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MALAYSIAN SCIENCE & TECHNOLOGY INDICATORS

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IMPORTANCE OF STI

As Malaysia moves towards Knowledge based economy, accessibility of reliable information on science, technology and innovation is critical. This invaluable information will be able to assist the public and private sector to develop informed business decisions. The government of Malaysia has responded positively with a threefold research funding in the 9th Malaysia Plan (2006 – 2010) as compared to the 8th Malaysia Plan (2000 – 2005).

The biennial Science and Technology Indicators (STI) report 2008, is a continuing effort by the Malaysian Science and Technology Information Centre (MASTIC). This STI report is the eighth since its first issue in 1992. It presents the key performance indicators and the trend of science, technology and innovations in the Malaysian context.

Primarily, the report is based on survey data and studies commissioned and published by MASTIC. This includes:

i. the National Research & Development Survey 2008,
ii. Public's Awareness of Science and Technology in Malaysia 2008 and
iii. Compilation of secondary data from relevant government agencies and organizations.

The Malaysian Science & Technology Indicators 2008 Report provides details of the national performance and trends in S&T including education, human resource, public support, research and development, innovation, intellectual property, information communication and technology (ICT), trade in technology, publications and citations (bibliometric) and public awareness, knowledge and attitude towards S&T. The report provides international comparisons of selected S&T indicators in order to gauge the level of Malaysian competitiveness in S&T at international level. For the 2008 S&T Indicators Report, a chapter on biotechnology is also included.

MASTIC wishes to record its gratitude to all individuals and organizations for their assistance and contributions towards the successful completion of the 8th Malaysian Science and Technology Indicators 2008 Report.

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- Malaysia Productivity Corporation (MPC)
- Malaysian Communications and Multimedia Commission (MCMC)
- Malaysian Examinations Council (MEC)
- Malaysian Industrial Development Authority (MIDA)
- Malaysian Institute of Microelectronic Systems (MIMOS)
- Malaysian Technology Development Corporation (MTDC)
- Ministry of Education (MOE)
- Ministry of Higher Education (MOHE)
- Ministry of Human Resource (MOHR)
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8 MP	8th Malaysia Plan (2001-2005)
9 MP	9th Malaysia Plan (2006-2010)
AIMST	The Asian Institute of Medicine, Science and Technology University
ANM	Agensi Nuklear Malaysia
ASEAN	Association of South East Asian Nation
BIOTEK	Bioteknologi Kebangsaan
BSc	Bachelor of Science
CAGR	Compound Annual Growth Rate
CRDF	Commercialization of Research and Development Fund
DAGS	Demonstrator Application Grant Scheme
DEL	Direct Exchange Line
DOS	Department of Statistics
E&E	Electrical & Electronic
FOR	Field of Research
FRGS	Fundamental Research Grant Scheme
FRIM	Forest Research Institute Malaysia
FTE	Full Time Equivalent
GBCD	Global Biotech Company Directory
GDP	Gross Domestic Product
GERD	Gross Expenditure of Research and Development
GPRS	General Packet Radio Service
GRIs	Government Research Institutes
I'TEX	Invention Innovation & Technology Exhibition
ICT	Information and Communication Technology
IDC	International Data Corporation
IGS	Industry Grant Scheme
IHLs	Institute of Higher Learning
IMD	International Institute for Management Development
IMR	Institute for Medical Research
IMU	International Medical University
IP	Intellectual Property
IPC	International Patent Classification
IRPA	Intensification of Research in Priority Areas
ITAF	Industry Technical Assistance Fund
JPSB	Jabatan Perhutanan Sabah
JTSB	Jabatan Pertanian Sabah
JTSK	Jabatan Pertanian Sarawak
KUSTEM	Kolej Universiti Sains Teknologi Malaysia
LHDN	Lembaga Hasil Dalam Negeri
MARDI	Malaysian Agricultural Research and Development Institute

List of Abbreviations

MASTIC	Malaysian Science and Technology Information Centre
MATRADE	Malaysia External Trade Development Corporation
MCMC	Malaysian Communications and Multimedia Commission
MDeC	Multimedia Development Corporation Sdn Bhd
MEC	Malaysian Examinations Council
MGS	Multimedia Super Corridor R&D Grant Scheme
MIDA	Malaysian Industrial Development Authority
MIMOS	Malaysian Institute of Microelectronic Systems
MINDS	Malaysian Invention & Design Society
MINT	Malaysian Institute for Nuclear Technology Research
MLSCF	Malaysian Life Sciences Capital Fund
MMS	Multimedia Messaging Service
MMU	Malaysia Multimedia University
MOE	Ministry of Education
MOHE	Ministry of Higher Education
MOSTI	Ministry of Science, Technology and Innovation
MPOB	Malaysian Palm Oil Board
MSC	Multimedia Super Corridor
MSc	Master of Science
MTDC	Malaysian Technology Development Corporation
MUST	Malaysia University of Science and Technology
MyIPO	Intellectual Property Corporation of Malaysia
NIC	National Innovation Council
OECD	Organization for Economic Co-operation and Development
PC	Personal Computer
PhD	Doctor of Philosophy
PIKOM	Persatuan Industri Komputer dan Multimedia
R&D	Research and Development
RDC	Research and Development Commercialization
RM	Ringgit Malaysia
RSM	Remote Sensing Malaysia
S&T	Science and Technology
SEO	Social Economic Objective
SIRIM	Standard and Industrial Research Institute of Malaysia
SMEs	Small and Medium Enterprises
SMI	Small and Medium Industries
SMIDEC	Small and Medium Industries Development Corporation
SMS	Short Message Service
SPM	Sijil Pelajaran Malaysia
STI	Science, Technology and Innovation

STPM	Sijil Tinggi Pelajaran Malaysia
TAF	Technology Acquisition Fund
TAF-W	Technology Acquisition Fund for Women
TPM	Technology Park Malaysia
UiAM	Universiti Islam Antarabangsa Malaysia
UiTM	Universiti Teknologi MARA
UKM	Universiti Kebangsaan Malaysia
UM	Universiti Malaya
UMP	Universiti Malaysia Pahang
UMS	Universiti Malaysia Sabah
UMT	Universiti Malaysia Terengganu
UniKL	Universiti Kuala Lumpur
UniMAP	Universiti Malaysia Perlis
UNIMAS	Universiti Malaysia Sarawak
UNISEL	Universiti Industri Selangor
UNITAR	Universiti Tun Abdul Razak
UNITEN	Universiti Tenaga Nasional
UPM	Universiti Putra Malaysia
USM	Universiti Sains Malaysia
USPTO	United States Patent and Trade Mark Office
UTAR	Universiti Tunku Abdul Rahman
UTeM	Universiti Teknikal Malaysia Melaka
UTHM	Universiti Tun Hussein Onn Malaysia
UTM	Universiti Teknologi Malaysia
UTP	Universiti Teknologi PETRONAS
UUM	Universiti Utara Malaysia
WIPO	World Intellectual Property Organization

Glossary	Explanation
3G	3G is the third generation of telecommunication hardware standards and general technology for mobile networking.
Applied Research	Research done with the intention of applying the result of the findings to solve specific problems currently being experienced.
Basic Research	Research done chiefly to enhance the understanding of certain problem that occur.
Bibliometric	A set of methods used to study or measure texts and information. Often used in the field of library and information science.
Biennial Reports	A report that produced every two years.
Big Bang Theory	The idea that the universe has expanded from a primordial hot and dense initial condition at some finite time in the past and continues to expand to this day.
Broadband	Telecommunication in which a wide band of frequencies is available to transmit information.
Citation	To mention something by quoting from book to support an argument.
Copyright	Type of intellectual property which gives the creator of an original work exclusive rights time period in relation to that work.
Darwin's Theory of Evolution	Darwin proposes in his book, Descent of Men, that man had descended from non-human ancestors.
Dial-up	Relating to a network connection, as to the Internet, which requires that a telephone number be dialed.
Direct Exchange Line (DEL)	Often referred to as a private line where people who have your contact number can reach you directly.
E-Commerce	Buying and selling of products or services over electronic systems such as the Internet and other computer networks.
Enrolment	The process of initiating attendance to a school.
Experimental Research	An attempt by the researcher to maintain control over all factors that may affect the result of an experiment.
External Fund	Funds brought in from outside the company, such as through a bond or equity offering.
Full Time Equivalent (FTE)	Way to measure a worker's involvement in a project, or a student's enrollment at an educational institution.
Headcount	Number of people in a particular group.
Intellectual Properties	Exclusive rights over creations of the mind, both artistic and commercial, such as books, photographs, and software.

Importance of STI

As Malaysia moves towards Knowledge based economy, accessibility of reliable information on science, technology and innovation is critical. This invaluable information will be able to assist the public and private sector to develop a better informed policies and business decisions. It has become increasingly important during tough economic periods to have an integrated approach to STI information management armed with knowledge and tools to enhance the report, thus leading to more competitive and adept Malaysian organizations. The government of Malaysia has responded positively with a threefold research funding in the 9th Malaysia Plan (2006 – 2010) as compared to the 8th Malaysia Plan (2000 – 2005). In the 9MP, 1.45% of GDP was allocated for research fund compared to only 0.5% in the 8MP.

The biennial Science and Technology Indicators (STI) Report 2008, is a continuing effort by the Malaysian Science and Technology Information Centre (MASTIC). This STI report is the eighth since its first issue in 1992. It presents the key performance indicators and the trend of science, technology and innovations in the Malaysian context.

Primarily, the report is based on survey data and studies commissioned and published by MASTIC. This includes:

i The National Research & Development Survey 2008,
ii Public Awareness of Science and Technology in Malaysia 2008, and
iii Compilation of secondary information from relevant government ministries, agencies and private organizations.

The Report

This 13-chapters report details the key performance and trends in science, technology and innovations. This is the eighth S & T Indicators biennial report since its inaugural in 1992.

This report covers the following 11 areas for science and technology namely:

- Education in S&T
- Human Resource for S&T
- Public Support for S&T
- Research and Development for S&T
- Innovation in S&T
- Intellectual Property of Malaysia
- Information and Communication Technology in Malaysia
- Biotechnology in Malaysia
- Trade in Technology
- Publications and Citations (Bibliometric)
- Public Awareness, Knowledge and Attitudes Towards S&T

As the report focused on 11 different areas, both the public and private sectors can capitalize on these valuable information, when developing strategies. This report would sufficiently provide a good source of S & T indicators, though it may not be an exhaustive one.

HIGHLIGHTS OF THE SCIENCE & TECHNOLOGY INDICATORS REPORT 2008

Education in STI

i) Generally, the number of students registered in Science and Technology subjects at STPM (pre-university) level decreased by 17.4% in 2006 and slightly increased by 3.3% in 2007. In terms of study subjects, during the period under review (2005-2007), Mathematics T was the most preferred subject.

ii) At the first degree level, the total number of students' enrolment in public educational institutions increased steadily by 4.8% in 2006, and 13.7% in 2007, while the enrolment in private educational institutions increased by 22.4% in 2006. As of June 2007, the number of students enrolled increased by 13.2%. In terms of gender composition, the number of female undergraduate students in public educational institutions were almost twice higher than the number of males.

iii) Students graduated in first degree level in public educational institutions increased by nearly 10% in 2006 and 6.2% in 2007. In the private educational institutions, the number of students graduated increased by 33.9% in 2006. For the first-half of 2007, the number of students graduated in first degree level in private educational institutions totaled 11,762 students. By gender composition, there were more female graduates as compared to their male counterparts with a ratio of about 2:1.

iv) The toltal number of students' enrolment in master's degree courses in public educational institutions decreased by 13.6% in 2006. The number increased by 11.5% in 2007. Overall, female students dominated in the masters' degree level in public educational institutions. Nevertheless, the percentage composition of male students in master's degree level in public educational institutions as compared to female students has increased marginally from 45.9% in 2005 to 46.7% in 2006 and 47.1% in 2007.

v) In the private educational institutions, the number of master's degree students enrolment increased by 33.6% in 2006. For the first-half of 2007, the number decreased by 6.1%. Students graduated in master's degree courses in public institutions increased by 12.3% in 2006 and increased by 11.5% in 2007. However, master's degree students who graduated from private educational institutions increased by 47.4% in 2006. As of June 2007, there were 418 students graduated in master's degree. The distribution of female students as opposed to male students at master's degree level did not show obvious gender gap.

vi) The number of students' enrolment in PhD level in public educational institutions decreased by 24.7% in 2006 but increased by 42.2% in 2007. While, in private educational institutions the number of students' enrolment in PhD level increased by 43.8% in 2006 but decreased by 5% in 2007. It was observed that at PhD level in public educational institutions, male students outnumbered their female counterparts with a ratio of about 3:2. The number of students' graduated in PhD level in public educational institutions increased steadily every year from 2006 to 2007. Similarly, the number of students graduated in PhD level in private educational institutions also increased steadily from 2005 to 2007.

Executive Summary

Human Resource for Science and Technology

i) Overall, the total number of national headcount and FTE in research and development decreased in 2006. R&D researchers are dominated by mostly male researchers, with PhD degrees and working within the IHL environments. Male researchers made up 72.8% of the total R&D researchers in Private Institutions, 59.8% in IHLs and 58.0% in GRIs. The women participation in R&D decreased in 2006 but the proportion of the women personnel increased by 9.1% from 2004. The proportion of women researchers involvement increased fairly throughout the year, indicating the strength and significant of women in R&D. This increasing pattern in the proportion of women involvement may continue at a similar pace for the next two years.

ii) Engineering sciences recorded the highest number of researchers among the top six fields of research (FOR).

iii) Among the three research institutions, IHLs recorded extremely high number of researchers in natural sciences, technology & engineering (83.7%) in 2006 compared to GRIs (12.2%) and private institutions (0.1%).

iv) The number of applications approved under returnees programme totaled 681 in 2006. Most of the Malaysian-born scientists and engineers (MBSE) were engaged in the field of 'medical & health', 'Information Technology (IT)' and 'accounting & financing'. The highest number of MBSE was found in the United Kingdom, followed by the United States and Singapore.

Public Support for Science and Technology

i) During the period 2005-2007, a total of 27 projects were granted under Technology Acquisitions Fund (TAF) involving approximately RM35.6 million being disbursed to the projects. Most of the projects were related to advanced material (6 projects), electronics and electrical (6 projects), and biotechnology (5 projects).

ii) A total of 75 applications were made for the Commercialization of Research and Development Fund (CRDF) during the period 2005-2007. Most of the applications were related to biotechnology (16 applications), industrial products (16 applications) and electrical & electronics (10 applications). During the same period, a total of 52 projects were granted with CRDF. The total amount granted was approximately RM95.54 million. Most of the projects were related to biotechnology (10 projects), industrial products (9 projects) and electronics and electrical (8 projects).

iii) There were a total of 8 Demonstrator Applications Grant Scheme (DAGS) applications received in 2007. Of the total applications, 5 were Social Digital Inclusion projects while the remaining 3 were E-Public Services projects. The total amount applied for the grant was RM23.4 million. All 8 applications were granted approval with a total amount of RM17.0 million.

iv) Total number of applications approved for Multimedia Super Corridor R & D Grant Scheme (MGS) increased from 2 projects in 2005 to 9 projects in 2007 with total grant of RM9.2 million, below the amount approved in 2006 i.e. RM17.6 million (4 projects).

v) Under the Matching Grant Schemes, for the period of 2005 – 2007, a total of 402 projects were approved under the Matching Grant for Product and Process Improvement with a total approved amount of RM60.18 million, while RM32.5 million were granted for 821 projects under the Matching Grant for Certification and Quality Management System.

vi) During 2007 and 2008, MLSCF (Malaysian Life Sciences Capital Fund) received an increasing number of projects. During the period, healthcare biotechnology recorded the highest number of projects applications (90 projects), followed by industrial technology (33 projects) and agricultural biotechnology (14 projects).

vii) A total of RM125.82 million was disbursed for 60 approved projects under biotechnology R&D Grant Scheme in 2006 and 2007.

viii) Under the ScienceFund scheme, 978 projects were approved in 2007, a drop of 18.3% as compared to 2006. Total amount approved for the ScienceFund was RM188.47 million, an increase of 2.08% over the previous year. Sectors which received substantial amount of grant under the scheme were industry (RM63.44 million), biotechnology (RM43.50 million) and ICT (RM32.63 million).

ix) The number of projects applied for TechnoFund was dramatically decreased by 83.8% in 2007. All sectors recorded decreases in the number of applications. Similar scenario can also be observed in the number of projects approved in 2007. The applications approved in 2007 dropped drastically by 87.5% in 2007.

Research and Development for Science and Technology

i) The National GERD increased consistently from 1996 to 2006. The ratio of the GERD per GDP decreased slightly in 2004 at 0.06%. This indicates the growth in GERD does not necessarily result in the increase in the ratio of GERD over GDP.

ii) Overall, R&D expenditure continued to increase in 2006. Operating expenditure contributed the most with 73% of the total R&D expenditure.

iii) Expenditure for applied research increased slightly, while experimental development expenditure increased almost one fold from RM810.9 million in 2004 to RM1,590.1 million in 2006.

iv) The upward and downward trends in expenditure can be observed for various reporting fields within public sector (GRIs and IHLs). ICT has been the field which utilizes the most of the R&D expenses throughout 1996 to 2002.However, the expenses have decreased in 2004 to 2006. Such a decrease seems to be compensated with slight increase in expenditures in various other fields in 2004.

v) The trend in R&D expenditure for the top seven field of research in the private sectors shows quite the opposite situation. Significant increases can be found from 2004-2006 in various R&D fields. The most significant in expenditure was engineering sciences, followed by applied sciences and agriculture sciences. The increase in R&D expenditure within the private sector may be explained by the government focus of research direction to applied ICT and manufacturing sector during the reporting period of 2004-2006.

vi) Expenditure in public sectors by social economic objectives (SEO) saw significant increase in R&D expenditure for natural sciences, technology & engineering. Similarly, the R&D expenditure in the private sectors by SEO has increased significantly over the years with the contribution of expenses mainly made through the manufacturing sector. Other SEOs experienced decreasing or unimproved trend in the overall expenses.

vii) The bulk of R&D expenditures (97%) in GRIs was conducted locally, while IHLs outsourced about 69% to foreign researchers. Outsourcing activities in the private sector were heavily focused in Malaysia.

Innovation in Science and Technology

i) Based on 2002-2004 Innovation Report, the percentage share of innovating firms increased to 54% compared to the previous innovation studies 2000-2001 (35%) and 1997-1999 (21%). This trend is expected to remain the same with further increasing percentage in firms involving in innovation.

ii) The 2002-2004 innovations have been made focused on biotechnology products, computing, and machinery. It is expected that the trend in the following years to be made more on biotechnology, motor vehicles and machinery, and ICT. This is predicted based on the huge allocation of the government grants disbursed to the industries for these purposes.

iii) The reports in 2006 also indicated that factors which determine innovativeness in a firm, are size, age, geographical distribution, innovation types, turnover distribution, and ownership structure.

iv) Innovation was also recorded much higher in only few states in Malaysia such Selangor, Kuala Lumpur, Penang and Johor. Innovation seems to focus on only two types, of which were (1) product, process and project in progress and (2) product and process. Both types of innovation accounted for 89% of innovation type in 2002-2004. Based on the same survey period, innovating firms also tend to be having annual turnover of less than RM5 million (54%).

v) Market driven innovation model can be described as innovations driven by the need of the market which inspires the knowledge entrepreneurs, through their best knowledge in science and technology, to innovate and produce technological innovation that meet the market.

vi) In technology driven model, scientists are funded for R&D through various government grants in any area that has market potential. The technology-based innovation will be developed organically, and thus eventually commercializing their ideas or products for the global market.

vii) The trends in innovation have been observed to be different quite significantly from the period of 1997-1999 to the period of 2002-2004. These differences can be seen in the drivers of innovation, the objectives of innovation, and types of innovation.

Intellectual Property in Malaysia

i) From 2006 to 2008 there were 12,575 patent applications of which 16% were applications by Malaysian and the remaining 84% were applications by foreign innovators or organizations. There was a large increase of Malaysian applications (97.9%) from 1996-2000 to 2001-2005 (from 1,017 to 2,013 total applicants respectively).

ii) Total number of patents granted from 2006 to 2008 was 15,974, 70.0% higher than 2001-2005. Of the total, 4% were granted to Malaysians, while the remaining 96% were granted to non-Malaysians.

iii) Total number of trademark applications in 2008 increased marginally (0.5%) from the previous year. Total number of trademark granted was 27,847, an increase of 9.2% over the previous year.

iv) The number of industrial design applications decreased by 11.3% from 1,920 in 2007. Of the total, 630 applications were filed by Malaysian companies and 1,072 by foreign applicants. Similarly, the number of registered industrial design decreased by 11.3% from 1,673 in 2007 to 1,483 in 2008.

v) The United States of America holds the highest number of patents granted by the USPTO from 1977 to 2007 with 2,004,055 patents. This is followed by Japan with a total of 682,050 patents, the United Kingdom (95,917 patents), France (95,584 patents), Taiwan (79,019 patents) and Canada (75,202 patents). Malaysia has improved by owning 949 USPTO patents.

vi) Global comparisons indicates that Malaysian innovative works is insignificant based on the small number of patents applied and granted by USPTO.

Information and Communication Technology in Malaysia

i) Total number of employees in IT industry in Malaysia has grown about 43% percent from 254,208 in 2000 to 364,656 in 2005. Based on similar yearly growth rate of 7.5%, a total number of IT workers are predicted to increase to 497,071 by year 2010.

ii) Spectrum Research Collaboration Programme (SRCP) is funded and managed by the Malaysian Communications and Multimedia Commission (MCMC) in promoting research collaboration amongst institutions of higher learnings (IHLs). MCMC allocates and manages its own fund to selected institutions and currently RM 4 million has been allocated per annum for such purposes.

iii) According to a report by IDC, total PC market growth in terms of number and values has increased in year 2007 as compared to 2006. Few factors that contributed to an increasing pattern on overall sales are the public sector spending in developing Smart School and the bridging of digital divide (BDD).

iv) The IT services sector has spent about 40.1% in 2007 in project oriented services, 32% in support and training services and 27% in outsourcing. It is predicted that the percentage in project oriented services spending will drop slightly in 2008 to 2009 and back to similar level in 2012.

v) Malaysia has contributed quite a significant amount (6.4%) in exporting ICT goods to the world compared to other countries such as Singapore and Taiwan.

vi) Major importers of ICT goods were Taiwan, Germany, France, and Hong Kong, all of which share more than 10% of the import market share. Malaysia contributed about 10% of the market share in the import of ICT goods activities.

vii) Broadband is a newly introduced wireless technology to enable Internet access among wireless users. The introduction of broadband is made possible with the use of GPRS and 3G in data transfer.

viii) The overall statistical reports indicate the increase performance by the Malaysian government in sustaining ICT growth from the previous reporting years. Malaysia is also considered comparable to other well developed countries in the world in terms of ICT infrastructure and access.

Biotechnology

i) Bioequipment has the highest number of registered companies (25.9%) followed by manufacturing (19.6%), agriculture (17.9%), pharmaceutical (9.8%) and R&D Company (9.8%).

ii) According to BioNexus, healthcare industry dominates in the industrial distribution (43.1%), followed by agriculture (31.4%), industrial (21.6%) and bioinformatics (3.9%). Industrial category has contributed the most (RM371 million, 37.4%) in the amount of investment, despite the lower number of companies listed under this category.

iii) Out of 4,481 students graduated in the biotech related programmes, the highest number was found graduated in Food Science (28.6%), followed by Pharmacy/Pharmacology (681, 15.2%), Biotechology (605, 13.5%), Biomedic (582, 13.0%) and Plant Science (495, 11.05%).

iv) There were 505 jobs created in the area of biotechnology within the year 2007. Of the total, Molecular Biology has the highest number of jobs, followed by animal. Plant offers the lowest in terms of job availability, which account for only 20 people in total.

v) Natural Products had RM19.2 million grants approved among all other projects and the highest number of biotechnology projects is 12 in Animal projects. On the other hand, the lowest number of projects is Environment (2 projects) and the lowest grant amount is Biopharmacy (RM 3.2 million).

vi) A total amount of RM2,021.3 million (9MP) and RM577.4 million (8MP) have been allocated and used respectively in Malaysia for the purpose of advancing the biotechnology industry. Additional expenditure in the amount of RM100 million has been allocated for biotechnology acquisition programme during 9MP.

vii) In 2007, it was estimated that the biotechnology industry worldwide generated total revenue of US$84,782 million and offered employment to 204,930 people. Total number of biotechnology companies was 4,414.

Trade in Technology

i) Throughout 2001 to 2006, Malaysia's trade in technology recorded improvements for all accounts.

ii) In the manufactured goods for export, 64.3% of the manufactured goods dominated by high tech goods, while medium high-tech manufactured goods contributed only 1.8% of the share.

iii) Trade manufactured goods for imports increased by 8.5% in 2006. The strong performance was contributed by positive trade balance of high tech manufactured goods, while trade balance for medium high tech products continued to register negative balance in 2005 and 2006.

iv) Receipts in the royalty account have not shown any significant improvement during 2001–2008. Royalty payments for the trade in services abroad by Malaysian residents in the period 2003 to 2005 increased significantly but fell in 2006. In general, Malaysia is a royalty payer, selling less of its patented technology abroad. The balance of payments in the royalty accounts showed large deficits in the account throughout 2001–2008.

v) Total contracts and professional fee payments rose steadily over the period 2002 to 2004 but it dropped in 2005. Receipts collected rose gradually from 2001 to 2008 except for 2002 and 2005 when it fell slightly. Despite showing the positive growth in receipts, the overall balance of payments continued to show wide deficits in the account. The balance of payments fell sharply in 2003 with a drop of 235% from the previous year. Nevertheless, the accounts showed improvements in 2005 onwards.

vi) There were large deficits in the balance of payments for the construction and engineering services. Even though the total construction and engineering receipts have shown steady improvements from 2001 to 2007, the gaps were still wider as the total payments grew even faster than the total earnings.

vii) Overall, the services account continued to record deficits from 2001 to 2008 despite showing some improvements in the receipts.

Publications and Citations (Bibliometric)

i) Malaysia managed to increase its publication four times higher within the 2001-2008 periods.

ii) On average, Malaysian authors have received 2.4 citations per publication throughout the publishing period.

iii) Over the years, an increasing pattern can be observed in the growth rate of S&T publications.

iv) The direction of S&T in Malaysia is more towards medicine, engineering, biochemistry, genetics & molecular biology and agricultural & biological sciences.

v) Low focus given by the Malaysian authors in publishing in high impact journals.

vi) In ASEAN region, Malaysia is ranked third after Singapore and Thailand in terms of total number of publications.

vii) Even though Singapore was producing the largest volume of publications in the ASEAN region, its growth rate was much lower than both Malaysia and Thailand. In 2008, Singapore recorded a decrease in the number of publications produced, while Malaysia and Thailand continue to grow significantly higher in total number of publication.

viii) In terms of global output by fields of research, publications in medicine received the warmest response from researchers around the globe. It was followed by biochemistry, genetics & molecular biology and engineering.

ix) Malaysia only managed to produce an equivalent of only 1% shared percentage of world publications. It is so small even compared to Taiwan and Finland.

Public Awareness, Knowledge and Attitude towards Science and Technology

i) Malaysian perceived that they have a weak knowledge in concept and basic scientific fact, but their perceptions have not been improving over the years.

ii) Malaysians' attitudes are beginning to become more positive towards the benefit of S&T.

iii) Majority of Malaysian people still believe that S&T would bring more positive effect than negative.

iv) Malaysians have a good understanding on basic concept of science such as 'The earth travels around the sun' and 'plants produce the oxygen'. However, many did not do very well on questions that may require higher knowledge level in S&T.

v) Many Malaysians were quite aware of various S&T programmes organized in promoting awareness in S&T. However, they were very poor at participating in most of the programmes organized.

vi) Television was the leading source of information about S&T (82.4%), followed by newspapers (62.1%), radios (32.1%), internet (24.8%) and magazine (22.1%).

vii) In terms of international comparisons, Malaysia is left far behind from many developed countries such as the United States, South Korea and European Union.

STI Performance Scorecard 2008

Malaysia has significantly improved its STI performance in almost all the six areas indicated in the STI performance scoreboard. However it should be noted that the scoreboard has its limitation as the coverage and number of other indicators that captures the performance of the STI system were not included.

The challenge for the policy-makers is to build on the gains and address the deficiencies of the STI system as described in this report.

STI Performance Scorecard 2008

Category	Indicator	Year 2006	Year 2004	Trend	Average / Selected OECD
R&D Investments and Expenditure	Overall R&D Intensity	0.64	0.63	+ve	2.26[1]
	Industry R&D expenditure as % of GERD	85.0	71.5	+ve	63.9[2]
Human Resources	Total R&D Personnel (Headcount)	24,588	30,983	-ve	>100,000[3]
	Researchers per 10,000 labor force	17.9	21.3	-ve	70[4]
	Total FTE per researcher	0.51	0.55	-ve	NA
	Science and engineering enrolment as % of total first degree enrolment	32.6	48.2	-ve	NA
	Science and engineering enrolment as % of total post-graduate enrolment	30.6	40.6	-ve	NA
	Proportion of postgraduate enrolment to undergraduate enrolment	1:8.4	1: 6.6	+ve	NA
	Women researchers as proportion of total researchers (%)	37.7	35.8	+ve	30[5]
Interactions and Cooperation	% of public R&D financed by industry / external funds	3.0	2.0	+ve	3.7[6]
Outputs and Outcomes	Total number of publications in SCOPUS-indexed journals	3,593	2,384	+ve	45,417[7]
	Total Citations	6,424	9,511	-ve	NA
	No. of patents applied	531	522	+ve	4,114[8]
	No. of patents granted	187	24	+ve	13,094[9]
	No. of USPTO patents granted per million population	4.9	3.6	+ve	NA

Knowledge Infrastructure and Diffusion	No. of computer per 1000 people	238	192	+ve	NA
	Internet users per 100 population	51.9	38.2	+ve	58.4[10]
	Cellular phone subscription per 100 inhabitants	72.3	56.5	+ve	80 (2005)
S&T Knowledge, Understanding and Awareness	Mean Score of perceived interest in S&T	2.41(2008)	2.40	+ve	NA
	Mean Score of perceived knowledge in S&T	2.07 (2008)	2.22	-ve	NA
	Attitude towards S&T[#]	61.5 (2008)	63.7	-ve	
	Index of Scientific Promise[#]	77.9 (2008)	71.9	+ve	US(83); South Korea (89.5)
	Index of Scientific Reservation[#]	52.7 (2008)	47	+ve	US(49.5); South Korea (65)

1 STI Outlook 2008
2 OECD Main S&T Indicators 2006
3 Many OECD countries has >100,000
4 OECD Main S&T Indicators 2006
5 Ditto
6 STI Outlook 2008
7 Average number of journal for Australia, Korea and Finland in 2006 (SCOPUS)
8 Main S&T Indicators 2006 (EPO)
9 Ditto
10 International Telecomunication Union
Survey on Public Attitudes Towards S&T

INTRODUCTION | Chapter 1

The chapter is categorized into three sections; (1) the preamble, which covers the background of the report, (2) basis of the report , relying on primary and secondary information and finally (3) the organization of the 12 chapters of the report.

1.1 PREAMBLE

Good info-structure and infrastructure will enable Malaysia to sustain the current FDI as well as attract new ones. Investors look towards not only for competitive products and services but also political stability, level of local skills and knowledge in science & technology. To stay competitive and be able to continue to attract foreign direct investment (FDI), Malaysia needs to leverage its competitive advantage especially in the sub-sectors that involve science and technology. It is this sub-sector that drives innovation plus research and development for more competitive products and services. Even though Malaysia supplies good basic human capital, it lacks high technology human capital. This is probably due to the education system which did not factor or encourage creativity and innovation.

As Malaysia approaches knowledge based economy by 2020, requirement for a highly knowledgeable, high tech human capital is very critical in order to cater for the needs of capital intensive/technological investments. The Asian business environment has become highly competitive with many rising economies catching up with Malaysia's competitive advantage. More intensive training and retraining are needed to leverage the Malaysian human capital.

Even though Malaysia's ranking in the global measure of competitiveness has been unchanged for the last three years (21 among 133 countries in Global Competitiveness Report 2008-2009), the country needs to improve its ranking especially in the technology areas. Malaysia lacks behind in terms of technology infrastructure. The following chapters in this Science & Technology Indicators Report 2008 will highlight insights to the areas that need further improvements and enhancements.

1.2 HOW THE REPORT WAS PREPARED

The content of the STI Report 2008 is based on inputs from surveys (Research and Development and Public Awareness) commissioned by MASTIC in 2006. Others are from secondary sources namely; ministries, government agencies and other relevant sources. The principal references employed in the preparation of the STI report 2008 are as indicated in the following table.

Table 1.1: Principal References Employed in Preparation of Malaysia Science and Technology Indicators Report 2008

Chapter	Title	Principal Source of Information
2	Education in Science and Technology	Ministry of Education (MOE) Ministry of Higher Education (MOHE) Malaysian Examinations Council (MEC)
3	Human Resource for Science and Technology	National Survey of Research and Development – 2008 Report IMD World Competitiveness Year Book 2008
4	Public Support for Science and Technology	Ministry of Science, Technology and Innovation (MOSTI) Malaysian Technology Development Corporation (MTDC) Small and Medium Industries Development Corporation (SMIDEC) Malaysian Life Sciences Capital Fund (MLSCF) (www.mlscf.com) Malaysia BiotechCorp Sdn Bhd Malaysia Communications and Multimedia Commission (MCMC) Lembaga Hasil Dalam Negeri (LHDN) Multimedia Development Corporation (MDeC) Malaysian Industry Development Authority (MIDA)
5	Research and Development for Science and Technology	National Survey on Research and Development 2008
6	Innovation in Science and Technology	Global Innovation Index (GII) Ministry of Science, Technology and Innovation (MOSTI)
7	Intellectual Property in Malaysia	Intellectual Property Corporation of Malaysia (MyIPO) United States Patent and Trademark Office (USPTO)
8	Information and Communication Technology in Malaysia	International Data Corporation (IDC) RMK-9 Information Economy Report Multimedia Development Development Corporation (MDEC)/ Malaysian Communication and Multimedia Commission (MCMC)
9	Biotechnology	Malaysia BiotechCorp Sdn Bhd Technology Park Malaysia (TPM) National Biotechnology Division (BIOTEK) Malaysian Biotech Information Centre (BIC)
10	Trade in Technology	Department of Statistics (DOS) Bank Negara Malaysia (BNM)
11	Publications and Citations (Bibliometric)	SCOPUS
12	Public Awareness, Knowledge and Attitude Towards Science and Technology	Survey on Public Awareness, Knowledge and Attitudes towards STI 2008

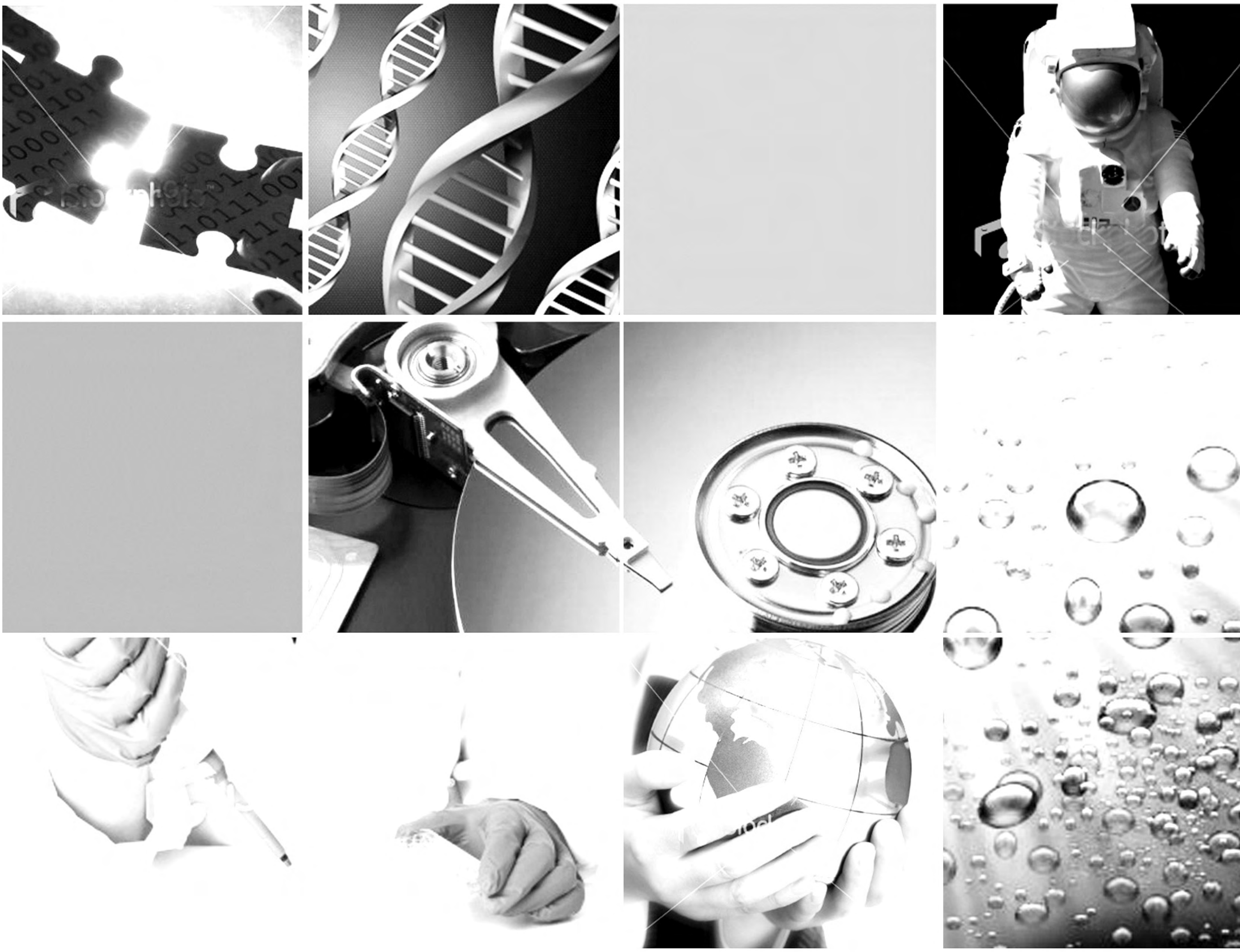
1.3 ORGANIZATION OF THE REPORT

The Executive Summary, which provides the overview of the report, precedes the 13 chapters in this report. After the Introduction chapter, the Education chapter takes the lead followed by the other areas of focus; namely:

Chapter 1	:	Introduction
Chapter 2	:	Education in S & T
Chapter 3	:	Human Resource for S & T
Chapter 4	:	Public Support for S & T
Chapter 5	:	Research & Development for S & T
Chapter 6	:	Innovation in S & T
Chapter 7	:	Intellectual Property in Malaysia
Chapter 8	:	Information and Communication Technology in Malaysia
Chapter 9	:	Biotechnology in Malaysia
Chapter 10	:	Trade in Technology
Chapter 11	:	Public Awareness, Knowledge and Attitudes towards S & T
Chapter 12	:	Publication and Citation (Bibliometric)
Chapter 13	:	Conclusion /The way forward

The 13 chapters have been re-vamped to give the 2008 Science & Technology indicators Report a better flow. Arrangements of the 13 chapters have been re-sequenced, a new chapter has been introduced and another chapter has been given a more relevant title.

Chapter 6	:	No current Innovation survey data were available, it is compensated with Industry information.
Chapter 7	:	Has been renamed 'Intellectual Property in Malaysia', which covers patenting, industrial design, trademarks and copyrights.
Chapter 9	:	This is a new chapter on 'Biotechnology in Malaysia'.



EDUCATION IN SCIENCE
AND TECHNOLOGY

Chapter 2

2.1 INTRODUCTION

Malaysia's education system consists of pre-school, primary, secondary, and tertiary education. Basically, primary and secondary educations are under the purview of the Ministry of Education, whilst tertiary education is under the purview of the Ministry of Higher Education, formed in 2004. Tertiary education level includes certificate, diploma, and undergraduate as well as postgraduate studies.

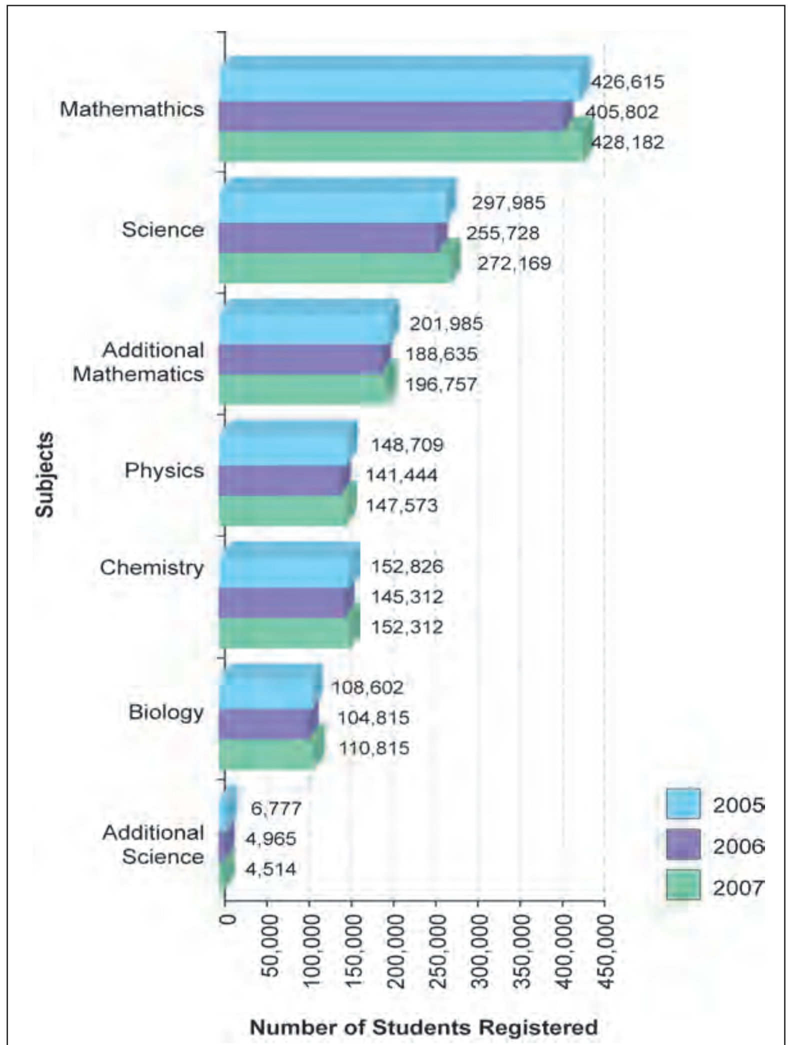
This chapter monitors the S&T (inclusive non-S&T) educational background from SPM, pre-university and tertiary levels for both public and private institutions. Most of the information used for this chapter was sourced from the Ministry of Education (MOE), Ministry of Higher Education (MOHE) and Malaysian Examinations Council (MEC).

2.2 EDUCATION IN SCIENCE AND TECHNOLOGY AT THE SECONDARY AND PRE-UNIVERSITY LEVEL

2.2.1 Science and Technology at the SPM Level

This section examines education in S&T at the Sijil Pelajaran Malaysia (SPM) level. It provides statistics of students registered in S&T at SPM level.

Figure 2.1: Registration for SPM by Science and Technology Subjects (2005 – 2007)



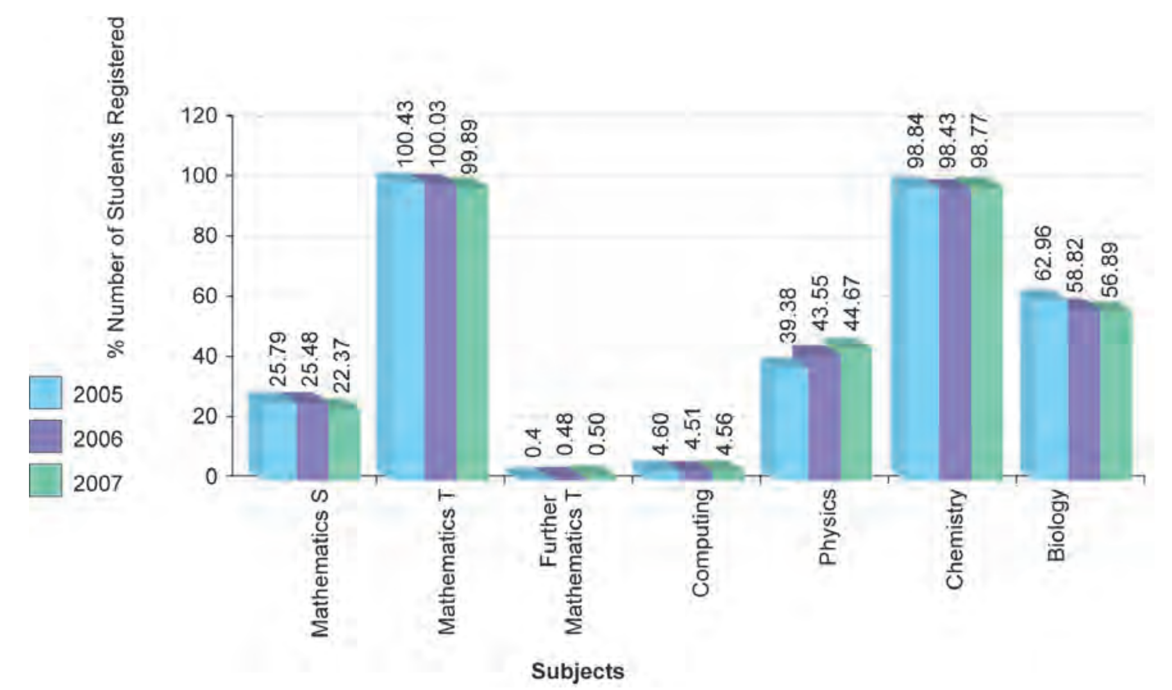
Source: Malaysian Examinations Council, 2008

A slight decreased is observed in 2006 in the number of students taking the subject during the year 2006. However, the number of students registered for science and mathematics in 2007 increased by 5.2% over 2006. (Figure 2.1)

2.2.2 Science and Technology at the STPM Level

This section examines education in S&T at STPM level. It compares the statistics number of students registered in S&T subjects to the total number of students registered for STPM.

Figure 2.2: Registration for STPM by Science and Technology Subjects (200 – 2007)



(Total number of Students: 2005: 16,685; 2006: 13,774; 2007: 14,235)

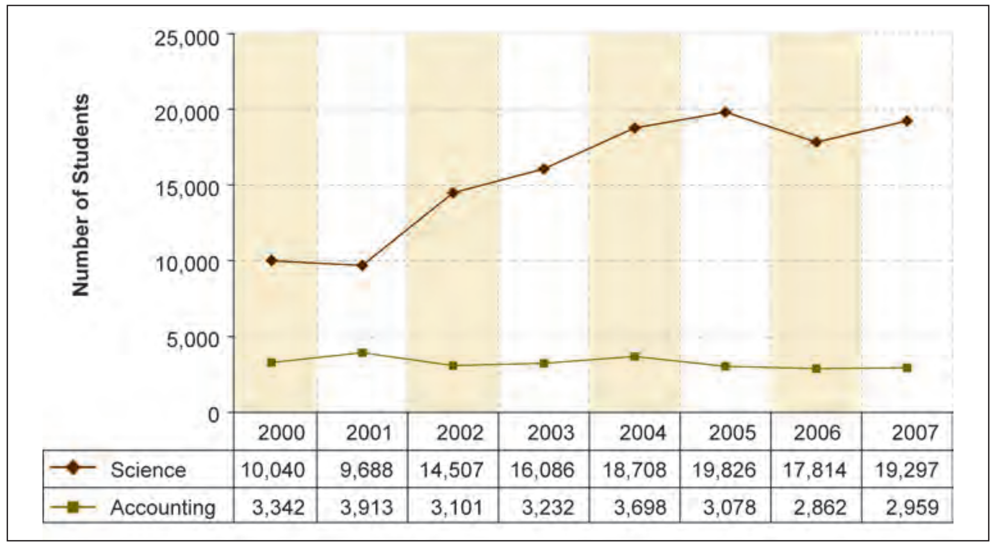
Source: Malaysian Examinations Council, 2008

Figure 2.2 above provides the distribution of registered students for STPM according to science and mathematical subjects taken during 2005, 2006, 2007 fiscal years. The number of students registered in S&T subjects decreased by 17.4% in 2006, but increased slightly in 2007. In terms of study subjects, Mathematics T was the most preferred subject, followed by Chemistry, Biology, Physics and Mathematics S. Not many students were interested in Computing and Further Mathematics T subjects.

2.2.3 Science and Technology at the Matriculation Level

This section examines education in S&T at matriculation level. It compares the statistics number of students registered in S&T courses to Non-S&T courses and also the ratio of the students passed the matriculation to the number of students registered.

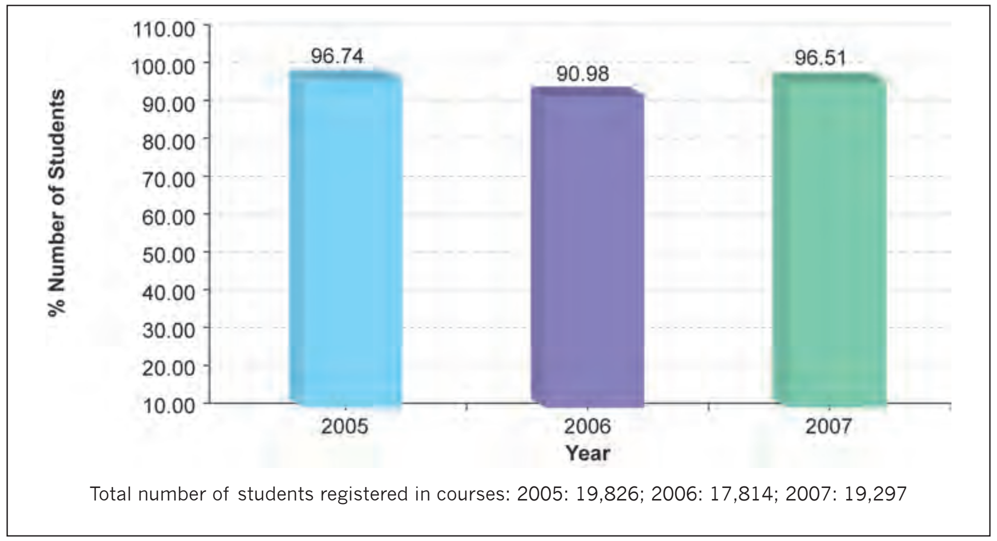
Figure 2.3: Registration for Matriculation for Science and Technology and Non-Science and Technology Subjects (2005 – 2007)



	2000	2001	2002	2003	2004	2005	2006	2007
Science	10,040	9,688	14,507	16,086	18,708	19,826	17,814	19,297
Accounting	3,342	3,913	3,101	3,232	3,698	3,078	2,862	2,959

Source: Ministry of Higher Education Malaysia

Figure 2.4: Percentage of Students Who Passed Matriculation in Science, 2005 – 2007



Source: Ministry of Higher Education Malaysia

Figure 2.3, shows trend the number of students registered for matriculation increase steadily since 2000 until 2007. Only in 2001 and 2006 the number of students registered decreased about 3.51% and 10.15% respectively. While, the trend number of students registered for non-science courses was fluctuated throughout the year.

Based on figure 2.4, the percentage number of students passed the matriculation in science decreased in 2006 (5.76%) but increased in 2007 (5.53%).

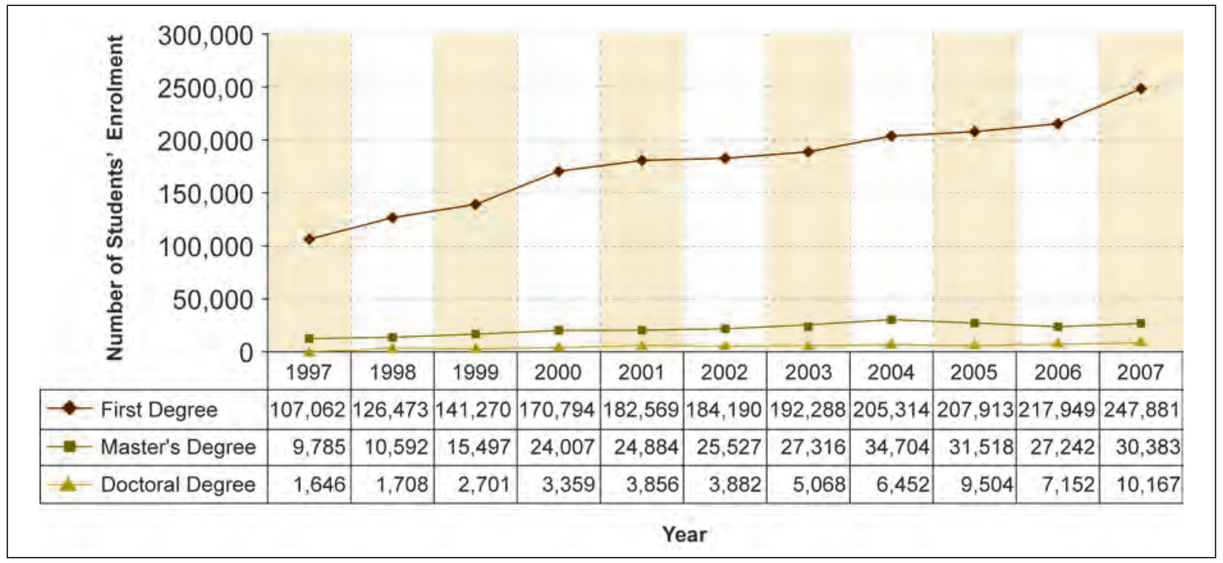
2.3 TERTIARY EDUCATION IN SCIENCE AND TECHNOLOGY

This section examines the students' enrolment and graduation in tertiary education from both public and private institutions of higher learning (IHL) at first degree and post-graduate levels.

2.3.1 Tertiary Education in Public Institutions

This section examines the students' enrolment and graduation in tertiary education in public IHL according to levels of academic programs such as undergraduates, masters and PhD level. Comparisons are made based on academic programs.

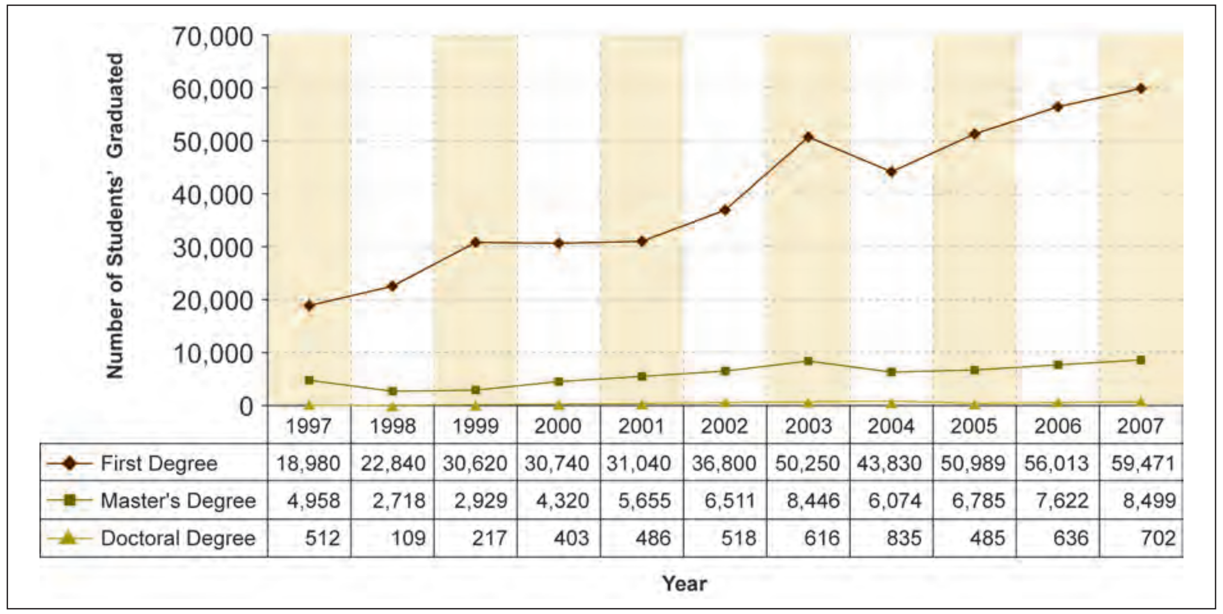
Figure 2.5: Enrolment in Public Institution of Higher Learning by Level of Education (1997 – 2007)



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
First Degree	107,062	126,473	141,270	170,794	182,569	184,190	192,288	205,314	207,913	217,949	247,881
Master's Degree	9,785	10,592	15,497	24,007	24,884	25,527	27,316	34,704	31,518	27,242	30,383
Doctoral Degree	1,646	1,708	2,701	3,359	3,856	3,882	5,068	6,452	9,504	7,152	10,167

Source: Ministry of Higher Education Malaysia

Figure 2.6: Graduates in Public Institution of Higher Learning by Level of Education, 1997 – 2007



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
First Degree	18,980	22,840	30,620	30,740	31,040	36,800	50,250	43,830	50,989	56,013	59,471
Master's Degree	4,958	2,718	2,929	4,320	5,655	6,511	8,446	6,074	6,785	7,622	8,499
Doctoral Degree	512	109	217	403	486	518	616	835	485	636	702

Source: Ministry of Higher Education Malaysia

Based on Figure 2.5, the number of students' enrolment in public IHLs for the first degree courses rose steadily from 107,062 students in 1997 to 247,881 students in 2007.
The number of students' enrolment in master's degree also continued to rise from 9,785 students in 1997 to 34,704 students in 2004. Following the long period of growth, enrolment in master's degree, a slight declined can be observed in 2006.

The number of students' enrolment in doctoral courses increased steadily from 1997 (1,646 students) to 2001 (3,856 students), but eventually decreased in 2002 (3,882 students). In 2003 (5,068 students), the number of students enrolment in doctoral courses rose until 2005 (9,504 students) and fell again in 2006 (7,152 students). The figure, however, bounced back in 2007 with 10,167 students.

Similar pattern can also be found for graduation statistics. As shown in Figure 2.6, the number of students graduated in the first degree level increased from 18,980 students in 1997 to 50,250 students in 2003, however, the figure declined to 43,830 students in 2004. The number continued to increase steadily in 2005 with 50,989 students until 2007 (59,471 students).

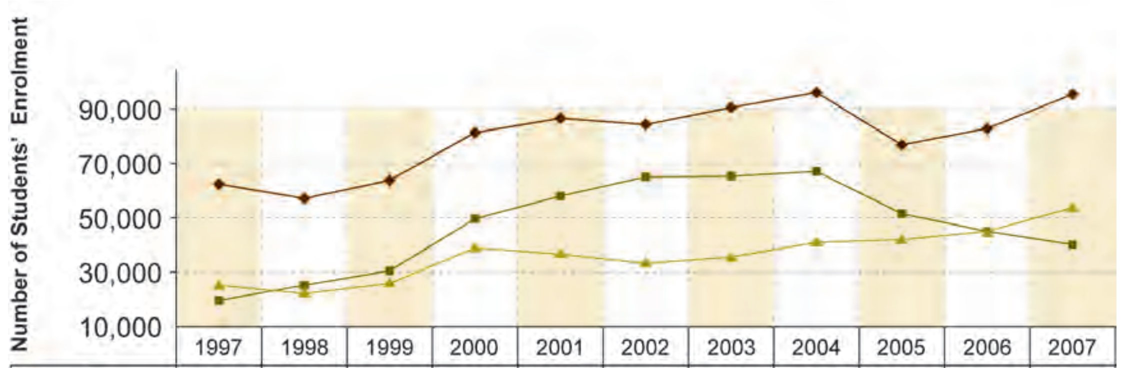
For master's degree level, the number of students graduated decreased in 1998 (2,718 students). However, from 1999 (2,929 students) the number of students graduated increased steadily until its peak in 2003 (8,446 students) before it dropped in 2004 (6,074 students). However, in 2005 (6,785 students) the number started to increase consistently until 2007 (8,499 students).

The number of students graduated in doctoral degree courses decreased in 1998 (109 students) but somehow increased in 1999 (217 students) until 2004 (835 students). However, in 2005 the number of students graduated in doctoral courses declined to 485 students. The number increased steadily in 2006 (636 students) until 2007 (702 students).

2.3.1.1 First Degree Courses at Public Institutions of Higher Learning by Field of Studies

This section examines the first degree students' enrolment and graduation by field of studies offered by the public IHLs.

Figure 2.7: Enrolment in First Degree Courses at Public Institutions of Higher Learning by Field of Studies (1997 – 2007)

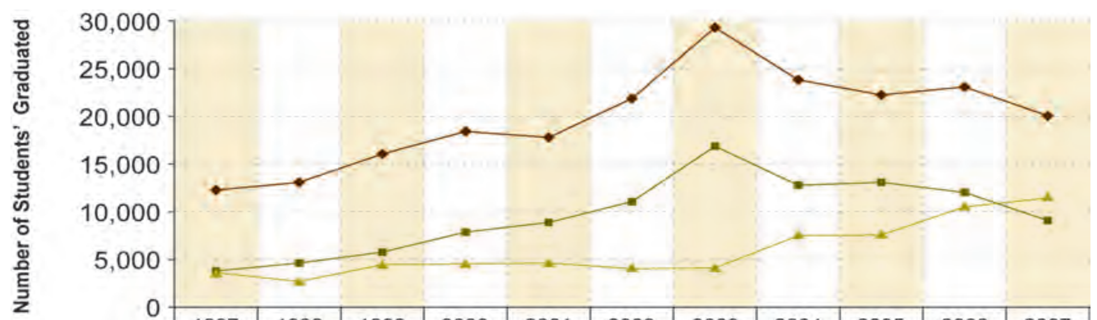


	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Arts	62,528	57,587	64,092	81,914	87,482	84,311	90,925	96,581	76,935	83,354	95,969
Science	19,342	25,607	30,023	49,575	58,029	65,617	65,235	67,368	51,464	44,551	40,298
Technical	25,192	23,307	25,780	39,305	37,318	34,262	36,128	41,365	42,598	45,132	53,760

Year

Source: Ministry of Higher Education Malaysia

Figure 2.8: Graduates in First Degree Courses at Public Institutions of Higher Learning by Field of Studies (1997 – 2007)



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Arts	12,100	13,190	16,060	18,360	17,730	21,750	29,370	23,830	22,253	22,977	20,004
Science	3,330	4,300	5,530	7,830	8,710	10,940	16,700	12,590	12,983	11,785	8,982
Technical	3,550	2,600	4,380	4,550	4,600	4,110	4,180	7,410	7,522	10,360	11,375

Year

Source: Ministry of Higher Education Malaysia

As shown in Figure 2.7, in general, there has been an increasing trend in the number of students' enrolment in first degree level in public IHLs from 1997 to 2007 for arts and technical courses. However, the number of students' enrolment in science courses has been on a decreasing trend since 2005 until 2007.

Students' enrolment in the first degree level in arts courses decreased in 1998 (57,587 students) but increased steadily in 1999 (64,092 students) until 2001 (87,842 students). However, in 2002 the number of students' enrolment in arts decreased to 84,311 students. In 2003 and 2004, the number of students' enrolment increased. However, in 2005 the number of students' enrolment decrease, again but subsequently in 2006 and 2007, the number increased steadily.

The number of students' enrolment in science, increased steadily from 1997 (19,342 students) to 2002 (65,617 students). However, the number declined in 2003 (65,235 students) but increased in 2004 (67,368 students). From 2005 to 2007, the number has been on a decreasing trend i.e. from 51,464 students to 40,298 students.

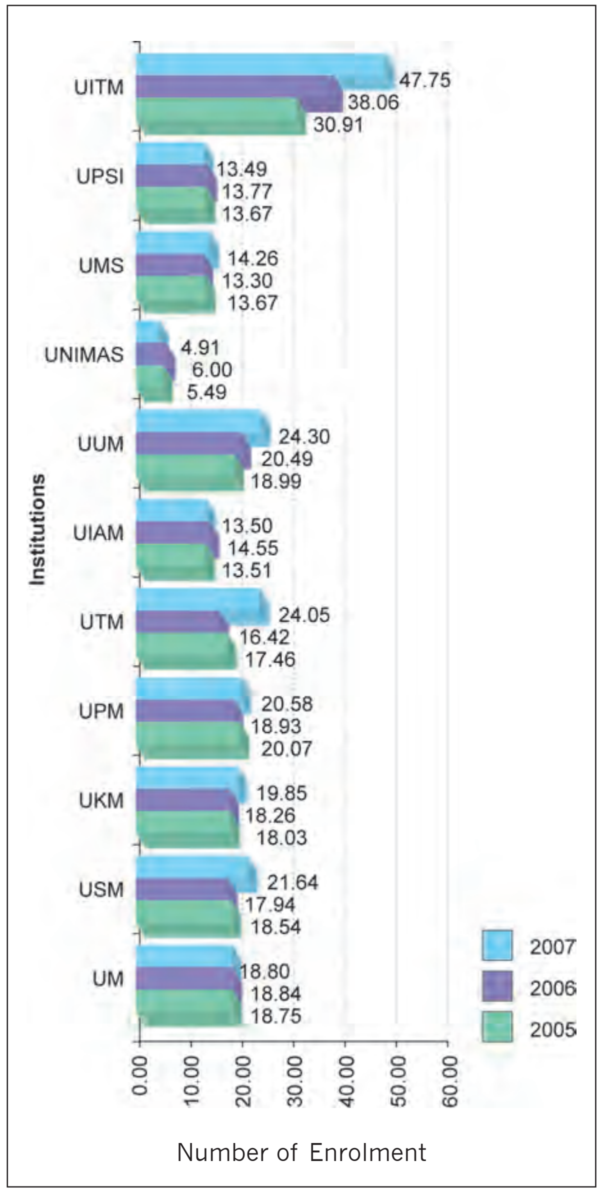
The number of students' enrolment in technical courses decreased in 1998 (23,307 students). Subsequently, the number increased for two consecutive years in 1999 (25,780 students) and in 2000 (39,305 students). However, the number seems to decrease again in 2001 (37,318 students) and 2002 (34,262 students), before it starts to increase again in 2003 (36,128 students) until 2007 (53,760 students).

Figure 2.8 shows the pattern of first degree level graduation in arts, science and technical education at the public IHLs. Similar pattern can be seen for both arts and science students' graduation. The number has increased steadily from 1997 (12,100 students) to 2003 (29,370 students), before it declined from 2004 (23,830 students) until 2007 (20,004 students). The reduction in government funding for tertiary education may explain this drastic decrease.

The same trend was observed for the students graduated in science courses. The number has increased steadily from 1997 (3,330 students) to 2003 (16,700 students), and then decreased in 2004 (12,590 students) until 2007.

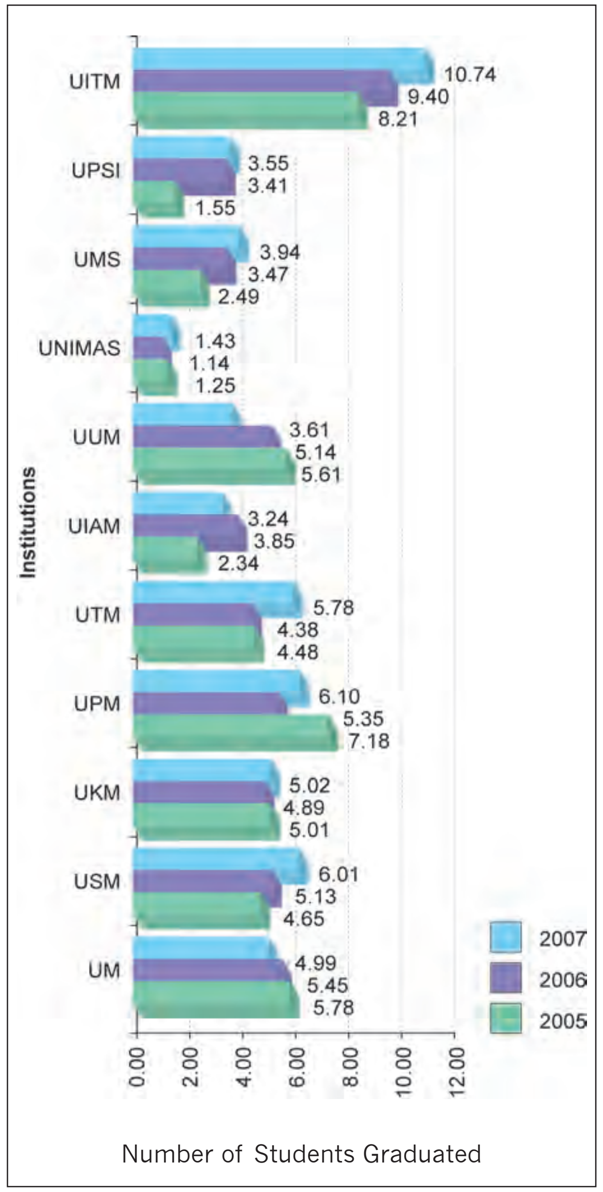
Further observation on the students graduated in technical courses showed a different trend. The number of students' graduated decreased in 1998 to 2,600 students. Nevertheless, the number started to pick up in 1999 (from 4,380 students) until 2007, where the number has reached at 11,375 in total number of graduated students.

Figure 2.9: Enrolment in First Degree Courses at Public Institutions of Higher Learning by Institutions ('000)



Source: Ministry of Higher Education Malaysia

Figure 2.10: Graduates in First Degree Courses at Public Institutions of Higher Learning by Institutions ('000)



Source: Ministry of Higher Education Malaysia

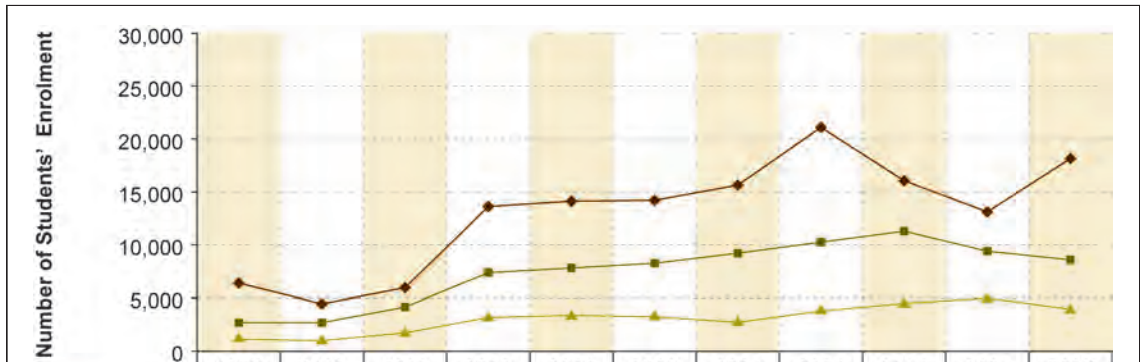
Figure 2.9 shows the number of students' enrolment in the first degree level at the public IHLs. Generally, the number of students' enrolment at all the public IHL increased from 2005 to 2007. UiTM recorded the highest number of students' enrolment in first degree level followed by UUM and UTM.

Figure 2.10 shows the number of students' graduated in first degree level at the public IHLs. Students graduated from the public institutions of higher learning increased from 2005 to 2007. However, there were several public institutions of higher learning which recorded decreases in the number of first degree graduates from 2005 to 2007.

2.3.1.2 Post Graduate Degree Courses

This section examines the students' enrolment and graduation from the public institutions of higher learning at the post graduate degree level programme.

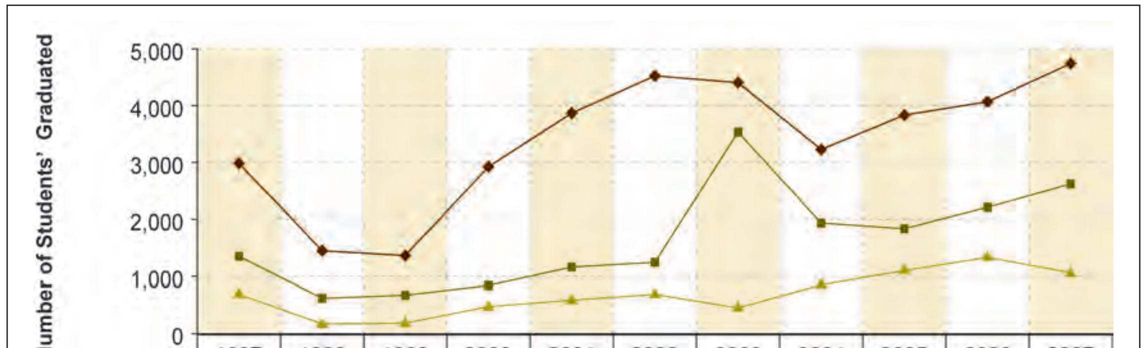
Figure 2.11: Enrolment in Master's Degree Programme at Public Institutions of Higher Learning by Courses (1997 – 2007)



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Art	6,140	4,400	5,820	13,480	14,010	14,140	15,500	20,810	15,995	13,010	18,012
Science	2,400	2,500	4,040	7,040	7,680	8,060	8,990	10,210	11,065	9,207	8,411
Technical	1,250	1,040	1,720	3,130	3,200	3,320	2,830	3,690	4,458	5,025	3,960

Source: Ministry of Higher Education Malaysia

Figure 2.12: Graduates in Master's Degree Programme at Public Institutions of Higher Learning by Courses (1997 – 2007)



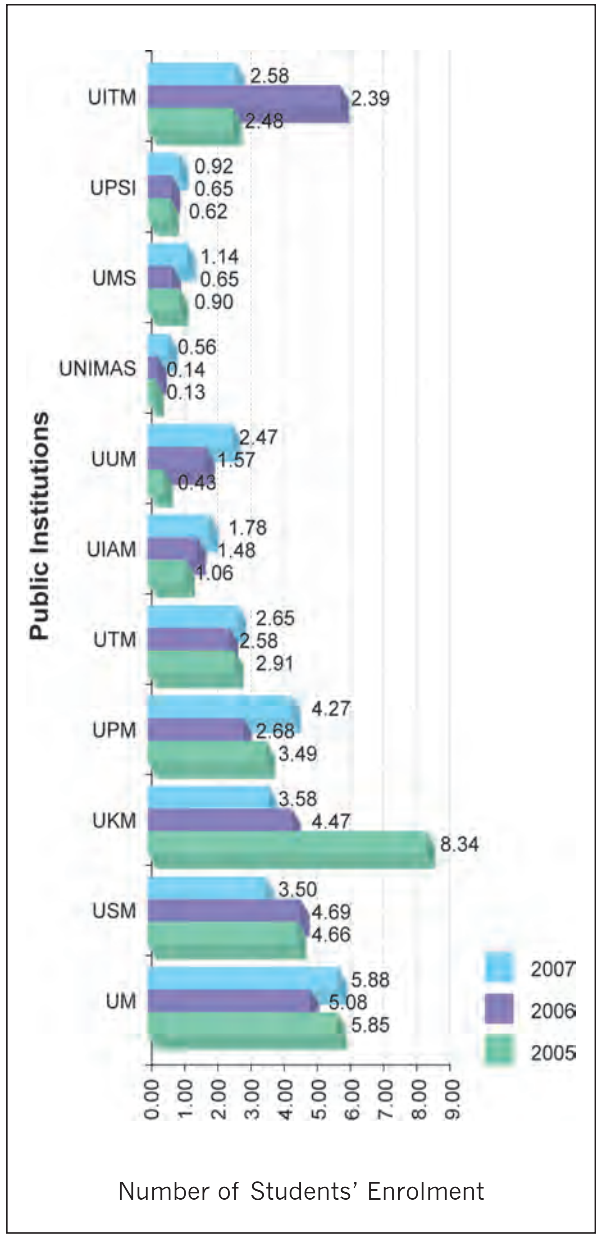
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Art	2,974	1,461	1,361	2,941	3,921	4,577	4,442	3,252	3,864	4,045	4,791
Science	1,332	594	669	891	1,174	1,236	3,552	1,952	1,830	2,216	2,622
Technical	652	143	154	488	560	698	452	870	1,091	1,361	1,086

Source: Ministry of Higher Education Malaysia

In general, the enrolment in Master's degree programme at public IHL has been showing a positive increasing trend with arts students dominated the group, followed by science students and technical students (Figure 2.11).

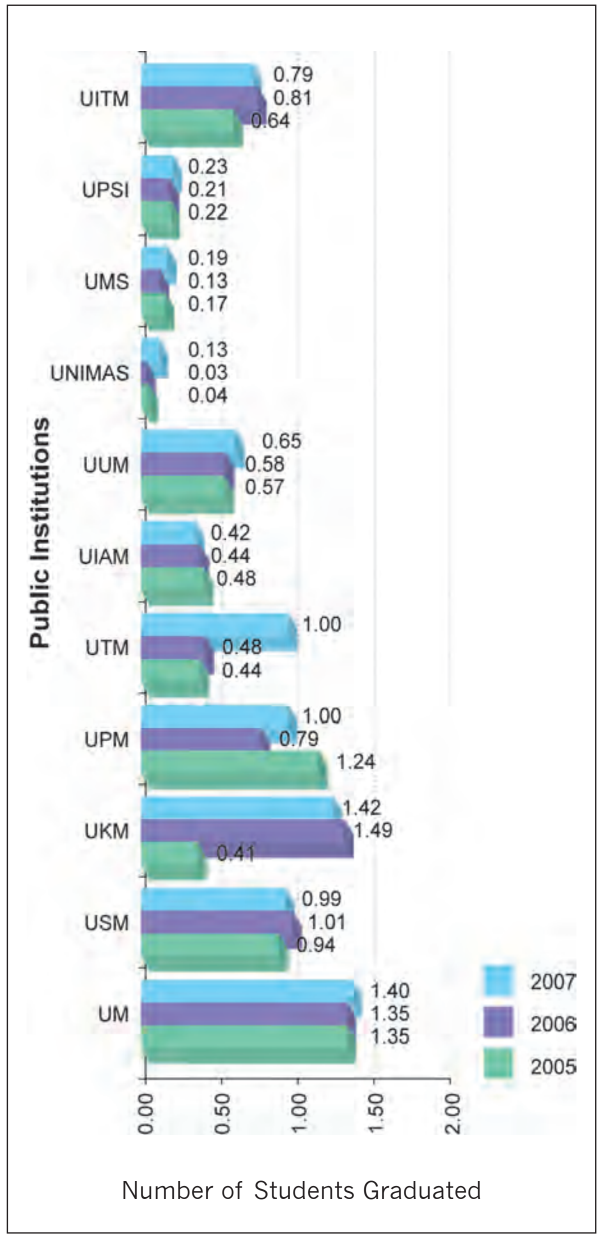
The number of graduates in the Master's degree programme at public IHL by courses is shown in Figure 2.12. Throughout the years, master's degree holders in arts dominated the group, followed by graduates in sciences and technical.

Figure 2.13: Enrolment in Master's Degree Courses at Public Institutions of Higher Learning by Institutions ('000)



Source: Ministry of Higher Education Malaysia

Figure 2.14: Graduates in Master's Degree Courses at Public Institutions of Higher Learning by Institutions ('000)

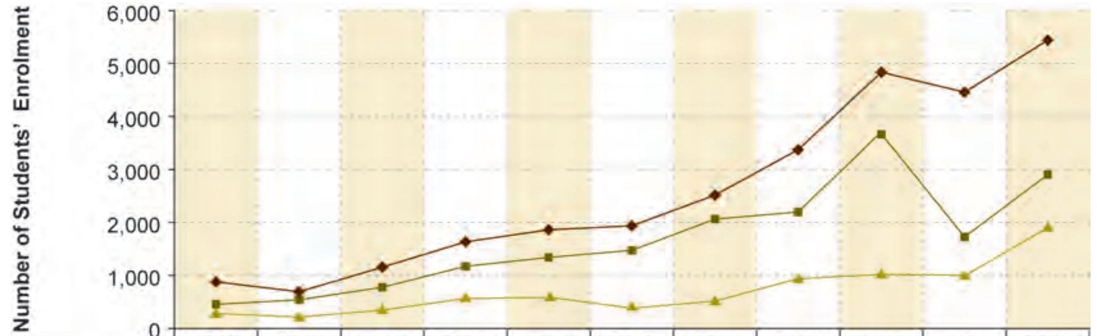


Source: Ministry of Higher Education Malaysia

Figure 2.13 shows the number of students' enrolment in the master's degree level programme at the public IHL from 2005 to 2007. UKM recorded the highest number of students' enrolment in the programme followed by UM and UPM.

The number of graduates in the master's degree level programme from the public IHL is shown in Figure 2.14. For the academic session of 2007/2008, UKM recorded the highest number of graduates, followed by UM, UTM, UPM and USM.

Figure 2.15: Enrolment in the PhD Degree Programme at the Public Institutions of Higher Learning by Field of Study (1997 – 2007)

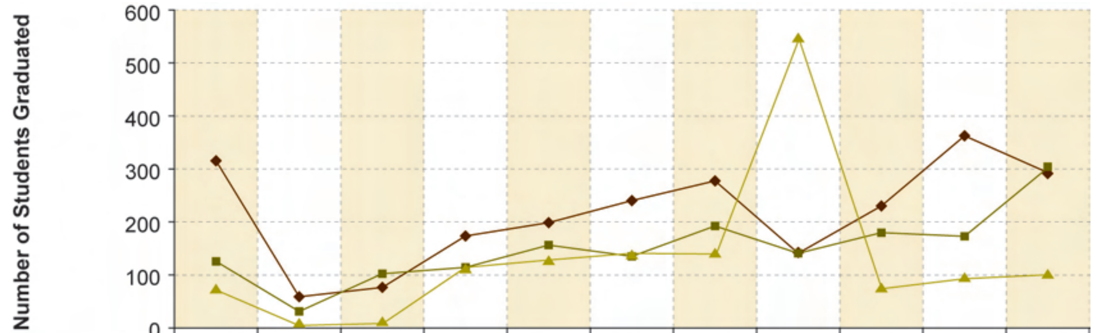


	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Art	897	665	1,154	1,637	1,898	1,975	2,514	3,361	4,827	4,445	5,409
Science	422	484	752	1,158	1,331	1,468	2,034	2,160	3,630	1,704	2,881
Technical	327	277	383	564	627	439	520	931	1,047	1,003	1,877

Year

Source: Ministry of Higher Education Malaysia

Figure 2.16: Graduates in PhD Degree Programme at the Public Institutions of Higher Learning by Field of Study (1997 – 2007)



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Art	315	59	79	176	199	242	279	141	231	366	295
Science	125	34	103	114	159	136	193	143	180	175	305
Technical	72	6	9	113	128	140	144	551	74	95	102

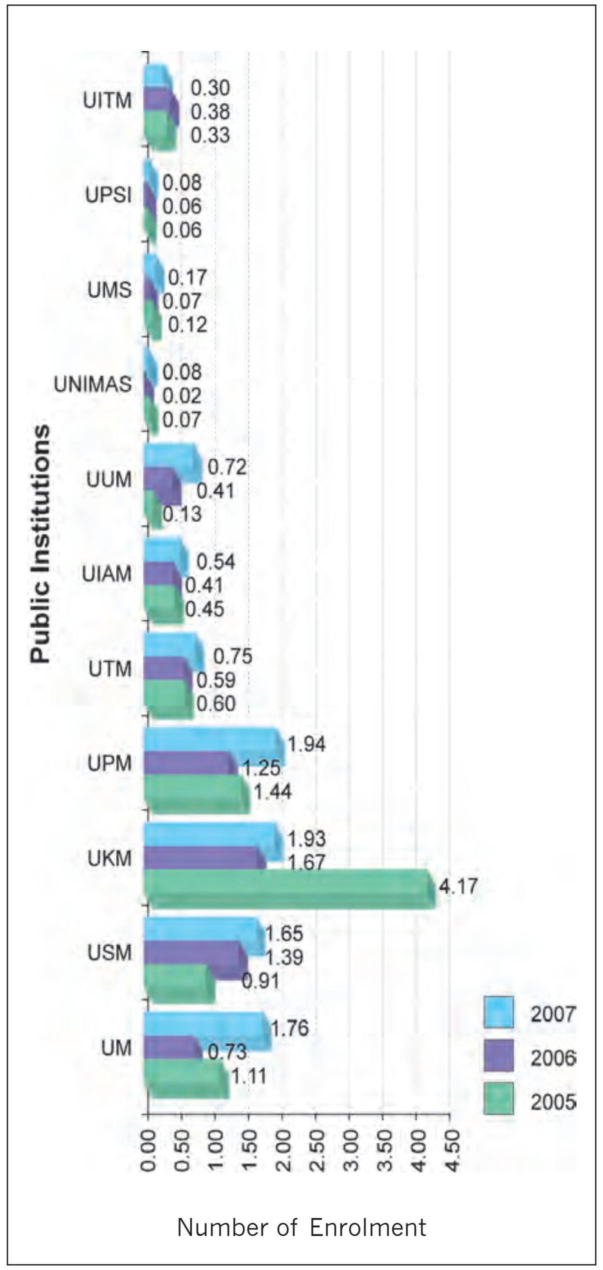
Year

Source: Ministry of Higher Education Malaysia

In general, the enrolment of students in the PhD level programme at the public institutions of higher learning has been showing a positive and similar trend with arts students dominated the group, followed by science students and technical students (Figure 2.15).

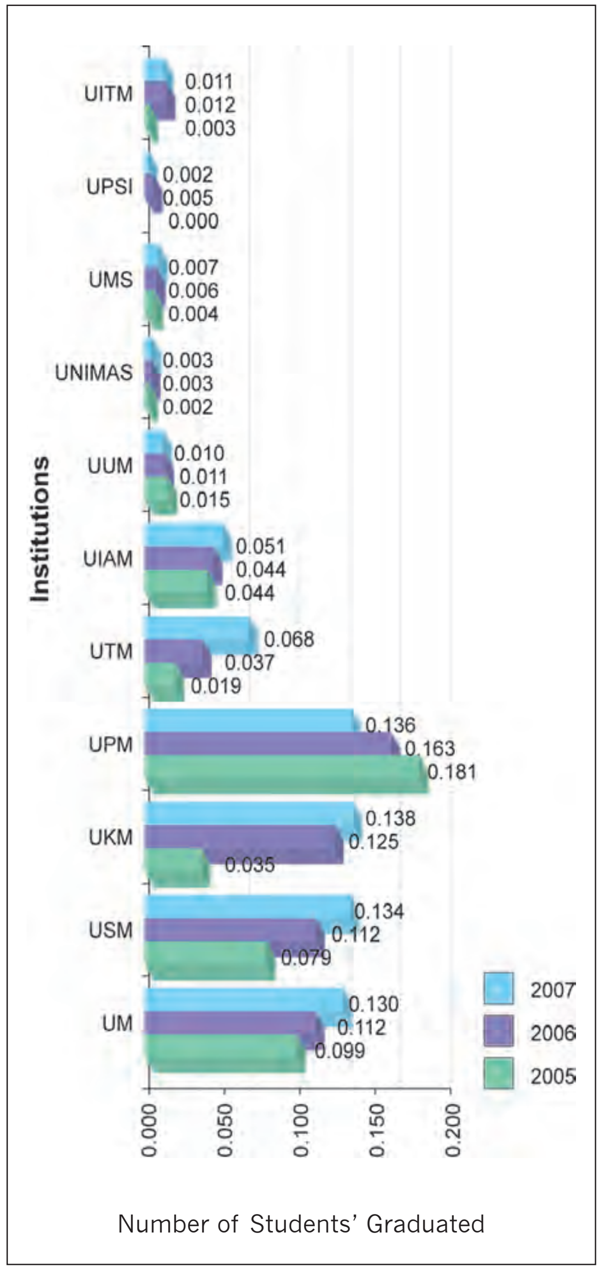
The number of graduates in the PhD level programme from the public IHLs is shown in Figure 2.16. Except in 1991, 2004 and 2007, PhD holders in arts also dominated the groups. In 2004, the number of graduates in technical course seems to increase dramatically leading the arts and science far behind.

Figure 2.17: Enrolment in PhD Level at Public Institutions of Higher Learning by Institutions (‘000)



Source: Ministry of Higher Education Malaysia

Figure 2.18: Graduates in Doctoral Courses at Public Institutions of Higher Learning by Institutions (‘000)



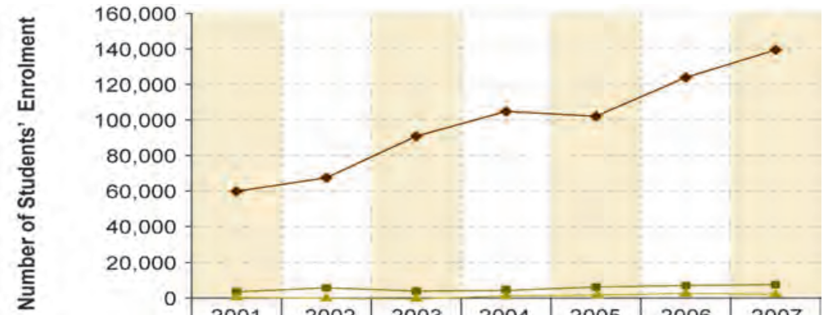
Source: Ministry of Higher Education Malaysia

Figure 2.17 and 2.18 show the distribution of students’ enrolment and graduation at the PhD level from various public IHLs from 2005 and 2007. UKM has recorded the highest number of students’ enrolment and graduation in the PhD level programme, followed by UPM and UM.

2.3.2 Tertiary Education in Private Institutions of Higher Learning

This section examines and reports students’ enrolment and graduation in the private institutions in the first degree and post-graduate levels programmes.

Figure 2.19: Enrolment in Private Institutions of Higher Learning by Level of Education (2001 – 2007)

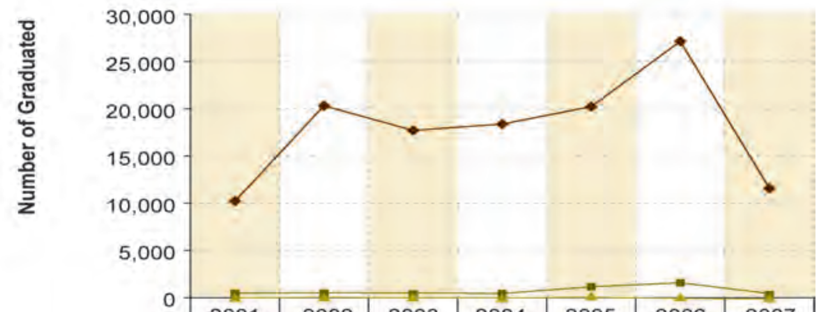


	2001	2002	2003	2004	2005	2006	2007
First Degree	59,965	67,062	90,631	105,325	101,395	124,071	140,422
Master's Degree	2,176	4,019	3,048	2,981	4,849	6,477	6,084
Doctoral Degree	131	197	86	108	598	860	817

Year

Source: Ministry of Higher Education Malaysia

Figure 2.20: Graduates in Private Institutions of Higher Learning by Level of Education (2001 – 2007)



	2001	2002	2003	2004	2005	2006	2007
First Degree	10,267	20,255	17,786	18,385	20,294	27,176	11,762
Master's Degree	395	571	410	423	1,080	1,592	418
Doctoral Degree	-	4	45	46	47	51	59

Year

Source: Ministry of Higher Education Malaysia

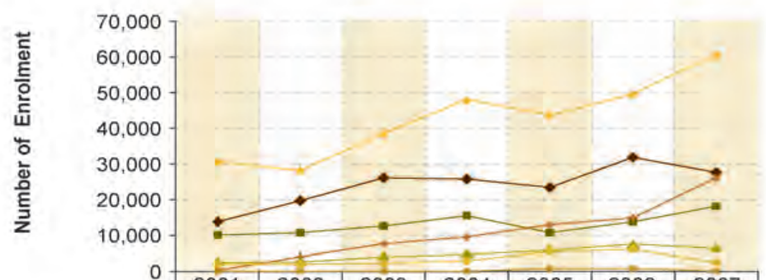
Figure 2.19 shows the number of students’ enrolment in science and technology courses in the private IHL according to all three levels of academic programmes. Obviously there has been an upward trend for the first degree students’ enrolment. Nevertheless, the trend for both masters’ degree and doctoral degree students’ enrolment has been quite consistent.

As shown in Figure 2.20, the number of first degree students who graduated from the private institutions has been on a decreasing trend as of 2007. The trend was quite consistent for graduates in master’s degree and doctoral degree. The numbers of enrolment and graduation of the post-graduate study programmes in the private IHLs are considered very small and insignificant.

2.3.2.1 First Degree Courses at Private Institutions of Higher Learning

This section examines the first degree students' enrolment and graduation from the private institutions according to various academic disciplines in science and technology.

Figure 2.21: Enrolment in First Degree Courses at Private Institutions of Higher Learning by Field of Studies (2001 – 2007)

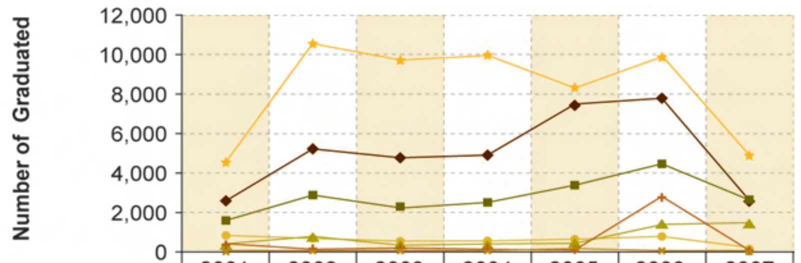


	2001	2002	2003	2004	2005	2006	2007
Natural Sciences	14,143	19,977	26,166	26,066	23,311	31,730	27,527
Engineering and Tech	9,776	10,591	12,294	14,892	10,419	13,867	17,836
Medical Science	2,381	2,469	3,886	4,724	5,669	7,717	6,641
Agriculture Science	-	-	-	-	272	370	-
Social Science	30,708	28,153	38,632	47,652	43,477	49,579	60,293
Humanities	2,145	2,052	2,042	735	5,298	6,042	2,362
Other Fields	812	3,820	7,611	9,256	12,949	14,766	25,763

Year

Source: Ministry of Higher Education Malaysia

Figure 2.22: Graduates in First Degree Courses at Private Institutions of Higher Learning by Field of Studies (2001 – 2007)



	2001	2002	2003	2004	2005	2006	2007
Natural Sciences	2,524	5,266	4,817	4,963	7,502	7,816	2,588
Engineering and Tech	1,642	2,869	2,263	2,481	3,377	4,448	2,659
Medical Science	351	782	366	376	483	1,417	1,475
Agriculture Science	-	-	-	-	59	-	-
Social Science	4,540	10,479	9,728	9,939	8,213	9,899	4.826
Humanities	848	697	508	520	630	819	214
Other Fields	362	162	104	106	30	2,777	-

Year

Source: Ministry of Higher Education Malaysia

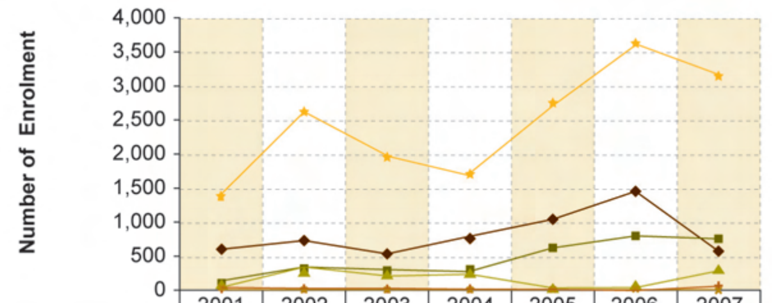
Figure 2.21 shows enrolment in the first degree level courses at the private IHLs. The figure also indicates that social science recorded the highest number of enrolments throughout all the fiscal years reported. An increasing trend can be observed in students' enrolments from year 2001 to 2007.

As shown in Figure 2.22, the number of graduates in the first degree level courses seems to fluctuate inconsistently throughout the year 2001 to 2007. As of June 2007, the total number of graduates in private institutions only stood at 11,762 students, almost similar to value in the past six years.

2.3.2.2 Post Graduate Degree Courses at Private Institutions of Higher Learning

This section describes the post-graduate students' enrolment and graduation in the private IHLs by area of studies.

Figure 2.23: Enrolment in Masters' Degree Programmes at Private Institutions of Higher Learning by Field of Studies (2001 – 2007)

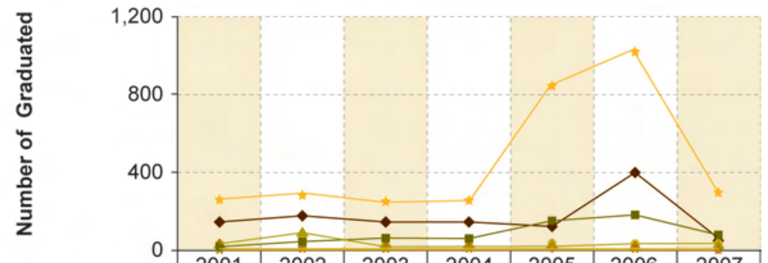


	2001	2002	2003	2004	2005	2006	2007
Natural Sciences	619	748	538	793	1,066	1,483	580
Engineering and Tech	91	317	289	266	601	808	737
Medical Science	-	305	220	189	9	13	288
Agriculture Science	-	-	-	-	-	-	-
Social Science	1,417	2,612	1,963	1,695	2,733	3,594	3,147
Humanities	12	-	-	-	-	-	40

Year

Source: Ministry of Higher Education Malaysia

Figure 2.24: Graduates in Masters Degree Programmes at Private Institutions of Higher Learning by Field of Studies (2001 – 2007)



	2001	2002	2003	2004	2005	2006	2007
Natural Sciences	136	176	131	135	111	397	43
Engineering and Tech	1	35	42	43	137	159	71
Medical Science	-	80	-	-	-	-	6
Agriculture Science	-	-	-	-	-	-	-
Social Science	2,58	2,80	237	245	832	1,017	280
Humanities	-	-	-	-	-	-	-
Other Fields	-	-	-	-	-	19	18

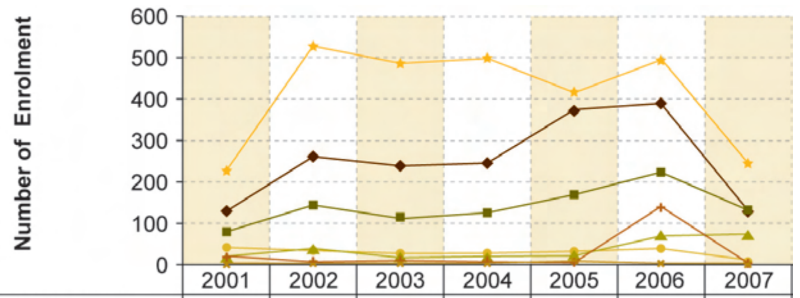
Year

Source: Ministry of Higher Education Malaysia

As shown in Figure 2.23, the number of Master's degree students enrolled at the private IHLs has generally increased from 2004 to 2006. The number has, however, showed a decreasing pace in 2007. Similar to public IHLs, social sciences field indicate the highest in enrolment number since 2001 to 2007.

The number of graduates in the Master's degree programmes has shown an increasing trend from 2004 to 2006 before plunging sharply in 2007. Almost all academic programmes dropped in the number of graduates by 2007 (see Figure 2.24).

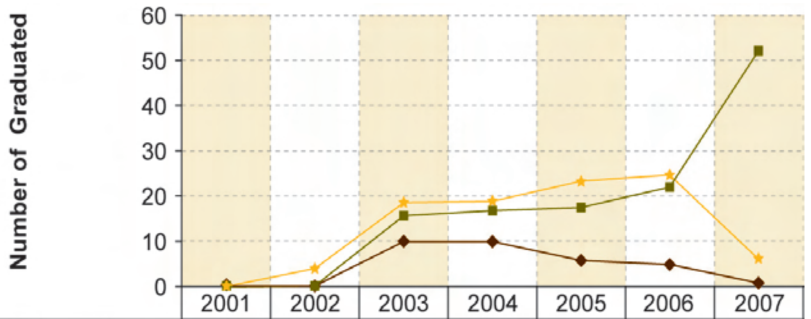
Figure 2.25: Enrolment in Doctoral Courses at Private Institutions by Courses



	2001	2002	2003	2004	2005	2006	2007
Natural Sciences	-	1	16	16	104	176	50
Engineering and Tech	-	1	28	26	130	212	56
Medical Science	-	-	-	-	4	7	18
Agriculture Science	-	-	-	-	-	-	-
Social Science	16	195	42	66	333	430	573
Humanities	115	-	-	-	-	-	-
Other Fields	-	-	-	-	27	35	120

Source: Ministry of Higher Education

Figure 2.26: Graduates in Doctoral Courses at Private Institutions by Courses



	2001	2002	2003	2004	2005	2006	2007
Natural Sciences	-	-	10	10	6	5	1
Engineering and Tech	-	-	16	17	18	21	52
Social Science	-	4	19	19	23	25	6

Source: Ministry of Higher Education Malaysia

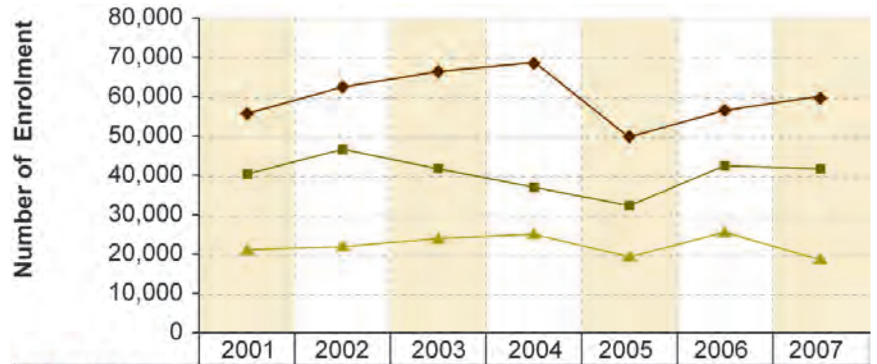
As shown in Figure 2.25, enrolment in social science courses for the PhD level at the private IHLs continued to increase from 2004 until 2007. However, the number of enrolment in other courses showed a declining pattern after 2006.

Figure 2.26 shows the number of PhD student graduates for all courses at the private IHLs increased steadily from 2001 until 2006. However, in 2007, the number of student graduates in engineering and technical were sharply increased, while other courses decreased.

2.3.2.3 Other Academic Level Courses at Private Institutions of Higher Learning

This section examines the students' enrolment and graduation at diploma and certificate levels in private IHLs.

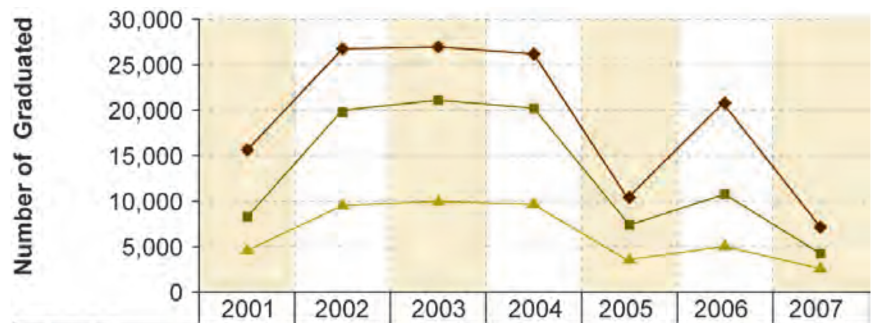
Figure 2.27: Enrolment in Diploma Level in Private Institutions, 2001 – 2007.



	2001	2002	2003	2004	2005	2006	2007
Art	55,844	62,464	66,739	68,868	50,157	56,543	59,888
Science	40,046	45,998	41,442	36,741	31,712	41,749	41,370
Technical	21,200	21,467	23,766	24,656	19,442	25,645	19,110

Source: Ministry of Higher Education Malaysia

Figure 2.28: Graduates in Diploma Level in Private Institutions, 2001 – 2007



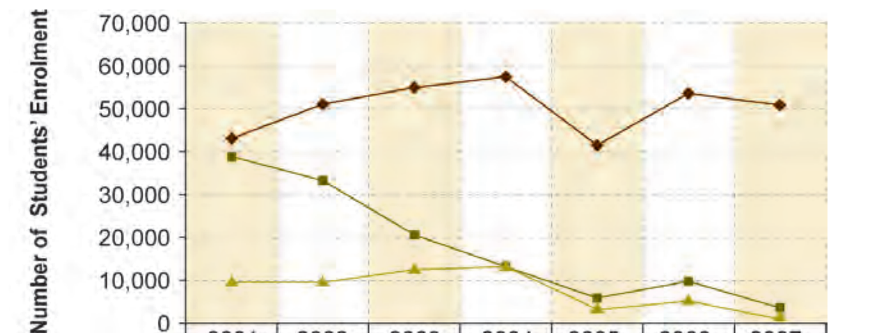
	2001	2002	2003	2004	2005	2006	2007
Art	15,621	26,724	26,894	26,136	10,196	20,660	7,091
Science	8,055	19,723	20,776	20,189	7,412	10,654	4,263
Technical	4,603	9,541	9,953	9,735	3,578	5,007	2,582

Source: Ministry of Higher Education Malaysia

As shown in Figure 2.27, enrolment for science courses at the diploma level in private institutions showed a decreasing trend from 2002 to 2005, but picking up in 2006 and 2007 to reach at 41,749 and 41,370 students, respectively. On the contrary, enrolment for technical and art courses has been on the upward trend from 2001 to 2004. However, the number dropped in 2005 only to pick up a little bit in 2006. As of June 2007, enrolment for technical and art courses stood at 19,110 and 59,888 students, respectively.

On the supply side, the number of diploma graduates in all categories of courses has been on an upward trend since 2002 to 2004 before it took a dip in 2005 and bounced back in 2006. Graduates in arts courses formed the largest number since 2001 to June 2007, followed by those in science and technical courses (Figure 2.28).

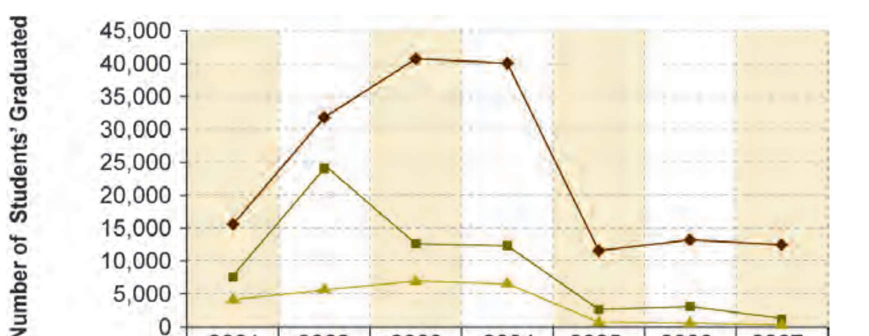
Figure 2.29: Enrolment in Certificate Level in Private Institutions



	2001	2002	2003	2004	2005	2006	2007
Art	43,103	50,798	55,192	57,533	41,532	53,686	50,651
Science	38,658	32,850	20,535	13,046	5,802	9,568	3,342
Technical	9,781	9,745	12,905	13,633	3,338	5,188	1,539

Source: Ministry of Higher Education Malaysia

Figure 2.30: Graduates in Certificate Level in Private Institutions



	2001	2002	2003	2004	2005	2006	2007
Art	15,669	32,073	40,997	40,510	11,820	13,602	12,634
Science	7,834	24,516	12,900	12,519	2,565	3,481	1,072
Technical	4,477	5,743	7,257	7,044	961	963	451

Source: Ministry of Higher Education Malaysia

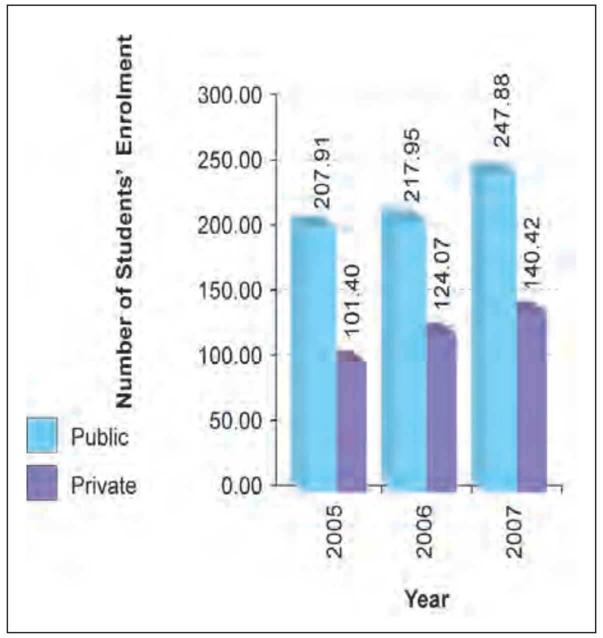
Enrolment in science courses at the certificate level in private institutions has been slowing down since 2002 to June 2007. The trend was found reversed for enrolments in arts and technical courses, whereby an increasing trend can be observed from 2002 to 2004 before it took a dip in 2005 and bounced back in 2006. As of June 2007, the number of students enrolled in arts courses formed the largest percentage, accounting for 91.2% of total enrolments, followed by science students (6.0%) and technical students (2.8%). (Figure 2.29).

Figure 2.30 shows that in general, the number of certificate holders in private institutions experienced a growth period from 2002 to 2004 before it dropped in 2005. The number increased a little in 2006 and dropped again in 2007 (as of June). As of June 2007, certificate holders in arts courses formed the largest number with 12,634 students, followed by those in science courses (1,072 students) and technical graduates (451 students).

2.4 COMPARISON BETWEEN PUBLIC AND PRIVATE INSTITUTIONS

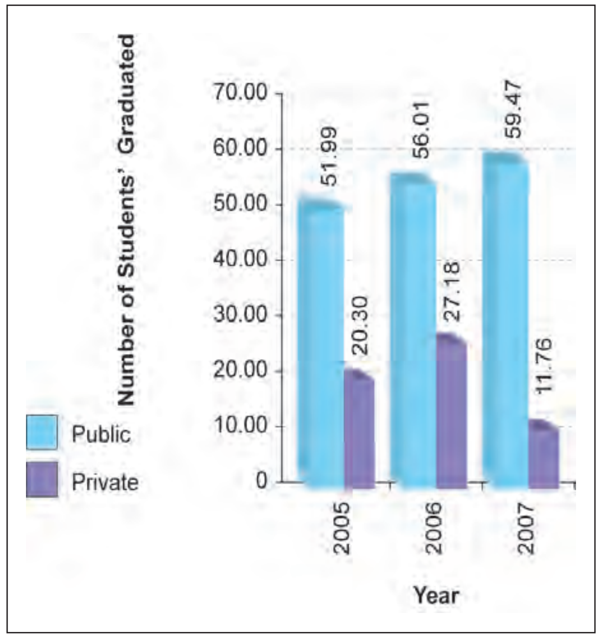
This section examines the ratio of students' enrolment and graduation in tertiary education in public and private institutions at first degree and post-graduate levels.

Figure 2.31: Enrolment in First Degree Level in Public and Private Institutions of Higher Learning (2005 – 2007)('000)



Source: Ministry of Higher Education Malaysia

Figure 2.32: Graduates in First Degree Level in Public and Private Institutions of Higher Learning (2005 – 2007)('000)



Source: Ministry of Higher Education Malaysia

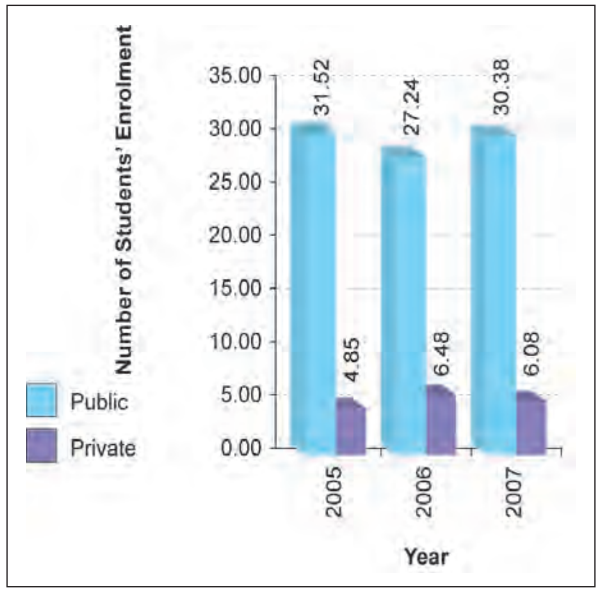
Figure 2.31 indicates a slight increase in the total number of students' enrolment for first degree level at both the private and public IHLs from 2005 to 2007. The number increased by 4.8% in 2006 and 13.7% in 2007. The enrolment in private IHLs increased a bit higher by 22.4% from 2005 to 2006 and 13.2% from 2006 to 2007 (June 2007).

In 2005, the shared percentages of students' enrolment in public and private institutions were 67.2% and 32.8% respectively. The percentage of students' enrolment in public institutions recorded a decrease of 3.5% in 2006. In the first-half of 2007, the shared percentage of student's enrolment in private institutions was 36.2% as compared to 64.8% for public institutions. This data records an increasing proportion of students shared by the private IHL.

As shown in Figure 2.32, students graduated in the first degree level from public institutions increased constantly from year 2005 to 2007. In the private institutions, on the other hand, the number of students graduated seems to decrease slightly in 2007 by more than half the figure in 2006.

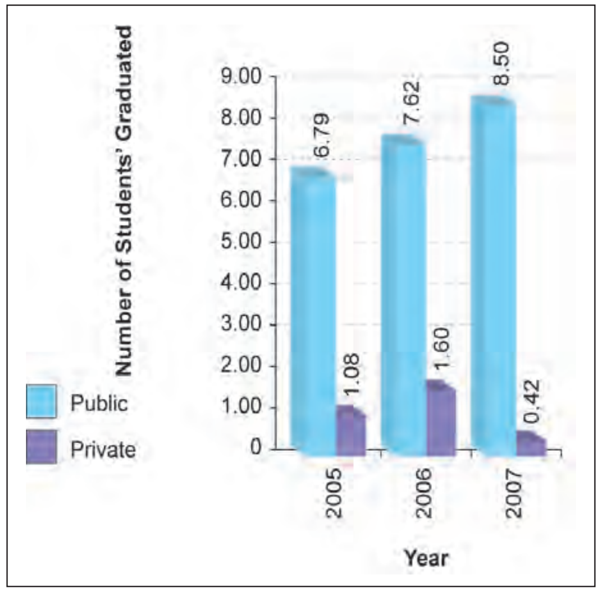
In 2005, the shared percentage of students graduated in the public institutions was 71.5% compared to private institutions, which was 28.5%. The proportion shrank by 4.2 percentage points to 67.3% in 2006. In 2007 the proportion seems to increase tremendously with the decrease in the number of graduated students in the private IHLs.

Figure 2.33: Enrolment in Master's Degree Level in Public and Private Institutions of Higher Learning (2005 – 2007) ('000)



Source: Ministry of Higher Education Malaysia

Figure 2.34: Graduation in Master's Degree Level in Public and Private Institutions of Higher Learning (2005 – 2007) ('000)



Source: Ministry of Higher Education Malaysia

Based on figure 2.33, it shows that students' enrolment in master's degree programmes at the public IHLs decreased by 13.6% from 31,518 students in 2005 to 27,242 students in 2006. The number however, increased by 11.5% to 30,383 students in 2007. This figure, however, is still found lower than the figure in 2005.

The master's degree enrolment in private institutions increased by 33.6% from 4,849 students in 2005 to 6,477 students in 2006. For the first-half of 2007, the number decreased by 6.1% to 6,084 students.

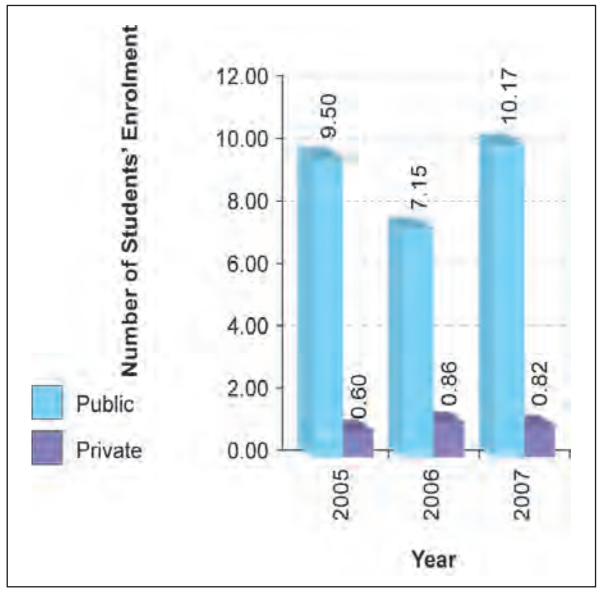
In 2005, the shared percentage of students' enrolment in master's degree for public institutions was 86.7% as compared to private institutions with only 13.3%. The share of students' enrolment for the public institutions was smaller in 2006 i.e. 80.8%. However it increased to 83.3% in 2007.

Figure 2.34 shows that students graduated in the master's degree programme from the public IHLs has increased by 12.3% in 2006 and 11.5% in 2007. The master's degree students graduated from the private IHLs has also shown an increased of 47.4% from in 2006. As of June 2007, there were 418 students graduated it in the master's degree programme.

In 2005, the shared percentage of students graduated in the master's degree programme from the public IHLs was 86.3% as compared to private institutions with a proportion of 13.7%. The proportion seems to shrank to 82.7% in 2006 but increased again to 95.3% in 2007.

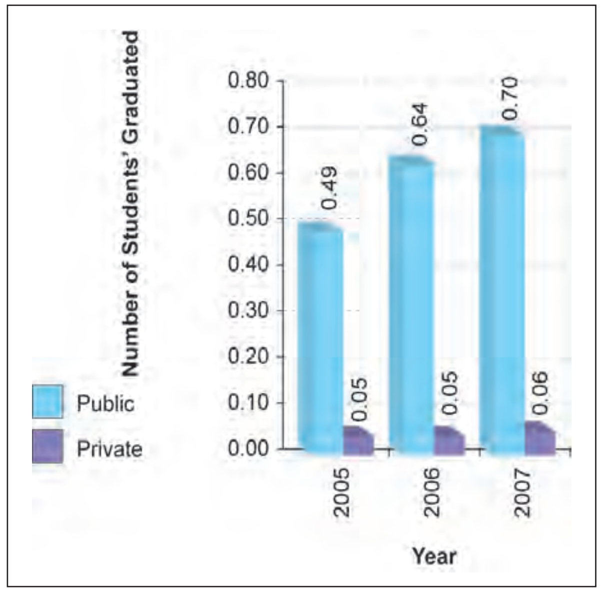
The overall overview of both figures, indicate the slight shrinking in registration of students in the master's programme at the public IHLs. This may reflect the importance of quality as compared to volume. It seems, the shrinking value of enrollments was fairly compensated by the constant increase in students' graduation.

Figure 2.35: Enrolment in PhD Level in Public and Private Institutions (2005 – 2007) ('000)



Source: Ministry of Higher Education Malaysia

Figure 2.36: Graduation in PhD Level in Public and Private Institutions (2005 – 2007)('000)



Source: Ministry of Higher Education Malaysia

As shown in Figure 2.35, the pattern is also the same for students' enrolment in the PhD level programme at the public IHLs as compared to the master's degree programme above. The number of enrollments seems to decrease by 24.5% from 9,504 in 2005 to 7,152 students in 2006 but increased by 42.2% with 10,167 students in 2007.

Similarly, the number of students' enrolment in the PhD level programmes at the private IHLs seems to increase by 43.8% from 598 students in 2005 to 860 students in 2006 but decreased by 5% with 817 students in 2007.

In 2005 the shared percentages of students' enrolment in the PhD level programme for public and private IHLs were 95% and 5% respectively. The shared percentage was smaller for the public IHLs in 2006 (89.3%). However, the proportion seems to increase to 92.5% in 2007.

Based on Figure 2.36, the number of students' graduated at the PhD level from the public IHLs was found increasing steadily every year from 485 students in 2005 to 702 students in 2007. Similarly, the number of students' graduated at the PhD level in the private IHLs also increased steadily from 47 students in 2005 to 59 students in 2007.

In 2005 the shared percentage of students' graduated at the PhD level from the public IHLs was 91.2% as compared to private institutions with 8.8%. The shared percentage of students' enrolment was larger in 2006 (with 92.6%).

The small value for both enrollments and graduations at the private IHLs indicates that these institutions are mostly teaching based institutions. This means their allocations for research and post graduate studies are very small and limited.

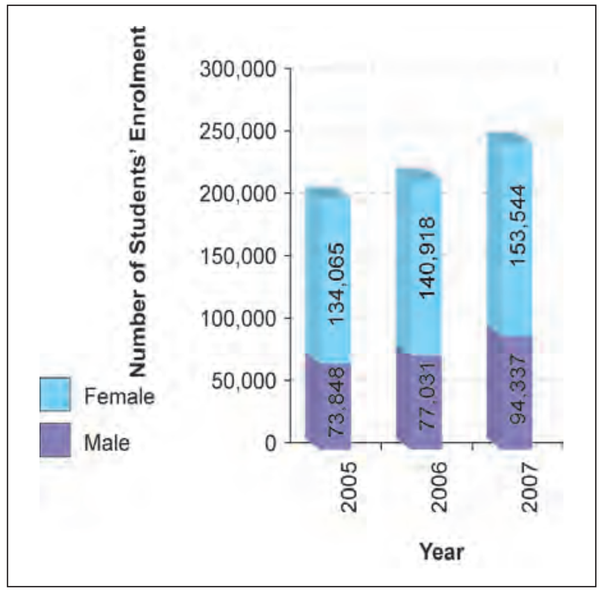
2.5 SOME GENDER COMPARISONS

This section provides gender comparisons on the number of students enrolled and graduated in public and private institutions at the first degree and post-graduate degree levels.

2.5.1 Gender Comparisons in Public Institutions

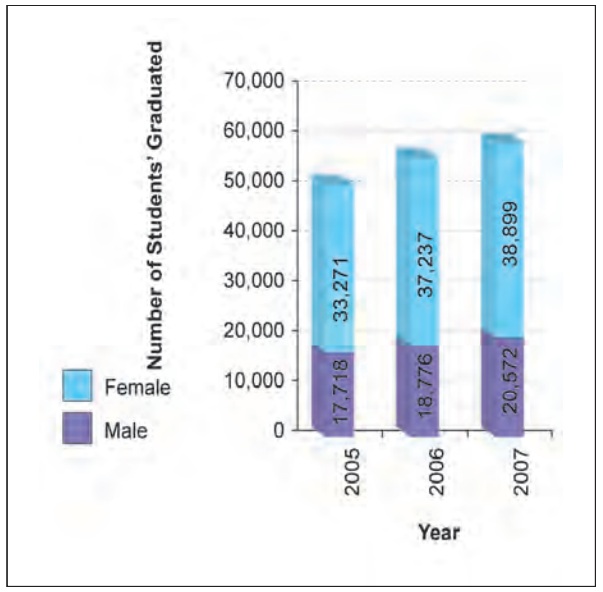
This sub-section provides comparative data for male and female students' enrolment and graduation at first degree and post-graduate levels in the public IHLs for fiscal year 2005-2007.

Figure 2.37: Gender Comparison for Students' Enrolment in First Degree Level in Public Institutions



Source: Ministry of Higher Education

Figure 2.38: Gender Comparison for Students' Graduated in First Degree Level in Public Institutions

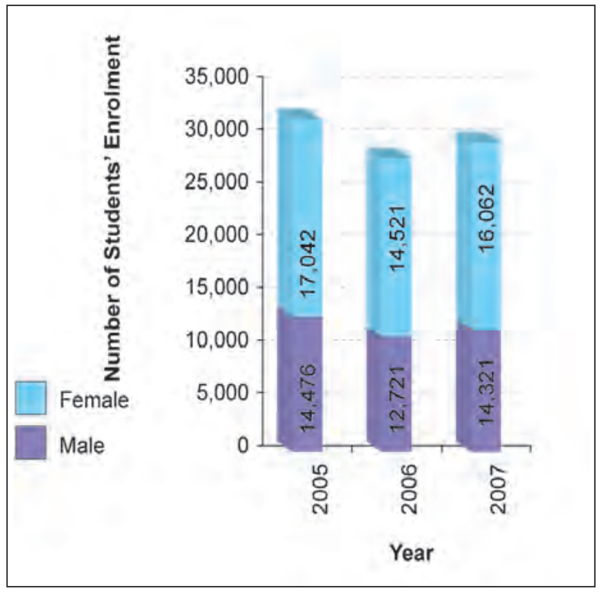


Source: Ministry of Higher Education

Based on the statistics given, for the period under review (2005-2007), female undergraduate students in public institutions outnumbered their male counterparts. The number of female undergraduates was almost twice higher than the number of males (Figure 2.37).

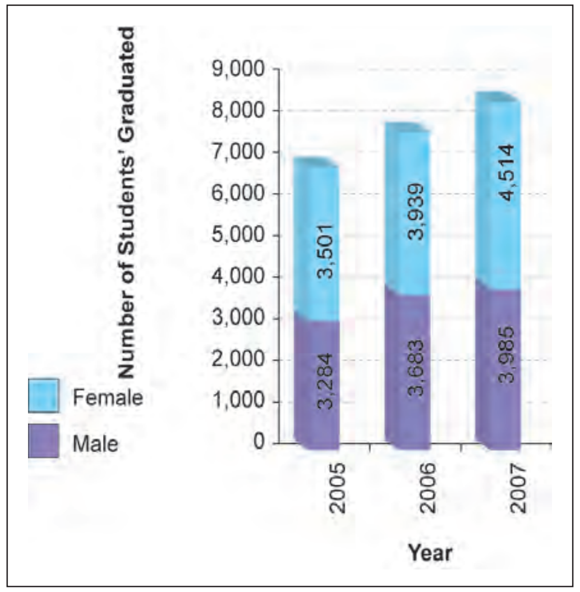
As shown in Figure 2.38, similar scenario can be observed with regard to the number of degree holders in public institutions. There were more female graduates as compared to their male counterparts with a ratio of about 2:1.

Figure 2.39: Gender Comparison for Students' Enrolment in Masters' Degree Level in Public Institutions



Source: Ministry of Higher Education

Figure 2.40: Gender Comparison for Students' Graduated in Masters' Degree Level in Public Institutions

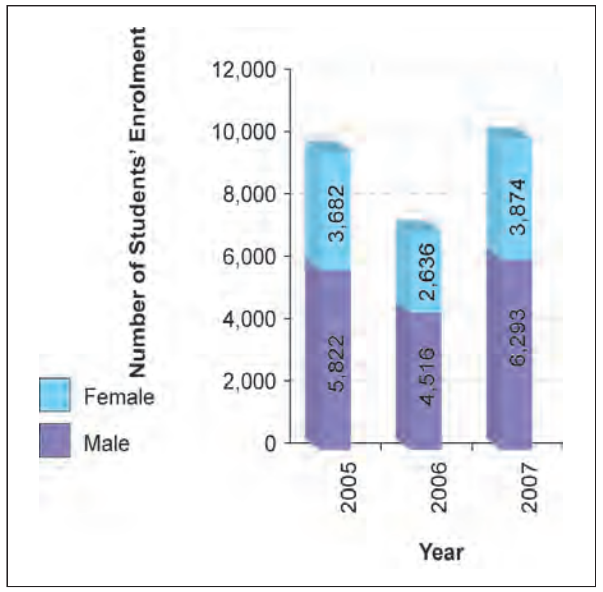


Source: Ministry of Higher Education

Overall, female students still dominated in the masters' degree level programme in public IHLs. Nevertheless, the percentage composition of male students in master's degree level in public educational institutions as compared to female students has increased marginally from 45.9% in 2005 to 46.7% in 2006 and 47.1% in 2007 (Figure 2.39).

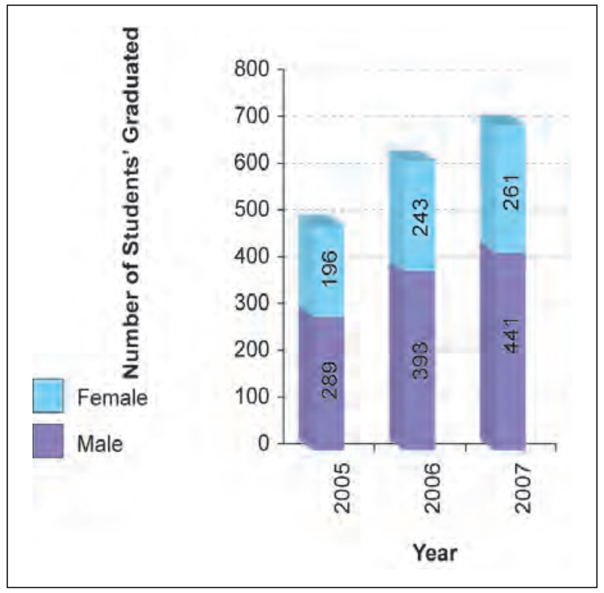
At Master's degree level (Figure 2.40), the distribution of female students as opposed to male students did not show obvious gender gap. The percentage composition of female students was slightly higher than those of male students i.e. a little over 50%.

Figure 2.41: Gender Comparison for Students' Enrolment in PhD Level in Public Institutions



Source: Ministry of Higher Education

Figure 2.42: Gender Comparison for Students' Graduated in PhD Level in Public Institutions



Source: Ministry of Higher Education

Figure 2.41 shows different scenario observed at PhD level in public institutions, whereby male students outnumbered their female counterparts with a ratio of about 3:2. Similar scenario was observed for graduates at the PhD level, in which male students outnumbered their female counterparts with a ratio of about 3:2 (Figure 2.42).

2.6 CONCLUSION

Overall, the total number of students' enrolment in the first degree level at the public and private IHLs has been on the rise since 2005 until 2007.

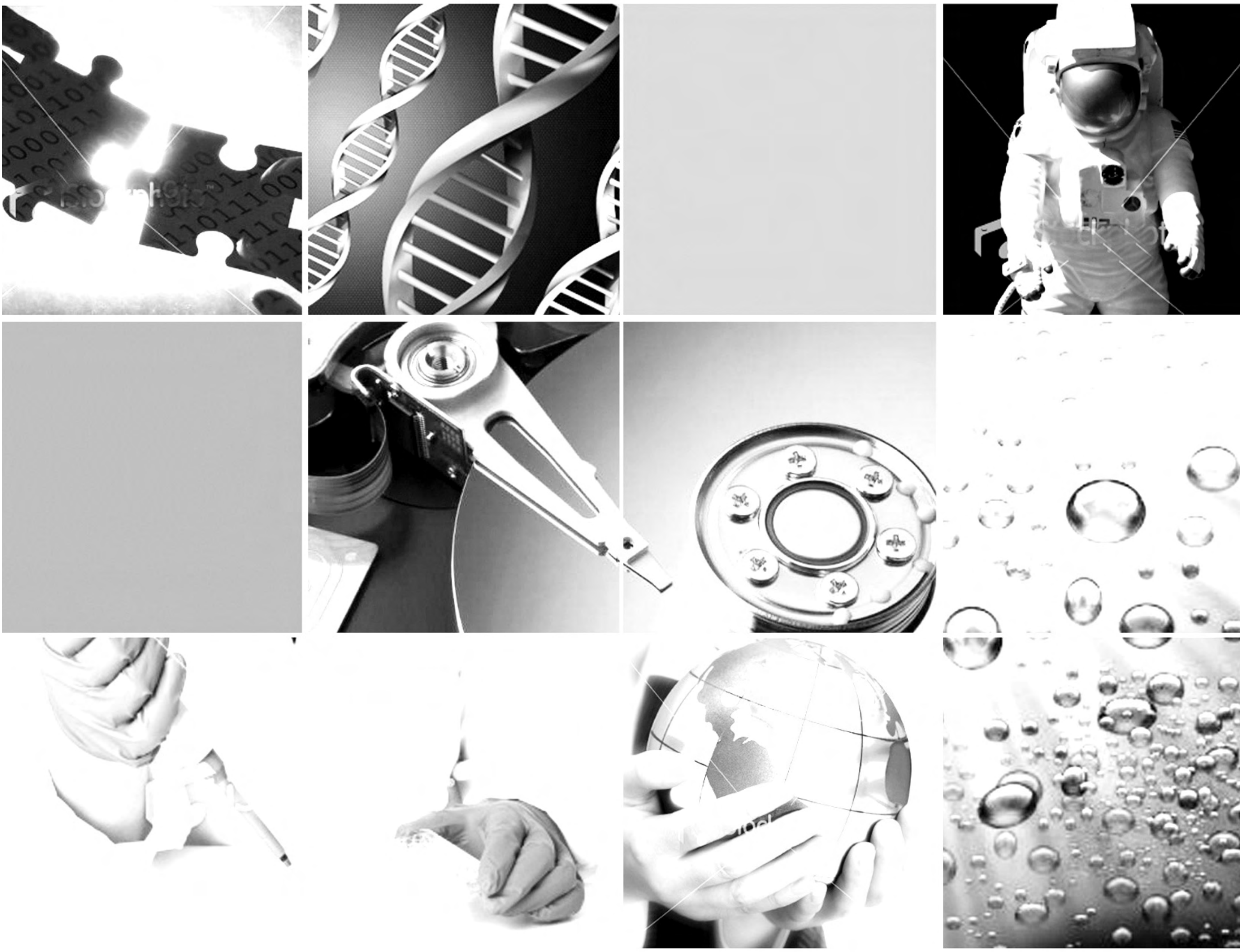
Students graduated in first degree level in public institutions increased steadily in 2005 until 2007. In the private institutions, the number of students graduated has been on the growth for two consecutive years from 2005 to 2006. However, the number decreased tremendously in 2007.

Students' enrolment in the master's degree programmes in the public IHLs seems to decrease in 2006. However, the number increased in 2007. The master's degree enrolment in private institutions increased in 2006. Nevertheless, the number decreased in 2007.

Students graduated in the master's degree courses in the public IHLs have been on the rising scale since 2005 to 2007. The master's degree students graduated in the private institutions also depicting a growing number in 2005 and 2006 but declining in 2007. Public institutions produced a higher number of graduates in the masters' degree programmes as compared to private institutions.

Enrolment in social science courses for the PhD level at the public institutions continued to increase from 2004 until 2007. However, the number of enrolment in other courses showed a declining trend after 2006.

In terms of gender composition, female undergraduate students in public institutions outnumbered their male counterparts with a ratio of 2:1. It was observed, however, that male students who enrolled and graduated in PhD courses in public institutions outnumbered their female counterparts with a ratio of about 3:2.



HUMAN RESOURCE FOR SCIENCE AND TECHNOLOGY

Chapter 3

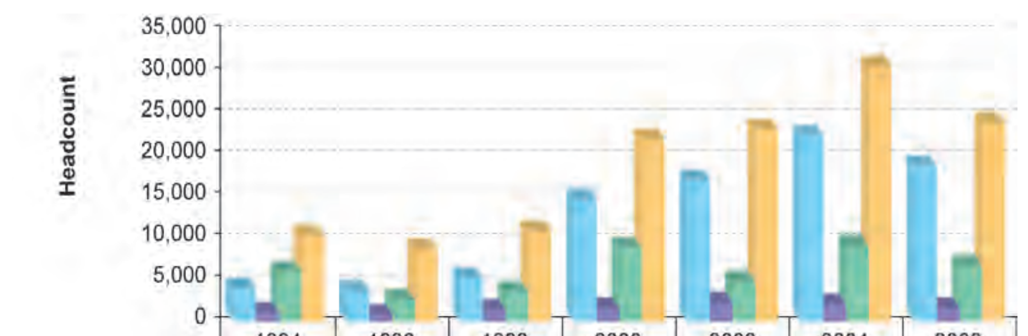
3.1 INTRODUCTION

This chapter provides information leading to human resources development per full time equivalent (FTE) in science and technology (S&T) R&D covering various government and non government sectors over the period of 1994 to 2006. These sectors include, but not limited to, the Government Research Institutions (GRIs), Institutions of Higher Learning (IHLs) and private sectors. In this report, data on academic qualification, field of research and expertise, and gender comparisons are also provided within each sector. The data and information included in this report has been provided by the National Survey on Research and Development 2008 Report.

3.2 NATIONAL HEADCOUNT AND FTE IN RESEARCH AND DEVELOPMENT

This section looks at the national headcount of R&D personnel from the period of 1994-2006 by providing statistical data on the overall headcount, and more detail statistics on qualification of the human resource, distribution according to research areas, participation of women in R&D, distribution of researchers according to selected field, distribution of researchers according to socio-economic and international comparison.

Figure 3.1 National Headcount of R&D Personnel, 1994 – 2006



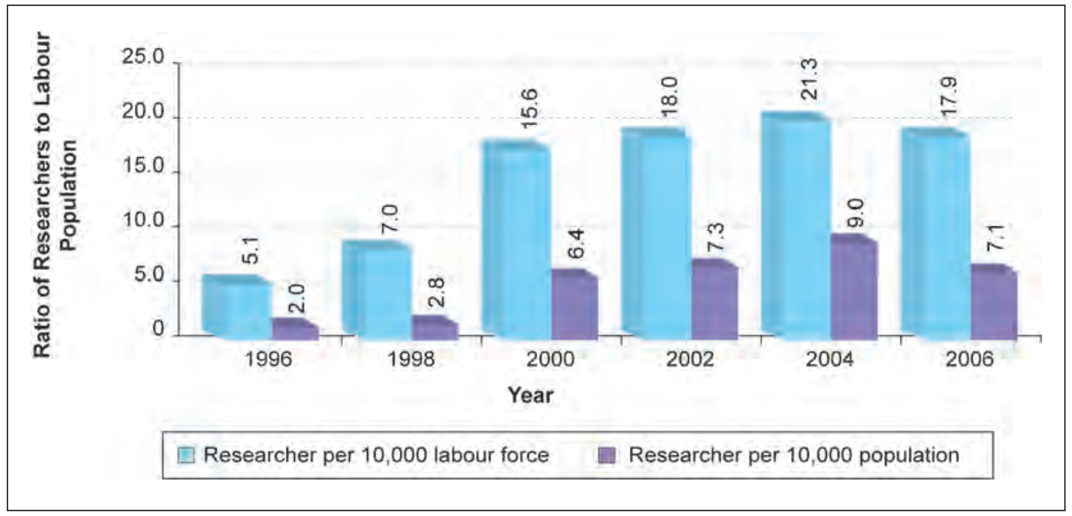
	1994	1996	1998	2000	2002	2004	2006
Researchers	4,545	4,243	6,249	15,022	17,790	23,092	19,021
Technicians	1,666	1,321	1,697	2,289	3,090	2,919	1,891
Support Staff	5,261	3,669	4,181	5,951	4,057	4,972	3,676
Total Headcount	11,472	9,233	12,127	23,262	24,937	30,983	24,588

Year

Source: National Survey on Research and Development 2008 Report

Figure 3.1 above illustrates the headcount of overall human resource in R&D, which includes researchers, technicians, and support staffs from the period of 1994 to 2006. The figure indicates a rising trend from 1994 to 2004, but decrease slightly in 2006 to 24,588 (-20.6%) to almost equivalent to the number recorded in 2002. This downward trend from 2004 to 2006 has been attributed to less headcounts for all job levels in the sector.

Figure 3.2 Ratio of Researchers to Labour Force/Population, 1996 – 2006

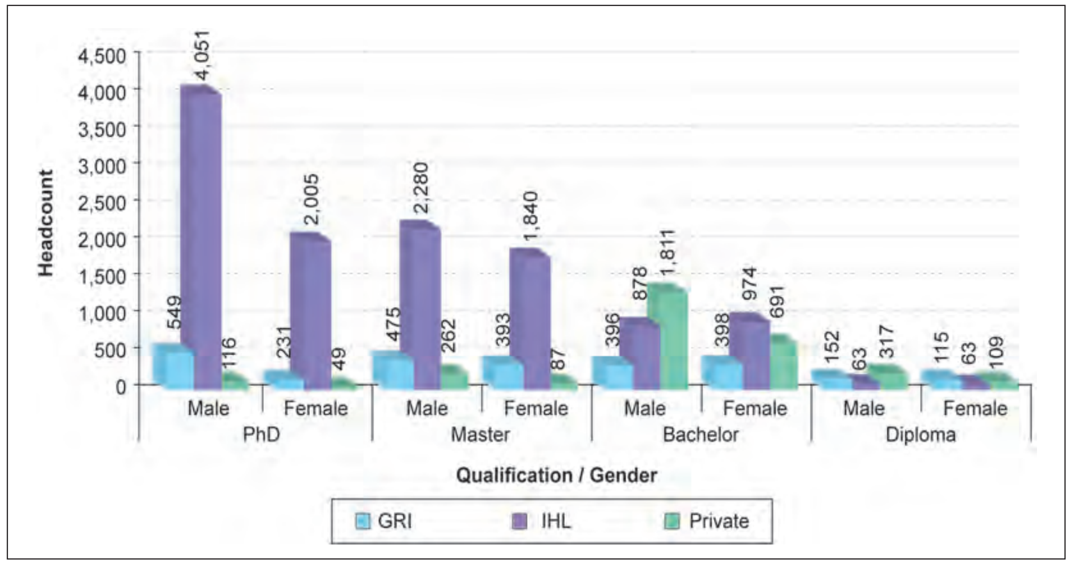


Source: National Survey on Research and Development 2008 Report

Figure 3.2 shows the ratio of researchers per 10,000 labour force and population throughout 1996 to 2006 reporting years. The upward trend can be observed from 1996 to 2004. Both ratios, however, show a decreasing account in 2006. Researcher per 10,000 labour forces recorded a slump of 16.0% from 2004 and 21.1% for researchers per 10,000 populations. This downward trend may be attributed to less allocation of budget to the R&D projects during 2005 to 2006.

3.2.1 Human Resource by Qualification and Gender

Figure 3.3 R&D Researchers (Headcount) by Sector, Qualification and Gender in 2006

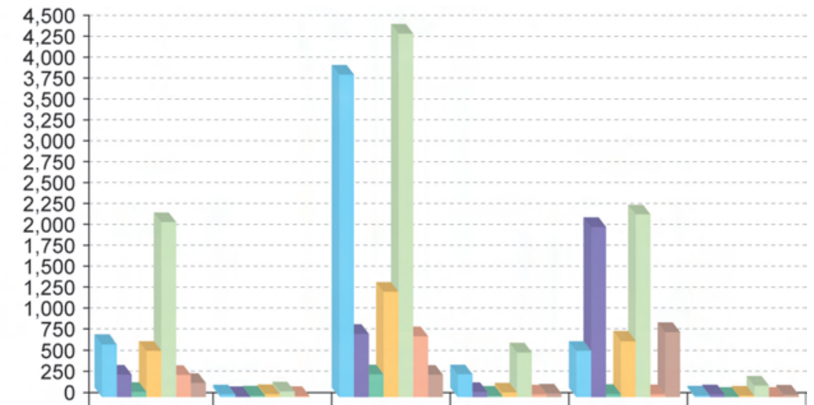


Source: National Survey on Research and Development 2008 Report

Figure 3.3 shows the number of researchers in GRI, IHL and private sectors according to qualifications and gender in the 2006 reporting year. Based-on the figure, the R&D researchers are dominated by mostly male researchers with PhD and working within the IHL environments. In terms of headcount, male made up to 72.8% of the total R&D researchers in Private Institutions, 59.8% in IHLs and 58.0% in GRIs. Large numbers of the male researchers were PhD and master degree holders in all sectors in 2006. Overall male researchers by headcount made up to 62.0% of the total R&D researchers in the research institutional.

3.2.2 Human Resource by FTE

Figure 3.4 Research Personnel (Headcount) by Sector, Nationality and Types of Research in 2006



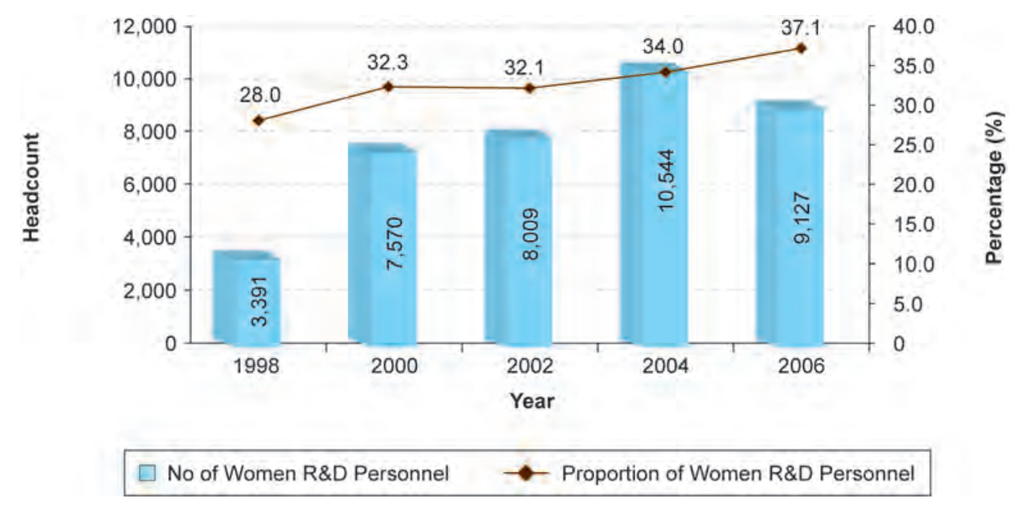
	Malaysian (GRI)	Foreigner (GRI)	Malaysian (IHL)	Foreigner (IHL)	Malaysian (Private)	Foreigner (Private)
Basic Research	674	9	3,898	329	616	46
Experimental Development	308	2	819	60	2,096	63
Basic Research & Experimental Development	156	7	315	20	80	1
Basic, Applied & Experimental Development	628	8	1,303	103	719	22
Applied Research	2,176	18	4,436	470	2,263	160
Basic Research & Applied Research	347	4	775	71	104	3
Applied Research & Experimental Development	219	–	354	44	836	16

Source: National Survey on Research and Development 2008 Report

Figure 3.4 shows the number of research personnel (headcount) by sector, nationality and type of research in 2006. The figure indicates that majority of the researchers were engaged in applied research, basic research and experimental development research. A smaller number were engaged in other types of research such as a combination of basic and applied research, basic and experimental research, and applied and experimental research. Only 5.9% (1,456) of the R&D researchers were foreigners and majority was hired at the IHLs.

3.2.3 Participation of Women in R&D

Figure 3.5 Women R&D Personnel, 1998 – 2006



Source: National Survey on Research and Development 2008 Report

Women participation in R&D increased steadily from 1998 to 2004. The total number of women participation in R&D decreased slightly in 2006. However, the proportion of women participation increased to 37.1%, a 9.1% increase from previous two years (Figure 3.5).

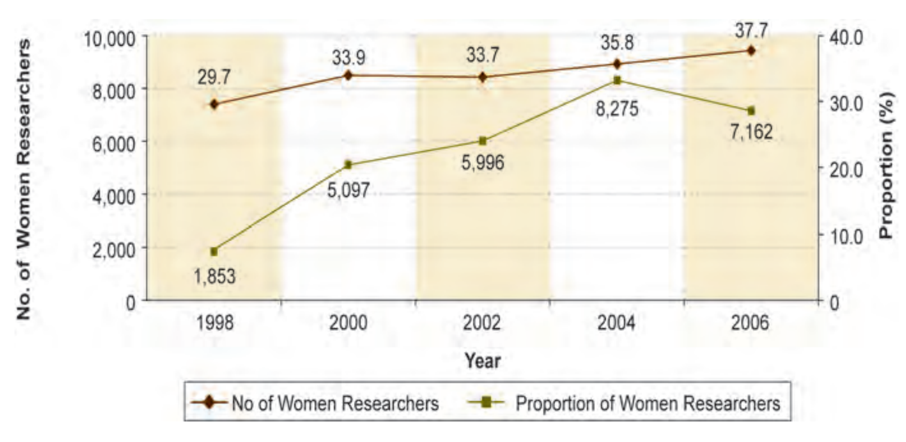
Figure 3.6 R&D Personnel (Headcount) by Sector, Nationality and Gender in 2006

	Malaysian						Foreigners					
	Researchers Male	Researchers Female	Technicians Male	Technicians Female	Supporting Staff Male	Supporting Staff Female	Researchers Male	Researchers Female	Technicians Male	Technicians Female	Supporting Staff Male	Supporting Staff Female
GRI	1,534	1,128	518	203	841	284	38	9	1	-	-	-
IHL	6,363	4,718	240	95	257	237	909	162	-	-	17	9
Private Institutions	2,848	1,124	693	134	913	1,002	167	21	7	-	115	1
Total Headcount	10,745	6,970	1,451	432	2,011	1,523	1,114	192	8	-	132	10

Source: National Survey on Research and Development 2008 Report

Figure 3.6 provides more statistical information on gender comparisons in R&D personnel according to sector, occupation types, and nationality. In terms of headcount, male workers seem to outnumber the female co-workers among the research personnel, technicians and supporting staffs in all sectors.

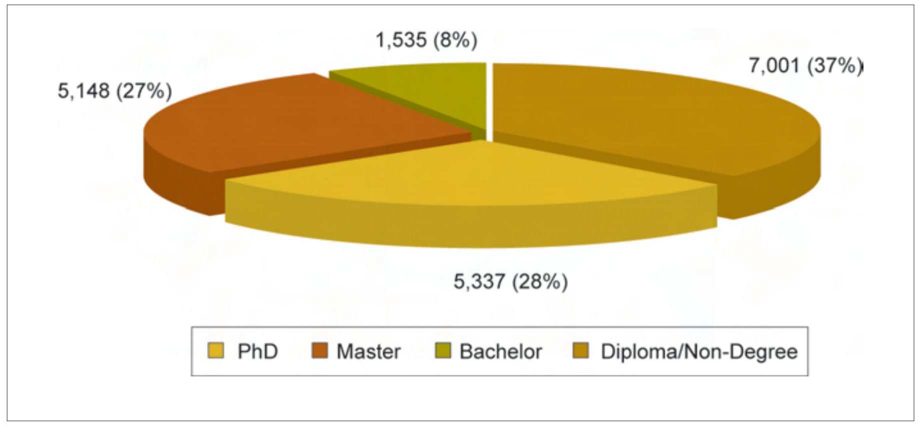
Figure 3.7 Women Researchers in R&D, 1998 – 2006



Source: National Survey on Research and Development 2008 Report

Figure 3.7 further highlights the engagement of women in R&D through their roles as researchers. The number of women researchers increased from 1998 to 2004 and marked a significant year in 2004 when it reached 8,275 (+38.0%). In 2006, the number of women researchers dropped by 13.5% from 8,275 in 2004. Women involvement proportion seems to increase fairly throughout the year, indicating the strength and significant of women in R&D. This increasing pattern in the proportion of women involvement may continue at a similar pace for the next two years.

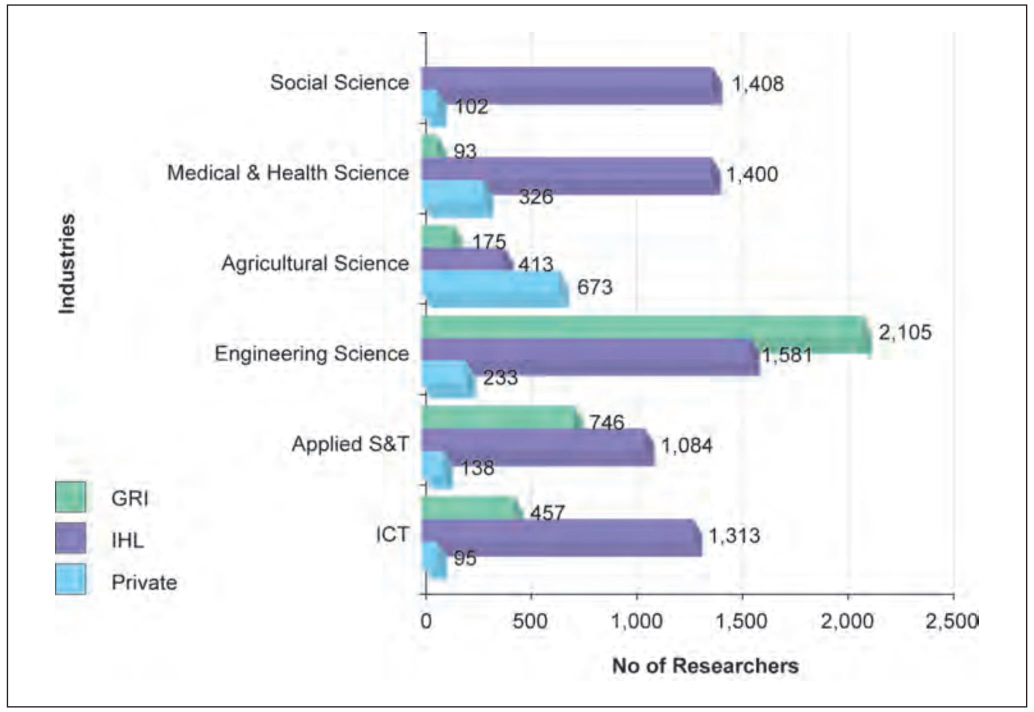
Figure 3.8 Numbers of Researchers by Qualification for Women Researchers in Malaysia, 2006



Source: National Survey on Research and Development 2008 Report

Majority of women researchers in Malaysia hold Ph.D. degrees, followed by masters degree, bachelor degrees and diploma in 2006 (Figure 3.8). In terms of qualification, 37% of the total number of women researchers in Malaysia constituted of doctorate holders. The proportions of the masters and bachelors degree holders were quite similar with 28% (5,337) and 27% (5,148) respectively. Only 8% of the women researchers were diploma or non-degree holders in 2006.

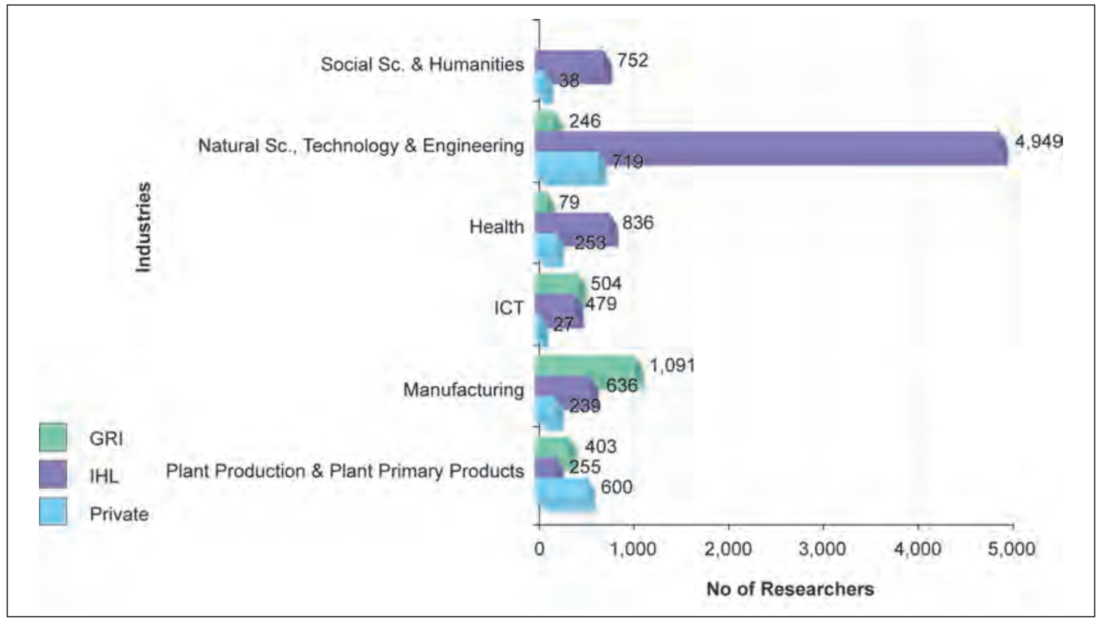
Figure 3.9 Sectoral Comparisons and Ranking of Top Six FORs, 2006



Source: National Survey on Research and Development 2008 Report

Figure 3.9 shows the distribution of researchers by selected top six fields of research in R&D in GRI, IHL and private sectors. Among the top six fields are engineering science, medical & health sciences, social sciences, applied science & technology, ICT and agricultural science. IHLs dominate most of the sectors in the number of researchers hired. However, engineering sciences recorded the highest number of researchers hired by the private sectors, whereas agricultural science recorded the highest number of researchers hired by the GRIs.

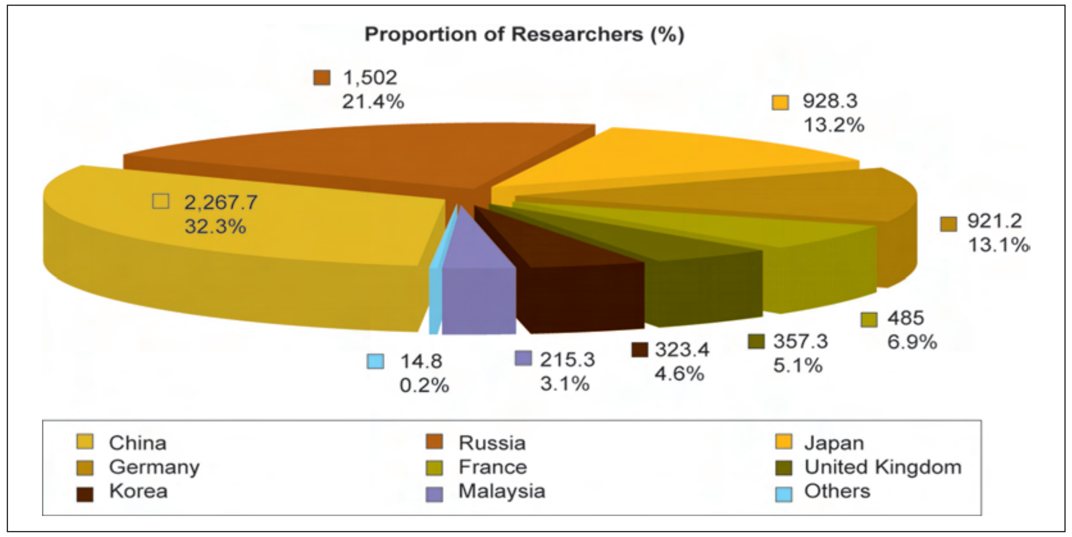
Figure 3.10 Sectoral Comparisons and Ranking of Top Six SEOs, 2006



Source: National Survey on Research and Development 2008 Report

Socio-economic objectives or SEO allows R&D in Malaysia to be categorized according to the intended purposes or outcomes of the research rather than processes or techniques used in order to achieve these objectives. As shown in Figure 3.10, IHLs recorded extremely high number of researchers in natural sciences, technology & engineering (83.7%) in 2006 compared to GRIs (12.2%) and private institutions (0.1%). Other sectors like manufacturing and ICT have been slightly dominated by the private industries, whereas plan production and plant primary products have been dominated by the GRI in terms of the number of researchers.

Figure 3.11 International Comparison of Total FTE of Researchers, 2006

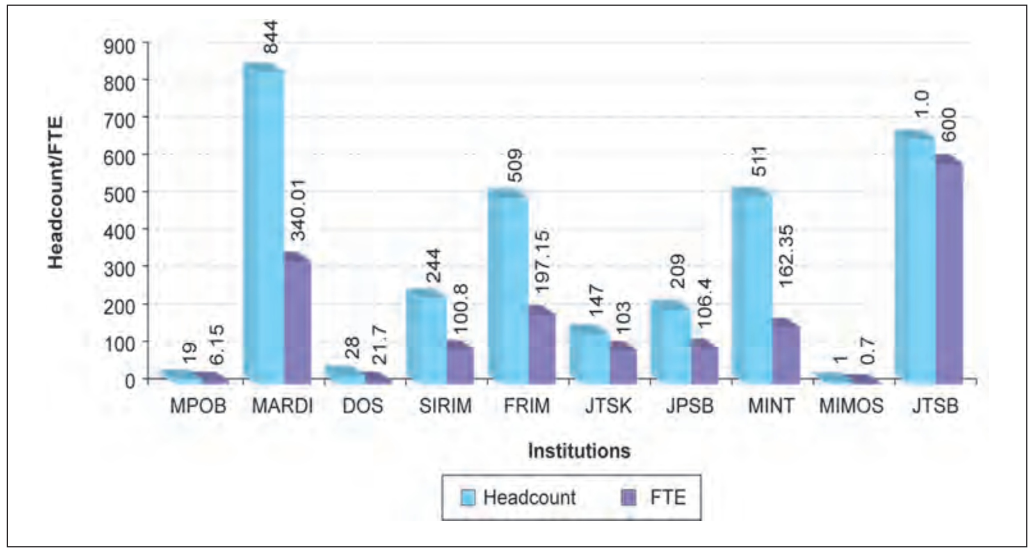


Source: IMD World Competitiveness Year Book 2008

Figure 3.11 shows the number of total R&D personnel worldwide in 2006. The highest proportion in the full-time equivalent (FTE) was recorded with China, which constituted of 21.4% followed by Russia (13.2%), Japan (13.1%), Germany (6.9%), France (5.1%), United Kingdom (4.6%) and Korea (3.1%). Malaysia only recorded with a very small proportion of the researchers with 0.2% of the total R&D personnel.

3.2.4 R&D Personnel in Selected GRIs

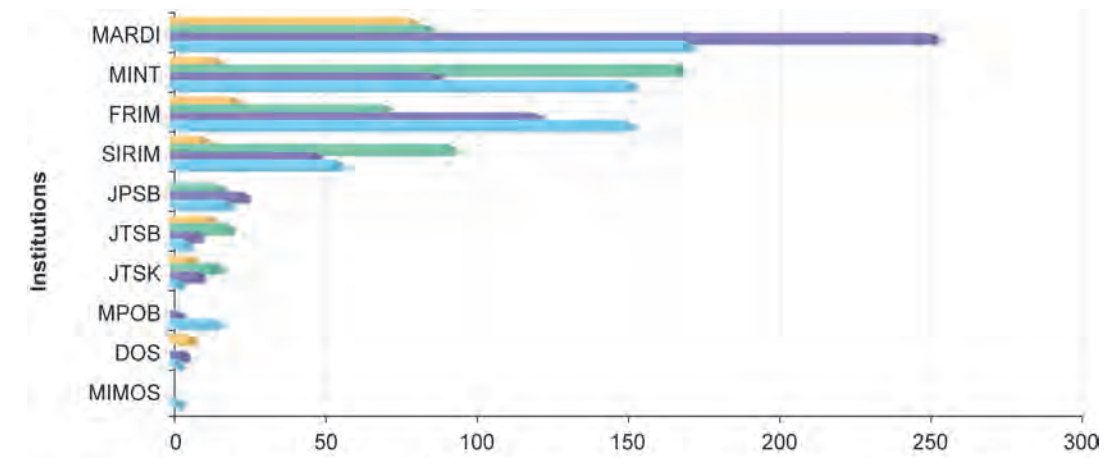
Figure 3.12 R&D Personnel (Malaysian & Foreigners) (Headcount & FTE) in Selected GRIs, 2006



Source: National Survey on Research and Development 2008 Report

Figure 3.12 illustrates the total number of Malaysian and foreigners R&D personnel in terms of headcount and FTE in the selected GRIs. Malaysian Agricultural Research and Development Institute (MARDI) recorded the highest number of R&D personnel in 2006 with 844 for headcount and 340.01 for FTE. This is followed by JTSB, MINT and FRIM, which also constitute the top employers of research personnel.

Figure 3.13 Researchers (Malaysians) (Headcount) by Qualification in Selected GRIs, 2006



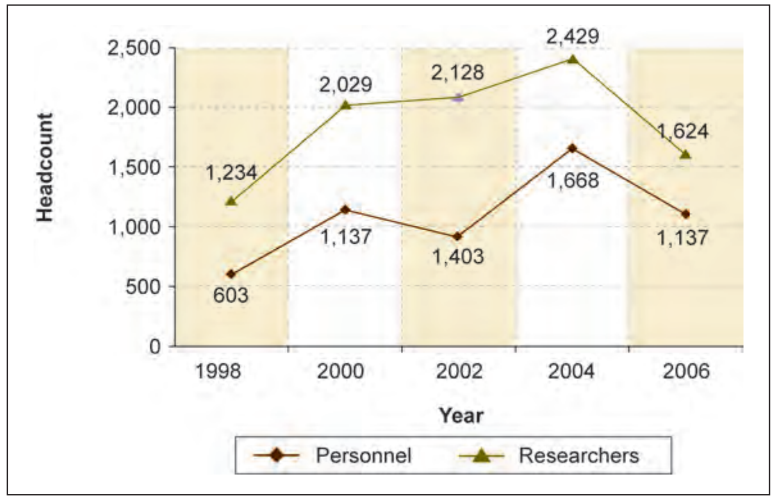
	MIMOS	DOS	MPOB	JTSK	JTSB	JPSB	SIRIM	FRIM	MINT	MARDI
Diploma	-	8	-	8	14	-	12	22	16	80
Bachelor	-	-	-	16	20	17	93	71	168	86
Master	-	5	1	10	9	25	48	121	88	252
PhD	1	2	16	2	6	20	56	151	152	171

No of Researchers

Source: National Survey on Research and Development 2008 Report

Figure 3.13 shows Malaysian researchers in terms of headcount by qualification in the selected GRIs. Among the GRIs that involved in R&D in 2006 were MARDI, MINT, FRIM, SIRIM, JPSB, JTSB, JTSK, MPOB, DOS and MIMOS. MARDI recorded the highest number of researchers during that year 2006 with a total of 589 personnel. Majority of researchers were holding masters degree (43%), followed by doctorate degree holders (29%), and bachelors and diploma degrees (15% and 14%). MINT, FRIM and SIRIM employed over 50% of the total Malaysian researchers combined.

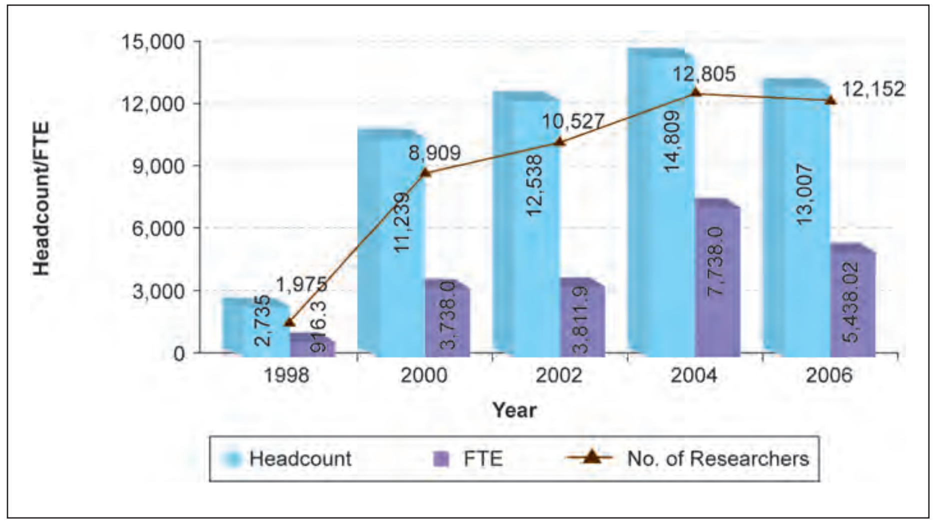
Figure 3.14 Women R&D Personnel and Researchers in GRIs, 2006



Source: National Survey on Research and Development 2008 Report

The trend of women researchers increased from 1998 to 2004 but it fell in 2006. It marked a significant decline when it dropped to 1,624, 33.1% from 2004 for R&D personnel by headcount. Figure 3.14 also illustrated the downward trend in the total number of women participation in R&D, which about 31.8% dropped to 1,137 R&D personnel from the previous year.

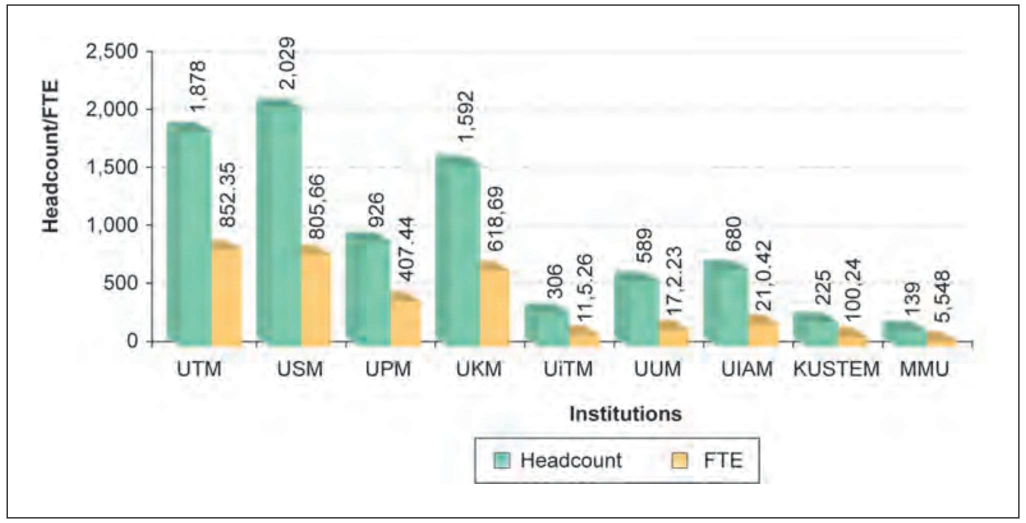
Figure 3.15 R&D Personnel in IHLs by Headcount and FTE, 1998 – 2006



Source: National Survey on Research and Development 2008 Report

Figure 3.15 shows the total number of researchers by headcount and FTE in IHLs from 1998 to 2006. The increasing trend in the number of research personnel can be observed from year 1998 to 2004. In 2006, the number of R&D personnel decreased by 12.1% (headcount), 29.7% (FTE) and 5.1% in the number of researchers. Overall the R&D personnel in IHLs by headcount and FTE recorded the highest number in 2004.

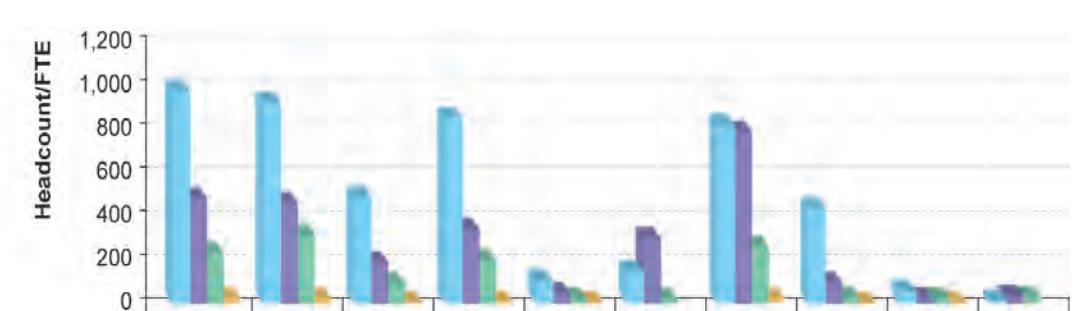
Figure 3.16 R&D Personnel (Malaysians & Foreigners) (Headcount & FTE) in Selected IHLs, 2006



Source: National Survey on Research and Development 2008 Report

Figure 3.16 shows the total number of researchers in nine IHLs by headcount and FTE. The statistics shows that USM, UTM, UKM and UPM were among the top IHLs employing R&D personnel in 2006. USM ranked as the highest IHL by headcount with 2,029 personnel, followed by UTM (1,878), UKM (1,592), UPM (926), UIAM (680), UUM (589), UiTM (306), KUSTEM (225) and MMU (139). In terms of FTE, UTM had the largest number of R&D personnel in 2006.

Figure 3.17 Researchers (Malaysians & Foreigners) (Headcount) in Selected IHLs, 2006



	UTM	USM	UPM	UKM	UiTM	UUM	UM	UIAM	KUSTEM	MMU
PhD	1,000	959	529	887	152	179	850	475	99	43
Master	520	498	217	378	86	336	811	129	52	65
Bachelor	7	356	124	236	54	51	295	66	59	30
Diploma	25	25	9	14	3	-	18	3	2	-

Institutions

Source: National Survey on Research and Development 2008 Report

Figure 3.17 shows the distribution of researchers in selected IHLs according to academic qualification. Overall, University Science of Malaysia (USM) hired the highest number of researchers (19%) with Universiti Teknologi Malaysia (UTM) falls slightly behind (18%) from the overall figure. Those with Ph.D. degrees made up the majority of the researchers in IHLs with University Technology Malaysia (UTM) leading the figure, followed by University Sains Malaysia (USM), Universiti Kebangsaan Malaysia (UKM), University of Malaysia (UM), Universiti Putra Malaysia (UPM), and International Islamic University Malaysia (UIAM).

HUMAN RESOURCE FOR SCIENCE AND TECHNOLOGY

Chapter 3

Table 3.1 Percentage of Researchers in IHLs According to Academic Qualification per University Population, 2006

	UTM	USM	UPM	UKM	UITM	UUM	UM	UIAM	KUSTEM	MMU
PhD	55	52	60	59	52	32	43	71	47	31
Masters	29	27	25	25	29	59	41	19	25	47
Bachelor	15	19	14	16	18	9	15	10	28	22
Diploma	1	1	1	1	1	-	1	-	1	-
Total	100	100	100	100	100	100	100	100	100	100

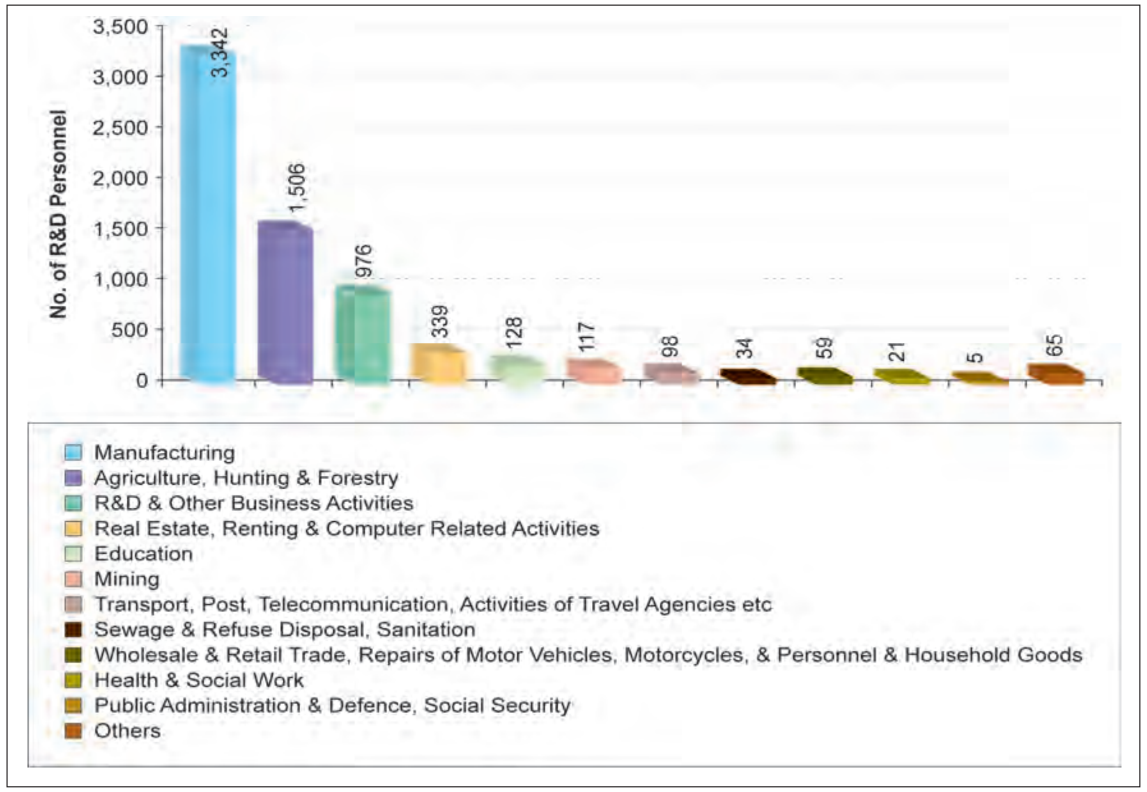
Source: National Survey on Research and Development 2008 Report

Table 3.1 looks at the distribution of the researchers in each IHL based on the shared qualification percentages per university population in 2006. Based on the information, International Islamic University had the highest percentage (71%) of the PhD holder researchers in its population. This is followed by UPM (60%), UKM (59%), UTM (55%), USM (52%) and UITM (52%), KUSTEM (47%), UM (43%), UUM (32%) and MMU (31%). Though UTM had the highest number of Ph.D. holders overall, the percentage per population is a bit lower than three other universities mentioned earlier.

3.3 HUMAN RESOURCE IN PRIVATE SECTOR

3.3.1 Private Sector R&D Personnel by Industry and Nationality

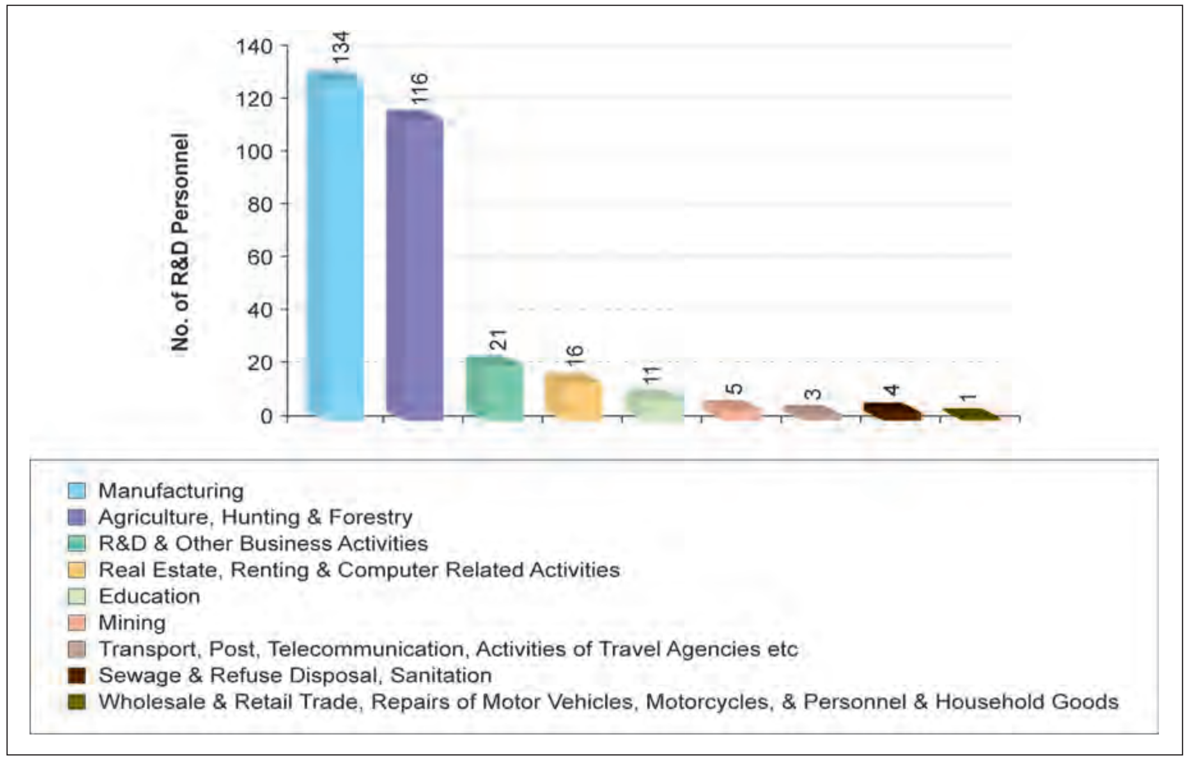
Figure 3.18 Private Sector R&D Personnel (Malaysians) (Headcount) by Industry, 2006



Source: National Survey on Research and Development 2008 Report

As expected, Figure 3.18 shows that most of the Malaysian R&D personnel in the private sector organizations engaged in manufacturing industries with over 50% of the shared percentage. This is followed by agriculture, hunting & forestry (1,506), R&D & other business activities (976), mining (339) and other industries.

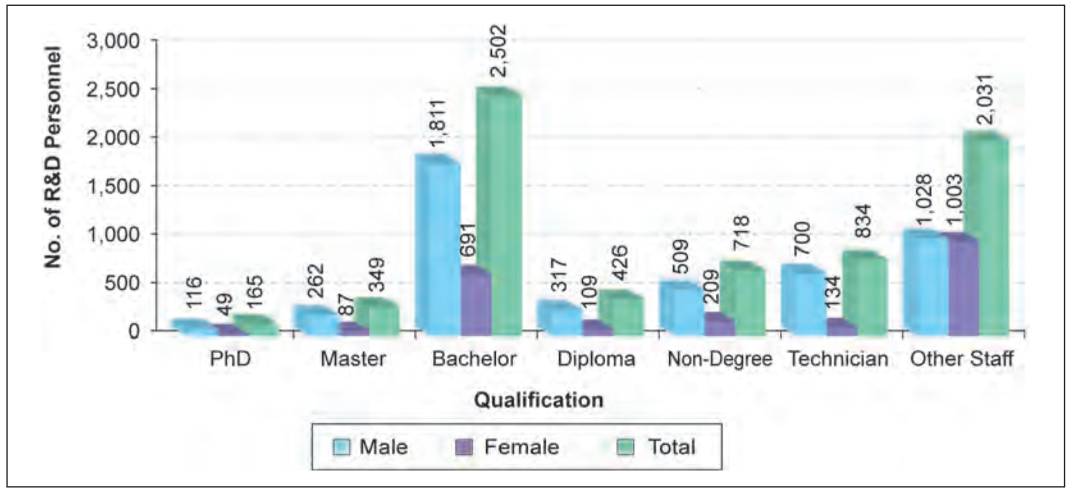
Figure 3.19 Private Sector R&D Personnel (Foreigners) (Headcount) by Industry, 2006



Source: National Survey on Research and Development 2008 Report

Figure 3.19 indicates the foreign R&D personnel by headcount in 2006. Manufacturing contributed the highest number of R&D personnel with 134 headcount (48.1%), agriculture, hunting & forestry (116: 37.3%), R&D & other business activities (21: 6.8%) and other industries contributed a minor share in the overall headcount.

Figure 3.20 Private Sector R&D Personnel by Qualification and Gender, 2006



Source: National Survey on Research and Development 2008 Report

Figure 3.20 shows the distributions of R&D personnel by qualification and gender in the private sector. Bachelor degree holders represented 35.6% of the proportion and the other qualifications contributed 3.4% to 28.9% of the total number of R&D personnel in private sector. This indicates the nature of R&D personnel in the private sectors was mostly bachelor degree holders and was highly male dominant.

3.4 PROGRAM TO ENCOURAGE MALAYSIAN CITIZENS WITH EXPERTISE RESIDING OVERSEAS TO RETURN TO MALAYSIA

Thousands of Malaysian-born scientists and engineers (MBSE) are currently working abroad. The Malaysia government has introduced a programme in 2001 to encourage Malaysian citizens with expertise residing overseas to return to Malaysia. This programme was initiated to create a Malaysian world class workforce in various area of expertise effective from 1st January 2001.

In order to encourage expertise residing overseas, Malaysian government had given incentives to the expertise such as:

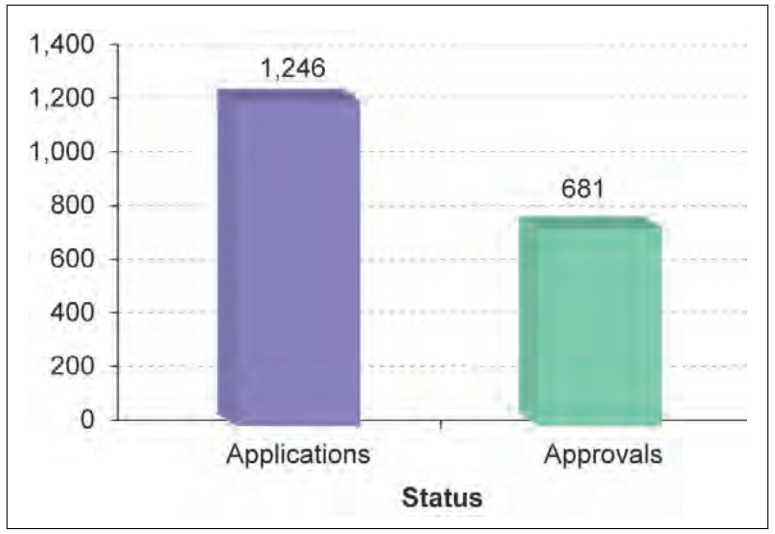
i. Tax exemption from import & excise duties and sales tax for all personal possessions including motorcars will be given.

ii. Permanent resident status the spouse and children after 6 months residency.

iii. Freedom to enter international school for the children.

iv. Expertise's spouse allowed applying "employment pass" if their qualification and expertise needed.

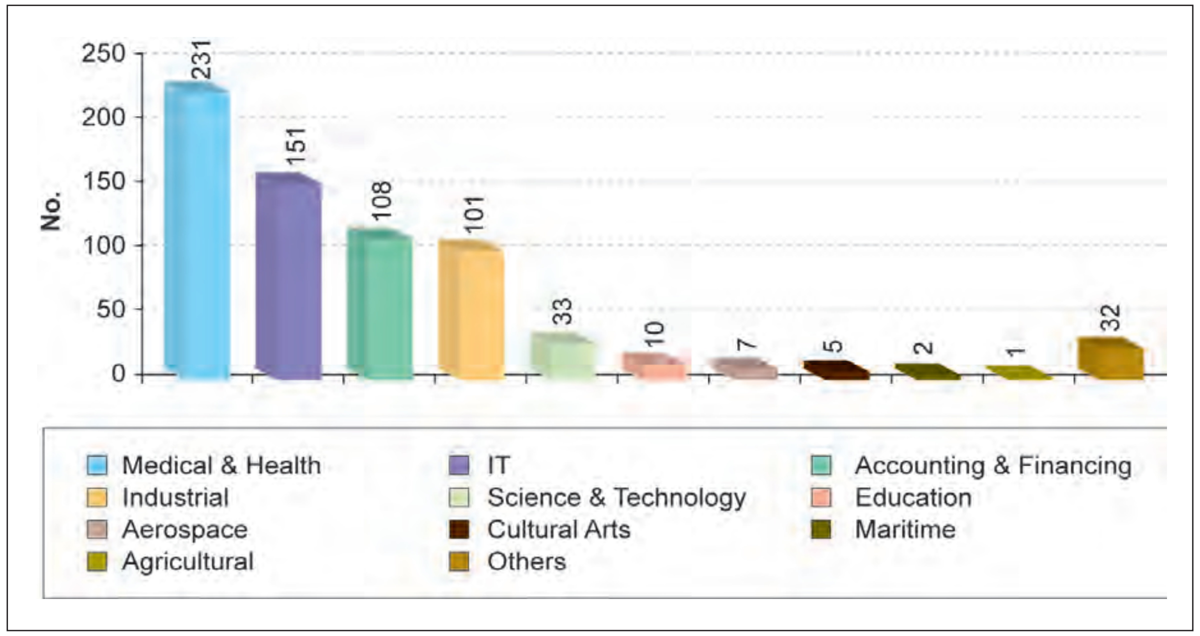
Figure 3.21 Number of Programme Applications and Approvals



Source: Ministry of Human Resources

The data represents the returnees programme to encourage Malaysians citizen with expertise residing overseas to return to Malaysia from 1st January 2001 to 12th March 2009. The number of applications received was 1,246. Of the total, about 55% have been approved.

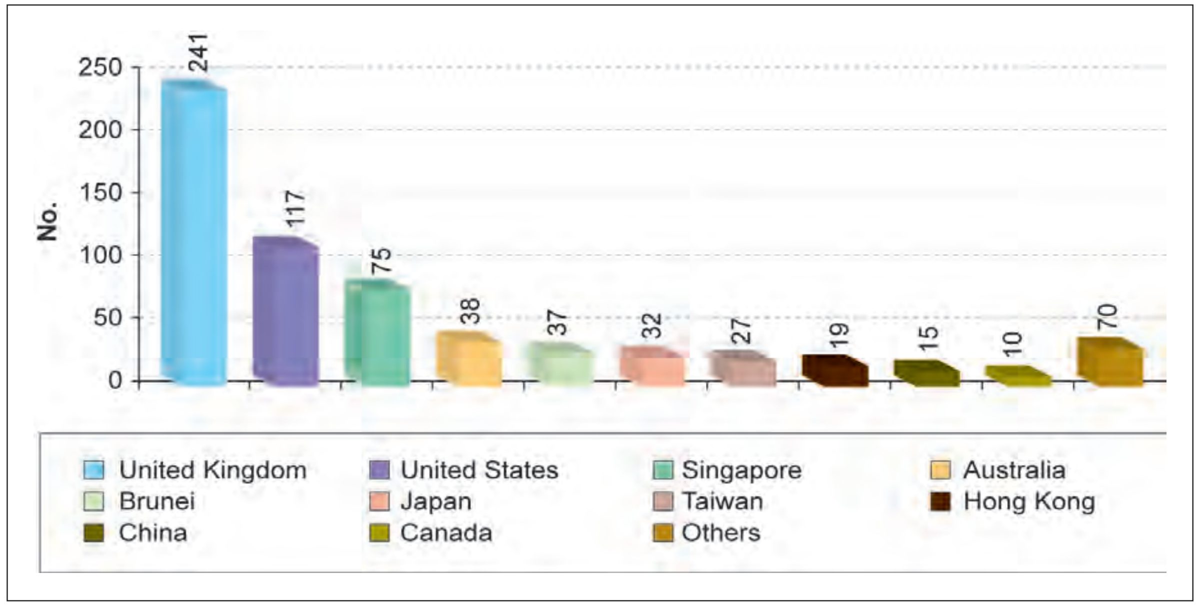
Figure 3.22 Approved Applications According to Area of Expertise



Source: Ministry of Human Resources

Figure 3.22 provides the distribution of approved applications in the expertise programme according to their area of expertise. From the total number of the applications approved, most of approved applicants were in the area of medical and health sciences (34%), IT (22%), accounting & financing (16%), industrial (15%) and science & technology (5%).

Figure 3.23 MBSE According to Countries



Source: Ministry of Human Resources

Figure 3.23 shows the MBSE distribution according to the countries in which the applicants reside. The United Kingdom had the highest number of Malaysian expertise working, with 36% (241) in the total proportion, followed by the United States (17% : 117), Singapore (11% : 75), Brunei (5% : 37), Australia (6% : 38), Japan (5% : 32), Taiwan (4% : 27), Hong Kong (3% : 19), China (2%: 15) and Canada (1% : 10).

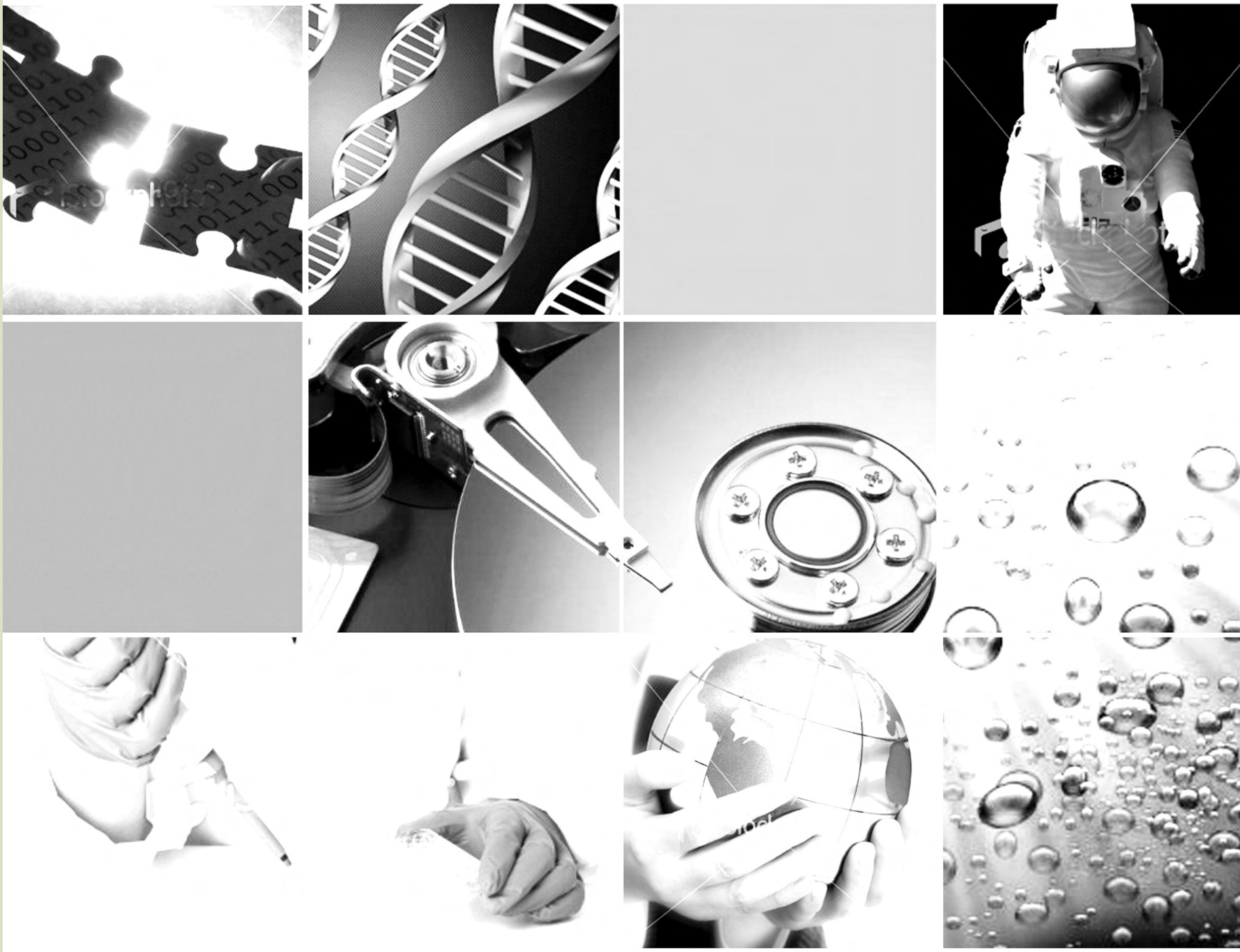
3.5 CONCLUSION

In this report, it has been observed that the overall trend in the R&D human resource development is on the rise, except in 2005-2006. The years may have marked some decrease in R&D allocation by the Malaysian government. IHLs has been the biggest employers of the R&D researchers with majority of them are holding the PhD degrees, followed by the GRIs and private sectors. The report also indicates the increasing trend in women participation in R&D, although the R&D field is still dominated by men. The gap in women and men proportion is also seen as lower in IHLs compared to GRIs and private sectors. This report also provides data looking at various other comparisons such as nationality of the researchers, gender and qualification at GRIs and private sector.

Six top fields with R&D researchers has been identified as engineering science, medical & health sciences, social sciences, applied science & technology, ICT and agricultural science. The difference between IHLs, GRIs and private sector is attributed to the research fields that the researchers engaged in or hired for. IHLs dominate most of the sectors in the number of researchers hired. However, engineering sciences records the highest number of researchers hired by the private sectors, whereas agricultural science records the highest number of researchers hired by the GRIs.

Comparisons between IHLs points towards the shared percentage of R&D researchers in terms of qualifications and several top IHLs employers. Several universities were identified as employers with majority of them were PhD holders. They were UTM, USM, UPM, UiTM, UM, UIAM, UUM, KUSTEM, and MMU. While UTM have had the highest number of PhD holders are researchers, UIAM is found having the highest proportion of PhD holders in the population.

Overall, this report should provide information and insight in the progress of R&D human resource development in Malaysia, with special focus on S&T. Based on the trend, the number of researchers is expected to increase further. However, the increasing rate can be a bit lower than the past years.



PUBLIC SUPPORT FOR SCIENCE AND TECHNOLOGY

Chapter 4

4.1 INTRODUCTION

Since 1988, the Government has implemented a centralized grant system of financing science and technology (S&T) research in public institutions and research agencies. The Ministry of Science, Technology and Innovation (MOSTI) is in-charged with the responsibility of managing the fund and the implementation of S&T research and development (R&D) programmes in the country. Other private agencies such as Malaysian Technology Development Corporation (MTDC), Small and Medium Industries Development Corporation (SMIDEC), and Malaysian Industrial Development Authority (MIDA) participate in providing assistance.

MOSTI's Science and Technology Indicators 2006 Report highlighted that many countries have introduced a number of measures both fiscal and non-fiscal. The purposes were to promote greater R&D and innovative activities, attract foreign knowledge-intensive companies and promote technology diffusion and acquisition of technologies. Factors peculiar to each country will determine the choice of measures to be taken, that is, whether incentives, direct grants, loans, patent rights or other instruments will be adopted to stimulate research and innovative investments.

This chapter explains the types of public schemes to accelerate Science and Technology Innovation (STI) such as Research and Development, Commercialization, Acquisition of Technology, and etc. in the nation's drive to become one of the world's most competitive industrialized economies by 2020. According to Science and Technology Indicators 2004 Report, there were four new schemes introduced by Government of Malaysia in order to further encourage the development of science and technology industry in the country. These are the Technology Acquisition Fund for Women (TAF-W), the E-Manufacturing Grant, the Grant for Rosettanet Standard Implementation for Small and Medium Size Enterprises, and the Grant for Upgrading Engineering Design Capabilities.

In this report (Science and Technology Indicators 2008 Report), several new schemes were introduced by the Government of Malaysia in order to achieve their mission to harness Science, Technology and Innovation. The schemes were Malaysian Life Sciences Capital Fund (MLSCF), Biotechnology R&D Grant Scheme, ScienceFund, TechnoFund and Spectrum Research Collaboration Program (SRCP).

4.2 APPLICATION AND APPROVAL FOR S&T – RELATED GRANT SCHEMES

Malaysian government has approved several grants and incentives for the development of Science and Technology Innovation (STI) in Malaysia, encompassing of the whole range of activities from the idea generation stage to commercialization and marketing stage through several agencies such Malaysian Technology Development Corporation (MTDC), Multimedia Super Corridor (MSC) and Ministry of Science, Technology & Innovation (MOSTI). This section will examine the performance of the following grant schemes:

- Technology Acquisition Fund (TAF).
- Commercialization of R&D Fund (CRDF).
- Demonstrator Application Grant Scheme (DAGS).
- Multimedia Super Corridor R&D Grant Scheme (MGS).
- Industrial Technical Assistance Fund (ITAF).
- Industry Research & Development Grant Scheme (IGS) ➡ As IGS has been stopped in 2005; the information of IGS is not included.

In order to achieve the mission for 'First Class Mentality' in knowledge and innovation, several grants have been allocated in the 9thMalaysia Plan for such purpose. The distribution of the allocation is given in Table 4.1 below:

Table 4.1: Type of Grants by Government of Malaysia and Total Allocation

Type of Grants	Allocation (RM)
i) Prioritizing and consolidating Research Development and Commercialization (RDC) initiatives: ➢ ScienceFund ➢ TechnoFund	 1.2 billion 1.5 billion
ii) Enhancing Science and Technology human capital ➢ Human Resources Development (HRD) Fund ➢ National "Brain Gain" Program	 500 million 50 million
iii) Promoting Technopreneurship ➢ Technology Incubator Program ➢ Technology Acquisition Program	 163 million 162.5 million

Source: http://www.irc-malaysia.com/pengundi/Misi%20Nasional%20dan%20RMK-9.pdf

In accordance with the priority given to R&D, the funding for R&D grant schemes increased by 59.9 percent from the 7th Malaysia Plan period. With this increase, a total of RM 1.4 billion was allocated for R&D during the 8th Malaysia Plan period. Of this total, RM 1.0 billion was provided for direct public sector involvement in R&D while the remaining RM 430 million was allocated to enhance private sector R&D through:

- Industry Research and Development Grant Scheme (IGS) (However, as IGS has stopped in 2005, the information of IGS is not included)
- Multimedia Super Corridor R&D Grant Scheme (MGS)
- Demonstrator Application Grant Scheme (DAGS)

In addition, in order to boost the rate of commercialization, a special package was also put forth in the form of the following:

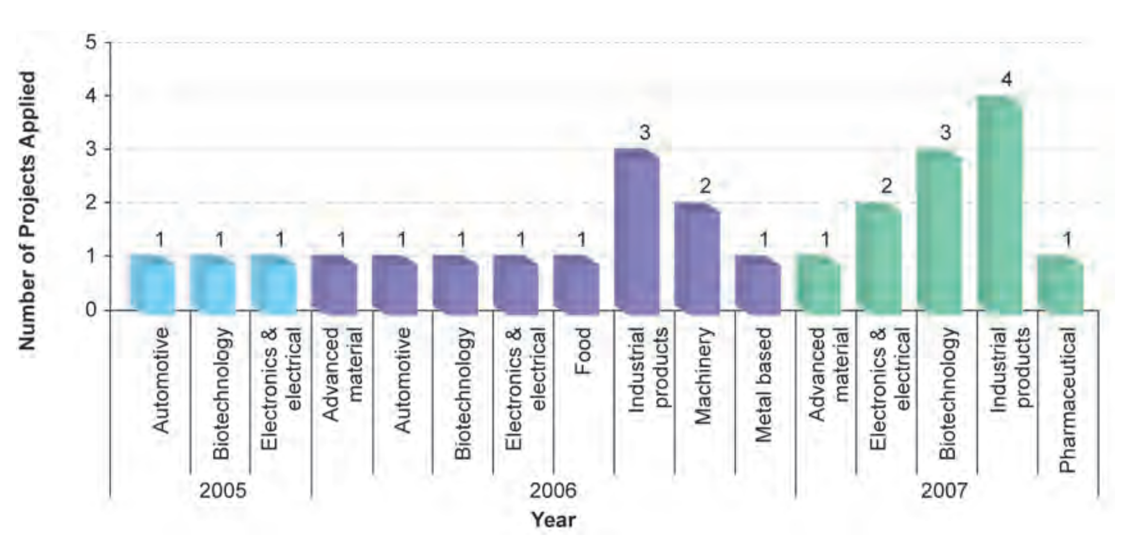
- Commercialization of R&D Fund (CRDF)
- Technology Acquisition Fund (TAF) / Technology Acquisition Fund for Women (TAF-W)

4.2.1 Technology Acquisition Fund (TAF)

Malaysian Technology Development Corporation (MTDC) was appointed by the Government of Malaysia to manage Technology Acquisition Fund (TAF) which is intended to facilitate the acquisition of strategic and relevant technology by the Malaysian companies. TAF provides partial grant to further promote efforts by the private sectors to enhance their technology level and production processes.

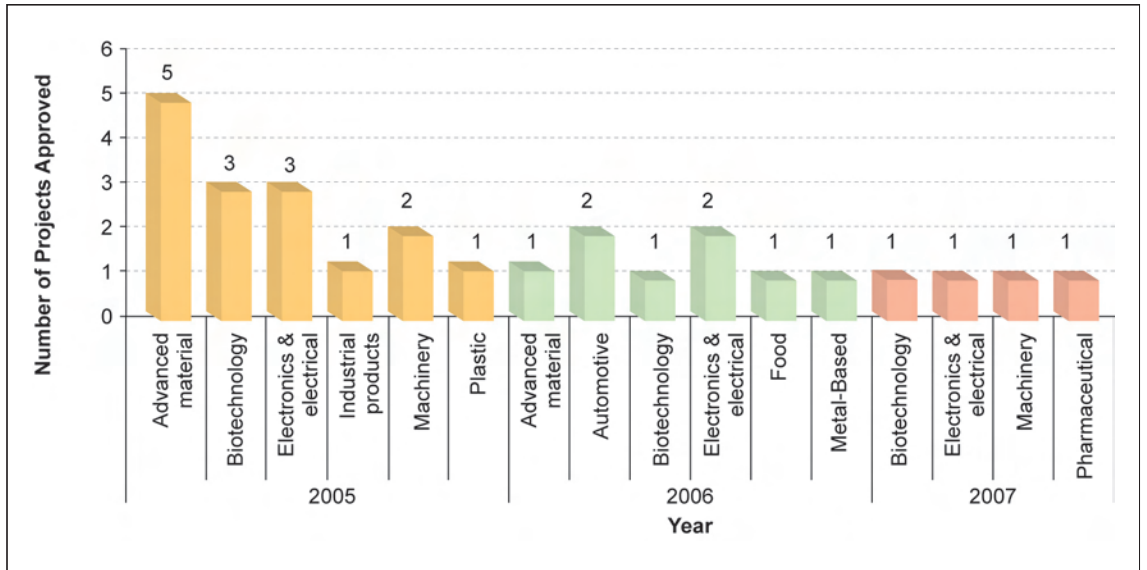
Source: http://www.smidec.gov.my

Figure 4.1: Number of Projects Applied for TAF by Industrial Sector, 2005 – 2007



Source: Malaysian Technology Development Corporation (MTDC)

Figure 4.2: Number of Projects Approved for TAF by Industrial Sector, 2005 – 2007



Source: Malaysian Technology Development Corporation (MTDC)

Figure 4.1 and Figure 4.2 show the number of projects applied and approved for TAF by industrial sector for the period of 2005-2007. A total of 25 applications were made by companies from several industries during the period, with a total of 27 approvals granted by MTDC in 2007. The number of projects approved was slightly higher than the number of projects applied due to the fact that the pending approvals were granted for applications made in the previous period. The evidence is reflected in the highest approved applications recorded in the year 2005. Most of the applications received were related to industrial products, biotechnology, electrical & electronics, advanced materials and machinery as these sectors exhibit dynamic technical innovations.

Table 4.2: Number of TAF Approved Projects and Approved Grant Amount, 2005 – 2007

Year	Projects Approved	Amount Approved (RM Million)
2005	15	25.32
2006	8	8.08
2007	4	2.19

Source: Malaysian Technology Development Corporation (MTDC)

During the period of 2005-2007, a total of RM35.59 million was granted for TAF involving 27 projects. Of this total, RM25.32 million was disbursed in 2005 for 15 approved projects, RM8.08 million in 2006 for 8 approved projects and RM 2.19 million in 2007 for 4 approved projects. In terms of industrial sector, advanced material received the highest amount of grant which is RM11.55 million, followed by electronics & electrical (RM8.54 million), machinery (RM4.96 million), biotechnology (RM3.47 million), automotive (RM2.21 million), mould, tools & die (RM0.62 million) and metal-based industry (RM0.25 million).

4.2.2 Commercialization of Research & Development Fund (CRDF)

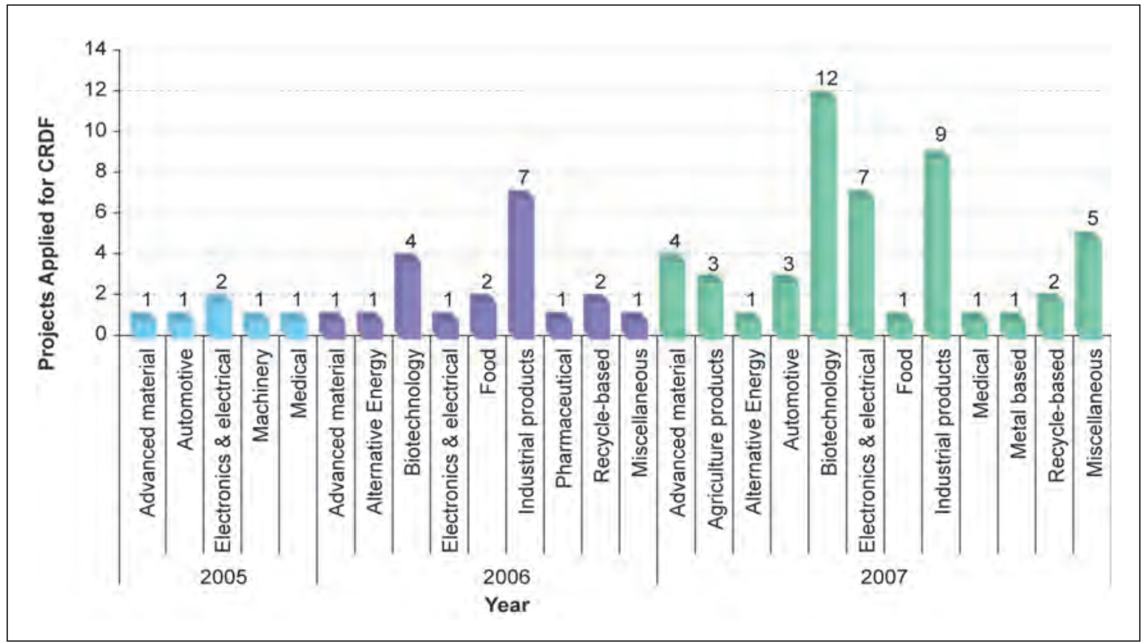
As an added stimulus towards the commercialization of R&D activities, the CRDF was established to provide partial grants to qualified R&D projects for commercialization purposes. In addition, the role of CRDF is to facilitate the development of new products and production processes, and to assist participating companies to start-up production capacity.

The amount of fund that can be approved under this programme is up to a maximum of 70% from the eligible expenses or up to RM 2 million, whichever is lower. The grant approved is to be utilized for the following eligible activities:

Phase I: Market Survey and Research
Phase II: Product/Process Design and Development
Phase III: Standard and Regulatory Compliance and Intellectual Property Protection
Phase IV: Demonstration of Technology

Source: www.mtdc.com.my

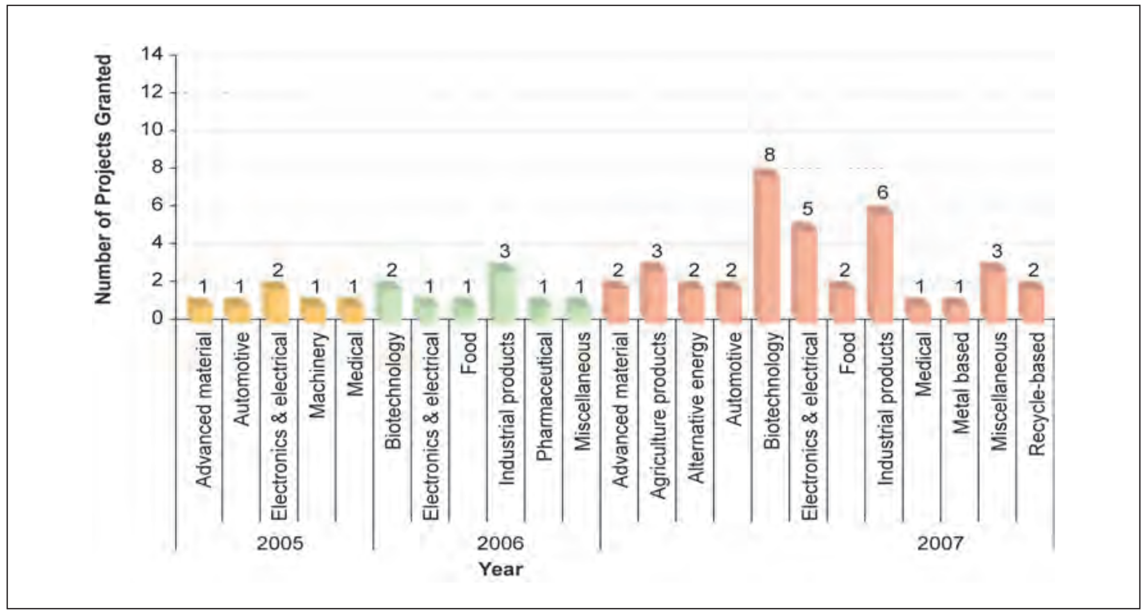
Figure 4.3: Number of Projects Applied for CRDF by Industrial Sector, 2005 – 2007



Source: Malaysian Technology Development Corporation (MTDC)

As shown in Figure 4.3, during the period of 2005-2007, a total of 75 applications were made for CRDF. Most of the applications were related to biotechnology (16 applications), industrial products (16 applications) and electrical & electronics (10 applications). Other industries that applied for CRDF included advanced material (6 applications), automotive (4 applications), recycle-based (4 applications), agriculture products and food with 3 applications respectively.

Figure 4.4: Number of Projects Granted for CRDF by Industrial Sector, 2005 – 2007



Source: Malaysian Technology Development Corporation (MTDC)

A total of 52 projects (Figure 4.4) valued at some RM 95.54 million were approved during the same period, which accounted for 83.1% from the total RM 115 million budget allocated under the 9th Malaysia Plan. The number of approved projects was higher than what was recorded during the period of 2003 and 2004 (21 projects).

In terms of industrial sector, most of the projects were related to biotechnology (10 projects), industrial products (9 projects), and electronics and electrical projects (8 projects). During the period under review, industrial products obtained the highest amount of grant which is RM 24.68 million, followed by biotechnology (RM 14.54 million), electronics & electrical (RM 11.39 million), advanced material (RM 8.34 million) and automotive (RM 5.68 million).

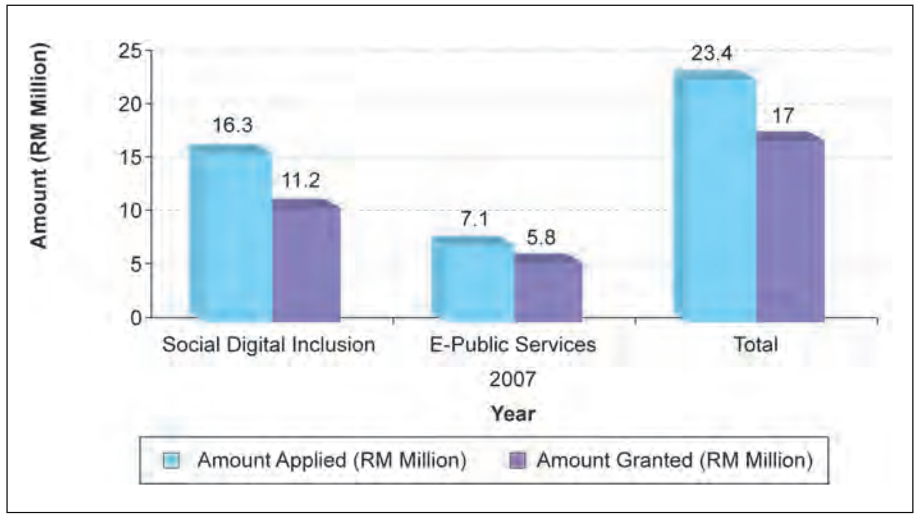
4.2.3 Demonstrator Application Grant Scheme (DAGS)

The Demonstrator Applications Grant Scheme (DAGS) was launched on 21 April 1998. It is to facilitate the growth of bottom-up innovations which are indigenous in design, contain local content and culturally relevant to meet the demands of the Malaysian community. Priority is given to IT and multimedia technology-based proposals that have local content and services.

As stated in the 9th Malaysia Plan, in order to promote wider application of information and communication technology (ICT) at the community level and motivate innovations, an allocation of RM 79.3 million was approved for 51 projects under the DAGS.

The DAGS is open to all applicants with at least 51% local ownership and a committed project champion. It must demonstrate community participation in the implementation of the project from the beginning until the end. The quantum of fund payable under this grant scheme will be a maximum of 70% of approved total project cost and with a maximum of 30% allocation for hardware. The scope of the funding is limited to 1 year duration only.

Figure 4.5: Amount Approved for DAGS Applications, 2007



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

Table 4.3: Number of Project Applications and Approvals for DAGS, 2007

Year	Industry	No. of Applications	No. of Approvals
2007	Social Digital Inclusion	5	5
	E-Public Services	3	3
	Total	8	8

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

Figure 4.5 and Table 4.3, shows the number of applications and approvals for DAGS in 2007. There were a total of 8 applications received in 2007. Of the total applications, 5 were Social Digital Inclusion projects while the remaining 3 were E-Public Services projects. The total amount applied for the grant was RM 23.4 million. All 8 applications were granted approval with a total amount of RM 17 million.

4.2.4 Multimedia Super Corridor R&D Grant Scheme (MGS)

The MGS is a scheme administrated by the Multimedia Development Corporation (MDeC). The scheme is aimed at assisting local companies or joint venture companies in developing multimedia technologies and applications which would contribute to the overall development of Multimedia Super Corridor (MSC). The purpose of the scheme is to fund various research and development projects that facilitate the development of new products and services across the multimedia value chain and Flagship Applications. Under the 9th Malaysia Plan, the Government allocated RM 120 million for the grant.

Table 4.4: Number of Approvals and Amount Approved for MGS, 2005 – 2007

Year	No. of Projects Approved	Total Cost of Projects (RM Million)
2005	2	2.72
2006	4	17.64
2007	9	9.19

Source: Multimedia Development Corporation (MDeC)

Table 4.4 shows the increasing trend in the number of approvals made under the MGS scheme where 9 projects approval was given throughout 2007. During the period under review (2005-2007), a total of RM 29.55 million was approved for 15 projects. Most of the approvals made under this scheme were for projects which were focusing on business applications (RM 10 million), semiconductor (RM 9.7 million), engineering applications (RM 6.4 million), and wireless development (RM 3.4 million).

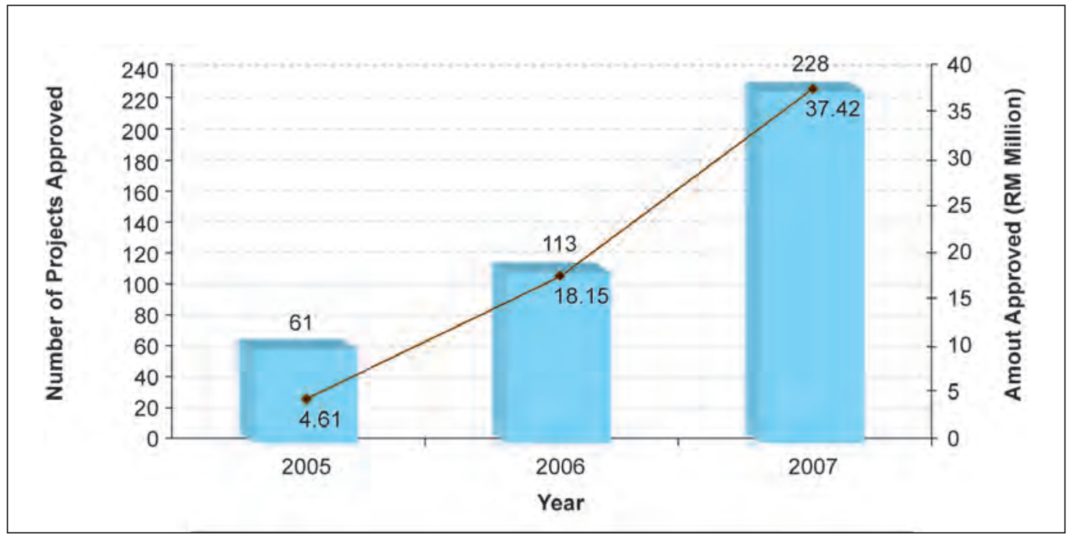
4.2.5 Matching Grant Schemes

The Matching Grant Scheme was initially established as The Industrial Technical Assistance Fund (ITAF) in 1990 to assist small and medium enterprises (SMEs) to become technologically proficient as well as cost effective. Several sub-categories of this fund have been established to address specific requirement of SMEs such as the following:

Table 4.5: Type of Matching Grants, Purpose and Total Grant Allocated

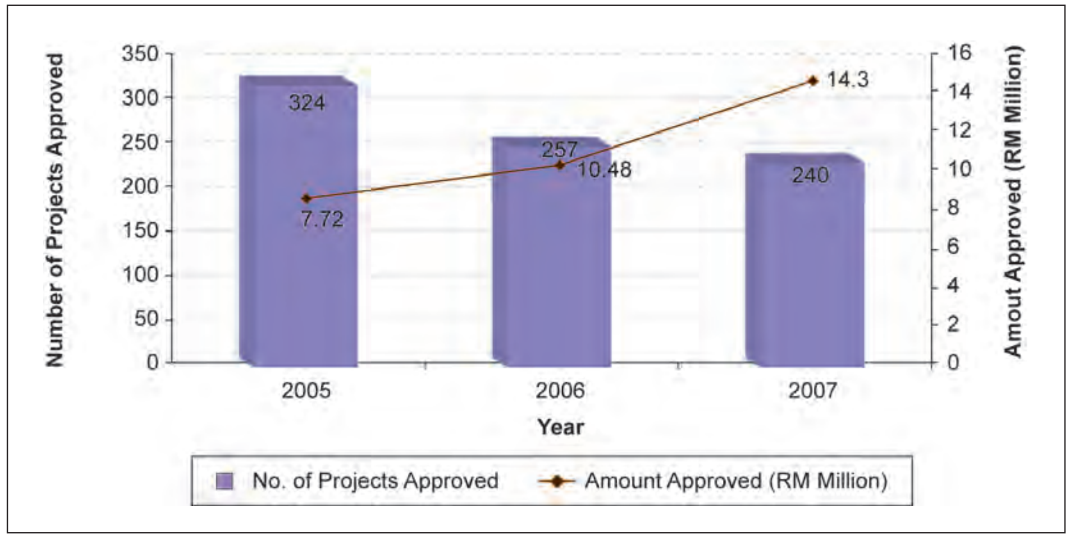
Type of Grant	Purpose	Max. Grant
Matching Grant for Product and Process Improvement	Assistance to improve and upgrade existing product, product design and processes.	RM500,000
Matching Grant for Certification and Quality Management System	Assistance for productivity and quality improvement and to achieve international quality standards and qualification.	RM250,000

Figure 4.6: Number of Projects and Amount Approved under Matching Grant for Product and Process Improvement, 2005 – 2007



Source: SMIDEC's Monthly Status and Performance Report

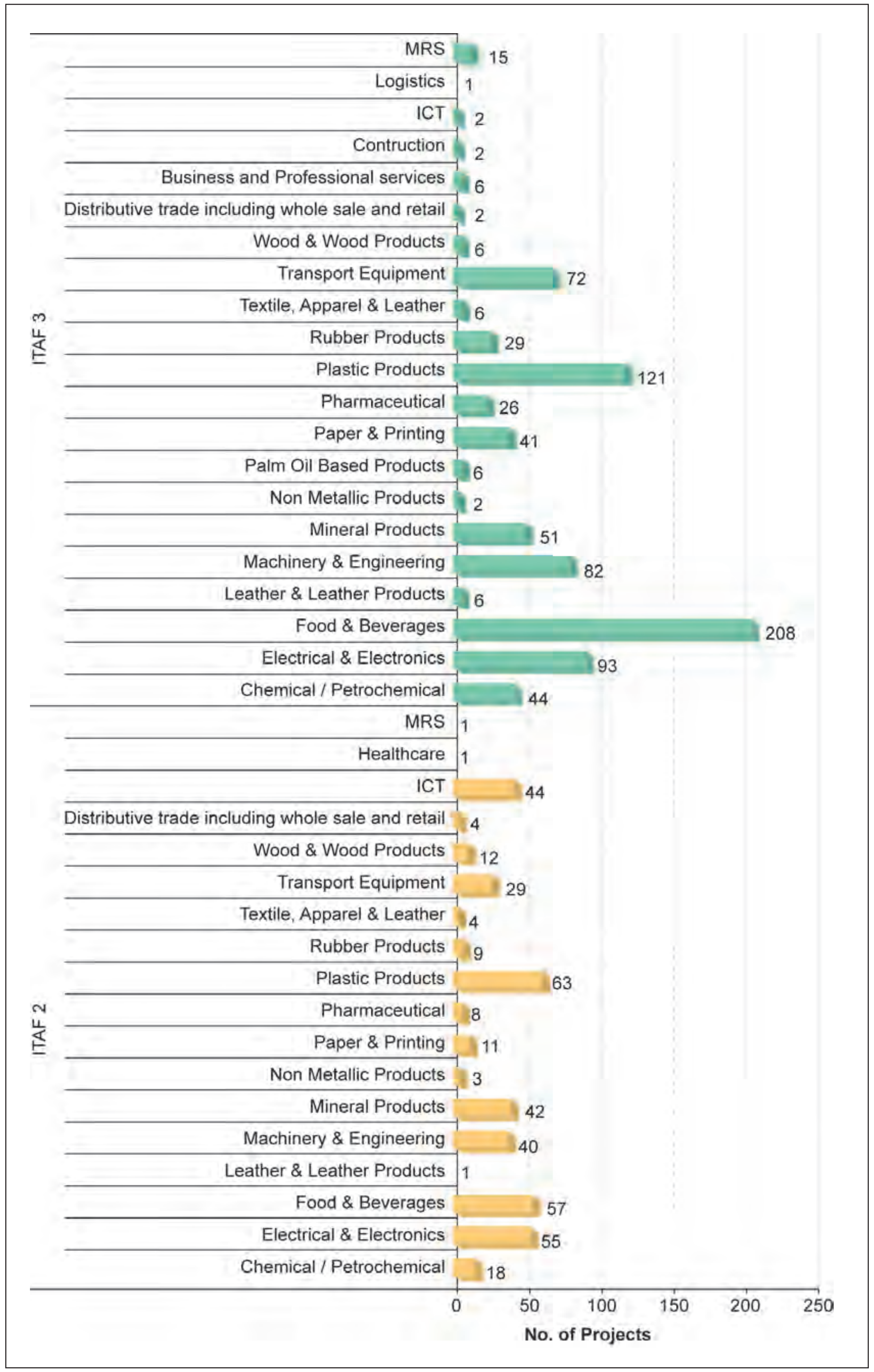
Figure 4.7: Number of Projects and Amount Approved Under Matching Grant for Certification and Quality Management System, 2005 – 2007



Source: SMIDEC's Monthly Status and Performance Report

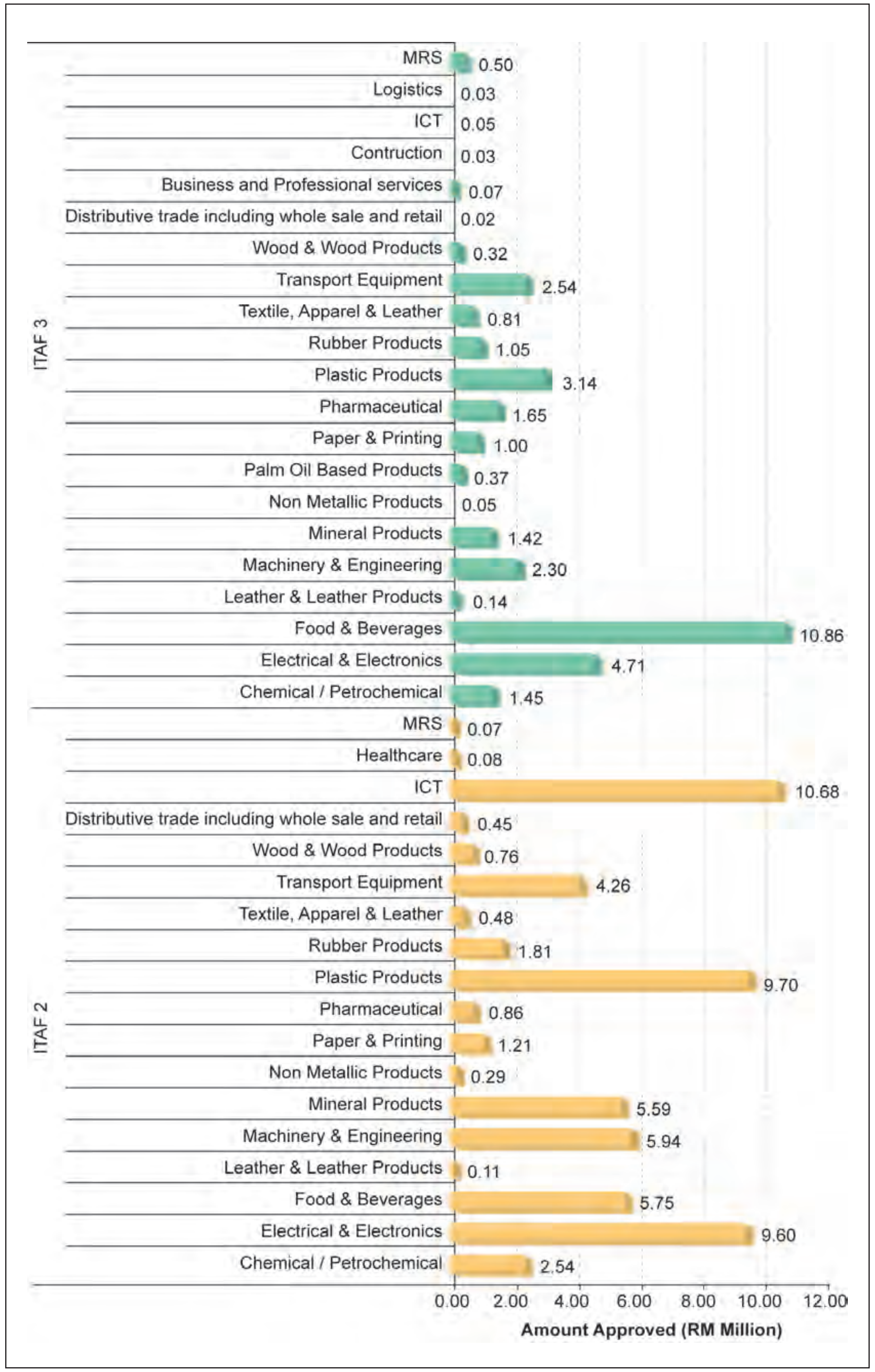
Figure 4.6 and Figure 4.7, show the project approvals and the amount approved under Number of Project and Amount Approved under the Matching Grant for Product and Process Improvement and the Matching Grant for Certification and Quality Management System for the period of 2005-2007. During the period under review, a total of 402 projects were approved under the Matching Grant for Product and Process Improvement with a total approved amount of RM 60.18 million. The highest number of approvals was in 2007 with 228 projects worth RM37.42 million. While the number of approved projects and value for Number of Project and Amount Approved under the Matching Grant for Product and Process Improvement increased from year to year, different scenario was observed for the Matching Grant for Certification and Quality Management System scheme. The number of Matching Grant for Certification and Quality Management System approved projects decreased by 21% from 324 projects in 2005 to 257 projects in 2006 and further reduced by 7% in 2007.

Figure 4.8: 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 – 2007



Source: SMIDEC's Monthly Status and Performance Report

Figure 4.9: 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, 2005 – 2007



Source: SMIDEC's Monthly Status and Performance Report

Figures 4.8 and 4.9 show the cumulative approvals and amount approved under Number of Project and Amount Approved under the Matching Grant for Product and Process Improvement and the Matching Grant for Certification and Quality Management System by sector for the period of 2005 to 2007. During the period, plastic products sector recorded the highest total cumulative approvals under Number of Project and Amount Approved under the Matching Grant for Product and Process Improvement with 63 projects at RM9.70 million, followed by food & beverages (57 projects at RM5.75 million), electric and electronics (55 projects at RM9.60 million), ICT (44 projects at RM10.68 million) and mineral products (42 projects at RM 5.59 million).

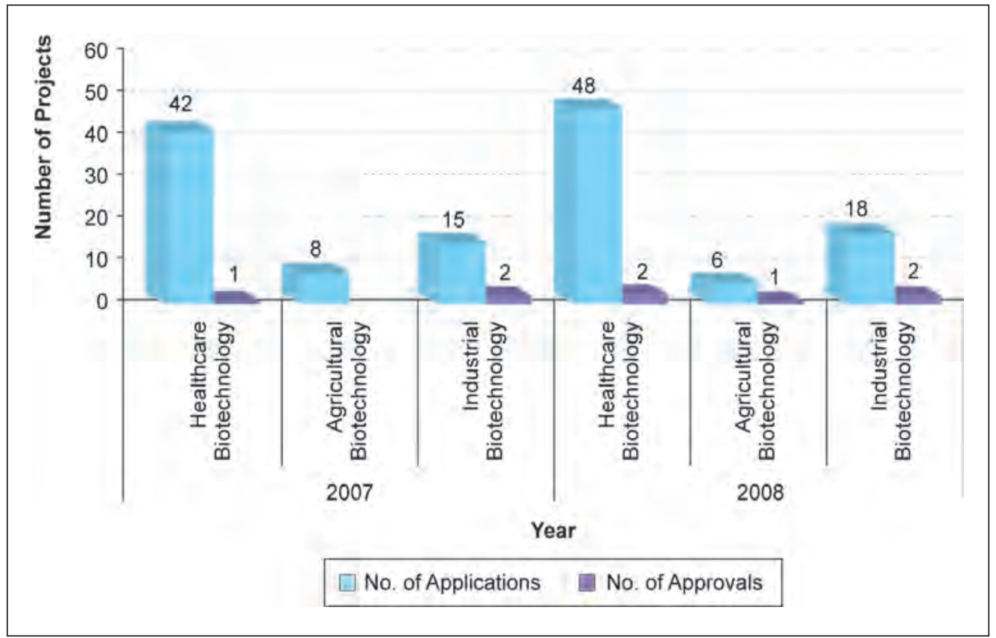
Under the Matching Grant for Certification and Quality Management System, food and beverages sector recorded the highest total cumulative approvals with 208 projects worth RM10.86 million. This was followed by plastic products (121 projects at RM3.14 million), electric & electronics (93 projects at RM RM4.71 million), Machinery & Engineering (82 projects at RM2.30 million), and Transport Equipment (72 projects at RM2.54 million)

4.2.6 Malaysian Life Sciences Capital Fund (MLSCF)

In line with the effort of the government of Malaysia to enhance S&T development in the country, a newly formed life sciences venture fund was introduced in late 2006 called Malaysian Life Sciences Capital Fund (MLSCF). The fund is co-managed by Malaysian Technology Development Corporation (MTDC) and Burrill & Co. MLSCF focuses on early stage investments in the areas of agriculture, industrial and healthcare biotechnology.

As stated in the Star (8 September 2006), MLSCF has attracted US$150mil (RM 522 mil) of committed funds which provided investors with an opportunity to diversify and gain knowledge in the business. In 2007, 3 investments were approved under MLSCF and further 5 investments were approved in 2008. The investments approved under MLSCF for 2007 and 2008 were 3 in healthcare biotechnology, 1 in agricultural biotechnology and 4 in industrial biotechnology.

Figure 4.10: Application & Approval of Investments Under the Malaysian Life Science Capital Fund (MLSCF) by Industrial Sector, 2007 & 2008



Source: Malaysian Technology Development Corporation (MTDC)

Figure 4.10 shows the increasing number of investment applications for Malaysian Life Science Capital Fund (MLSCF) during 2007 and 2008. During the period, healthcare biotechnology recorded the highest number of investment applications (90 projects), followed by industrial biotechnology (33 projects) and agricultural biotechnology (14 projects).

Table 4.6: Total of Amount Invested by MLSCF by Industrial Sector, 2007 & 2008

Year	Industry	Amount Granted (US $ Million)
2007	Healthcare Biotechnology	4.99
	Agricultural Biotechnology	-
	Industrial Biotechnology	7.50
2008	Healthcare Biotechnology	2.51
	Agricultural Biotechnology	2.00
	Industrial Biotechnology	8.60

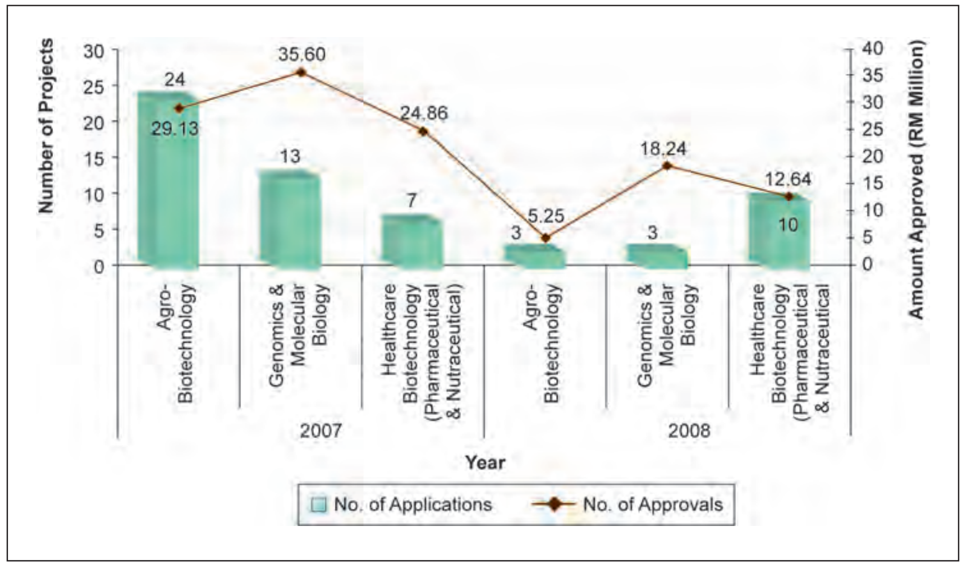
Source: Malaysian Technology Development Corporation (MTDC)

A total of 5 investments were approved in 2008. US$8.60 million was invested in industrial biotechnology, followed by healthcare biotechnology (US$2.51 million) and agricultural biotechnology with US$2.0 million investment as shown in Table 4.6.

4.2.7 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 commercialization of research findings in specific areas that is of national importance to the Malaysian biotechnology industry. There are 3 types of R&D initiatives given under this scheme such as agro-biotechnology R&D initiatives, genomic & molecular biology R&D initiatives and pharmaceutical & nutraceutical R&D initiatives.

Figure 4.11: Project and Grant Approvals Under Biotechnology R&D Grant Scheme by Type of Initiatives, 2006 & 2007



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

Government of Malaysia granted RM125.82 million for 60 approved projects under biotechnology R&D Grant Scheme in 2006 and 2007 as reflected in Figure 4.11. Of this total, RM89.59 million was disbursed in 2006 for 44 approved projects, and RM36.23 million in 2007 for 16 approved projects. In terms of type of incentives, genomics & molecular biology received the highest amount of grant with RM53.94 million, followed by agro-biotechnology with RM34.38 million and healthcare biotechnology (pharmaceutical & nutraceutical) with RM22.64 million.

4.2.8 SUPPORT FOR R&D IN INSTITUTE OF HIGHER LEARNING (IHL)

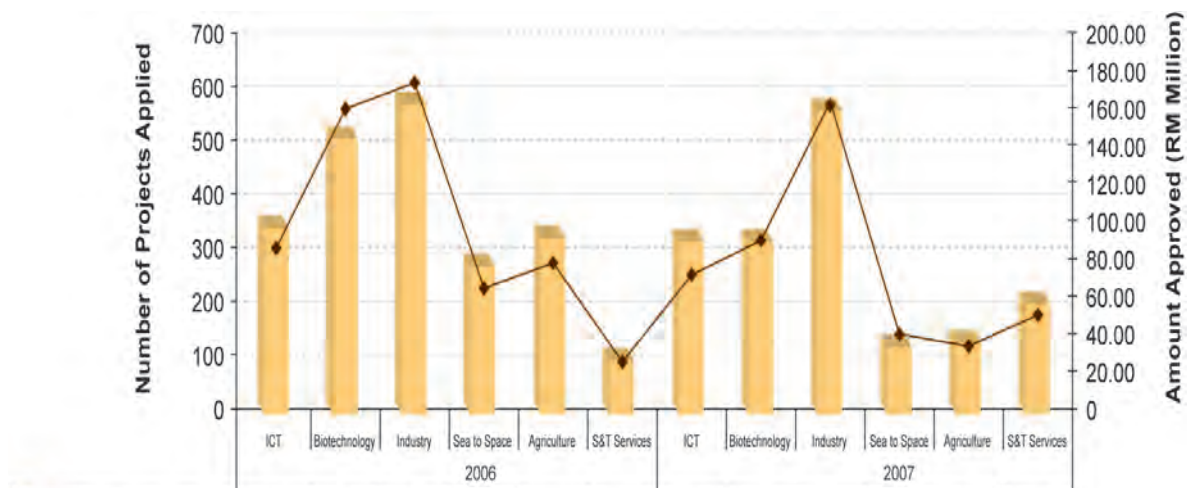
Realizing the importance of Research and Development (R&D) and innovation, Malaysia called on IHLs to look at R&D and Innovation as a way to increase capability and capacity of Malaysian IHLs to undertake market driven R&D and to commercialise R&D outputs. Under the 9th Malaysia Plan, specific schemes were introduced to prioritize and consolidate R&D and Innovation. These schemes take form of the following grant allocation:

- ScienceFund
- TechnoFund
- Spectrum Research Collaboration Program (SRCP)

4.2.8.1 ScienceFund

Government of Malaysia provided ScienceFund as a support for R&D projects that can acquire and generate new knowledge in strategic basic and applied sciences in specific research clusters (RC). It is also aimed at generating more research capabilities and expertise within the country. The outcome of research under ScienceFund which has commercial potential can be considered for additional funding under the TechnoFund.

Figure 4.12: Number of Projects Applied for ScienceFund by Sectors, 2006 & 2007



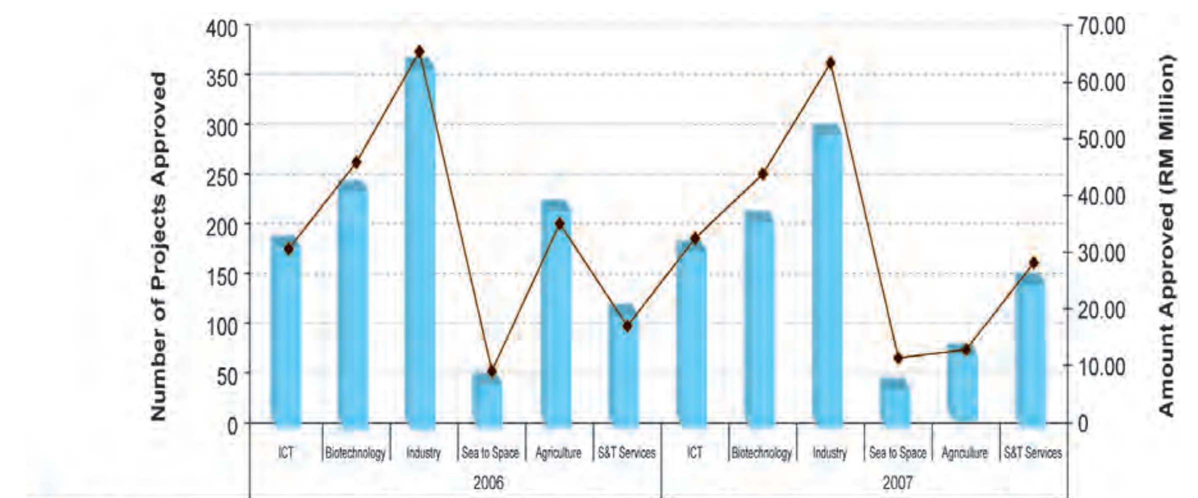
	ICT	Biotechnology	Industry	Sea to Space	Agriculture	S&T Services	ICT	Biotechnology	Industry	Sea to Space	Agriculture	S&T Services
Number of Projects Applied	364	526	594	294	343	120	339	335	579	139	150	225
Amount Applied (RM Million)	83.99	159.86	173.89	65.65	78.44	26.47	70.98	91.30	162.74	41.49	35.15	51.37

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

Figure 4.12 shows the number of projects applied for ScienceFund by IHLs and sectors in 2006 and 2007. In general, almost all sectors except S&T Services recorded declines in the number of

applications in 2007 as compared to 2006. Total number of projects applied in 2007 was 1,767, a drop of 21.1% from 2,241 recorded in 2006. Top applications came from industry (579), ICT (339) and biotechnology (335).

Figure 4.13: Number of Projects Approved for ScienceFund by Sectors, 2006 & 2007



	ICT	Biotechnology	Industry	Sea to Space	Agriculture	S&T Services	ICT	Biotechnology	Industry	Sea to Space	Agriculture	S&T Services
Number of Projects Approved	364	526	594	294	343	120	339	335	579	139	150	225
Amount Applied (RM Million)	83.99	159.86	173.89	65.65	78.44	26.47	70.98	91.30	162.74	41.49	35.15	51.37

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

Figure 4.13 illustrates the number of projects approved under the ScienceFund scheme by sectors during 2006 & 2007.

The number of projects approved in 2007 was 978, a drop of 18.3% as compared to 2006. Total amount approved for the ScienceFund was RM188.47 million, an increase of 2.08% over the previous year. Sectors which received substantial amount of grant under the scheme were industry (RM63.44 million), biotechnology (RM43.50 million) and ICT (RM32.63 million).

4.2.8.2 TechnoFund

TechnoFund is a competitive funding by Government of Malaysia to foster greater collaboration between Malaysian private entities and government research institutes or institutions of higher learning. The fund is allocated for pre-commercialisation of cutting-edge technologies in ICT, Advanced Materials, Advanced Manufacturing, Biotechnology, Renewable Energy and Nanotechnology. There are 2 types of funding:

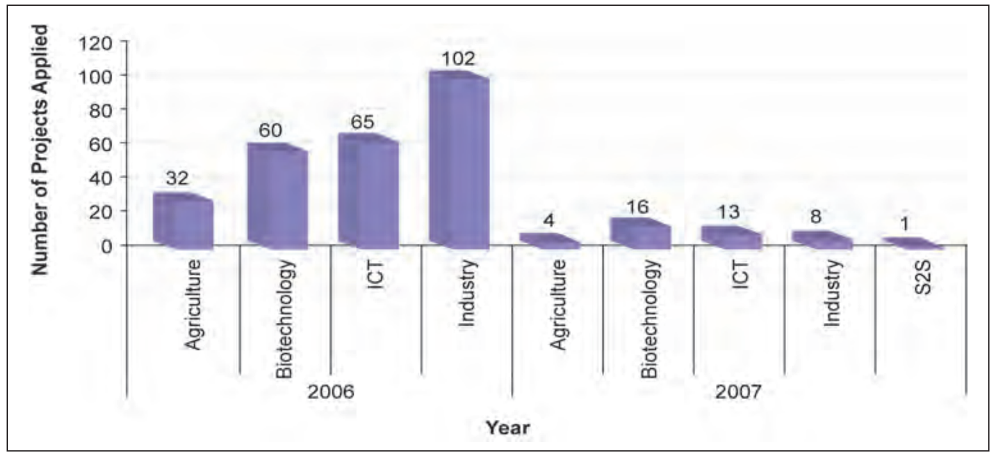
i. Pre-Commercialisation

Pre-Commercialisation activities consist of development of commercial ready prototypes / pilot plants / clinical trials / up-scaling for demonstration and testing purposes.

ii. IP Acquisition

Comprises acquisition of IP (academic/laboratory scale prototype) from overseas or local sources and must be further developed to pre-commercialization stage.

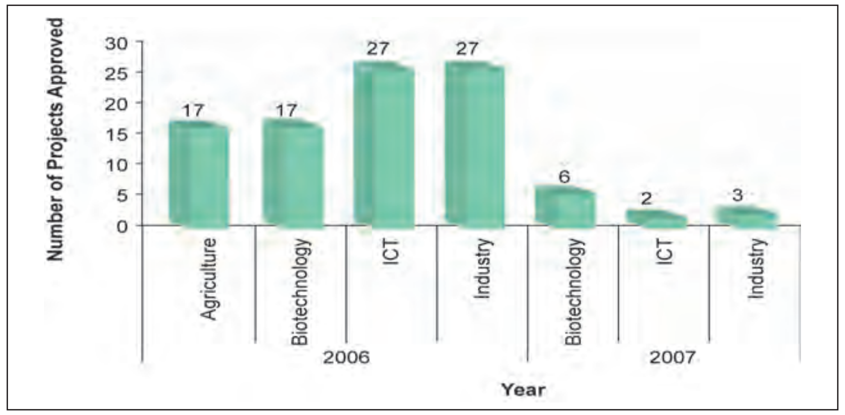
Figure 4.14: Number of Projects Applied for TechnoFund by Sectors, 2006 & 2007



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

The number of projects applied for TechnoFund was dramatically decreased by 83.8% in 2007, from 259 applications in 2006 (see Figure 4.14). All sectors recorded decreases in the number of applications.

Figure 4.15: Number of Projects Approved for TechnoFund by Sectors, 2006 & 2007



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

Similar scenario can also be observed in the number of projects approved in 2007. The applications approved in 2007 dropped drastically by 87.5% from 88 approvals in 2006 to 11 approvals in 2007 (Figure 4.15).

4.2.8.3 Spectrum Research Collaboration Program (SRCP)

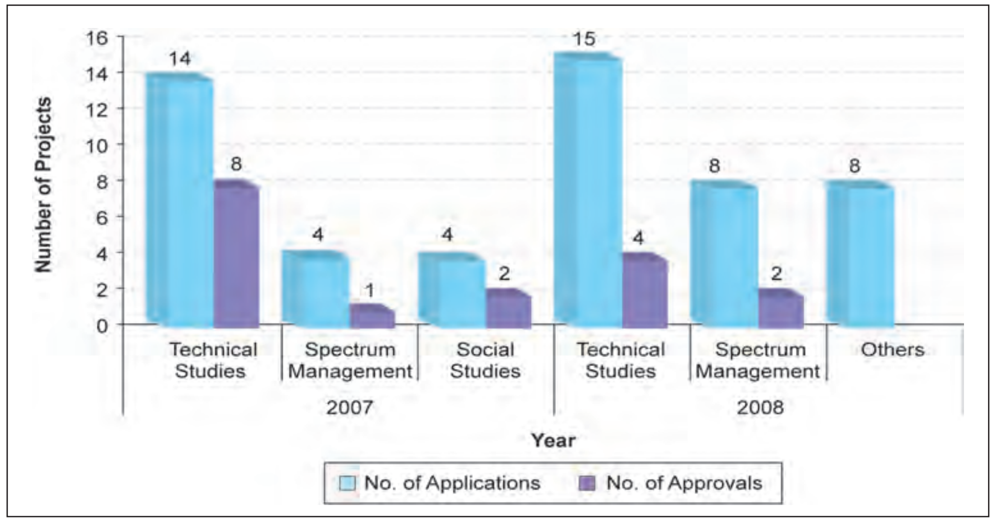
Spectrum Research Collaboration Program is funded and managed by the Malaysian Communications and Multimedia Commission (MCMC) in promoting research collaboration between institution of higher learnings (IHLs) and various other public and private sectors. Started in September 2006, this research programme allows Malaysian IHLs and the public and private sectors to participate in various spectrum research projects under the themes proposed by MCMC. SRCP was established to improve the administrative, regulatory and technical expertise of frequency management, by promoting and funding research on spectrum related matters.

Three priority research areas have been identified in 2007 under SRCP which are; Emerging wireless technologies, Spectrum management and Spectrum and us. MCMC expects empirical results from

these research and development projects in assisting its regulatory and administration of wireless frequencies within the telecommunication industry.

MCMC allocates and manages its own fund to selected institutions and currently RM 4 million has been allocated per annum for such purposes.

Figure 4.16: Application & Approval of Grant Under the Spectrum Research Collaboration Programme (SRCP) by Industrial Sector, 2007 & 2008



Source: Malaysian Communications & Multimedia Commission (MCMC)

Figure 4.16 shows the number of applications and grant approvals under the Spectrum Research Collaboration Programme (SRCP) in 2007 and 2008. The number of applications increased by 42.3% from 22 applications in 2007 to 32 applications in 2008. Nevertheless, the approved projects declined from 11 in 2007 to 6 in 2008.

Throughout 2007 and 2008 fiscal years, a total of 53 applications worth RM 18.42 million were made by IHLs. However, only a total of 17 approvals worth RM 4.88 million were granted by Malaysian Communications & Multimedia Commission (MCMC). Table 4.7 provides the detail distribution of the grant.

Table 4.7: Total Amount Granted for SRCP by Research Areas, 2007 & 2008

Year	Industry	Amount Applied (RM Million)	Amount Granted (RM Million)
2007	Technical Studies	3.71	2.96
	Spectrum Management	0.41	0.09
	Social Studies	2.76	0.78
	Others	–	–
2008	Technical Studies	5.28	0.75
	Spectrum Management	3.11	0.30
	Social Studies	–	–
	Others	3.15	–

Source: Malaysian Communications & Multimedia Commission (MCMC)

4.3 DOUBLE DEDUCTION FOR TAX PURPOSES

Companies including companies in the ICT sector are eligible for double deduction on non-capital expenses incurred for undertaking R&D activities. For this purpose, R&D is defined under the Promotion of Investment Act 1986 as follows:

"Research and development" means any systematic or intensive study carried out in the field of science or technology with the object of using the results of the study for the production or improvement of materials, devices, products, produce or processes but does not include:

- quality control of products or routine testing of materials, devices, products or produce;
- research in the social sciences or the humanities;
- routine data collection;
- efficiency surveys or management studies;
- market research or sales promotion

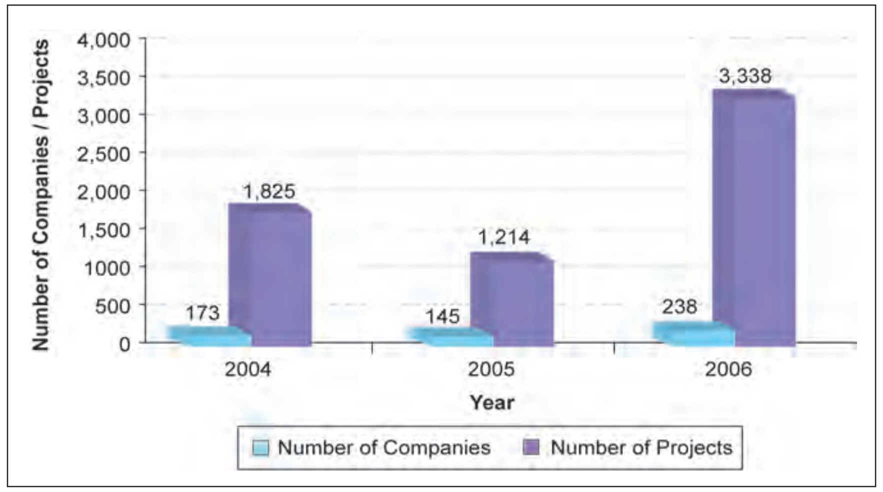
With effect from year of assessment 1998, a company that carry out designing or prototyping as an independent activity will also qualify for R&D incentives.

The double deduction for R & D covers the following:

- Approved Research for non-capital expenditure incurred on research and development approved by the Minister of Finance. (Delegated to IRB) – Section 34A of the Income Tax Act 1967
- Payment for Services – Section 34B (1) (b) & (c)

Source: http://www.treasury.gov.my/index.php?ch=18&pg=43&ac=632

Figure 4.17: Number of Projects and Number of Companies Claimed for R&D Expenditure in the year 2004 – 2006



Source: Inland Revenue Board Malaysia

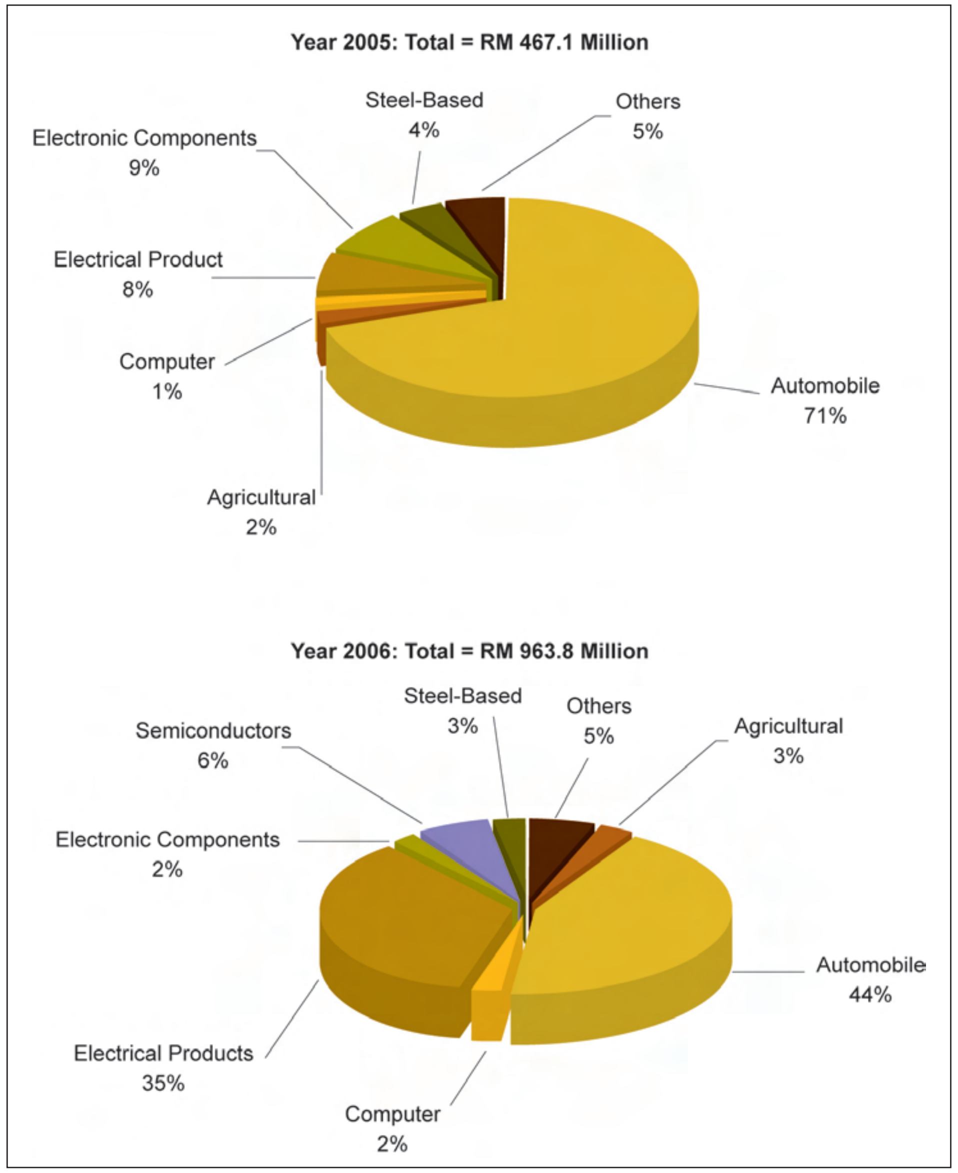
Table 4.8: Number of Projects Approved and the Estimated Amount of Deduction for R&D, 2004 - 2006

Year	Number of Projects	Estimated Amount of Deduction (RM Million)
2004	1,825	499.5
2005	1,214	467.11
2006	3,338	963.81

Source: Inland Revenue Board Malaysia

Figure 4.17 and Table 4.8 illustrate the number of projects approved and the estimated amount of R&D expenditure during the period of 2004-2006. The number of applications dropped from 173 in 2004 to 145 in 2005. However, the number picked up to almost double in 2006. The estimated of R & D expenditure amount under this incentive stood at RM 499.5 million in 2004, dropped to RM 467.11 million in 2005, but eventually increased to RM 963.81 million in 2006.

Figure 4.18: Leading Recipients of Double Deduction for R&D Expenditure by Industrial Sector, 2005 & 2006

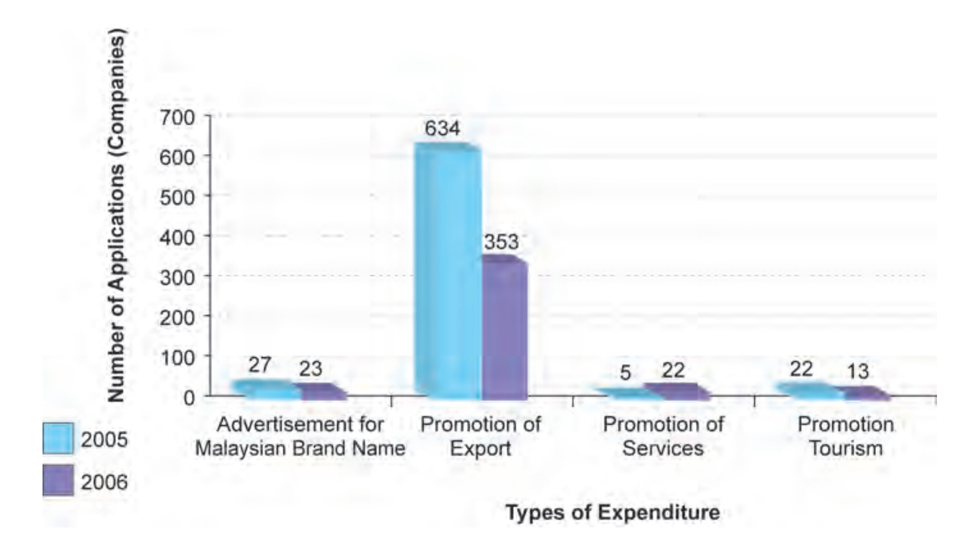


Source: Inland Revenue Board Malaysia

As shown in Figure 4.18 , major recipients of the double deduction in 2006 were companies in the automotive and electrical product sectors with 44% and 35% in total estimated amount, respectively. However, compared to 2005, there was a reduction in 2006 in the amount claimed by companies particularly in the automotive sector. However, other companies such as those companies in the electrical product sector enjoyed great benefit out of the estimated amount.

The increasing number of deductions granted is in line with the rapid growth of the economy and the high purchasing power of its population in the local car market. At the same time, the establishment of national car projects, PROTON and PERODUA, has transformed Malaysia from a mere motorcar assembler into a car manufacturer. The industry has boosted the development of engineering, auxiliary and supporting industries and contributed to skills development and the upgrading of technological and engineering capabilities. These factors have further enhanced the attractiveness of Malaysia as a base for global automotive manufacturers.

Figure 4.19: Number of Applicants (Companies for Double Deduction) by Type of Expenditure, 2005 & 2006



Source: Inland Revenue Board Malaysia

Figure 4.19 shows the number of applications by type of expenditure during 2005 and 2006. As shown in the figure, most of the applications were for export promotion activities such as overseas advertising, supply of free samples abroad, supply of technical information abroad, exhibits and/or participation in trade or industrial exhibitions approved by the Ministry of International Trade and Industry (MITI), cost of maintaining sales offices overseas for the promotion of exports and so forth.

4.4 R&D INVESTMENT INCENTIVES

The Government encourages Research and Development (R&D) activities in both the public and private sectors in order to develop indigenous technology and to increase their productivity and remain competitive in the international market. To encourage R&D activities particularly by companies in the manufacturing sector, the government under Malaysian Industrial Development Authority (MIDA) introduced various incentives under the Promotion of Investments Act 1986. These incentives include:

(i) Contract R&D Company

A contract R&D company is a company that provides R&D services in Malaysia to a company other than its related company. A contract R&D company is eligible to apply for Pioneer Status with income tax exemption of 100% of the statutory income for five years or an Investment Tax Allowance (ITA) of 100% on the qualifying capital expenditure incurred within ten years.

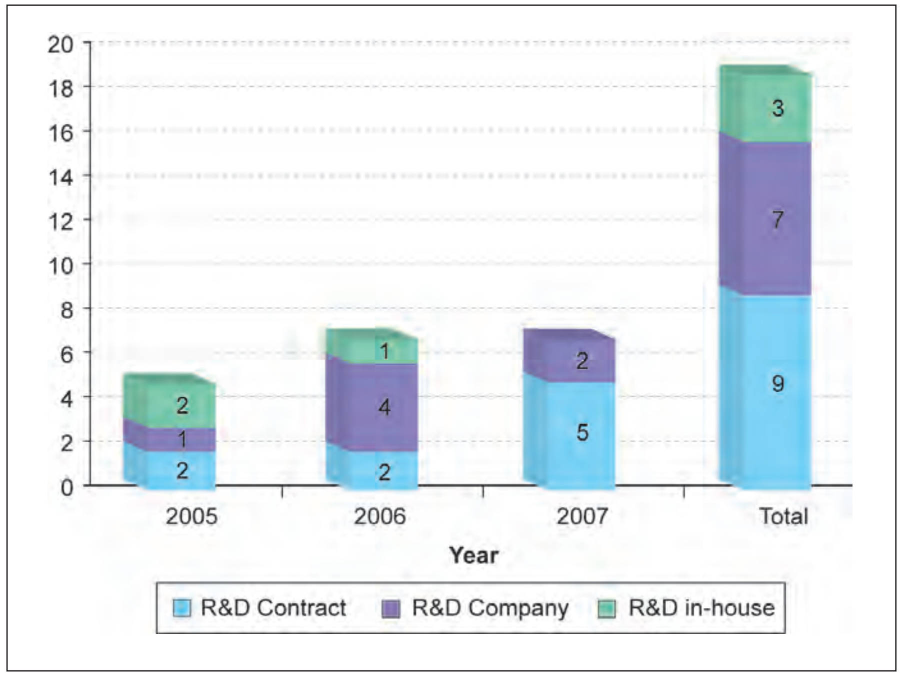
(ii) R&D Company

An R&D company is a company that provides R&D services in Malaysia to its related company or to any other company. An R&D company is eligible for an ITA of 100% on the qualifying capital expenditure incurred within ten years

(iii) In-House Research

In-house research means research and development carried out in Malaysia within a company for the purposes of its own business. That company can apply for an ITA of 50% of the qualifying capital expenditure incurred within ten years.

Figure 4.20: Number of R&D Projects by Types of Incentives, 2005 – 2007



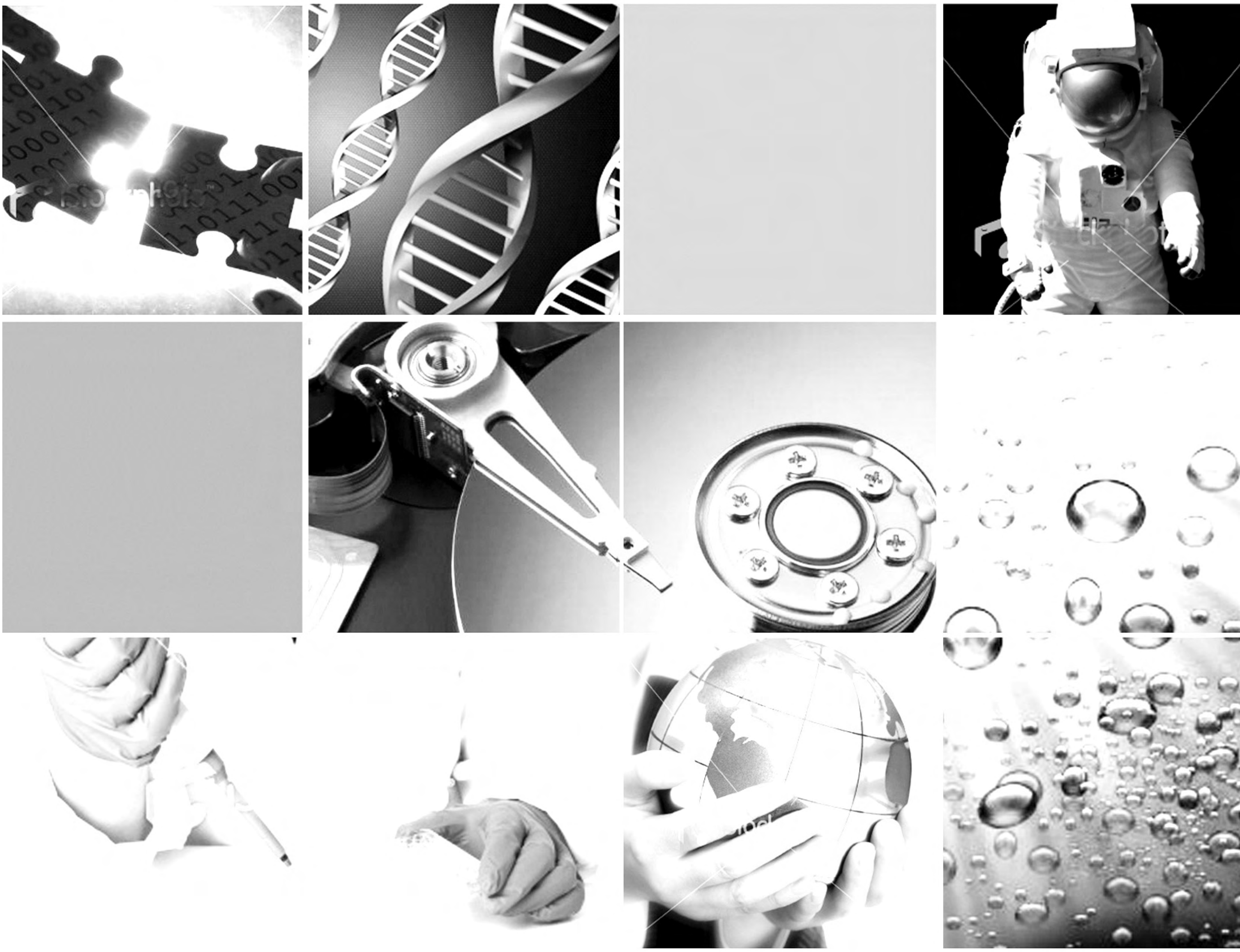
Source: Malaysian Industrial Development Authority (MIDA)

Figure 4.20 shows the number of R&D projects by type of incentives for the period of 2005- 2007. During the period, a total of 19 R&D projects were approved with total approved amount of RM73.58 million. Most of the approved applications were for incentives of R&D contract (9 approvals) and R&D company (7 approvals).

4.5 CONCLUSION

This chapter has provided comprehensive statistics on the funding information provided by the Malaysian government and its funding agencies such as Malaysian Communications & Multimedia Commission (MCMC) and Inland Revenue Board Malaysia for various S&T R&D programmes in the country. Much of the concern should be given on the capacity of the public and the private sectors in utilizing the budgets to its fullest benefit into bringing the country to become more competitive.

According to Malaysia's S&T Policy for the 21st century, the country envisioned the increase in R&D spending to at least 1.5% of Gross Domestic Product (GDP) by year 2010, in order to boost its national capacity in R&D. Evidently, the government is anticipating better competition in the global market in terms of R&D.



RESEARCH & DEVELOPMENT FOR SCIENCE AND TECHNOLOGY

Chapter 5

5.1 INTRODUCTION

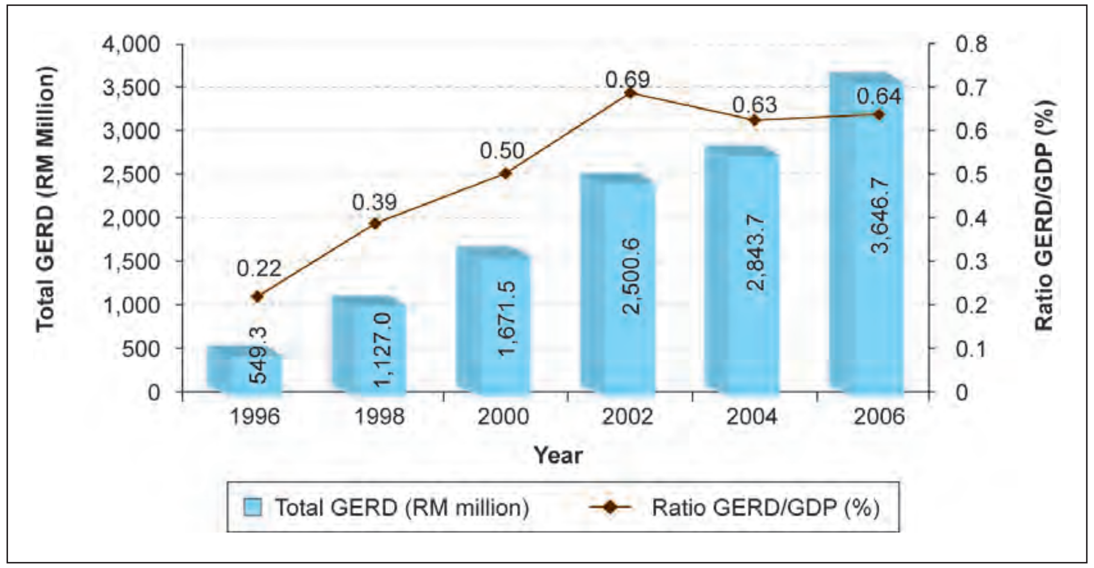
This chapter reports Research and Development (R&D) activities conducted by the Government Research Institutes (GRIs), Institute of Higher Learnings (IHLs), and Private Sector in Malaysia from 1996 to 2006. The statistical information was provided by the National Survey on Research & Development Report 2008. The scopes of this chapter comprise topics on the national overview of expenditure and activities on R&D, R&D by GRI, R&D by IHL, and R&D by Private sector in terms of cost, field of research, socio-economic objectives, sources of fund, outsourcing and international comparisons.

5.2 NATIONAL OVERVIEW OF R&D

This section examines an overview of R&D expenditure in Malaysia by looking at the trend in R&D expenses from 1996 until 2006, by sectors, type of cost (TOC), type of research (TOR), field of research (FOR), and social economic objective (SEO). This chapter also examines the sources of fund in R&D in year 2006.

5.2.1 National GERD

Figure 5.1: National GERD and Ratio GERD/GDP, 1996 – 2006



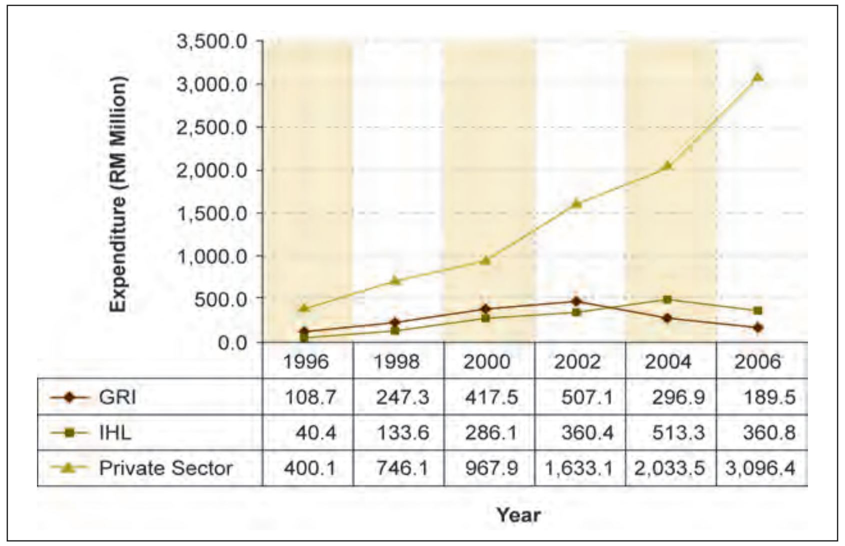
Source: National Survey of Research & Development 2008 Report

Based on Figure 5.1, National GERD increased consistently from 1996 to 2006. However, the ratio of the GERD per GDP only increased consistently from 1996 to 2002. The ratio decreased slightly at 0.06% in 2004. This indicates the growth in GERD does not necessarily result in the increase in the ratio of GERD over GDP.

5.2.2 National Expenditure on R&D

5.2.2.1 Expenditure by Sectors (GRI, IHL, Private)

Figure 5.2: Expenditure in R&D by Sectors (1996 – 2006)



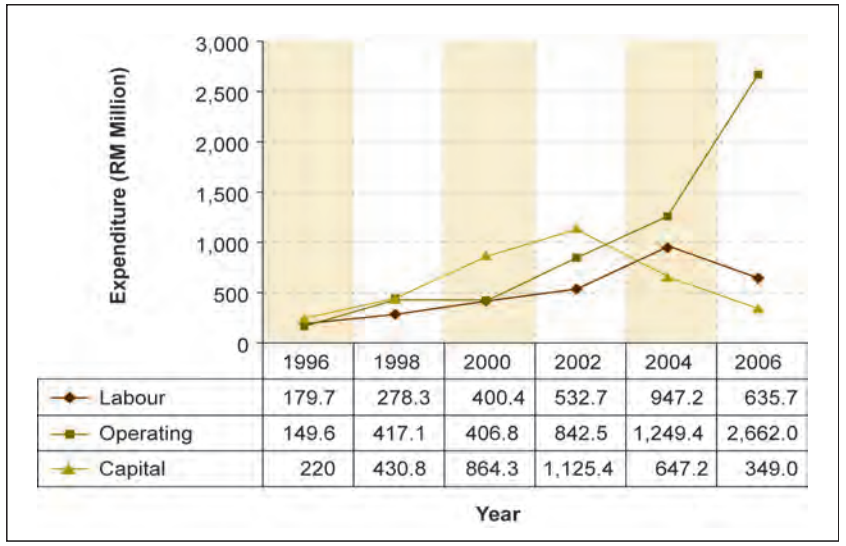
	1996	1998	2000	2002	2004	2006
GRI	108.7	247.3	417.5	507.1	296.9	189.5
IHL	40.4	133.6	286.1	360.4	513.3	360.8
Private Sector	400.1	746.1	967.9	1,633.1	2,033.5	3,096.4

Source: National Survey of Research & Development 2008 Report

Figure 5.2 shows the breakdown of R&D expenditure by sectors in 1996 to 2006. R&D expenditure seems to decline for both GRIs and IHLs. However, the amount increased almost exponentially for the private sector. The total amount spent on R&D in 2006 by the private alone was RM3,096.4 million. This has therefore triggered the overall increase in R&D expenditure in 2006. Such huge expenditure on the private R&D by the Malaysian government is most likely due to the expensive grants given in high technology manufacturing and marketing of new machinery products, through applied R&D.

5.2.2.2 Expenditure by Type of Cost (TOC)

Figure 5.3: Expenditure by Type of Cost (1996 – 2006)



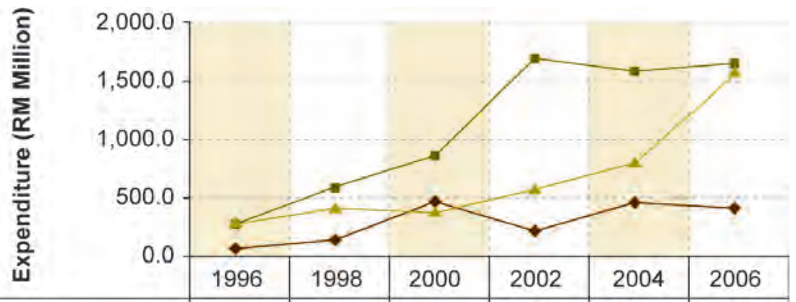
	1996	1998	2000	2002	2004	2006
Labour	179.7	278.3	400.4	532.7	947.2	635.7
Operating	149.6	417.1	406.8	842.5	1,249.4	2,662.0
Capital	220	430.8	864.3	1,125.4	647.2	349.0

Source: National Survey of Research & Development 2008 Report

During the period of 1996 to 2006, a total of RM12,338 million was spent in terms of cost's type. Figure 5.3 shows the upward trend from as low as RM549.3 million in 1996 to RM3,646.7 million in 2006. However, the trend varies by type of costs, whereby the cost expenses for labor and capital declined from 2002 to 2006, while the cost expenses for operation increased significantly from 2000 to 2006.

5.2.2.3 Expenditure by Type of Research (TOR)

Figure 5.4: Expenditure in R&D by Type of Research



	1996	1998	2000	2002	2004	2006
Basic Research	49.3	138.8	451.9	209.6	462.0	411.4
Applied Research	228.6	568.7	852.2	1,714.7	1,570.9	1,645.2
Experimental Development	271.4	419.5	367.4	576.3	810.9	1,590.1

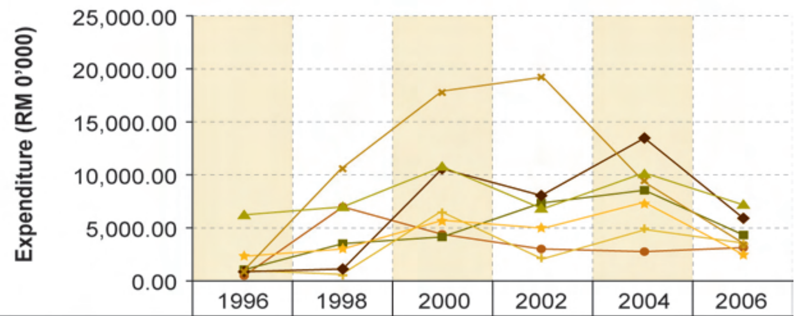
Year

Source: National Survey of Research & Development 2008 Report

Figure 5.4 presents expenditure in R&D by type of research from 1996 to 2006. There are three types of research categorized in R&D expenditure. These are basic research, applied research and experimental development research. In terms of expenditure, applied research has been recorded the highest each year, in the amount of expenses utilized. This type of research, however, seems to decline in 2004, which coincides with the increase in the expenditure on the experimental development research. While the total amount of expenditure increases constantly every year, the differences in types of research expenditure can be attributed to different focus given by the Malaysian government on different types of method used in R&D and focused objectives.

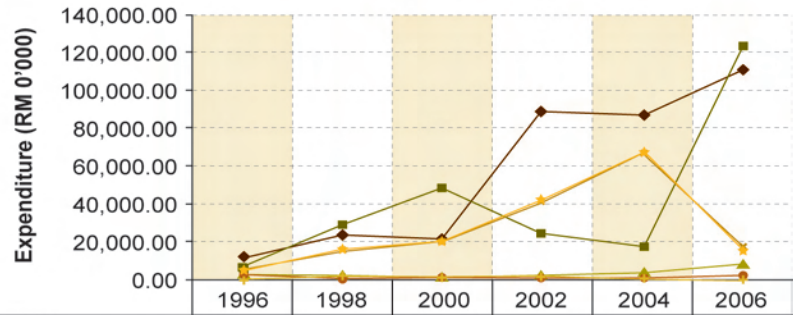
5.2.2.4 Expenditure by Field of Research (FOR)

Figure 5.5: Expenditure in R&D by Field of Research



	1996	1998	2000	2002	2004	2006
Engineering Sciences	1,026.3	1,202.6	10,658.8	8,080.5	13,530.3	6,070.2
Applied Sciences & Technologies	1,017.6	3 ,417.5	4,218.0	7,451.1	8,570.2	4,323.9
Agriculture Sciences	6,258.5	6,960.6	10,878.7	6,927.7	10,439.9	7,310.2
Information, Computer & Communication Technologies	695.6	10,655.6	17,772.7	19,226.3	9,417.2	3,602.6
Biological Sciences	2,371.0	3,089.6	5,752.4	4,998.5	7,254.9	2,462.8
Chemical Sciences	507.6	6,983.0	4,478.7	3, 135.8	2,822.8	3,292.1
Social Sciences	917.85	45.4	6,437	92,147.1	4,924.4	3,525.5

Year
Public Sectors (GRIs and IHLs)



	1996	1998	2000	2002	2004	2006
Engineering Sciences	12,658.87	23,047.46	19,435.64	89,712.03	87,120.29	11,1472.48
Applied Sciences & Technologies	7,464.89	29,173.18	48,613.81	23,940.90	17,516.11	122,178.76
Agriculture Sciences	3,231.87	2,886.90	2,962.06	2,785.04	4,202.90	9,456.98
Information, Computer & Communication Technologies	5,696.11	15,642.69	20,451.32	41,779.84	67,040.83	17,119.11
Biological Sciences	372.71	301.90	1,007.90	413.49	1,591.08	5,089.34
Chemical Sciences	3,374.16	548.55	1,061.57	1,547.09	897.74	2,123.12
Social Sciences	-	985.56	434.36	123.04	199.38	-

Year
Private Sectors

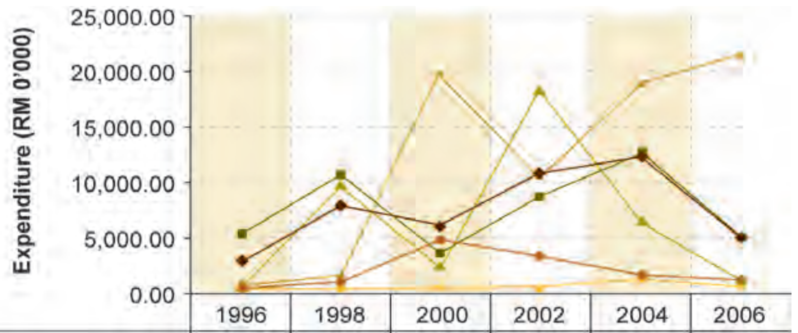
Source: National Survey of Research & Development 2008 Report

Figure 5.5 shows the overall trend of expenditure in R&D in the top seven field of research in the public (GRIs and IHLs) and private sectors. The upward and downward trends in expenditure can be observed for various reporting fields within GRIs and IHLs. ICT has been the field which utilizes the most of the R&D expenses throughout 1996 to 2002. The expenses have, however, decreased in 2004 to 2006. Such decrease seems to be compensated with slight increase in expenditures in various other fields in 2004. However, the number of expenditure for all fields in the public sector started to decrease in 2006. This shows that overall government spending in R&D through GRIs and IHLs has decreased significantly throughout 2005 and 2006.

The trend in R&D expenditure for the top seven field of research in the private sector shows quite the opposite situation. Significant increase can be found from 2004 to 2006 in various R&D fields. The most significant increase in expenditure was engineering science, followed by applied sciences & technologies and agriculture sciences. The increase in R&D expenditure within the private sector may be explained by the government focus of research direction to applied ICT and manufacturing during the reporting period of 2004 – 2006.

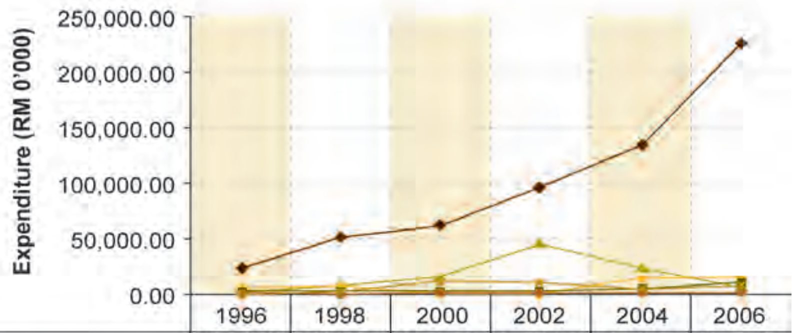
5.2.2.5 Expenditure by Social Economic Objective (SEO)

Figure 5.6: Expenditure in R&D by Social Economic Objective



	1996	1998	2000	2002	2004	2006
Manufacturing	2,761.32	7,764.99	5,957.39	10,670.04	12,393.45	5,010.83
Plant Production & Plant Primary Product	5,224.74	10,505.65	3,341.62	8,528.69	12,616.57	4,966.89
Information & Communication Services	182.69	9,649.13	2,264.79	18,133.84	6,391.17	1,274.07
Natural Sciences, Technology & Engineering	429.76	1,358.01	19,625.44	10,245.21	18,731.28	21,378.52
Energy Resources	340.16	156.89	309.88	441.86	1,280.26	604.30
Natural Resources	437.33	912.71	4,820.57	3,369.34	1,527.11	1,151.66

Year
Public Sectors (GRIs and IHLs)



	1996	1998	2000	2002	2004	2006
Manufacturing	22,748.03	50,606.47	61,741.29	95,627.65	131,723.17	224,462.5
Plant Production & Plant Primary Product	2,969.96	3,096.45	3,073.62	27,45.50	5,322.64	10,118.24
Information & Communication Services	1,448.06	8,305.15	15,693.77	46,337.79	23,336.60	6,654.37
Natural Sciences, Technology & Engineering	89.17	1,979.71	11,131.86	10,270.23	5,381.51	7,537.91
Energy Resources	5,561.99	7,601.87	39.83	216.31	1,4581.48	14,249.53
Natural Resources	129.34	4.49	80.97	130.82	64.00	194.15

Year
Private Sectors

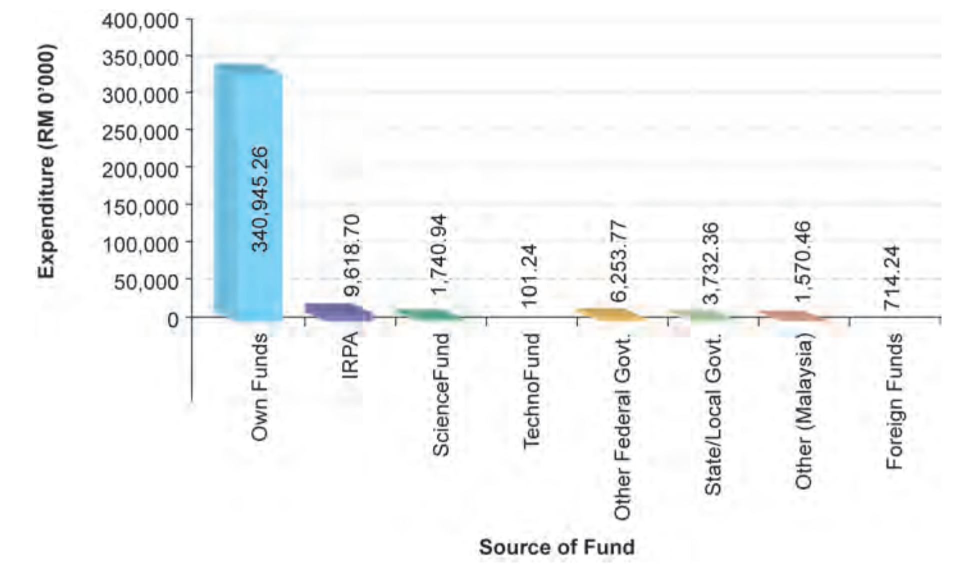
Source: National Survey of Research & Development 2008 Report

Figure 5.6, shows the expenditure in R&D for the top six social economic objectives in public and private sectors. The patterns of R&D expenditure in the public sectors seem to vary from year to year with ups and downs trends. The most significant increase in expenditure in public sectors by social economic objectives (SEO) was natural sciences, technology & engineering. The expenditure in the natural sciences, technology & engineering increased steadily from 1996 until 2000. However, in 2002 the expenditure decreased about 47.80%.

The R&D expenditure in the private sectors by SEO has increased significantly over the years with the contribution of expenses mainly made through the manufacturing sector. Other SEOs have also experienced decreasing or unimproved trend in the overall expenses.

5.2.3 Sources of Fund

Figure 5.7: Sources of Fund (RM) in 2006



Source: National Survey of Research & Development 2008 Report

Figure 5.7 illustrates the sources of fund in 2006 for R&D purposes. As stated in this figure, there are several types of funding such as own funds, IRPA, ScienceFund, TechnoFund and etc. in R&D. The highest expenditure (with a very huge proportion) comes from own fund (RM3.409 billion) or self generated income by respective research agencies. This is followed by various other government grants such as IRPA (RM96.18 million), other federal government agencies grant (RM62.53 million), Science fund, Techno fund, etc.

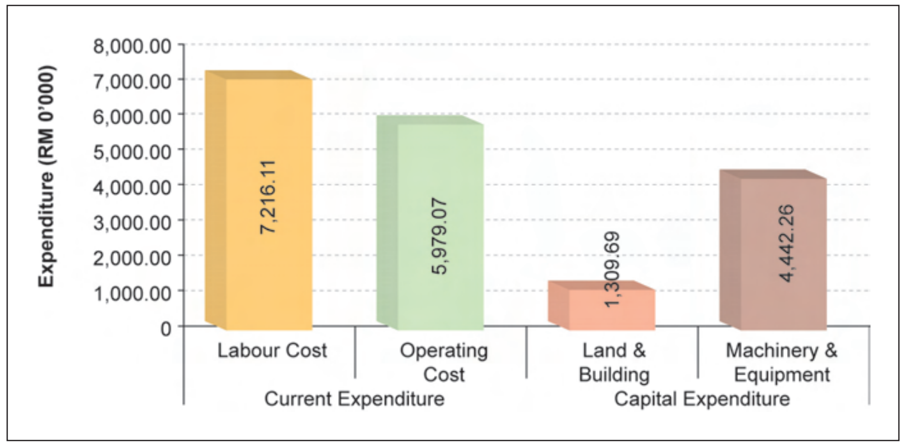
5.3 R&D IN GRI SECTORS

This section examines R&D expenditures and activities in 2006 in various government research institutes (GRIs). The reports on the expenditure and activities are categorized by sectors, type of cost, type of research, field of research, and social economic objectives. This section also provides information on the sources of fund in R&D in 2006 and the amount of outsourced R&D.

5.3.1 Expenditure in GRIs

5.3.1.1 Expenditure in GRI by TOC

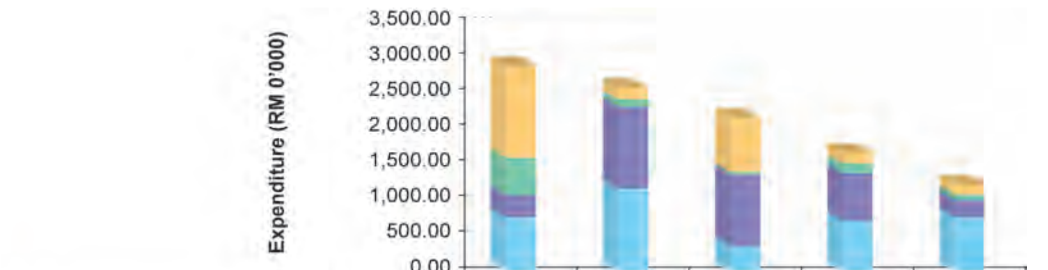
Figure 5.8: Total Expenditure in GRI by Type of Cost in 2006



Source: National Survey of Research & Development 2008 Report

Figure 5.8 shows total expenditure in GRIs by type of cost in 2006, which are divided into capital expenditure and current expenditure. Current expenditure on R&D comprise of labour cost and operating cost (RM131.9 million (69.6%)), whereas capital expenditure (RM57.5 million (30.4%)) was comprised of land & building and machinery & equipment. The figure indicates the high proportion of current expenditure compared to the capital expenditure. Most of the expenses in GRIs were made up of labour cost and operating cost.

Figure 5.9: Expenditure in GRI by Type of Cost and Five Selected GRIs in 2006



	ANM	MARDI	SIRIM	FRIM	JTSB
Capital Expenditure Machinery & Equipment	1,285.26	153.94	788.35	123.02	127.60
Capital Expenditure Land & Building	530.56	80.59	23.06	163.04	65.08
Current Expenditure Operating Cost	307.73	1,143.93	984.50	671.25	241.75
Current Expenditure Labour Cost	814.81	1,231.88	427.38	771.29	829.13

GRI Institution

Source: National Survey of Research & Development 2008 Report

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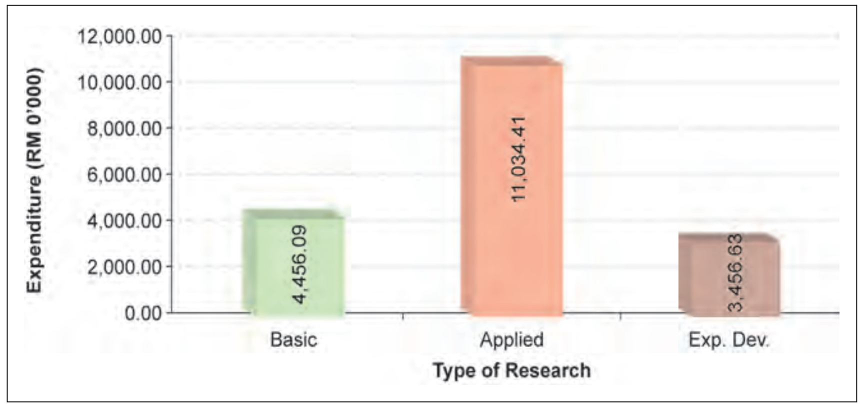
Figure 5.9 shows the distribution of expenditures in five selected GRIs (ANM, MARDI, SIRIM, FRIM and JTSB) according to different types of costs. In terms of expenditure, ANM spent the highest (RM29.4 million) on capital and current expenditure followed by MARDI (RM26.1 million) and SIRIM (RM22.2 million). The pattern of GRI spending based on type of cost proportions is found to be different from one agency to another. For instance, ANM has had bigger proportions of its cost on capital expenditure. However, MARDI, has had bigger proportion of its expenditure on operations and labour, whereas SIRIM, has had bigger proportion of expenditure on capital and operating costs.

5.3.1.2 Expenditure in GRI by TOR

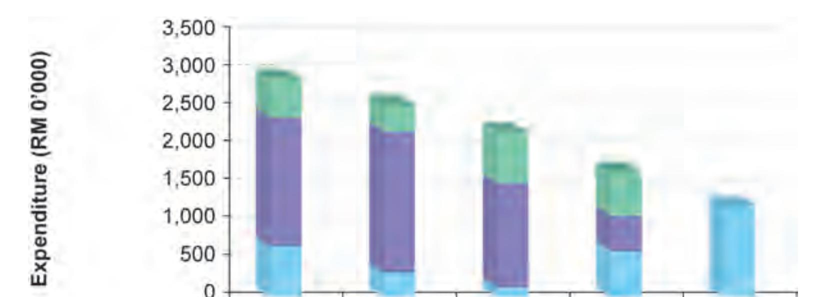
Figure 5.10: Total Expenditure in GRI by Type of Research in 2006



Source: National Survey of Research & Development 2008 Report

Figure 5.10 shows the distribution of expenditure in GRI by type of research (TOR) in 2006. Similar to the private institution, the highest proportion of expenditure in GRI was on applied research (58%), followed by basic (24%) and experimental development (18%). The pattern is in line with the nature of GRIs' establishment, which is to promote R&D in products development and enhancement based on the Malaysian existing natural resources.

Figure 5.11: Expenditure in GRI by Type of Research in 2006 by GRI Institutions



	ANM	MARDI	SIRIM	FRIM	JTSB
Exp. Dev.	514.84	369.12	659.01	604.80	-
Applied	1,680.07	1,844.84	1,473.55	431.95	1,263.56
Basic	743.45	396.38	90.73	691.85	-

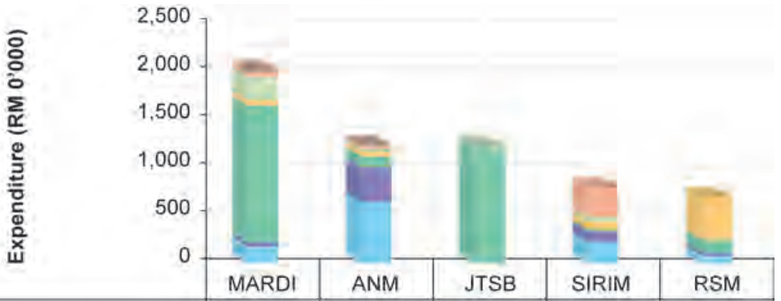
GRI Institutions

Source: National Survey of Research & Development 2008 Report

In terms of expenditure by type of research, MARDI recorded as the agency that spent the most in applied research (RM18.4 million) followed by ANM, SIRIM, JTSB and FRIM. In basic research, ANM was found spending the most (RM7.4 million), followed by FRIM and MARDI (see Figure 5.11).

5.3.1.3 Expenditure in GRI by FOR

Figure 5.12: Expenditure in GRI by Field of Research in 2006 by Institutions



	MARDI	ANM	JTSB	SIRIM	RSM
Social Sciences	5.90	8.27	-	-	-
Chemical Sciences	44.48	24.53	-	256.82	-
Biological Sciences	241.76	16.69	14.73	57.28	-
Information, Computer & Communication Technologies	51.84	51.82	-	91.98	453.60
Agriculture Sciences	1,468.20	121.25	1,248.82	9.49	170.46
Applied Sciences & Technologies	29.78	345.13	-	130.95	21.63
Engineering Sciences	206.02	700.74	-	276.05	91.11

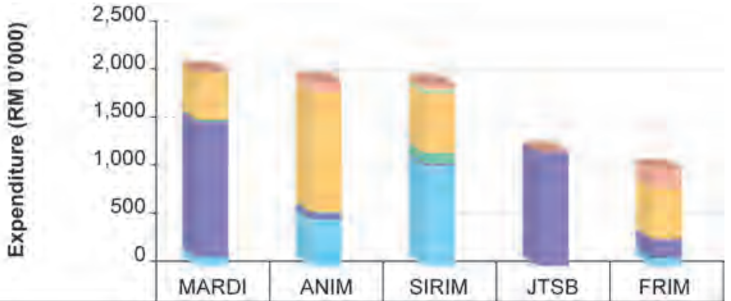
GRI Institutions

Source: National Survey of Research & Development 2008 Report

Figure 5.12 shows the distribution of expenditure in GRI by field of research (FOR) and by specific institutions in 2006. As shown in the figure, agriculture sciences is found to dominate the expenses in GRIs, with two research institutions (MARDI and JTSB) leading the figure. Other dominating fields are engineering sciences, through which most of the expenditures incurred were within ANM, SIRIM and MARDI. This is followed by ICT with the largest proportions of total expenditure incurred in RSM. The top 3 institutions in terms of expenditure by FOR were MARDI, ANM and JTSB, in which the amount of spending reached RM45.8 million out of RM61.4 million (74.6%) in total in 2006.

5.3.1.4 Expenditure in GRI by SEO

Figure 5.13: Expenditure in GRI by Social Economic Objective in 2006 by Institutions



	MARDI	ANIM	SIRIM	JTSB	FRIM
Natural Resources	15.73	107.68	54.02	12.10	198.05
Energy Resources	-	4.20	49.80	-	-
Natural Sciences, Technology & Engineering	497.69	1,239.28	617.28	-	521.47
Information & Communication Services	12.39	8.53	107.27	-	-
Plant Production & Plant Primary Product	1,420.59	72.13	13.98	1,251.46	260.72
Manufacturing	142.20	545.03	1,104.75	0.00	75.00

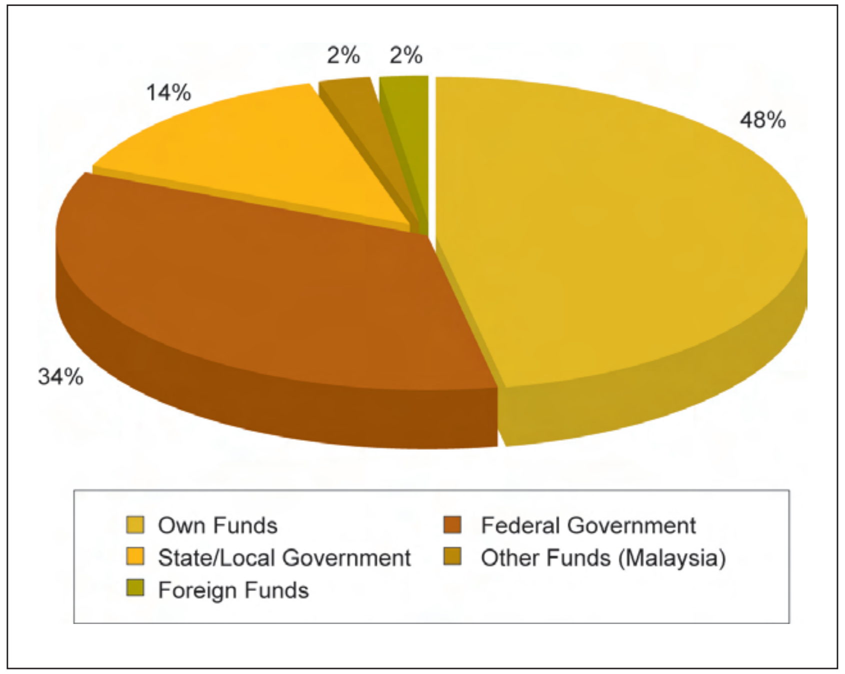
GRI Institutions

Source: National Survey of Research & Development 2008 Report

Figure 5.13 provides information on the expenditures in GRIs based on six major categories of social economic objectives (SEO), namely natural resources, energy resources, natural sciences, technology & engineering, information & communication services, plant production & plant primary product, and manufacturing. The institutions with the highest SEO expenditure in 2006 were MARDI, followed by ANM, SIRIM, JTSB and FRIM. Based on the proportion in SEO expenses within each institution, several SEOs are identified as the main focus in the establishment and basic operations of the specified institutions. Plant production and plant primary product made up the biggest proportion in MARDI and JTSB with 47% and 41% shared proportion respectively. While MARDI also allocated its expenses on natural sciences, technology and engineering, and manufacturing, JTSB only allocated its expenses solely on plant production and primary product. ANM allocated most of its expenses on natural sciences, technology and engineering, with some focus given to manufacturing and natural resources. SIRIM, on the other hand, had given most of its focus on manufacturing and natural sciences, technology and engineering. FRIM had its' SEO cost distributions fairly largely on natural sciences, technology and engineering, plant production, and natural resources.

5.3.2 Sources of Fund in GRI

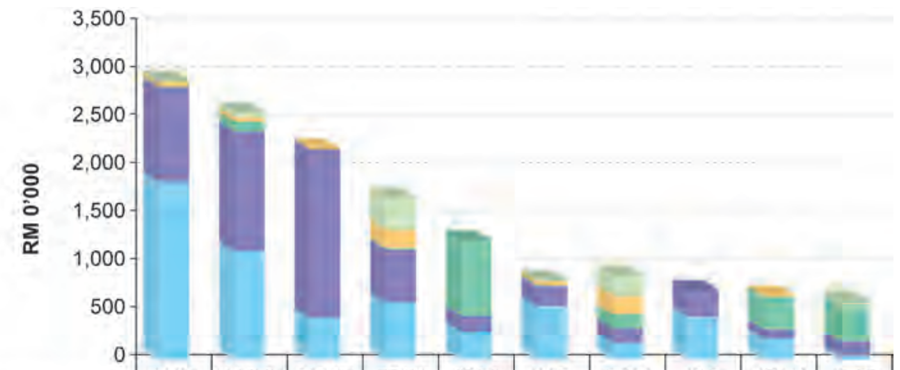
Figure 5.14: Sources of Fund in GRI



Source: National Survey of Research & Development 2008 Report

As shown in Figure 5.14, sources of fund in GRI comprise of self generated or own funds, state/local government funds, foreign funds, federal government and others. As reported previously, private sector depended mostly on its own generated fund for R&D. This is also similar to the case of GRIs, where a large proportion of source of funding comes from self generated income. According to the above figure, the highest source of funding comes from own fund (48%) followed by federal government (34%) and state/local government (14%). Being initiated as government research institutions, GRIs also depend in large portion from the public funding.

Figure 5.15: Sources of Fund in GRI by GRI Institutions



	ANM	MARDI	SIRIM	FRIM	JTSB	IMR	RSM	IPP	JTSK	JPSB
Foreign Funds	13.1	40.71	-	341.6	-	7.1	-	-	-	27.63
Other Funds (Malaysia)	46.83	40.15	2.808	194	-	50.75	-	-	14.5	3.6
State/Local Government	1 .5	103.4	-	3.578	765.6	1	53.31	-	367.7	404.9
Federal Government	984.2	1266	1743	566.1	179.8	214	11.5	266.8	66.61	144.8
Own Funds	1893	1161	477.8	623.3	318.1	591.2	769.1	499.4	262.6	62.88

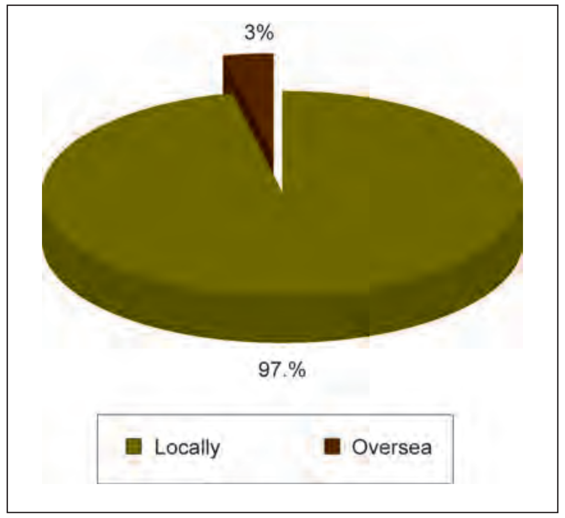
GRI Institutions

Source: National Survey of Research & Development 2008 Report

Figure 5.15 shows the breakdown of the sources of fund by 10 highest funded GRIs. The highest funded institutions from the top 10 GRIs was Malaysian Nuclear Agency (ANM) with a total of RM29.4 million in grants. Most of the funds in ANM were acquired through self funding with 64% from the total income. Jabatan Perhutanan Sabah (JPSB) was the least funded institutions with an income of RM6.4 million mostly coming from state or local government grants.

5.3.3 Outsourcing by GRI

Figure 5.16: Outsourcing by GRI in 2006

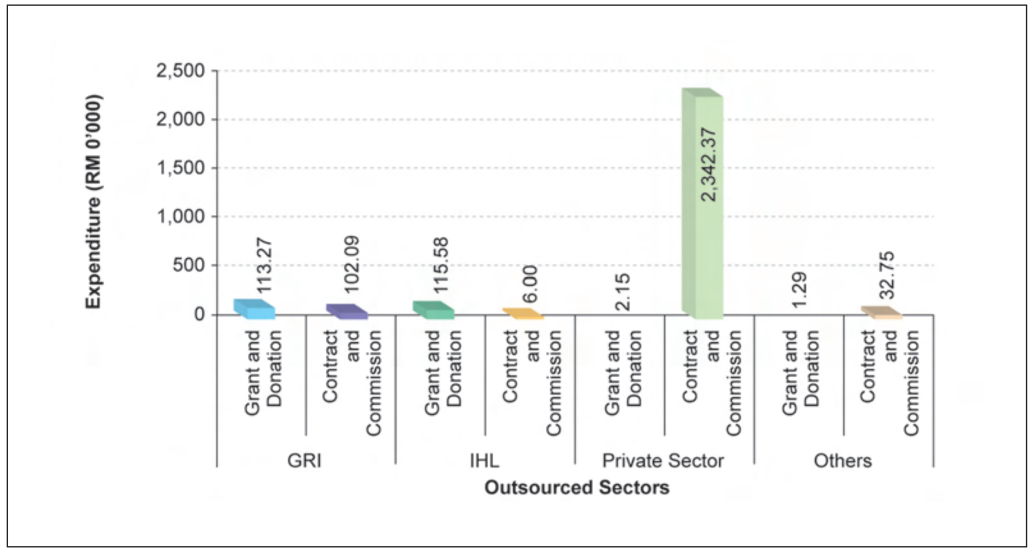


Source: National Survey of Research & Development 2008 Report

Some R&D activities in GRI have been outsourced to outside providers locally or from abroad. Figure 5.16, shows the type of outsourcing providers with local outsourcing providers dominating the proportion up to 97%.

5.3.3.1 Outsourcing by GRI Locally

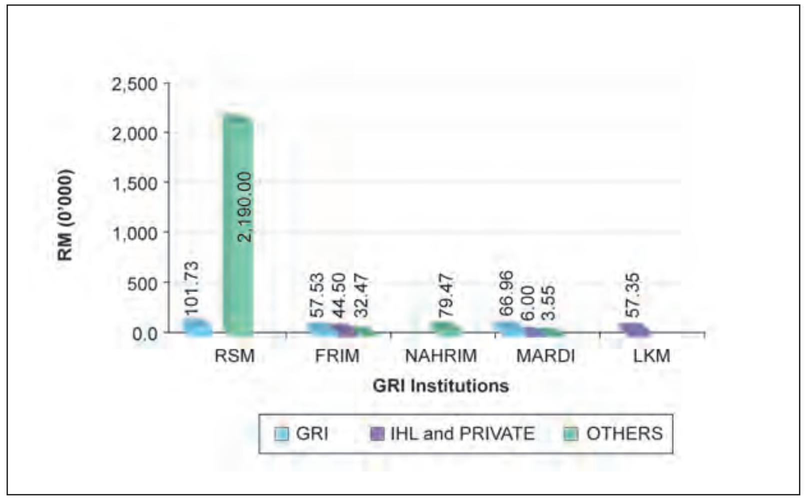
Figure 5.17: Outsourcing by GRI Locally



Source: National Survey of Research & Development 2008 Report

GRIs has outsourced some of their R&D activities to various providers such as other GRIs, IHL, private sector, and others. Figure 5.17 shows that the biggest proportion of outsourcing service providers in 2006 are the private sectors. The amount of outsourcing grant to the private sectors was RM23.4 million, 99% of which were outsourced by using contract and commission.

Figure 5.18: Outsourcing by GRI Locally by GRI Institutions



Source: National Survey of Research & Development 2008 Report

Figure 5.18 shows that Remote Sensing Malaysia (RSM) has been the biggest outsourcing clients in 2006 with the amount of RM22.9 million far exceeding other GRIs. This is followed by Forest Research Institute Malaysia (FRIM), National Hydraulic Research Institute of Malaysia (NAHRIM), Malaysia Research Development Institute (MARDI), and Malaysia Cocoa Institute (LKM). RSM outsourced most of its R&D activities to private institutions.

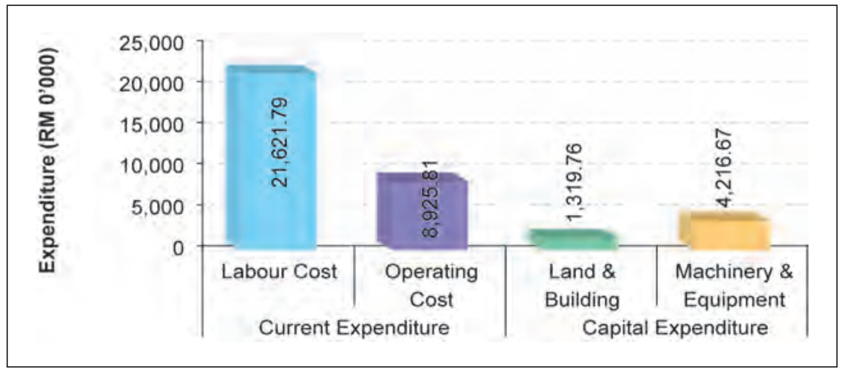
5.4 R&D IN IHL SECTORS

This section reports on R&D expenditures and activities in 2006 in the Malaysian institute of higher learning (IHL). The reports on the expenditure and activities are categorized by sectors, type of cost (TOC), type of research (TOR), field of research (FOR), and social economic objectives (SEO). This section also provides information on the sources of fund in R&D in 2008 and the number of outsourced R&D.

5.4.1 Expenditure in IHL

5.4.1.1 Expenditure in IHL by TOC

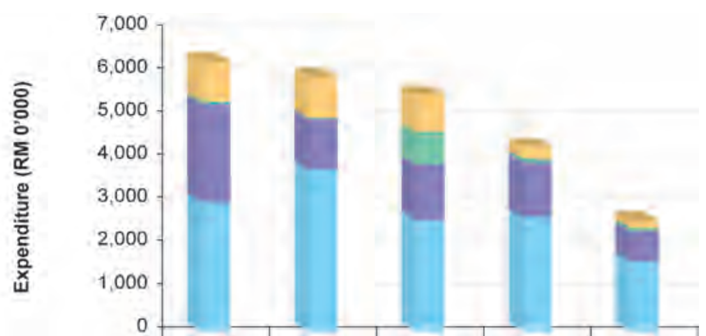
Figure 5.19: Total Expenditure in IHL by Type of Cost in 2006



Source: National Survey of Research & Development 2008 Report

Figure 5.19 shows the total expenditure in IHLs by type of cost in 2006. In terms of total expenditure, labour cost recorded as the highest type of expenditure (RM216.2 million or 60% out of RM360.8 million). This is followed by operating cost (24%), machinery and equipment (12%), and land and building (4%). This cost distribution is also similar to those of the private and GRIs sectors.

Figure 5.20: Expenditure in IHL by Type of Cost in 2006 by IHL Institutions



	UM	UTM	UKM	USM	UPM
Capital Expenditure Machinery & Equipment	915.88	973.56	824.12	293.52	154.53
Capital Expenditure Land & Building	44.70	5.55	764.33	43.61	51.66
Current Expenditure Operating Cost	2,279.19	1,162.96	1,269.96	1,266.95	670.74
Current Expenditure Labour Cost	3,110.27	3,883.92	2,719.94	2,783.78	1,793.25

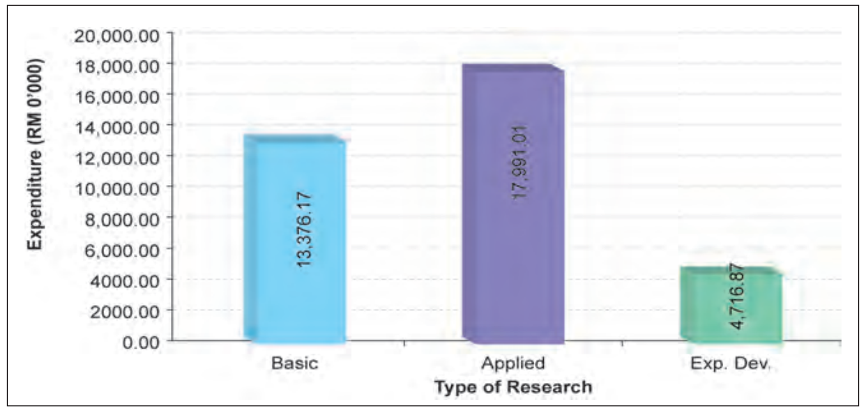
GRI Institutions

Source: National Survey of Research & Development 2008 Report

Figure 5.20 illustrates the type of expenditure of the top 5 IHLs in 2006. In terms of total expenditure, UM, UTM, UKM, USM and UPM remained as the top spenders in IHLs. Accordingly, UM was the highest spender among the top 5 IHLs with RM63.5 million in total expenses. The university also had the highest proportion of expenditure on operating cost compared to other IHLs. In most of the IHLs reported, labour cost made up the highest cost proportion in their total expenses.

5.4.1.2 Expenditure in IHL by TOR

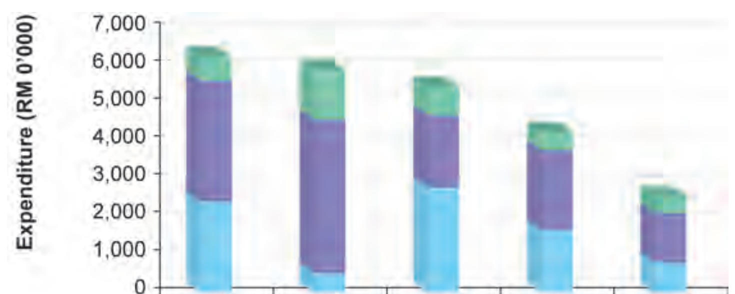
Figure 5.21: Expenditure in IHL by Type of Research in 2006



Source: National Survey of Research & Development 2008 Report

Figure 5.21 shows the distribution of the amount of expenditure in IHLs according to TOR. The total amount of expenditure of the IHLs by type of research in 2006 was RM360.8 million, which were distributed in three major areas of research: basic research, applied, and experimental development research. The figure shows that applied research also dominates the total expenditure in IHLs with total spending of RM179.9 million (50%). However, the proportions of basic and experimental development research were much higher in IHLs compared to the private and GRI sectors (37% and 13% respectively).

Figure 5.22: Expenditure in IHL by Type of Research and IHL Institutions in 2006



	UM	UTM	UKM	USM	UPM
Exp. Dev.	609.76	1,337.73	777.99	509.45	458.79
Applied	3,221.92	4,009.37	1,904.38	2,118.47	1,265.87
Basic	2,518.35	678.89	2,895.98	1,759.95	945.51

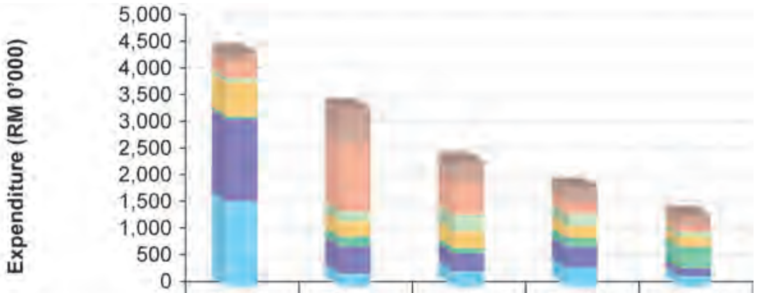
IHL Institutions

Source: National Survey of Research & Development 2008 Report

Figure 5.22 shows the distribution of expenditure according to TOR and top 5 IHLs. The distribution indicates more emphasis given on applied and basic research in most of the institutions. The proportion of applied research was much higher than other types of research in UM, UTM, USM and UPM. Only UKM demonstrated higher proportion on basic research (52%) than applied (34%) and experimental development (14%) research.

5.4.1.3 Expenditure in IHL by FOR

Figure 5.23: Expenditure in IHL by Field of Research in 2006 by IHL Institutions



	UTM	UKM	UM	USM	UPM
Social Sciences	142.03	660.05	338.26	275.96	173.56
Chemical Sciences	313.64	1,274.67	657.56	218.27	139.16
Biological Sciences	69.45	182.23	318.62	234.89	98.15
Information, Computer & Communication Technologies	644.34	281.33	311.80	222.74	170.03
Agriculture Sciences	30.90	195.70	101.19	152.57	472.33
Applied Sciences & Technologies	1537.25	463.59	337.21	389.93	150.04
Engineering Sciences	1,695.66	363.65	373.99	445.35	208.25

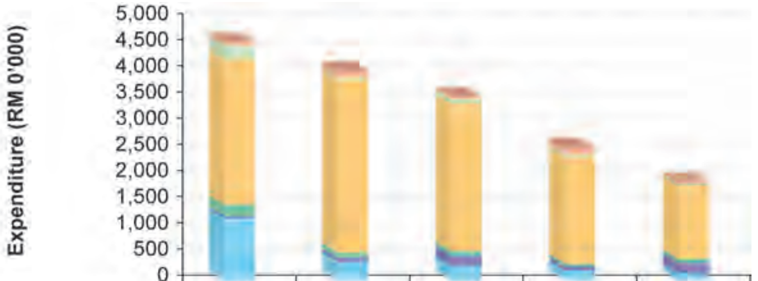
IHL Institutions

Source: National Survey of Research & Development 2008 Report

Figure 5.23 shows the distribution of expenses in top 5 IHLs according to field of research. The distribution indicates the different focuses given by each IHL on different types of research. UTM, being the highest in R&D expenditure, has given focus on its expenditure on engineering sciences, applied science and technology, and ICT. On the other hand, UKM and UM seem to be spending in similar proportions on all types of field of research. In this regard, chemical sciences dominate the proportions followed by applied sciences and technologies, and social sciences. While USM also focused on applied science and technologies, and engineering in a much smaller amount than UTM, UPM is the sole university giving focus on agriculture science in its expenses.

5.4.1.4 Expenditure in IHL by SEO

Figure 5.24: Expenditure in IHL by Social Economic Objective in 2006 by IHL Institutions



	UTM	UKM	UM	USM	UPM
Natural Resources	8.19	101.37	23.70	142.81	29.09
Energy Resources	290.49	16.30	115.35	41.61	0.96
Natural Sciences, Technology & Engineering	2,775.80	3,367.59	2,791.21	2,065.56	1,422.51
Information & Communication Services	234.64	80.58	104.37	40.30	86.41
Plant Production & Plant Primary Product	9.56	47.65	176.81	76.68	263.75
Manufacturing	1281.29	459.13	363.22	270.98	128.34

IHL Institutions

Source: National Survey of Research & Development 2008 Report

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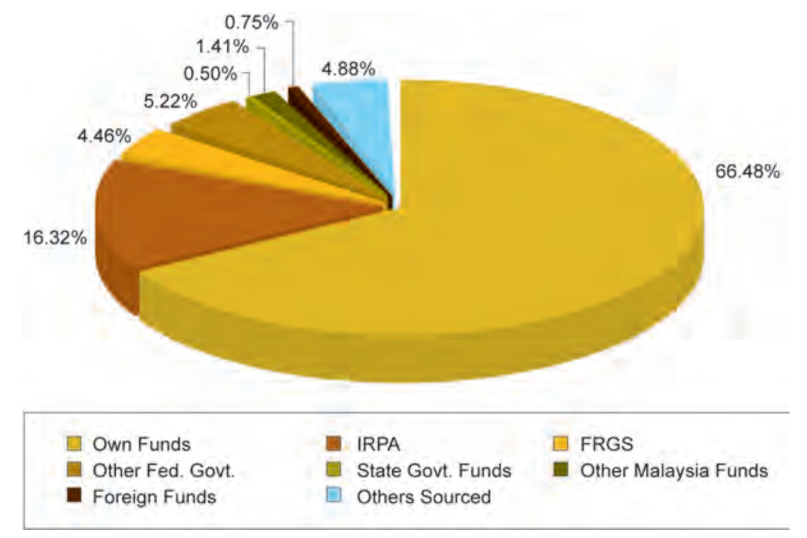
Figure 5.24 shows statistical distribution according to SEO in top 5 IHLs. The distribution indicates the high focus of the government in natural sciences, technology and engineering for R&D expenses in IHLs. This is due to the large proportion of expenses of these SEO in each of the top 5 IHLs reported. Some small proportions have been given on manufacturing, plant production and primary product, energy resources, ICT resources, and natural resources.

5.4.2 Sources of Fund in IHL

Figure 5.25: Sources of Fund in IHLs

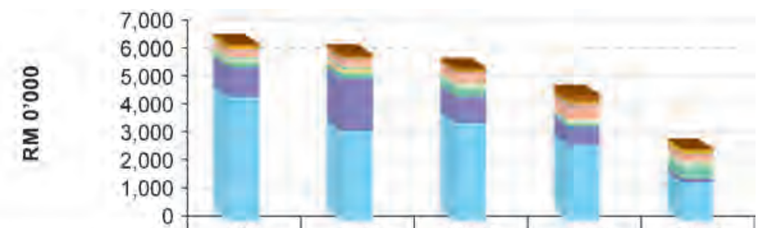


Source: National Survey of Research & Development 2008 Report

(Other funds: NIH+Cess+Techno Funds+FRGS)

Figure 5.25 shows various sources of funds in IHLs in 2006. Most of the fund in R&D in IHLs were sourced by their own (66.48%), followed by IRPA with 16.32%, and other federal government with 5.22%.

Figure 5.26: Sources of Fund in IHL by IHL Institutions



	UM	UTM	UKM	USM	UPM
Foreign Funds	25.36	28.08	60.07	62.58	2.50
Other Malaysia Funds	66.64	30.13	39.02	64.30	79.57
State Govt. Funds	7.17	74.58	12.09	62.36	2.36
Other Fed. Govt.	226.08	157.51	347.43	381.96	258.50
FRGS	219.44	207.89	208.15	132.35	199.14
Techno Funds	-	55.00	-	-	-
Science Funds	131.24	178.62	258.84	78.07	425.99
IRPA	1,081.15	1,893.17	954.35	672.27	127.05
Own Funds	4,592.96	3,401.01	3,698.40	2,933.98	1,575.06

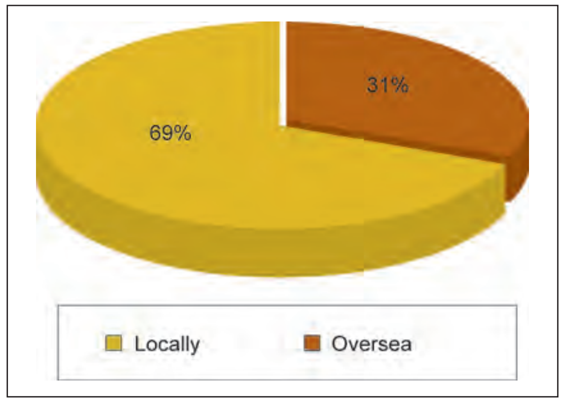
IHL Institutions

Source: National Survey of Research & Development 2008 Report

Figure 5.26, shows sources of fund in IHL by IHLs institutions. Overall, most of the IHLs depended on their own fund followed by fund from IRPA. UM recorded receiving the highest amount of fund in IHLs with 72.33% of the fund came from its own fund; followed by research grants from IRPA (17.03%) and other sources.

5.4.3 Outsourcing by IHLs

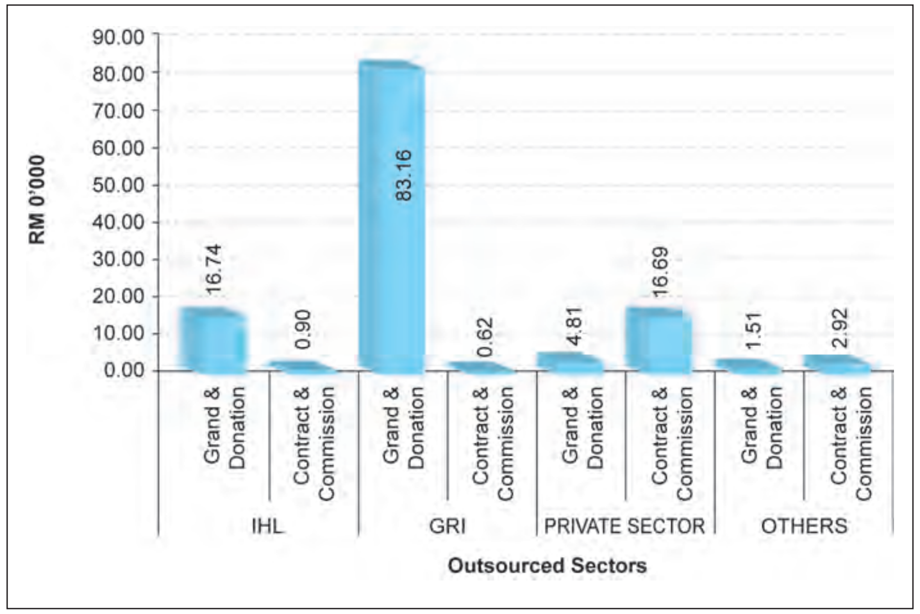
Figure 5.27: Outsourcing by IHLs



Source: National Survey of Research & Development 2008 Report

Based on figure 5.27, 69% of the outsourced R&D activities in IHLs were given to foreign researchers and only 31% were outsourced locally in 2006. This is true when the outsourcing activities take in the form of foreign experts and visiting professorship. Few projects were granted to local outsourcing provider most likely due to the nature of universities that tend to acquire local resources as experts within its human resources.

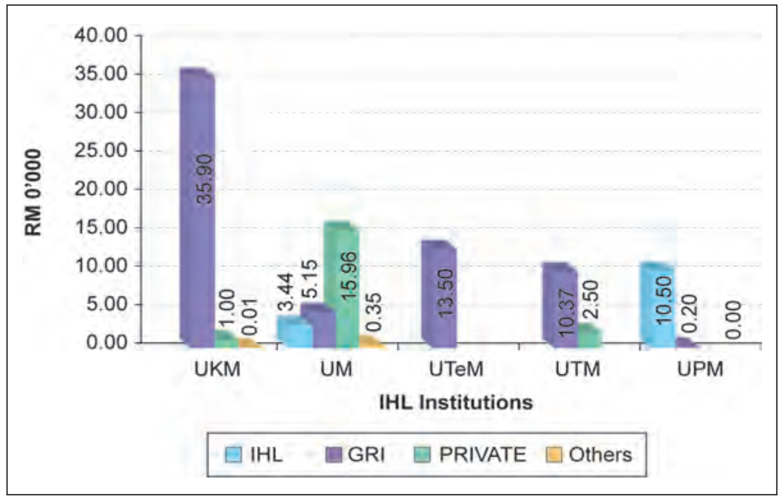
Figure 5.28: Outsourcing by IHL Locally



Source: National Survey of Research & Development 2008 Report

In 2006, outsourcing of projects by IHLs locally was given mostly to GRIs with an amount of RM0.84 million in total. Out of the total expenditure, 99.26% were outsourced by using grand and donation.

Figure 5.29: Outsourcing by IHL Institutions



Source: National Survey of Research & Development 2008 Report

Based on Figure 5.29, UKM spent the highest in outsourcing expenditure in 2006. Most of the outsourcing projects were given to GRIs by major institutions such as UKM, UTEM and UTM. However, other institutions such as UM outsourced most its R&D projects to private institutions, and UPM to other IHL.

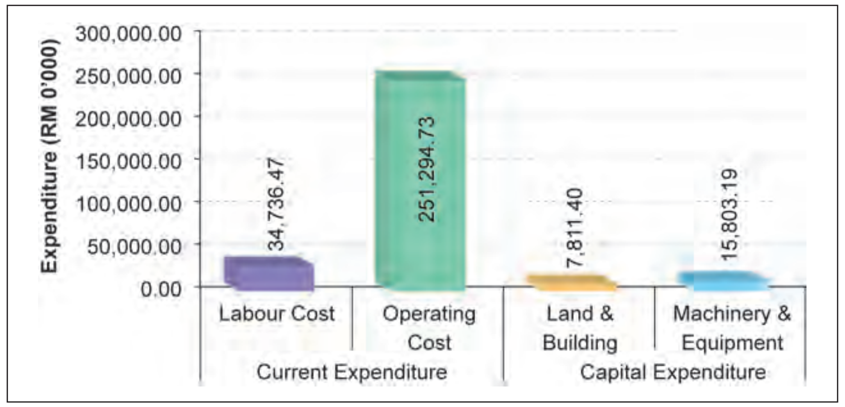
5.5 R&D IN PRIVATE SECTORS

This section examines R&D expenditure and activities in the private sectors in 2006. This report is similar to the reports on GRIs and IHLs provided earlier. This section is divided into several sub-sections comprising expenditure and activities by sectors, type of cost, type of research, field of research, and social economic objective. Reports on sources of fund and outsourcing expenses are also provided in this section.

5.5.1 Expenditure in Private Sectors

5.5.1.1 Expenditure in Private Sector by TOC

Figure 5.30: Total Expenditure in Private Sector by Type of Cost in 2006

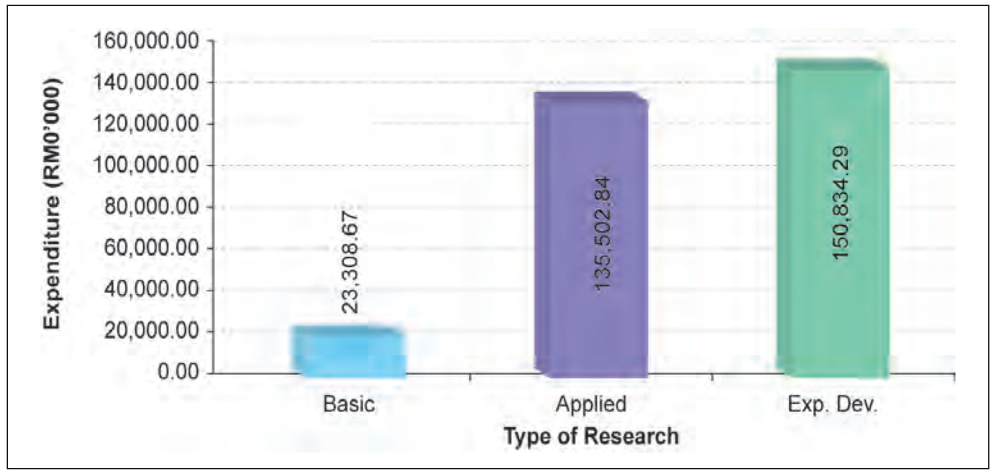


Source: National Survey of Research & Development 2008 Report

Figure 5.30 illustrates the total expenditure in private sector by type of cost in 2006. A large proportion of expenditure in the private sectors was on operating cost with an amount of RM2,512.9 million. The next highest expenditure was made on labour cost, which was RM347.4 million in total.

5.5.1.2 Expenditure in the Private Sector by TOR

Figure 5.31: Total Expenditure in Private Sector by Type of Research in 2006

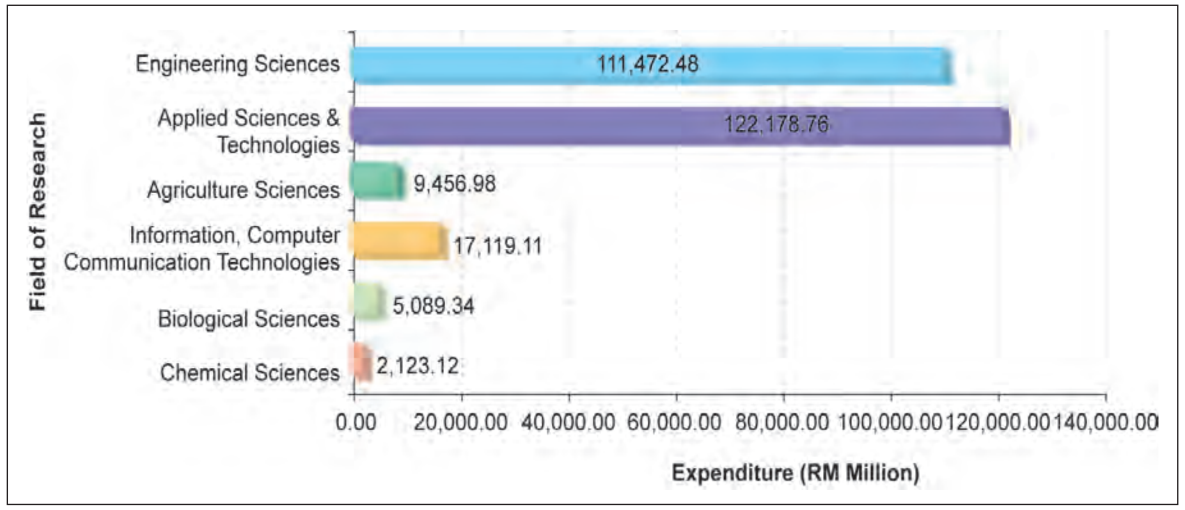


Source: National Survey of Research & Development 2008 Report

Figure 5.31 shows the amount of expenditures by type of research in the private sectors in 2006. In contrast to the GRIs and IHLs by TOR expenditure reported previously, the focus on R&D expenditure in the private sectors was given more on the experimental development (RM1,508.3 million) research, followed by applied and basic research. Applied research was also considered very important and the amount spent was only 10.16% less than the amount spent on experimental development research.

5.5.1.3 Expenditure in the Private Sector by FOR.

Figure 5.32: Expenditure by Field of Research in 2006

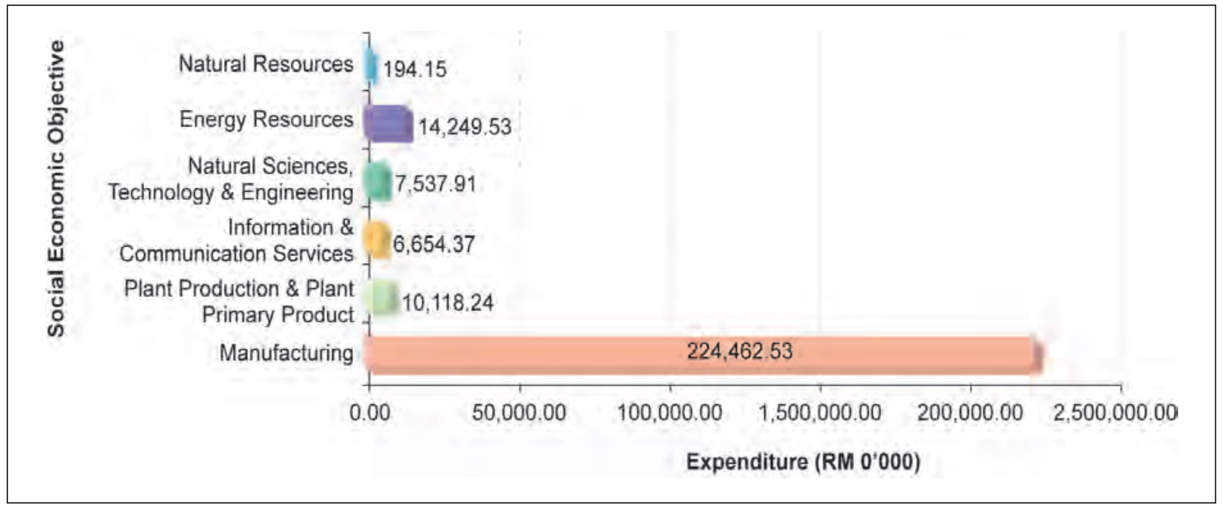


Source: National Survey of Research & Development 2008 Report

Figure 5.32 indicates that engineering sciences, and applied science & technology were the major research areas in the private sector expenditures. This is due to the need of the private sectors and industries to develop new products or to enhance existing products in order to stay competitive in the market. Both FOR allows for such objectives to be achieved within the private sectors.

5.5.1.4 Expenditure in the Private Sector by SEO

Figure 5.33: Expenditure by Social Economic Objective in 2006

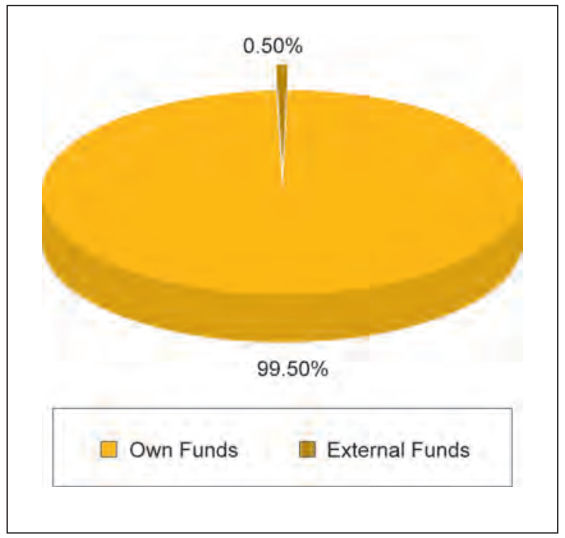


Source: National Survey of Research & Development 2008 Report

Figure 5.33 presents the expenditure by social economic objective in 2006. There are 6 major categories namely manufacturing, plant production & plant primary product, information & communication services, natural sciences, technology & engineering, energy resources and natural resources. This figure shows manufacturing as the highest SEO (RM2,244.6 million), being focused on by the private sectors in terms of spending.

5.5.2 Sources of Fund in Private Sector

Figure 5.34: Sources of Fund in Private Sector

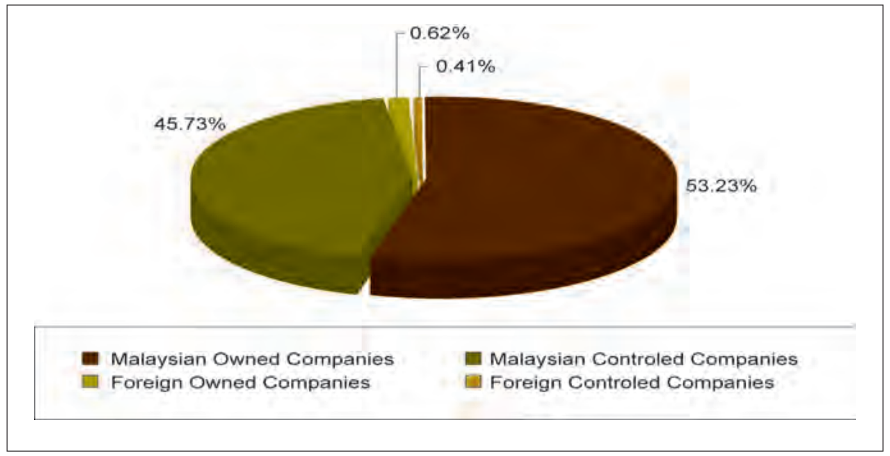


Source: National Survey of Research & Development 2008 Report

R&D expenses in the private sector depend on two types of sources; own or self generated fund, and external sources such as the government research grant. Figure 5.34, indicates that own fund is the main source of fund for the private sectors (99.50%) compared to various other external funds (0.50%). Its shows that private sector prefers to use their own fund in conducting R&D activities.

5.5.3 Outsourcing by Private Sector

Figure 5.35: Outsourcing of R&D by Private Sector



Source: National Survey of Research & Development 2008 Report

In terms of outsourcing of R&D by the private sectors (Figure 5.35), Malaysian owned companies recorded a high proportion (53.23%) of outsourcing activities. This proportion is higher than other Malaysian controlled companies, foreign companies, and foreign own companies.

5.6 LIMITING FACTORS IN R&D

This section looks at the factors that are limiting R&D from 1996 until 2006 as reported by National Survey of Research and Development 2008. The factors were divided into two categories, namely the internal and external limiting factors.

5.6.1 Internal Limiting Factors

Table 5.1: Internal Limiting Factors in R&D (1996 – 2006)

Internal Limiting Factors in R&D	1996	1998	2000	2002	2004	2006
Delay in making decisions	GRI IHL PRIVATE					
Lack of new products / strategy	GRI IHL PRIVATE					
Limited financial resources		GRI IHL				
Lack of skilled R&D personnel		PRIVATE	PRIVATE	GRI IHL		PRIVATE
No priority and thrust area and No future Direction			GRI IHL			
Limited Financial Resources				PRIVATE	PRIVATE	
Limited time due to classes or administrative works					GRI IHL	GRI IHL

Source: National Survey of Research & Development 2008 Report

Based on Table 5.1, there were seven internal limiting factors from 1996 until 2006. The most common internal limiting factors faced by private sectors were lack of skilled R&D personnel (1998, 2000, 2002, and 2006) and limited financial resources (2002, 2004). In GRIs and IHLs, the most common factors were due to limited time faced by the researchers, who were also academic personnel, with various teaching and administrative work loads (2004 and 2006).

5.6.2 External Limiting Factors

Table 5.2: External Limiting Factors in R&D

External Limiting Factors in R&D	1996	1998	2000	2002	2004	2006
Shortage of R&D personnel	GRI IHL PRIVATE					PRIVATE
Increasing capital costs		GRI IHL				GRI IHL
Shortage of R&D personnel with requisite expertise		GRI IHL PRIVATE	GRI IHL PRIVATE	GRI IHL PRIVATE		
Increasing labour costs					PRIVATE	

Source: National Survey of Research & Development 2008 Report

Based on Table 5.2, there were four external limiting factors in R&D from 1996 until 2006. The factors were shortage of R&D personnel, increasing capital costs, shortage of R&D personnel with requisite expertise, and increasing labour costs. Out of the four factors, the most common factor was shortage of R&D personnel with requisite expertise. This factor was faced by GRIs, IHLs, and private sectors in 1998, 2000, and 2002.

5.7 CONCLUSION

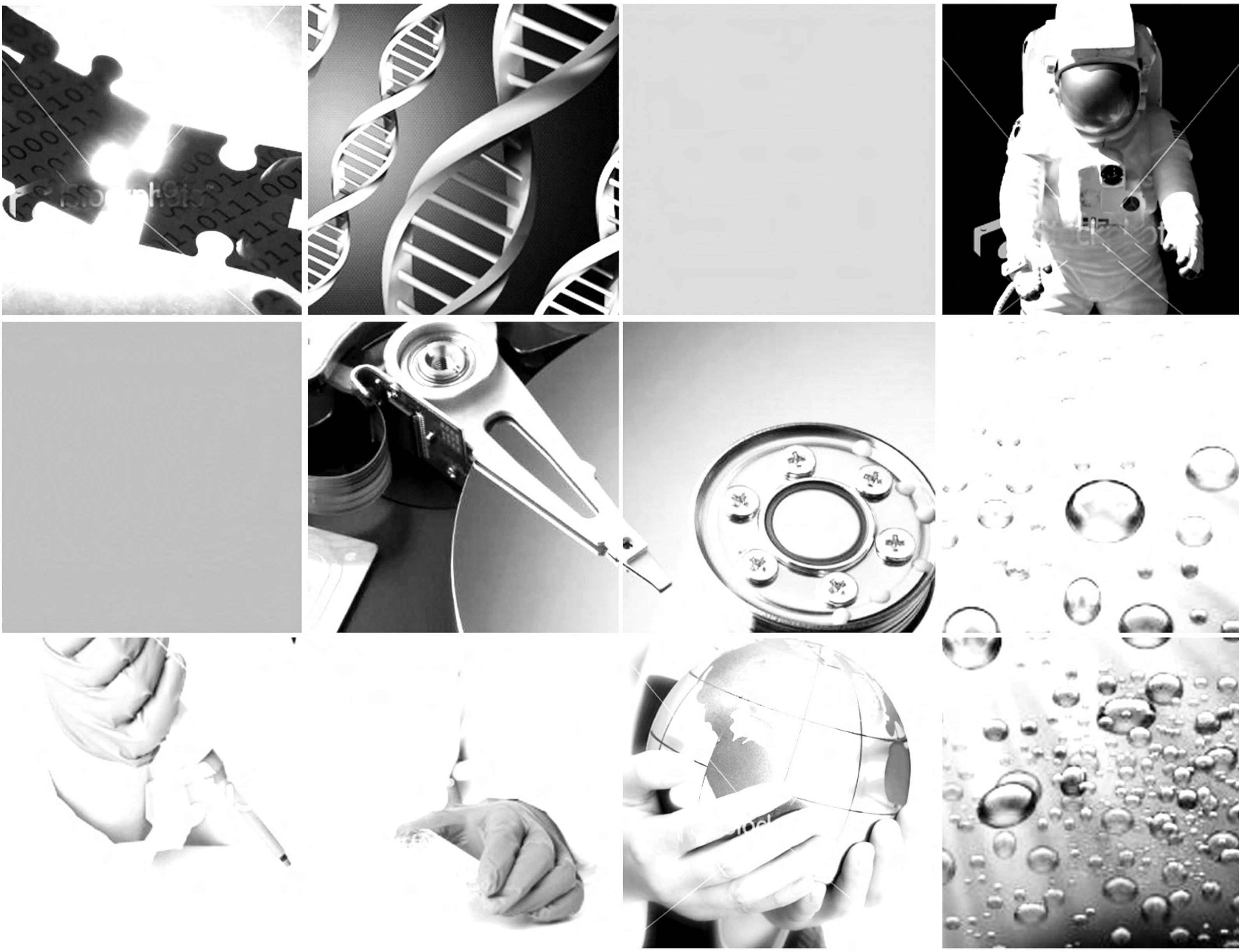
This chapter reports statistical information on the progress of R&D in Malaysia through various reports on R&D expenditures and sources of funding in three major sectors: GRI, IHLs, and private sectors. Based on this report, it can be concluded that significant amount of expenses has been utilized by these three majors sectors in promoting R&D.

Analyses based on type of cost, type of research, field of research, source of fund, and outsourcing provide information on similarities and differences between the three sectors. In terms of types of cost, most sectors indicate huge expenses being made on expenditure on labour and operating costs. Institutions seem to vary in terms of type of research. The focus in GRI seems to be given on applied research, whereas the focus in IHL was given a bit more in applied and basic. The private sector seems to be the champion in experimental development research within the engineering sciences area, as well as in applied research in technological development and applied science.

Based on the R&D classification, seven selected FORs for 2006 were Engineering Sciences, Applied Sciences & Technologies, Agriculture Science, Information, Computer & Communication Technologies, Biological Sciences, Chemical Sciences and Social Sciences. For GRI, MARDI recorded as the most active institutions in R&D spending in that year, whereas, for IHL, UTM has been recorded as the most active institutions in R&D spending.

The top six SEO were Natural resources, energy resources, natural sciences, technology & engineering, information & communication services, plant production & plant primary product, and manufacturing. Each institution within GRI and IHL were found giving different focuses in SEO, whereas, the private sectors were found focusing mainly on manufacturing SEO.

Since the period of 1996 until 2006, the R&D trend looks consistent. However, there have been several limiting factors identified through the national survey, which fall into internal or external factors. The limiting factors were found to be different between government institutions (GRI and IHL) and the private sectors. While the government institutions were struggling with personnel issue of lack of time in R&D activities, the private sectors were tied with lack of fund and skilled R&D personnel.



INNOVATION IN SCIENCE AND TECHNOLOGY

Chapter 6

6.1 INTRODUCTION

Being essential engines of growth, science, technology and innovation has been known to drive firms into better economic performances. In highly industrialized countries, innovation and technological developments have been given a central place in economic policies. Therefore, some indicators are needed to determine the state of innovation in a country as a measure of S&T progress and as a determinant to economic policies and regulation.

Malaysian Science and Technology Information Centre (MASTIC) has been a government agency being made responsible in gathering official statistics and indicators on innovation status, trends and future directions in various Malaysian firms and industries. These statistics form an integral part of the National S&T Indicators. These studies are carried out on a biennial basis; following the Organization for Economic Cooperation and Development (OECD) guidelines. The national survey of innovation has been conducted since 1995 to provide the information on the state of technological development in the country. It has assisted policymakers in identifying the characteristic of innovation in greater detail which is important for the purpose of policy intervention. It is unfortunate that the survey for the fiscal year of 2006-2008 is not yet available to be reported in this chapter.

In S&T indicator report 2006, a chapter on "Innovation in Manufacturing Sector" was provided in giving out information from a national survey conducted on innovation by Malaysian Science and Technology Information Centre (MASTIC). The last reporting period was 2002-2004. Since the next sequence of the survey was not ready during the time of this report, no similar information is provided in this report pertaining to the status of current state of innovation in Malaysia.

This chapter only serves as an overview of innovation with some reflection of past report and some discussions on the innovation drivers, government support, and international comparisons.

6.2 OVERVIEW OF 2002-2004 INNOVATION REPORT

The last reporting period of innovation was in 2002-2004 based on a survey conducted by MASTIC in 2005. The report has been made available in Malaysian Science and Technology Indicators 2006 Report. Based on the report, the percentage share of innovating firms seems to increase 54% compared to the previous innovation studies 2000-2001 (35%) and 1997-1999 (21%). This trend is expected to remain the same with further increasing percentage in firms involving in innovation. Innovation by industry has observed the high involvement in radio, television, and communication equipment (76%), textiles (73%), motor vehicles, and recycling (67%). The 2002-2004 innovations have been made focused on biotechnology products, computing, and machinery. It is expected that the trend in the following years to be made more on biotechnology, motor vehicles and machinery, and ICT. This is predicted based on the huge allocation of the government grants disbursed to the industries for these purposes.

The reports in 2006 also indicate that innovation is a factor of size, age, geographical distribution, innovation types, turnover distribution, and ownership structure. In most of the surveys, innovation tends to be active among the firms with employee size bigger than 50 people. The firms that were born during the period of 1990-1999 have been recorded the highest in the shared percentage of innovation (68%). Innovation was also recorded much higher in only few states in Malaysia such Selangor, Kuala Lumpur, Penang and Johor. Innovation seems to focus on only two types, of which were (1) product, process and project in progress and (2) product and process. Both types of innovation accounted for 89% of innovation type in 2002-2004. Based on the same survey period, innovating firms tend to be large scale companies with annual turnover of less than RM5 million (54%). The limited company seems to dominate innovation compared to other types of company such as public listed, partnership and sole proprietorship. However, the shared percentage seems to reduce from 1997-1999 to 2000-2001, and from 2000-2001 to 2002-2004.

In 2002-2004, the main drivers of innovation have been the government support through various innovation grants, and the reduction of environmental damage. Compared to past years, innovation objectives were mainly for the purpose of product improvement and market expansion. Diversion of objectives can be observed over the years, with more dependency on the government.

6.3 INNOVATION DRIVERS

There is a compelling need for Malaysia to strengthen its capacity for innovation, thus accelerating the role of innovation in the country's economic development. MOSTI, with strong support from other agencies is instrumental in harnessing science, technology and innovation as the key driver in raising the national capacity to acquire and utilize e-knowledge and to foster innovation. In this regard, efforts have been taken to measure the extent of innovation in the country and to determine the nature of government intervention in promoting innovation through R&D in science and technology.

6.3.1 Market Driven

Market driven innovation model can be described as innovations driven by the need of the market which inspires the knowledge entrepreneurs, through their best knowledge in science and technology, to innovate and produce technological innovation that meet the market. This approach can provide rapid commercialization target that immediately fulfill what the people want from the product. Past report indicates that market driven approach had been the trend in 1997-1999 report as well as in 2000-2001 report. This was shown through high percentages (83% and 77% respectively) of innovation within these periods, which were driven by the need for improving product quality, as well as for market opening and expansion. Whereas the percentage share of these drivers were very low during 2002-2004 reporting period (1.6% and 7.5% respectively), and it is depending on government stimulant.

6.3.2 Technology Driven

Malaysia's innovation model can be described as a balance approach between technology driven innovation and market driven innovation. In technology driven model, scientist are funded for R&D through various government grants in any area that has market potential. The technology-based innovation will be developed organically, and thus eventually commercializing their ideas or products for the global market. In 2002-2004, this approach had been the main driver of innovation, where government support became the major source of contributor. The next sub section provides detail information on the contribution of the Malaysian government in boosting innovation in the country through various grants.

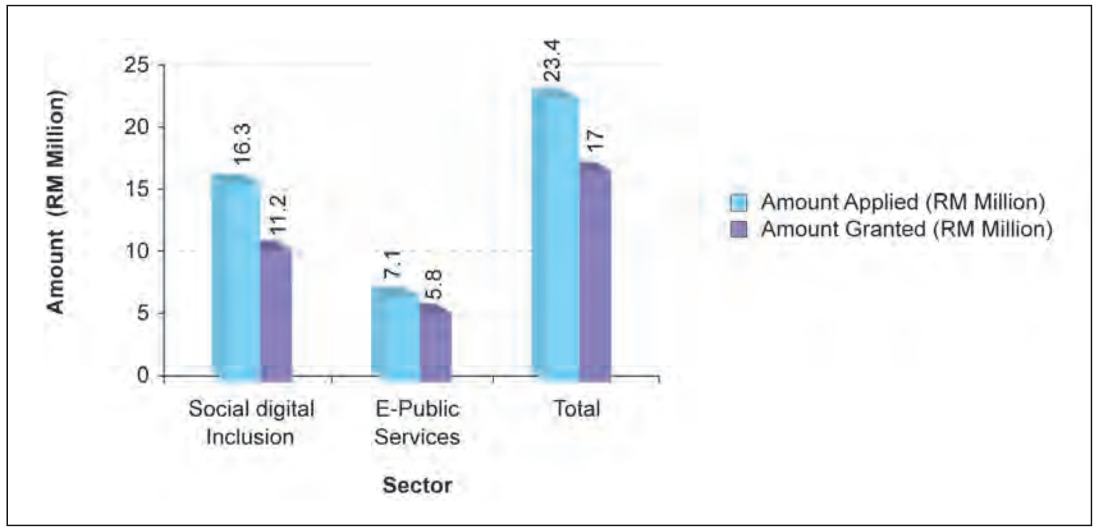
6.3.3 Government Incentives as Innovation Driver

The previous survey had indicated the importance of government support in promoting innovation. Most of these supports were made through various types of government grants disbursed to various agencies private and public in encouraging R&D.

6.3.3.1 Demonstrator Applications Grant Scheme (DAGS)

The Demonstrator Applications Grant Scheme (DAGS) is established to facilitate the growth of bottom-up innovations which are indigenous in design, contain local content and culturally relevant to meet the demand of the Malaysian community. The report in the figure below is made based on the projects and expenses in 2007.

Figure 6.1: Amount Approved for DAGS Applications, 2007



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

Table 6.1: Number of Project Applications and Approvals for DAGS, 2007

Year	Industry	No. of Applications	No. of Approvals
2007	Social Digital Inclusion	5	5
	E-Public Services	3	3
	Total	8	8

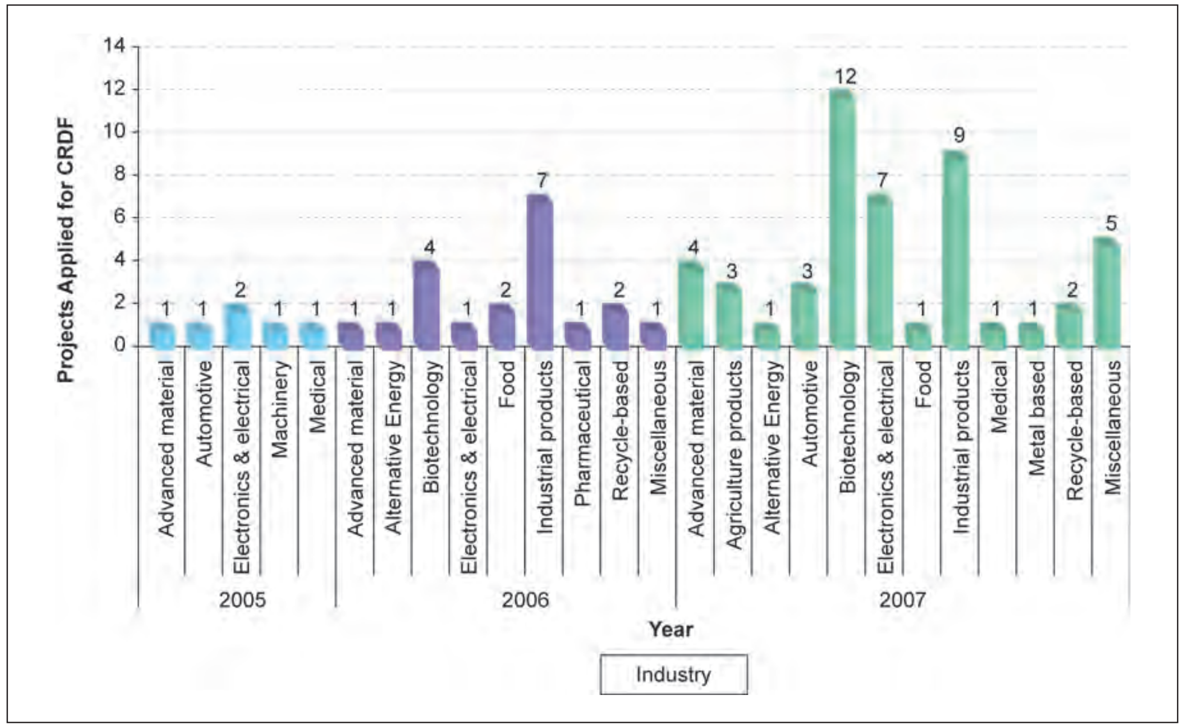
Source: Ministry of Science, Technology and Innovation (MOSTI)

The figure and table above show the number of applications and approvals for DAGS in 2007. There were a total of eight applications in 2007. From the total, 5 were on Social Digital Inclusion projects and the remaining three were E- Public Services projects. The total amount applied for the grant was RM23.4 million. Total amount of RM17 million was granted for 8 approved applications.

6.3.3.2 Commercialization of Research & Development Fund (CRDF)

Commercialization of Research & Development Fund (CRDF) was established to provide partial grant to qualified R&D projects for commercialization purposes. The role of CRDF is to facilitate the development of new products and production processes, and to assist participating companies to start-up production capacity.

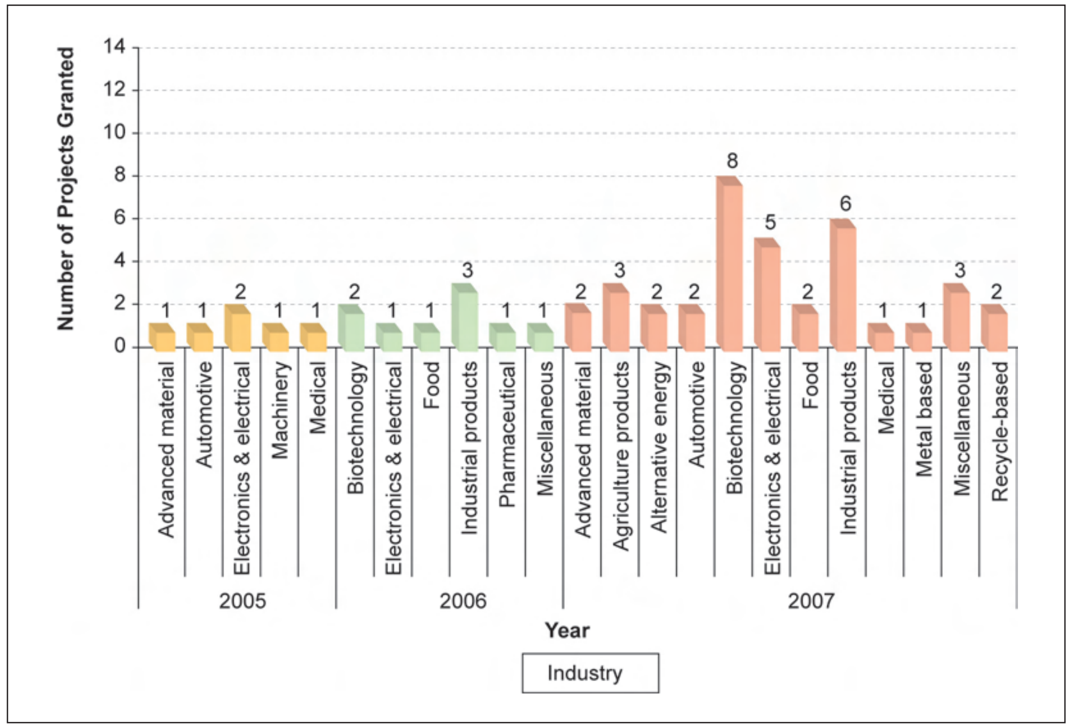
Figure 6.2: Number of Projects Applied for CRDF by Industrial Sector, 2005 – 2007



Source: Malaysian Technology Development Corporation (MTDC)

A total of 75 applications were made for CRDF since year 2005 to 2007 as shown in the above figure. The highest applications were made in biotechnology and industrial products with 16 applications each. This is followed by electrical & electronics with 10 applications.

Figure 6.3: Number of Projects Granted for CRDF by Industrial Sector, 2005 – 2007



Source: Malaysian Technology Development Corporation (MTDC)

Fifty two projects valued at RM95.54 million were approved in year 2005-2007 as shown in Figure 6.3. of projects. Most of the projects funded were in industrial products and biotechnology. Based on the amount of grants and the number of projects sponsored by the government, the trend in innovation within this reporting years should indicate the technological driven which attributed mainly by government injections.

6.4 INTERNATIONAL COMPARISON

Table 6.2: International Ranking in Innovation Index

Country	Rank
United States	1
Germany	2
Sweden	3
United Kingdom	4
Singapore	5
Japan	14
Malaysia	25
China	47

Source: Global Innovation Index (GII)

According to Global Innovation Index (GII) 2008-2009, of 130 ranked countries, the United States of America (USA) has been the global leader in innovation for many years. It has been in the top rank due to its consistent commitment to innovation for over 100 years. This is followed by Germany, Sweden and the United Kingdom. Singapore moved up two notches from 7th place to 5th place. Surprisingly, Japan was relegated to 14th place from 4th place in the last ranking. Malaysia was not as bad in the ranking at the 25th place.

6.5 CONCLUSION

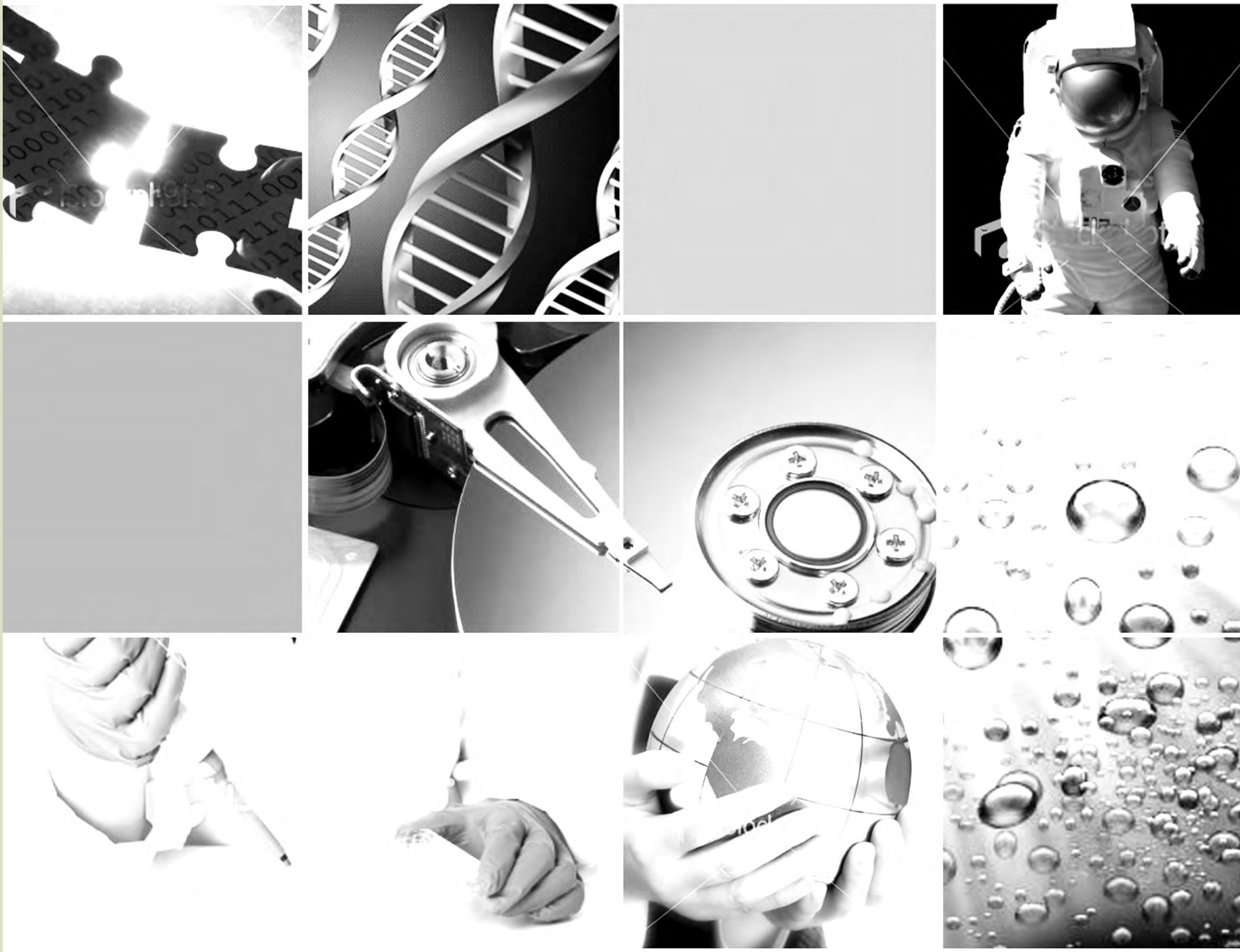
This chapter provides an overview of innovation in Malaysia by taking into account the absence of the most current survey data. The survey is expected to provide detail information from various industries on their involvement in various innovative works and activities. However, analysis of past surveys, and discussions on the drivers of innovation, as well as international comparisons made when writing this chapter, has allowed us to provide an overview of what the current and future status for Malaysian innovation hold.

The trends in innovation have been observed to be different quite significantly from the period of 1997-1999 to the period of 2002-2004. These differences can be seen in the drivers of innovation, the objectives of innovation, and types of innovation. Over the years, the government has played a very significant role in promoting innovation in the country. In the past, innovation might have been restricted to a large scale companies with abundant of innovation and development budgets, and which efforts most likely driven by the demand of the market. The later trend in innovation has not seen much restriction in the size and type of companies to engage in innovation. While the focus has been given more on biotechnology and industrial innovation, current trend in innovation has not placed restriction on the scale and type of industry. The technology driven innovation has opened for opportunities to many firms and individual researchers

from IHLs and GRIs to apply for government grants to conduct research and innovate in commercialized products.

Current and future innovation can be seen through the improvement of various biotechnology, machinery and ICT products. Innovation within the industries and public institutions will continue to take place as long as the support from the government continues to grow. Being aware of the importance of innovation, firms will need to engage more in knowledge management and ensure they are ahead of others in terms of competition.

International comparison based on Global Innovation Index of 130 ranked countries, has indicated the high position of Malaysia (25th position) in the face of world innovation. Malaysia has been very active in innovation and the trend is expected to continue in the future.



INTELLECTUAL PROPERTY IN MALAYSIA

Chapter 7

7.1 INTRODUCTION

Intellectual property refers to creations of the mind including inventions, literary and artistic works, and symbols, names, images, and designs used in commerce. It is divided into two categories which are industrial property and copyright. Industrial property includes inventions (patents), trademarks, industrial designs and geographic indications. Copyright includes literary and artistic works such as novels, poems and plays, films, musical works, artistic works such as drawings, paintings, photographs and sculptures, and architectural designs. Rights related to copyright include those of performing artists in their performances, producers of phonograms in their recordings, and those of broadcasters in their radio and television programmes.

This chapter analyzes Intellectual Property scenario in Malaysia and a few other selected countries. More focus is given on patenting trend in Malaysia which includes the patenting process that is being practiced by the Intellectual Property Corporation of Malaysia (MyIPO). There are also details on patent applications filed and granted by MyIPO as well as patents granted based on field of technology.

This chapter also provides concise views on trademark, and industrial design trends in Malaysia. Finally, it also includes international comparison sourced from the United States Patent and Trademark Office (USPTO). Excluded in this chapter is copyrights due the mixed of information with works that are not related with science and technology.

7.2 INTELLECTUAL PROPERTY IN MALAYSIA

7.2.1 Patenting

According to MyIPO, a patent is an exclusive right granted for an invention, which is a product or a process that provides a new way of doing something, or offers a new technical solution to a problem.

7.2.2 Trademark

A Trade Marks is a mark which distinguishes the goods and services of one trader from those of another. A mark includes words, logos, pictures, names, letters, numbers or a combination of these. Trade Marks is used as a marketing tool to enable customers in recognizing the product of a particular trader. (Source: MyIPO)

7.2.3 Industrial Design

An industrial design is the ornamental or aesthetic aspect of an article. The design may consist of three-dimensional features such as the shape and configuration of an article, or two-dimensional features, such as pattern and ornamentation. The design features must be applied to an article by any industrial process or means of which the features in the finished article appeal to eye. (Source: MyIPO)

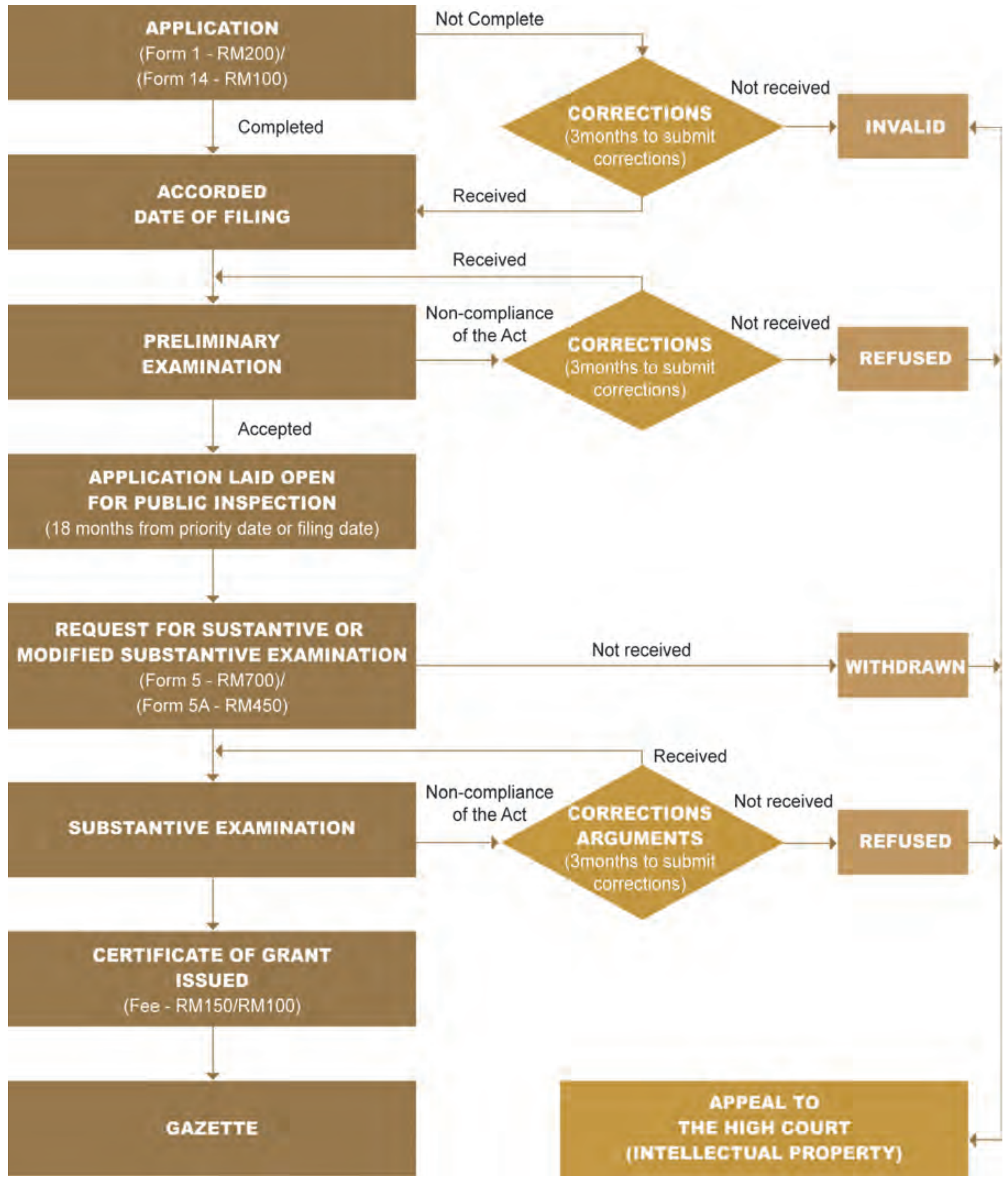
INTELLECTUAL PROPERTY IN MALAYSIA
Chapter 7

7.3 PATENTING IN MALAYSIA

7.3.1 Patenting Process by Intellectual Property Corporation of Malaysia (MyIPO)

Figure 7.1: Flowchart of Application Procedure

FLOWCHART PATENT APPLICATION AND GRANNING PROCEDURE
(PATENT ACT 1983)



* Kindly refer to Patents Regulations for Detail procedure

Source: Intellectual Property Corporation of Malaysia (MyIPO)

Figure 7.1 above shows the flowchart of an application procedure by the Intellectual Property Corporation of Malaysia (MyIPO) which is under the jurisdiction of the Ministry of Domestic Trade, Cooperative and Consumerism. According to this process of Patent Application and Granting Procedure (Patent Act

1983), the inventor should first apply a patent by filing in a form (Form 1 – Request for grant of patent, with a fee of RM200 or Form 14 – Application for grant of certificate for utility innovation, with a fee of RM100). Once MyIPO receives the application, it will be accorded the date of filing in accordance to Section 28 of the Patents Act. Preliminary examination will be conducted to ensure the application meets the formality requirements of the Patent Act. Adverse Preliminary Examination Report will be sent to the applicant is given 3 months to make correction.

The application is lay open for public inspection after 18 months from the priority date or filing date. Within 2 years from the date of filing, the applicant has to request for full substantive examination. This request can be submitted using Form 5 – Request for substantive examination, fee RM700 or Form F5A – Request for modified substantive examination, fee RM450. If Form 5 / Form 5A is not submitted within the prescribed time, the application is deemed withdrawn. No further action will be taken on the application.

The application that has successfully undergone for search and substantive examination will be granted or issued with a certificate of grant. Otherwise, the non-compliant application will be issued with Adverse Substantive Examination Report and is given 3 months to respond to the report.

Any third party or an aggrieved person can apply to the High Court (Intellectual Property) to invalidate the patent that has been granted by MyIPO due to the reasons as mentioned in the Patents Act 1983.

7.3.2 Patent Applications Filed and Granted in Malaysia from 1996 – 2008

7.3.2.1 Patent Applications Filed in Malaysia, 1996 – 2008

Table 7.1: Patent Applications Filed in Malaysia for Period 1996 – 2000, 2001 – 2005 and 2006 – 2008

Nationality	1996-2000	2001-2005	2006 - 2008	Variation (Percentage increase or decrease during the two period under review)	Variation (Percentage increase or decrease during the two period under review)
Malaysian	1,017	2,013	2,065	97.9	2.6
Non-Malaysian	29,047	25,648	10,510	-11.7	-59.0
Total Applications	30,064	27,661	12,575	-8.0	-54.5

Source: Intellectual Property Corporation of Malaysia (MyIPO)

Table 7.1 above shows patent applications filed in Malaysia by the Intellectual Property Corporation of Malaysia (MyIPO). The applications are divided into Malaysian and Non-Malaysian applicants. The numbers of applications were 30,064, 27,661 and 12,575 for the year 1996-2000, 2001-2005 and 2006-2008 respectively.

The numbers of applications are found dropped by 8% from the period of 1996-2000 to 2001-2005. Applications from Non-Malaysian are also found much higher than those of Malaysians. From the period of 2006 to 2008 there were 12,575 applications of which 16% were applications by Malaysian and the remaining 84% were applications by foreign innovators or organizations. The huge difference was most likely due to the contribution of various multinational companies as a result of government policy that encourages foreign direct investment in Malaysia.

There was a large increase of Malaysian applications (97.9%) from 1996-2000 to 2001-2005 (from 1,017 to 2,013 total applicants respectively). There was a marginal increase in the Malaysian applicants in the year 2006-2008.

As for applications filed by Non-Malaysian, there was a decrease of 12% in 2001-2005 from applications registered in 1996-2001. However applications for non-Malaysian in 2006- 2008 stood at only 10,510.

7.3.2.2 Patents Granted in Malaysia, 1996 – 2008

Table 7.2: Patent Granted by the Intellectual Property Corporation of Malaysia (MYIPO) for Period 1996 – 2000, 2001 – 2005 and 2006 – 2008

Nationality	1996-2000	2001-2005	2006 - 2008	Variation (Percentage increase or decrease during the two period under review)	Variation (Percentage increase or decrease during the two period under review)
Malaysian	215	142	723	-34.0	409.2
Non-Malaysian	4,072	9,253	15,251	127.5	64.8
Total Applications	4,287	9,395	15,974	119.4	70.0

Source: Intellectual Property Corporation of Malaysia (MyIPO)

As shown in Table 7.2, the total number of patents granted in the period of 2006 until 2008 was 15,974, 70% higher than in 2001-2005. Of the total, 4% were granted to Malaysians, while the remaining 96% were granted to non-Malaysians.

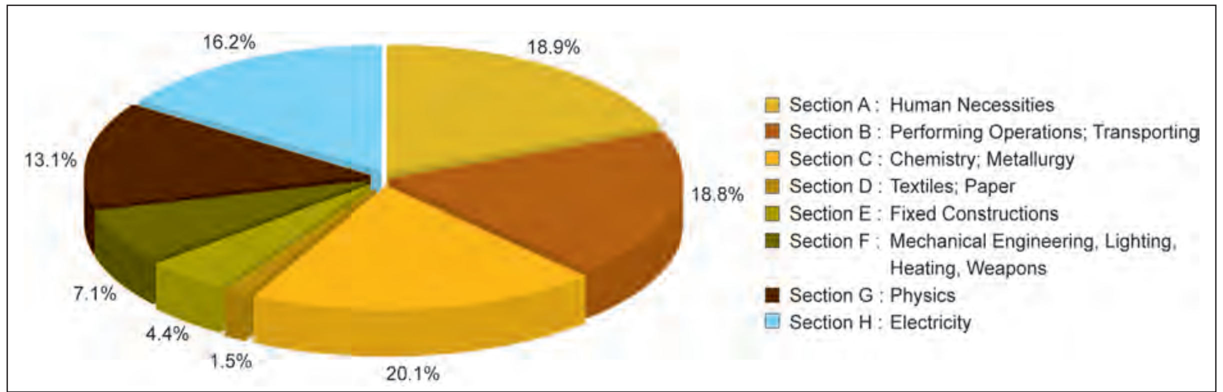
Patents granted for non-Malaysian applicants in 1996-2000 were 4,072, 9,253 in 2001-2005 and 15,251 in 2006-2008. A large increase of 5,181 (127.2%) can be observed for patents granted for the year 1996-2000 to 2001-2005. It is expected that there will be a tremendous increase of patents granted for the year 2006-2010 as there was a total of 15,251 patents granted for Non-Malaysians in 2006-2008. This is most likely due to the more efficient and effective patenting processes by MyIPO to boost up Malaysian innovative efforts.

Despite the decreasing trend in the number of patent applications in Malaysia for the past few years, the number of patents granted has been on the rise during the period. During 2006-2008, the patents granted to Malaysian applicants rose by 409.2% and patent applications granted to non-Malaysians increased by 64.8% over 2001-2005 period.

7.3.2.3 Patents Granted in Malaysia by Field of Technology, 2005 – 2008

Figure 7.2: Patents Granted Based on Field of Technology Classified According to the International Patent Classification (IPC) System, 2005 to 2008

	Section	2005	2006	2007	2008	2008%
A	Section A : Human Necessities	333	948	1,179	423	18.9
B	Section B : Performing Operations; Transporting	452	1,155	1,213	421	18.8
C	Section C : Chemistry; Metallurgy	600	1,275	1,748	451	20.1
D	Section D : Textiles; Paper	30	101	109	33	1.5
E	Section E : Fixed Constructions	82	197	221	98	4.4
F	Section F : Mechanical Engineering, Lighting, Heating, Weapons	164	448	407	159	7.1
G	Section G : Physics	316	1,042	883	293	13.1
H	Section H : Electricity	531	1,583	1,223	364	16.2
Total	Total	2,508	6,749	6,983	2,242	100.00



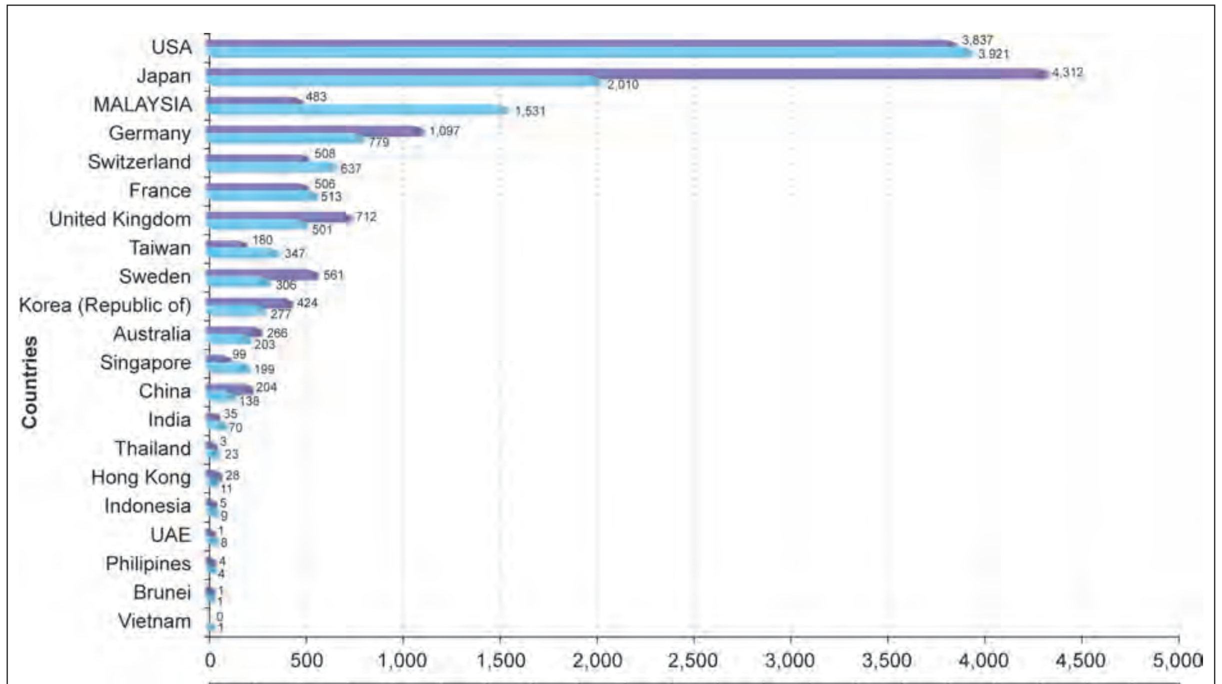
	A	B	C	D	E	F	G	H	Total
2005	333	452	600	30	82	164	316	531	2,508
2006	948	1,155	1,275	101	197	448	1,042	1,583	6,749
2007	1,179	1,213	1,748	109	221	407	883	1,223	6,983
2008	423	421	451	33	98	159	293	364	2,242

Source: Intellectual Property Corporation of Malaysia (MyIPO)

Figure 7.2 shows the number of patents granted in Malaysia by the Intellectual Property Corporation of Malaysia (MyIPO) according to the field of technology for the year 2005 to 2008. The number of patents granted in 2008 decreased by nearly 70% as compared to the previous year. Chemistry and metallurgy recorded the highest number of patents granted (451 or 20.1%), followed by human necessities (423 or 18.9%), performing transporting operations (421 or 18.8%) and electricity (364 or 16.2%). It was observed that all the fields of technology registered decreases in the number of patents granted.

7.3.2.4 Patents Application and Patents Granted in Malaysia by Country Applicants

Figure 7.3: Number of Patents Applied and Granted in Malaysia for Selected Countries for Period 2005 – October 2007



	Vietnam	Brunei	Philipines	UAE	Indonesia	Hong Kong	Thailand	India	China	Singapore	Australia	Korea (Republic of)	Sweden	Taiwan	United Kingdom	France	Switzerland	Germany	MALAYSIA	Japan	USA
Granted	0	1	4	1	5	28	3	35	204	99	266	424	561	180	712	506	508	1,097	483	4,312	3,837
Applied	1	1	4	8	9	11	23	70	138	199	203	277	306	347	501	513	637	779	1,531	2,010	3,921

No of patents

Source: Intellectual Property Corporation of Malaysia (MyIPO)

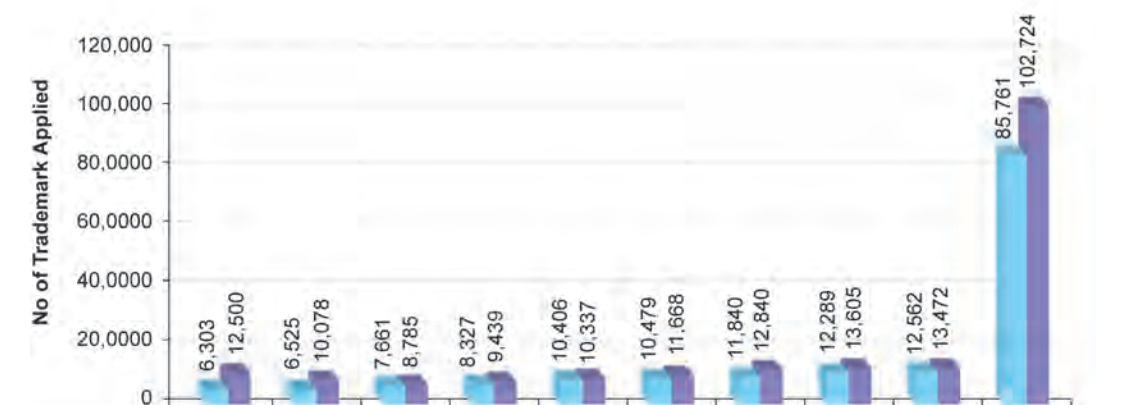
Figure 7.3 shows the number of patents applied and granted in Malaysia for foreign applicants from 20 selected countries for the period of 2005 to October 2007. According to the statistics, a total of 11,489 patents were filed at MyIPO during the period. Of the total, 3,921 or 34.1% were applied by applicants originated from the United States of America. This was followed by applicants originated from Japan (2,010 or 17.5%), Malaysia (1,531 or 13.3%), Germany (779 or 6.8%) and Switzerland (637 or 5.5%).

On the other hand, the number of patent granted for the period of 2005 to October 2007 was 13,266. Of the total, 4,312 or 32.5% were granted to applicants originated from Japan, followed by the United States of America (3,837 or 28.9%), Germany (1,097 or 7.5%) and the United Kingdom (712 or 4.9%). Applications from Malaysia accounted for 3.3% of total patents granted.

The record indicates that the total number of patents granted for Japan was much greater than the total number of patents applied. The total number of patents application also happened to be much lower for the year 2005 to October 2007. The total number of patents granted for the period of 2005-October 2007 is high as the result of the accumulation of patents applied during the past years.

7.4 TRADEMARK

Figure 7.4: Number of Trademark Applications from 2000 to 2008



	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Malaysia	6,303	6,525	7,661	8,327	10,406	10,479	11,209	12,289	12,562	85,761
Foreign	12,500	10,078	8,785	9,439	10,337	11,668	12,840	13,605	13,472	102,724

Year

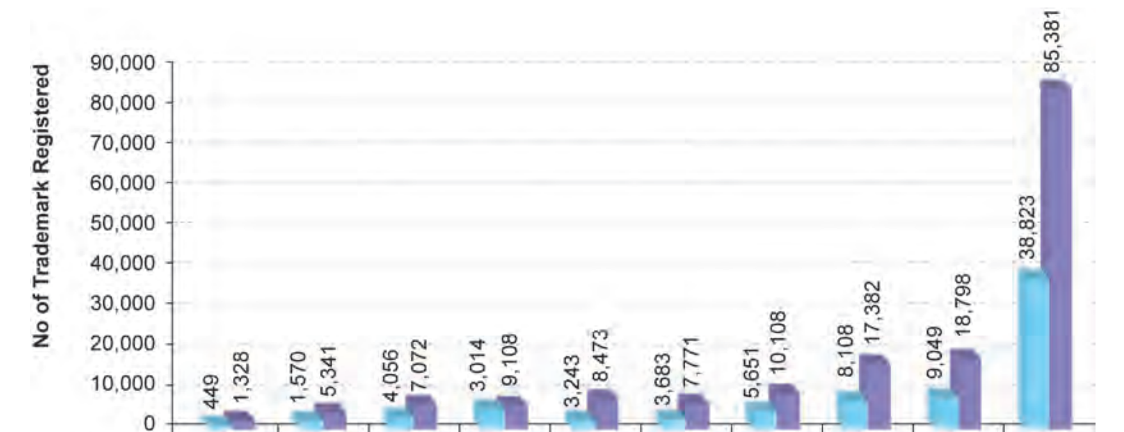
Source: Intellectual Property Corporation of Malaysia (MyIPO)

Figure 7.4 shows the number of trademark applications for the year 2000 to 2008 by the Intellectual Property Corporation of Malaysia (MyIPO). Total number of trademark applications in 2008 increased marginally (0.5%) from the previous year. In 2008, the number of trademark applications for Malaysia was 12,562 and 13,472 for foreign applicants

The number of trademark applications increased almost every reporting year. In 2004, applications by Malaysian and foreigners were reaching almost similar points (10,406 and 10,337 respectively).

Overall observation in the statistics indicates a slight different between Malaysian and foreign applicants each year, with foreign applicants leading the figures.

Figure 7.5: Number of Trademark Registrations from 2000 to 2008



	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Malaysia	449	1,570	4,056	3,014	3,243	3.683	5,651	8,108	9,049	85,761
Foreign	1,328	5,341	7,072	9,108	8,473	7,771	10,108	17,382	18,798	85,381

Year

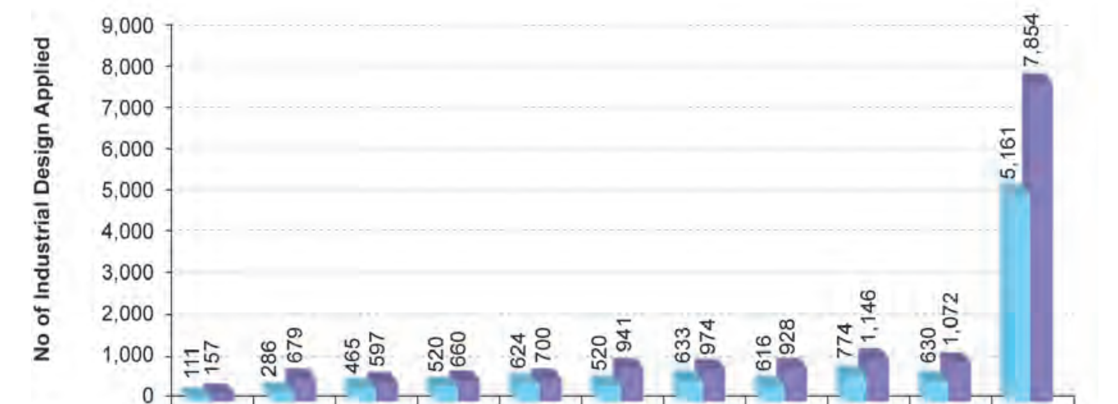
Source: Intellectual Property Corporation of Malaysia (MyIPO)

Figure 7.5 shows number of trademark registrations from 2000 to 2008 by the Intellectual Property Corporation of Malaysia (MyIPO). In 2000, the number of trademark registrations was 449 for Malaysian and 1,328 for foreign applicants. In 2001, the number of registration increased to 1,570 for Malaysia with a large increase can also be observed in 2002. The increasing patterns continue for registration by the foreigners until 2008.

From the figure, it can be observed that trademark registrations seem to reduce slightly for Malaysians from year 2002 until year 2005. The figure began to increase tremendously in 2005 onwards. However, the increase in the number of trademarks for Malaysians is much less compared to those of the foreigners. The year 2007 has been the turning point of such increase. Foreign trademarks leads more than double in total compared to those of Malaysians.

7.5 INDUSTRIAL DESIGN

Figure 7.6: Number of Industrial Design Applications from 1999 to 2008



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Malaysia	111	286	465	502	624	520	633	616	774	630	5,161
Foreign	157	679	597	660	700	941	974	928	1,146	1,072	7,854

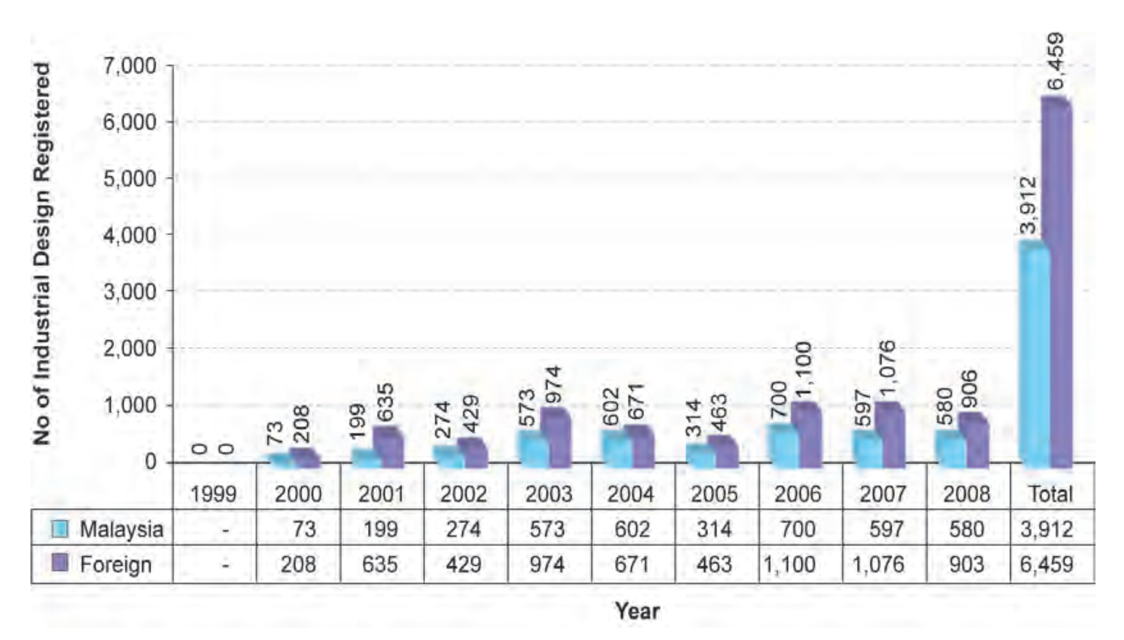
Year

Source: Intellectual Property Corporation of Malaysia (MyIPO)

Figure 7.6 shows number of industrial design applications from 1999 to 2008 by the Intellectual Property Corporation of Malaysia (MyIPO). The figure also compares the difference in the number of applications by Malaysians and foreigners. In 1999, the number of industrial design applications by Malaysians was 111 and by foreigners 157. While in 2000, the number of applications increased to 286 for Malaysians and 679 for foreigners.

The number of industrial design applications for both Malaysians and foreigners keep on increasing each year from 1999 to 2003, but the number of applications seemed to decrease for Malaysians in 2004 to 520 as compared to 624 in 2003. In 2008, the number of industrial design applications was 630 for Malaysia and 1,072 for foreign applicants.

Figure 7.7: Number of Industrial Design Registrations from 1999 to 2008



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Malaysia	-	73	199	274	573	602	314	700	597	580	3,912
Foreign	-	208	635	429	974	671	463	1,100	1,076	903	6,459

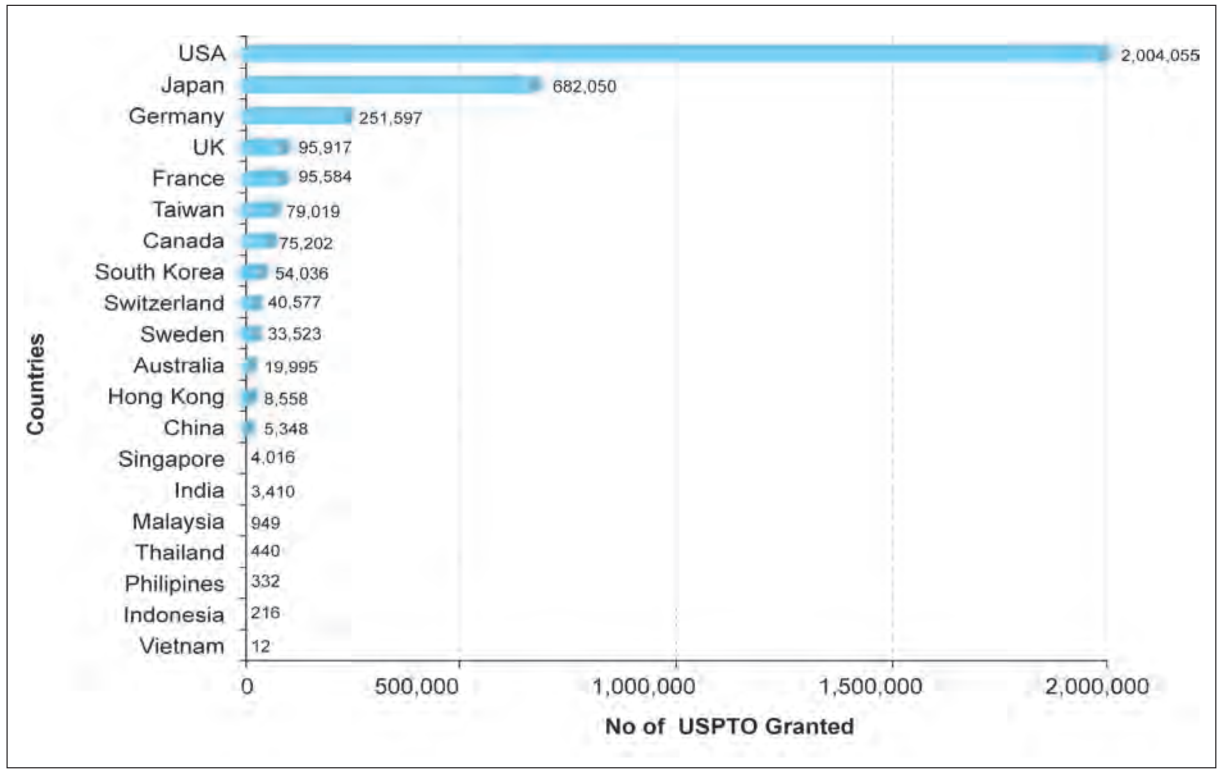
Source: Intellectual Property Corporation of Malaysia (MyIPO)

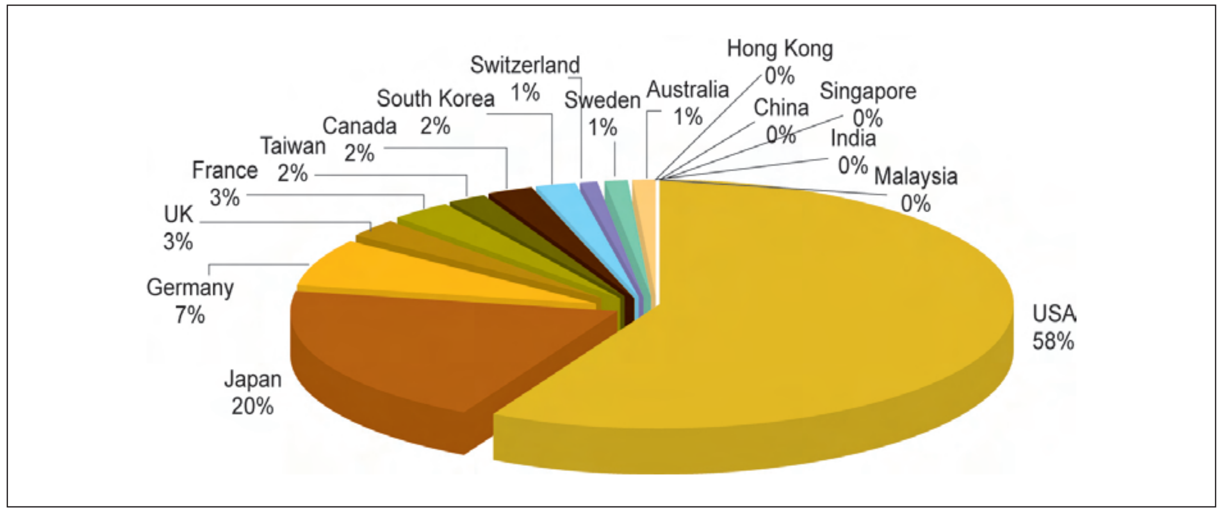
Figure 7.7 shows number of industrial design registrations from 1999 to 2008 by the Intellectual Property Corporation of Malaysia (MyIPO) along with comparisons with Malaysian and foreign registrations for each reporting fiscal year. There is no industrial design registered in 1999 as it was only open for application in that particular year. In 2000, the number of industrial design registration was only 73 for Malaysians and 208 for foreigners. While in 2001, the number of registration increased to 199 for Malaysian and 635 for foreigner.

The pattern of industrial design registrations seems to vary year by year. Some increase can be observed for foreign registries and Malaysian registries within different fiscal year. There was a vast increase in industrial design registration for the year 2003 with a total number of 573 registrations for Malaysians and 974 for foreigners. However, the number of industrial design registrations went down for both Malaysians and foreigners in 2005.

7.6 INTERNATIONAL COMPARISONS

Figure 7.8: Patents Granted by the United States Patent & Trademark Office (USPTO) for Selected Countries from 1977 to 2007





Source: United States Patent and Trademark Office (USPTO)

Figure 7.8 above shows the distribution of patent granted by the US Patent and Trademark Office (USPTO), which compares patent granted from various countries all over the world. While US holds the highest number of patents granted from 1977 to 2007 with 2,004,055, Japan also contributes significantly in the US patern granted. This is followed by UK with a total of 95,917 patents, France (95,584 patents), Taiwan (79,019 patents) and Canada (75,202 patents).

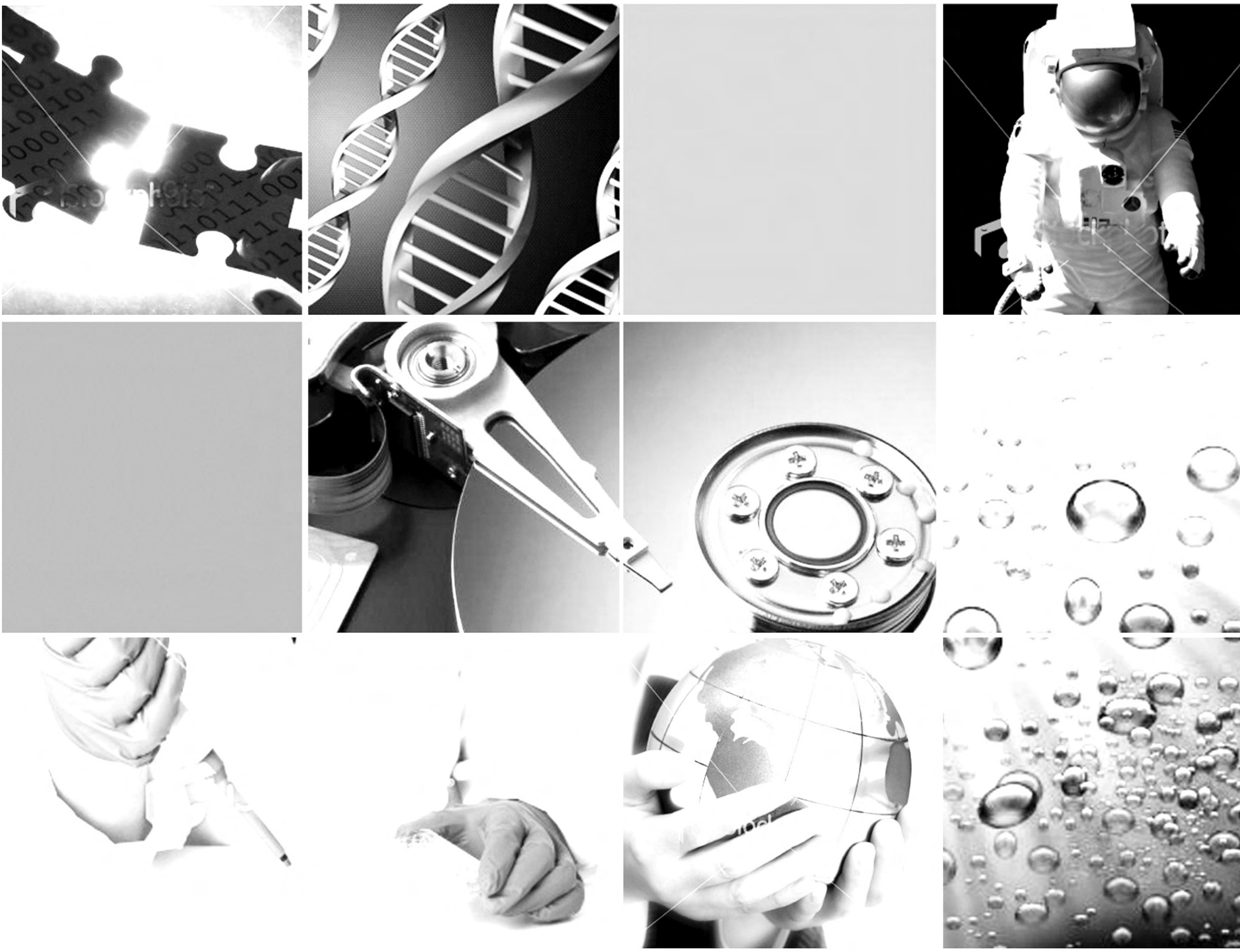
Malaysia has made a good improvement by owning 949 USPTO patents. The number is much higher compared to its ASEAN counterparts such as Thailand (440), the Philippines (332), Indonesia (216) and Vietnam (12).

7.7 CONCLUSION

Generally, the numbers of applications received for Intellectual Property rights including patenting, trademark and industrial designs are much higher for foreigners than for Malaysians. The same also goes to the number of applications granted and registered for these rights. On the other hand, the figures are looking somewhat promising for a developing country like Malaysia. The increasing patterns in patent granted indicate that Malaysia is actively participating in various innovative design activities each year. The high number of foreign registrations most likely reflects government's initiative in foreign direct investment in the high technology industries.

Patent application by foreigners was seen dropped during 2001 to 2005 period. However, patents granted for both foreigners and Malaysians increased.

Global comparisons indicates that Malaysian innovative works is quite insignificant based on the small number of patterns applied and granted by USPTO. However, the country is considered progressing well as compared to its other ASEAN counterparts such as Thailand, Philippines, Indonesia and Vietnam. More innovative works in Malaysia should be registered at the International level such as with USPTO.



INFORMATION AND COMMUNICATION TECHNOLOGY IN MALAYSIA

Chapter 8

8.1 INTRODUCTION

Malaysian National ICT Agenda (NITA) defined information and communication technology (ICT) as both production sector and an enabler in its growth development strategy and in moving the country into knowledge society and knowledge economy. In the 8th Malaysia Plan (RMK-8), ICT is considered a key strategic driver to support and contribute directly to the growth of the economy and to enhance the quality of life of the population. In the RMK – 9, ICT is regarded a key determinant in the development process to move the economy up the value chain. Various ICT strategies have been developed in these regards in order to move the Malaysian society and its economy to become more competitive in the globalized market.

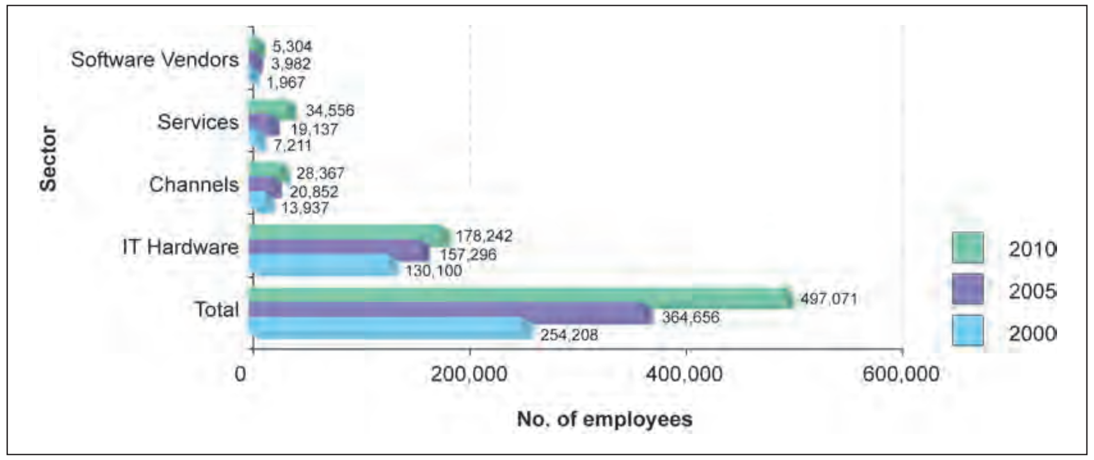
According to the Malaysian ICT report 2007, the Malaysian ICT industry has continued to grow positively from year to year over the past decade. In 2006 alone ICT spending was totaled to US$ 9.32 billion. Subsequently, ICT spending continues to grow at an annual growth rate of 7.5% within the forecasted period of 2005 to 2010. By the year 2010, the ICT spending is expected to increase to US$ 12.31 billion. (Source: IDC)

This chapter covers the current status of ICT development in Malaysia. The ICT indicators reported in this chapter are categorized into three categories, namely, workforce in ICT, ICT funding and expenses, ICT industry, ICT infrastructure and access, and International comparisons.

8.2 WORKFORCE IN ICT

Figure 8.1 below provides the distribution of workforce in the IT industry from year 2000 to 2005. Based on the prediction made by IDC through a yearly increment rate of 7.5 %, the figure also provides an expected number of workforces by year 2010. The industrial sectors involved include software vendors, IT services, channel, and IT hardware. Most of the IT workforces can be found occupying the job within the IT hardware industry and services.

Figure 8.1: Number of Employees in Malaysia by IT Sector, 2000 – 2010



Source: IDC report

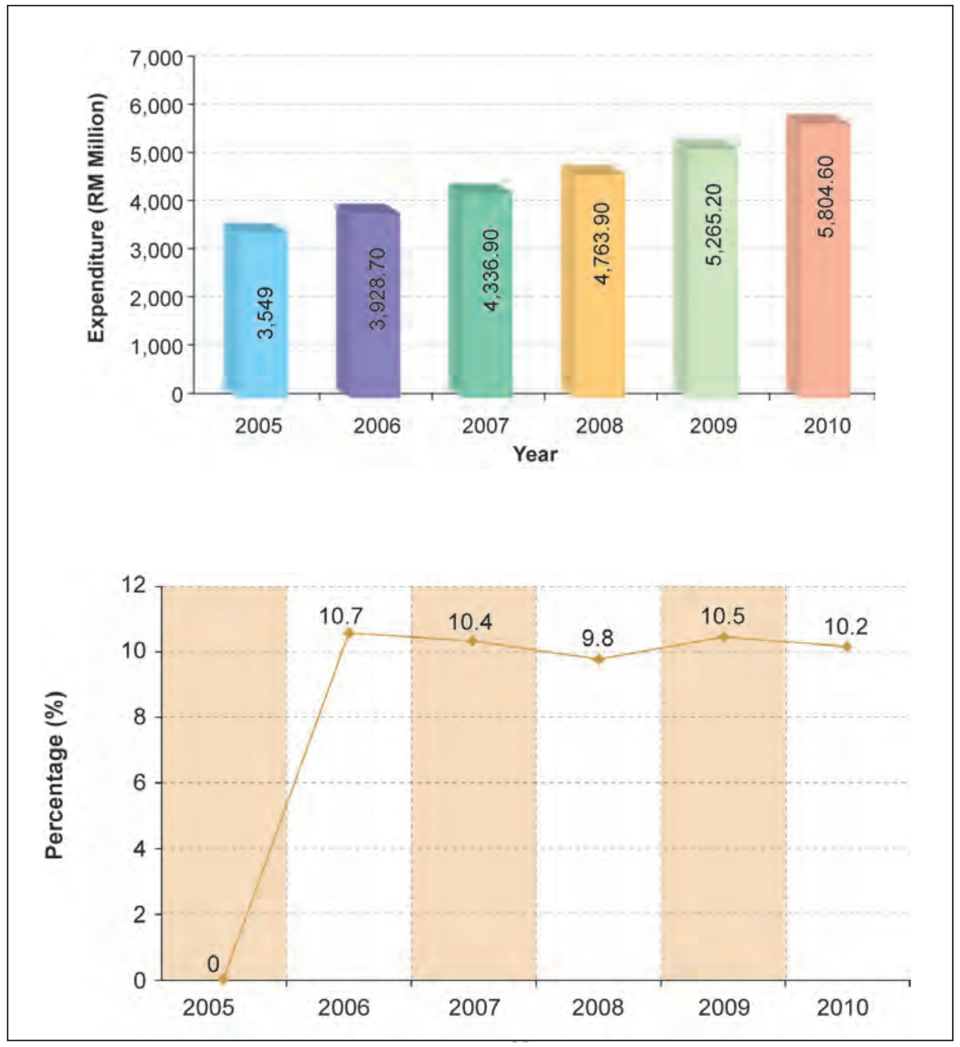
Total number of employees in IT industry in Malaysia has grown about 43% from 254,208 in 2000 to 364,656 in 2005. Based on similar yearly rate of increase of 7.5%, a total number of IT workers is predicted to increase to 497,071 by year 2010. A constant growth can also be observed, in all of the IT industry sectors reported. Since year 2000 the number of employees in the IT Hardware industry has increased 21% to 157,296 in 2005. Based on similar rate, the amount is expected to increase.

8.3 ICT FUNDING AND EXPENDITURE

8.3.1 Government Expenditure

A resource from IDC provides information on Malaysian ICT spending from 2005 until 2007, and ICT spending as predicted by IDC from 2008 until 2010 (see Figure 8.2). The growth in the ICT expenditure is found quite linear at an average rate of growth of 10% per year. The figure also provides the total amount of expenditure on ICT per US million dollars for each consecutive year.

Figure 8.2: Malaysian ICT Spending (in US$ Millions), 2005 – 2010

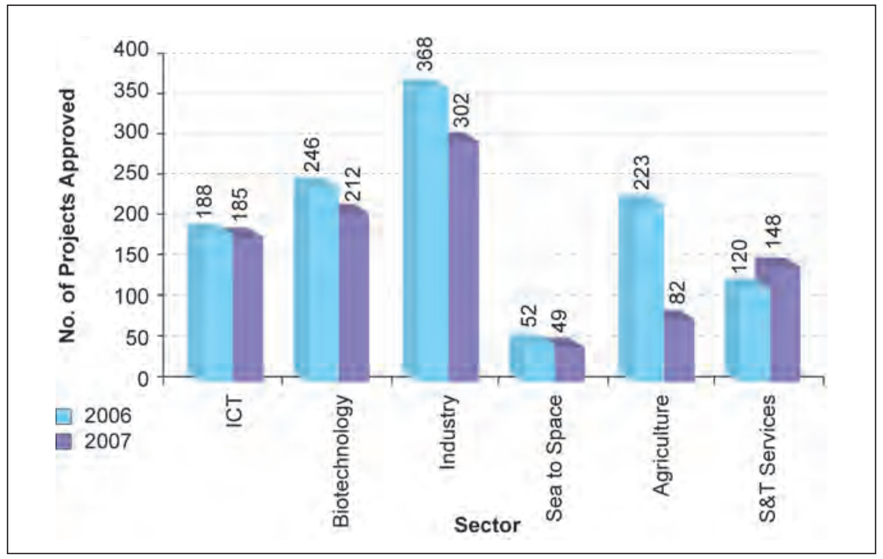


Source: IDC

8.3.2 Public Funding on ICT

Public funding for promoting the growth of ICT industry comes from various government and semi-government resources such as Multimedia Development Corporation (MDeC), Ministry of Science and Technology (MOSTI), and Malaysian Communications and Multimedia Commission (MCMC). Among the source of funds reported in this chapter are grants provided by MOSTI such as ScienceFund (Figure 8.3) and Technofund (Figure 8.4), and a grant from MCMC called Spectrum Research Collaborative Programme (SRCP) (Figure 8.5).

Figure 8.3: Number of Projects Approved under ScienceFund by Sectors, 2006 & 2007

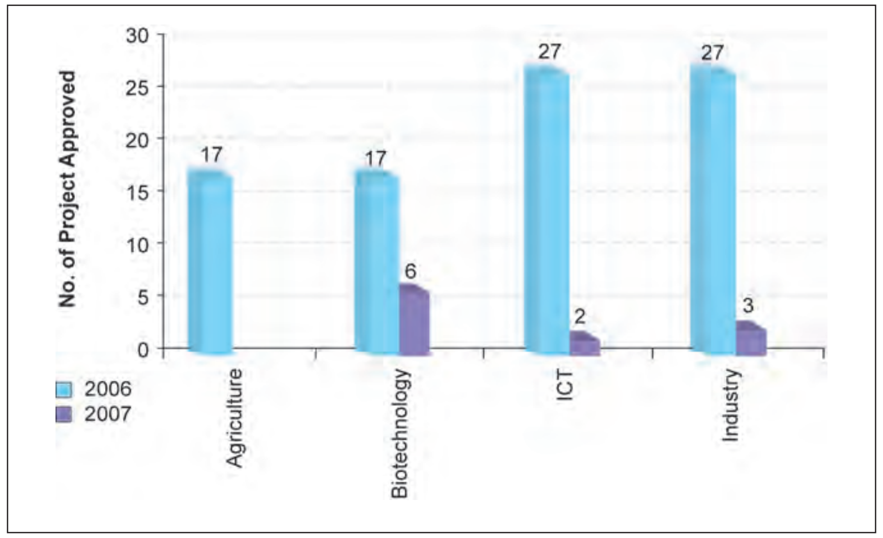


Source: Ministry of Science, Technology and Innovation (MOSTI)

Figure 8.3 above shows the distribution of the number of projects approved under the ScienceFund grant according to different areas of science and technology research during the year 2006 and 2007. The grant is provided by the Malaysian government to support R&D projects for institution of higher learning (IHL) in the area of science and technology. The government has granted RM 65.49 million worth of funds for the S&T industry in 2006, 188 of which were allocated for projects in the ICT sector.

Techno Fund is a competitive grant by the government given through the Ministry of Science Technology and Innovation (MOSTI) to foster greater collaboration between Malaysian private entities and government research institutes or institutions of higher learning in S&T innovation and commercialization. The distribution of the projects approved under this grant is provided in Figure 8.4 below.

Figure 8.4: Number of Projects Approved for TechnoFund by Sectors, 2006 & 2007



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

A dramatic decrease can also be seen in the number of projects approved for TechnoFund in 2006 and 2007. The number of projects approved for ICT sector has decreased from 27 projects in 2006 to only 3 projects in 2007.

INFORMATION AND COMMUNICATION TECHNOLOGY IN MALAYSIA

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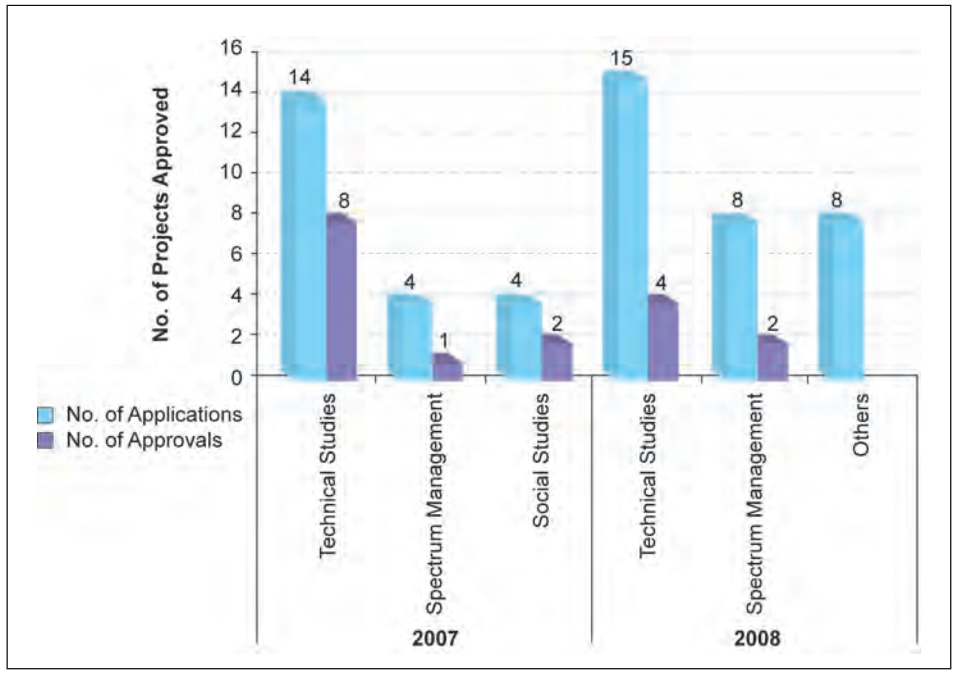
Figure 8.5: Application & Approval of Grants under Spectrum Research Collaboration Programme (SRCP) by Industrial Sector, 2007 & 2008



Source: Malaysian Communications and Multimedia Commission (MCMC)

SRCP is funded and managed by MCMC in promoting research collaboration between IHLs. MCMC allocates and manages its own fund to selected institutions and currently RM 4 million has been allocated per annum for such purposes.

Figure 8.5 above shows the approved and applied SRCP in 2007 and 2008. Three types of grants were applied and approved under three research categories. These are technical studies, spectrum management and social studies for a total of 11 approved projects. Table 8.1 provides the information on the amount approved in each research areas.

Table 8.1: Total Amount Granted for SRCP by Research Areas, 2007 & 2008

Year	Industry	Amount Applied (RM Million)	Amount Granted (RM Million)
2007	Technical Studies	3.71	2.96
	Spectrum Management	0.41	0.09
	Social Studies	2.76	0.78
	Others	-	-
2008	Technical Studies	5.28	0.75
	Spectrum Management	3.11	0.3
	Social Studies	-	-
	Others	3.15	-

Source: Malaysian Communications and Multimedia Commission (MCMC)

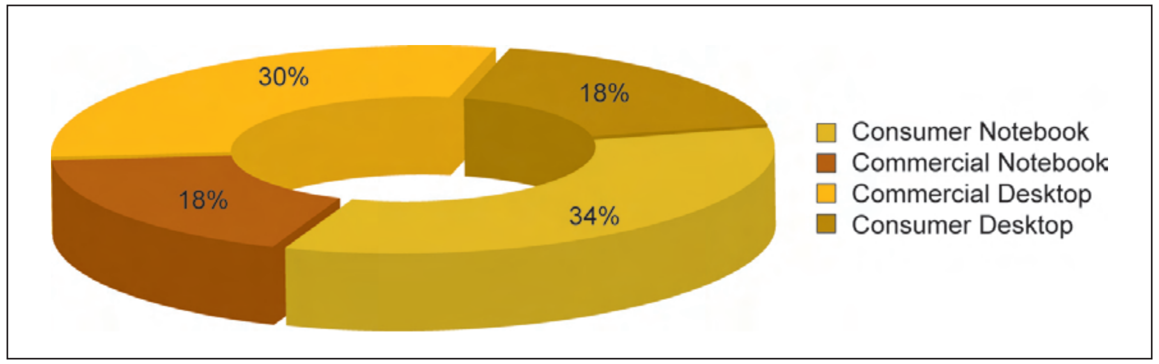
8.4 ICT INDUSTRY

This section reports the distribution of market share and revenue generated from three categorized ICT industries. These are the PC industry, IT and telecommunication services, and importers and exporters. Information in this section is provided by IDC and MCMC.

8.4.1 PC, Packaged Software Market Growth, Application Development and Deployment Software Market

According to a report by IDC, total PC market growth in terms of number and values has increased in year 2007 as compared to 2006. Few factors that contributed to an increasing pattern on overall sales are the public sector spending in developing Smart School and the bridging of digital divide (BDD).

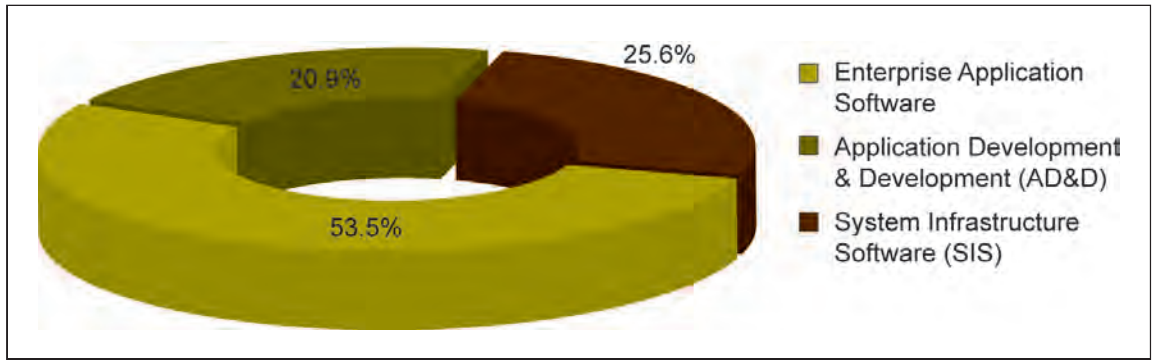
Figure 8.6: Distribution of PC Market 2007



Source: IDC Report

The figure above shows that notebook dominates the PC market with 52% share in 2007 compared to the desktop market share. This trend is expected to remain with the percent market share of notebook to lead in a much higher percentage for several years to come, despite the equal distribution of both notebook and desktop in the comsumer market share.

Figure 8.7: Market Share of Packaged Software



Source: IDC Report

Figure 8.7 above shows the distribution of market share for packaged software. Accordingly, Enterprise Application Software (EAS) has the largest share with 53.5% of the market followed by System Infrastructure Software (SIS) with 25.6%, and Application Developement and Deployment Software (AD&D) with 20.9% of the total market distribution.

INFORMATION AND COMMUNICATION TECHNOLOGY IN MALAYSIA

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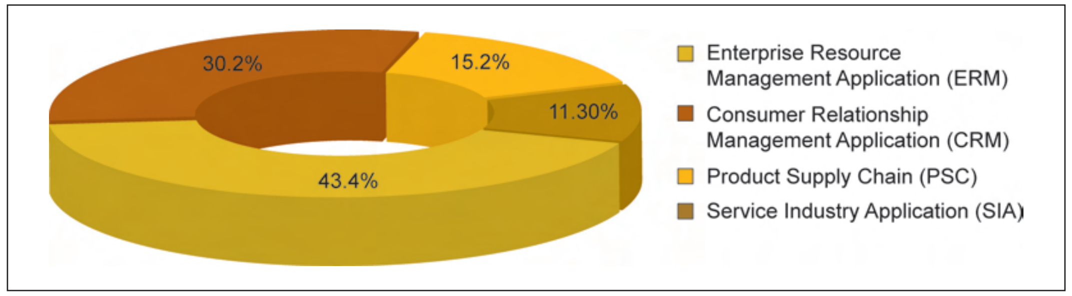
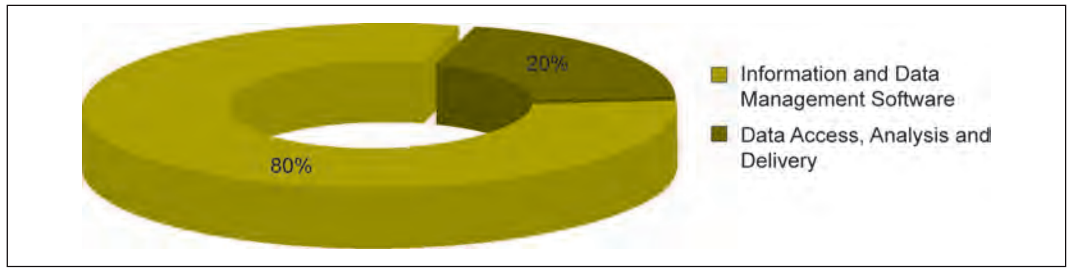
Figure 8.8: Secondary Market Share within Enterprise Application



Source: IDC Report

Figure 8.8 shows the distribution of secondary market share within the enterprise application software (EAS) industry. As shown in the figure, Enterprise Resource Management (ERM) application software seems to dominate the market proportion (43.4%), followed by consumer relationship management (CRM) application (30.2%), product supply chain, and service industry application (11.3%). Furthermore, PSC application are widely used in Malaysia in inventory management, manufacturing applications and retail applications. While, Service Industry Application (SIA) with 11.3% are used especially in banking and finance sector.

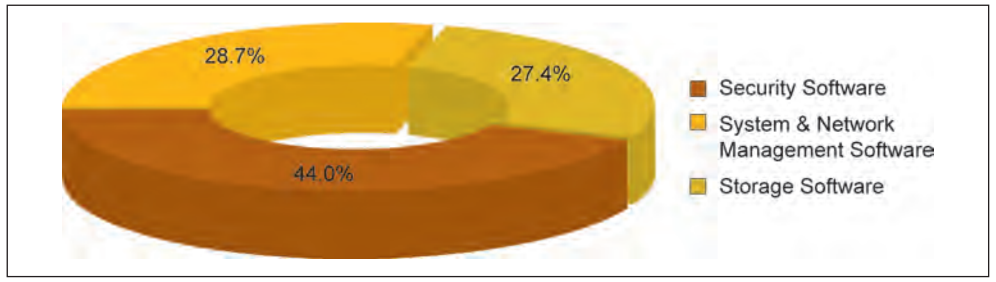
Figure 8.9: Secondary Market Share within Application Development & Development Software



Source: IDC Report

Figure 8.9 shows the market share distribution within the application development and development software industry. There are two dominant software applications in the development and deployment (AD&D) software industry. These are information and data management software (IDMS), which accounted for more than three quarters of the shared distribution, and data access, analysis & delivery (DAAD), which only contribute about 20% of the market. Despite its smaller shared distribution, the demand for the software application are still growing.

Figure 8.10: Secondary Market within System Infrastructure Software



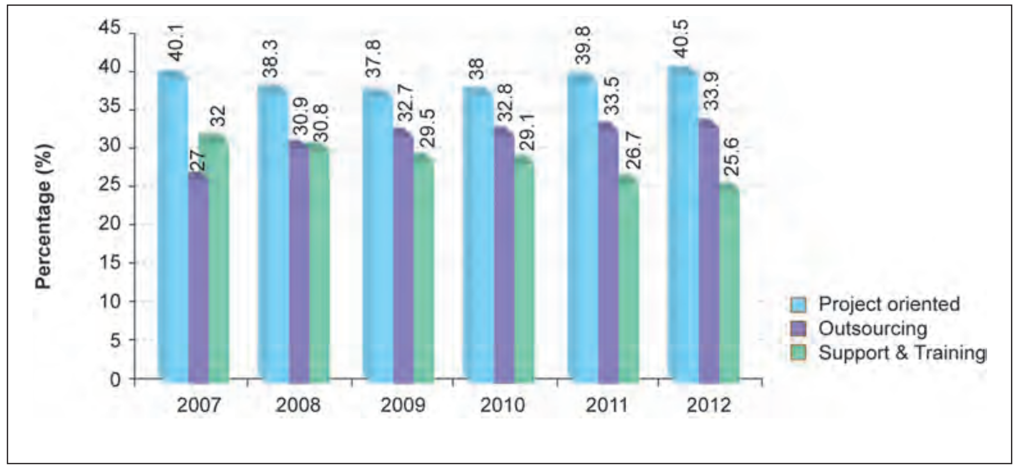
Source: IDC Report

The figure above shows the market share distribution within system infrastructure software (SIS) application industry. The market share within this industry is dominated by three types of software. These are security software (44%), system and network management software (SNMS) (29%) and storage software (27%). SIS segment has grown 14% in 2007 compared to year 2006 with security software as one of the fastest growing software market in Malaysia.

8.4.2 IT and Telecommunication Services

This section covers reports on IT services in terms of spending, and the market and revenue reports of telecommunication services industry. Both sectors are considered key component in ICT development and spending in the country.

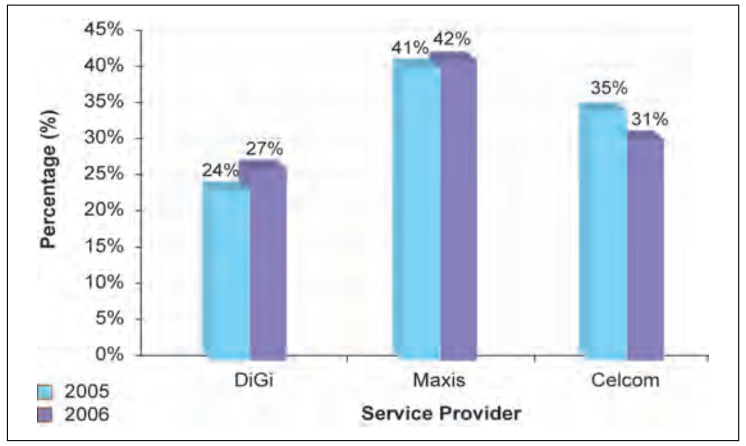
Figure 8.11: Malaysia IT Services Spending by Macromarket, 2007 – 2012



Source: IDC Report

According to IDC, Malaysia IT services market has increased 14.9% in 2007 from the previous year. Figure 8.11 provides the distribution of IT services into three categories. The IT services sector has spent about 40.1% in 2007 in project oriented services, 32% in support and training services and 27% in outsourcing. It is predicted that the percentage in project oriented services spending will drop slightly in 2008 to 2009 and back to similar level in 2012. Similarly, the percentage of outsourcing services is predicted to increase only slightly by 2012. The figure also indicates that the proportionate spending amount on support and training is expected to decrease over time. The overall chart also indicates the flat growth in IT spending in the IT services sector.

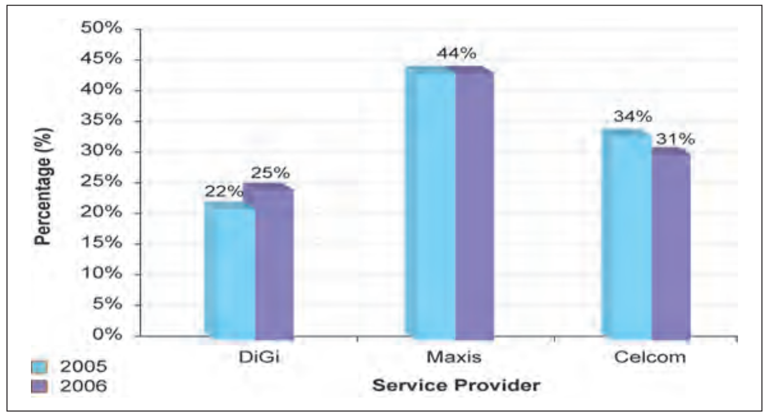
Figure 8.12: Subscriber Market Share, 2005 & 2006



Source: Malaysian Communications and Multimedia Commission (MCMC)

Figure 8.12 shows the distribution of market share for hand phone subscribers in Malaysia for the year 2005 and 2006. The main service providers were dominated by Maxis Communication Sdn. , Celcom (M) Sdn. Bhd., and DiGi Telecommunication Sdn. Bhd. for both years. The figure only shows three major operators due to the license restriction for mobile operators, which at the time, only granted to these companies.

Figure 8.13: Mobile Cellular Domestic Revenue Market Share, 2005 & 2006



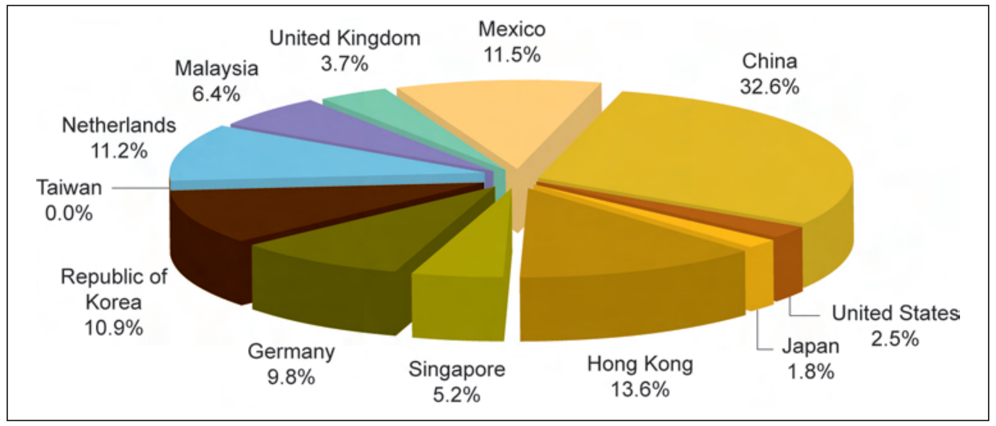
Source: Malaysian Communications and Multimedia Commission (MCMC)

Figure 8.13 shows the mobile cellular revenue market share for 2005 and 2006. Maxis has dominated the shared percentage for the two consecutive years with 44% share. This is followed by Celcom, with 34% and 31%, and Digi with 22% and 25%. Obviously the shared percentage of the market for Celcom in 2006 has been taken by Digi, while Maxis managed to retain its performance for both years.

8.4.3 Selected Exporters and Importers

This section reports the import and export activities involving IT goods in the word. The distributions of the shared percentages of import and export goods among several selected countries are shown in Figure 8.14 and 8.15 below.

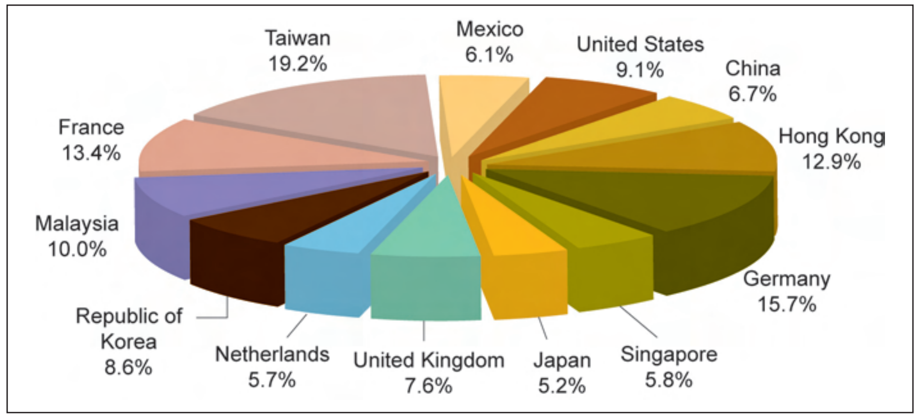
Figure 8.14: Exports of ICT Goods, CAGR, 1996 – 2005



Source: Information Economy Report, 2007-2008

From the above figure, it shows that major exporters of ICT goods in the world from year 1996 to 2005 were China (32.6%), Hong Kong (13.6%), Mexico (11.5%), Netherlands (11.2%) and Republic of Korea (10.9%). Malaysia has contributed quite a significant amount (6.4%) in exporting ICT goods to the world compared with other countries such as Singapore, Taiwan and UK.

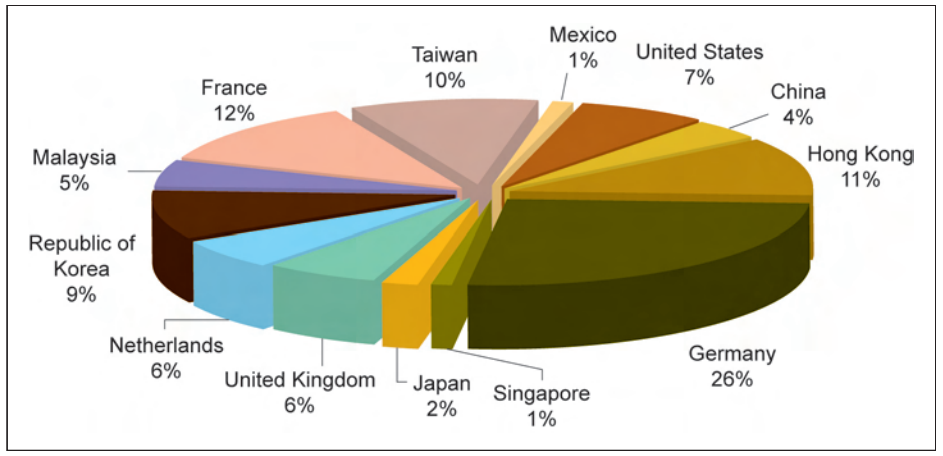
Figure 8.15: Imports of ICT Goods, 1996 – 2005



Source: Information Economy Report, 2007-2008

The above figure shows the import distributions of ICT goods from year 1996 to 2005. The figure shows the small pieces of pies being shared close to equal amounts (between 5% to 10%) by many countries. Major importers were Taiwan, Germany, France, and Hong Kong, all of which share more than 10% of the import market share. Malaysia contributed about 10 market share in the import of ICT good activities. Figure 8.16 below shows the import distribution chart for the fiscal year of 2000 – 2005.

Figure 8.16: Imports of ICT Good, 2000 – 2005

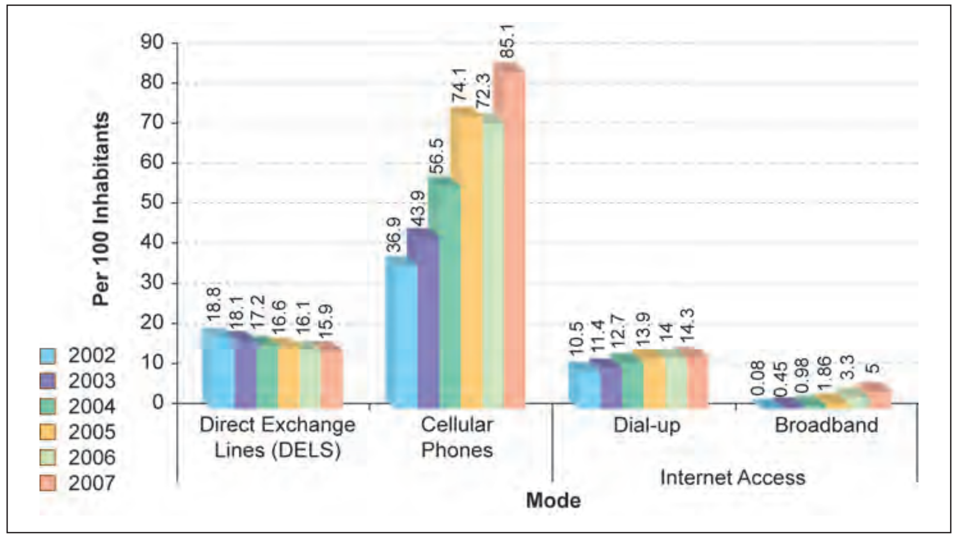


Source: Information Economy Report, 2007-2008

8.5 ICT INFRASTRUCTURE AND ACCESS

Malaysia is highly committed in bridging the digital divide of the society through its 8th and 9th Malaysia Plan. Part of the efforts is to ensure the increased access to the Internet by a broad range of its community within a broad range of geographic boundary. The penetration rates of cellular phones and the Internets become significant measures of access of Malaysian community to the outside world. Figure 8.17 shows the penetration rates for direct exchange line (DEL), cellular phones line and broadband. According to Malaysian Communications and Multimedia Commission (MCMC), direct exchange line (DEL) is defined as connection between a customer's equipment to the public switched telephone network (PSTN) and has a dedicated port on a telephone exchange. There are five licensees currently in Malaysia, namely Telekom Malaysia Bhd., Celcom Transmission (M) Sdn. Bhd., Maxis Broadband Sdn. Bhd., and TT dotCom Sdn. Bhd.

Figure 8.17: Penetration Rates for DELs, Cellular Phones and Internet Access in Malaysia, 2002 – 2007

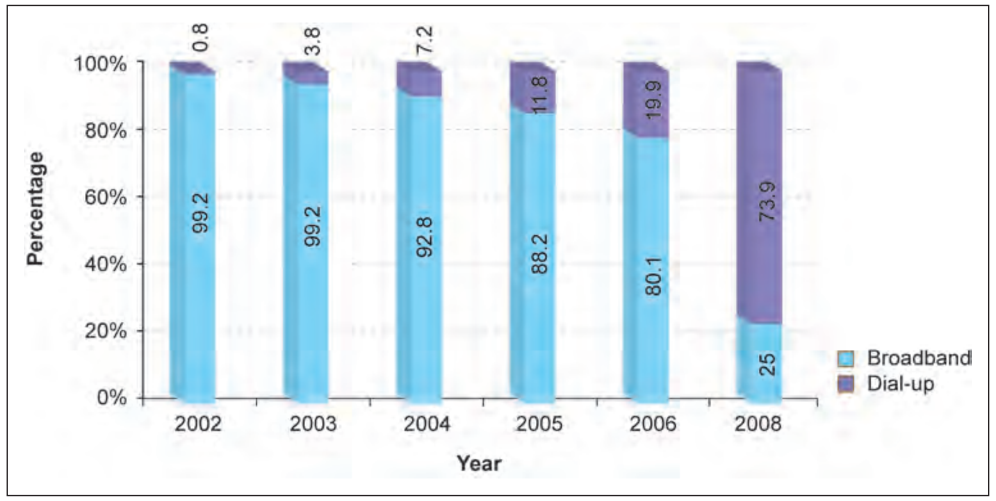


Source: Malaysian Communications and Multimedia Commission (MCMC)

The above figure indicates the downward pattern of DEL use and the significant upward pattern of cellular phone use from 2002 to 2007. The rate increases more than double in percentage (42%) from 2002 to 2007. The penetration rate has shown a steady increase through dial up and broadband. While the use of broadband is gaining popularity, the internet dial-up still remain a major mean of internet connection in Malaysia. This is due to the limitation of the broadband coverage which recently only covers major cities in Malaysia such as KL, Penang and Johor Bahru. As of 2007, the penetration rate of the Internet in Malaysia is still considered small (14.3%) compared to other more developed countries.

8.5.1 Mode of Internet Access in Malaysia

Figure 8.18: Household Internet Access Modes in Malaysia, 2002 – 2008

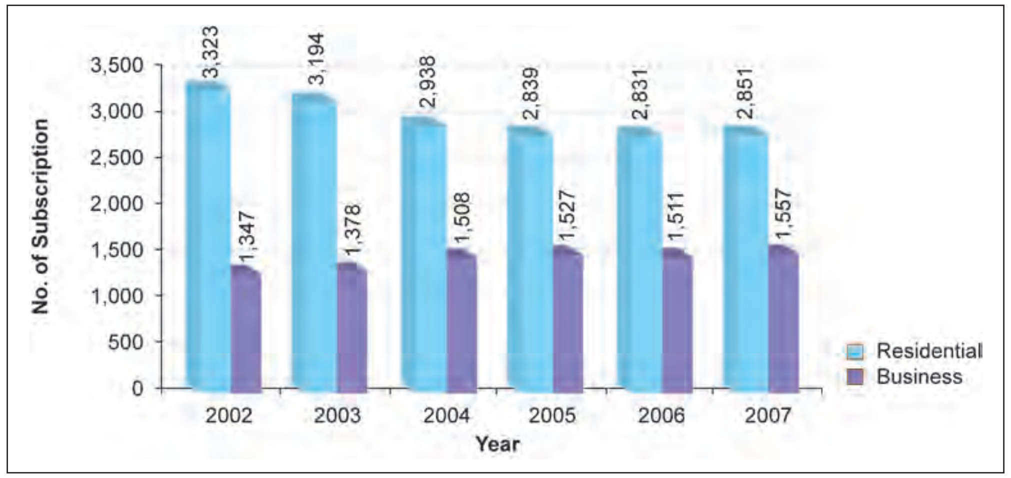


Source: Malaysian Communications and Multimedia Commission (MCMC)

Dial-up has been the main Internet access mode in Malaysia during the period of 2002 until 2005. As shown in Figure 8.18 dial-up connection decreased rapidly from 88.2% in 2005 to 25% in 2008. This reduction is due to the rapid increases in broadband use for Internet access. No data was reported during the year 2007 due to unavailability of the survey during the fiscal year. This migration can be attributed to lack of DEL popularity and the high penetration rate for cellular connectivity. Improvement in wireless communication technology has enabled huge data transfer through 3G services by the telecommunication providers. Users can easily switch their regular GPRS services to 3G for better internet connection. The broadband was introduced during the same year and quickly gained popularity and subscribers.

8.5.2 Direct Exchange Lines (DELs) in Malaysia

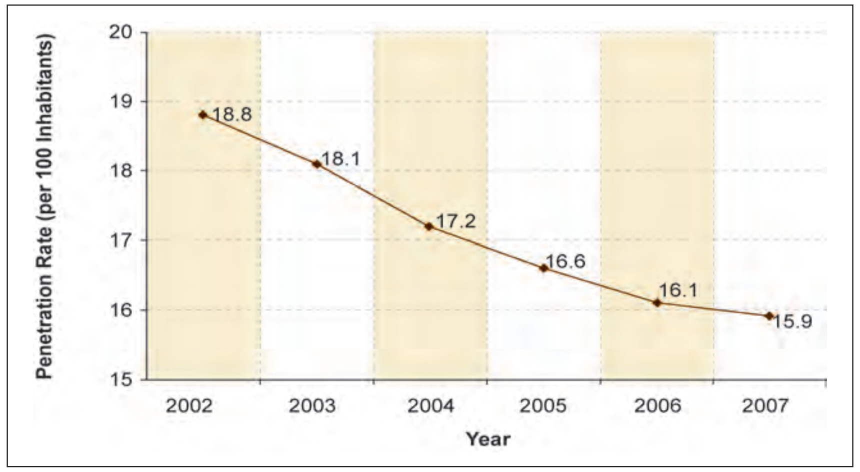
Figure 8.19: Number of Subscriptions ('000) for DELs in Malaysia, 2002 – 2007



Source: Malaysian Communications and Multimedia Commission, 2007

The figure above provides the distribution of DEL according to number of subscribers and type of subscriptions, which are categorized into residential and business. These two categories of DELs experienced different trends during the period of 2002-2007. DELs residential subscribers experienced about 14.6% decline from 3,323,000 in 2002 to 2,839,000 in 2005. In 2007, it has increased slightly to 2,851,000 from year 2005. However, business subscribers are found quite stable throughout the reporting years.

Figure 8.20: Penetration Rate of DEL in Malaysia, 2002 – 2007

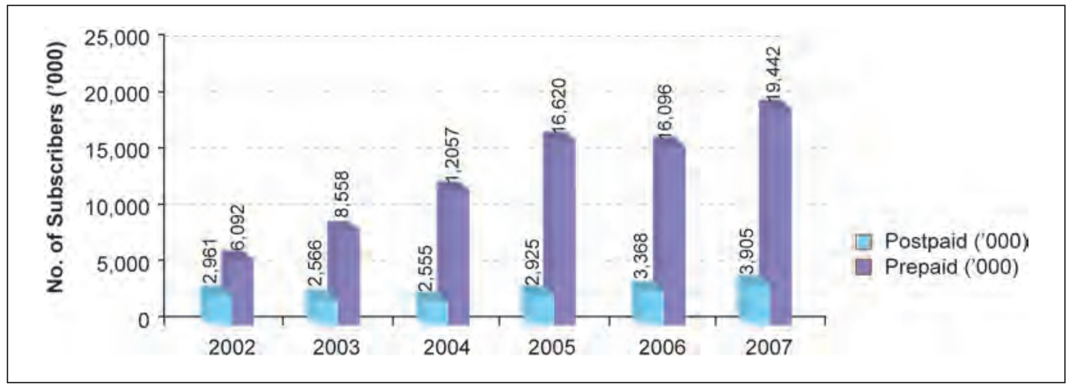


Source: Malaysian Communications and Multimedia Commission (MCMC)

Following the decline in subscriptions, there is a large decrease in penetration rate from 2002 - 2007. The decrease also coincides with the increase in penetration rate for cellular phones. Simpler explanation to this scenario is simply due the migration of the subscribers from DEL to cellular phone. Figure 8.21 may provide such evidence.

8.5.3 Cellular Phones in Malaysia

Figure 8.21: Cellular Phones in Malaysia, 2002 – 2007

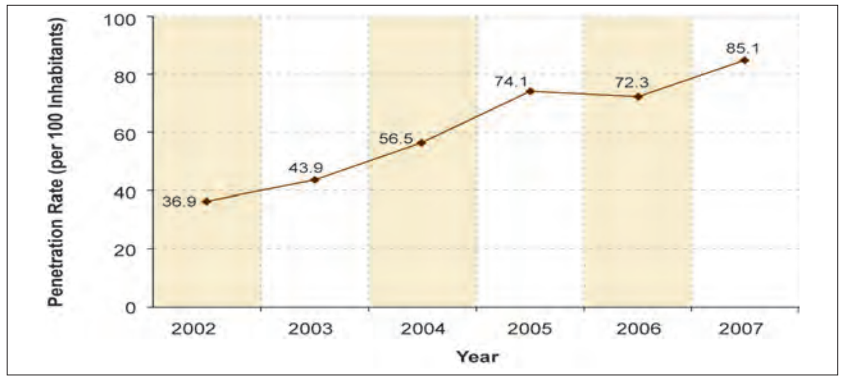


Source: Malaysian Communications and Multimedia Commission, 2007

Figure 8.21 provides the MCMC research report on the distribution of cellular phone subscribers from 2002 to 2007. With the introduction of prepaid services, the number of its subscribers plunged dramatically in 2005. The number of prepaid subscribers is expected to increase in years to come despite a slight decrease in 2006. On the other hand, the number of postpaid cellular phone subscribers has remained constant through the reporting period of 2002-2007.

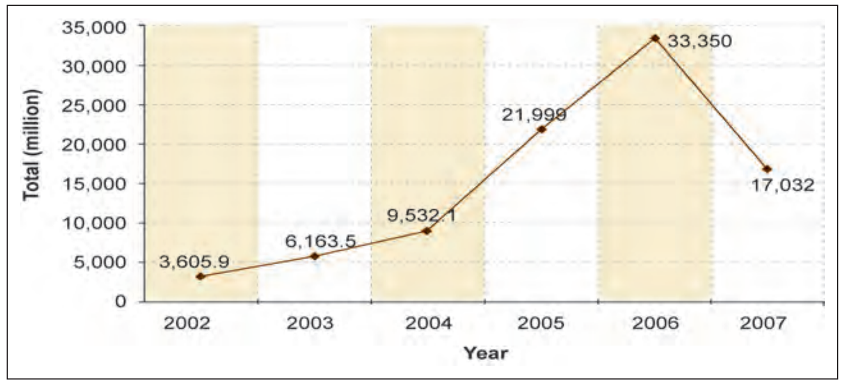
Figure 8.22 below, provides overall pattern of cellular phone penetration rate In Malaysia, which experienced constant increased due the increase in the number of subscribers.

Figure 8.22 : Penetration Rate of Cellular Phones in Malaysia, 2002 – 2007



Source: Malaysian Communications and Multimedia Commission, 2007

Figure 8.23: SMS Usage in Malaysia, 2002 – 2007



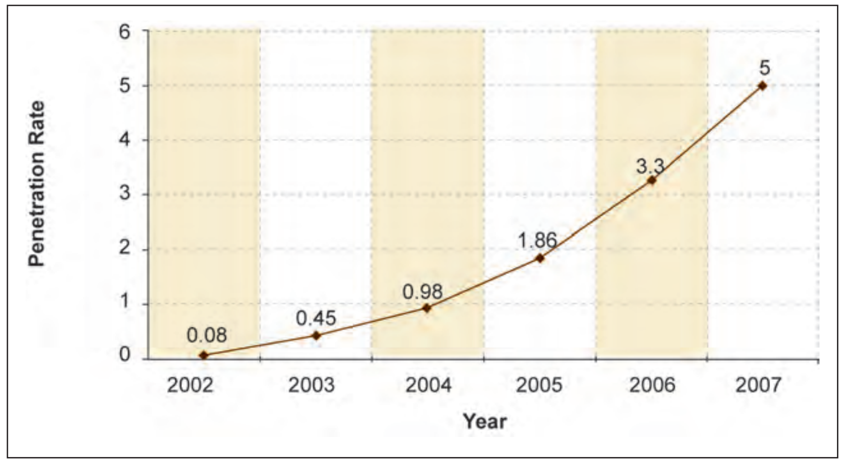
Source: Malaysian Communications and Multimedia Commission (MCMC)

Figure 8.23 above shows the pattern of SMS usage in million. A noticeable high increases in SMS usage can be observed from 2004. However, a sharp decrease can be observed from 2006 to 2007. It is difficult to explain why this drop occurs. However, some explanation can be due to the low tariff on voice call and the introduction of MMS. Competitiveness among the service providers may result in the reduction of voice communication tariff.

8.5.4 Broadband in Malaysia

Broadband is a newly introduced wireless technology to enable Internet access among wireless users. The introduction of broadband is made possible with the use of GPRS and 3G in data transfer. Being new in the market, the penetration rate of broadband is considered very fast (see Figure 8.24). This is most likely due to the reasonable tariff on the subscription and the convenient use of the device through its high mobility.

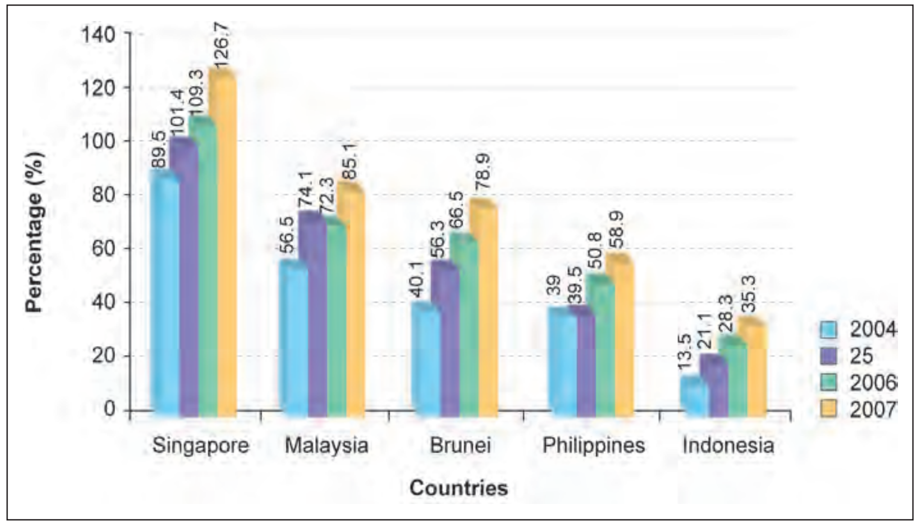
Figure 8.24: Broadband Penetration Rate (per 100 Population)



Source: Malaysian Communications and Multimedia Commission (MCMC)

8.6 INTERNATIONAL COMPARISON

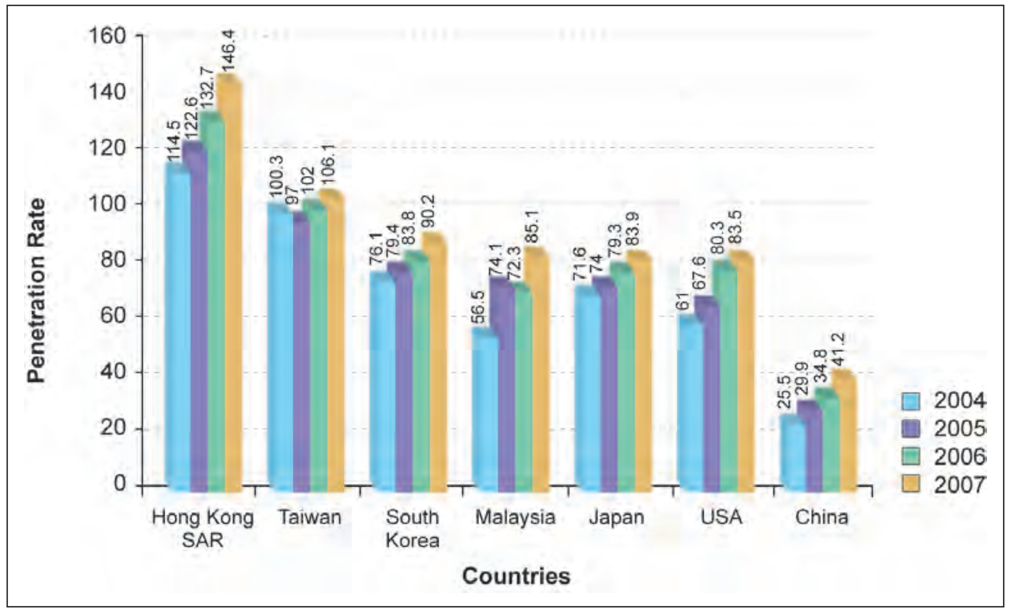
Figure 8.25: Cellular Phones Penetration Rate (per 100 Inhabitants) in ASEAN Countries, 2004 – 2007



Source: Malaysian Communications and Multimedia Commission (MCMC)

Figure 8.25 above shows the international comparison between each of the ASEAN country. The pattern indicates consistent growth in penetration rate in all five countries. Singapore is reported to have the highest penetration rate, which is above 100% for the three consecutive years since 2005, Brunei, the Philippines and Indonesia.

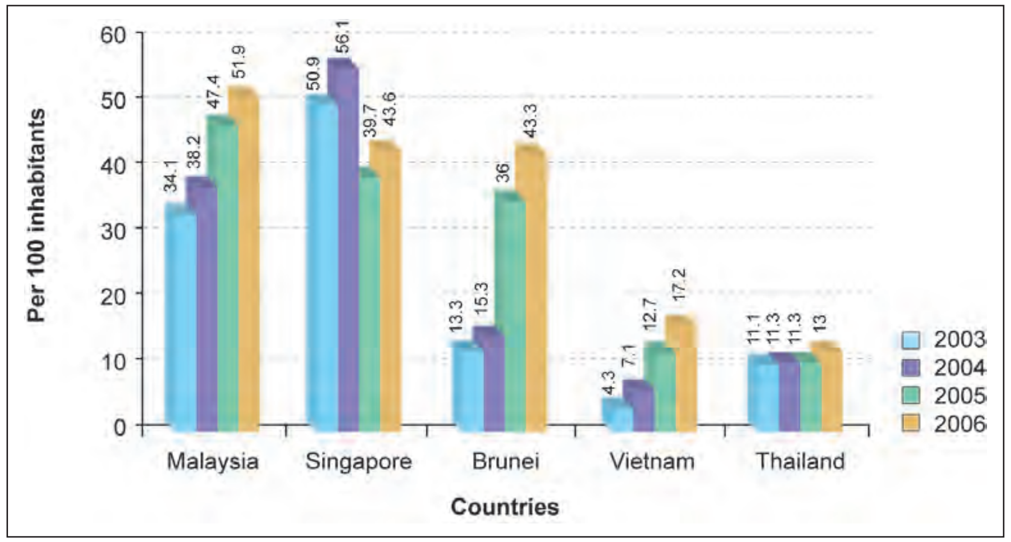
Figure 8.26: Cellular Phones Penetration Rate (per 100 Inhabitants) in Selected Economies, 2004 – 2007



Source: Malaysian Communications and Multimedia Commission (MCMC)

Penetration rate for cellular phones in selected economies has consistently increased every year from 2004 to 2007 (see Figure 8.26). Penetration rate in Hong Kong SAR is the highest among the selected countries. In this comparison, Malaysian penetration rate is comparable to other countries such as Japan, South Korea, USA and China.

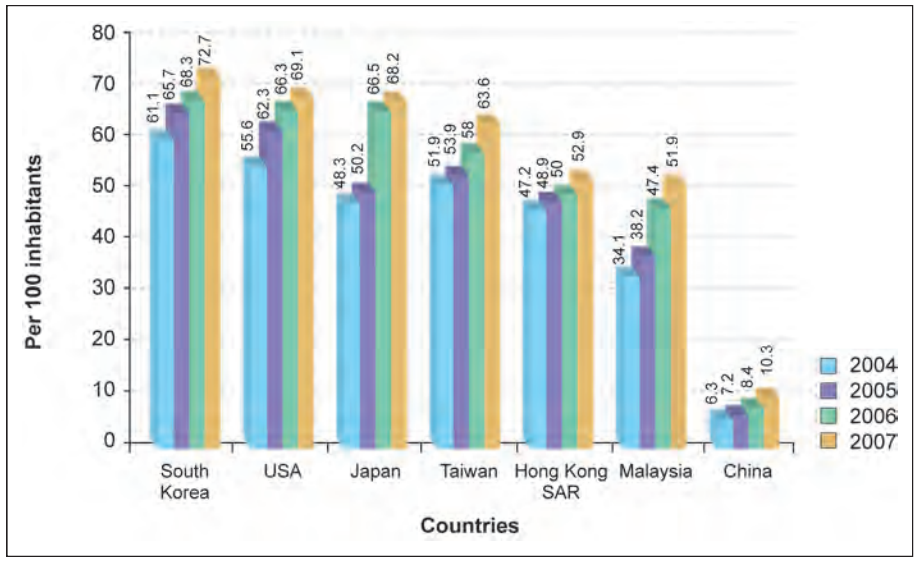
Figure 8.27: Internet Users per 100 Inhabitants, ASEAN Countries, 2003 – 2006



Source: Malaysian Communications and Multimedia Commission (MCMC)

Figure 8.27 shows how comparable Malaysia is in terms of Internet access. In 2006, Internet penetration rate in Malaysia is the highest compared to other ASEAN countries including Singapore. While Singapore is experiencing a decreasing rate in 2005, the Internet penetration rate in Malaysia, Brunei, and Vietnam are steadily on the rise. The figure also reflects that Malaysia is doing extremely well in providing wider access per 100 inhabitants to the Internet in both ASEAN countries and other selected economies. Figure 8.28 below indicates the position of Malaysia among other selected economies in terms of Internet penetration rate.

Figure 8.28: Internet Users per 100 Inhabitants, Selected Economies, 2003 – 2006



Source: Malaysian Communications and Multimedia Commission (MCMC)

INFORMATION AND COMMUNICATION TECHNOLOGY IN MALAYSIA

Chapter 8

Article Box 8.1: The Media Shoppe Berhad (TMS)

Incorporated in 1996, TMS is a developer and integrator of Enterprise Knowledge Portal technologies and solutions to the Enterprise, Government, Education and Community sectors. One of TMS' key strengths is its research and development expertise. Besides ensuring the future ease of integration and adaptability of TMS' current product offerings, the key focus of its R&D is to ensure that its products and solutions continuously address and cater to the market's needs, as well as evolve with current technological advancement. TMS today reaps the returns of its investment of close to RM8 million into its R&D over the last 13 years. Highly regarded as one of the pioneering companies in the field of knowledge management, TMS has successfully developed a suite of dynamic knowledge management products and solutions to meet its customers' needs, and help them create a learning environment that fosters a continuous creation, aggregation, use and reuse of both organizational and personal knowledge in the pursuit of new business value.

Built on open source Java technologies, TMS' enterprise solution, tmsEKP™ (Enterprise Knowledge Portal), is designed to provide organizations with a single dashboard to integrate information, business applications and services from heterogeneous systems and sources so as to encourage collaboration, efficiency, informed decision making and employee self-service. Serving as a single and unified gateway to a company's information and knowledge base for employees, shareholders, customers and vendors, tmsEKP™ enables enterprises to design and build a suite of modular solutions – such as content management, collaboration, e-learning, project management, human resources, helpdesk, and sales force automation. Besides tmsEKP™, TMS' other solutions include School Management System, Corporate Learning System, Airline Integrated Management System, Government Solutions and other customized turn-key solutions. TMS' 220 plus domestic and overseas clients range from diverse industries such as banking and finance, airline, publication, education, government, telecommunication and energy; spread across various countries such as Costa Rica, Columbia, Dominican Republic, USA, Brunei, Thailand and Indonesia.

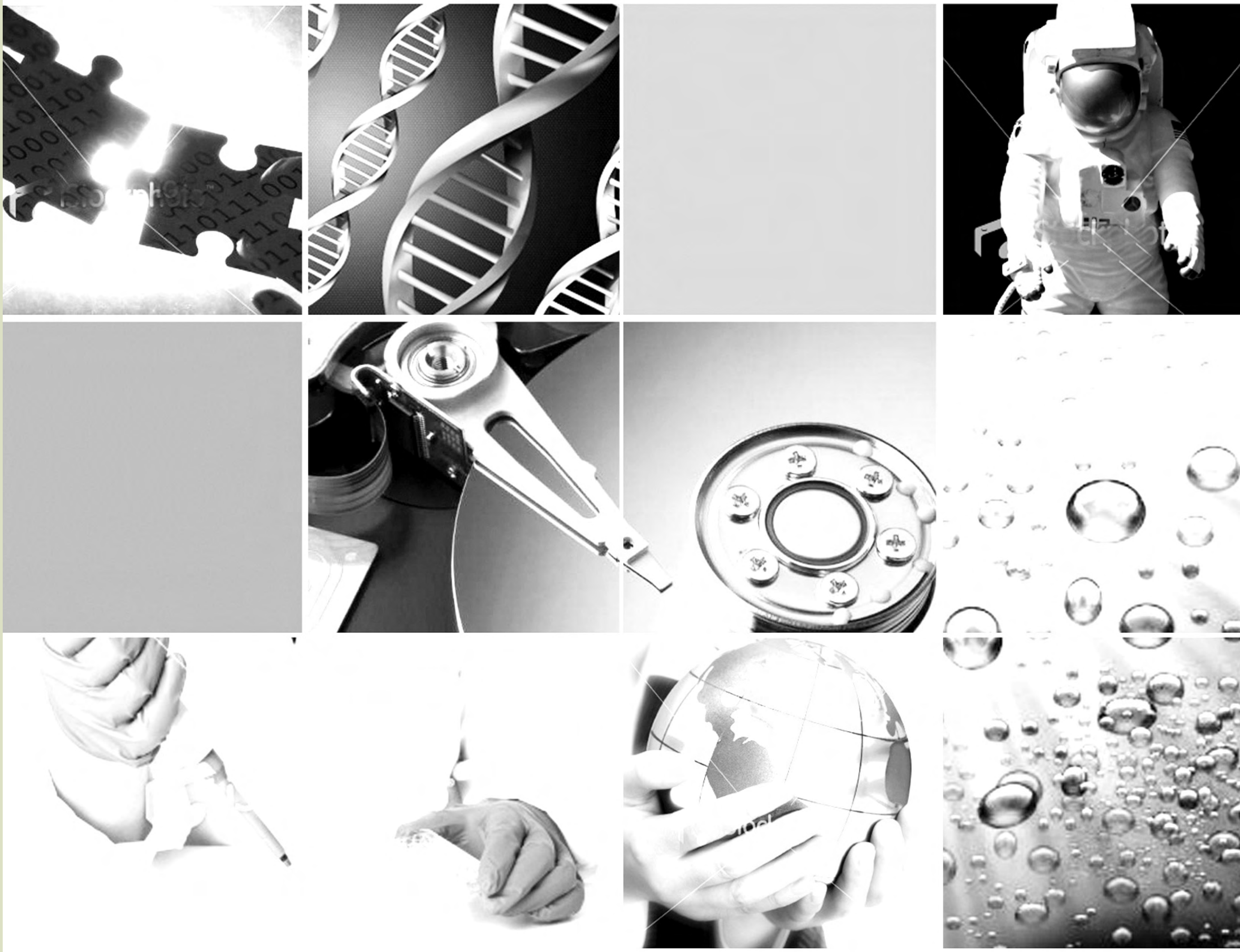
Source: TMS Bhd.

8.7 CONCLUSION

This chapter reports the status of ICT development and growth in Malaysia by covering a broad area of statistical reports such as workforce, funding and expenses, industrial market share, infrastructure and access, and some international comparison.

Most statistical report provided in this chapter is sourced from several agencies which are the Ministry of Science, Technology and Innovation, IDC, and MCMC. Some of the most updated reports were not made available due to lack of research conducted in certain fiscal year that provides relevant statistical information. This report depends highly on secondary resources provided by these government agencies mentioned above.

The overall statistical reports indicate the increase performance by the Malaysian government in sustaining ICT growth from the previous reporting years. Malaysia is also considered comparable to other well developed countries in the world in terms of ICT infrastructure and access.



BIOTECHNOLOGY IN MALAYSIA

Chapter 9

9.1 INTRODUCTION

According to the National Biotechnology Policy, biotechnology is described as an enabling tool for advances in agriculture and healthcare industries by providing immense benefits to the nation, through development of skills, value-added employment and improving the quality of a wide range of products and services.

Malaysian Biotechnology Corporation (BiotechCorp) defined biotechnology in two different ways; firstly, it can mean any technique which uses living organisms to make or modify products, improve plant or animal productivity or to develop microorganisms for specific use; secondly, it can be defined in a narrower scope as new 'high-end' biotechnology, involving recombinant deoxyribonucleic acid (DNA), cell fusion and novel bio-process engineering techniques such as gene transfer and embryo manipulation.

Malaysia has identified biotechnology as a key driver of growth for its economy in achieving its vision 2020. Its rich biodiversity; strong governmental support and commitment in R&D and a sound financial system provide a solid base for further developments in the biotech sector (sourced GBCD). The National Biotechnology Division (BIOTEK), which was established in 2005, is a government agency under the Ministry of Science, Technology and Innovation being made responsible in carrying out the biotechnology missions and visions of the country. BIOTEK carries the mission to spearhead the biotechnology development for wealth creation and social well-being by establishing Malaysia as the biotechnology centre through:

- Research and Development (R&D)
- International bridge for local biotechnology industry
- Human Capital and Resource Planning
- Public Understanding / Life time Education
- Research Funding

This chapter includes article boxes in areas of biotechnology in Malaysia and covers various Biotechnology development such as education, human resources, research and development, and patenting.

This chapter also provides views on Malaysia's Biotechnology performance in terms of projects and grants approved, expenditure and allocation, and some discussions on BioNexus companies in Malaysia. It also includes comparisons of global performances in the biotechnology sector.

9.2 AREAS OF BIOTECHNOLOGY INDUSTRY IN MALAYSIA

Several areas of biotechnology industries can be found operating in Malaysia. They are listed in BIOTEK directory under the category of health, bio laws, agriculture, bioequipment, bioinformatics, nutraceutical, pharmaceutical, R&D company, venture capitalist, and manufacturing.

9.2.1 Biotechnology Categories and Number of Registered Companies

National Biotechnology and Bioinformatics Network (NBBnet) provides the directory of all biotech companies registered in Malaysia according to the categories depicted in the table below.

Table 9.1 Biotech Categories and Number of Registered Companies in NBBnet, 2008

Biotech Categories	No of registered companies
Health	6
Bio Laws	3
Agriculture	20
Bioequipment	29
Bioinformatics	6
Nutraceutical	2
Pharmaceutical	11
R&D Company	11
Venture Capitalist	2
Manufacturing	22
Total	112

Source: National Biotechnology and Bioinformatics Network

Table 9.1 above shows biotechnology categories and number of registered companies in NBBnet as of 2008. Bioequipment has the highest number of registered companies (25.9%), followed by manufacturing (19.6%), agriculture (17.9%), pharmaceutical (9.8%) and R&D Company (9.8%).

9.2.2 BioNexus Companies

BioNexus Status is a recognition awarded by the Malaysian Government, through BiotechCorp, to qualified companies that participate in and undertake value-added biotechnology businesses. It is a status which designation awarded to qualifying biotechnology companies making them eligible for privileges under the Bill of Guarantees, grants and tax incentives.

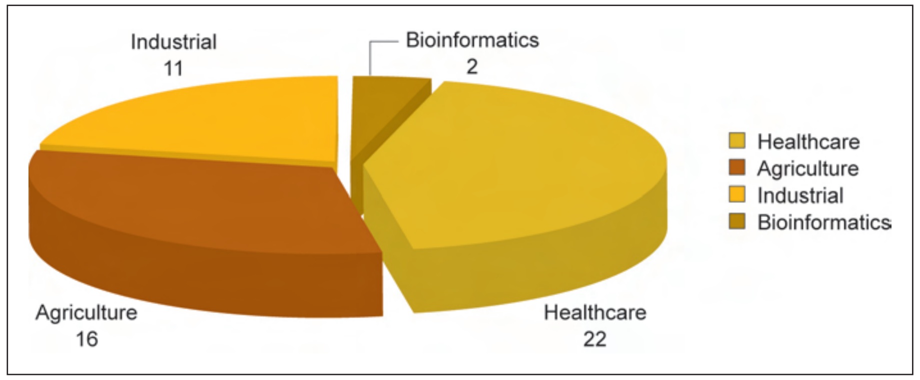
Table 9.2: Number of BioNexus Companies by State

States	Agriculture	Healthcare	Industrial	Bioinformatics	Total
Perak	1	-	-	-	1
Selangor	4	11	-	1	21
WP. Kuala Lumpur	6	7	3	1	17
Negeri Sembilan	1	1	-	-	2
Melaka		1	-	-	1
Johor	4	-	1	-	5
Sarawak	-	1	1	-	2
Pulau Pinang	-	1	1	-	2
Total	16	22	11	2	51

Source: BiotechCorp (as at March 2008)

Table 9.2 above shows the number of BioNexus companies by states in Malaysia. The total number of BioNexus companies in Malaysia is 51. The highest goes to Selangor with 21 companies followed by Kuala Lumpur (17) and Johor (5).

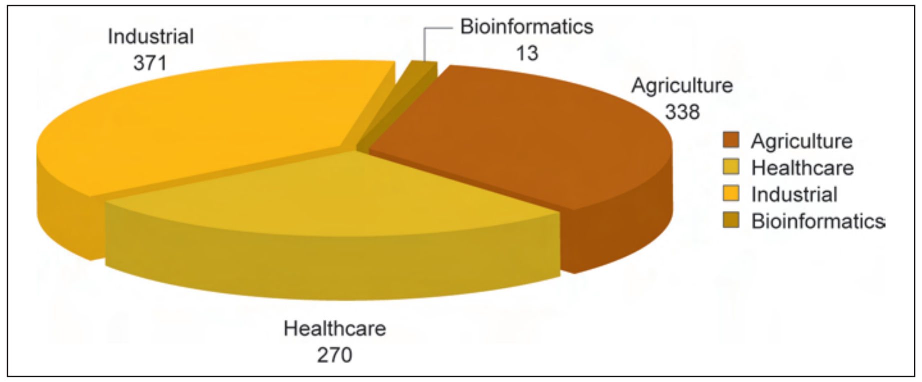
Figure 9.1: Number of Bionexus Companies by Area



Source: BiotechCorp (as of March 2008)

Figure 9.1 above shows the number of BioNexus companies by certain focused area in biotechnology. The figure indicates that healthcare industry dominates in the industrial distribution (43.1%), followed by agriculture (31.4%), industrial (21.6 %) and bioinformatics (3.9 %).

Figure 9.2: Total Bionexus Investment (amount in RM Mil)



Source: BiotechCorp (as at March 2008)

Figure 9.2 above shows the distribution of the industrial investments made by the BioNexus companies according to five different biotech areas. A total of RM992 million was invested by these companies. Industrial category has contributed the most (RM371 million, 37.4%) in the amount of investment, despite the lower number of companies listed under this category. This is followed by agriculture (RM 338 million, 34.1%), healthcare (RM 270 million, 27.2%) and bioinformatics (RM 13 million, 1.3%).

9.2.3 Article Box by Technology Park Malaysia (TPM)

TPM Biotech Sdn Bhd (TPMB) was established in 2004 as a fully owned subsidiary of Technology Park Malaysia (TPM) Corporation Sdn. Bhd., a Malaysian government–linked company. There are two divisions in TPMB: Biotechnology Development Centre and Herbal Biotech Centre.

TPM Biotechnology Development Centre is located at Bukit Jalil, Kuala Lumpur. This division is the focal point for all biotechnology services. Other than that, it is also the centre of all sales and marketing activities.

TPM Biotech Sdn Bhd, The Herbal Biotech Centre (HBC) is located at Kg. Ulu Sungai, Batu Talam, in the district of Raub, Pahang, approximately 190 km from Kuala Lumpur. HBC is a processing centre where all semi-finished and finished herbal based products are produced.

BIOTECHNOLOGY IN MALAYSIA
Chapter 9

Malaysia is famous for her biodiversity, and TPM's management recognised the opportunity and potential to utilize these abundance natural resources. In line with the global market trend and the growing demand for biodiversity products, the establishment of TPMB was materialised.

Samples descriptions of biotech activities by some registered companies are provided in Article Box 9.1, 9.2, and 9.3 below.

Article Box 9.1: Granulab (M) Sdn Bhd

GranuLab (M) Sdn. Bhd. (formerly known as Supreme Headline Sdn. Bhd.) located at Technology Park Malaysia, Bukit Jalil, was established in May 2005 and is a subsidiary of Sindora Berhad (Member of Johor Corporation). GranuLab has been granted by SIRIM Berhad the sole licensing to commercialise GranuMas™, a granular synthetic bone graft material and has embarked upon the setting up of medical grade plant for the production of GranuMas™.

GranuLab (M) Sdn. Bhd. has been granted the commercialization of granular synthetic bone graft material, GranuMas™ by SIRIM Bhd. It subsidiary of Sindora Bhd (Member of Johor Corporation), GranuLab has embarked upon the setting up of medical grade plant for the production of GranuMas™. GranuLab is led by En. Romli Ishak as the Managing Director.

Granulab's mission is to establish the nation first medical grade production plant for synthetic bone graft and Granulab's vision is to promote Malaysia as a centre for healthcare biotechnology through research and development, innovation, and commercialisation.

GranuMas™ is an osteoconductive granular synthetic bone graft material based on calcium phosphate hydroxyapatite. It is an excellent alternative material for the repair of bone defects due to its chemical composition being similar to the mineral phase of human bone. It is also chemically similar to the hydroxyapatite that is currently being used clinically as a bioactive coating on many surgical and dental implants such as in the Dental, ENT, Orthopaedics and Maxillofacial specialties.

GranuMas™ using a patented process **[Malaysian Patent Pending P1 2004 0748].** It is derived from pure commercial chemicals and Malaysian limestone and has fulfilled all of the criteria required under the **ASTM F1185-88 (1993) Standard for Composition of Hydroxyapatite (HA) for Surgical Implants.**

This product has gone through extensive biocompatibility and safety evaluation and has also demonstrated excellent biofunctionality in clinical trials and successfully screened through various in vitro and in vivo tests, which were all conducted with the collaboration of respectable institutions of higher learning in Malaysia. Its highly osteoconductive properties promotes good callus formation and the subsequent healing of bone defects.

Source: TPM Biotech Sdn Bhd

Article Box 9.2: Yakin Invest Corporation Sdn Bhd

Yakin Invest Corporation Sdn Bhd is an established Good Manufacturing Practice (GMP) certified OEM factory located in Hulu Langat, Malaysia with ISO 9001:2000. We produce skincare and bodycare products in accordance with the regulations set by ASEAN cosmetic regulations under Malaysia's National Pharmaceutical Control Bureau (BPFK). The products are also HALAL certified by Department of Islamic Development Malaysia (JAKIM). This ensures their skincare and cosmetic manufacturing and control conform to the highest international requirements.

Yakin Invest Corporation Sdn Bhd core values are as follows:

- To regard customer satisfaction as the company's top priority
- To maintain integrity, loyalty and trust at all times
- To seek continuous improvement in everything we do in a cost effective manner
- To value the pleasure to serve above the duty to deliver
- To put team work above individualism
- To communicate openly and sincerely
- To reward and promote employees on merit

The company has won a number of industry awards, including:

- Good Manufacturing Practice
- ISO 9001:2000
- HALAL
- Malaysia Superbrand 2006
- The 4th Asia Pacific International Honesty Enterprise – Kris Award 2005
- The 5th Asia Pacific International Entrepreneur Excellent Service Award 2006
- The 4th Global Outstanding Enterprise Golden Rim Award 2005
- SME Young Entrepreneur Award

Source: TPM Biotech Sdn Bhd

9.3 BIOTECHNOLOGY INDICATORS

Biotechnology indicators in Malaysia can be reflected through statistics acquired in various areas such as education, human resources, research and development, and patenting. This section provides information on some of the statistics as provided by the National Biotechnology Division, MOSTI.

9.3.1 Education

Table 9.3: Students Graduated From the Public Higher Learning Institutes (Biotechnology Programme and Biotech Related Programmes)

Academic Session	Graduated						Total
	2005/ 2006			2006/ 2007			
Field	BSc	MSc	PhD	BSc	MSc	PhD	
Biochemistry	69	1	-	51	19	4	144
Molecular Biology	-	-	-	-	12	2	14
Microbiology	41	4	-	74	8	6	133
Plant Biotechnology	33	-	-	23	25	2	83
Plant Science	162	80	64	183	5	1	495
Animal Science/ Zoology	25	-	-	44	4	-	73
Food Science	726	17	-	472	64	1	1,280
Marine Science	132	5	-	70	26	1	234
Bioinformatics	-	-	-	16	-	-	16
Genetic	33	1	1	15	20	7	77
Pharmacy/ Pharmacology	256	41	-	327	56	1	681
Biotechnology	268	47	-	266	23	1	605
Forensic Science	27	1	-	35	1	-	64
Biomedic	352	1	-	227	2	-	582
Total	2,124	198	65	1,803	265	26	4,481

Source: Ministry of Higher Education (MOHE)

Table 9.3 above shows the number of students graduated from the public higher learning institution in various areas related to biotechnology programme for 2005/2006 and 2006/2007 academic sessions. Out of 4,481 students graduated in the biotech related programmes, the highest number is found graduated in Food Science (28.6%), followed by Pharmacy/ Pharmacology (681, 15.2 %), Biotechnology (605, 13.5%), Biomedic (582, 13.0 %) and Plant Science (495, 11.0 %). There has been some slight reduction in the number of graduates from 2006 to 2007 in the Bachelor of Science degree programme as well as the Ph.D. level programme.

9.3.2 Human Resources

Table 9.4: Human Resources Development in 2007

Focus Area	MSc	PhD	Post Doctorate	Total
Animal	77	39	3	119
Plant	13	5	2	20
Food	26	8	-	34
Biopharmacy	49	16	-	65
Medical	52	25	-	77
Molecular Biology	105	32	4	141
Environment/ Industry	30	19	-	49
Total	352	114	9	505

Source: National Biotechnology Division, MOSTI

Table 9.4 shows the national report on human resources development in biotechnology areas for the fiscal year 2007. Compared to the number of university graduates in biotechnology, human resource development through the availability of jobs is somewhat smaller. There were 505 jobs created in the area of biotechnology within the year 2007. Of the total, Molecular Biology has the highest number of jobs, followed by animal. Plant offers the lowest in terms of job availability, which account for only 20 people in total.

9.3.3 Research & Development

Table 9.5: R&D Top Down Projects in Biotechnology under 8th Malaysia Plan (2001 – 2006/2007)

Focus Area	Number of Projects	Grant (RM million)
Animal	12	20.6
Plant	4	8.9
Food	4	3.8
Biopharmacy	9	24.8
Medical	8	21.2
Molecular Biology	8	19.6
Environment/ Industry	2	6.5
Total	47	105.4

Source: National Biotechnology Division, MOSTI

Table 9.5 above shows R&D projects in biotechnology under 8th Malaysia plan from 2001 to 2006/2007. These projects are funded under the "Top Down Biotechnology Research Programmes". A total grant of RM105.4 million has been released for projects in biotechnology area from these grants and funding agencies. Biopharmacy focus area received the highest from the total grant, followed by medical, animal, molecular biology, plant, environment, and food. However, the highest number of project has been given out to animal focus area.

9.3.4 Patenting

Table 9.6: List of Patents Filed and Granted for 2007

Focus Area	International	Local	Total
Animal	2	6	8
Plant	-	-	-
Food	-	-	-
Biopharmacy	3	8	11
Medical	23	11	34
Molecular Biology	3	5	8
Environment/ Industry	-	9	9
Total	31	39	70

Source: National Biotechnology Division, MOSTI

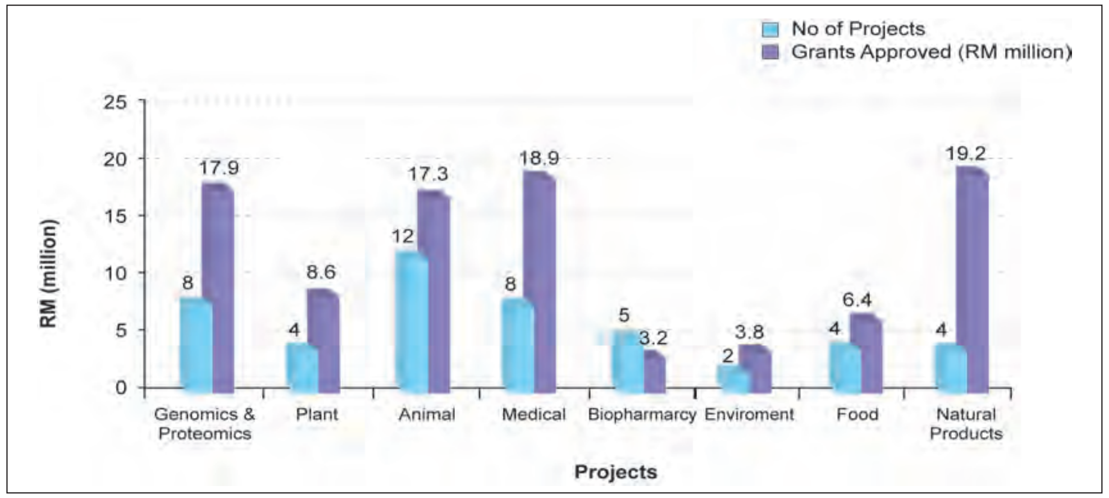
Table 9.6 above shows the number of patents granted for the year 2007 in various biotechnology areas. A total of 70 patents were filed and granted in 2007. The highest patent granted was given to medical focus area with a total number of 34. There is only a slight different between the local and the international patent registration.

9.4 INDUSTRIAL ALLOCATION, GRANTS AND EXPENDITURE

9.4.1 Number of Biotechnology Projects and Grants Approved, 2001-2005 for Biotechnology Industry

Funding approved comes from different types of grant such as IRPA, Malaysia-MIT Biotech. Programme, Technology Development for SMIs, Technology Acquisition Fund, Commercialization of Technology (IGS, MGS, DAGS, CRDF) and S&T Infrastructure & Development.

Figure 9.3: Number of Projects and Grants Approved, 2001 – 2005

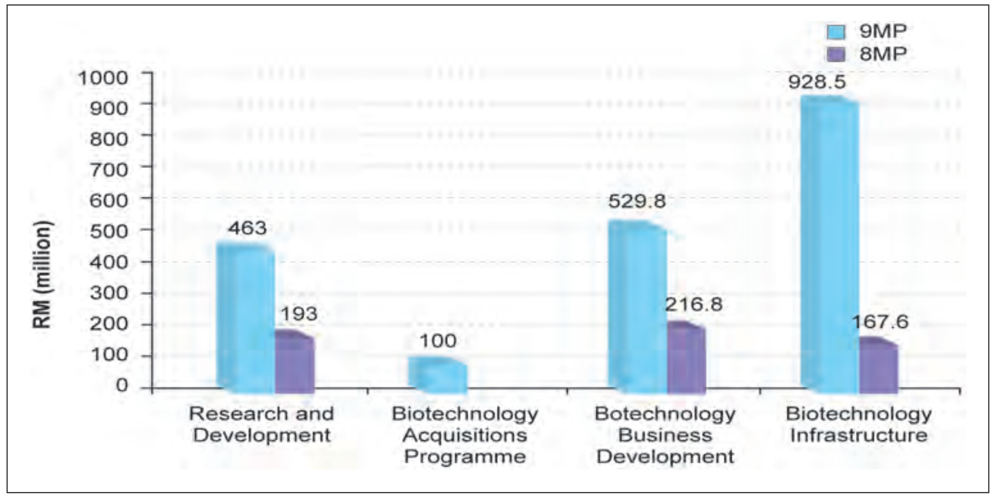


Source: Ministry of Science, Technology and Innovation

Figure 9.3 above shows number of projects and grants approved from 2001 to 2005 by the Ministry of Science, Technology and Innovation in the area of biotechnology. According to the graph, Natural Products lead the rankings with RM19.2 million grants approved among all other projects and the highest number of biotechnology projects is 12 in Animal projects. On the other hand, the lowest number of projects is Environment (2 projects) and the lowest grant amount is Biopharmacy (RM 3.2 million).

9.4.2 Biotechnology Expenditure and Allocation

Figure 9.4: Biotechnology Expenditure & Allocation in 8MP and 9MP



Source: National Biotechnology Division, MOSTI

Figure 9.4 shows biotechnology budget expenditure and allocation for the 8th Malaysia Plan and the 9th Malaysia Plan. A total amount of RM2,021.3 million (9MP) and RM577.4 million (8MP) have been allocated and used respectively in Malaysia for the purpose of advancing the biotechnology industry. The amount in the 9MP has been allocated more than double the amount in the 8MP in all areas of biotechnology specified. Biotechnology infrastructure received the most attention for budget allocation and expenditure during 9MP. Additional expenditure in the amount of RM100 million has allocated for biotechnology acquisition programme during 9MP. For the 8MP, the highest biotechnology expenditure and allocation is in biotechnology business development (RM216.8 million) followed by research and development (RM193) million and biotechnology infrastructure (RM167.6) million.

9.5 INTERNATIONAL COMPARISONS

Table 9.7: Global Biotechnology at a Glance, 2007

	GLOBAL	US	EUROPE	CANADA	ASIA-PACIFIC
Public Company Data					
Revenue (US$M)	84,782	65,175	12,945	2,692	3,970
R&D expense (US$M)	31,806	25,836	4,567	915	488
Net Loss (US$M)	2,694	277	1,689	722	6
Number of employees	204,930	134,600	47,720	7,330	15,280
Number of companies					
Public Companies	798	386	181	82	149
Public and Private Companies	4,414	1,502	1,744	404	764

Source: Earnst & Young

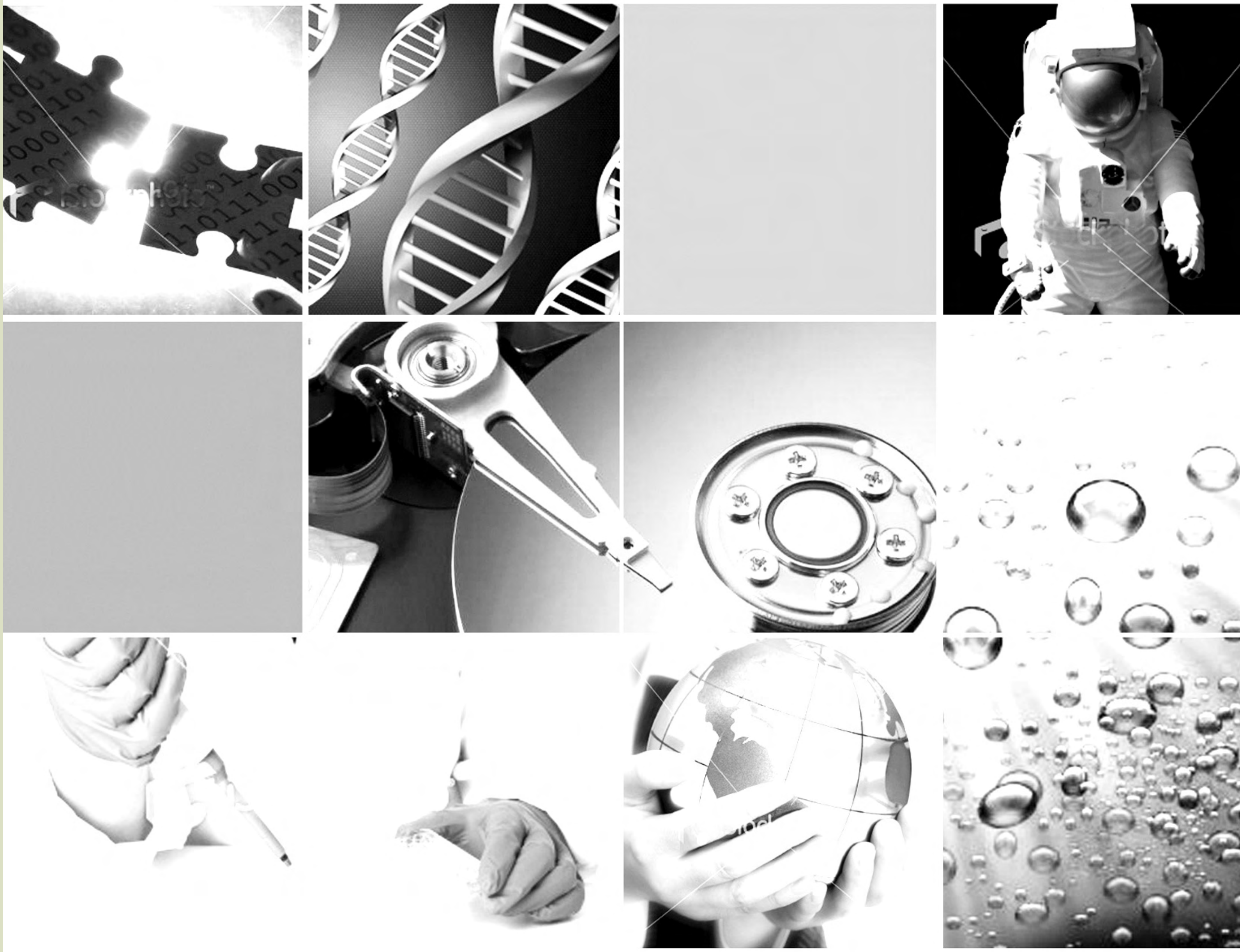
Table 9.7 provides comparisons of global performances in biotechnology in terms of revenue (US$84,782 million), R&D expense (US$31,806 million), net loss (US$2,694 million), number of employees (204,930), public companies (798), and public and private companies (4,414). The figures indicate that US holds the highest amount in all of the categories listed. Asia-Pacific, in which Malaysia resides, spent the lowest in R&D expenses. However, this region provided larger number of employment opportunities compared to Canada.

9.6 CONCLUSION

This chapter reports the progress of the Malaysian government in biotechnology. Such progress in provided through statistical reports on biotechnology industry, education, human resource, research and development, patenting, government grant and expenditure, and international comparison.

The biotechnology industry seems to grow with health and agricultural companies started dominating the market. Other indicators provide information on the number of students' registration at the IHL in the areas related to biotechnology and the number of jobs available. The figures may have been on the rise by the time this report is produced. The significant amount of government grant and expenditure in the 9th Malaysia Plan will most likely boost the biotechnology innovation and industrial development.

During the process of writing this report, some obstacles and difficulties occurred in getting objectives data and statistics. Not much work has been done in providing measures and indicators in the area of biotechnology. However, based on the above report, some analysis can be derived on the performance of biotechnology in the country.



TRADE IN TECHNOLOGY

Chapter 10

10.1 INTRODUCTION

This chapter attempts to report on Trade in Technology in Malaysia. Two categories are used in this report namely trade in manufactured goods and trade in services. Trade in manufactured goods consists of high and medium-high technology manufactured products, while trade in services comprises royalties, contract and professional fees, and construction and engineering fees.

In a recent IMD's (International Institute for Management Development) Executive Opinion Survey 2008, Malaysia was ranked among the top five in the category of exports as a percentage of high-technology exports. For October 2008, Malaysia achieved a trade value of RM97.3 billion, a decrease of 3.8% from October 2007, and the exports and imports value decreased by 2.6% and 5.3 %, respectively.[1]

10.2 TRADE IN MANUFACTURED GOODS

In the first three quarters of 2007, the manufacturing sector expanded by 2.3% and is expected to contribute 30.3% to GDP. Manufactured products amounted to RM452.5 billion and accounted for 74.8% of Malaysia's exports in 2007. This was attributed to the greater interest in capital-intensive and high value-added projects among both domestic and foreign investors.[2]

Expansion in exports to the growing markets was contributed by electrical & electronic products (E&E), chemicals and chemical products, machinery, appliances and parts, iron and steel products, palm oil and sawn timber and logs.

The manufacturing sector is expected to record a moderate expansion of 1.8 % in view of the slower external demand in particular from the US electrical and electronic industry. Nevertheless the sustained domestic demand and the expansion in the regional economies are expected to support growth in some domestic-oriented and resource-based industries.

[1] Malaysia External Trade Development Corporation (MATRADE), Malaysia External Trade Statistics (Preliminary Release), Page 1, October 2008

[2] Malaysian Industrial Development Authority (MIDA), MIDA Annual Media Conference On The Performance Of The Manufacturing And Services Sectors In 2007, Page 1, 19 February 2008

10.2.1 Manufactured Exports

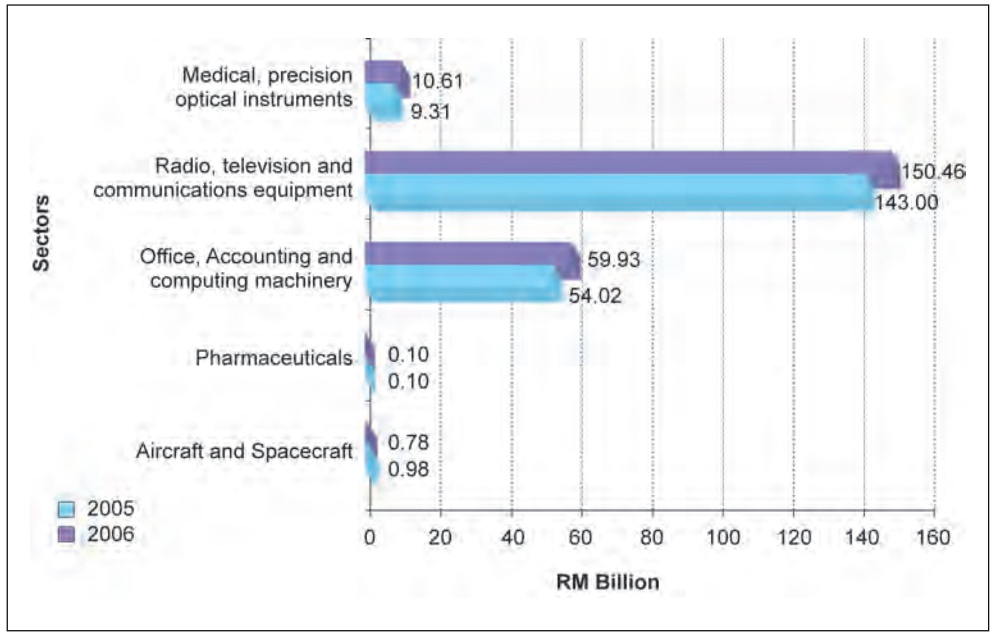
According to MATRADE Statistics, ASEAN accounted for RM13.6 billion or 25.4% of Malaysia's total exports in October 2008, a decrease of 6.1% from October 2007.3 Malaysia's exports of manufactured goods accounted for 74.8% of total exports in 2007.

The Organization for Economic Cooperation and Development (OECD) identifies high-tech industries based on a comparison of industry R&D intensities, a calculation dividing sub-sector R&D expenditures by sub-sectors sales.[4]

High-technology products can be divided into five categories according to the OECD classification on technological intensities:

1. Aircraft and spacecraft
2. Pharmaceuticals
3. Office, accounting and computing machinery
4. Radio, television and communications equipment
5. Medical, precision and optical instruments

Figure 10.1: High Tech Manufactured Exports (RM Billion), 2005 – 2006



Source: Department of Statistics Malaysia

[3] Malaysia External Trade Development Corporation (MATRADE), Malaysia External Trade Statistics 1 (Preliminary Release), Page 2, October 2008

[4] http://www.cpu.gov.hk/

Table 10.1: High Tech Manufactured Exports (RM Billion), 2005 – 2006

Sectors	2005 RM Billion	2006 RM Billion	Percentage (%)	Composition (%)
Aircraft and Spacecraft	0.96	0.78	▼ 18.8	0.4
Pharmaceuticals	0.10	0.10	⧗ -	0.1
Office, Accounting and computing machinery	54.02	59.93	▲ 10.9	26.6
Radio, television and communications equipment	143.00	150.46	▲ 5.2	68.4
Medical, precision and optical instruments	9.31	10.61	▲ 14.0	4.6

Source: Department of Statistics Malaysia

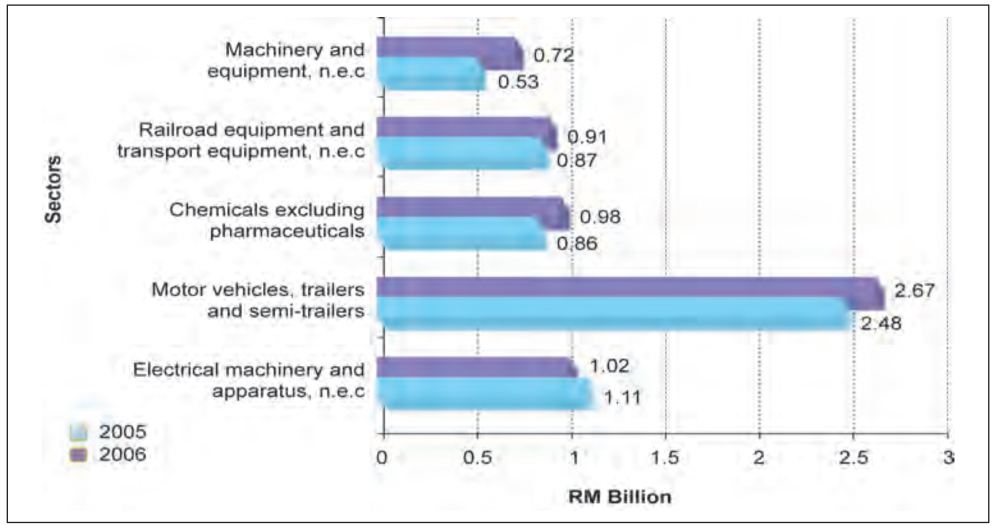
Table 10.1 shows the high-tech manufactured exports in the period of 2005 to 2006. The 'radio, television and communication equipment' sector was the major contributor to the high-tech manufactured goods exports, representing 68.4% of total exports 2005 and 2006, followed by the 'office, accounting and computing machinery' at 26.6% and the 'medical, precision and optical instruments' at 4.6%.

With the exception of the 'aircraft & spacecraft' sector which recorded declines of 18.8%, respectively, all the other sectors experienced growth in 2006. Growth was recorded by the 'office, accounting and computing machinery' (10.9%) and the 'medical, precision and optical instruments' (14.0%), while 'radio, television and communication equipments' had a growth of 5.2% over the previous year.

Based on the OECD's product-based classification, medium high-technology products are categorized as follows:

1. Electrical machinery and apparatus
2. Motor vehicles, trailers and semi-trailers
3. Chemicals (excluding pharmaceuticals)
4. Machinery and equipments
5. Railroad and transport equipments

Figure 10.2: Medium High Tech Manufactured Exports (RM Billion), 2005 – 2006



Source: Department of Statistics Malaysia

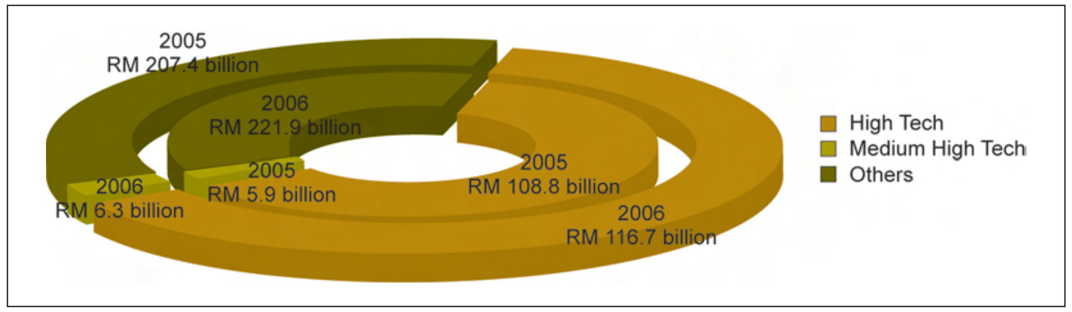
Table 10.2: Medium High Tech Manufactured Exports (RM Billion), 2005 – 2006

Sectors	2005 (RM Billion)	2006 (RM Billion)	Percentage (%)	Composition (%)
Electrical machinery and apparatus, n.e c	1.11	1.02	▼ 8.1	17.5
Motor vehicles, trailers and semi-trailers	2.48	2.67	▲ 7.7	42.4
Chemicals excluding pharmaceuticals	0.86	0.98	▲ 14.0	15.1
Railroad equipment and transport equipment, n.e.c	0.87	0.91	▲ 4.6	14.7
Machinery and equipment, n.e.c	0.53	0.72	▲ 35.8	10.3

Source: Department of Statistics Malaysia

Table 10.2 shows the medium high-tech manufactured exports for 2005-2006. In 2006, the 'motor vehicles, trailers and semi-trailers' sector contributed most to medium high-tech manufacturing exports with export value totaled RM2.67 billion (42.4% of total medium high-tech manufactured exports 2005 and 2006), representing an increase of 7.7% over the previous year. This was followed by the 'electrical machinery and apparatus' sector with RM1.02 billion, 'chemicals excluding pharmaceuticals' (RM0.98 billion), 'railroad and transport equipment' (RM0.91 billion) and 'machinery and equipment' (RM0.72 billion).

Figure 10.3 Structures of Manufactured Exports, 2005 – 2006



Source: Department of Statistics Malaysia

Table 10.3: Structure of Manufactured Exports, 2005 – 2006

Sectors	2005 (RM Billion)	2006 (RM Billion)	Percentage (%)
High Tech Manufactured Exports	207.4	221.9	▲ 7.0
Medium-High Tech Manufactured Exports	5.9	6.3	▲ 6.8
Others	108.8	116.7	▲ 7.3
Total	322.1	344.9	▲ 7.1

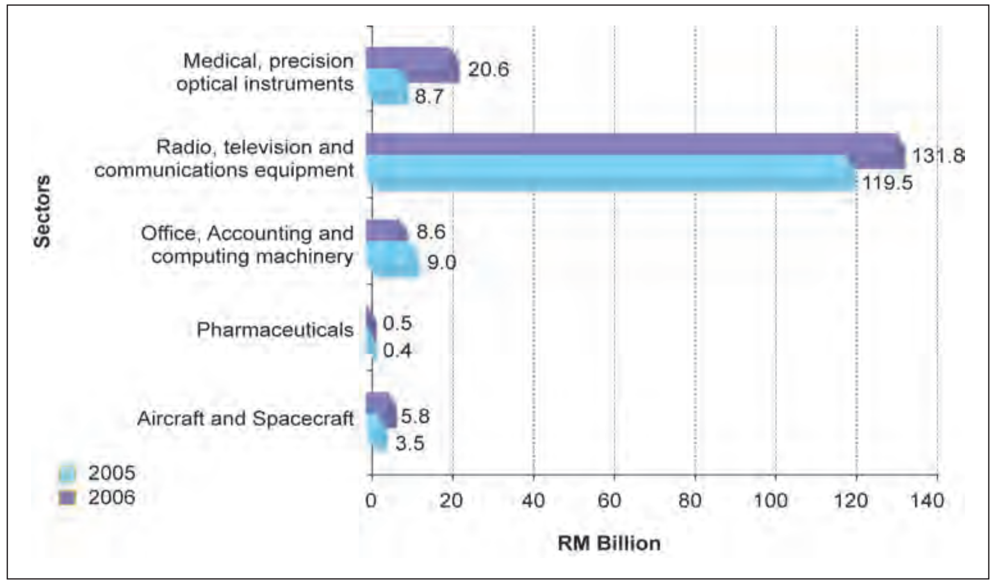
Source: Department of Statistics Malaysia

Overall, the manufactured exports increased by 7.1% from RM322.1 billion in 2005 to RM344.9 billion in 2006. In 2006, the high tech manufactured goods contributed the most, accounting for 64.3% of total manufactured exports. Compared to 2005, the high-tech manufactured exports showed an improvement of 7.0% in 2006. The medium high-tech manufactured products increased by 6.8% to RM6.3 billion in 2006 from RM5.9 billion recorded in 2005.

10.2.2 Manufactured Imports

This section presents data on high-tech and medium-high tech manufactured imports for the year of 2005 and 2006. Overall, there was a decrease in the high tech manufactured imports account during the period under review.

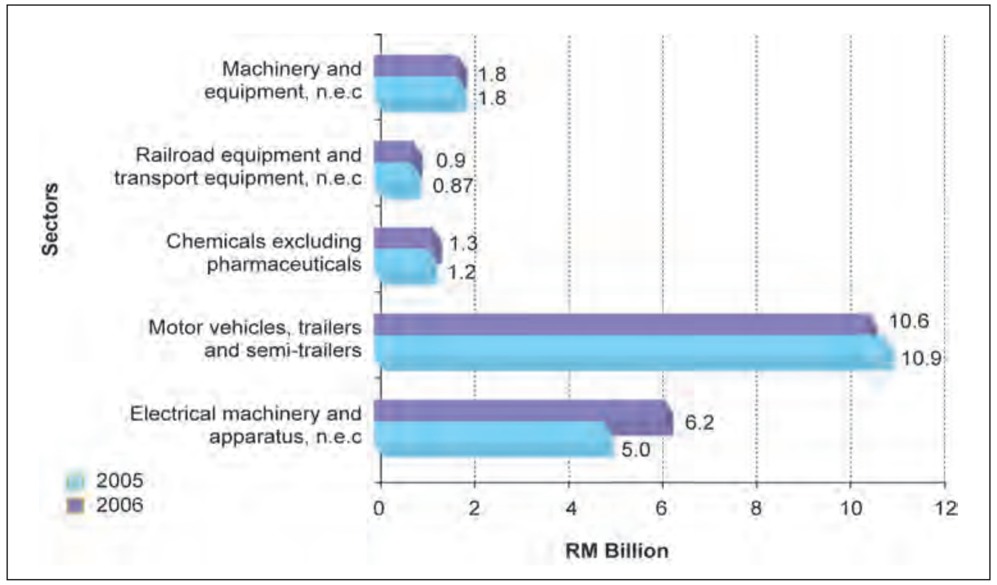
Figure 10.4: High Tech Manufactured Imports, 2005 – 2006



Source: Department of Statistics Malaysia

In 2006, radio, television and communications equipment dominated the high tech manufactured imports, accounting for nearly 80% of total imports. Import value for radio, television and communications equipment increased by 10.3% from RM119.5 billion in 2005 to RM131.8 billion in 2006. Other sectors that had increases in import values were medical, precision and optical instruments (+136.8%) and aircraft and spacecraft (+65.7%). There were no significant changes in import values for office, accounting and computing machinery and pharmaceutical sectors (Figure 10.4).

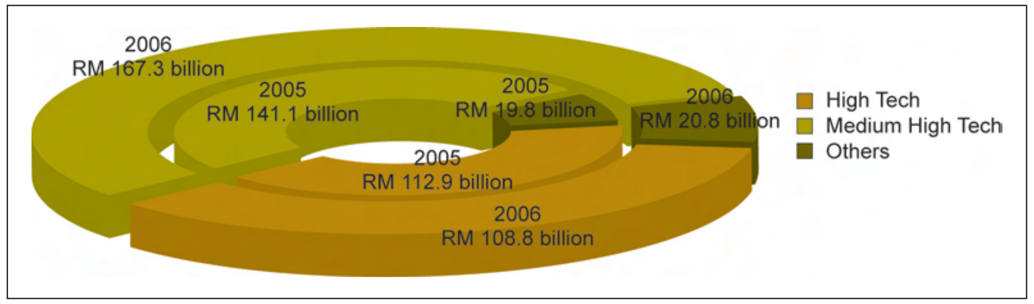
Figure 10.5: Medium High Tech Manufactured Imports, 2005 – 2006



Source: Department of Statistics Malaysia

Figure 10.5 shows the medium-high tech manufactured imports for 2005-2006. The motors vehicle, trailers and semi trailers contributed over 50% of the total imports. Other industries enjoyed nominal growth during the period. Overall, it was observed that the account increased by RM 1.0 billion in 2006 from RM19.8 billion recorded in 2005.

Figure 10.6: Structure of Manufactured Imports, 2005 – 2006



Source: Department of Statistics Malaysia

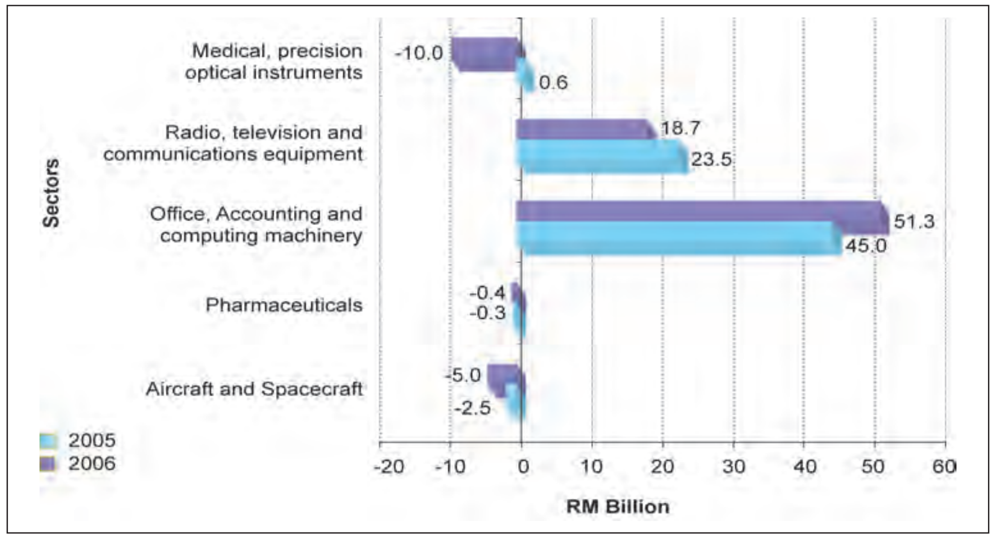
Table 10.4: Structure of Manufactured Imports, 2005 – 2006

Industry	2005 (RM Billion)	2006 (RM Billion)	Percentage (%)
High Tech Manufactured Imports	141.1	167.3	▲ 18.6
Medium High Tech Manufactured Imports	19.8	20.8	▲ 5.1
Others	112.9	108.9	▼ 3.5
Total	273.8	297.0	▲ 8.5

Overall, the manufactured imports increased by 8.5% in 2006, from RM273.8 billion recorded in 2005. The high tech manufactured goods contributed the most, accounting for over 50% of total manufactured imports. Imports for high tech manufactured goods showed an increase of 18.6% from RM141.1 billion to RM167.3 billion in 2006. While, imports for medium high tech goods recorded an increase of 5.1% over the previous year.

10.2.3 Manufacturing Trade Balance

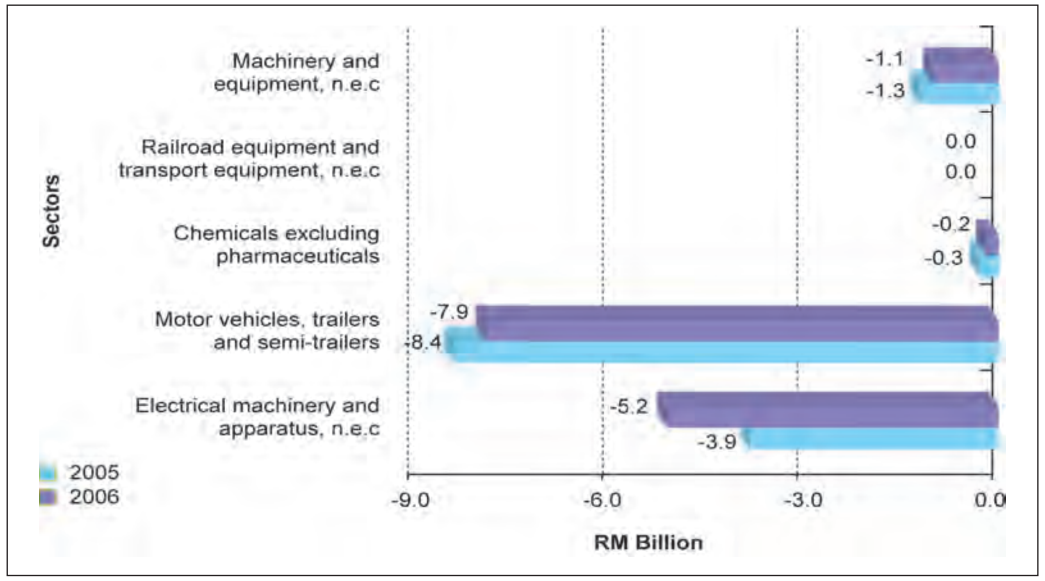
Figure 10.7: High Tech Manufactured Trade Balance, 2005 – 2006



Source: Department of Statistics Malaysia

Figure 10.7 shows the high tech manufactured trade balance for 2005 to 2006. 'Office, accounting and computing machinery' and 'radio, television and communications equipment' recorded trade surplus among the high-tech manufactured goods in 2005-2006. Other sub-industry such as 'medical, precision and optical instruments', 'aircraft and spacecraft' and 'pharmaceuticals' recorded trade deficits during the period.

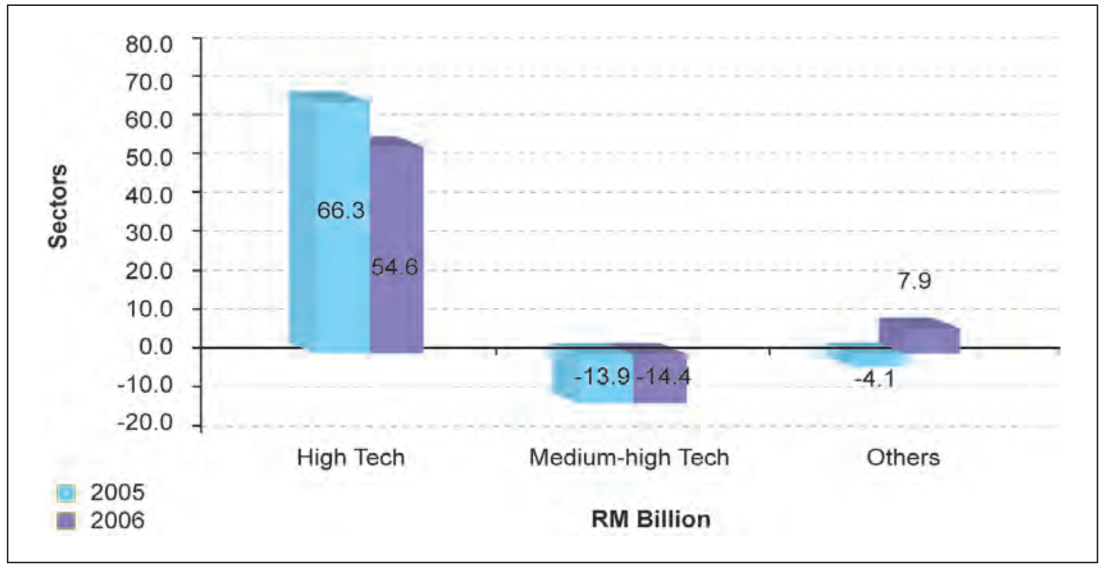
Figure 10.8: Medium High Tech Manufactured Trade Balance, 2005 – 2006



Source: Department of Statistics Malaysia

In general, the trade balance for medium high tech manufactured goods was not in Malaysia's favor. Malaysia continued to record trade deficits in 2005 (RM-13.9 billion) and 2006 (RM-14.4 billion). The highest deficit was contributed by motor vehicles, trailers and semi-trailers for 2005-2006, which recorded RM -8.4 billion in total loss in 2006.

Figure 10.9: Structure of Overall Trade Balance, 2005 – 2006



Source: Department of Statistics Malaysia

In general, Malaysia recorded trade surpluses in 2005 (RM48.3 billion) and 2006 (RM48.1 billion). The strong performance was contributed by positive trade balance of high tech manufactured goods such as 'office accounting and computing machinery' and 'radio, television and communications equipment'. Nevertheless, as previously shown in Figure 10.7, trade deficits were recorded for high tech manufactured goods such as 'medical, precision and optical instruments', aircraft and spacecraft' and 'pharmaceuticals'. Trade balance for medium high tech products continued to register negative balance in 2005 and 2006.

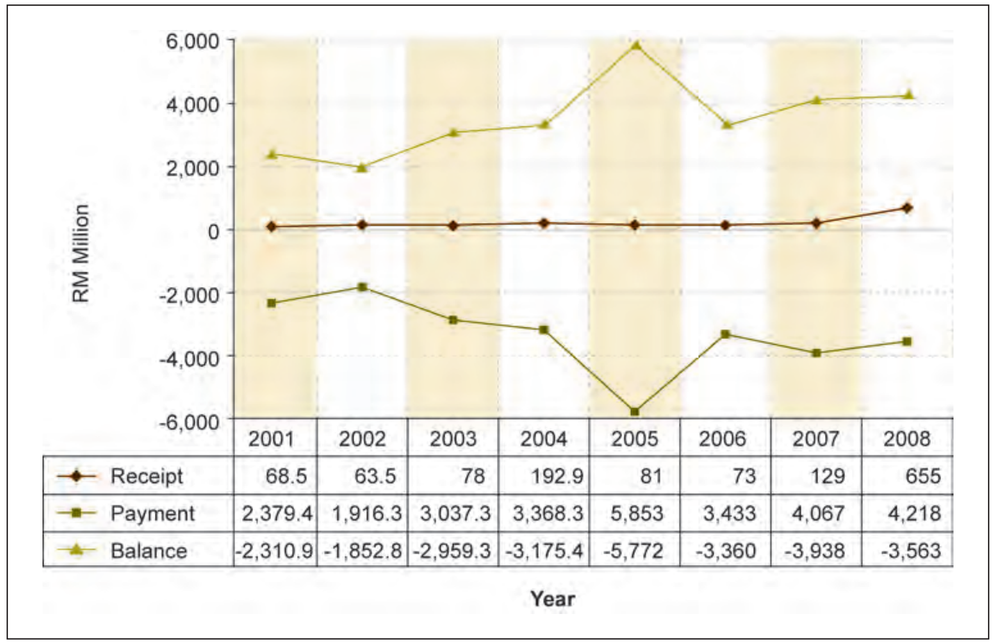
10.3 TRADE IN SERVICES

Trade in services refers to the sale and delivery of a product, called a service, between a producer and consumer. This section covers the total payments, receipts and trade balance for the royalties, contract and professional charges and construction and engineering fees for the years 2001 to 2008.

10.3.1 Payments and Receipts

This section reports on the total payments, receipts and balance for royalties, contract and professional charges, and construction and engineering fees made by Malaysia for the trade in services.

Figure 10.10: Total Royalty Payment, Receipt and Balance (RM Million), Malaysia 2001-2008

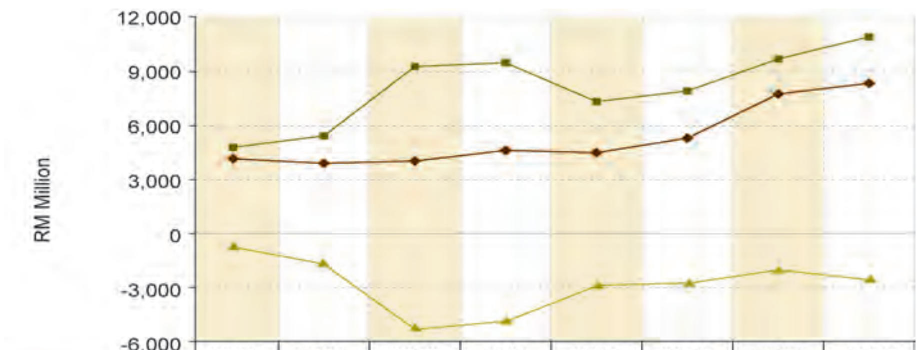


	2001	2002	2003	2004	2005	2006	2007	2008
Receipt	68.5	63.5	78	192.9	81	73	129	655
Payment	2,379.4	1,916.3	3,037.3	3,368.3	5,853	3,433	4,067	4,218
Balance	-2,310.9	-1,852.8	-2,959.3	-3,175.4	-5,772	-3,360	-3,938	-3,563

Source: Bank Negara Malaysia

Figure 10.10 shows the patterns of technology trade in terms of royalty receipts, payments and balance for the period 2001-2008. Receipts in the royalty account have not shown much improvement throughout the reporting period. Royalty payments for the trade in services abroad by Malaysian based companies in the period 2003 to 2005 but fell in 2006. In general, Malaysia is a royalty payer, selling less of its patented technology abroad. This is reflected in figure 10.10, where throughout 2001 to 2008, the balance of payments in the royalty accounts showed large deficits.

Figure 10.11: Total Contract and Professional Payment, Receipt and Balance (RM Million), Malaysia 2001 – 2008



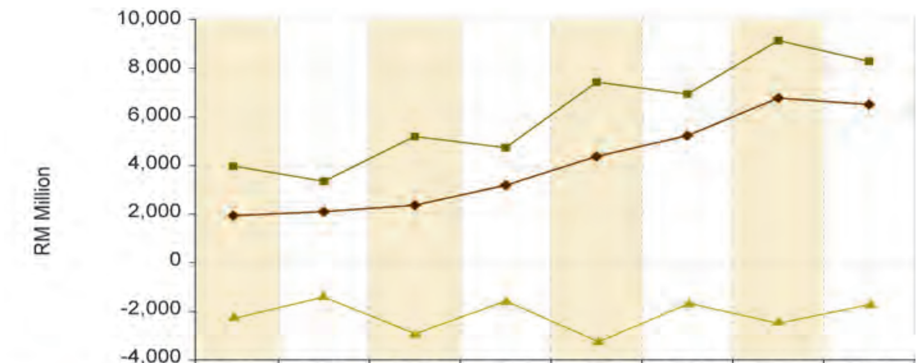
	2001	2002	2003	2004	2005	2006	2007	2008
Receipt	4,127.9	3,869.6	4,092.2	4,693.4	4,492	5,298	7,729	8,337
Payment	4,723.2	5,390	9,186.1	9,388.4	7,230	7,907	9,676	10,786
Balance	-595.3	-1,520	-5,094	-4,695	-2,738	-2,609	-1,947	-2,449

Year

Source: Bank Negara Malaysia

Figure 10.11 shows that there were large deficits in the balance of payments for the contract and professional services. Even though the total 'contract and professional' receipts have shown steady improvements from 2002 to 2008, the gaps were still broad as the total payments grew even higher than the total earnings. The highest year of payments was recorded in 2008 with RM10,786 million. Year 2007 also marked a significant improvement in the balance of payment, in which a total trade deficit of RM1,947 million was recorded during the year, reducing trade deficit by 25.4% as compared to the previous year.

Figure 10.12: Total Construction and Engineering Payment, Receipt and Balance (RM Million), Malaysia 2001 – 2008



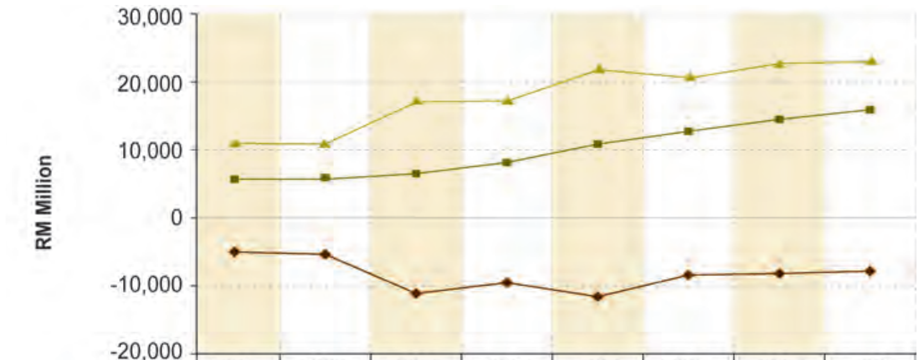
	2001	2002	2003	2004	2005	2006	2007	2008
Receipt	1,912.2	2,109.2	2,405	3,263.8	4,431	5,257	6,773	6,592
Payment	4013	3,378.9	5,225.4	4,713	7,499	6,962	9,155	8,265
Balance	-2,100.8	-1,269.7	-2,820.4	-1,449.2	-3,068	-1,705	-2,382	-1,673

Year

Source: Bank Negara Malaysia

Total 'construction and engineering' fee payments fluctuated over the period 2002 to 2008. Receipts collected increased gradually from 2001 to 2007. Year 2007 marked a significant improvement where receipts collected during the year reached 6,773 million, an increase of 28.8% from the previous year. Despite showing the positive growth in receipts, the overall balance of payments continued to show wide deficits in the account. The balance of payments showed fluctuations in the total fees when it fell sharply in 2005 with a drop of 111.7% from the previous year. Nevertheless, the accounts showed improvements in 2006 when it slightly increased to RM-1,705 million (Figure 10.12).

Figure 10.13: Total Payments, Receipts and Balance in Trade in Services (RM Million), Malaysia 2001 – 2008



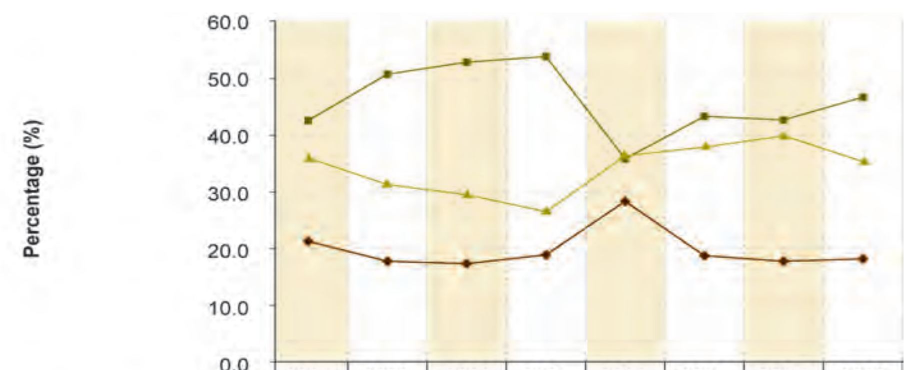
	2001	2002	2003	2004	2005	2006	2007	2008
Receipt	6,108.6	6,042.3	6,575.2	8,150.1	10,793	12,351	14,630	15,585
Payment	11,116	10,685	17,449	17,470	22,200	20,478	22,898	23,270
Balance	-5,007	-4643	-10,874	-9,320	-11,407	-8,127	-8,268	-7,685

Year

Source: Bank Negara Malaysia

The payments made by Malaysia grew much faster than the receipts collected during 2001 to 2008, causing service trade deficits to grow bigger. The largest deficit in account was recorded in 2005, where total payment exceeded total receipts by RM11,407 million. The total payments increased steadily from the year 2002 with only a slight dropped in 2006 before it grew back in the following years. The highest payment made was in 2008, with a total amount of RM23,270 million, representing an increase of 1.6% from RM22, 898 million recorded in 2007. On the other hand, the total receipts grew steadily over the period 2001-2008 and reached its peak in 2008 with total receipts of RM15,585 million.

Figure 10.14: Composition of Payments in Services Trade, Malaysia 2001 – 2008



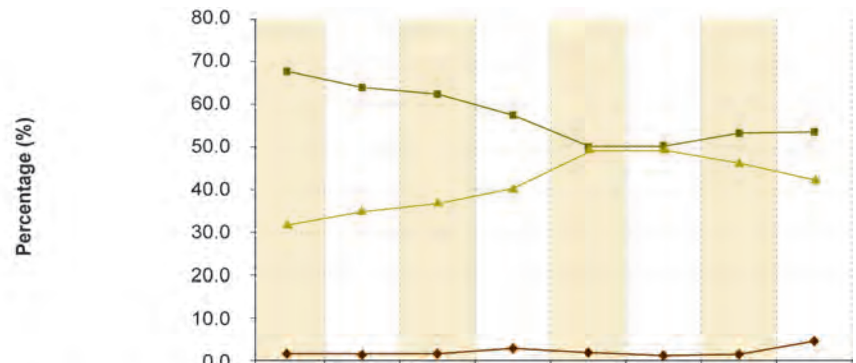
	2001	2002	2003	2004	2005	2006	2007	2008
Royalties	21.4	17.9	17.4	19.3	28.4	18.8	17.8	18.1
Contract and Professional Fee	42.5	50.4	52.6	53.7	35.1	43.2	42.3	46.4
Construction and Engineering Fee	36.1	31.6	29.9	27.0	36.4	38.0	40.0	35.5

Year

Source: Bank Negara Malaysia

Figure 10.14 shows the composition of payments in services trade over the years 2001 to 2008. Payments for contract and professional fees constituted the biggest portion, with above 40.0% shared percentage throughout 2001 to 2008 years period. Only 2005 marked a slight reduction in the portion, which constituted 35.1% of total payments. Meanwhile, 'construction and engineering' was ranked second place, contributing a share of above 30.0% throughout the period except for 2004, where it contributed 27.0% of total payments. Payments for royalties accounted for less than 25% throughout the period under review except for 2005 where royalty payments accounted for 28.4% of total payments.

Figure 10.15: Composition of Receipts in Services Trade, Malaysia 2001 – 2008



	2001	2002	2003	2004	2005	2006	2007	2008
Royalties	1.1	1.1	1.2	2.4	0.9	0.7	0.9	4.2
Contract and Professional Fee	67.6	64.0	62.2	57.6	49.9	49.8	52.8	53.5
Construction and Engineering Fee	31.3	34.9	36.6	40.0	49.2	49.5	46.3	42.3

Year

Source: Bank Negara Malaysia

Figure 10.15 shows the composition of receipts in services trade from 2001 to 2008. The biggest share of receipts composition was in the 'contract and professional' fee with above 50% share throughout 2001-2008, except for 2005 and 2006 where it accounted for 49.9% and 49.8% of total receipts in service trade. The highest share recorded by this receipt segment was in 2001 with 67.6% of total receipts.

Receipts from 'construction and engineering' fees contributed the second largest share in the service trade account. The collections from this service trade component increased steadily throughout the years but dropped slightly in 2008. The receipt from 'construction and engineering' segment showed a marked improvement in 2006 of receipts collected during that year.

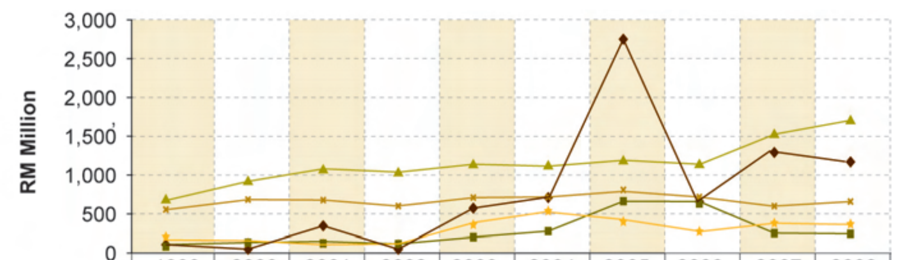
Receipts from royalties remained to be the smallest contributor to the trade in services accounts, contributing less than 5% of the total receipts.

10.3.2 Main Contributors to Payments and Receipts

This section presents payments, receipts and balances by major contributors for royalty, contract and professional charges, and construction and engineering fees.

10.3.2.1 Royalties

Figure 10.16: Royalty Payments, Malaysia (RM Million) 1999 – 2008



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
USA	677.1	928.3	1,089	1,028	1,139	1,119	1,197	1,135	1,521	1,718
JAPAN	568.8	680.1	677.5	601.5	708	698	825	727	604	672
SINGAPORE	212.6	165.9	115	105.8	394	550	419	273	383	394
UK	83.6	140.5	139	125.8	209	282	675	639	259	250
OTHERS	118.5	62	358.8	55	587	721.2	2737	659	1,300	1,184

Year

Source: Bank Negara Malaysia

The United States remained to be the largest country that received royalty payments from Malaysia throughout the period 1999-2008. Royalty payments to this country reached above RM900 million levels since 2000, with the highest royalty payment recorded in 2008 at RM1,718 million. Nevertheless, it was observed that royalty payment to Switzerland in 2005 was higher (RM1,997 million) than the United States. As a note, Switzerland was categorized under "others" as historical data prior to 2005 from this country was not available. Other countries which became Malaysia's major recipients of royalty were Japan, the United Kingdom and Singapore.

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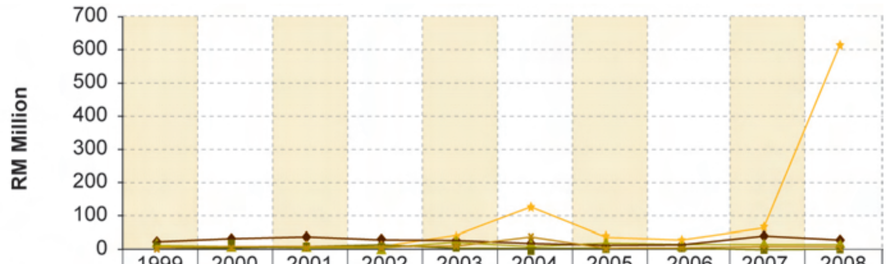
Figure 10.17: Royalty Receipts, Malaysia, (RM Million) 1999 – 2008



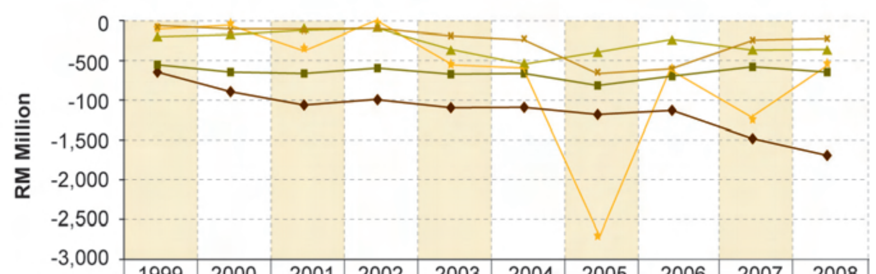
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
USA	23.3	30	38	29.2	26	17.5	11	11	38	27
JAPAN	6.7	14.3	3.2	4.9	2.4	1.7	3	6	1	2
SINGAPORE	11.6	5.3	10.5	6.4	11.3	10.3	22	19	13	18
UK	2.4	2	8.8	11.6	3.4	38	8	10	9	5
OTHERS	4.2	6.8	8	11.4	35	125.4	37	27	68	603

Year

Source: Bank Negara Malaysia

Figure 10.17 above shows receipts in royalty by major technology trade partners for the period 1999-2008. The United States remained as Malaysia's major contributor in terms of royalty receipts, contributing RM27 million or 4.1% of total royalty receipts. The amount represents a decrease of 29% from the previous year. The second largest contributor was Singapore with RM18 million, an increase of 38.5% over the previous year. The third largest contributor, the United Kingdom, recorded a 44% decrease in royalty receipts from RM9 million in 2007 to RM5million in 2006, while Japan recorded a one-fold increase from RM1 million in 2007 to RM2 million in 2008.

Figure 10.18: Royalty Balance, Malaysia (RM Million) 1999 – 2008



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
USA	-654	-898	-1,051	-999	-1,113	-1,102	-1,186	-1,124	-1,483	-1,691
JAPAN	-562	-666	-674	-597	-706	-696	-822	-721	-603	-670
SINGAPORE	-201	-161	-105	-99.4	-383	-540	-397	-254	-370	-376
UK	-81.2	-139	-130	-114	-206	-244	-667	-629	-250	-245
OTHERS	-114	-55.2	-351	-43.6	-552	-596	-2,700	-632	-1232	-581

Year

Source: Bank Negara Malaysia

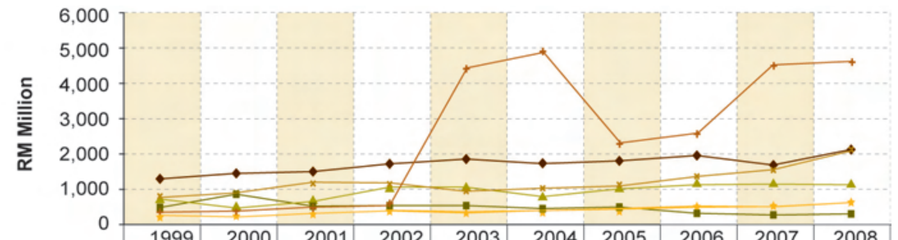
Overall, Malaysia recorded very substantial deficits in royalty payments throughout 1999 to 2008 indicating that Malaysian companies remained dependent on foreign technologies especially from the United States, Japan, the United Kingdom and Singapore.

Most technology trade partners recorded deficits in 2008. The largest were observed in the United States (RM -1,691 million), followed by Japan (RM-670 million), Singapore (RM-376 million) and the United Kingdom (RM-245 million).

10.3.2.2 Contract and Professional Charges

This section presents the payments, receipts and balance of payments for contract and professional charges by selected countries from 1999 to 2008.

Figure 10.19: Payments for Contract and Professional Charges by Country (RM Million), Malaysia 1999 – 2008



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
USA	1,314.4	1,445.4	1,513	1,718.9	1,880.5	1,743.2	1,846	1,958	1,680	2,089
JAPAN	541	846.4	551.4	527.4	520.3	481.2	469	333	279	307
UK	753.9	480.1	674.7	1,061.8	1,065.5	812	1,040	1,166	1,180	1,124
SINGAPORE	806.2	924.6	1,160.7	1,116.4	923.4	999.5	1,123	1,388	1,510	2,077
HONG KONG	253.8	311	334	418.3	373.5	428.5	455	498	542	623
OTHERS	371.4	424	489.4	547.2	4,422.9	4,924	2,297	2,564	4,485	4,566

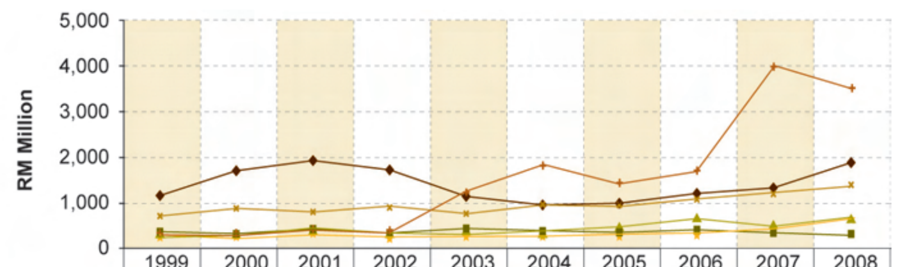
Year

Source: Bank Negara Malaysia

Overall, there has been an increase in the deficit in the 'contract and professional' charges account during the period of 2008. The United States remained to be the largest recipient of the 'contract and professional' fees made by Malaysia. In 2008, total payments to the country increased by 24.3% from RM1,680 million recorded in the previous year.

Singapore was the second largest recipient with RM2,077 million, a double digit increase of 37.6% from RM1,510 million in 2007. Other major recipients were the United Kingdom (RM1,124 million or -4.8%), Hong Kong (RM623 million or +15.0%) and Japan (RM307 million or +10.0%).

Figure 10.20: Receipts for Contract and Professional Charges by Country (RM Million), Malaysia 1999 – 2008



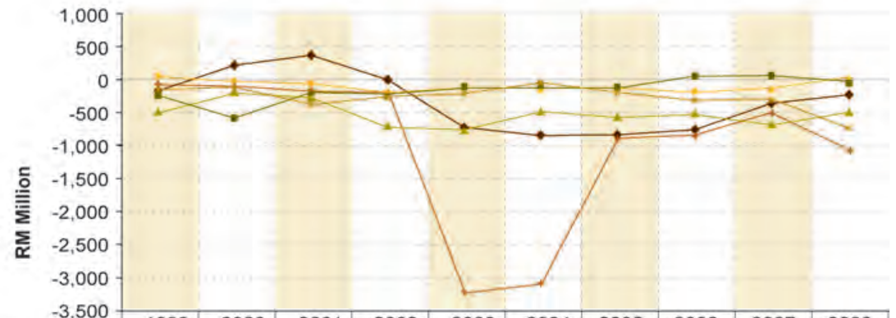
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
USA	1,163	1,671	1,902	1,738	1,145	913.2	994	1,195	1,328	1,877
JAPAN	326.9	250.2	388.3	310.7	405.3	371	363	377	346	272
UK	244.5	313.3	419	326.1	326.3	346	466	637	470	670
SINGAPORE	700.1	853.4	790.3	892.3	734.9	965.2	952	1,071	1,194	1,382
HONG KONG	270	272.3	285.5	245.1	280.3	277.9	308	319	389	635
OTHERS	301.1	343.1	343.2	357.6	1,200	1,820	1,409	1,699	4,002	3,501

Year

Source: Bank Negara Malaysia

The total receipts for 'contract and professional' charges showed an increasing trend from 1999 to 2008 except for 2002 when it dropped 6.5% from 2001. The United States accounted for the largest share in 2008, with 22.5% of total receipts. This was followed by Singapore (RM1,382 million or 16.6%), the United Kingdom (RM670 million or 8.0%), Hong Kong (RM635 million or 7.6%) and Japan (RM272 million or 3.3%).

Figure 10.21: Balance of Payments for Contract and Professional Charges by Country (RM Million), Malaysia 1999 – 2008



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
USA	-151.4	226	388.6	18.9	-735.2	-830	-852	-763	-352	-212
JAPAN	-214.1	-596.2	-163.1	-216.7	-115	-110.2	-106	44	67	-35
UK	-509.4	-166.8	-255.7	-735.7	-739.2	-466	-574	-529	-710	-454
SINGAPORE	-106.1	-71.2	-370.4	-224.1	-188.5	-34.3	-171	-317	-316	-695
HONG KONG	16.2	-38.7	-48.5	-173.2	-93.2	-150.6	-147	-179	-153	12
OTHERS	-70.3	-80.9	-146.2	-189.6	-3223	-3,104	-888	-865	-483	-1,065

Year

Source: Bank Negara Malaysia

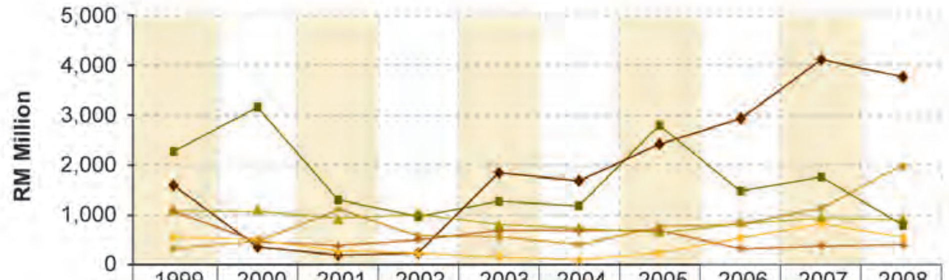
The payments for the 'contract and professional' charges grew faster than the receipts collected, resulting in high deficits in the balance of payments. In 2008, the balance of payments for contract and professional charges declined by 120.5% to RM-1,065 million, from RM-483 million recorded in 2007.

With the exception of Hong Kong which registered trade surplus of RM12 million, all other major trading partners registered trade deficits in contract and professional charges for 2008. The largest were observed in Singapore (RM-695 million), followed by the United Kingdom (RM-454 million), the United States (RM-212 million) and Japan (RM-35 million)

10.3.2.3 Construction and Engineering Fees by Country

This section reports about construction and engineering payments, receipts and balance of payments to the selected countries.

Figure 10.22 Construction & Engineering Payments (RM Million), Malaysia 1999 – 2008



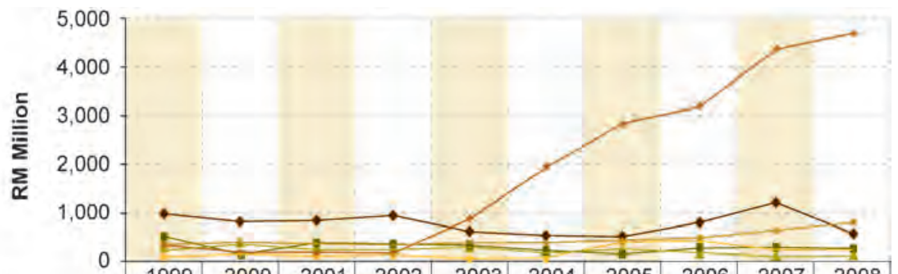
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
JAPAN	2,243	3,151	1,271	925.3	1,251	1,153	2,797	1,463	1,747	757
USA	1,093	1,079	923.2	1,012	794.4	732.5	652	842	962	891
SINGAPORE	306.2	459.5	1,107	537.9	564.2	399.9	711	823	1,120	1,971
GERMANY	517.6	450.3	212.6	203.8	136.4	100.2	222	554	824	512
UK	1,076	397	358	494.5	642.6	656	677	323	371	381
OTHERS	1,604	356.9	141.9	205.6	1,837	1,671	2,440	2,957	4,131	3,754

Year

Source: Bank Negara Malaysia

Figure 10.22 shows the major recipient countries of 'construction and engineering' payment from Malaysia from 1999 to 2008. The largest recipient country in 2008 was Singapore with RM1,971 million, up 76.0% from 2007, followed by the United States at RM891 million (-7.4%), Japan at RM757 million (-56.7%), Germany at RM512 million (-37.9%) and the United Kingdom at RM381million (+2.7%).

Figure 10.23: Construction and Engineering Receipts (RM Million), Malaysia 1999 – 2008



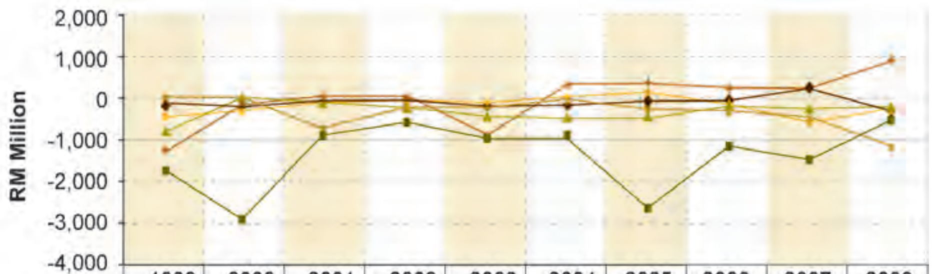
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
USA	974.5	817.9	811.1	922.2	594.8	545.5	530	766	1,220	567
JAPAN	464	172.9	333.4	317.9	268.9	178.7	124	280	235	197
UK	262.9	342	205.5	220.3	247.9	188.7	207	156	104	154
SINGAPORE	316.7	377.9	333.4	317.9	379.5	340.7	413	474	640	769
GERMANY	58.3	156.2	87.8	164.7	42.8	59.7	384	410	231	246
OTHERS	318.8	160.4	141	166.2	870.8	1,950.5	2,773	3,171	4,343	4,659

Year

Source: Bank Negara Malaysia

Figure 10.23 above shows receipts from 'construction and engineering' charges by major country for the period 1999-2008. Singapore overtook the United States in 2008 to become Malaysia's major contributor at RM769 million, 20.2% higher than the previous year. The second major contributor was the United States at RM567 million (-53.5%), followed by Germany at RM246 million (+6.5%), Japan at RM197 million (16.2%), and the United Kingdom at RM154 million (+48.1%).

Figure 10.24: Construction and Engineering Balance of Payment, (RM Million), Malaysia 1999 – 2008



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
USA	-118.2	-261.1	-112.1	-89.6	-199.6	-187	-122	-76	258	-324
JAPAN	-1,778.8	-2,978.1	-937.3	-607.4	-981.9	-974.7	-2,673	-1,183	-1,512	-560
UK	-812.8	-55	-152.5	-274.2	-394.7	-467.3	-470	-167	-267	-227
SINGAPORE	10.5	-81.6	-773.2	-220	-184.7	-59.2	-298	-349	-480	-1,202
GERMANY	-459.3	-294.1	-124.8	-39.1	-93.6	-40.5	162	-144	-593	-266
OTHERS	-1,285.1	-196.5	-0.9	-39.4	-966.2	279.5	333	214	212	905

Year

Source: Bank Negara Malaysia

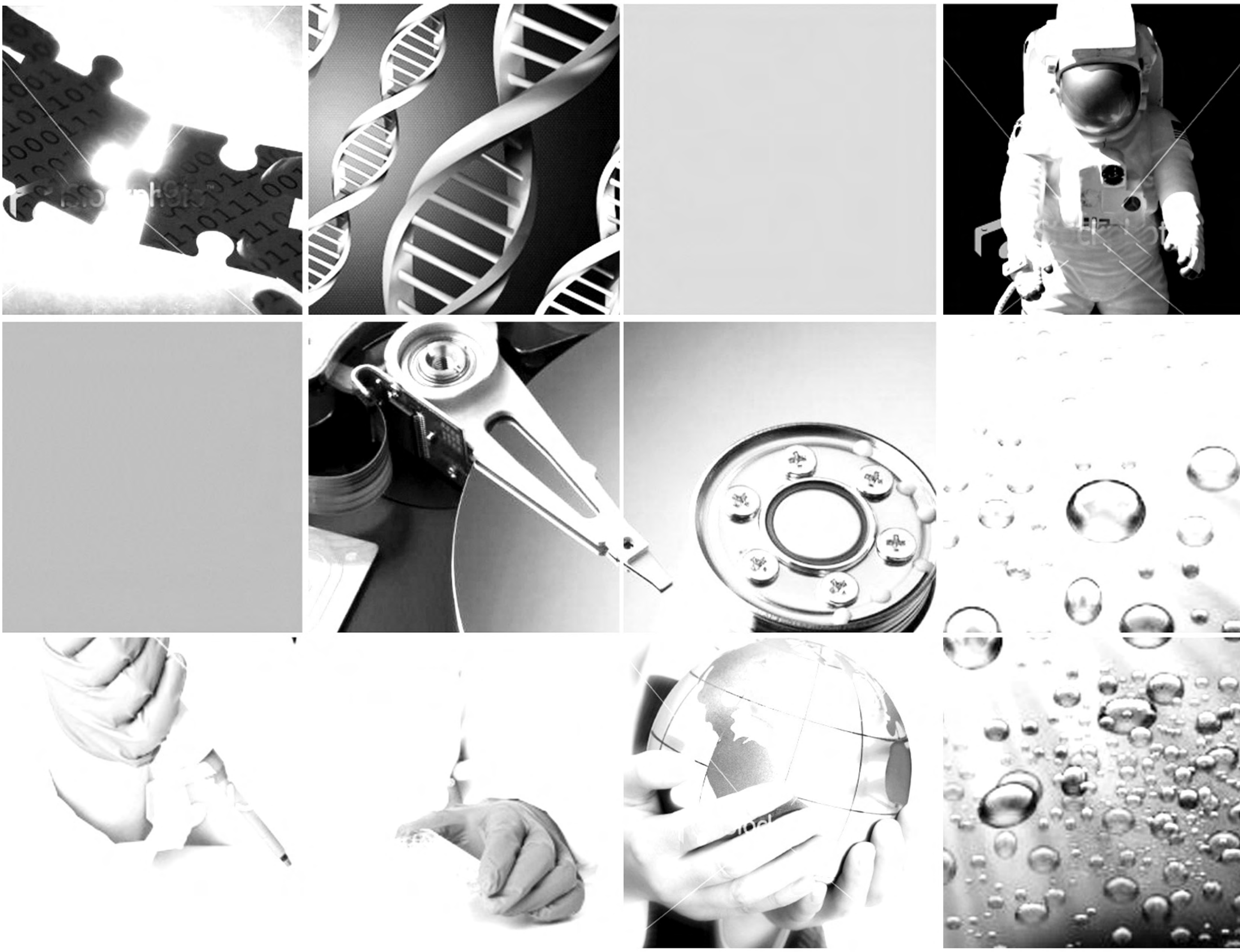
The payments made by Malaysia for 'construction and engineering' grew significantly faster than the receipts collected over the period of 1999 to 2008, resulting in huge deficits in the account. In 2008, Malaysia recorded deficits with most of its major trading countries. The largest were observed in Singapore (RM-1,202 million), followed by Japan (RM-560 million), the United States (RM-324 million), Germany (RM-266 million) and the United Kingdom (RM-227 million).

10.4 CONCLUSION

This chapter presents reports on trade in technology performance by Malaysia. In this report, the amount of trades through import and export of goods from high and medium tech industries were given. Throughout the years, Malaysia is considered performing well in the high tech industry through its surplus in trade balance compared to medium high tech manufacturing industry. The country is considered major importers of medium tech industry.

This chapter also provides an overview of trade in services involving the total payments, receipts and trade balances for the royalties, contract and professional charges and construction and engineering fees for the years of 2001 to 2006. The report indicates the existing of large deficits that the country is facing trade activities within the services sector. Huge amount of payments are observed made to various countries such as United States, Japan, Singapore, and United Kingdom for services payment such as royalties, contract and professional charges and construction and engineering fees.

In the future, Malaysia may need to consider more innovations in science and technology to improve its high and medium tech manufacturing industries, more production of medium tech manufactured goods, and more training in producing skilled professionals to reduce the consistently large deficits acquired through foreign consultancies. The acquiring of services from outside should be made temporary, and the country should make an effort to address these issues in order to become competitive as a developed country.



PUBLICATIONS AND CITATIONS (BIBLIOMETRIC)

Chapter 11

11.1 INTRODUCTION

This chapter provides a bibliometric report on the status of publications and citations of Malaysian researchers in S&T, as well as research conducted in collaboration with Malaysian authors with foreign countries. Publication report can indicate the achievement of research within certain high standard of academic and scientific acceptance among scholarly peers. Such report can provide as an indicator for Malaysian S&T progress and achievements. The increase in the number of publications reflects the increase in the R&D output and the increase in knowledge contributions by the Malaysian researchers.

Besides the publication report, citation analysis and report have been used as a common method of measuring the impact of a particular paper, author, or research area. To achieve a better status in the world of knowledge in science, it is important to monitor the pattern of the country's publication and citation progress. Thus, this chapter intends to outline Malaysian scientists' achievement in order to determine the directions as well as strength and weakness in the Malaysian S&T R&D through publication and citation reports in Malaysia.

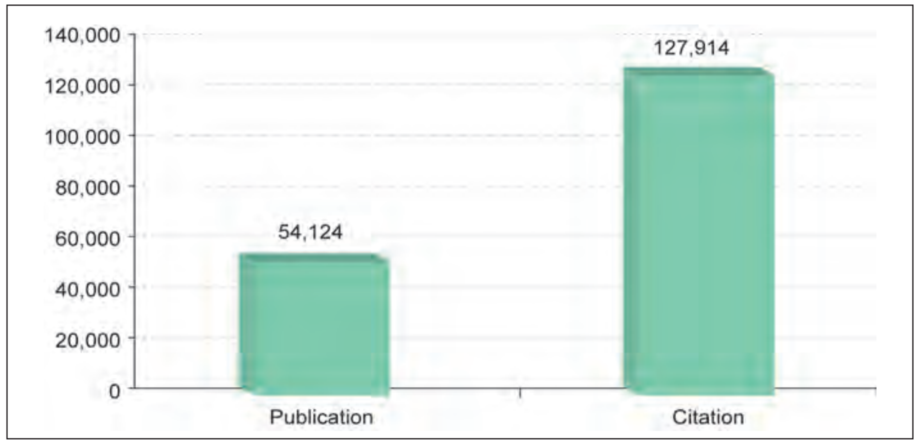
In this report, a bibliometric study was conducted by deriving information on publications and citations generated from the SCOPUS database. The rationale of using Scopus instead of other databases is that it covers over 16,000 peer-reviewed journals from more than 4,000 international publishers. A study by Bosman et al (2006) reported that Scopus covers substantially more journals than Web of Science. It is also suggested that the larger number of journals covered by Scopus is due to the fact that Scopus is oriented internationally. It is corresponding to the fact that more than half of Scopus content is originated from Europe, Latin America and the Asia Pacific region (Scopus.com, 2008). Furthermore, The Times Higher Education Supplement (THES) believes that Scopus gives a better representation for non-English language journals and produced a better result for non-US institutions (Topuniversities.com, 2007).

The study reported in this chapter focused on publication of Science & Technology in Malaysia over the period of 2001- February 2009. The figure in this chapter may differ from that given in other Malaysian Bibliometric study due to the coverage, which is restricted to only Scopus database. Though Scopus has a wider coverage of scientific publications from journal articles to conferences and notes as compared to the Science Citation Index from Thomson Web of Knowledge, many written and published works such as books, conferences and journals commonly published by Malaysian researchers are not indexed in Scopus.

11.2 OVERVIEW OF MALAYSIAN-AUTHORED PUBLICATIONS

An overview of information about Malaysian publication status in S&T can be observed from the figures and tables provided below (Figure 11.1, Figure 11.2, Table 11.1)

Figure 11.1: Publication and Citation of Scientific Papers in Malaysia (1909 – Feb 2009)

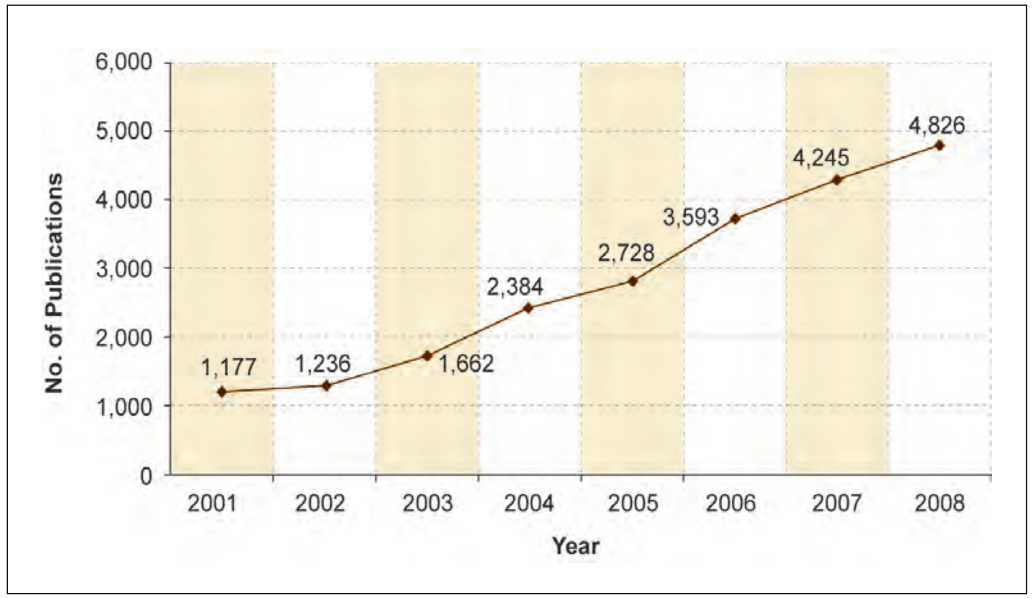


Note: Publication consists of Articles, Conference Papers, Reviews & Notes

Source: Scopus

The total number of Malaysian-authored science & technology publications as indexed in Scopus from the earliest date of 1909-February 2009 was 54,124 (the total number from 2001-February 2009 is 22,276). Accordingly, the number of citations received by Malaysian-authored publications was 127,914 for the same period of time. This indicates that, on average, Malaysian authors have received 2.4 citations per publication throughout the publishing period. Citation counts often being used to determine the impact of a paper on the body of knowledge it represents. However, not all papers are cited by many authors, and the work of one author can be cited by many other works. It is not surprising that seven percent of the authors contribute to 60 percent of the total publications and citations (Lotka's Law in Bibliometric).

Figure 11.2: Publication of Scientific Papers in Malaysia by Year (2001 – 2008)



Source: Scopus

Table 11.1: Summary Table of Publication Growth Rate of Malaysia (2001 – 2008)

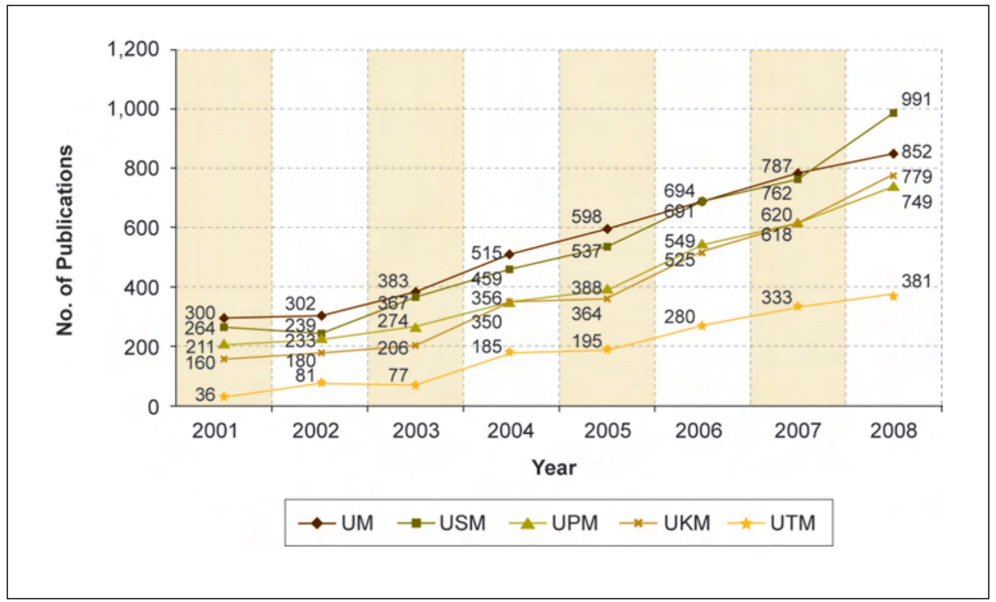
Year	Number of Publications	Growth Rate (%)
2001	1,177	-
2002	1,236	5.0
2003	1,662	34.5
2004	2,384	43.4
2005	2,728	14.4
2006	3,593	31.7
2007	4,245	18.1
2008	4,826	13.7

Figure 11.2 shows the pattern of Malaysian-authored publications in Malaysia from 2001 to 2008. Table 11.1 provides the growth rate of S&T publications per year. Over the years, an increasing pattern can be observed, with significant increase of 43% in 2004. However, fluctuations in the publication rate also occurred with a considerable big gap each year. Year 2002, 2005, 2007, and 2008 have recorded lower publication rates, as compared to year 2003, 2004 and 2006. This indicates the inconsistency in research activities in S&T throughout the years.

11.2.1 Publications by IHLs in Malaysia

The figure and table below provides the distribution of publications by public IHLs from 2001 to 2008. An increasing pattern can be observed throughout the reporting years for all IHLs with UM, USM, UPM, UKM, and UTM leading the figures.

Figure 11.3: Publication of scientific papers in Malaysia by Public Educational Institutions (2001 – 2008)



Note: Publication consists of Articles, Conference Papers, Reviews & Notes

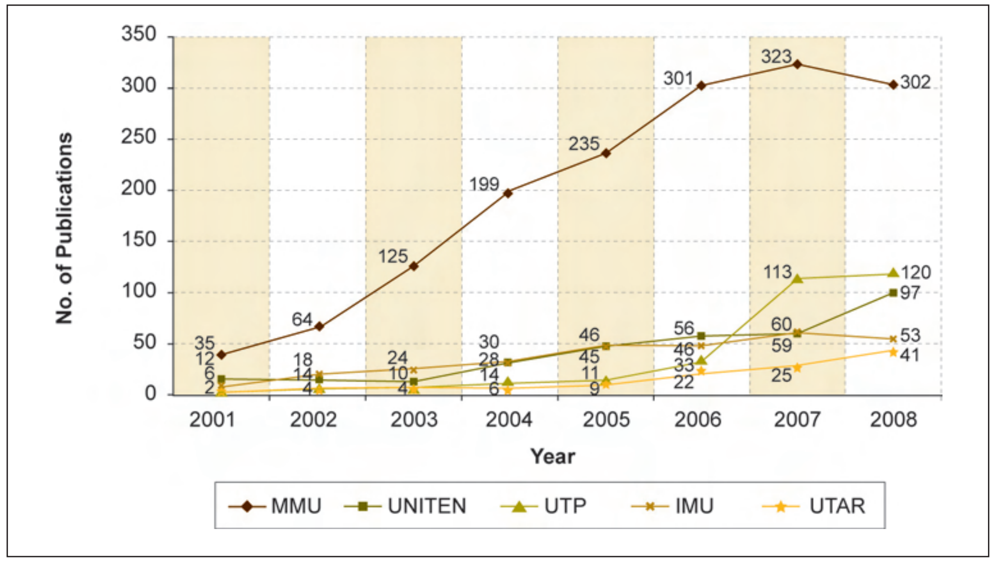
Source: Scopus

Table 11.2: Publication of Scientific Papers in Malaysia by Public Educational Institutions (2001 – 2008)

Institutions	Year								Total
	2001	2002	2003	2004	2005	2006	2007	2008	
UM	300	302	383	515	598	691	787	852	4,428
USM	264	239	367	459	537	694	762	991	4,313
UPM	211	233	274	356	388	549	618	749	3,378
UKM	160	180	206	350	364	525	620	779	3,184
UTM	36	81	77	185	195	280	333	381	1,568
UiTM	26	18	25	67	93	125	154	185	693
IIUM	9	14	36	61	58	135	156	201	670
UMS	16	11	25	44	52	69	124	98	439
UNIMAS	34	29	40	35	38	67	70	69	382
UniMAP	-	-	-	-	-	16	60	57	133
UUM	3	6	10	11	19	22	31	27	129
UMT	2	6	8	11	10	11	37	43	128
UTeM	-	-	-	-	-	-	42	18	60
UTHM	-	1	-	2	14	10	21	18	66
UMP	1	-	-	-	-	1	11	22	35

University of Malaya (UM) has produced the highest number of publications in S&T. From the period of 2001 to 2008, Scopus has indexed a number of 4,428 publications from UM, which consists of articles, conference papers, reviews & notes. Universiti Sains Malaysia (USM) secures the second place with a total of 4,313 publications, followed closely by Universiti Putra Malaysia (UPM) with a total of 3,378 publications, and UKM and UTM. Although the volume of S&T publications seems quite low for other public IHLs, the ratio between the number of publications and the S&T staffs can be much bigger for others.

Figure 11.4: Publication of scientific papers in Malaysia by Private Educational Institutions (2001 – 2008)



Note: Publication consists of Articles, Conference Papers, Reviews & Notes

Source: Scopus

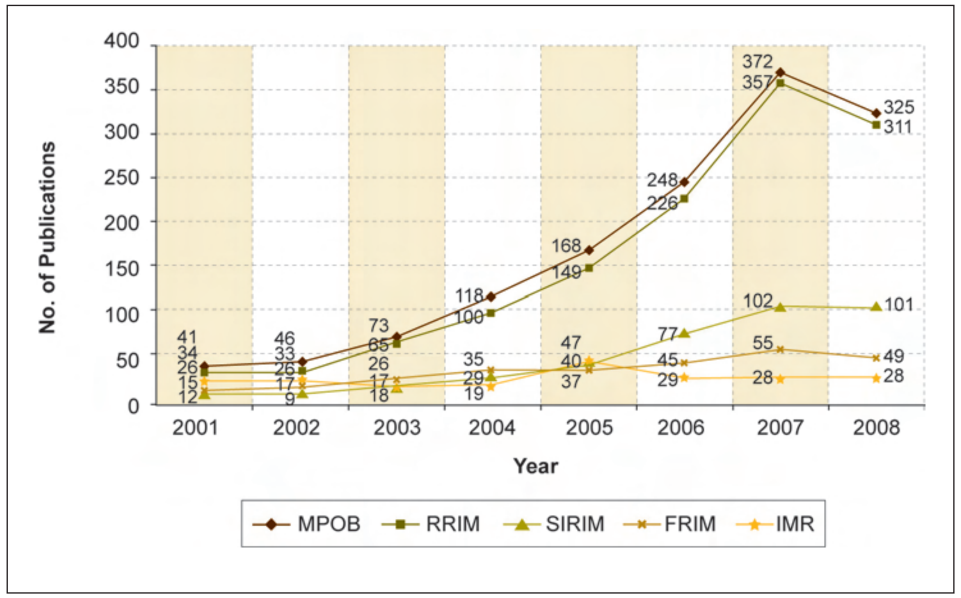
Table 11.3: Publication of Scientific Papers in Malaysia by Private Educational Institutions (2001 – 2008)

Institutions	Year								Total
	2001	2002	2003	2004	2005	2006	2007	2008	
MMU	35	64	125	199	235	301	323	302	1,584
UNITEN	12	14	10	30	45	56	59	97	323
UTP	-	4	4	14	11	33	113	120	299
IMU	6	18	24	28	46	46	60	53	281
UTAR	2	4	4	6	9	22	25	41	113
AIMST	-	1	16	11	13	10	13	28	92
MUST	-	1	4	6	12	9	20	10	62
UNISEL	-	-	-	4	5	10	11	5	35
UniKL	-	-	-	7	1	5	3	7	23
UNITAR	-	-	-	-	1	3	4	5	13

In order to obtain a much wider view on the strength of learning institutions in Malaysia, comparisons of publications between private higher institutions is also important. For this reason, 10 private institutions had been selected for comparisons. From 2001 to 2008, 1,584 publications had been indexed in Scopus under the name of Multimedia University of Malaysia (MMU). The university is doing extremely well by leading all other private institutions far behind. Universiti Tenaga Nasional (UNITEN) came in second with 323 publications, and followed by Universiti Teknologi Petronas (UTP) with 299 publications. Many private institutions are considered young and progressing, and their performances are yet to improve in time.

11.2.2 Publications by Government Research Institutions

Figure 11.5: Publication of Scientific Papers in Malaysia by Government Research Institutes (2001 – 2008)



Note: Publication consists of Articles, Conference Papers, Reviews & Notes

Source: Scopus

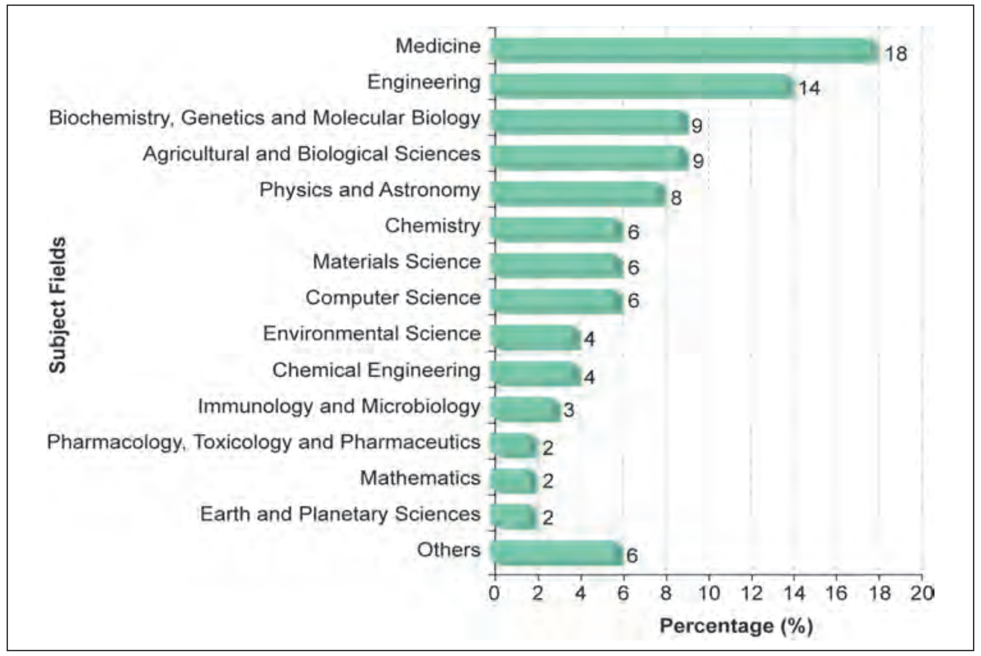
Table 11.4: Publication of Scientific Papers in Malaysia by Government Research Institutes (2001 – 2008)

Institutions	Year								Total
	2001	2002	2003	2004	2005	2006	2007	2008	
MPOB	41	46	73	118	168	248	372	325	1,391
RRIM	34	33	65	100	149	226	357	311	1,275
SIRIM	12	9	18	29	40	77	102	101	388
FRIM	15	17	26	35	37	45	55	49	279
IMR	26	26	17	19	47	29	28	28	220
MINT	21	8	13	18	14	25	28	13	140
MARDI	7	5	10	11	11	31	13	24	112
MIMOS	-	1	2	4	1	1	3	3	15
PORIM	6	4	1	2	-	1	1	-	15

Government Research Institutions (GRI) also contributed significantly to the development of S&T in Malaysia. Their publications in Scopus are considered large enough to mark their importance in knowledge generations within the S&T fields. Figure 11.5 shows the output published by the government research institutions (GRI's) that are indexed in Scopus. For this study, only 9 research institutions had been selected for comparisons. The overall distribution indicates that Malaysia Palm Oil Board (MPOB) is ahead of other agencies in total publications (1,391) from the period of 2001 to 2008. Rubber Research Institute of Malaysia (RRIM) followed closely at the second place with 1,275 publications. The number of publications seems to decrease in 2008 for many GRIs. Publications from MPOB were found peaked in 2007 (372) before dropped by 12.6% in the following year. The same goes to RRIM where the volume of publications peaked in 2007 (357), an increase of 58% compared to the previous year before decreased to 12.9% (311) in 2008. The drop in total publications may be due to the drop in the public support during the fiscal year 2007.

11.2.3 Publications by S&T Subject Fields

Figure 11.6: Percentage of Scientific Publication in Malaysia by Subject Fields (1909 – Feb 2009)



Source: Scopus

Figure 11.6 shows the publication of scientific papers in Malaysia by subject fields for the period of 1909 to February 2009. The report indicates that the field of medicine has been the leader in contributing towards S&T publications in Malaysia. This is followed by engineering, biochemistry, genetics and molecular biology, agricultural and biological sciences, physics and astronomy, chemistry, and etc. This pattern of publications by subject fields indicates that the direction of S&T in Malaysia is more towards medical sciences, engineering, biotechnology and agriculture-based research.

Table 11.5: Publication of Scientific Papers in Malaysia by Subject Fields (1909 – Feb 2009)

Subject	Publications (1909 – Feb 2009)	Publications (2001-Feb 2009)
Medicine	9,711	4,652
Engineering	7,355	6,011
Biochemistry, Genetics and Molecular Biology	5,046	3,235
Agricultural and Biological Sciences	4,636	2,642
Physics and Astronomy	4,370	3,313
Chemistry	3,466	1,881
Materials Science	3,303	2,400
Computer Science	3,056	2,819
Environmental Science	2,282	1,350
Chemical Engineering	1,964	1,497
Immunology and Microbiology	1,808	NA
Pharmacology, Toxicology and Pharmaceutics	1,332	NA
Mathematics	1,307	NA
Earth and Planetary Sciences	1,304	NA
Energy	870	NA
Multidisciplinary	729	NA
Decision Sciences	332	NA
Veterinary	329	NA
Neuroscience	256	NA
Health Professions	237	NA
Dentistry	237	NA
Nursing	194	NA
Total	**54,124**	**29,800**

Note: Publication consists of all document types

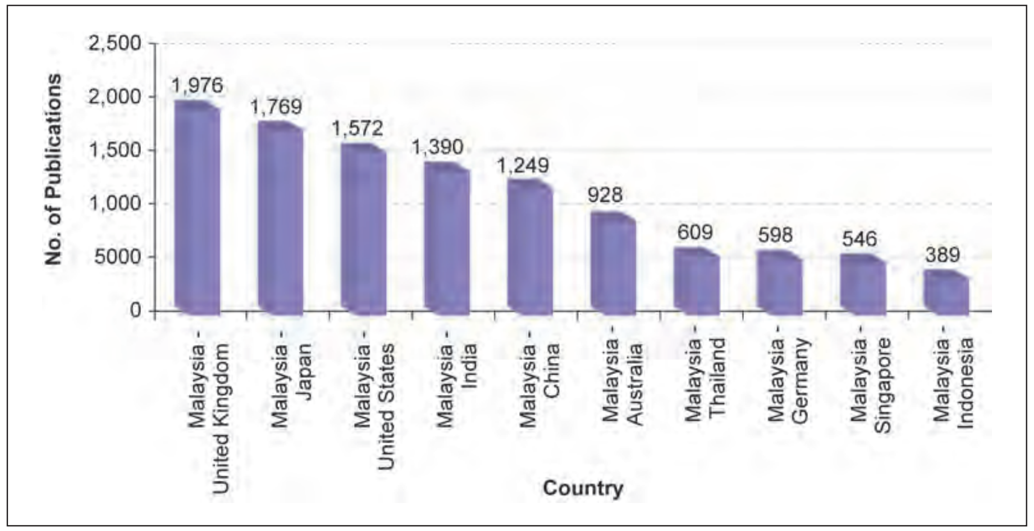
Source: Scopus

Table 11.5 shows the distribution of publications for all 22 fields of research indexed in Scopus, and top ten fields throughout the duration of 2001 to Feb. 2009. The information from the table reveals that the trend in research and publications in Malaysia seems to divert from medical science to engineering and from biochemistry, genetics and molecular biology to other fields such as computer science, and physic and astronomy.

11.2.4 Countries that Collaborated with Malaysia-Based Author

The interdependent research relationships between authors from different countries can enable both entities to sustain growth in their areas. Research collaboration can also strengthen knowledge transfer and flow from experts in the more developed countries to a developing country such as Malaysia. Therefore, another way of measuring the strength in publication of Malaysia is by monitoring collaboration between Malaysia-based authors with authors from different countries.

Figure 11.7: Countries that Collaborated with Malaysia-Based Authors Sorted by Total Number of Publications (2001 – Feb 2009)



Note: Publication consists of Articles, Conference Papers, Reviews & Notes

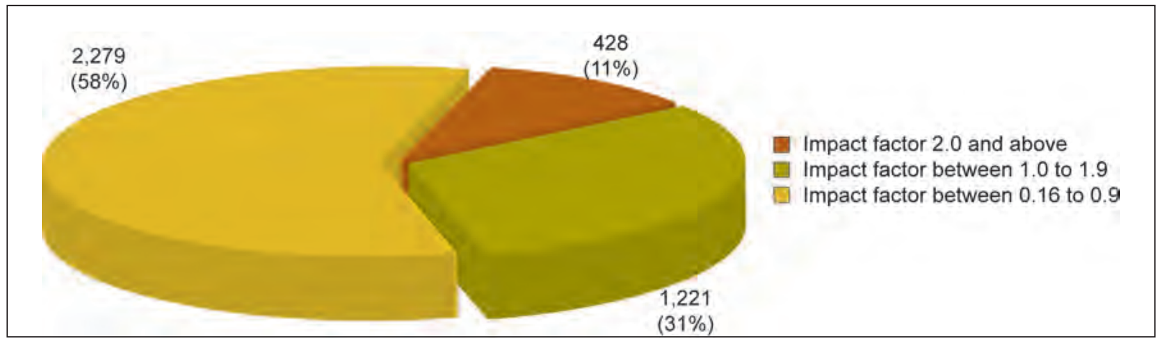
Source: Scopus

Figure 11.17 shows the number of collaborations that occur between Malaysian-authors and foreign experts from different countries from 2001 to February 2009. Collaboration between United Kingdom (UK), Japan, and United States, were among the highest so far, with Malaysian-based authors. Researchers from new economic power in Asia, India and China also have been working closely with Malaysian-based authors in producing publications. Collaborations between the two sides have produced a total of 1,390 and 1,249 publications within the same period of time. In the ASEAN region, Malaysian researchers have also established a good bonding with academicians from neighboring countries, namely Thailand, Singapore and Indonesia. Such collaborations have produced 609, 546 and 389 publications respectively.

11.2.5 Publications in High Impact Journal

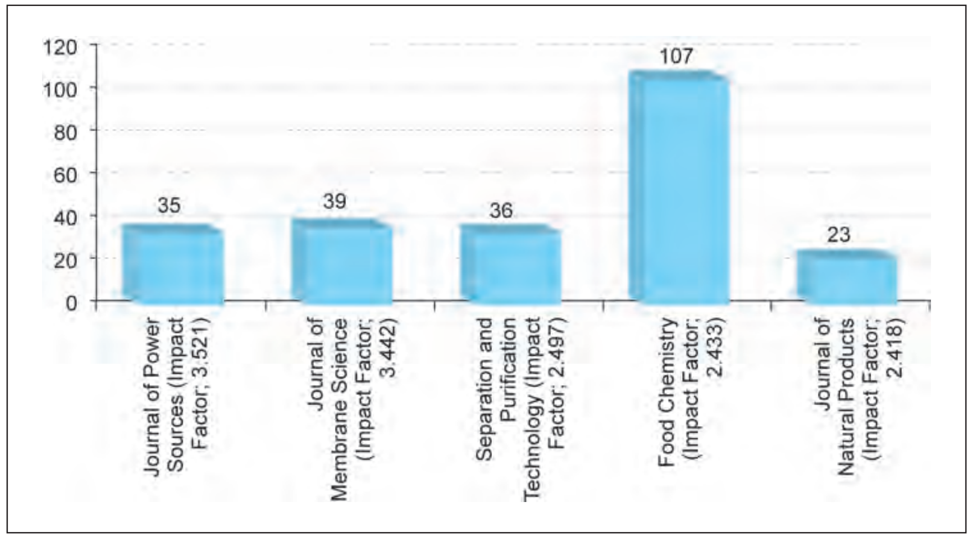
About 161 journals and conferences have been retrieved from the published articles, with the Malaysian-based author affiliations, of which 72 journals have impact factors calculated with a maximum factor of 3.52 and a minimum factor of 0.16. Impact factors are calculated based on the total number of citations from articles published in a journal within two years period divided by the total number of articles published in that particular journal within the same period. Total Malaysian-based publications produced in these impact journals are 3,928 with a shared percentage of 18% from total publications (22,276) produced from 2001 – Feb. 2009. Figure 11.8 shows the percentage distribution of high impact journals according to different level of impact factor. The finding indicates the low focus given by the Malaysian authors in publishing in high impact journals.

Figure 11.8 Percentage Distribution of Publication in Impact Journals



Source: Thompson JCR 2007

Figure 11.9: Quantity of Papers Published in High Impact journal (2001 – Feb 2009)



Sources: Scopus

Table 11.6: Publications in Impact Journals

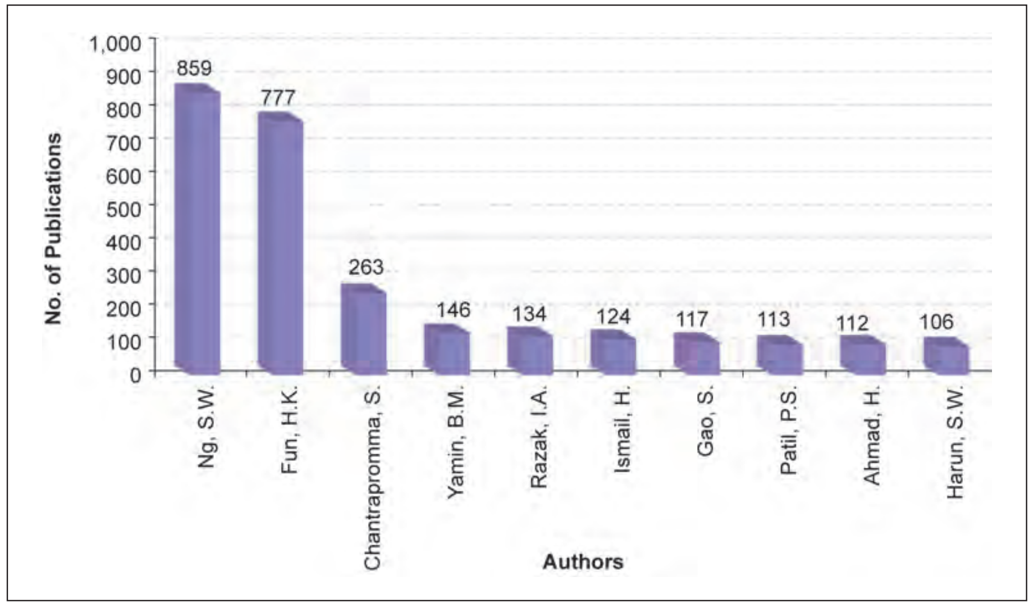
Journal	No. of Publications	Impact Factor
Journal of Power Sources	35	3.521
Journal of Membrane Science	39	3.442
Separation and Purification Technology	36	2.497
Food Chemistry	107	2.433
Journal of Natural Products	23	2.418
Phytochemistry	20	2.417
Sensors and Actuators B Chemical	18	2.331
Bioresource Technology	49	2.18
European Polymer Journal	20	2.113
Aquaculture	36	2.081

Five selected journals with impact factors 2.0 onwards are shown in Figure 11.9 above. On examining the figure, it can be observed that a good number of publications in S&T from Malaysia have been widely accepted for publication at many high impact journals. However, given the large number of total publications (22,276 articles) by Malaysian-based authors, the number of publications in high impact journals is still considered low. The distribution of articles in top 10 high impact journal (from the 161 journal analyzed) can be found in Table 11.6.

11.2.6 Publication by Individual Authors or Scientists

Analysis of individual authors provides the list of 159 authors with the highest published articles of 859 and the lowest articles of 31 (see appendix) with a total of 9,532 number of publications. From the total, about one third of the authors have produced about 60% of the total publications. Figure 11.10 below shows the distribution of top ten authors and the number of articles published under their names from 2001 to February 2009.

Figure 11.10: Publication of Scientific Papers in Malaysia by Individual Scientist (2001 – Feb 2009)



Note: Publication consists of Articles, Conference Papers, Reviews & Notes

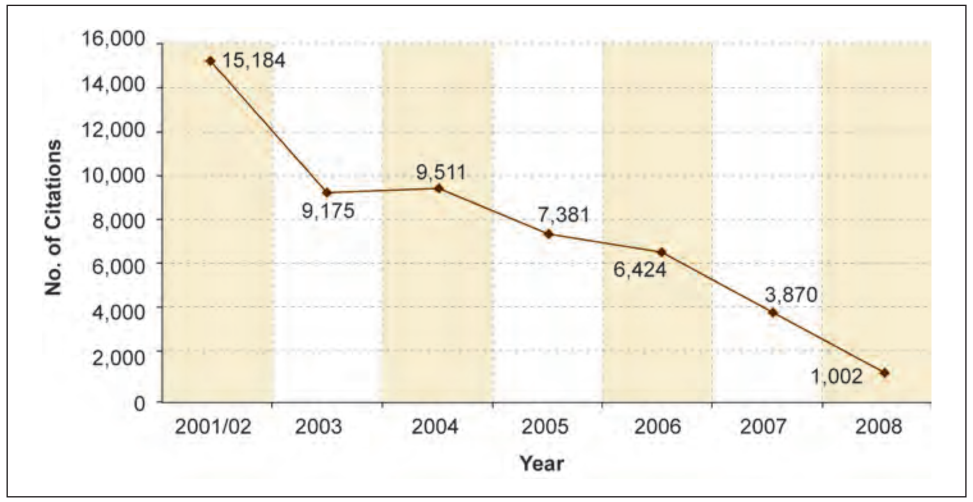
Source: Scopus

Based on Figure 11.10 above, Ng Seik Weng of Universiti Malaya (UM) has produced the highest number of publications. The award winner of Malaysia Toray Science Foundation (MTSF) prize 2000 secure the top place with 859 published articles. On the other hand, Fun Hoong Kun of Universiti Sains Malaysia (USM), who was awarded the most productive scientist in Malaysia for the period 1955 to 2002 (Bibliometric Study 2003), came close at second place with 777 of his publications indexed in Scopus. Other individual authors are found following far behind from these two authors.

11.3 OVERVIEW OF CITATIONS OF MALAYSIAN-BASED AUTHORS

Analysis of citations was conducted to find out how far Malaysia performs in S&T in terms of contribution to bigger body of knowledge, as well as in the generation of new knowledge from the published research output. As of 2008, the total number of citations for Malaysia-based author publications was recorded at 127,194.

Figure 11.11: Number of Citation Malaysian-based Authors (2001 – Feb 2009)



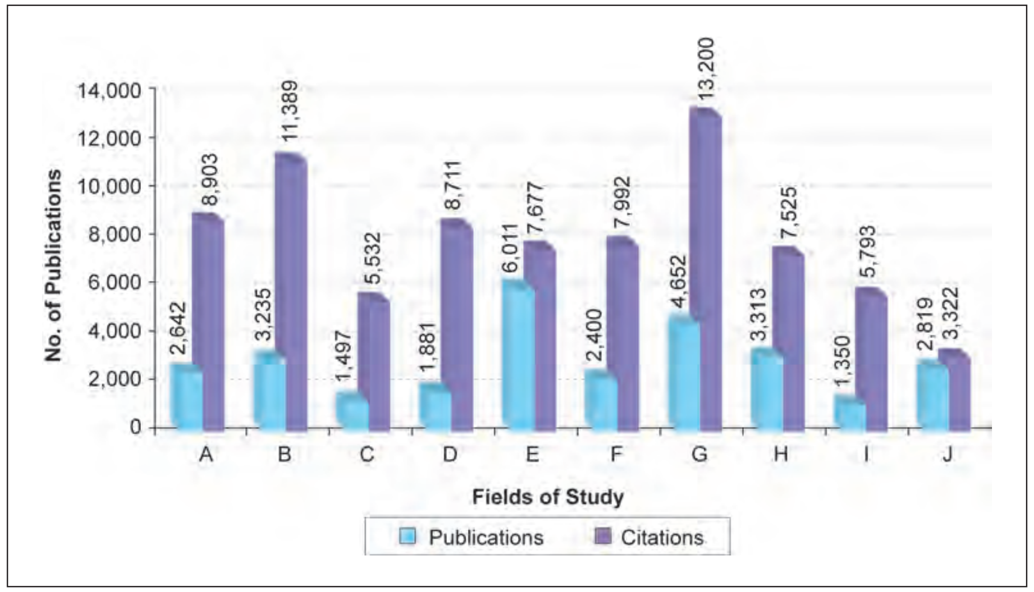
Source: Scopus

Citation counts were also generated from the period of 2001 to 2008. The count was recorded the highest for publications in 2001 and the lowest for publications in 2008. The decreasing pattern is considered normal, since publications can take years before they be cited and counted. On average, most articles will take within 2-3 years at the earliest before they can give any impact on other research and publications, in which citations can be made. This explains the decreasing patterns by years as illustrated in the figure.

11.3.1 Citations by Subject Fields

Citation analysis was conducted on eight major subject fields to find out which subjects have given the most impact to the re-generation of knowledge through publications. The calculation of subject citation ratio allows us to know the impact (on average) of each subject field through citations per publication.

Figure 11.12: Number of Citations Received in Malaysia by Subject Fields (2001 – Feb 2009)



Source: Scopus

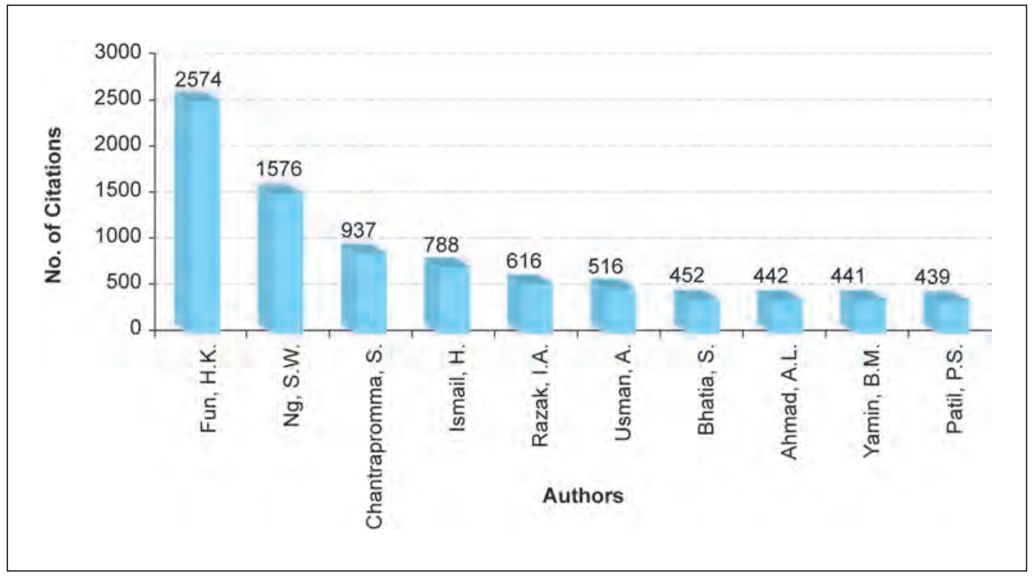
Table 11.7: Ratio of Citation over Publication

Subject Fields	Alphabet	Ratio of Citation : Publication
Agricultural and Biological Sciences	A	3 : 1
Biochemistry, Genetics and Molecular Biology	B	4 : 1
Chemical Engineering	C	4 : 1
Chemistry	D	5 : 1
Engineering	E	1 : 1
Materials Science	F	3 : 1
Medicine	G	3 : 1
Physics and Astronomy	H	2 : 1
Environmental Science	I	4 : 1
Computer Science	J	1 : 1

Figure 11.12 shows the distribution of citations received by Malaysian-based author across subject fields for the year 2001 till February 2009. Table 11.7 provides the ratio of citations over publication for each top ten subject fields. The report indicates that the field of Medicine has received the highest number of citations (13,200 citations), followed by Biochemistry, Genetic & Molecular (11,389) Agriculture & Biological Science (8,903), and etc, with computer science receiving the lowest number. The high total citations may not reflect the high impact of particular subject field publications on the generation of knowledge. Based on the citation to publication ratio, the field of chemistry has had the highest score by achieving 5 citations for each published articles on average. This is followed by biochemistry, genetics and molecular biology (4:1), chemical engineering (4:1), environment science (4:1), and so on, with engineering and computer science scored the lowest in the ratio (1:1). Although engineering is among the highest in total publications, the field is considered the lowest in giving impact to knowledge generations compared to other fields. In other words, Chemistry has been the most influential fields of research in Malaysia in giving impact to knowledge generation worldwide.

11.3.2. Citations by Individual Authors

Figure 11.13: Number of Citations by Individual Scientist (2001 – Feb 2009)



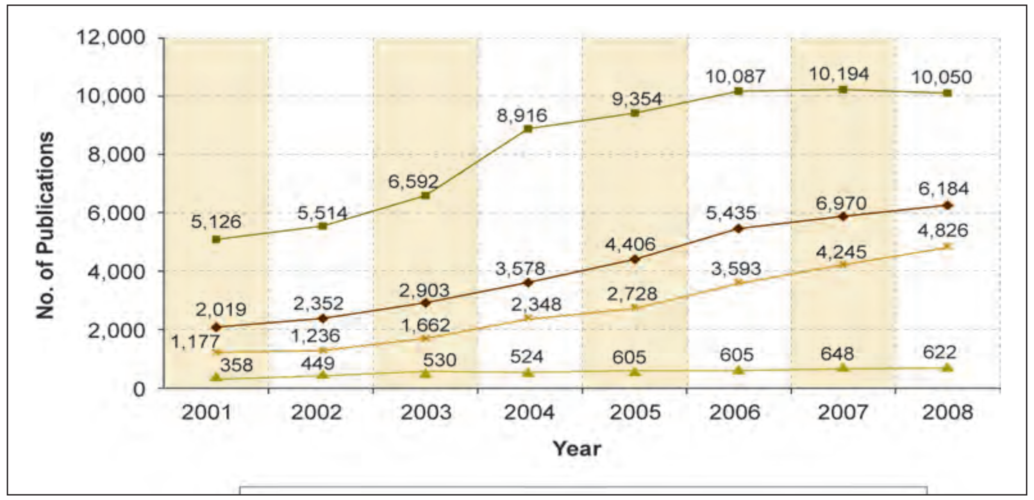
Source: Scopus

Figure 11.13 shows the distribution of citations by individual authors. The work of Fun Hoong Kun from Universiti Sains Malaysia (USM), was cited the most among the top 10 Individual Scientists' published work. Even though he was not recorded as the most productive author (by number of publications indexed in Scopus) in Malaysia, his works have given more impact to knowledge development than those of other individual authors. Next is Ng Seik Weng of Universiti Malaya (UM), whose citation count was recordet at 1,576 for his published works. For the same period of time, Suchada Chantrapromma, Ismail H. and Ishak Abdul Razak received 937, 788 and 616 citation points respectively. Out of 159 authors derived, it is expected that only a few would received citations more than 10 times.

11.4 INTERNATIONAL COMPARISON: ASEAN REGION

In this particular section, international comparisons of publications from several selected ASEAN countries are made. Such comparisons are important to know where Malaysia stands among these neighboring countries and as a measure of Malaysian S&T performance indicator against these other countries.

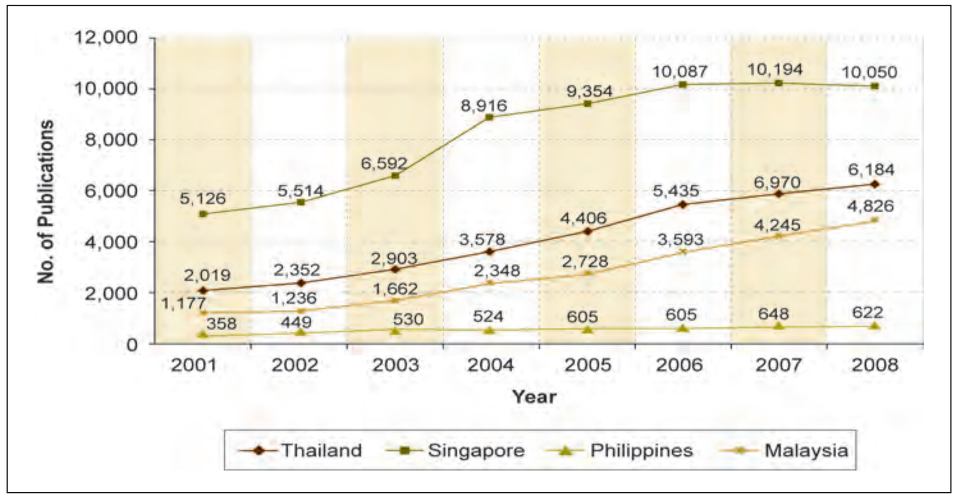
Figure 11.14: Comparisons of Publications Between Selected ASEAN Countries (2001 – Feb 2009)



Note: Publication consists of all document types

Source: Scopus

Figure 11.15: Publication of Scientific Papers in Selected ASEAN Countries (2001 – 2008)



Note: (Malaysia, Singapore, Thailand & Philippines) Publication consists of all document types

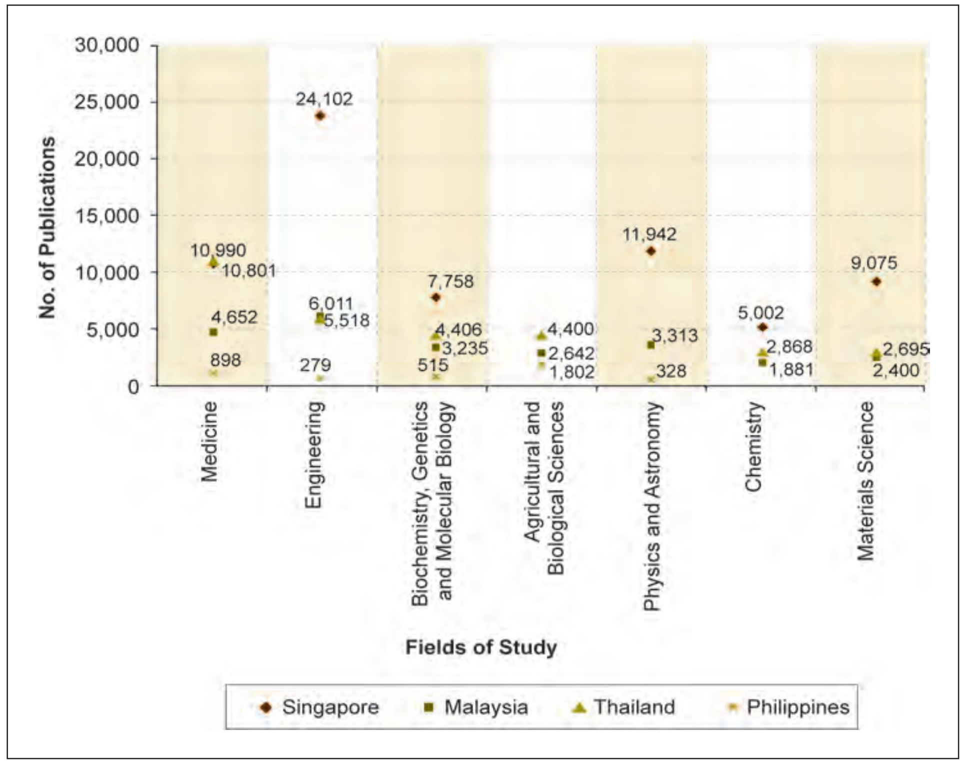
Source: Scopus

Table 11.8: Summary Table of Publication Growth Rate by Countries' (2001 – 2008)

Country	Number of Publications		Growth (%) from 2001-2008
	2001	2008	
Singapore	5,126	10,050	96.1
Thailand	2,019	6,184	206.3
Malaysia	1,177	4,826	310
Philippines	358	622	73.7

Figure 11.14 and 11.15 shows that Malaysia's publication achievement is third in ASEAN countries after Singapore and Thailand. Given its third position, the growth rate is however, has been remarkably high (310%) from 2001 to 2008 compared to Singapore, Thailand and the Philippines (see Table 11.8). Thailand's growth rate for publication of scientific papers during the same period of time was 206.3%. Even though Singapore was producing the largest volume of publications in the ASEAN region, its growth rate (96.1%) was much lower than both Malaysia and Thailand. In 2008, Singapore recorded a decrease in the number of publications produced as compared to 2007, while Malaysia and Thailand continue to grow significantly higher in total number of publications.

Figure 11.16: Comparison of Publication Between Selected ASEAN Countries by Fields of Study (2001 – Feb 2009)



Note: (Agricultural & Biological Sciences) Publications for Singapore is not known

(Physics & Astronomy) Publications for Thailand is not known

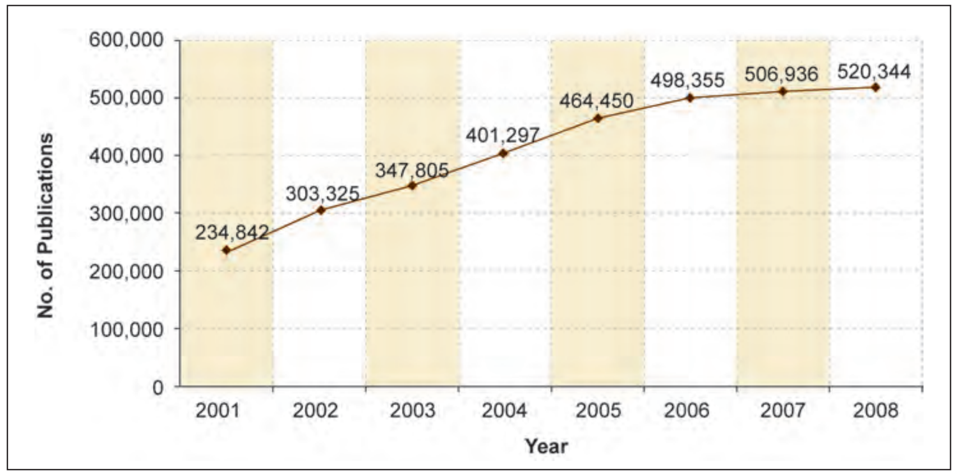
(Chemistry & Material Science) Publications for Philippines is not known

Source: Scopus

Another useful analysis is to compare the volume of papers on selected research fields from Malaysia with those from other neighboring countries. Based on Figure 11.16, huge gaps can be observed between publications from Singapore and all other ASEAN countries in fields such as engineering, physics & astronomy and material science. In most cases, Malaysia falls in the third place accept in the field of engineering, and physics and astronomy, where the number of publications is much higher than Thailand. Malaysia managed to produce a number of 6,011 engineering-related publications, 18,091 less than Singapore (24,102), but much higher than Thailand (5,518) and the Philippines (279).

11.5 INTERNATIONAL COMPARISON: THE WORLD

Figure 11.17: Publication of Scientific Papers in the World by Year (2001 – 2008)



Note: Publication consists of all document types

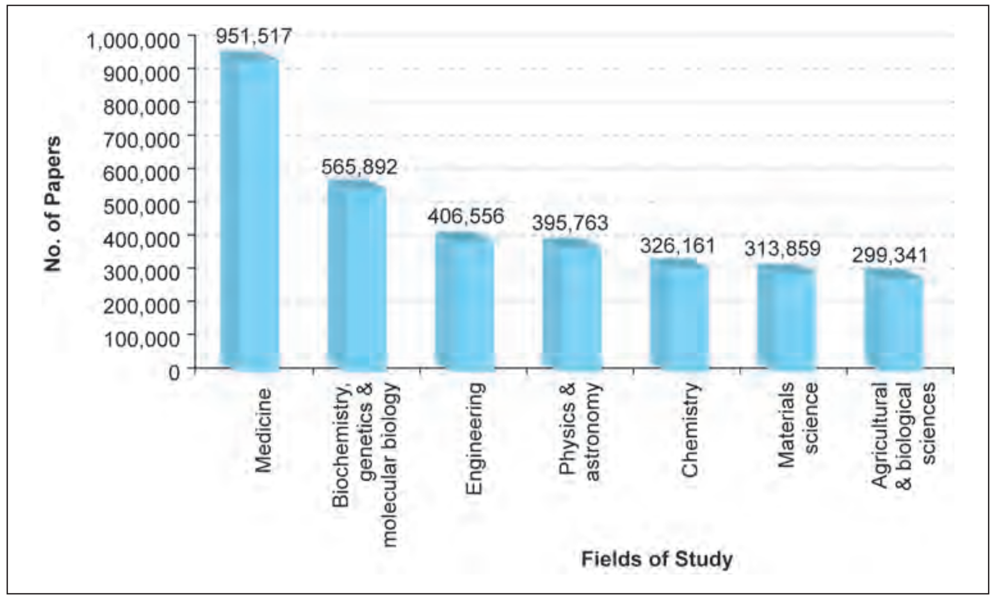
Sources: Scopus

Table 11.9: Publication of Scientific Papers in The World by Year (2001 – 2008)

Year	Number of Publication	Growth Rate (%)
2001	234,842	-
2002	303,325	29.16
2003	347,805	14.66
2004	401,297	15.38
2005	464,450	15.74
2006	498,355	7.30
2007	506,936	1.72
2008	520,344	2.64
Total	3,277,354	

Scopus indexed approximately 3,277,354 publications for the period of 2001 to 2008 with the average of 409,669 publications each year from all over the World. The S&T publication output grew from approximately 235,000 in 2001 to nearly 521,000 in 2008, with an increase of 122%. The most remarkable is the growth of publications in 2002 (compared to 2001) where the number of publications increased by 29.16%, from 234,842 in 2001 to 303,325 publications in 2002. The percentage of growth dropped to 14.66% in 2003, but increased marginally in 2004 and 2005 to 15.38% and 15.74% respectively (see Figure 11.17 and Table 11.9). The rate of growth slowed down, however, from 2006 onwards. The period of 2006-2007 shows the slowest growth rate in the World publications where it recorded only 1.72% increase compared to the previous year.

Figure 11.18: Publication of Scientific Papers in the World by Subject Fields (2001 – Feb 2009)



Note: Publication consists of all document types

Sources: Scopus

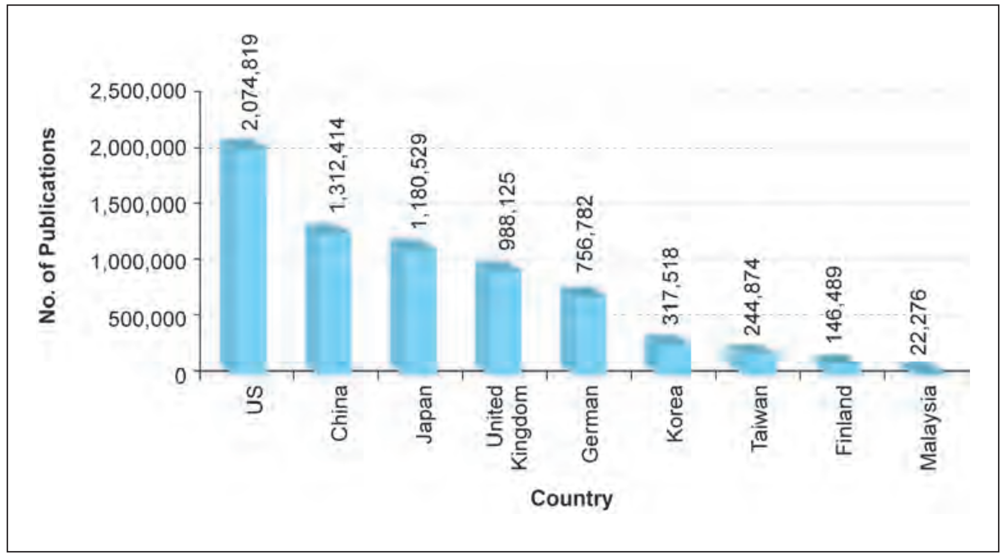
Table 11.10: Percentage of Malaysian Contribution to World Papers

Fields of Study	World	Malaysia	% Contribution to World papers
Medicine	951,517	4,652	0.49
Biochemistry, genetics & molecular biology	565,892	3,235	0.57
Engineering	406,556	6,011	1.48
Physics & astronomy	395,763	3,313	0.84
Chemistry	326,161	1,881	0.58
Materials science	313,859	2,400	0.76
Agricultural & biological sciences	299,341	2,642	0.88

In terms of global output by fields of research, publications in medicine (951,517) received the warmest response from researchers around the globe (Figure 11.18). Contribution of papers in the field of medicine is almost twice as much as the papers in biochemistry, genetics & molecular biology (565,892). Papers in engineering shared third place (406,556) in world S&T publications, followed by physics & astronomy (326,161).

Table 11.9 shows the contribution of Malaysia-based authors in S&T to the world publications. Based on the table, Malaysia contributes the highest in engineering-related publications with percentage contribution to World papers of 1.48%. This is followed by its agricultural and biological sciences, physics and astronomy, material sciences, chemistry, biochemistry, and medicine.

Figure 11.19: Comparisons of Publication Between Selected Countries (2001 – Feb 2009)



Note: Publication consists of all document types

Source: Scopus

Figure 11.19 shows the distribution of 8 selected countries in the world in terms of total scientific publication outputs for the period of 2001-Feb 2009. As depicted in the figure, the United States of America (US) has produced the largest number of scientific publications at 2,074,819, which is equivalent to 63% of the world publications. China came in second place with 1,312,414 publications, followed closely by Japan with 1,180,529 publications. Malaysia only managed to produce 22,276 publications with an equivalent of only 1% shared percentage of world publications. It is so small even compared to Taiwan and Finland.

11.6 CONCLUSION

This chapter provides a report on the bibliometric study as an indicator of S&T progress in Malaysia. The focus of this chapter has been given on publication and citation counts of Malaysia-based authors using Scopus indexed database. Based on the analysis, total publications and citations have been derived from the earliest publication date of 1909 to present (Feb. 2009). Most of the reports based on authors and subject fields were also derived from the period of 2001 to Feb. 2009.

The reports have revealed that publications of Malaysian-based authors are increasing at a different growth rate each year, with the peak of its growth in 2004. Malaysia managed to increase its publication four times higher within the 2001-2008 periods. Most of the publications in Malaysia were produced by IHLs with six major universities (UM, USM, UPM, UKM, MMU, UTM) taking the lead. Several GRIs such as MPOB and RRIM are also active in producing research output through publications.

Within the field of S&T, medicine has been traditionally a popular field, by taking the lead in the total number of publications as indexed in Scopus (overall). However, analysis of later time period (from 2001-Feb2009) indicates other applied S&T fields are beginning to take the lead in publications such as engineering and computer science. Analysis of publications in high impact journals indicates the low publication count among the Malaysian-based authors who published in these journals. In this regard, more awareness and reward systems are needed to encourage publication of research output in this type of journals.

With the large number of publications produced by Malaysian-based authors, Lotka's Law in Bibliometric still apply, where only a small percentage of authors are producing more than 60% of publication counts in Malaysia. Ng Seik Weng and Fun Hoong Kun alone have been producing about 1,636 publications in Malaysia through their attachment with University of Malaya and Universiti Sains Malaysia.

Analysis of citations provides information on which S&T subject fields in Malaysia has given the most impact to the generation of new knowledge and research. Although engineering and medicine have recorded the highest publication counts, the fields of chemistry, biochemistry, chemical engineering, and environmental science have been reported to have the biggest impact on knowledge generation. This is due to the high ratio in citations per publication rate achieved.

In ASEAN region, Malaysia is ranked third after Singapore and Thailand in terms of total number of publications. However, Malaysia recorded the highest overall growth rate in number of publications within 2001-2008 period compared to other ASEAN countries.

In global comparisons, publication of scientific papers by Malaysian-based author is still considered very small compared to other countries. Malaysian however contributes a noticeable amount of publications in the field of engineering with 1.5% of world outputs in the area. More continuous efforts by all parties are needed in order to promote knowledge generation in S&T within the country. Analysis of publications and citations has been a good measure for looking at how far Malaysia stands as a consumer and a producer of knowledge. In order to become a developed country, Malaysia needs to be independent in terms of research and development, and capable of generating knowledge, based on continuous research and publication.

PUBLIC AWARENESS, KNOWLEDGE AND ATTITUDE TOWARDS SCIENCE AND TECHNOLOGY

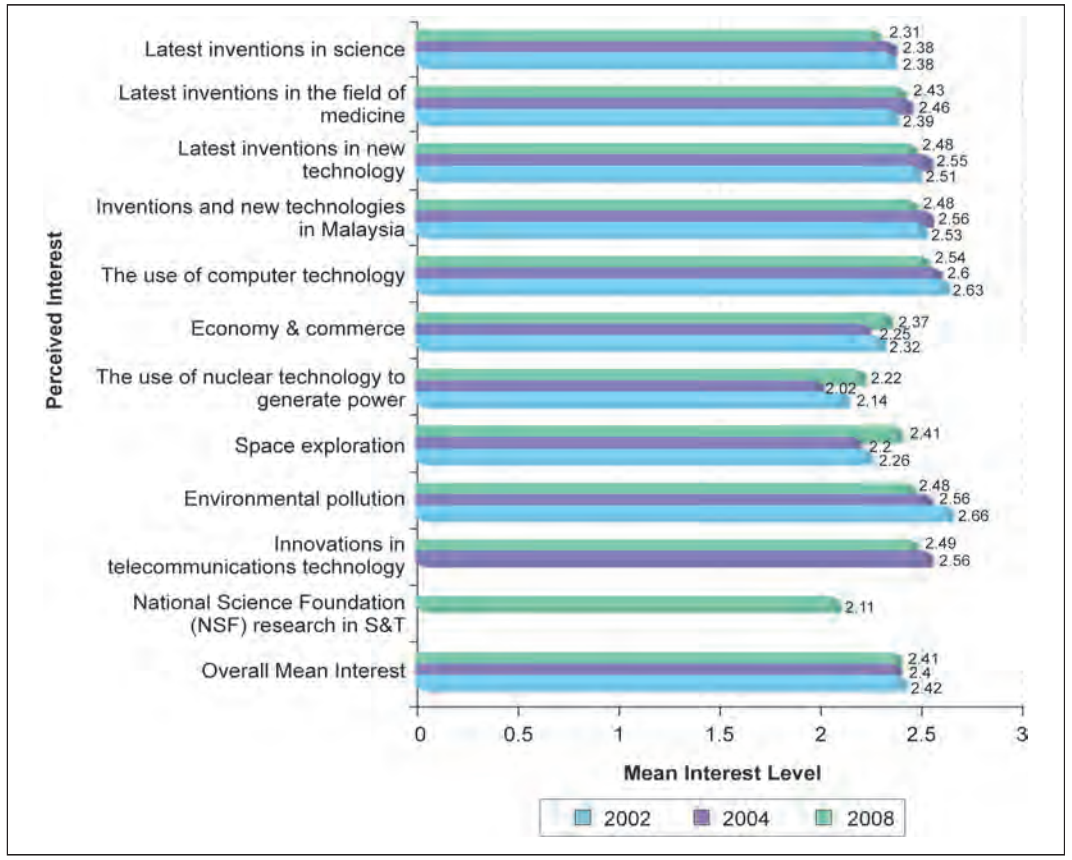
Chapter 12

12.1 INTRODUCTION

Science and technology can explain and solve problems within wide areas of field of knowledge and improves significantly the way of life for billions of people on earth who values its importance. Advances in science and technology can improve a society through better quality of life and better standard of living. Such society can be more competitive and can have better chance of survival in the face of global difficulty. Measures need to be taken to ensure that the society is aware how important S&T is in facing with global competition. In addressing such measures, the Ministry of Science, Technology and Innovation (MOSTI) has commissioned public opinion research, since 1994, to measure awareness and attitudes towards science and technology across a number of key issues. The 2008 survey is the seventh in the series of its kind and conducted on 18,447 respondents throughout Malaysia. The number of respondents is much higher than the 2004 study (6,896), allowing the findings to be better generalized to the Malaysian population. The data were collected through face-to-face interviews, guided by the structured questionnaire and conducted by trained enumerators. The result of this survey is important because in order for science to advance, members of society need to, first of all be scientifically literate (Public Awareness of S&T, 2004), and able to participate in various S&T activities that can promote growth in innovation. Thus, the public opinion survey needs to be conducted in order to measure the awareness of the society, through which actions can be taken for its improvement.

12.2 PERCEPTION OF INTEREST IN SCIENCE AND TECHNOLOGY

Figure 12.1: The Public's Perception of Interest in S&T Issues – Data Series



Notes:

(2002) Interest Level: 4=Interested, 3=Moderately Interested, 2=Slightly Interested, 1=Not Interested

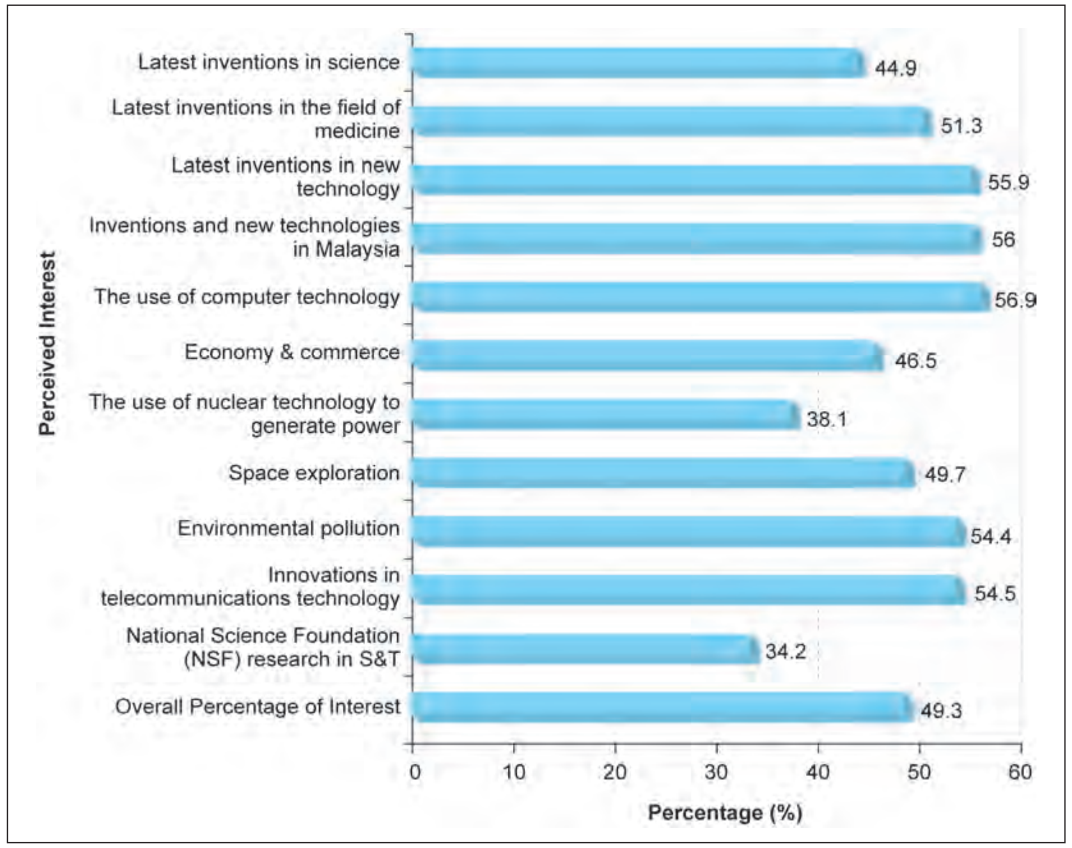
(2004 & 2008) Interest Level: 4=Very Interested, 3=Interested, 2=Not Sure, 1=Not Interested

Overall Mean Interest are calculated without including innovations in telecommunications technology and NSF research in S&T

Source: The Public's Awareness of Science & Technology Malaysia 2008

Figure 12.1 above shows the mean score for several areas of innovations in the survey conducted in 2002, 2004, and 2008. The comparison made through three consecutive surveys indicates lack of improvement in the public interest on innovation from 2002 to 2008. The mean score comparing each type of innovation between three surveys shows differences that are not significant. Only slight increases in awareness can be observed in 2008, which are in the use of nuclear technology and space exploration. These interests might have been lead by Malaysian effort in sending its representative to space and the controversial issue of nuclear crisis in Iran. The scores that are mostly below 3.0 for all areas categorized indicate the presence of less than moderate interest among the Malaysian public towards S&T research and innovation. In other words, Malaysians are only slightly interested in S&T R&D. This may not be good enough for the country to promote more S&T research and innovation as the support from the public can be quite low. Malaysians are also least interested in nuclear technology research and innovation. They are mostly more interested in environmental pollution, ICT, and telecommunication technology R&D. Different measures and plan of actions may need to be taken by the government to promote public awareness and interest in S&T.

Figure 12.2: The Public's Perception of Interest in S&T Issues 2008



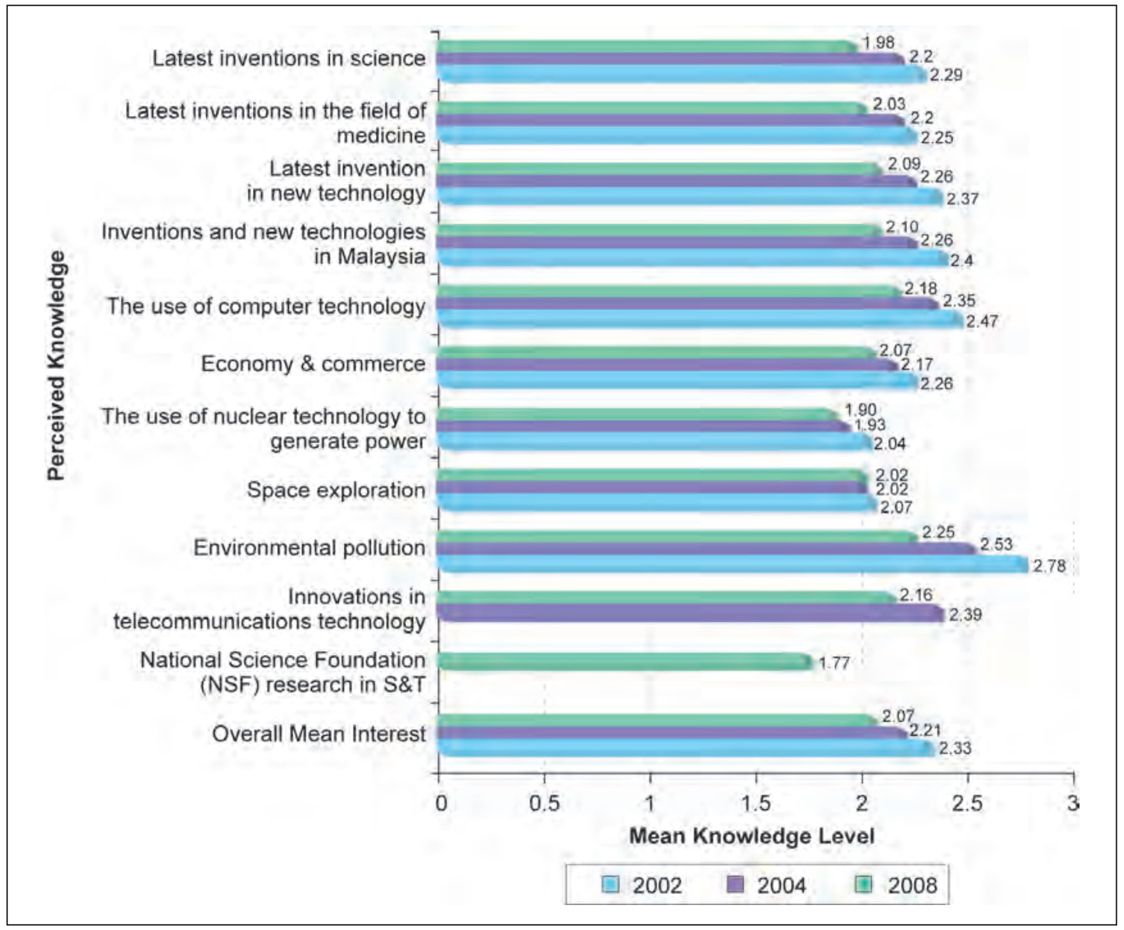
Note: Interest Level= Interested + Very Interested

Source: The Public's Awareness of Science & Technology Malaysia 2008

Figure 12.2 shows the interest level of the society in the form of percent score for both interested and very interested response scale. Based on the result of the survey conducted in 2008, the percentages are either slightly above 50% or slightly below. Six areas of R&D are found gaining interest in slightly more than half of the total sample. These are ICT, inventions and new technologies in Malaysia, latest inventions in new technology, innovations in telecommunication technology, environmental pollution, and latest inventions in the field of medicine. Malaysians are least interested in national science foundation in research in S&T, followed by nuclear energy research and innovation, latest invention in science, and economy and commerce. The overall distribution indicates that about half of the Malaysian populations are interested in innovation, leaving another half either neutral or not interested.

12.3 PERCEPTION OF KNOWLEDGE IN SCIENCE AND TECHNOLOGY

Figure 12.3: The Public's Perception of Knowledge in S&T Issues – Data Series



Note: (2002) Knowledge Level: 4=Excellent, 3=Average, 2=Poor, 1=None

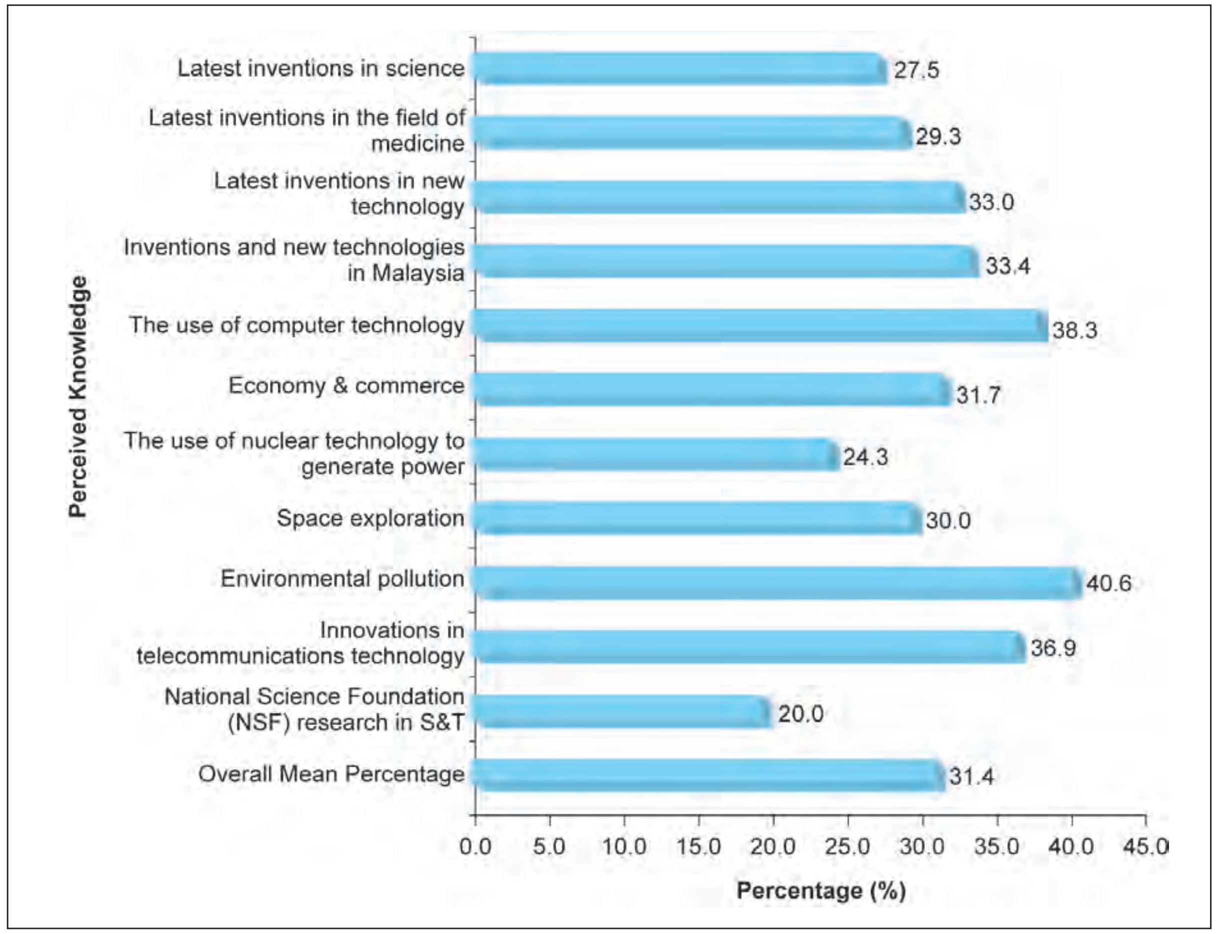
(2004&2008) Knowledge Level: 4=Good, 3=Average, 2=Weak, 1=None

Overall Mean Knowledge are calculated without including innovations in telecommunications technology and NSF research in S&T

Source: The Public's Awareness of Science & Technology Malaysia 2008

Throughout the reporting years, public awareness on S&T studies in Malaysia revealed that Malaysians perceived themselves as having between poor and average knowledge of S&T-related issues. Majority of them thought that they only had a little understanding about science and technology. Figure 12.3 shows that the mean scores of perceived knowledge level of Malaysians are decreasing over time. The deterioration in the perceived knowledge level can be observed in all issues in S&T. In 2004 study, the mean perceived knowledge level (based on Likert-type scale of 1 to 4) dropped to 2.21 from 2.33 in 2002. The overall mean perceived knowledge level of Malaysians dropped again by 0.14 to 2.07 in 2008 survey. The result indicates that not only Malaysian perceived that they have a weak knowledge in basic scientific fact and concept, but their perceptions have not been improving over the years. This lack of improvement may remain the same in the next two to four years if no significant measures are taken by the Malaysian Government to promote better knowledge level in S&T among the society.

Figure 12.4: The Public's Perception of Knowledge in S&T Issues 2008



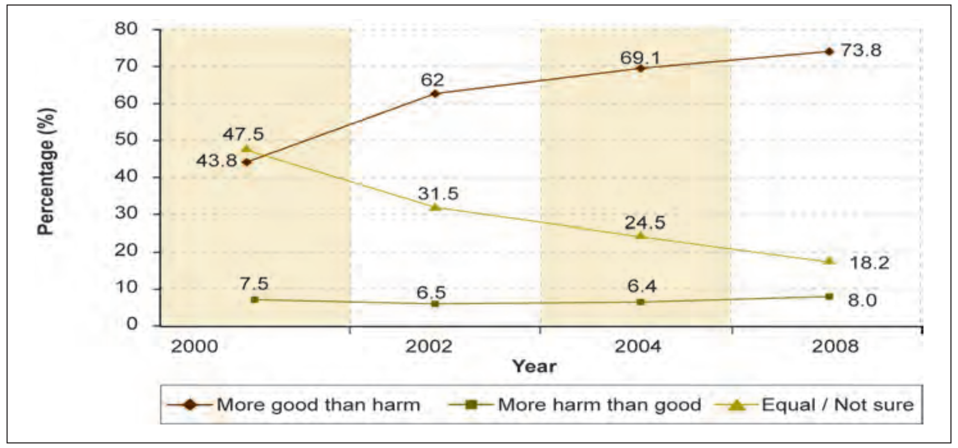
Note: Knowledge Level= Average + Good

Source: The Public's Awareness of Science & Technology Malaysia 2008

Figure 12.4 further distributes the perceived knowledge level of the Malaysian public according to percentage of average and good responses in the survey. With the low level of overall knowledge understanding in the past three surveys, this figure shows the breakdowns from those who actually have average to good understanding of S&T. The 2008's study reveals that fewer than 50% of the respondents describe themselves as having good knowledge in various S&T-related issues. The percentage is considered very low compared to the findings from the past two surveys. While the maximum percentage (41%) was reported in the area of environment pollution, the least were reported in the area of NSF and nuclear technology. The pattern of perceived knowledge level is found quite similar for all the three surveys, with environment pollution leading the figure, followed by ICT, and the rest.

12.4 ATTITUDE TOWARDS SCIENCE AND TECHNOLOGY

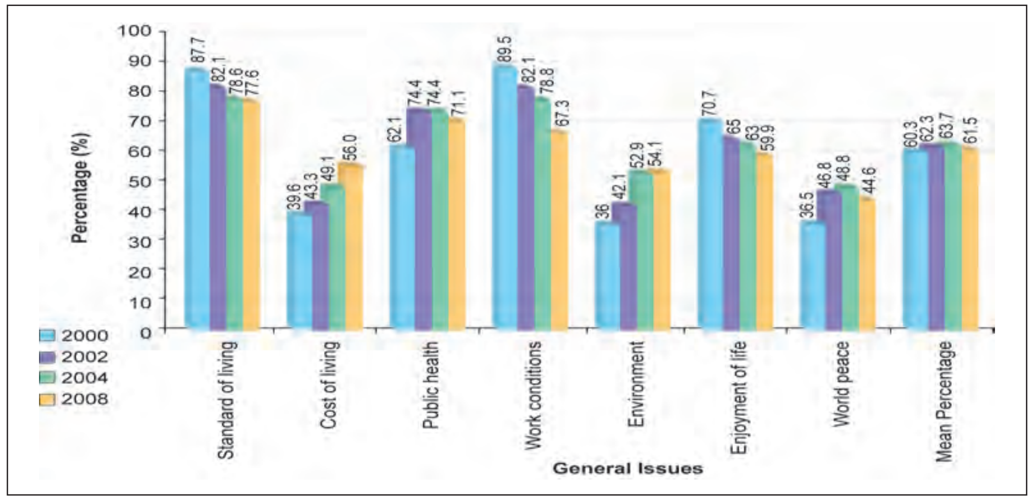
Figure 12.5: Opinion of Public on Effect of S&T – Data Series



Source: The Public's Awareness of Science & Technology Malaysia 2008

In this part of the survey, respondents were asked their attitudes and perceptions of whether S&T can bring more good than harm, more harm than good, or no effect at all to common life practices. Figure 12.5 shows that public attitudes about science and technology have generally improved over the years. Despite the downward trend on the public perception of knowledge in selected S&T issues, the public's confidence in science and technology community has remained high for several years. In the year 2000, the number of people who felt that S&T brought equal or no effect (47.5%) to common life were much higher than the number of people who thought that S&T would do more good than harm (43.8%). However, throughout the years of development, the perception of people towards S&T began to change to become more positive. As a result, the number of people who felt that S&T will do more good than harm increased to 73.8% in 2008 from 69.1% in 2004 and 62% in 2002. On the other hand, the number of people who felt that life would not be affected with the expansion of S&T, decreased to 18.2% in 2008 from 24.5% in 2004 and 31.5% in 2002. From the findings, we can conclude that Malaysians' attitudes are beginning to become more positive towards the benefit of S&T, even though their knowledge and awareness on specific areas within S&T innovations are quite low.

Figure 12.6: Public Attitudes towards S&T on General Issues – Data Series



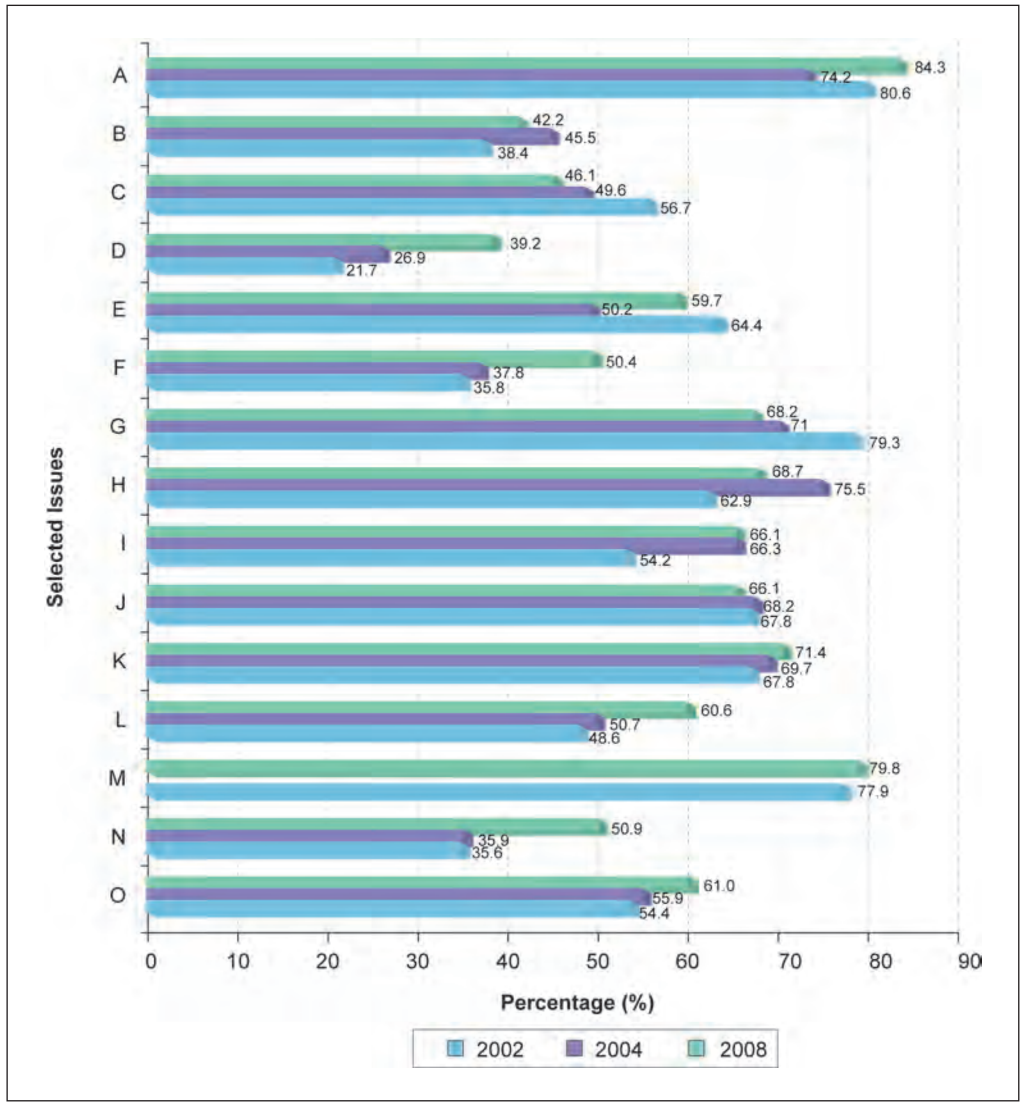
Note: This graph shows the percentages of the Malaysian Public who stated that S&T has a positive effect on the above issues.

Source: The Public's Awareness of Science & Technology Malaysia 2008

A series of questions was formulated on the general S&T-related issues and respondents were asked to state the effect of S&T according to their own perspectives. Based on Figure 12.6, it was found that the percentage of people who felt that S&T has positive effect on standard of living, work condition and enjoyment of life is declining over time. In 2008, only 77.6% of respondents felt that S&T would positively affect the standard of living compared to 78.6% in 2004 and 82.1% in 2002. The same findings can be seen in people's perspective about the effect of S&T on work condition where in 2008, positive effect is only avowed by 67.3% of respondents compared to 78.8% in 2004 and 82.1% in 2002. On the other hand, more and more people are beginning to believe that S&T will leave a positive effect on the cost of living and the environment.

Overall, majority of people still believe that S&T would bring more positive effect than negative. However, the deterioration in the positive perception on certain issues such as standard of living, work condition, and enjoyment of life may send a different signal indicating the effect of S&T in the opposite direction. The higher percentage on the perceived effect of S&T on the cost of living over the years may indicate that S&T has been perceived as giving impact on the high cost of living that can cause burden to their lives.

Figure 12.7: Public Attitudes towards S&T on Selected Issues – Data Series



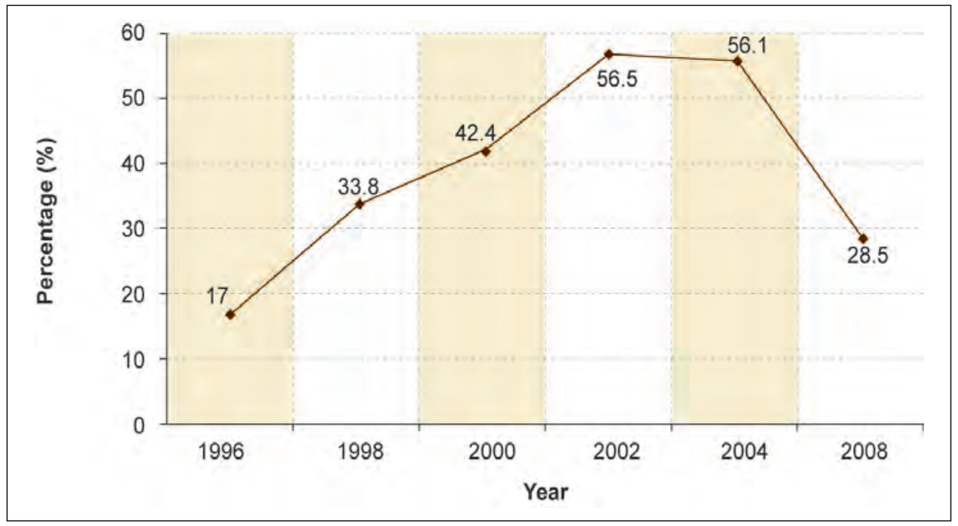
Note: The graph shows the percentages of the Malaysian public who agreed to the above statements.

Source: The Public's Awareness of Science & Technology Malaysia 2008

No.	Selected Issues
A	Science & Technology improves the quality of our lives
B	The quality of science education in school is not satisfactory
C	The use of automation will increase job opportunities in factories
D	We depend too much on science & not enough in faith
E	Scientific research increase knowledge although it does not produce immediate benefits
F	Although research on animals may cause suffering, it has to be done for the sake of humankind
G	The government should provide more funds for scientific research
H	We need to have knowledge about science in order to manage our daily lives better
I	Science causes our lifestyle to change too rapidly
J	Most scientists strive to make human lives more comfortable
K	Our daily work will be more interesting with the use of Science & Technology
L	New discoveries will help to solve the negative effects of Science & Technology
M	Science & Technology is very important for the progress of our nation
N	Civilization has existed without the help of Science & Technology
O	Mean Percentage Score

Based on Figure 12.7, people were asked about their agreement/disagreement towards selected issues. It was found that, majority of Malaysians had consistently been positive towards the notion, “S&T improves the quality of our lives”. For instance in 2008, majority of Malaysians (84.3%) stated their agreement with the statement. It was a 10.1 percentage point increase compared to the previous year. When asked about the sensitive statement such as “We depend too much on science & not enough in faith”, only 39.2% of respondents in 2008 surveys addressed their agreement with the statement. However, it was a 12.3 percentage point increase compared to 2004 (26.9%). Respondents were also questioned about their opinion towards the notion “Although research on animals may cause suffering, it had to be done for the sake of humankind”. In 2002 and 2004, only 35.8% and 37.8% of respondents agreed with the statement respectively. However, in 2008, 1/2 of the total respondents (50.4%) were likely to be agreeing with the statement. In the statement “Most scientists strive to make human lives more comfortable”, the Malaysian public had been relatively consistent in their responses over the three surveys. The percentages of Malaysian who agreed about the statement fluctuated around 65% to 69% for the past 8 years. It indicates that Malaysian are fully aware of the contribution made by scientists. In overall, public’s attitude towards S&T is relatively positive. When comparing the mean percentage for the 3 surveys (2002, 2004 and 2008), it shows an upward trend, indicating that Malaysians’ attitude towards S&T is on the rise with the highest mean percentage can be observed in 2008 at 61%.

Figure 12.8: Awareness of Genetic Engineering or Cloning

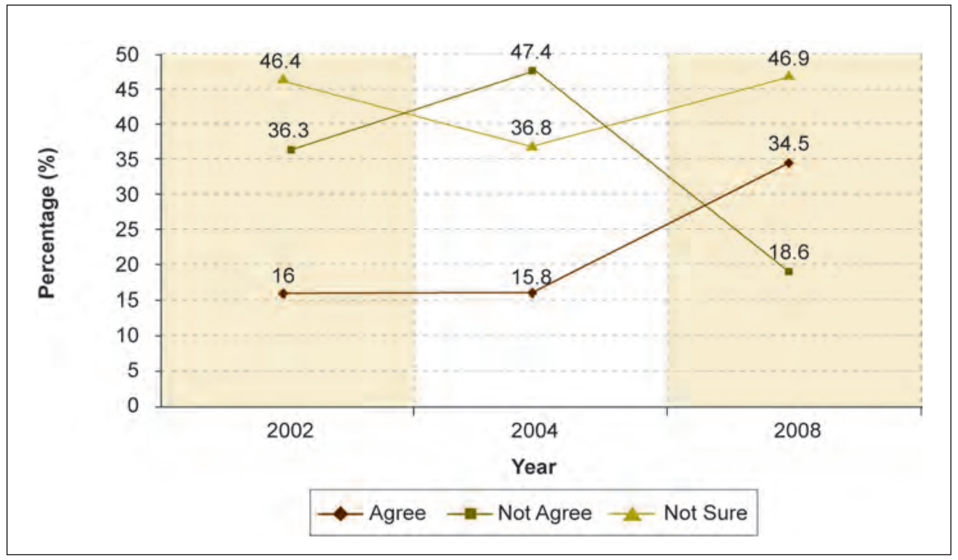


Source: The Public’s Awareness of Science & Technology Malaysia 2008

Genetic engineering or cloning is one of the most controversial issues in S&T. Although cloning technique has been applied in agricultural sector for several thousands of years back, recent technological advancements in cloning technique have been highly controversial. The success in cloning of animals (Dolly, Daisy, Snuppy, etc.,) and potentially human, has raised a lot of ethical issues from many parties. Since 1996, Malaysian awareness and opinion about the particular topics has been assessed in order to determine where Malaysia stands among other countries in the world in terms of these issues.

Figure 12.8 shows that, from 1996 to 2002, the percentage of Malaysians who have heard of genetic engineering or cloning increased consistently. In the 2002 survey, more than half of the respondents reported that they had at least heard about it. However, in 2004 survey, the percentage had dropped by 0.4 percentage point. It is unfortunate to see that in the 2008 survey, only 28.5% of the respondents had heard about genetic engineering or cloning. It is 27.6 percentage points lower than the 2004 survey. It indicates that the awareness of the 2008 survey respondents towards this scientific endeavor is shockingly low compared to the four previous studies.

Figure 12.9: Public Opinion on the implementation of Genetic Engineering or Cloning

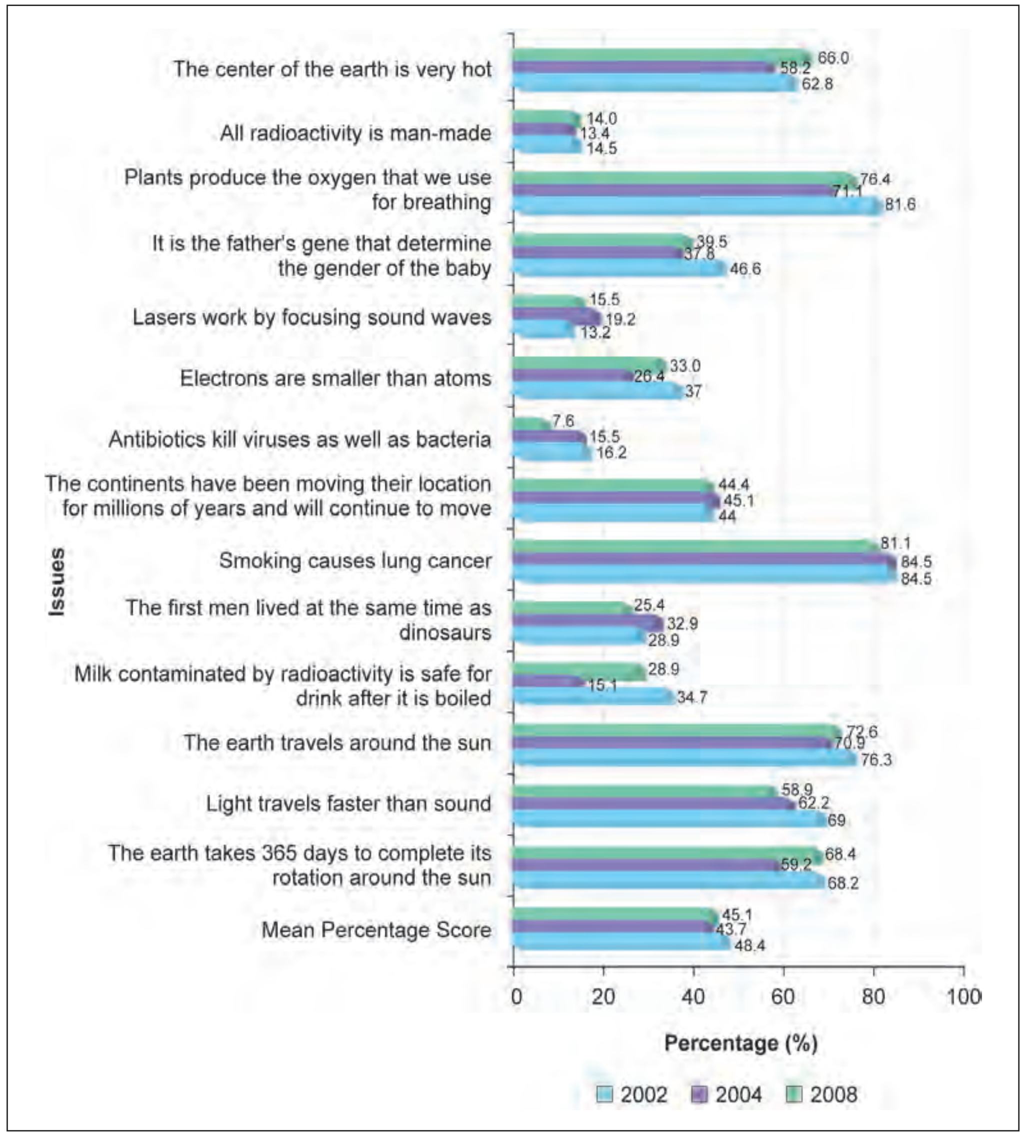


Source: The Public’s Awareness of Science & Technology Malaysia 2008

In the 2002 study, the percentage of respondents who agreed with the implementation of genetic engineering was quite small (16%), and becoming slightly smaller (15.8%) in 2004. On the other hand, the percentage of disagreement increased sharply by 11.1 percentage points in 2004. However, the respondents' opinion towards these issues shows slightly different pattern in the 2008 study. Of the 5,253 respondents who recorded to have at least heard of genetic engineering or cloning, 1,813 or 34.5% of them showed positive attitudes toward its implementation. It was a remarkably 18.7% increase compared to the previous study. The remaining 18.6% of the respondent expressed their disagreement, and a much bigger crowd (46.9%) was uncertain about their opinion towards the implementation of genetic engineering or cloning. It proves that the public acceptance of certain scientific outputs is increasing.

12.5 PUBLIC UNDERSTANDING OF SCIENCE AND TECHNOLOGY

Figure 12.10: Public Understanding of S&T Issues – Data Series



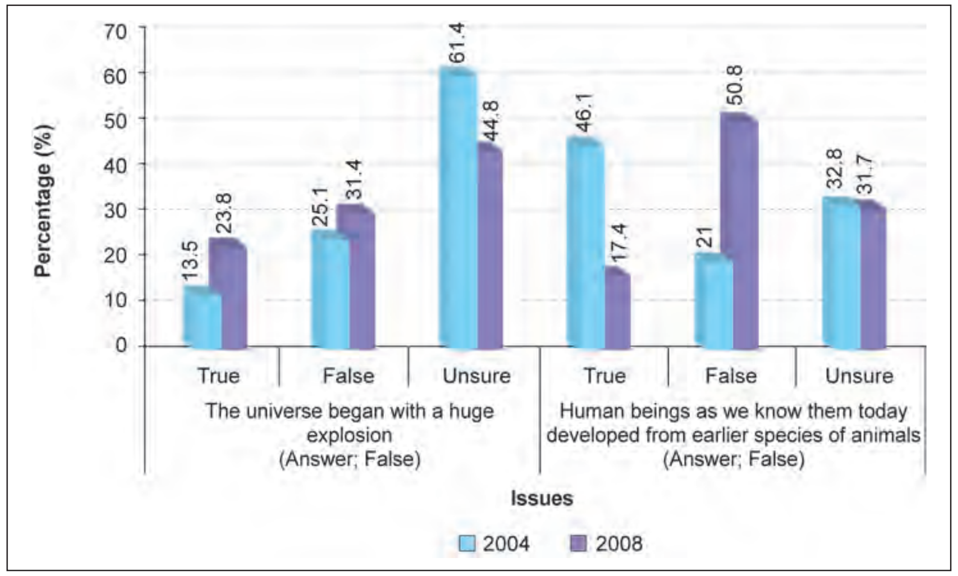
Note: The graph shows the percentages of the Malaysian public who answer correctly to the above statements.

Source: The Public's Awareness of Science & Technology Malaysia 2008

In this particular section, Malaysians were asked to answer a series of questions related to S&T statements. They were given a chance to determine whether the S&T-related statements given to them were TRUE or FALSE or whether they were UNSURE about the statements. Many Malaysians did not do well when tested on their knowledge of S&T. For instance, in 2008's study, the mean percentage of correct answer was 45.1%. It indicates that less than half of the Malaysian population gave the correct answer. There was an increase of 1.4 percentage points compared to 43.7% in 2004, but much lower than 2008 (48.4%). It was found that since 2002, majority of Malaysians were familiar with the fact that smoking causes lung cancer.

It was also found that understanding of Malaysians in most questions for the 3 different periods of studies fluctuated insignificantly over time. However, bigger fluctuation can be observed for some questions. For example, in 2002, 62.8% of respondents answered correctly to the question 'The center of the earth is very hot'. In 2004, the percentage dropped to 58.2% but increased in 2008 to 66%. The same was also true to the question 'Milk contaminated by radioactivity is safe for drink after it is boiled' where in 2002, the percentage of correct answer was 34.7%, decreased sharply by 19.6 percentage points in 2004 (15.1%) but increased in 2008 (28.9%). In general, Malaysians seem to have a good understanding on basic concept of science such as 'The earth travels around the sun' and 'plants produce the oxygen'. However, many did not do very well on questions that may require higher knowledge level in S&T.

Figure 12.11: Public Understanding of S&T Issues 2008 – Controversial Theories



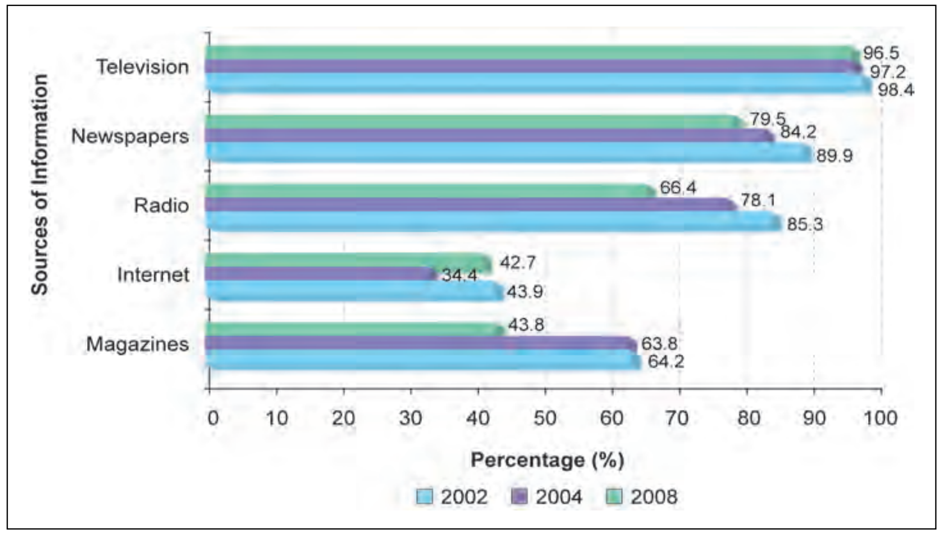
Source: The Public's Awareness of Science & Technology Malaysia 2008

Besides the statement that tested Malaysians' understanding of S&T, their knowledge on selected controversial theories was also tested. The first statement, famously known as the Big Bang theory seeks to explain what happen at the very beginning of the universe. On the other hand, the second statement was first introduced during the Ancient Greek era before being made popular by Charles Darwin through his theory of evolution (AllAboutScience.Org, 2008). For many different reasons not to be mentioned in this report, the survey decided to take 'False' as the correct answer for both questions, different from the American and European version, hence eliminates any chances of international comparison involving these two statements.

From Figure 12.11, we can see an improvement made by Malaysians regarding their answer to both of the questions. In 2004, only 25.1% of Malaysians responded to the correct answer for a question related to the Big Bang theory, while majority of them chose not to deliver (61.4%) their opinions. In 2008, the percentage of correct answer was 31.4%, representing an increase of 6.3 percentage points over the previous study. Regarding the second statement, about one in two Malaysians (50.8%) answered the questions correctly. There was a 29.8% increase compared to the 2004 study (21%). The percentage of wrong answer however fell sharply by 28.7% to only 17.4% in 2008. Another 31.7% of Malaysians were unsure about the answer.

12.6 INFORMATION SOURCES & AWARENESS OF S&T

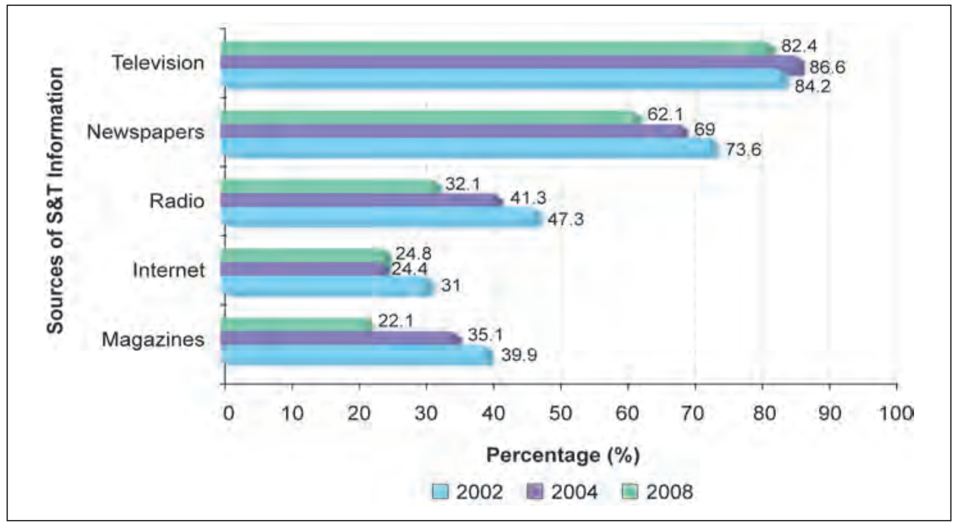
Figure 12.12: General Sources of Information – Data Series



Source: The Public's Awareness of Science & Technology Malaysia 2008

Figure 12.12 indicates that television is the top source of general information for the period of 2002 to 2008. In fact, it has been the most popular source of information for Malaysians since 1996. In 2008, 96.5%, or almost every Malaysian turns to television as their source of information. Newspapers (79.5%) and radios (66.4%) followed closely behind television as the second and the third most popular sources of information. Despite the attentions given to the use of television, newspapers and radios as main sources of information, the pattern seems to indicate the decreasing use over time. However, the decreasing use of television may not be as significant as the decreasing use of magazine, radio and newspaper. Only the use of the Internet shows a slight increase as the source of information.

Figure 12.13: Sources of S&T Information – Data Series

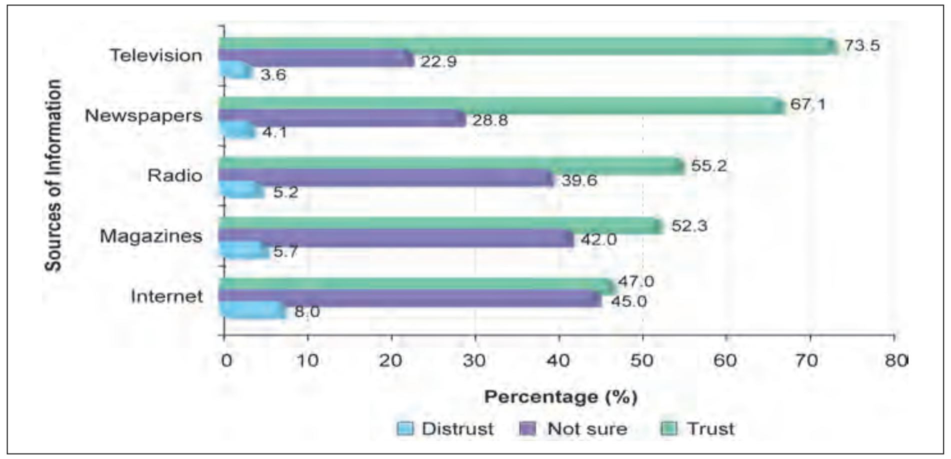


Source: The Public's Awareness of Science & Technology Malaysia 2008

Figure 12.13 shows the pattern of Malaysian sources of S&T information, which is not much different from figure 12.12. Malaysian seems to seek less and less information over the years. In 2008, 82.4% of Malaysian sought S&T information through television; a decrease by 4.2 percentage points compared to 2004 study (86.6%). Newspapers, radios and magazines showed significant decreases over the years. On

the other hand, internet has had a small increase of 0.4 percentage points in 2008. The internet was well-received by Malaysians and is expected to become one of the important sources of S&T information in the near future.

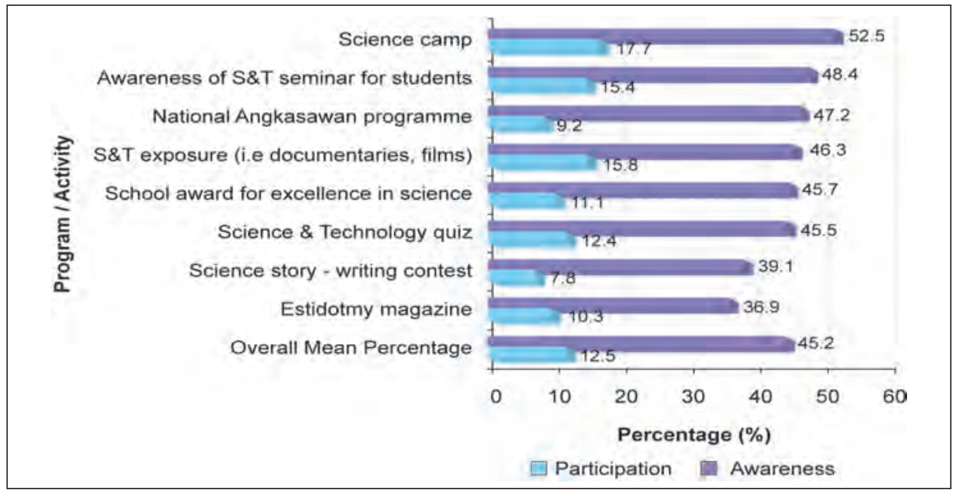
Figure 12.14: Level of Trust in the Media in 2008 Survey



Source: The Public's Awareness of Science & Technology Malaysia 2008

Based on Figure 12.14, the most trusted (as expressed by trust and highly trusted) source of information for Malaysian in 2008 was television (73.5%), followed by newspaper (67%), radio (55.2%), magazine (52%) and the Internet (47%). The findings indicate that most Malaysians put a high level of trust in the information they received from the television. Moreover, the level of distrust (as expressed by distrust and highly distrust) is low (3.6%). This can imply that awareness programme in S&T should be made more actively over these media, especially the television. The high level of trust placed on some mass media such as television and radio should reflect the high amount of time spent by Malaysian in seeking for more entertainment types of media for getting information rather than reading. However, this is about to change as the Internet is beginning to take place as an important source of information for all level of the Malaysian society.

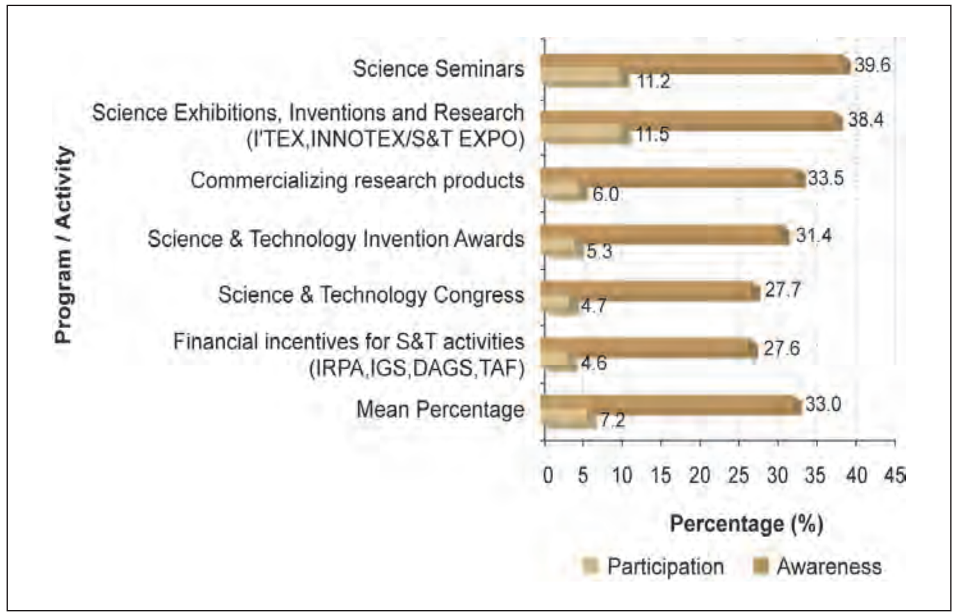
Figure 12.15: Awareness & Participation of S&T Program / Activity 2008



Source: The Public's Awareness of Science & Technology Malaysia 2008

In Figure 12.15, Malaysians were asked about their awareness and participation in various S&T programmes as organized by the Malaysian government as well as the private sectors. Many Malaysians were quite aware of various S&T programmes organized in promoting awareness in S&T. S&T programmes that most of the respondents were aware of were science camp (52.5%) and S&T seminars for students (48.4%). Almost half of the respondents also recognized the existence of National Angkasawan programmes (47.2%). However, Malaysians were very poor at participating in most of the programmes organized. Only a very small percentage of Malaysians participated with the highest percentage in the science camp programme, followed by film and documentaries, seminars for students, quizzes, special space programmes, etc. Most of these programmes were most likely attended by school children and parents, who made up the majority of those who participated.

Figure 12.16: Awareness & Participation of S&T Program / Activity 2008 (Adult)



Note: Respondents = 13,741 Malaysian Adults

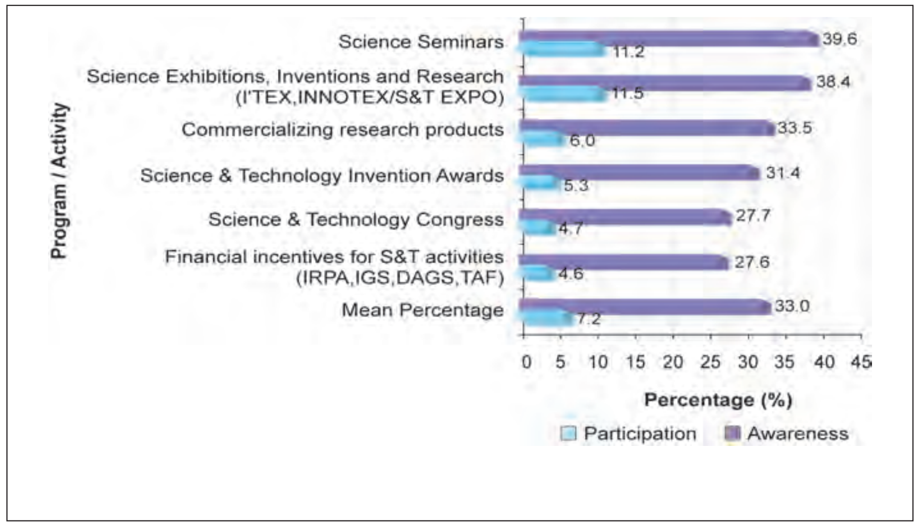
Source: The Public's Awareness of Science & Technology Malaysia 2008

In order to determine level of involvement of Malaysian adults in S&T programme/activity, 13,741 respondents were selected to answer the questions comprising of a set of activities in S&T. As usual, awareness may not necessarily lead to actual participation. While the awareness rate is quite high, the participation rate had been extremely low. For instance, 39.6% of adults participating in 2008 survey said that they were aware of science seminar held in Malaysia. However, only 11.2% of them participated in the programmes/activities. Involvement of Malaysians in science exhibitions, inventions and research program such as I'TEX and INNOTEX was also small (11.5%) even though 38.4% of them do aware of such program. Overall, out of 13,741 respondents, 33% of them were aware of the S&T programmes organized in Malaysia. Yet, the percentage of Malaysians who took part in the program was small (7.2%). Lack of promotion maybe the reason for low participation and overall awareness. Active measures need to be taken in promoting various S&T programmes through various mass media such as TV, radios, newspapers, and magazine. The previous reports indicated how much Malaysians depend on these mass media for information.

PUBLIC AWARENESS, KNOWLEDGE AND ATTITUDE
TOWARDS SCIENCE AND TECHNOLOGY

Chapter 12

Figure 12.17: Visits to S&T Related Places – Data Series



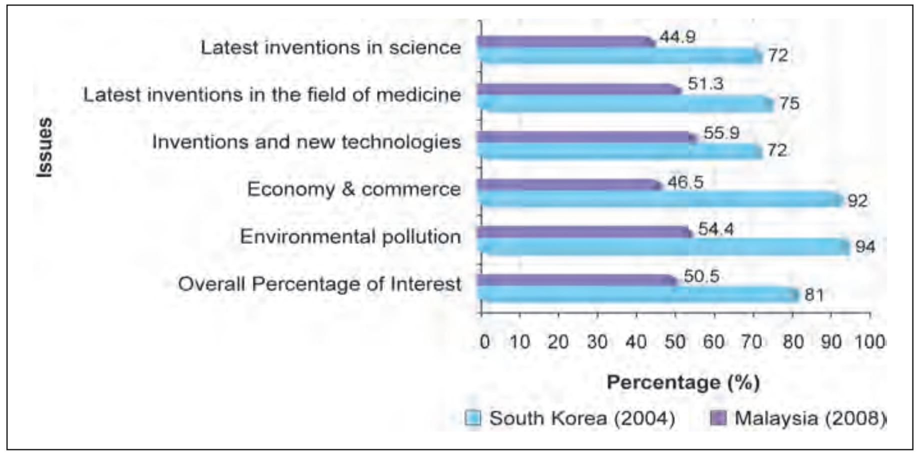
Note: The graph shows the percentages of the Malaysian public who have made a visit at least one time to the above places.

Source: The Public's Awareness of Science & Technology Malaysia 2008

Figure 12.17 shows the S&T related places that Malaysians have visited at least once in their lives. Places of interest that attracts 30% to 40% of Malaysians to visit are the zoos, museums, and parks. The highest recorded visits were in 2002 at almost all S&T places of interest. Year 2008 recorded the lowest incidents of visits, the reasons of which should be taken rather seriously by the government. The decrease in visits may imply the high cost of fees charged and the low interest of the society towards awareness activities during the year. As shown in the figure, Malaysians tend to visit places such as the zoos, the parks and the museum compared to others. Other places of interest such as the planetarium, the National Science Centre, the Petrosains, and the planetarium were not so popular with very small percentages of visits recorded by the respondents.

12.7 INTERNATIONAL COMPARISONS

Figure 12.18: International Comparison: The Public's Perception of Interest in S&T Issues



Note: (Malaysia) Interest Level= Interested + Very Interested

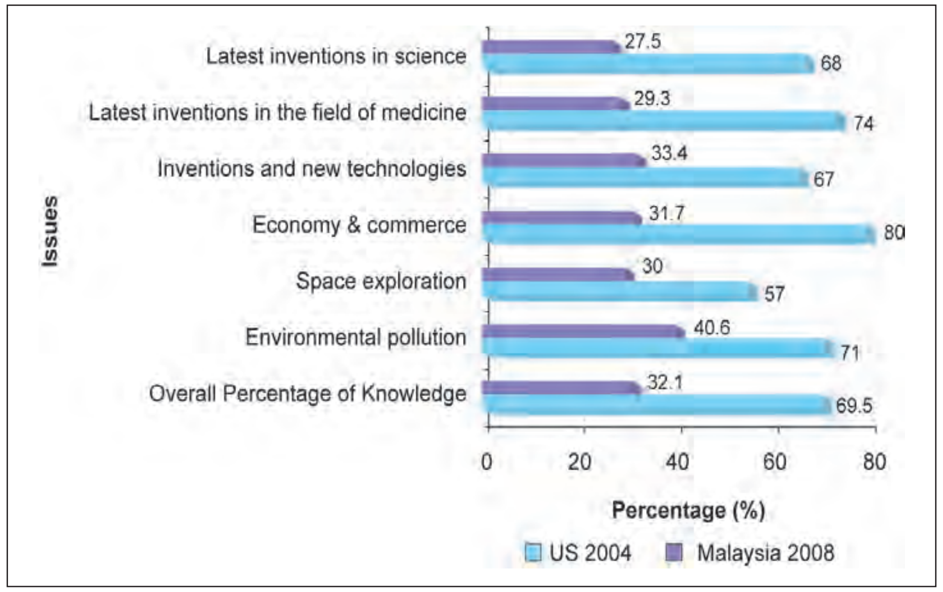
(South Korea) Interest Level= Moderately Interested + Very Interested

**(South Korea) Source: Science & Engineering Indicators 2004*

Source: The Public's Awareness of Science & Technology Malaysia 2008

Figure 12.18 shows the comparison of interest in S&T issues between Malaysian and South Korea. The Koreans' interest in various S&T issues exceeded the Malaysians, so far away in all areas. Majority of respondents from Korea seem to be interested in environmental pollution (94%) and economy & commerce (92%) issues, with overall percentage of (81%). Malaysia needs to work much harder in order to generate such similar interest in its population. Public awareness is highly needed to produce a nation that is competitive and able to survive on its own through R&D activities.

Figure 12.19: International Comparison: The Public's Perception of Knowledge in S&T Issues



Note: (Malaysia) Knowledge Level= Average + Good

(US) Knowledge Level= Moderately + Very Well Informed

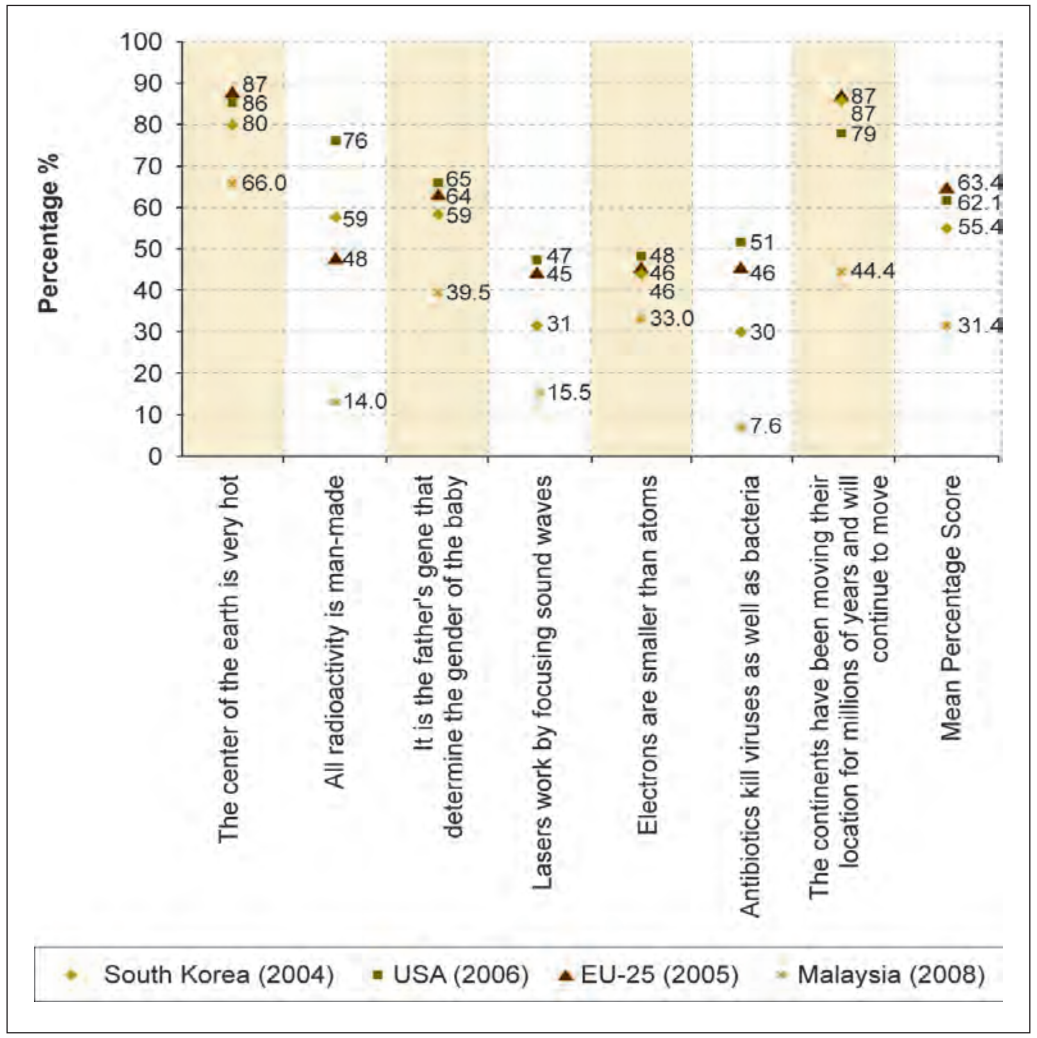
**(US) Source: Science & Engineering Indicators 2006*

Source: The Public's Awareness of Science & Technology Malaysia 2008

The American respondents put high confidences in their knowledge on certain S&T issues. 80% of the respondents perceived themselves as having good (as expressed by moderately & very well informed) knowledge of the latest inventions in science, 74% of them in latest inventions in the fields of medicine, while another 71% in encironmental pollution. Unlike the American respondents, Malaysia respondents have a much lower confidence in their knowledge. They felt that they were best informed about environmental pollution (40.6%), latest inventions in new technology (33%) and economy & commerce (31.7%)

When combining these results, we can see that only one third or 32% of Malaysian respondents felt that they were well informed about selected S&T issues. It was 37 percentage points much lower than the American respondents (69.5%).

Figure 12.20: International Comparison: Public Understanding of S&T Issues



*Note: *(South Korea, USA and EU-25) Source: Science and Engineering Indicators 2008*

Source: The Public's Awareness of Science & Technology Malaysia 2008

In order to determine the level of understanding of S&T issues, it is necessary that comprisons are made with other countries. Figure 12.20 shows the comrison of findings between Malaysia, South Korea, USA and EU-25. In the 2008 study, 66% of Malaysian respondents answered correctly to the questions 'the centre of the earth is very hot'. It is lower than any other countries compared. Also, only 44.4% of Malaysian respondents answered correctly to the question ' the continents have been moving their location for millions of years and will continue to move'. It was much lower compared to respondents in South Korea (87%), EU-25 (87%) and USA (79%). In addition, only 7.6% of Malaysian respondents responded correctly to a question "antibiotics kill viruses as well as bacteria". Overall, Malaysians understanding on selected S&T issues is still lower compared to other countries. With 31.4% in mean percentage score, Malaysia was 24 percentage point lower than South Korea (55.4%), 30.7 percentage point lower than EU-25 (62.1%) and 32 percentage point lower than US (63.4%). Given that this comprison is only made with much advanced economy countries and region, Malaysia may have achieved more if compared with other similar developing countries.

12.8 CONCLUSION

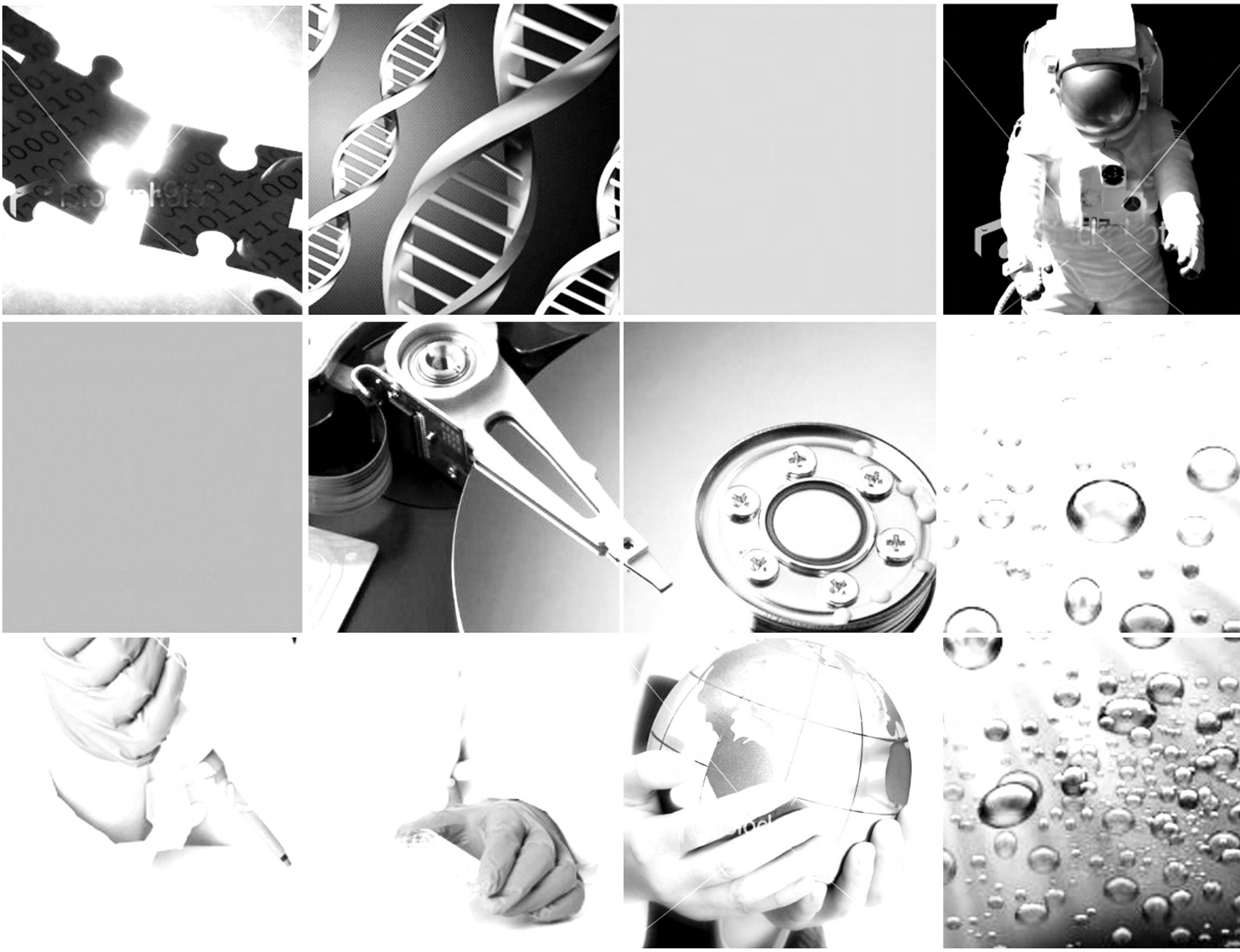
This chapter analyzes the research findings on the public awareness of S&T and its various issues by the Malaysian public. The reports were derived from the one in two years survey by the Ministry of Science, Technology and Innovation Malaysia. The surveys were made to provide measures on the perceptions and attitudes of the society in various areas of S&T. Knowledge and understanding from the surveys should allow the government to provide proper actions in promoting S&T in the country.

According to the survey, the respondents were assessed according to their interest, and knowledge level in various S&T issues and basic concepts. They were also assessed in terms of information sources, awareness and participation in various S&T activities. The overall assessment allows the Malaysia government to know how far the Malaysian public will be able to support S&T activities in the country. With the research taking place in every two years, the statistics indicate very little improvement in Malaysian interest of S&T-related issues over the past 3 surveys. In addition, the Malaysian perception of knowledge in S&T issues also deteriorated over the years. Many were unsure of their knowledge and understanding in S&T.

One area of improvement, however, can be observed in Malaysians' attitude towards S&T in terms of their perceived important and benefit. Generally, more and more Malaysians are admitting that S&T can bring more goods than harms. Malaysians' understanding on S&T has improved slightly based on basic S&T test score. The respondents have recorded a higher percentage of correct answers in at least 8 questions asked, compared to the previous study.

Malaysians are in general, not much aware of various S&T issues and programmes introduced to promote S&T development. They also participated less in S&T activities introduced. In terms of information resources, they also depended too much on the mass media in informing and educating them on various S&T issues and knowledge. To ensure the change in the attitudinal scores or more improvement in the upcoming study, active planning is needed by the government to ensure attitudinal changes on the public towards S&T issues and knowledge. Better or more positive attitude can lead to more support and activities in S&T in the future.

In terms of international level comparisons, Malaysia seems to be left far behind from many developed countries such as the United States, South Korea and European Union. The huge different between Malaysia and these countries indicates that more effort has to be done in order to stimulate Malaysian interest especially in S&T issues.



CONCLUSION / THE WAY FORWARD

Chapter 13

13.1 INTRODUCTION

This chapter provides an overview on the state of STI in Malaysia based on the indicators developed from various related fields of Science and Technology namely Research and Development, Human Resource, Public Support for S&T, Innovation in S&T, Intellectual Property, Information and Communication Technology, Trade in Technology, Publications and Citations (Bibliometric) and Public Awareness, Knowledge and Attitudes Towards S&T.

In measuring the performance of Malaysia in STI, a scorecard comprising a set of selected S&T indicators was developed and compared against the same indicators used in the previous report. Where applicable, these indicators are benchmarked against those of selected OECD countries to gauge the nation's performance in promoting Science and Technology in Malaysia.

13.2 ABOUT THE SCORECARD

The scorecard presented in Table 13.1 comprises a set of indicators developed from various categories of S&T. These indicators are crucial in that they can be used to gauge and monitor Malaysia's performance in terms of R&D investments, human resource for S&T, funding, knowledge infrastructure and diffusion, publications and citations, and knowledge understanding and awareness towards STI.

The scorecard is clustered into six (6) broad categories with twenty three (23) leading indicators as follows:

R&D Investments and Expenditure

- Overall R&D Intensity
- Industry R&D expenditure as % of GERD

Human Resources

- Total R&D Personnel (Headcount)
- Researchers per 10,000 labour force
- Total FTE per researcher
- Science and engineering enrolment as % of total first degree enrolment
- Science and engineering enrolment as % of total post-graduate enrolment
- Proportion of postgraduate enrolment to undergraduate enrolment
- Women researchers as proportion of total researchers (%)

Interactions and Cooperation

- % of public R&D financed by industry / external funds

Outputs and Outcomes

- Total number of publications in SCOPUS-indexed journals
- Total Citations
- No. of patents applied
- No. of patents granted
- No. of USPTO patents granted per million population

Knowledge Infrastructure and Diffusion

- No. of computer per 1,000 people
- Internet users per 100 population
- Cellular phone subscription per 100 inhabitants

S&T Knowledge, Understanding and Awareness

- Mean Score of perceived interest in S&T
- Mean Score of perceived knowledge in S&T
- Attitude toward S&T
- Index of Scientific Promise
- Index of Scientific Reservation

13.3 SUMMARY OF MALAYSIA'S PERFORMANCE AGAINST EACH CATEGORY

13.3.1 R&D Investments and Expenditure

Investment in R&D activities showed that Malaysia is spending more money than ever before. Gross Expenditure on Research and Development (GERD) as a proportion of GDP continued to show a positive trend, registering 0.64% of the GDP in 2006 as compared to 0.63% in 2004. The industry R&D expenditure as percentage of GERD increased to 85.0% from 71.5% in 2004, higher than the average recorded by OECD countries (63.9%). Nevertheless, compared to selected OECD countries, which recorded 2.26% in GERD, Malaysia is considered well behind in terms of overall R&D intensity.

13.3.2 Human Resources

In 2006, total R&D personnel dropped by almost 21% from 30,983 recorded in 2004. Similarly, the number of researchers per 10,000 labor force reduced to 17.9 from 21.3, far below the average of 70 researchers recorded by OECD countries. The FTE per researcher slightly decreased from 0.55 in 2004 to 0.51 in 2006. Science and Engineering enrolment as a proportion of total undergraduate enrolment declined to 32.6% in 2006 as compared to 48.2% in 2004. Similar scenario was observed for the proportion of post-graduate enrolment in science and engineering, whereby the percentage has dropped to 30.6% from 40.6% in 2004. Women researchers continued to play significant role in R&D, in which they constituted 37.7% of total researchers in 2006. The proportion is higher than that recorded in 2004 (35.8%) and above the percentage recorded by the OECD countries (30.0%).

13.3.3 Interactions and Cooperation

Joint research projects between public sector organizations and industry has further improved, whereby 3.0% of public R&D expenditure in 2006 was funded by industry and external funding sources (2004: 2.0%), below than the average OECD figure of 3.7%.

13.3.4 Outputs and Outcomes

In 2006, Malaysia managed to produce 3,593 publications (as indexed in Scopus), a 50.7% increase compared to 2004. However, compared to selected OECD countries, Malaysia is lagging behind by a ratio of 1:13. Besides scientific publications, another type of indicator that is commonly used to evaluate the outputs and outcomes of S&T activities is patent statistics. By looking at the USPTO statistics, S&T activities in Malaysia are on the rise where the number of patents granted has increased to 4.9 (per million populations) in 2006.

13.3.5 Knowledge Infrastructure and Diffusion

The pace of diffusion of information and communication technologies has become steadier than the previous reporting period, most notably in terms of mobile density (72.3%) and internet usage (51.9%).

13.3.6 S&T Knowledge, Understanding and Awareness

Perception of interest in S&T among Malaysian has improved during a four-year period of 2004 to 2008. No such improvement however can be observed on the perception of Malaysian towards their knowledge in S&T during the same period of time. The improvements made in the index of scientific promise shows that Malaysian opt for a more optimistic view and have a strong belief in the promise of S&T. By contrast, the increase in the index of scientific reservation shows that Malaysian have a high level of concern towards the development of S&T.

13.4 CONCLUSION

Malaysia's performance in Science and Technology in 2006 has shown improvements in almost all the six areas indicated in the STI performance scoreboard. However it should be noted that the scoreboard has its limitation as the coverage and number of other indicators that captures the performance of the STI system were not included.

The challenge for the policy-makers is to build on the gains and address the deficiencies of the STI system as described in this report.

Table 13.1: STI Performance Scorecard 2008

Category	Indicator	Year 2006	Year 2004	Trend	Average / Selected OECD
R&D Investments and Expenditure	Overall R&D Intensity	0.64	0.63	+ve	2.26[5]
	Industry R&D expenditure as % of GERD	85.0	71.5	+ve	63.9[6]
	Total R&D Personnel (Headcount)	24,588	30,983	-ve	>100,000[7]
Human Resources	Researchers per 10,000 labor force	17.9	21.3	-ve	70[8]
	Total FTE per researcher	0.51	0.55	-ve	NA
	Science and engineering enrolment as % of total first degree enrolment	32.6	48.2	-ve	NA
	Science and engineering enrolment as % of total post-graduate enrolment	30.6	40.6	-ve	NA
	Proportion of postgraduate enrolment to undergraduate enrolment	1:8.4	1: 6.6	+ve	NA
	Women researchers as proportion of total researchers (%)	37.7	35.8	+ve	30[9]

5 STI Outlook 2008
6 OECD Main S&T Indicators 2006
7 Many OECD countries has >100,000
8 OECD Main S&T Indicators 2006
9 Ditto
10 STI Outlook 2008
11 Average number of journal for Australia, Korea and Finland in 2006 (SCOPUS)

Interactions and Cooperation	% of public R&D financed by industry / external funds	3.0	2.0	+ve	3.7[10]
Outputs and Outcomes	Total number of publications in SCOPUS-indexed journals	3,593	2,384	+ve	45,417[11]
	Total Citations	6,424	9,511	-ve	NA
	No. of patents applied	531	522	+ve	4,114[12]
	No. of patents granted	187	24	+ve	13,094[13]
	No. of USPTO patents granted per million population	4.9	3.6	+ve	NA
Knowledge Infrastructure and Diffusion	No. of computer per 1,000 people	238	192	+ve	NA
	Internet users per 100 population	51.9	38.2	+ve	58.4[14]
	Cellular phone subscription per 100 inhabitants	72.3	56.5	+ve	80 (2005)
S&T Knowledge, Understanding and Awareness	Mean Score of perceived interest in S&T	2.41(2008)	2.40	+ve	NA
	Mean Score of perceived knowledge in S&T	2.07 (2008)	2.22	-ve	NA
	Attitude toward S&T# Index of Scientific Promise# Index of Scientific Reservation#	61.5 (2008) 77.9 (2008) 52.7 (2008)	63.7 71.9 47	-ve +ve +ve	 US(83); South Korea (89.5)[15] US(49.5); South Korea (65)[16]

[12] OECD Main S&T Indicators 2006 (EPO)
[13] Ditto
[14] International Telecommunications Union
Survey on Public Attitudes Towards S&T
[15] Science and Engineering Indicators 2008
[16] Ditto

13.5 WAY FORWARD

This biannual publication provides a set of selected indicators that reflect the level and structure of the efforts undertaken by Malaysia government in the field of science and technology over the period of 2004-2006. During the period under review, there are a number of areas of concern which need to be addressed. Among the issues of concern are:

i. Decline in S&T Enrolment at First Degree and Post-Graduate Levels

The number of students' enrolment in science courses in public IHLs has been on a decreasing trend since 2005 until 2007. During the period, arts students dominated the group. Similar scenario was observed among the students at Master's degree and Phd. level programs at public IHLs whereby arts students dominated the groups.

In-depth studies should be conducted to analyze the evolution of supply and demand in view of the expected stabilization of student numbers in higher education.

Young people often have stereotyped visions of S&T professionals and their careers. In order to encourage students to take science courses, they should be provided with accurate information (such as through direct contacts with real professionals).

ii. Decline in Number of R&D Personnel

There was a remarkable decrease (-21%) in the number of R&D personnel in 2006 from 30,983 registered in 2004. Both public and private sectors recorded decreases of 21% and 20% in the number of R&D personnel, respectively. The FTE in 2006 was 13,415.9, a decline of 25% from 17,886.6 recorded in 2004. The number of researchers per 10,000 labor force decreased to 17.9 from 21.3, far below the average of 70 researchers recorded by OECD countries.

Significant efforts should be made to increase the supply of science and technology graduates and research personnel who have adequate skills in S&T.

iii. Underutilized R&D Fund

There are various funds made available to boost R&D activities. However, these funds are underutilized. In this regard, much of the concern should be given on the capacity of the public and the private sectors in utilizing the budgets to its fullest benefit into bringing the country to become more competitive.

iv. Limiting Factors in R&D Activities

Since the period of 1996 until 2006, the R&D trend looks consistent. However, there have been several limiting factors identified through the national survey, which fall into internal or external factors. The limiting factors were found to be different between government institutions (GRI and IHL) and the private sectors. While the government institutions were struggling with personnel issue of lack of time in R&D activities, the private sectors were tied with lack of fund and skilled R&D personnel.

viii. Lack of Innovative Works

Despite the increasing number of patent applications in Malaysia, globally, Malaysian innovative works is quite insignificant based on the small number of patterns applied and granted by USPTO. However, the country is considered progressing well as compared to its other ASEAN counterparts such as Thailand, Philippines, Indonesia and Vietnam. More innovative works in Malaysia should be registered at the International level such as with USPTO.

vi. Scarcity of Biotechnology Indicators

There currently exists a lack of detailed data on biotechnology. Insofar as the Malaysian biotechnology is concerned, not much work has been done in providing measures and indicators in the biotechnology field. Compilation of biotechnology indicators should be initiated through surveys on enterprises and institutions that perform biotechnology-oriented R&D, or which use it for their products and processes. It is necessary to have a complete database of enterprises and institutions to survey. Apart from surveys, compilation of statistical data can be obtained through other private sources, patent databases, etc.

vii. Deficits in Trade & Technology Balance of Payment

Malaysia is facing large deficits in trade activities within the services sector. Huge amount of payments are observed made to various countries such as the United States, Japan, Singapore, and the United Kingdom for services payment such as royalties, contract and professional charges and construction and engineering fees.

In the future, Malaysia may need to consider more innovations in science and technology to improve its high and medium tech manufacturing industries, more production of medium tech manufactured goods, and more training in producing skilled professionals to reduce the consistently large deficits acquired through foreign consultancies. The acquiring of services from outside should be made temporary, and the country should make an effort to address these issues in order to become competitive as a developed country.

viii. Lack of Interest and Awareness in S&T

Despite numerous efforts taken by the public and private sectors to promote S&T, many citizens remained ignorant towards the importance of S&T and how it affects their lives. In this regard, people's interest for S&T is vital and need to be nourished continuously, starting from the infant to the elderly. In order to encourage people's interest in S&T, the knowledge itself has to be relevant and parallel with the local culture. The S&T results and findings also need to be returned with clear explanation, to not only laypeople but also to the government decision makers and researchers.

Moreover, a much bolder support from the government is also needed in the development of S&T awareness among the publics, especially in reaching the rural society. Japan for example has taken a big step in creating and adopting a competitive fund system to support the expenditure for outreach activities or programs. A better fund system will encourage the private sector to establish more S&T outreach activities. In return, two way communications between researchers and public, in rural area especially, is established, hence creating a better learning atmosphere.

In addition, the contributions of universities and public research institutions also need to be exposed to the public on a regular basis. The opening of science facilities and science lab to the public for example, will definitely help to increase the level of interest, especially among the younger generation, towards S&T.

ix. Low volume of Publications in High Impact Journals

Analysis of publications in high impact journals indicates the low publication count among the Malaysian-based authors who published in these journals. In this regard, more awareness and reward systems are needed to encourage publication of research output in this type of journals.

In global comparisons, publication of scientific papers by Malaysian-based author is still considered very small compared to other countries. Malaysian however contributes a noticeable amount of publications in the field of engineering with 1.5% of world outputs in the area. More continuous efforts by all parties are needed in order to promote knowledge generation in S&T within the country. Analysis of publications and citations has been a good measure for looking at how far Malaysia stands as a consumer and a producer of knowledge. In order to become a developed country, Malaysia needs to be independent in terms of research and development, and capable of generating knowledge, based on continuous research and publication.

Malaysian Communications and Multimedia Commission (MCMC). 2008. My Convergence: *Malaysian Communications & Multimedia Industry (Trends in 2008).* Kuala Lumpur.

Ministry of Science, Technology and Innovation (MOSTI). 2004. *Malaysian Science and Technology Indicators Report 2004*. Kuala Lumpur.

Ministry of Science, Technology and Innovation (MOSTI). 2006. *Malaysian Science and Technology Indicators Report 2006*. Kuala Lumpur.

Economic Planning Unit, Prime Minister's Office. 2005. *Ninth Malaysia Plan 2006-2010.* Kuala Lumpur.

Malaysian Science and Technology Information Centre (MASTIC). 2008. *Malaysian Research and Development Classification System 5th Edition.* Kuala Lumpur.

Malaysian Communications and Multimedia Commission (MCMC). 2008. *Communication & Multimedia Selected Facts & Figures (Q4 2007).* Kuala Lumpur.

Association of the Computer and Multimedia Industry (PIKOM). 2008. *IT Job Market Outlook in Malaysia August 2008*. Kuala Lumpur.

Association of the Computer and Multimedia Industry (PIKOM). 2008. *ICT Strategies, Societal & Market Touch November 2008*. Kuala Lumpur.

Malaysian Communications and Multimedia Commission (MCMC). 2007. *Trends and Markets in Malaysian Mobile Service (Industry Report 2007, Volume 5).* Kuala Lumpur.

Multimedia Development Corporation (MDeC). 2007. *Malaysian ICT 2007*. Kuala Lumpur.

Ministry of Science, Technology and Innovation (MOSTI). 2004. *Public Awareness of Science and Technology Malaysia 2004*. Kuala Lumpur.

Ministry of Science, Technology and Innovation (MOSTI). 2008. *Public Awareness of Science and Technology Malaysia 2008 (Interim Report).* Kuala Lumpur.

Ministry of Science, Technology and Innovation (MOSTI). 2004. *The Bibliometric Study of Science and Technology Knowledge Productivity in Malaysia.* Kuala Lumpur.

Organisation for Economic Co-operation and Development (OECD). 2008. *Main Science and Technology Indicators.* Paris.

Electronic Sources:

Ernst &Young (E&Y). Global Biotechnology Report 2008. [Online] Available.
http://www.ey.com/Publication/vwLUAssets/Industry_Biotechnology_Beyond_Borders_2008/$file/Biotechnology_Beyond_Borders_ 2008.pdf, Retrieved on June 8, 2009.

BiotechCorp. BiotechCorp Annual Report 2008. [Online] Available.
http://www.biotechcorp.com.my, Retrieved on June 22, 2009.

National Science Foundation (NSF). Science and Engineering Indicators 2008. [Online] Available.
http://www.nsf.gov/statistics/seind08, Retrieved on December 10, 2008.

National Science Foundation (NSF). Science and Engineering Indicators 2008. [Online] Available.
http://www.nsf.gov/statistics/seind06, Retrieved on January 6, 2009.

International Telecommuncation Union (ITU). Internet indicators: subscribers, users and broadband subscribers 2006. [Online] Available.
http://www.itu.int/ITU-D/ICTEYE/Indicators/Indicators.aspx#, Retrieved on February 17, 2009.

Bosman et al. Scopus reviewed and compared 2006. [Online] Available.
http://info.scopus.com/news/coverage/utrecht.pdf, Retrieved on February 13, 2009.

Appendix 1

Publication of Scientific Papers in Malaysia by Individual Scientists (2001 – February 2009)

Author	No. of Publications	Author	No. of Publications	Author	No. of Publications
Ng, S.W.	859	Othman, M.	57	Rahim, N.A.	43
Fun, H.K.	777	Yusoff, K.	57	Lai, O.M.	42
Chantrapromma, S.	263	Ismail, A.F.	55	Samsudin, A.R.	42
Yamin, B.M.	146	Teoh, S.G.	55	Abdullah, K.	42
Razak, I.A.	134	Salleh, A.B.	55	Abdullah, J.M.	41
Ismail, H.	124	Ali, A.M.	54	Ibrahim, K.	41
Gao, S.	117	Abd-Shukor, R.	54	Low, W.Y.	40
Patil, P.S.	113	Basri, M.	54	Jamuar, S.S.	40
Ahmad, H.	112	Rao, M.V.C.	53	Tan, S.G.	40
Harun, S.W.	106	Jebas, S.R.	51	Aminuddin, B.S.	40
Dharmaprakash, S.M.	100	Tan, W.S.	51	Yuen, K.H.	39
Ahmad, A.L.	92	Chua, K.B.	50	Yam, F.K.	39
Mahdi, M.A.	91	Hameed, B.H.	50	Ibrahim, H.	39
Usman, A.	89	Tan, C.P.	50	Zainal, Z.	39
Bhatia, S.	86	Boo, N.Y.	49	Yap, C.K.	39
Hassan, Z.	86	Ali, B.M.	49	Omar, A.R.	39
Arof, A.K.	86	Kam, T.S.	49	Kordesch, A.V.	39
Mohamed, A.R.	76	Yusof, M.S.M.	47	Taufiq-Yap, Y.H.	38
Hussain, A.	76	Mohd-Yasin, F.	47	Ariffin, A.	38
Hamouda, A.M.S.	75	Abdullah, M.K.	47	Aroua, M.K.	38
Pop, I.	74	Eswaran, C.	47	Phan, R.C.W.	38
Hashim, I.	73	Reaz, M.B.I.	46	Ewe, H.T.	38
Goh, K.L.	73	Lim, C.P.	46	Mahlia, T.M.I.	38
Masjuki, H.H.	72	Ng, S.L.	46	Velmurugan, D.	37
Sapuan, S.M.	70	Lo, K.M.	46	Ishiaku, U.S.	37
Ismail, M.	69	Abdullah, M.K.	46	Cheong, S.K.	37
Che Man, Y.B.	69	Ahmad, M.	45	Peh, S.C.	37
Seetharamu, K.N.	69	Mohamed, A.	45	Sahari, B.B.	36
Majlis, B.Y.	67	Teh, J.B.J.	44	Ruszymah, B.H.	36
Ali, H.M.	66	Abbou, F.M.	44	Baharin, B.S.	36
Huo, L.H.	66	Noorani, M.S.M.	44	Fu, Y.L.	36
Shaari, S.	65	Karalai, C.	44	Fakhru'l-Razi, A.	36
Khatun, S.	63	Abdullah, B.J.J.	44	Rozman, H.D.	36
Chinnakali, K.	62	Xu, J.H.	44	Loh, L.C.	36
Chuah, H.T.	62	Mohd Ishak, Z.A.	44	Daud, W.R.W.	36
Kia, R.	58	Naing, N.N.	43	Ngo, D.C.L.	36
Nazar, R.	57	Lajis, N.H.	43	Ismail, B.S.	36

Appendix 2

Classification of Products by Technology Intensity; High Technology Industries

Industry	ISIC Rev.3	ISIC Description	SITC Rev.3	SITC Description
Aircraft and spacecraft	353	353 - Manufacture of aircraft and spacecraft	7921, 7922, 7923, 7924, 7925, 79291, 79293, 714, 87411 - 71489 - 71499	792.1 - Helicopters 792.2 - Aeroplanes and other aircraft, mechanically-propelled (other than helicopters),of an unladen weight not exceeding 2,000 kg 792.3 - Aeroplanes and other aircraft, mechanically-propelled (other than helicopters), of an unladen weight exceeding 2,000 kg but not exceeding 15,000 kg 792.4 - Aeroplanes and other aircraft, mechanically-propelled (other than helicopters), of an unladen weight exceeding 15,000 kg 792.5 - Spacecraft (including satellites) and spacecraft launch vehicles 792.91 - Propellers and rotors, and parts thereof 792.93 - Undercarriages, and parts thereof 714 - Engines and motors, non-electric (other than those of groups 712, 713 and 718); parts, n.e.s., of these engines and motors 874.11 - Direction-finding compasses; other navigational instruments and appliances **Exclude: 714.89 -** Other gas turbines and **714.99 -** Parts for the gas turbines of heading 714.89
Pharmaceuticals	2423	2423 - Manufacture of pharmaceuticals, medicinal chemicals and botanical products	5413, 5415, 5416, 5421, 5422	541.3 - Antibiotics, not put up as medicaments of group 542 541.5 - Hormones, natural or reproduced by synthesis; derivatives thereof, used primarily as hormones; other steroids used primarily as hormones, not put up as medicaments of group 542 541.6 - Glycosides; glands or other organs and their extracts; antisera, vaccines and similar products 542.1 - Medicaments containing antibiotics or derivatives thereof 542.2 - Medicaments containing hormones or other products of subgroup 541.5 but not containing antibiotics

Office, accounting and computing machinery	30	300 · Manufacture of office, accounting and	75113, 75131, 75132, 75134, 7521, 7522, 7523, 7526, 7527, 7529	751.13 · Automatic typewriters; word-processing machines 751.31 · Electrostatic photocopying apparatus operating by reproducing the original image directly onto the copy (direct process) 751.32 · Electrostatic photocopying apparatus operating by reproducing the original image via an intermediate onto the copy (indirect process) 751.34 · Non-electrostatic photocopying apparatus of the contact type 752 · Automatic data-processing machines and units thereof; magnetic or optical readers, machines for transcribing data onto data media in coded form and machines for processing such data, n.e.s. 759.97 · ....for the machines of group 752 **Exclude: 752.9 -** Data-processing equipment, n.e.s.
Radio, television and communications equipment	32	321 · Manufacture of electronic valves and tubes and other electronic components 322 · Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy 323 · Manufacture of television and radio receivers, sound or video recording or reproducing apparatus, and associated goods	76381, 76383, 764 · 76493 · 76499, 7722, 77261, 77318, 77625, 77627, 7763, 7764, 7768	763.81 · Video-recording or reproducing apparatus, whether or not incorporating a video tuner 763.83 · Other sound-reproducing apparatus 764 · Telecommunications equipment, n.e.s., and parts, n.e.s., and accessories of apparatus falling within division 76 **Exclude : 764.93 -** ....with the apparatus and equipment of groups 761 and 762 and subgroups 764.3 and 764.8 and **764.99 -**....with the apparatus falling within group 763 772.2 · Printed circuits 772.61 · ....for a voltage not exceeding 1,000 V 773.18 · Optical fibre cables 776.25 · Microwave tubes (excluding grid-controlled tubes) 776.27 · Other valves and tubes 776.3 · Diodes, transistors and similar semiconductor devices; photosensitive semiconductor devices (including photovoltaic cells, whether or not assembled in modules or made up into panels); light-emitting diodes 776.4 · Electronic integrated circuits and microassemblies
				776.8 · Piezoelectric crystals, mounted; parts, n.e.s., of the electronic components of group 776 898.79 · Recorded media, n.e.s.
Medical, precision and optical instruments	33	331 · Manufacture of medical appliances and instruments and appliances for measuring, checking, testing, navigating and other purposes, except optical instruments 332 · Manufacture of optical instruments and photographic equipment 333 · Manufacture of watches and clocks	774, 8711, 8713, 8714, 8719, 87211, 874, 88111, 88121, 88411, 88419, 89961, 89963, 89966, 89967	774 · Electrodiagnostic apparatus for medical, surgical, dental or veterinary purposes, and radiological apparatus 871.1 · Binoculars, monoculars, other optical telescopes, and mountings therefor; other astronomical instruments and mountings therefore (excluding instruments for radio astronomy) 871.3 · Microscopes (other than optical microscopes); diffraction apparatus; parts and accessories thereof, n.e.s. 871.4 – Compound optical microscopes (including those for photomicrography, cinephotomicrography or microprojection) 871.9 · Liquid crystal devices, n.e.s.; lasers (other than laser diodes); other optical appliances and instruments, n.e.s. 872.11 · Dental drill engines, whether or not combined on a single base with other dental equipment 874 · Measuring, checking, analysing and controlling instruments and apparatus, n.e.s. **Exclude : 874.11** · Direction-finding compasses; other navigational instruments and appliances and 874.2 · Drawing, marking-out or mathematical calculating instruments (e.g., drafting machines, pantographs, protractors, drawing sets, slide-rules, disc calculators); instruments for measuring length, for use in the hand (e.g., measuring rods and tapes, micromete... 881.11 · Photographic (other than cinematographic) cameras 881.21 · Cinematographic cameras 884.11 · Contact lenses 884.19 · Optical fibres and optical fibre bundles and cables; sheets and plates of polarizing material; unmounted optical elements, n.e.s. 899.61 · Hearing-aids (excluding parts and accessories)

				899.63 - Orthopaedic or fracture appliances 899.66 - Other artificial parts of the body 899.67 - Pacemakers for stimulating heart muscles (excluding parts and accessories)

Appendix 3

Classification of Products by Technology Intensity; Medium High Technology Industries

Industry	ISIC Rev.3	ISIC Description	SITC Rev.3	SITC Description
Electrical machinery and apparatus, n.e.c.	31	311 - Manufacture of electric motors, generators and transformers 312 - Manufacture of electricity distribution and control apparatus 313 - Manufacture of insulated wire and cable 314 - Manufacture of accumulators, primary cells and primary batteries 315 - Manufacture of electric lamps and lighting equipment	77862, 77863, 77864, 77865, 7787, 77884	778.62 - Tantalum fixed capacitors 778.63 - Aluminium electrolytic fixed capacitors 778.64 - Ceramic dielectric fixed capacitors, single layer 778.65 - Ceramic dielectric fixed capacitors, multilayer 778.7 - Electrical machines and apparatus, having individual functions, n.e.s.; parts thereof 778.84 - Electric sound or visual signalling apparatus (e.g., bells, sirens, indicator panels, burglar and fire-alarms), other than those of heading 778.34 or 778.82
Motor vehicles, trailers and semi-trailers	34	319 - Manufacture of other electrical equipment n.e.c. 341 - Manufacture of motor vehicles 342 - Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	781- 784, 786	781 - Motor cars and other motor vehicles principally designed for the transport of persons (other than motor vehicles for the transport of ten or more persons, including the driver), including station-wagons and racing cars 782 - Motor vehicles for the transport of goods and special-purpose motor vehicles 783 - Road motor vehicles, n.e.s. 784 - Parts and accessories of the motor vehicles of groups 722, 781, 782 and 783 786 - Trailers and semi-trailers; other vehicles, not mechanically-propelled; specially designed and equipped transport containers

				343 - Manufacture of parts and accessories for motor vehicles and their engines
Chemicals excluding pharmaceuticals	24 excl. 2423	241 - Manufacture of basic chemicals 242 - Manufacture of other chemical products 243 - Manufacture of man-made fibres 2411 - Manufacture of basic chemicals, except fertilizers and nitrogen compounds 2412 - Manufacture of fertilizers and nitrogen compounds 2413 - Manufacture of plastics in primary forms and of synthetic rubber 2421 - Manufacture of pesticides and other agro-chemical products 2422 - Manufacture of paints, varnishes and similar coatings, printing ink and mastics 2424 - Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations 2429 - Manufacture of other chemical products n.e.c. 2430 - Manufacture of man-made fibres	52222, 52223, 52229, 52269, 525, 531, 57433, 591	522.22 - Selenium, tellurium, phosphorus, arsenic and boron 522.23 - Silicon 522.29 - Calcium, strontium and barium; rare earth metals, scandium and yttrium, whether or not intermixed or interalloyed 522.69 - Other inorganic bases; other metal oxides, hydroxides and peroxides 525 - Radioactive and associated materials 531 - Synthetic organic colouring matter and colour lakes, and preparations based thereon 574.33 - Polyethylene terephthalate 591 - Insecticides, rodenticides, fungicides, herbicides, anti-sprouting products and plant-growth regulators, disinfectants and similar products, put up in forms or packings for retail sale or as preparations or articles (e.g., sulphur-treated bands, wicks and...
Railroad equipment and transport equipment, n.e.c	352, 359	3520 - Manufacture of railway and tramway locomotives and rolling stock 3591 - Manufacture of motorcycles 3592 - Manufacture of bicycles and invalid carriages	791, 785	791 - Railway vehicles (including hovertrains) and associated equipment 785 - Motor cycles (including mopeds) and cycles, motorized and non-motorized; invalid carriages

		3599 - Manufacture of other transport equipment n.e.c.		
Machinery and equipment, n.e.c.	29	291 - Manufacture of general purpose machinery 292 - Manufacture of special purpose machinery 293 - Manufacture of domestic appliances n.e.c. 2911 - Manufacture of engines and turbines, except aircraft, vehicle and cycle engines 2912 - Manufacture of pumps, compressors, taps and valves 2913 - Manufacture of bearings, gears, gearing and driving elements 2914 - Manufacture of ovens, furnaces and furnace burners 2915 - Manufacture of lifting and handling equipment 2919 - Manufacture of other general purpose machinery 2921 - Manufacture of agricultural and forestry machinery 2922 - Manufacture of machine-tools 2923 - Manufacture of machinery for metallurgy 2924 - Manufacture of machinery for mining, quarrying and construction 2925 - Manufacture of machinery for food, beverage and tobacco processing 2926 - Manufacture of machinery for textile,	71489, 71499, 71871, 71877, 71878, 72847, 7311, 73131, 73135, 73142, 73144, 73151, 73153, 73161, 73163, 73165, 73312, 73314, 73316, 7359, 73733, 73735	714.89 - Other gas turbines 714.99 - Parts for the gas turbines of heading 714.89 718.71 - Nuclear reactors 718.77 - Fuel elements (cartridges), non-irradiated 718.78 - Parts of nuclear reactors 728.47 - Machinery and apparatus for isotopic separation, and parts thereof, n.e.s. 731.1 - Machine tools for working any material by removal of material, by laser or other light or photon beam, ultrasonic, electrodischarge, electrochemical, 731.31 - Horizontal lathes, numerically controlled 731.35 - Other lathes, numerically controlled 731.42 - Other drilling machines, numerically controlled 731.44 - Other boring-milling machines, numerically controlled 731.51 - Milling machines, knee-type, numerically controlled 731.53 - Other milling machines, numerically controlled 731.61 - Flat-surface grinding machines, numerically controlled, in which the positioning in any one axis can be set up to an accuracy of at least 0.01 mm 731.63 - Other grinding machines, numerically controlled, in which the positioning in any one axis can be set up to an accuracy of at least 0.01 mm 731.65 - Sharpening (tool- or cutter-grinding) machines, numerically controlled 733.12 - Bending, folding, straightening or flattening machines (including presses), numerically controlled

		apparel and leather production 2927 - Manufacture of weapons and ammunition 2929 - Manufacture of other special purpose machinery 2930 - Manufacture of domestic appliances n.e.c.		733.14 - Shearing machines (including presses), numerically controlled, other than combined punching and shearing machines 733.16 - Punching or notching machines (including presses), including combined punching and shearing machines, numerically controlled 735.9 - Parts, n.e.s., and accessories suitable for use solely or principally with the machine tools of groups 731 and 733 737.33 - Machines and apparatus for resistance welding of metal, fully or partly automatic 737.35 - Machines and apparatus for arc (including plasma-arc) welding of metal, fully or partly automatic