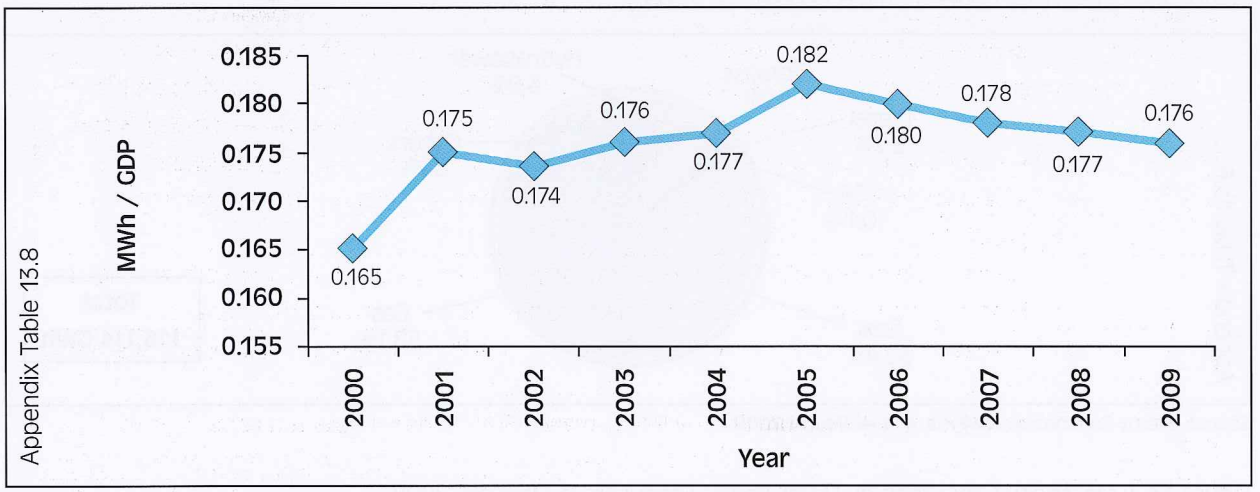
In 2009, the country, as a whole, consumed 514 thousand barrels (23.6 million tonnes) of oil daily against a production of 660 thousand barrels (34.2 million tonnes) per day. Currently, Malaysia's oil reserves are estimated at around 5.5 billion barrels. For comparison purposes, the oil reserves for Saudi Arabia stand at 260 billion barrels, Iran at 138 billion barrels, and Iraq at 115 billion barrels.

As for natural gas, Malaysia's current gas reserves stand at around 88 trillion cubic feet (tcf), compared to Russia at 1,680 tcf, Iran at 1,046 tcf, and Qatar at 900 tcf. An alarming trend of declining gas production can be observed in the country, with production declining at the rate of around 10.0% per annum. Consequently, about 25.0% of the natural gas being supplied to the domestic market is imported.

13.2 ENERGY EFFICIENCY INITIATIVES

Amid the increasing energy demand and declining domestic resources, the issue of energy security has taken center-stage discussion in Malaysia. This concern has re-emphasised the need to promote the efficient utilisation and elimination of wasteful non-productive patterns of energy consumption. According to the Energy Commission, the electricity intensity ratio for Malaysia remained at a high level of around 0.176 MWh/GDP in 2009, reflecting consistently inefficient electricity usage in the country **(Figure 13.8)**. Consequently, numerous efforts have been undertaken to intensify the implementation of energy efficiency programs, particularly in the transport, industrial, and power generation process. Attention has been focused on the energy industry to exercise efficiency in energy production, transportation, energy conversion, and utilisation, while the focus on consumers has been on wise energy consumption through the implementation of awareness programs.

Figure 13.8: Electricity Intensity Ratio in Malaysia, 2000-2009



Source: Energy Commission, Malaysia. *Annual Report 2009*

Malaysia has embarked on promoting efficient energy usage since the 9MP (2005-2010), with numerous energy efficiency initiatives being adopted during the period. Among others, specific measures include (i) enforcing the Efficient Management of Electricity Regulation 2008 to ensure more efficient use of electricity among large users; (ii) incorporating the Code of Practice on Energy Efficiency and Use of Renewable Energy for Non-Residential Buildings (MS1525: 2007) into the Uniform Building By-Laws; (iii) promoting usage of high energy-efficient appliances and equipment; (iv) developing local expertise in the manufacture of energy-efficient appliances and equipment; (v) improving energy efficiency in government buildings; and (vi) developing human capacity in the area of energy efficiency.

The Efficient Management of Electricity Regulation 2008, in particular, is applicable to the industrial and commercial sectors, and aims to promote the efficient usage of electrical energy through better energy planning and management. In the building sector, the government has constructed an intelligent building, equipped with an integrated energy efficient design, with the aim of demonstrating energy efficient and cost effective features for both the public and private sectors to replicate. The low energy office (LEO) building would enable energy savings of more than 50.0% compared to normal buildings, with an approximated electricity bill savings of about RM 600,000 per annum. The aim is to enable the LEO building to achieve zero energy consumption, whereby the building must not consume more electricity than it can produce using renewable energy sources. To ensure the continuous adoption of these initiatives, several government buildings have been audited for energy efficiency standards in 2009.

Special tax incentives are also given for improvements in energy efficiency. Companies providing services for energy efficiency improvement are eligible for pioneer status, with income tax exemption and an investment tax allowance. Other incentives include import duty and sales tax exemption on energy-efficient equipment that is not produced locally and a sales tax exemption on the purchase of equipment from local manufacturers. Meanwhile, companies that make capital expenditures to improve their energy consumption are also eligible for investment tax allowance.

Reflecting continuous commitment towards promoting energy efficiency in the country, additional initiatives were introduced under the 10MP (2011-2015), to meet the objective of energy efficiency in the residential, industrial, township, and building sectors **(Table 13.1).**

Table 13.1: Initiatives to Drive Energy Efficiency Efforts

Sector	Highlight Initiatives
Residential Township Industrial Building	• Phasing out of incandescent light bulbs by 2014 to reduce carbon dioxide emissions by an estimated 732,000 tonnes and reducing energy usage by 1,074 gigawatts a year. • Increasing energy performance labelling from four (air conditioner, refrigerator, television and fan) to ten electrical appliances (six additional appliances- rice cooker, electric kettle, washing machine, microwave, clothes dryer and dishwasher). Labelling appliances enables consumers to make informed decisions as they purchase energy efficient products.
	• Introduction of guidelines for Green Township and rating scales based on carbon footprint baseline, and promoting such townships, starting with Putrajaya and Cyberjaya.
	• Increasing the use of energy efficient machinery and equipment such as high efficiency motors, pumps, and variable speed drive controls. • Introduction of Minimum Energy Performance Standards for selected appliances to restrict the manufacture, import, and sale of inefficient appliances to consumers.
	• Revision of the Uniform Building By-Laws to incorporate the Malaysian Standard Code of Practice on Energy Efficiency and Renewable Energy for Non-Residential Buildings (MS1525). This allows for the integration of renewable energy systems and energy saving features in buildings. • Wider adoption of the Green Building index (GBI) to benchmark energy consumption in new and existing buildings. • Increasing the use of thermal insulation for roofs in air conditioned building to save energy.

Source: *National Energy Efficiency Master Plan,* 2010 as cited in *the 10th Malaysia Plan, 2010-2015*, Economic Planning Unit, Prime Minister Department

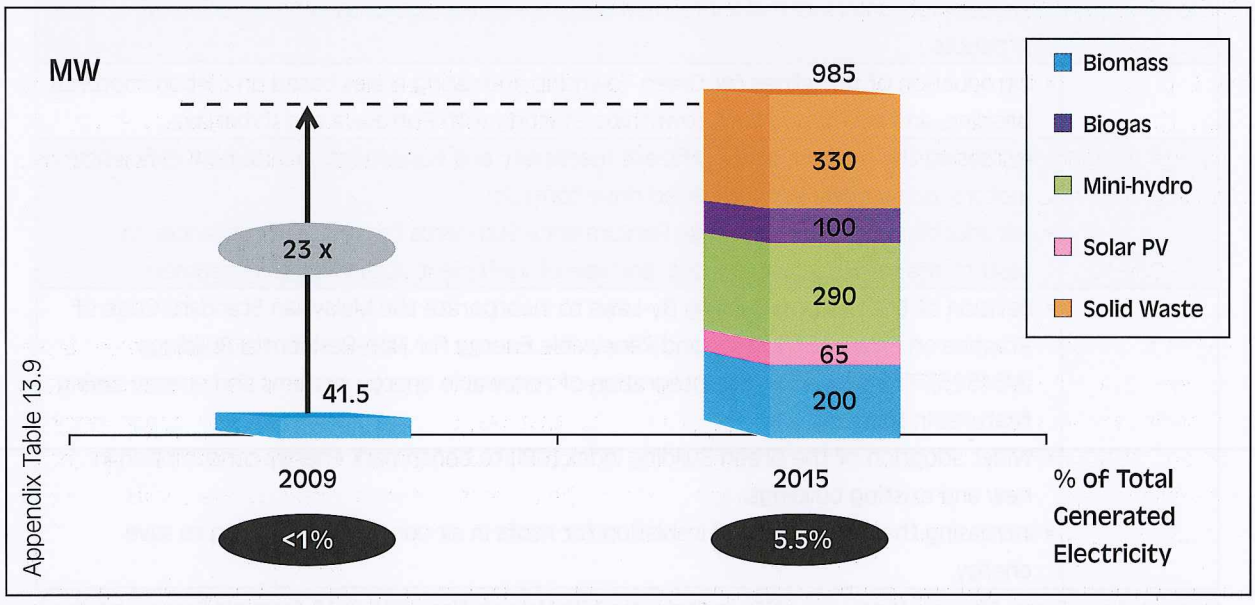
13.3 RENEWABLE ENERGY

Depleting energy sources, coupled with the rapidly increasing energy demand by the country, has made Malaysia among the countries which are at the fore front of renewable energy exploration. It is encouraging to note that Malaysia is blessed with abundant renewable energy sources such as biomass (empty fruit bunch, wood chips, rice husk, and municipal solid waste), landfill gas, biogas, mini hydro, wind, and solar. Continuous R&D activities are undertaken to increase the contribution from the renewable energy sources, and numerous incentives are given to support further exploration of these sources.

In this regard, the Renewable Energy as the Fifth Fuel Policy was launched in 2001, aimed at intensifying the development of renewable energy, particularly biomass, as the 'fifth fuel' resource. Several fiscal incentives were given by the Government, including investment tax allowances. Special incentives for companies venturing into renewable energy projects under the Small Renewable Energy Programme (SREP) were also given. The SREP encourages the connection of small renewable power generation plants to the national grid. In particular, the programme allows renewable energy projects with up to 10 MW of capacity to sell their electricity output to TNB, under 21-year license agreements. In 2009, a total of 10 applications were received, of which seven involved biomass projects, particularly palm oil waste. These projects involved the installation of 92 MW of grid-connected capacity.

Renewable energy received substantial focus in the 10MP. It is targeted that renewable energy would contribute about 5.5% of Malaysia's total electricity supply by 2015 **(Figure 13.9)**. Efforts are being aimed at developing both the non-renewable and renewable energy resources, with focus given to extending the life of domestic non-renewable energy resources and diversifying to include other forms of energy sources. In this regard, the government is committed to creating a stronger incentive system for investments in renewable energy by implementing specific measures, such as introducing a Feed-in Tariff (FIT) of 1.0% to be incorporated into consumers' electricity tariff; and establishing a Renewable Energy Fund from the FIT. It is estimated that these efforts would contribute towards an annual carbon dioxide (CO2) avoidance of 3.2 million tonnes.

Figure 13.9: Renewable Energy in Malaysia, 2009 & 2015



Source: Ministry of Energy, Green Technology and Water as cited in the 10th Malaysia Plan

13.4 GREEN TECHNOLOGY INITIATIVES

Caring for the environment has become one of the major objectives in any major energy project in the country. Mandatory environmental impact assessments are required on energy development projects so as to minimise the negative impact of energy production, transportation, conversion, utilisation, and consumption on the environment. Among others, the impact assessment includes environmental quality standards such as air quality and emission standards.

In an effort to address the issue of climate change, Malaysia adopted the National Climate Change Policy and the National Green Technology Policy in 2009, which are both aimed at implementing strategies to move towards a low-carbon economy and achieve sustainable development. The National Green Technology Policy 2009 was formulated to achieve several objectives such as (i) reducing energy usage and at the same time increasing economic growth; (ii) facilitating the growth of the green technology industry and enhancing its contribution to the national economy; (iii) increasing national capability and capacity for innovation in green technology development and enhancing Malaysia's competitiveness in green technology in the global arena; (iv) ensuring sustainable development and conserving the environment for future generations; and (v) enhancing public education and awareness on green technology and encouraging its widespread use. A special framework was introduced to ensure the effective implementation of the policy, which includes critical factors, namely awareness, faculty, finance, infrastructure, research, and marketing (AFFIRM). This included the establishment of a Green Technology Financing Scheme, amounting to RM 1.5 billion, to promote green technology in the country, where soft loans are provided to companies that supply or use green technology. In this scheme, the Government provides an interest rate subsidy of 2.0% of the loans procured and guarantees 60.0% of the loan amount, with the remaining 40.0% guaranteed by banking institutions. This financial support is expected to spur the development of green technology, especially market creation and the penetration of green technology in the economy.

Specific aspects of the green technology have already been adopted in the government administrative center township, namely Putrajaya and Cyberjaya, to serve as a showcase for the development of other townships in the country. Among others, Green Township has specific following guidelines including meeting the requirements of 10.0% savings in energy and water in all government buildings, developing the Green Rating System, and incorporating a Carbon Footprint Baseline system.

In addition to the numerous initiatives above, two other major initiatives will be further intensified in the 10MP to ensure the sustainable use of forests and their natural resources. These are the "Central Forest Spine" project, covering 4.3 million hectares in Peninsular Malaysia, and the "Heart of Borneo" project, covering 6.0 million hectares in Sabah and Sarawak.

13.5 CONCLUSION

The energy sector in Malaysia is facing several challenges that require substantial R&D in the efforts to meet these challenges. Amid the increasing energy demand and the depleting domestic resources, there is an impending need to expedite the exploration for renewable energy sources so that the country can reduce the dependency on traditional energy sources. In addition, the striving towards a higher level of economic development should not be at the expense of the environment and the quality of life of the citizens. As such, ensuring the quality of life of the citizens should also be included in the economic objectives of the country.

Realising these challenges, both the economic and environmental objectives are being well-attended to by the major development plans in the country, including the National Green Technology Policy 2009 and the 10MP 2011-2015, which specify the commitment to build an environment that enhances the quality of life of the citizens. Additionally, green technology has been identified as the driver to accelerate the economy and to promote the sustainable development of the country. All these reflect the continuous efforts to balance growth and quality of life, which are the essence of sustainable economic growth.

CHAPTER 14
- CONCLUSION & THE WAY FORWARD

CHAPTER 14

CONCLUSION & THE WAY FORWARD

14.1 INTRODUCTION

The preceding chapters in this report have provided an account of the state of the various S&T indicators in Malaysia. As with previous reports, this 2010 report presents only a partial overview of trends in the various STIs in the country. However, despite these limitations, the information provided in this report is important in order that we may chart the future directions of R&D activities and S&T development in Malaysia. This chapter presents a summary of the overall findings from each chapter in this report, followed by suggestions on "The way forward".

14.2 MALAYSIA'S S&T PERFORMANCE

In this section, Malaysia's performance on S&T is compared to that of the previous years using the scorecard as shown in **Table 14.1**. The scorecard is clustered into five broad categories, with 17 indicators. However, it has to be stressed that the indicators in the scorecard are used only to describe the general trends of our performance on S&T and are not to be considered as infallible indices of where we stand with regard to S&T.

In general, Malaysia has charted a notable improvement in several areas. For instance, in terms of knowledge infrastructure and diffusion, there has been a positive trend. From 137 computers in 2002, there were 192 computers in 2004, 250 in 2006, and 302 in 2008. In terms of internet users per 100 population, the ratio increased from 31.9 in 2002 to 62.8 in 2008, while cellular phone subscriptions per 100 inhabitants increased from 36.9 in 2002 to 98 in 2008.

We have also made a notable improvement in terms of the outputs and outcomes of R&D and innovation. The total number of publications in SCOPUS-Indexed journals increased from 938 in 2002 to 5,985 in 2008. In terms of the number of patents filed, the number increased from 322 in 2002 to 864 in 2004, while in terms of the number of patents granted, it increased from 32 in 2002 to 198 in 2008.

In terms of human resource for S&T, we have made a significant improvement in R&D personnel headcount, from 24,937 in 2002 to 29,945 in 2008; researchers per 10,000 labour force, from 18.0 in 2002 to 22.7 in 2008; and FTE per researcher, from 0.4 in 2002 to 0.5 in 2008. The proportion of women researchers to the total number of researchers have also improved, from 33.7 in 2002 to 41.6 in 2008, as has the science and engineering enrolment as a percentage of total first degree enrolment and as a percentage of total postgraduate enrolment, at 42.2% and 43.7%, respectively.

With regard to perceived interest in S&T, the Malaysian public, throughout the years, have reported that they are moderately interested, while, in terms of knowledge of S&T, the majority perceived themselves as having weak knowledge. Finally, despite the increase in the Index of Scientific Reservation, which suggests that they have more reservations about S&T, the increase in the Index of Scientific Promise suggests that Malaysians are also optimistic about the promise of S&T.

The areas in which there has been a noticeable decline are in R&D investments and expenditure, where the industry R&D expenditure as a percentage of GERD dropped from 85.0% in 2006 to 27.1% in 2008. There has also been a sharp decline in overall R&D intensity, from 0.69% in 2002, to 0.64% in 2006, to 0.24% in 2008. However, this is due to the poor response rate obtained in the NSRD 2008, which may not, in fact, reflect the true state of R&D expenditure in Malaysia.

Table 14.1: Performance Scorecard 2010

Category	Indicator	Year 2008	Year 2006	Year 2004	Year 2002	Trend
R&D Investments and Expenditure	Overall R&D Intensity (%)	0.24	0.64	0.63	0.69	-ve
	Industry R&D expenditure as % of GERD	27.1	85.0	71.5	65.3	-ve
Human Resources	Total R&D Personnel (Headcount)	29,945	24,588	30,983	24,937	+ve
	Researchers per 10,000 labour force	22.7	17.9	21.3	18.0	+ve
	Total FTE per researcher	0.50	0.51	0.55	0.40	-ve
	Science and engineering enrolment as % of total first degree enrolment	42.2	32.6	48.2	51.8	+ve when compared to 2006
	Science and engineering enrolment as % of total post graduate enrolment	43.7	30.6	40.6	44.2	+ve
	Women researchers as proportion of total researchers (%)	41.6	37.7	35.8	33.7	+ve
Outputs and outcomes	Total number of publications in SCOPUS-indexed journals	5,985	4,081	1,179	938	+ve
	No. of patents applied	864	531	522	322	+ve
	No. of patents granted	198	187	24	32	+ve
Knowledge Infrastructure and Diffusion	No. of computers per 1,000 people	302	250	192	137	+ve
	Internet users per 100 population	62.8	38.9	38.2	31.9	+ve
	Cellular phone subscriptions per 100 inhabitants	98	72.3	56.5	36.9	+ve
S&T Knowledge, Understanding and Awareness	Mean score of perceived interest in S&T	2.40	-	2.40	2.41	constant
	Mean Score of perceived knowledge in S&T	2.05	-	2.22	2.32	-ve
	Attitude towards S&T Index of Scientific Promise Index of Scientific Reservation	61.5 77.9 52.7	-	63.7; 71.9; 47	62.3; -	-ve +ve -ve

14.3 THE WAY FORWARD

Based on the trends observed in the STIs over the last few years, we put forward the following suggestions to improve the state of S&T in the country as the country enters into a new decade:

Education in S&T

- More efforts need to be undertaken to attract students to enroll in S&T courses and also to pursue postgraduate degrees in S&T. There is also a need for private institutions to increase their postgraduate enrolment in S&T so that more R&D and innovation activities, particularly in the NKEAs, can be conducted.

Public Sector Support for S&T

- With regard to public sector support for R&D, since the demand for these grants has, most of the time, exceeded the supply, allocations for the various funds need to be increased in order to allow for more companies as well as public universities and research institutes to benefit in developing new technologies and in promoting their research outputs.

- In order for Malaysia to avoid being trapped into becoming mainly a 'technology adopter' rather than a 'technology creator', additional funds, schemes, and incentives need to be established to encourage and accelerate the development of indigenous technologies for the country's long-term international competitiveness.

Human Resource and R&D activities in S&T

- The low response rate for the NSRD 2008 has resulted in an under-reporting of the actual level and value of R&D activities for the year 2008. The response rate for the NSRD needs to be improved significantly in the future so that policies on R&D can be based on more accurate information.

- Efforts should also be made to create a data bank of R&D conducting companies.

Intellectual Property Rights

- Since local ownership of intellectual property rights is still low, the government needs to dedicate funds to further improve local innovative activities towards producing high technology products and processes that can later be registered for intellectual property rights. There is also a need to evaluate the delivery system of the relevant government machinery in order to resolve problems such as unnecessary delays in processing the applications for intellectual property rights.

- Although there has been a notable increase in the patenting activities by local universities and research institutes, the commercialisation of these technologies is still not very satisfactory. In addition to existing support programmes, new measures need to be formulated and effectively implemented to improve the commercialisation of invented technologies.

- With regard to the SMEs' patenting activities, an appropriate legal framework and the provision of physical infrastructure is important to promote technological upgrading of the SMEs. It is also important to nurture trust and foster the spirit of collaboration among the government, IHLs and the SMEs, so as to avoid any mismatch between the government initiatives, industry needs and the research focus of IHLs and RIs.

Biotechnology

- Malaysia has a great deal of potential in biotechnology due to the abundance of its natural resources. Since the biotechnology industry is now moving to Phase II of the National Biotechnology Policy (NBP), support needs to be provided for R&D commercialisation in RIs and IHLs, particularly in their focus areas of agricultural and industrial biotechnology. More supportive laws and public policy need to be implemented that would facilitate technology transfer and transform universities into a source for commercialisable innovation.

Trade in Technology

- With regard to trade in technology, the high and medium-high technology manufacturing industries' production and exports are highly concentrated in a narrow range of products. Therefore, policies for diversification of the industry would be necessary to reduce the negative impact on the industry in the case of external shocks.

- The high and medium-high technology industry is already well established, however further efforts need to be undertaken to reduce dependency on imported inputs and technology. The sector also needs to move up the technological ladder fast to catch up with competitors in the region, and has to leap from an assembly-based production to a technology and knowledge intensive manufacturing process.

Publications and Citations

- In the area of publications and citations, the rapid increase in S&T article output needs to be accompanied with the increase in articles published in top journals. An improvement in the KPI requirements with regard to publication in high impact journals and the provision of the appropriate incentives may increase the share of publication in the top journals. A similar measure can be undertaken to increase the number of citations.

Public Awareness of S&T

- In order to improve public awareness on S&T, it is essential that the concept of scientific literacy be clearly defined as it will determine the direction that the country will take in terms of the national science curriculum for schools as well as the intervention strategies for S&T. A clear conception of scientific literacy would also allow us to develop our own items to assess awareness and understanding of S&T such that they take the local context and conditions into account. The issue of scientific literacy should be seriously discussed by academics, scientists, and all relevant parties.

- The focus of science instruction should be on enabling students to appreciate the value of science and so that they would see the relevance of science to their everyday lives. It is this appreciation of science that will spur students to seek knowledge of science and to be creative in their approach to problems. Science teaching should also focus on scientific thinking and problem solving. For too long, we have focused merely on the content of science, and in the accumulation of facts about science, which does not lead to analytical thinking or creative problem solving.

- Given the fact that the public consists of diverse groups of individuals, we need to use different approaches in delivering knowledge of science and in implementing strategies and programs, or they risk being considered uninteresting or even irrelevant. Our local media such as newspapers, radio, and TV can play a very big role in developing the public's awareness of and interest in S&T. These programs should not only be geared toward the general public, but also toward specific segments of our population, such as women, children, and the rural folk.

The Energy Sector

- A major challenge in the energy sector in Malaysia is to be able to meet the energy supply-demand mismatch as energy demand grew at a higher rate of 28.0% compared to energy supply at 25.7% over the 2003-2007 period. Hence, additional measures have to be undertaken to step up the R&D activities in exploring renewable energy sources such as biomass (empty fruit bunch, wood chips, rice husk, and municipal solid waste), landfill gas, biogas, mini-hydro, wind, and solar. This is pertinent as it is targeted that renewable energy would contribute about 5.5% of Malaysia's total electricity supply by 2015.

- In the energy sector, to address the issue of increasing demand but declining supply from the traditional domestic energy sources, efforts need to be intensified to promote efficient energy usage in the country, and diversify the domestic energy sources through the exploration for alternative sources such as from the renewable energy sources.

14.4 CONCLUSION

Malaysia continues to undertake measures to enhance its national capacity in R&D and its national capability in S&T to drive the economy towards higher value added activities. This is evident from the increase in its allocation for non-physical infrastructure from 21.8% in the 9MP to 40.0% in the 10MP, to be utilised partly for R&D activities. In the Budget Speech presented on 15 October 2010, an amount of RM 411.0 million has been allocated for research, development and commercialisation (R&D&C) activities for 2011. In addition, a Special Innovation Unit (UNIK) has also been established under the Prime Minister's Department that serves as a one-stop centre to set the direction and drive the National Innovation System and innovation policies and strategies. For 2011, an amount of RM 71.0 million has been allocated for the Special Innovation Unit for this purpose. Although the incentives given for R&D by the government has been substantial, the private sector needs to play a bigger role in financing R&D activities in Malaysia. With the strong public sector's support and an active private sector's participation in R&D, Malaysia is set on the right track to move forward towards becoming a high-income nation by 2020.

- LIST OF ACRONYMS AND ABBREVIATIONS

LIST OF ACRONYMS AND ABBREVIATIONS

10MP	: 10th Malaysia Plan
ASEAN	: Association of Southeast Asian Nations
CRDF	: Commercialization of Research and Development Fund
DAGS	: Demonstrator Application Grant Scheme
DEL	: Direct Exchange Lines
FTE	: Full Time Equivalent
GRI	: Government Research Institute
IGS	: Industrial Research and Development Grant Scheme
IHL	: Institutions of Higher Learning
IRPA	: Intensification of Research in Priority Areas
MCMC	: Malaysian Communications and Multimedia Commission
MDeC	: Multimedia Development Corporation
MIDA	: Malaysian Industrial Development Authority
MSC	: Multimedia Super Corridor
MTDC	: Malaysian Technology Development Corporation
NEM	: New Economic Model
NSRD	: National Survey of Research and Development
OECD	: Organisation for Economic Co-operation and Development
R&D	: Research and Development
RSE	: Researchers, Scientists and Engineers
SME Corp	: Small and Medium Industries Development Corporation
TAF	: Technical Acquisition Fund
WCY	: World Competitiveness Yearbook

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- APPENDIX I

Appendix

Agricultural and Biological Sciences	Earth and Planetary Sciences
Nature reviews Genetics	Annual Review of Astronomy and Astrophysics
Annual Review of Plant Biology	Annual Review of Earth and Planetary Sciences
Nature Reviews Neuroscience	Astrophysical Journal, Supplement Series
Current Biology	Paleobiology
Plant Cell	Visual Geosciences

Biochemistry, Genetics and Molecular Biology	Energy
Annual Review of Cell and Developmental Biology	Annual Review of Environment and Resources
Annual Review of Biochemistry	Progress in Energy and Combustion Science
Nature Genetics	Progress in Photovoltaics: Research and App
Cell	Journal of Power Sources
Cancer Cell	Fuel Cells

Medicine	Multidisciplinary
Ca-A Cancer Journal for Clinicians	Nature
Nature Genetics	Science
Cancer Cell	PNAS of the United States of America
Nature Medicine	Journal of the Royal Society Interface
Nature Reviews Neuroscience	Science Progress

Engineering	Decision Science
Nature biotechnology	Biostatistics
Nature Materials	Journal of Informetrics
Annual Review of Biomedical Engineering	Source Code for Biology and Medicine
Progress in Electromagnetics Research	Transportation Science
IEEE Journal of Solid-State Circuits	Journal of Classification

Physics	Veterinary
Reviews of Modern Physics	Veterinary Research
Nature nanotechnology	Medical Mycology
Nature Physics	Brain Research Bulletin
Physics Report	Journal of Medical Primatology
Reports on Progress in Physics	Fish and Shellfish Immunology

Chemistry	Neuroscience
Chemical Reviews	Annual Review of Neuroscience
Annual Review of Physical Chemistry	Neuron
Accounts of Chemical Research	Nature Neuroscience
Nano Letters	Nature Reviews Neuroscience
Chemical Society Reviews	Nature reviews Microbiology

Material Science	Health Professions
Nature nanotechnology	Journal of Nuclear Medicine
Advances in Physics	Radiology
Nano Letters	NMR in Biomedicine
Progress in Materials Science	Health Services Research
Progress in Polymer Science (Oxford)	Journal of Cardiovascular Magnetic Resonance

Computer Science	Dentistry
Bioinformatics	Periodontology 2000
PLoS Computational Biology	Journal of Dental Research
Briefings in bioinformatics	Journal of Clinical Periodontology
BMC bioinformatics [electronic resource]	Clinical Oral Implants Research
Digest of Technical Papers - IEEE International Solid-State Circuits Conference	Journal of Oral Pathology and Medicine

Environmental Science	Nursing
Annual Review of Ecology, Evolution, and Systematics	Progress in Lipid Research
	Journal of the American College of
Ecology Letters	Cardiology
PLoS Computational Biology	American Journal of Medicine
Ecological Monographs	Obesity
Mutation Research - Reviews in Mutation Research	Clin Med Res

Chemical Engineering	Pharmacology
	Annual Review of Pharmacology and
Annual Review of Biophysics	Toxicology
Trends in Biotechnology	Pharmacological Reviews
Catalysis Reviews - Science and Engineering	Nature Reviews Drug Discovery
Metabolic Engineering	DNA Repair
Yeast	Trends in Pharmacological Sciences

Immunology	Mathematics
Annual Review of Immunology	PLoS Computational Biology
Nature Immunology	Biostatistics
Immunity	BMC Systems Biology
Journal of Experimental Medicine	Quantum Information and Computation
Nature Reviews Immunology	Immunome Research

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