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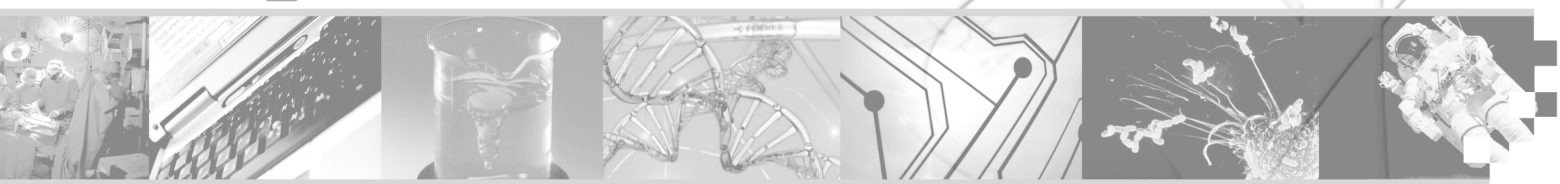
Malaysian Science and Technology Indicators 2006 Report

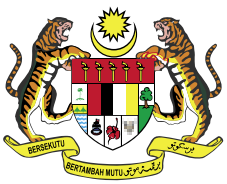
MOSTI

Malaysian Science and Technology Indicators



2006 Report

Published by:



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Design & Printed by
Creative & Communications House Sdn Bhd **(514743-X)**

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Preface

The availability of comprehensive information on national and international science, technology and innovation (STI) is fundamental towards informed decision-making and policy formulation in matters pertaining to national STI. As part of its ongoing efforts to disseminate information on Malaysia's STI, the Malaysian Science and Technology Information Centre (MASTIC) under the Ministry of Science, Technology and Innovation (MOSTI) is pleased to release this latest edition of the Malaysian Science and Technology Indicators 2006 Report. This is the seventh in a series of biennial reports on STI indicators published by MASTIC since the inaugural issue in 1992.

This report is based on survey data and studies commissioned and published by MASTIC including the National Research and Development 2006 Report, Public Awareness of Science and Technology in Malaysia 2004, National Survey of Innovation 2002-2004, as well as compilation of secondary data from other organisations.

The Malaysian Science and Technology Indicators 2006 Report provides details of the national performance and trends in STI including education, human resource, research and development activities, public support for STI, innovation in the manufacturing sector, trade in technology, publications and citations, patenting, ICT profile and awareness, knowledge and attitude towards STI. Additionally, a scorecard depicting how well the country has performed in the selected STI indicators since the publication of the last report is also included.

Acknowledgements

MASTIC wishes to record its gratitude to all individuals and organisations for their assistance and contributions towards the successful completion of the Malaysian Science and Technology Indicators 2006 Report.

We would like to thank in particular the Secretary-General of the Ministry of Science, Technology and Innovation (MOSTI) for extending invaluable guidance and unflinching support for the preparation of this report.

We also wish to record our appreciation to all the members of the Technical Committee and all the data providers for their contributions, assistance, advice and suggestions as follows:

- Ministry of Higher Education
- Intellectual Property Corporation of Malaysia
- Bank Negara Malaysia
- Department of Statistics Malaysia
- Small and Medium Industries Development Corporation (SMIDEC)
- Inland Revenue Board
- MIMOS Berhad
- Malaysian Examinations Council
- Malaysian Technology Development Corporation (MTDC)
- Multimedia Development Corporation Sdn Bhd (MDeC)
- Malaysian Industrial Development Authority (MIDA)
- Malaysian Invention and Design Society (MINDS)
- Various Divisions under Ministry of Science, Technology and Innovation (MOSTI)

Last but not least we would like to thank Assoc. Prof. Dr. K. Thiruchelvam and his team members from the Consultancy Unit of University of Malaya who were responsible for preparing this report.

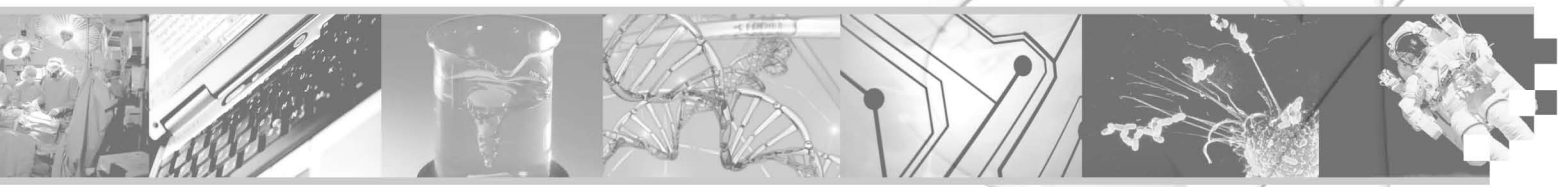
LIST OF ABBREVIATIONS

9 MP	9th Malaysia Development Plan (2006-2010)
AAHI	Arts and Humanities Citation Index
CRDF	Commercialization of Research and Development Fund
DAGS	Demonstrator Application Grant Scheme
DEL	Direct Exchange Line
FOR	Field of Research
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GERD	Gross Expenditure of Research & Development
GRIs	Government Research Institute
ICS	Information and Communication Services
ICT	Information and Communication Technology
IGS	Industry Grant Scheme
IHLs	Institute of Higher Learning
IP	Intellectual Property
IPR	Intellectual Property Rights
IRPA	Intensification of Research in Priority Areas
ISI®	Institute of Scientific Information
ITA	Investment Tax Allowance
ITAF	Industry Technical Assistance Fund
MGS	Multimedia Super Corridor R&D Grant Scheme
MKCS	Malaysian Knowledge Content Survey
NCR-Malaysia	Thompson ISI® National Citation Report for Malaysia
NGO	Non Governmental Organisation
NSB 2006 S&E	United States National Science Indicators Board 2006 Science and Engineering Indicators
NSI	National Survey on Innovation
NSIOD	Thompson ISI® National Science Indicators Deluxe 2006 edition
NSTP2	National Science and Technology Policy 2
PCT	Patent Cooperation Treaty
R&D	Research and Development
RM	Ringgit Malaysia
S&T	Science and Technology
SCI	Science Citation Index
SEO	Social Economic Objective
SMEs	Small and Medium Enterprises
SMS	Short Message Service
SSCI	Social Science Citation Index
SPM	Sijil Pelajaran Malaysia
STI	Science, Technology and Innovation
STPM	Sijil Tinggi Pelajaran Malaysia
TAF	Technology Acquisition Fund
TBP	Technology Balance of Payments

LIST OF ORGANISATIONAL ABBREVIATIONS

ASEAN	Association of South East Asian Nations
DOS	Department of Statistics
EPU	Economic Planning Unit
FRIM	Forest Research Institute Malaysia
IDC	International Data Corporation
IKRAM	Institut Kerja Raya Malaysia Bhd
IMR	Institute for Medical Research
JPS	Jabatan Perairan dan Saliran
JPSB	Jabatan Perhutanan Sabah
JTSB	Jabatan Pertanian Sabah
JTSK	Jabatan Pertanian Sarawak
KUSTEM	Kolej Universiti Sains Teknologi Malaysia
MACRES	Malaysian Centre for Remote Sensing
MARDI	Malaysian Agricultural Research Development Institute
MASTIC	Malaysian Science and Technology Information Centre
MCMC	Malaysian Communications and Multimedia Commission
MDeC	Multimedia Development Corporation
MIMOS	Malaysian Institute of Microelectronics System
MINT	Institut Penyelidikan Teknologi Nuklear Malaysia
MMU	Malaysia Multimedia University
MOSTI	Ministry of Science, Technology and Innovation
MOE	Ministry of Education
MPOB	Malaysia Palm Oil Board
MTDC	Malaysian Technology Development Corporation
MyIPO	Intellectual Property Corporation of Malaysia
OECD	Organization for Economic Cooperation and Development
SIRIM	Standards and Industrial Research Institute of Malaysia
SMIDEC	Small and Medium Industry Development Corporation
UiAM	Universiti Islam Antarabangsa Malaysia
UiTM	Universiti Teknologi MARA
UKM	Universiti Kebangsaan Malaysia
UM	Universiti Malaya
UMS	Universiti Malaysia Sabah
UNCTAD	United Nations Conference on Trade and Development
UN COMTRADE	United Nations Community Trade
UPM	Universiti Putra Malaysia
USM	Universiti Sains Malaysia
USPTO	United States Patent and Trade Mark Office
UTM	Universiti Teknologi Malaysia
UTP	Universiti Teknologi Petronas
UUM	Universiti Utara Malaysia
WIPO	World Intellectual Property Organization

EXECUTIVE SUMMARY



WHY PROFICIENCY IN SCIENCE, TECHNOLOGY AND INNOVATION IS IMPORTANT

Fluency in science, technology and innovation (STI) is crucial to Malaysia's future because it is the fundamental platform for creating sustainable socio-economic wealth for the nation. In today's increasingly knowledge-intensive economy success will go to countries with clear and committed policies and programmes that are underpinned by attention to developing skills, partnerships, selectivity and societal engagement.

Malaysia's competency in STI is still embryonic. As a small country, we need to leverage our STI system to capture the benefits of our increasing domestic investments as well as from external sources of knowledge. These investments are characterized by long lead times and they require the unflinching and sustained support by all parties including the Government, industry, non-governmental organizations and society as a whole.

Getting the most from our STI investments is not easy. Such an arduous task would be helped considerably through the provision of comprehensive and timely information on inputs, processes, outputs and impacts related to STI activities so that we can better monitor our investments as well as adopt more adequate responses to new developments.

What is this Report all about?

This biennial Report, the seventh since 1992, describes the findings of a study aimed at assessing the overall performance of STI in Malaysia through an examination of several related items pertaining to

- Education in STI;
- Human resource for STI;
- R&D activities;
- Public Support Schemes and incentives for STI;
- Innovation in the Manufacturing Sector;
- Trade in technology;
- Publications and citations;
- Patents;
- ICT development;
- Public awareness in STI

The main focus of this study is to ascertain where we are in the above items particularly our strengths and deficiencies in relation to the levels as contained in the previous report as well as to compare our achievements with selected countries. More importantly, the findings would assist policy makers in the identification of areas of strengths that should be maintained and developed and weaknesses and gaps that need to be addressed and remedied. Such constant monitoring and evaluation of our STI system is crucial given the changing nature and increasing capital intensity of knowledge creation and diffusion. A basic STI Scorecard is developed that is aimed at benchmarking our STI performance since the publication of the last report as well as in comparison to selected countries.

This report is based on primary information made available to the Consultant. Reports from secondary sources have also been used to enrich the discussion. The report provides a cursory sketch of Malaysia's STI system. More items, than presented here, need to be included to obtain a more holistic and detailed picture.

MAIN FINDINGS

The key findings that emerged from this study are as follows:

Education in STI

(i) There has been a steady increase in the total number of students registering for science and mathematics subjects at both the SPM and STPM levels. However, increase is not uniform across subjects. There is a noticeable decline in student registration for Further Mathematics T at the STPM level;

(ii) There has been a steady decline in the proportion of Arts students in first degree enrolment at public IHLs for period covering academic year 1999/2000 to 2004/2005. This decline is in line with government's policy of achieving Arts to Science student enrolment ratio of 40:60. A similar declining trend in Arts graduates over a ten year period from 1994-2004 is observed;

(iii) First degree enrolment at private IHLs has been on the upward trend and stood at 101,516 students in 2005 – almost 50% of the undergraduate enrolment of public IHLs. There has been a significant increase in the number of students pursuing Arts and other non-science and engineering fields during this period. Similarly, first degree graduation from private IHLs has also been on a steady increase with a total of 20,294 graduates in 2005 – almost 50% of the figure for graduations in public IHLs;

(iv) The expansion in Arts enrolment in private IHLs has resulted in the slight decline in the share of science and engineering enrolment to the overall first degree enrolment from 51.75% in 2002 to 48.15% in 2004;

(v) Post-graduate enrolment and graduation increased sharply over the period of 1994-2004 particularly in the public IHLs. In both cases, Arts enrolment and graduation predominate. Public IHLs contribute almost 88% of total post-graduate enrolment in 2004. Science and engineering postgraduate enrolment has declined slightly from 44% to 41% of total postgraduate enrolment for 2002 and 2004 respectively. Ratio of postgraduate to undergraduate enrolment has increased from 1:8.4 (11.8%) in 2002 to 1:6.6 (15.2%) in 2004;

(vi) Noticeable trend of higher women enrolment and graduates at first degree level in both the Arts and the Sciences in recent years. This trend is evident in both the public and private IHLs;

Human Resource for STI

(i) Number of R&D personnel (headcount) has increased significantly (24%) from 24,937 in 2002 to reach 30,983 in 2004. Most of the increase is largely due to the increase in researchers particularly in industry and IHLs. However, the number of technicians and support staff has not changed much. The number of researchers per 10,000 labour force has increased to 21.3 (from 18.0 in 2002);

(ii) Dramatic increase in R&D manpower in terms of FTE particularly in IHLs and GRIs but steady growth in industry. Also, FTE per researcher increased from 0.4 in 2002 to 0.55 in 2004 indicating more time spent in research by researchers particularly in IHLs and GRIs but decline in industry;

(ii) Most researchers (55%) are located in IHLs. Almost 56% of researchers possess post-graduate qualifications. Women constitute almost 36% of total researchers with the majority located in IHLs. Foreigners comprise 4.7% of total R&D personnel with majority in IHLs;

(iv) At the sectoral level, the GRIs, IHLs and industry have all increased their number of R&D personnel. MPOB has the most number of R&D personnel among GRIs whilst UTM ranks first among the IHLs in terms of R&D personnel. Number of R&D personnel in industry in 2004 recorded a sharp increase (69%) from total in 2002 with majority engaged in manufacturing related research;

(v) Most R&D personnel were engaged in applied research (40%) followed by basic (23%) and experimental development (12%). The top three FOR by R&D personnel in 2004 were Information, Computer and Communication Technology (ICCT), Engineering Science and Social Science. By sector, the GRIs were more prominent in agriculture, the IHLs were evenly spread in all fields whilst industry was more engaged in ICCT;

(vi) The top three SEOs by R&D personnel were Natural Sciences, Technology and Engineering, Manufacturing and Plant Production and Plant Primary products. By sector, the GRIs were more active in Plant Production and Plant Primary products, the IHLs more into Natural Sciences, Technology and Engineering while industry's involvement was skewed towards manufacturing;

R&D Investments and Expenditure

(i) Although there has been a steady increase in total R&D expenditure, the research intensity (GERD/GDP) has declined slightly to 0.63% in 2004 from 0.69% in 2002 due to greater expansion in GDP. Our research intensity is less than a third of the average for developed countries;

(ii) R&D expenditure continued to be largely devoted to applied research (55%). Industry contributed almost 72% of the total R&D expenditure. There has been a steady increase in industry expenditure in R&D reflecting industry's efforts to enhance their operations given the increasing competitiveness of the external environment. Public sector expenditure in R&D, especially that of the GRIs, has declined;

(iii) Most of the expenditure has been focused in the areas of engineering science, Information, Computer and Communication Technology (ICCT) and applied sciences and technology. In terms of socio-economic objectives, the expenditure has been largely in the areas of Manufacturing, Information and Communication Services, Natural Science, Technology & Engineering, Plant Production & Plant Primary Products as well as Energy Resources;

(iv) The bulk of the R&D in 2004 was conducted in Malaysia. Outsourced R&D (RM 32.9 million) declined significantly in 2004. About 44% of total industry R&D expenditure came from foreign-owned firms while large firms accounted for almost 77% of the total industry R&D expenditure;

Public Support Schemes and Incentives for STI

(i) The period 2004-2005 was characterized by a noticeable decline in approvals under the various R&D grant schemes. A sharp increase in the amount of expenses granted for double deduction income tax relief during the period 2002-2004 as compared to the earlier period of 2000-2002 was observed. The sudden increase can be attributed to the increasing number of companies and projects submitted for relief under this incentive scheme given the increasing competitive international environment;

(ii) There have been a substantial increase in investments in R&D by both foreign and local companies in response to the various investment incentives introduced by the government particularly the customized pre-packaged incentives which constituted almost 90% of the total investments from the various R&D investment incentives in 2005;

Innovation in the Manufacturing Sector

(i) The period 2002-2004 was characterized by improvements in the incidence of innovation in the manufacturing sector. The share of innovations reported by manufacturing firms in 2002-2004 increased significantly over the previous periods of 1997-1999 and 2000-2001;

(ii) There were also changes in the state of innovation in the manufacturing sector by size, ownership, age and location. Large firms reported increase in share of firms reporting innovation while local firms experienced decline over the period 2002-2004;

(iii) There was a fall in firms reporting an increase in new product development over the period 2000-2004. There was also a substantial increase in firms reporting falling innovation-related expenditure;

(iv) More firms reported favourable innovation environment including government policy and role of universities and public and private research institutions. Also, government support through incentives, grants, loans and other inducements emerged as the most important innovation stimulant during this period (2002-2004);

(v) Main obstacles hampering innovation during this period included lack of market information, human capital, information on technology and internal organizational rigidities. Sharp fall in innovation costs and sharp rise in firm-level organizational rigidities witnessed the biggest changes in reporting by firms between the periods 2000-2001 and 2002-2004;

(vi) The findings of the innovation survey suggest that government initiatives to address market failure in firm-level activities are beginning to take effect in the manufacturing sector but the small number of patent applications indicate that it is too slow to facilitate catching up by Malaysian firms in the international technology ladder;

Trade in Technology

(i) Malaysia's trade in technology during the period of 2002-2004 registered improvements in all accounts with the exception of royalties where deficits continued to grow;

(ii) High tech goods still dominate Malaysia's manufactured exports structure. Its share increased marginally from 55.9 to 56.1 percent in 2003-2004. The contribution of medium-high tech manufactured goods was extremely small rising slightly from 1.4 to 1.6 percent in the same period;

(iii) High tech goods accounted for over half of Malaysia's manufactured imports with its share falling from 53.7 to 51.0 percent in 2003-2004. The share of medium-high tech imports grew from 42.2 to 42.4 percent over the same period;

(iv) High tech manufactured goods recorded a positive trade balance with the nominal surplus rising in the period 2003-2004 while medium-high tech industries experienced a negative and worsening trade balance in the same period. Other goods enjoyed a huge trade surplus although declining slightly during the same period;

(v) Deficits in the royalty account grew further in 2002-2004. Although receipts grew in 2002-2004, the deficit widened because of faster growth in payments. The royalty balance involving the main trading partners of United States, Japan, Singapore and United Kingdom worsened in 2002-2004 despite some improvements from 2003. This trend suggests that much of the innovations that have taken place in firms in Malaysia are still not new to the universe;

(vi) There was greater diversification in the participation of trading partners in contract and professional charges. However, the positive balance enjoyed with the important trading partners of United States in 2000-2002 and Hong Kong in 1999 was no longer achieved in 2003-2004. The others category - with Australia as the main contributor – accounted for over 40 percent of the deficit professional and contract charges in 2003-2004;

(vii) The prime source of improvement in the services account in 2002-2004 came from construction and engineering. The receipts received from this account grew significantly faster than the payments in 2003-2004. Although the construction and engineering account involving important trading partners such as Japan, the United States and United Kingdom worsened between 2002 and 2004, the deficit with Singapore fell considerably and the balance with others had become positive in 2004;

(viii) Despite some improvements it can be seen that the overall picture in the services account has been negative with the deficits remaining high. The high deficits in royalty payments for intellectual property suggests that Malaysia is still a net technological learner - typical of economies still located low in the technological ladder. There is thus a need to strengthen government policy to quicken further learning and innovation in firms in Malaysia. The growth in surplus involving construction and engineering with other economies also suggests that the government should encourage diversification of service markets;

Publications and Citations

(i) Malaysia is ranked 52nd with a total of 5688 ISI-indexed publications (or 0.14% of the world's total) in all fields among the 179 countries covered in the ISI NSIOD database for the period 2001-2005. Among ASEAN countries, Singapore (32nd) and Thailand (45th) are ranked higher than Malaysia. In terms of citations, Malaysia is ranked 57th below that of Singapore (36th) and Thailand (43rd);

(ii) In field of biotechnology and applied microbiology, the gap in the quantity of publications among Thailand, Singapore and Malaysia is not wide. However, the gap broadens when comparison is made between ASEAN and the rest of the Asia-Pacific countries;

(iii) The top 4 IHLs (UM, USM, UPM and UKM) in Malaysia continue to be the main drivers of S & T knowledge output whereas the GRIs' knowledge output as measured by international publications and citations are minuscule;

(iv) There has been growth in Malaysian output (papers) for some strategic fields such as Applied Physics/Condensed Matter/Materials Science and Material Science & Engineering as well as in Biotechnology and Applied Microbiology;

(v) Publishing by Malaysians in top journals is minimal. China is Malaysia's top scientific collaborating partner. There is growing scientific partnership with other countries;

Patenting in Malaysia

(i) There has been a marked decline in patent applications during 2001-2005 period when compared to earlier period of 1996-2000. However, there was a significant increase in patent applications filed by Malaysians during period of 2001-2005;

(ii) Total number of patents granted increased during period 2001-2005 but number granted to Malaysians declined. Largest number of patents were granted in the fields of chemistry and metallurgy and electricity;

(iii) Average time for a patent application to mature to a grant in Malaysia is around 4 to 5 years. This approval period is slower than that in Singapore (2-4 years), UK (4 years) and US (3 years) but faster than that recorded in Japan (7-12 years) and European Patent Office (7-8 years);

(iv) A total of 158 patent applications from IRPA-funded projects were filed during the period 1996-2005. Of this number, a total of 20 patents were granted;

(v) There has been a sharp increase in the number of Malaysian inventors securing awards at international exhibitions and competitions;

Knowledge Diffusion: ICT Infrastructure and ICT Industry

(i) Small decline observed in Direct Exchange Line (DEL) subscription since 2002 although business DEL subscription recorded increase during the same period. Cellular phone subscription increased almost two-fold during period 2002-2005 largely due to rapid surge in prepaid cellular phone subscribers which now contribute to almost 85% of total cellular phone market in the country;

(ii) There has been a steady increase in Internet usage reaching some 474 users per 1000 people in 2005. This level of usage is highest among ASEAN member countries after Singapore. Internet access, however, is largely (88%) through dial-up mode although there has been a steady increase in broadband access;

(iii) Computer ownership increased 58% from 137 per 1000 people in 2002 to 216 per 1000 people in 2005. This ownership level is highest in ASEAN after Singapore;

(iv) There has been a steady increase in ICT expenditures and revenues. Manufacturing continues to be the leading sector of ICT expenditure. There is strong growth in the government sector reflecting commitment by the government towards adoption of ICT in the public sector;

(v) Malaysia is one of the leading exporters and importers of ICT goods. Due to the global dynamics of this sector, Malaysia's share of this burgeoning market declined some 8% during the period 2000-2003. This slide can be attributed to relocation of some of the manufacturing businesses to lower wage countries;

(vi) E-commerce transactions recorded a four-fold increase during the period 2002-2004. Majority of these transactions (more than 70%) was of the B2B-type;

(vii) Malaysia is the leading ASEAN country after Singapore in terms of main telephone line, internet and cellular phone penetration rates per 100 inhabitants. However, our penetration rates are well below that of the leading OECD countries. In terms of ICT tariffs, Malaysia is competitive among ASEAN countries in international fixed line and dial-up internet costs, but not in mobile telephone and broadband costs. In comparison to OECD countries, Malaysia is competitive in dial-up internet costs, international fixed telephone costs and mobile telephone costs, but not in broadband costs;

Public Awareness in STI

(i) Malaysians possess good understanding of scientific concepts and knowledge but are weak in questions that require higher order scientific knowledge. Perceived interest of Malaysian public towards S&T has remained constant for period 2000-2004 with the level of interest recorded between 'slightly interested' to 'moderately interested'. Computer technology registered highest interest among respondents whilst nuclear technology and space exploration were of least interest;

(ii) Malaysians perceived themselves as having between poor and average knowledge of S&T. This perception has not changed much over the period 1998-2004. When perceived knowledge is compared to level of interest, it is found that the former is often lower than the latter;

(iii) The attitude of Malaysians towards S&T has improved appreciably over the period 1996-2004. A similar conclusion can also be ascribed regarding public understanding of S&T in Malaysia;

(iv) Malaysians generally do not regard science as incompatible with their respective religions. Youths scored highest in terms of attitude towards S&T. Similar high scores were recorded by residents from urban locations and those with tertiary qualifications. There were no significant gender differences in terms of attitude towards S&T;

(v) Television and newspapers are by far the two most popular sources regarding public's sources of information on S&T;

(vi) Internationally, Malaysians compare favourably in terms of attitude and interest in S&T, but not in terms of understanding of S&T, when compared to the Japanese, Europeans and Americans;

STI Scorecard 2006 and Way Forward

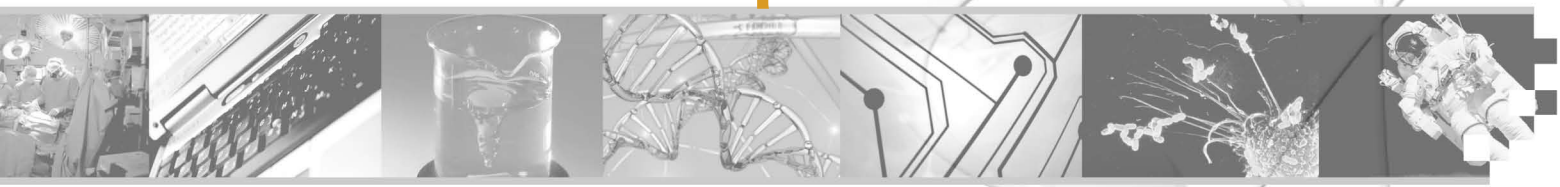
(i) Malaysia has improved its STI performance in almost all the indicators as described in the scorecard. However, it must be stressed that the scorecard is limited in scope and a number of other indicators that capture the performance of the STI system are not included. Additionally, we must recognize that in a number of key areas of publishing and patenting, we are well behind that of our ASEAN neighbours. 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 2006

Category	Indicator	Year 2004	Year 2002	Trend	Average/Selected OECD
R&D Investments and expenditure	Overall R&D Intensity	0.63	0.69	-ve	2.33[1]
	Industry R&D expenditure as % of GERD	71.5	65.3	+ve	> 62[2]
Human Resources	Total R&D Personnel (Headcount)	30,983	24,937	+ve	> 100,000[3]
	Researchers per 10,000 labour force	21.3	18.0	+ve	61[4]
	Total FTE per researcher	0.55	0.40	+ve	0.74[5]
	Science and engineering enrolment as % of total first degree enrolment	48.2	51.8	-ve	44.6[6]
	Science and engineering enrolment as % of total post-graduate enrolment	40.6	44.2	-ve	32.4[7]
	Proportion of postgraduate enrolment to undergraduate enrolment	1: 6.6	1:8.4	+ve	1:11.6[8]
	Women researchers as proportion of total researchers (%)	35.8	33.7	+ve	27[9]
Interaction and Cooperation	% of public R&D financed by industry/external funds	2.0	NA	-	>10[10]
Outputs and Outcomes	Total number of publications in ISI-indexed journals, (1981-2005)	1179	938	+ve	16,628[11]
	Total Citations (2001-2005)	1360	2716	-ve	37,502[12]
	No of patents applied (Malaysians)	522	322	+ve	> 10,000[13]
	No. of patents granted (Malaysians)	24	32	-ve	> 6,300[14]
	No of USPTO patents granted per million population	3.6	2.5	+ve	152[15]
Knowledge Infrastructure and Diffusion	No. of computer per 1000 people	192	137	+ve	> 500[16]
	Internet users per 100 population	38.2	31.9	+ve	> 60[17]
	Cellular phone subscription per 100 inhabitants	56.5	36.9	+ve	> 60[18]
S&T Knowledge, Understanding and Awareness	Mean Score of perceived interest in S&T	2.40	2.41	-	NA
	Mean Score of perceived knowledge in S&T	2.22	2.32	-	NA
	Attitude towards S&T[#] Index of Scientific Promise[#]; Index of Scientific Reservation[#]	63.7; 71.9; 47	62.3; -	+ve	 US (79); Europe (67); US(45); Europe (53)

See Survey on Public Attitudes towards S&T; (MASTIC, 2005); *Data for this section taken from various sources principally from OECD Main S&T Indicators; [1] Average OECD However, countries like Korea and Nordic countries report higher values; [2] Average OECD. Japan (75); [3] Many OECD countries have more than 100,000 researchers. For example, Korea has 210,000 researchers in 2004; [4] Average OECD; [5] Figure for Korea's researchers (2004); [6,7,8] Figures on Korean Education from Korea Educational Development Institute (2005) [9] Average value for EU/EFTA (UNESCO Institute for Statistics, 2006); [10] average of selected OECD [11&12]Average no. of ISI papers for Australia, Korea and Finland (NSIOD,2006); [13 & 14] Average value for figures for Germany, France, UK (OECD); [15] weighted average OECD; [16, 17, 18] Figures from IMD World Competitiveness Report 2006

Chapter 1



INTRODUCTION

1.1 PREAMBLE

Science, technology and innovation (STI) are the key driving forces propelling the growth of both advanced and developing economies. As the global economy evolves from one based on energy and raw materials to one based on the exploration and exploitation of knowledge, economic progress will be increasingly determined by how well a nation marshals its investments in STI. Managing such investments is not easy given the inherent uncertainties surrounding research and development (R&D) and its subsequent transformation to products, processes and services. Additionally, these investments are not cheap. Despite these imponderables, countries that are prepared to continuously invest and strategically manage these investments will be rewarded with enhanced socio-economic returns.

Malaysia has recognized the importance of investing in knowledge-seeking activities in its quest of attaining the status of a developed nation by the year 2020. Despite an almost 10-fold increase in public investments in science, technology and innovation over the past two decades, Malaysia's position in STI is still not satisfactory. The recent 2006 edition of the World Competitiveness Yearbook revealed that although Malaysia's ranking in scientific infrastructure has improved slightly since 2004, the country's weak position in terms of R&D expenditure and R&D personnel is evident.

These weaknesses cannot remain unchecked. The Government has in recent years announced a number of initiatives aimed at strengthening the nation's STI capacity and capabilities as well as the commercialization potentials of its public research system. These include, among others, the Science and Technology Policy 2, the National Biotechnology Policy, the Industrial Master Plan 3 and the Ninth Malaysia Plan. STI has been integrated into national development planning to ensure that its development is in tandem with the other sectors. The infrastructure for STI has been expanded and strengthened with the establishment of several new research and technology development and promotion institutions including specific initiatives to promote information and communication technology and biotechnology. Promotion of R&D as well as the development of S&T manpower has been accorded particular attention. Under the Ninth Malaysia Plan (2006-2010), the allocation for S&T has almost doubled that of the previous plan.

Even with these substantial efforts, our STI proficiency, as mentioned earlier, is weak. It is generally acknowledged that we are competent in adopting imported technologies but poor in generating new or improved technologies. This deficiency in innovative capacity is worrying since there are several countries, which are more competitive than us in terms of land and labour. And, many of these countries are catching up fast. We need to quickly move up the ladder of technological competency by becoming a fast and continuous learner; competent in absorbing and adapting imported technologies; and to continuously enhance our indigenous technological capabilities so that we will be able to compete confidently in the world markets.

Given this intense competition, it becomes imperative that we reap dividends from our substantial investments in STI. Accordingly, we need to monitor closely on our performance in our STI investments as well as how well we are doing relative to our competitors so that we can regularly review and adjust our policies to meet new challenges. This Indicators Report does this by presenting a balanced range of indicators covering inputs, outputs as well as impacts showing the overall trends and performance of Malaysia's STI system. This biennial report represents the seventh volume published by the Malaysian Science and Technology Information Centre (MASTIC), Ministry of Science, Technology and Innovation. It is hoped that the information presented in this report will help promote informed debate on STI policy issues.

1.2 HOW THE REPORT WAS PREPARED

This report was prepared based on inputs drawn from surveys commissioned by MASTIC as well as secondary sources of information as indicated in Table 1.1. The reader is advised to refer to the reports on surveys of R&D, innovation and awareness for details pertaining to the methodology employed in generating the findings of these surveys.

Table 1.1: Principal references employed in preparation of Malaysian Science and Technology Indicators Report 2006

Chapter	Title	Principal Source of Information
2	Education in STI	Data provided by Ministry of Higher Education
3	Human Resources for STI	Survey on R&D 2004
4	Research and Development Activities	Survey on R&D 2004
5	Public Support for STI	Data provided by various agencies including MOSTI, SMIDEC, Inland Revenue Board and MIDA.
6	Innovation in the Manufacturing Sector	Survey on Innovation 2002-2004
7	Trade in Technology	Data provided by Department of Statistics and Bank Negara
8	Publications and Citations	Data from ISI Thompson NSIOD 2006 Edition and Thomson ISI National Citation Report
9	Patenting in Malaysia	Data provided by Ministry of Domestic Trade and Consumer Affairs
10	ICT in Malaysia	Data provided by Malaysian Communications and Multimedia Commission
11	Awareness, Knowledge and Attitudes towards STI	Survey on Public Awareness, Knowledge and Attitudes towards STI
12	Our STI Scorecard and way forward	Compilation from earlier chapters, OECD and various sources

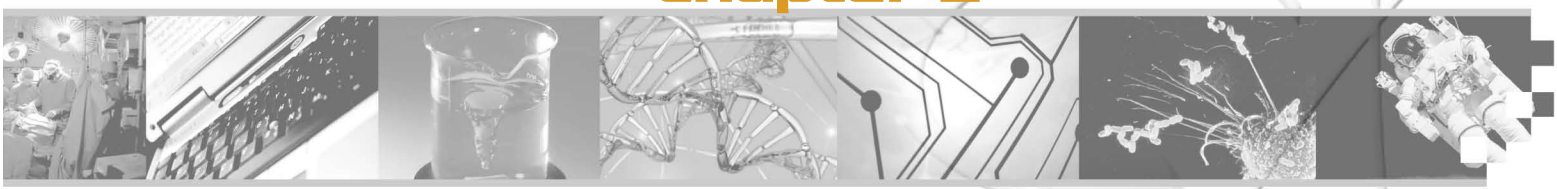
1.3 ORGANISATION OF THE REPORT

This Report is presented in 12 chapters with scientific inputs presented first followed by outputs and finally by attitudes and our scorecard. An Executive Summary precedes these chapters as it provides the overview of this report. The chapters in this report are:

Chapter 1 – Introduction
Chapter 2 – Education in STI
Chapter 3 – Human Resources for STI
Chapter 4 – Research and Development Activities
Chapter 5 – Public Support for STI
Chapter 6 – Innovation in the Manufacturing Sector
Chapter 7 – Trade in Technology
Chapter 8 – Publications and Citations
Chapter 9 – Patenting in Malaysia
Chapter 10 – ICT in Malaysia
Chapter 11 – Public Awareness, Knowledge and Attitude towards STI
Chapter 12 – Our STI Scorecard and Way Forward

Three new chapters have been introduced in this report. Firstly, a new chapter on ICT Profile of Malaysia has been included to provide information on how we have employed and diffused ICT for meeting both economic as well as social needs. Such information is vital in identifying trends in the use of ICT as well as assisting government in monitoring its policies and draw comparisons with other countries. Secondly, a separate chapter on patenting has been included to provide a more comprehensive coverage on patenting in Malaysia. Finally, a concluding chapter that describes a scorecard aimed at comparing our STI performance with that achieved in the previous Indicators Report as well as to benchmark our performance in relation to selected countries is included. It would also highlight areas where we need to focus on our STI efforts arising from the findings of this report. The chapter on International Comparisons, which was included in the previous report, was excluded in this report as such comparisons would have already been addressed in the separate chapters.

Chapter 2



EDUCATION IN SCIENCE AND TECHNOLOGY

2.1 INTRODUCTION

The purpose of this chapter is to present an overview of the state of education in science and technology in Malaysia, from the upper secondary school level where streaming into science-related subjects first takes place, to the tertiary education level which includes programmes at the Bachelor's, Master's and Doctorate levels. Data obtained from both public sector and private sector educational institutions will be used to draw comparisons between enrolment in arts and science-related fields of study, in order to assess the extent to which the government's efforts to increase the nation's scientific and technological manpower resource has been achieved. Comparisons will also be made between public and private educational institutions. The data gathered will cover at least a three-year period, if not longer, in order to observe any discernible trend. An analysis will then be made of the data obtained with a view to assessing the state of progress of science and technology education in this country over the last three years or so.

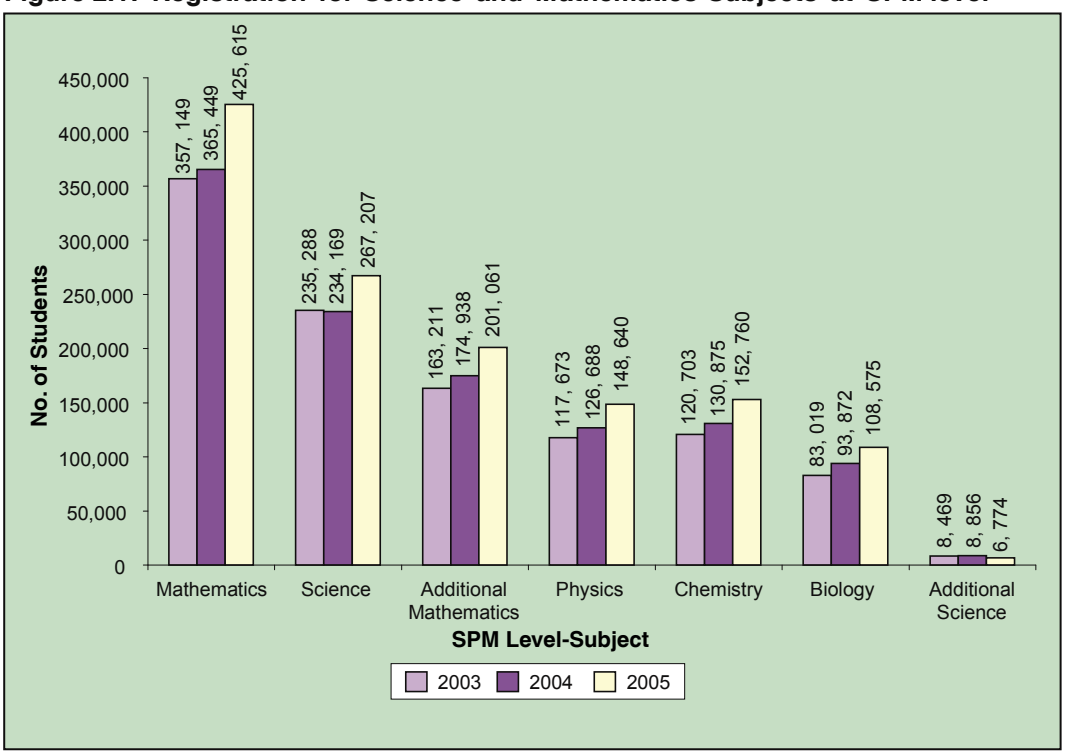
2.2 EDUCATION IN SCIENCE AND MATHEMATICS AT THE SECONDARY AND PRE-UNIVERSITY LEVEL

2.2.1 Science and Mathematics at the SPM Level

As illustrated in **Figure 2.1**, there has been a steady increase in the total number of students registering for science and mathematics subjects at the SPM level from 2003 to 2005, with a 4.5% increase in 2004, and a 15.5% increase in 2005. Looking at the breakdown in terms of individual subjects, all the subjects registered an increase in student registration throughout the three year period with the exception of Science which showed a slight drop from 2003 to 2004, and additional science which showed a 23.5% drop in 2005.

Increasing number of students registering for science and mathematics subjects at SPM level

Figure 2.1: Registration for Science and Mathematics Subjects at SPM level



Source: Examinations Syndicate, Ministry of Education Malaysia

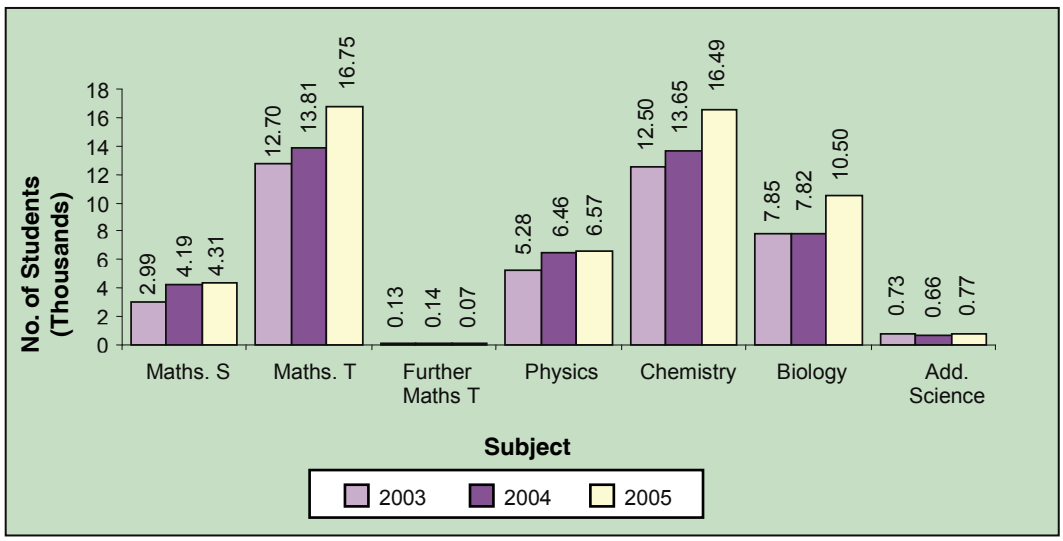
2.2.2 Science and Mathematics at the STPM Level

There has been an overall increase for students registering in science and mathematics subjects at the STPM level from 2003 to 2005, with a 10.8% increase in 2004, and

an 18.7% increase in 2005. However, when looked at in terms of the breakdown into individual subjects, as shown in Figure 2.2, there has been no uniform increase for all subjects across the board. For example, Further Mathematics T showed a drop from 138 in 2004 to 68 in 2005, Biology registered a slight drop from 2003 to 2004 (but picked up significantly in 2005), and Additional Science showed a drop from 2003 to 2004. The rest, that is, Mathematics S, Mathematics T, Physics and Chemistry, all registered increases in student registrations over the three year period.

Similar increasing trend observed at STPM level over 2003-2005 period. Noticeable decline in Further Mathematics T

Figure 2.2: Registration for Science and Mathematics Subjects at STPM Level

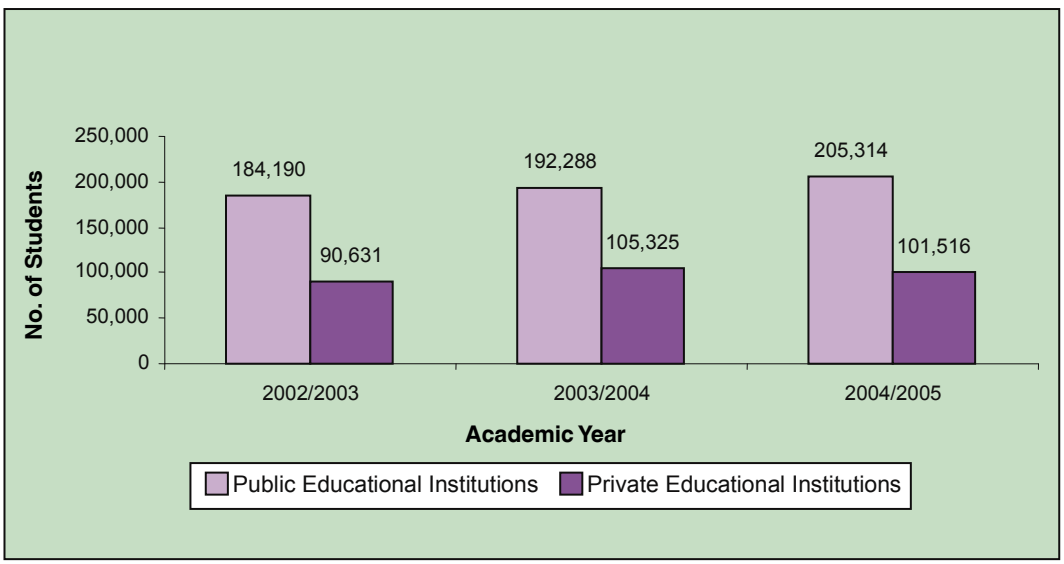


Source: Malaysian Examination Council

2.3 TERTIARY EDUCATION IN SCIENCE AND TECHNOLOGY IN PUBLIC AND PRIVATE EDUCATIONAL INSTITUTIONS

Tertiary education in science and technology is provided by both public and private educational institutions, with the bulk provided by public educational institutions. A comparison with respect to enrolment in first degree courses from 2002/2003 to 2004/2005 shows that the enrolment in public educational institutions is roughly twice that in private educational institutions, which shows that private educational institutions also provide a substantial contribution, that is, about a third of the total enrolment **(Figure 2.3)**.

Figure 2.3: Enrolment in First Degree Courses in Public and Private Educational Institutions



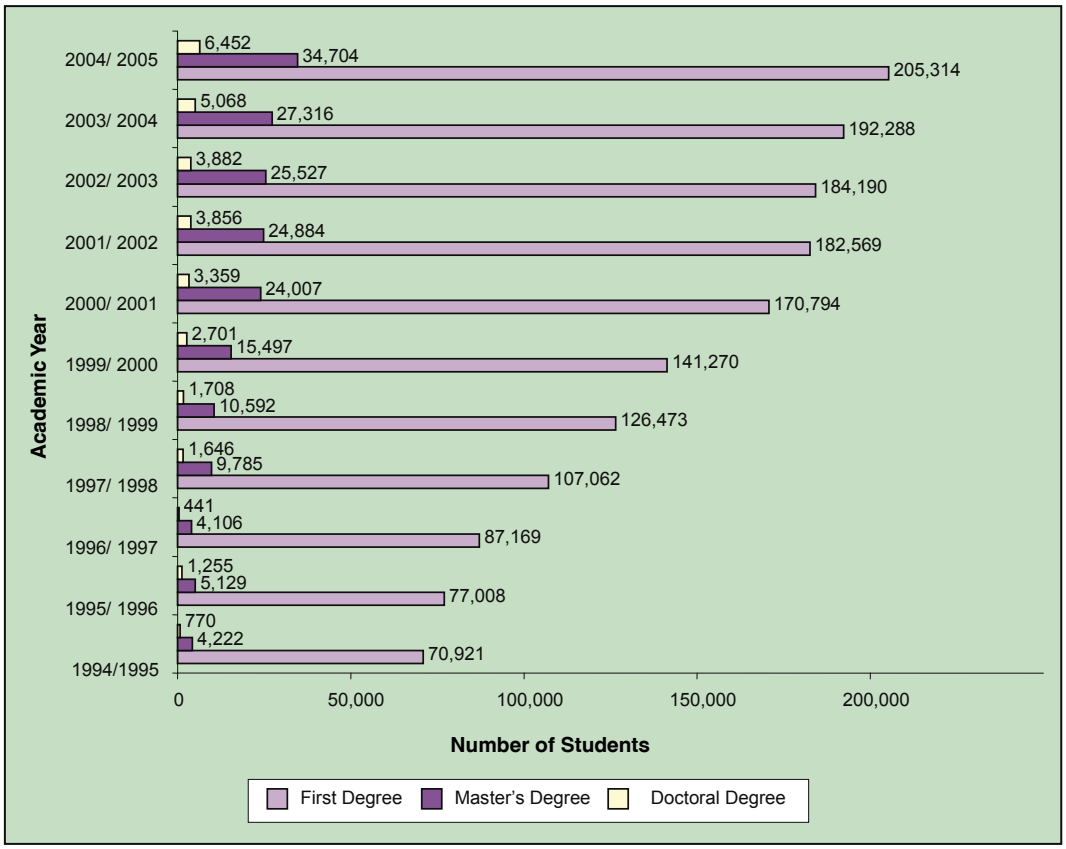
Source: Department of Higher Education Management, Ministry of Higher Education Malaysia

2.3.1 Public Educational Institutions

Increasing trend of post-graduate enrolment over 1994-2004 period

Figure 2.4 reveals the enrolment in public educational institutions, inclusive of both undergraduate and post-graduate degrees, increased steadily every year from a total of 75,913 in 1994 to 246,470 in 2004, that is, more than a three-fold increase over a ten-year period. The percentage of undergraduates in 1994 was 93.42%, while in 2004 it was 83.30%, indicating an increase in the ratio of postgraduate enrolment over the ten year period.

Figure 2.4: Enrolment in Public Educational Institutions, 1994-2004

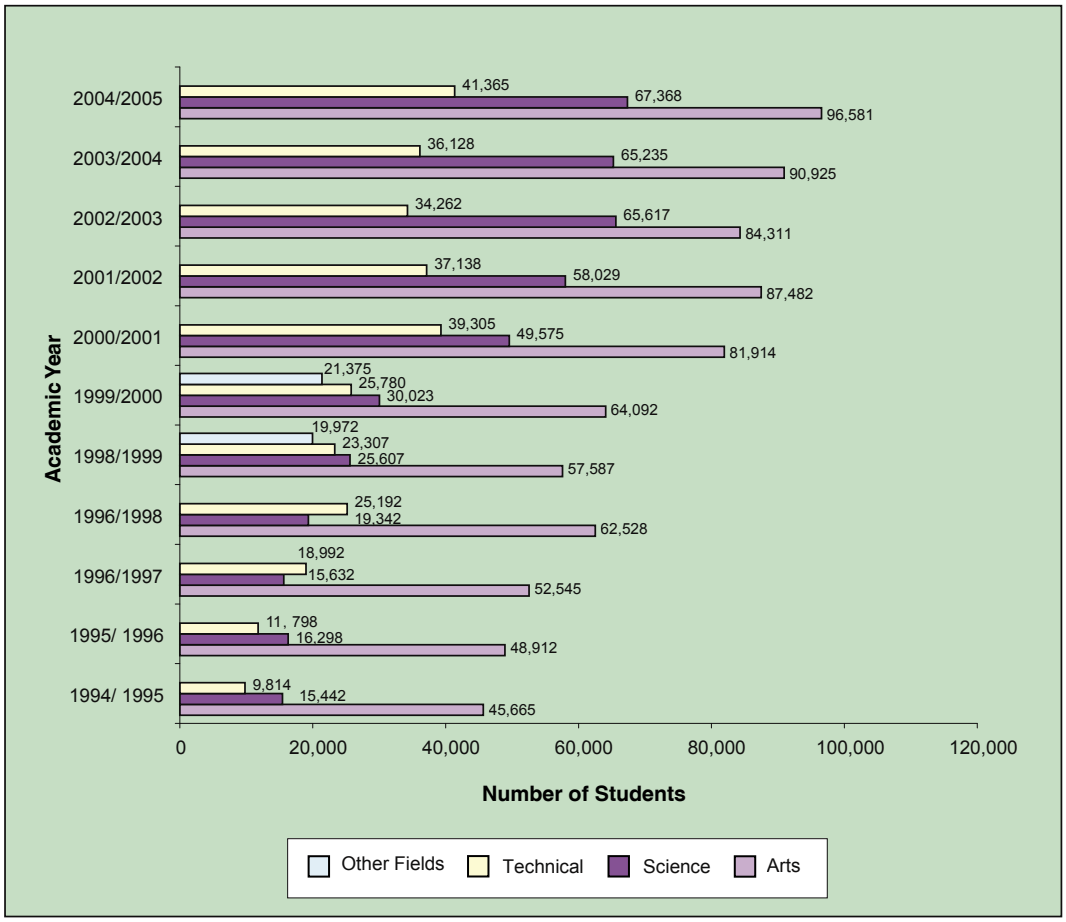


Source: Department of Higher Education Management, Ministry of Higher Education Malaysia

2.3.2 Enrolment in First Degree Courses

There has been a steady increase in student enrolment in public educational institutions from 1994 to 2004 as shown in **Figure 2.5** below. From 70,921 in 1994/1995, it increased every year reaching a figure of 205,314 in 2004/2005, giving an almost three fold increase over a ten year period.

Figure 2.5: Enrolment in First Degree Courses at Public Educational Institutions, 1994/1995 to 2004/2005



Source: Department of Higher Education Management, Ministry of Higher Education Malaysia

In terms of breakdown by fields of study, it can be seen from the figure above, that the percentage of Arts students is higher than either science students or students in technical fields, for all the years. However, there has been a steady decline in the proportion of Arts students over the years, from 64.39 % in 1994 to 47.04% in 2004. This seems to be in line with the government's policy of having an Arts to Science ratio of about 40:60.

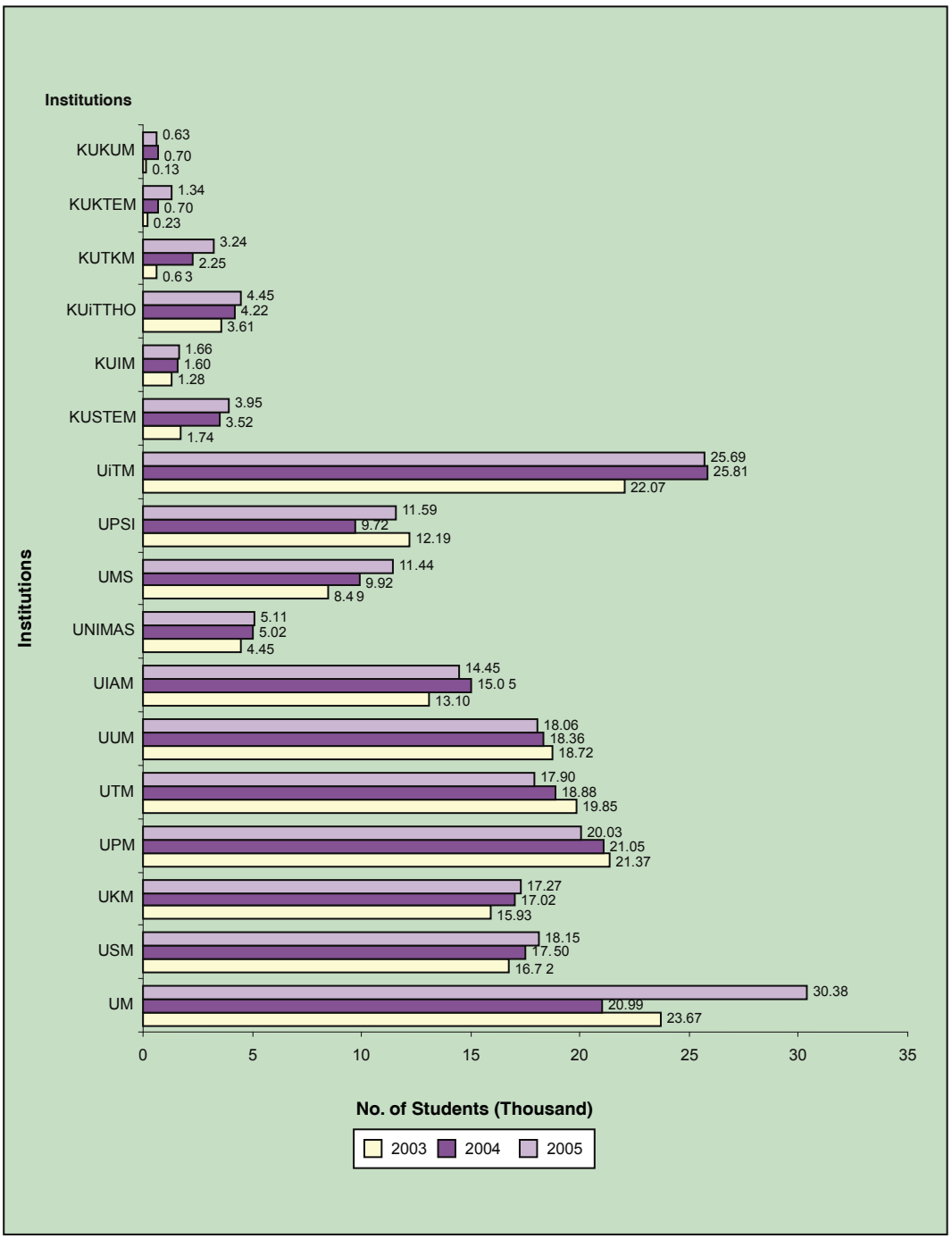
Decline in proportion of Arts students in enrolment of first degree courses from 64.4% in 1994 to 47% in 2004

In terms of distribution of enrolment according to public educational institutions, for 2002/2003 Universiti Malaya recorded the highest enrolment at 23,671 (12.85%), followed by Universiti Teknologi MARA at 22,073 (11.98%), Universiti Putra Malaysia at 21,374 (11.60%), Universiti Teknologi Malaysia at 19,845 (10.77%), and Universiti Utara Malaysia

UM, UPM and UiTM are the leading public educational institutions in undergraduate enrolment

at 18,720 (10.16%). For 2003/2004, Universiti Teknologi MARA recorded the highest enrolment at 25,812, followed by Universiti Putra Malaysia at 21,049, Universiti Malaya at 20,989, Universiti Teknologi Malaysia at 18,877, and Universiti Utara Malaysia at 18,356. For 2004/2005, Universiti Malaya recorded the highest intake at 30,375, followed by Universiti Teknologi Mara at 25,686, Universiti Putra Malaysia at 20,029, Universiti Sains Malaysia at 18,148, and Universiti Utara Malaysia at 18,057. A more detailed account is given in **Figure 2.6** below:

Figure 2.6: Enrolment in First Degree Courses at Public Educational Institutions



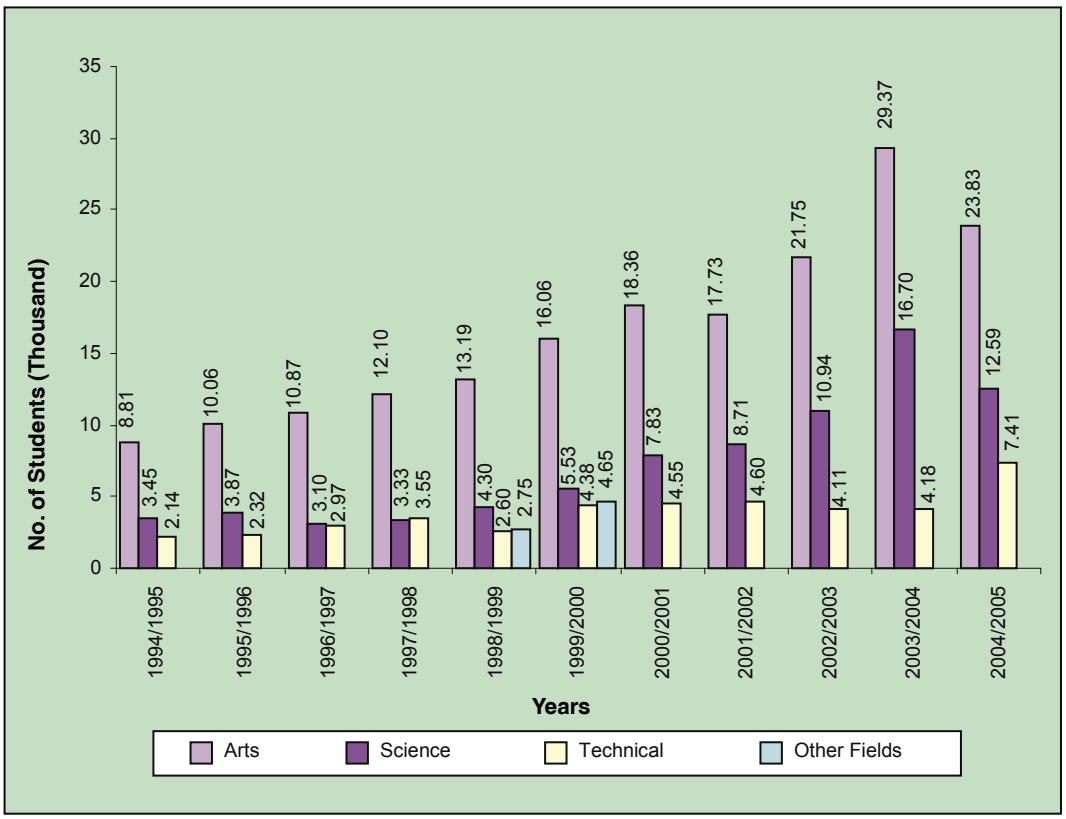
Source: Department of Higher Education Management, Ministry of Higher Education Malaysia

2.3.3 Graduations in First Degree Courses at Public Educational Institutions, 1994-2004

Decline in percentage of Arts graduates in first degree graduations at public IHLs from 61.2% in 1994 to 54.6% in 2004

Overall, as shown in **Figure 2.7**, the total number of graduates has been increasing every year except for 2004/2005 which showed a drop from 50,249 in 2003/2004, to 43,826. From 1994 to 2004, there has been roughly a three fold increase over a ten year period in the number of first degree graduates, that is, from 14,396 in 1994 to 43,826 in 2004. In terms of fields of study, again we see that the percentage of Arts graduates is higher than science graduates or graduates in technical fields. However, since 1998 there has been a decrease in the percentage of Arts graduates to the point that the percentage of Arts graduates in 2004 stands at 54.38% as compared to 61.18% in 1994.

Figure 2.7: Graduations in First Degree at Public Educational Institutions, 1994-2004



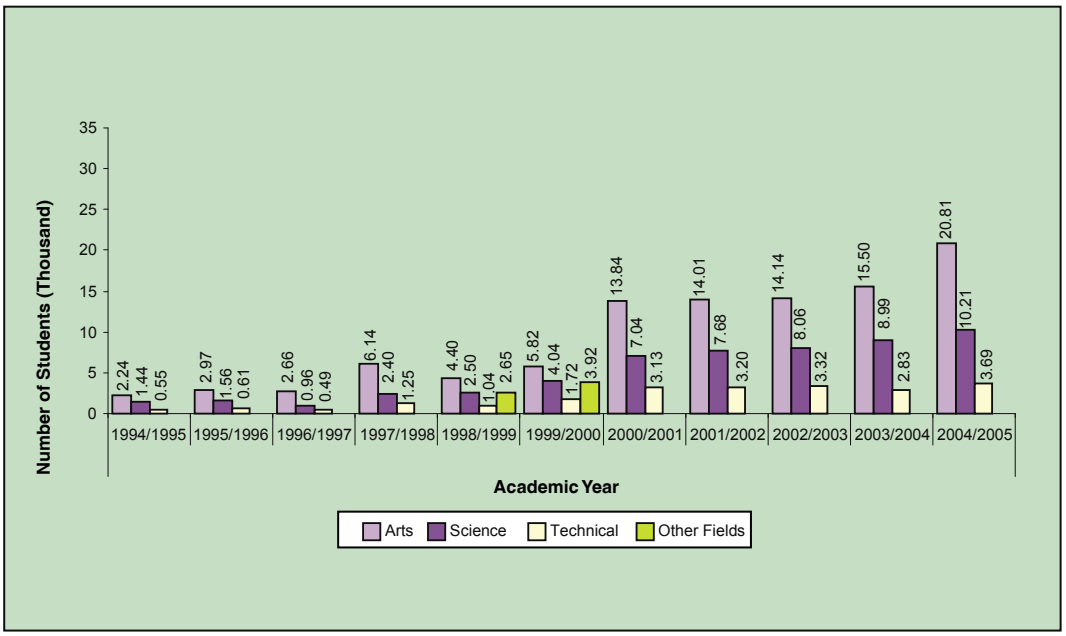
Source: Department of Higher Education Management, Ministry of Higher Education Malaysia

2.3.4 Enrolment in Graduate Degree Courses

Sharp rise in post-graduate enrolment over 1994-2004 period. More enrolment in Arts than Science or Technical courses

Enrolment for master's degree courses in public universities showed a steady annual increase from 1994/1995 to 2004/2005, except for the year 1996/1997. From a mere 4,222 in 1994/1995, the figure came to 34,704 in 2004/2005, giving more than an eight fold increase over a ten year period. In all the years, the enrolments for Arts courses exceed that of Science or Technical courses **(Figure 2.8)**.

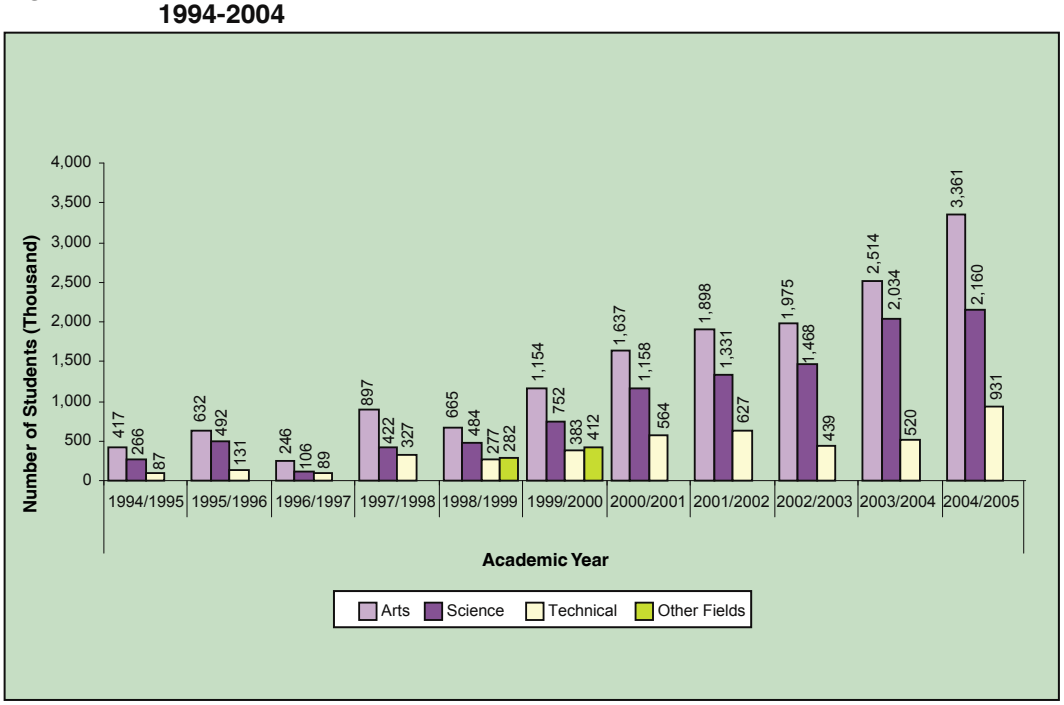
Figure 2.8: Enrolment in Master's level Courses at Public Educational Institutions, 1994-2004



Source: Department of Higher Education Management, Ministry of Higher Education Malaysia

Enrolment for doctoral degree courses also showed an annual increase from 1994/1995 to 2004/2005, except for the year 1996/1997. From a total enrolment of 770 in 1994/1995, it reached 6,452 in 2004/2005, giving an eight fold increase over a ten year period **(Figure 2.9)**.

Figure 2.9: Enrolment in Doctoral level Courses at Public Educational Institutions, 1994-2004



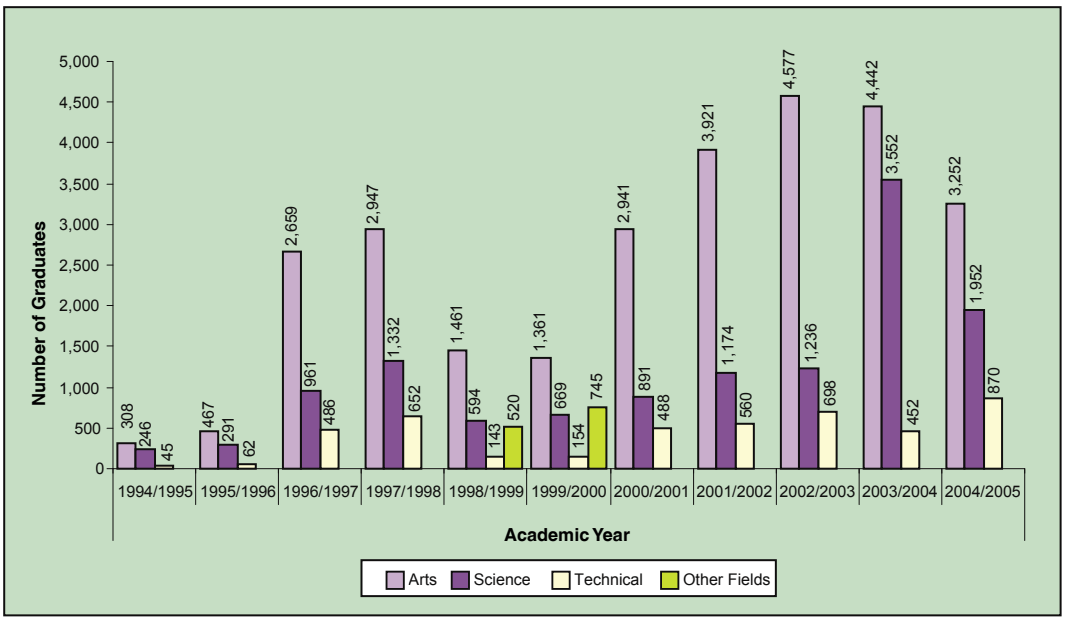
Source: Department of Higher Education Management, Ministry of Higher Education Malaysia

2.3.5 Graduations In Post-Graduate Degree Courses

The number of Master's degree graduates from 1994 to 2004 increased every year except for 1998 and 2004. From a mere 599 Master's graduates in 1994, the figure increased to 8,446 in 2003, showing an increase of slightly more than fourteen times over nine years, but the figure dropped to 6,074 in 2004. In terms of field of study, the number of Arts graduates is more than the number of graduates in science or technical fields, for each year **(Figure 2.10)**.

Dramatic increase in post-graduate graduation. More post-graduate graduation in Arts than Sciences or Technical disciplines

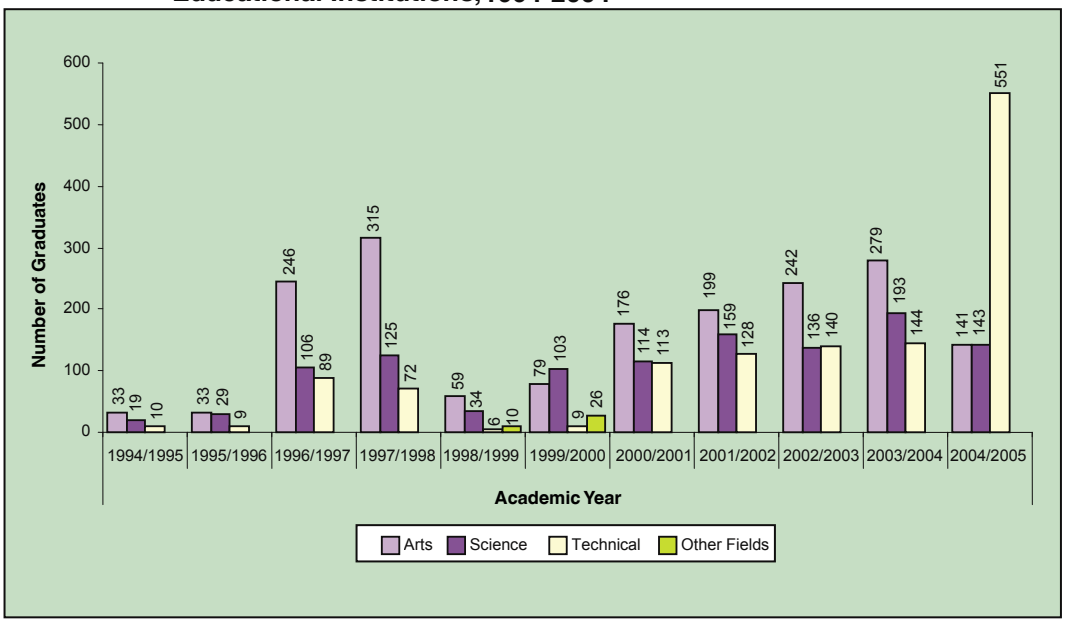
Figure 2.10: Graduations in Master's Degree at Public Educational Institutions, 1994 - 2004



Source: Department of Higher Education Management, Ministry of Higher Education Malaysia

The total number of PhD graduates increased annually from 62 in 1994, to 512 in 1997. In 1998 it dropped to 109, but began to climb up again in 1999 with 217 graduates, until it reached 835 in 2004. The percentage of Arts PhD graduates was higher than Science graduates in all years except 1999/2000 and 2004/2005 **(Figure 2.11)**.

Figure 2.11: Graduations in Doctoral Degree Courses at Public Educational Institutions,1994-2004



Source: Department of Higher Education Management, Ministry of Higher Education Malaysia

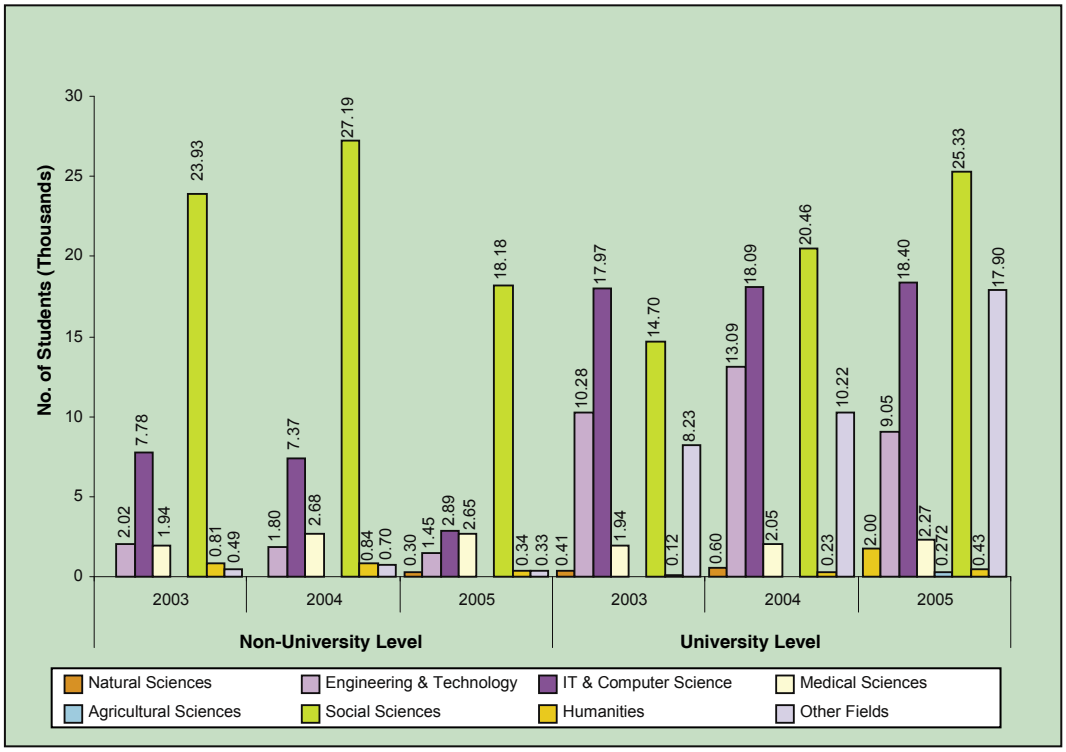
2.4 TERTIARY EDUCATION IN S&T IN PRIVATE EDUCATIONAL INSTITUTIONS

Apart from public educational institutions, private educational institutions also provide a substantive contribution to higher education in this country. This consists of private universities such as Universiti Teknologi Petronas, Universiti Tenaga Nasional (university level) -which are among the big ones, and smaller institutions such as private colleges (non-university level). The size of enrolment and graduation in these institutions is quite substantial, and overall they form about a third of that of public educational institutions.

2.4.1 Enrolment in First Degree Courses

The data for enrolment in first degree courses at private educational institutions for the years 2003-2005 is given in **Figure 2.12** below. For most fields of study, enrolments in university-level private educational institutions have been increasing from 2003 to 2005.

Figure 2.12: Enrolment in First Degree Courses in Private Educational Institutions

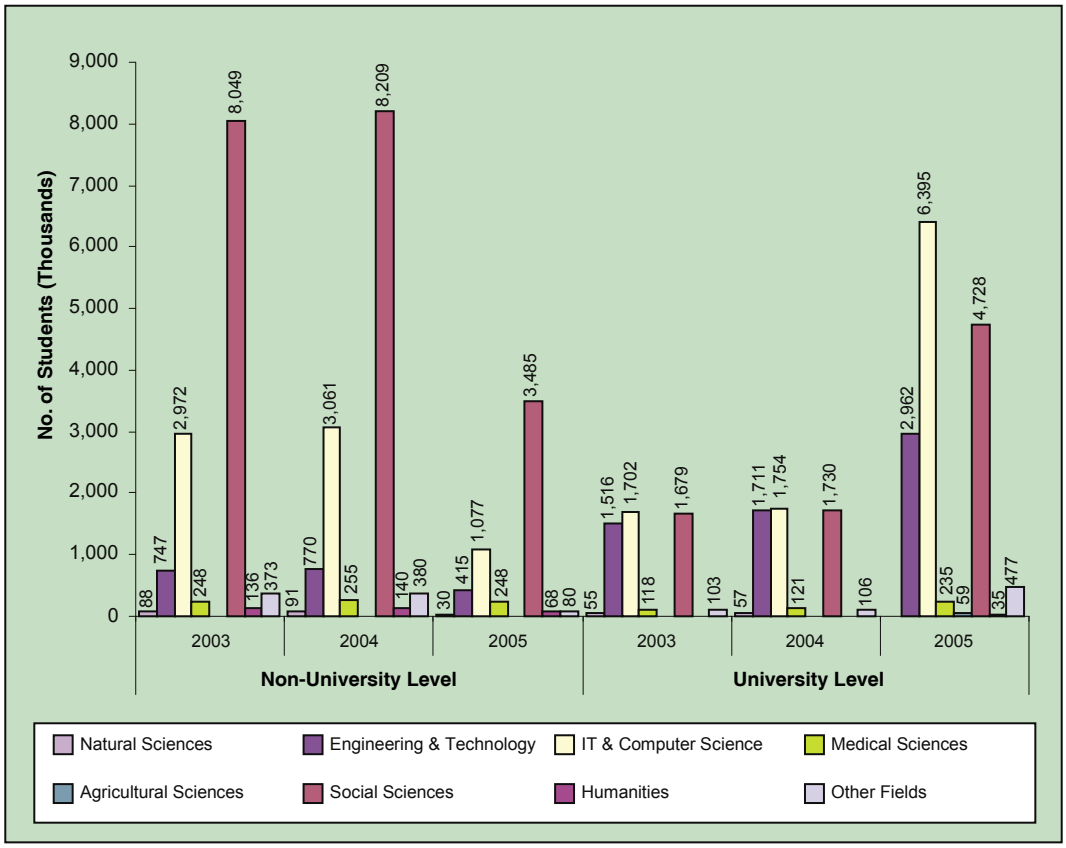


Source: Department of Higher Education Management, Ministry of Higher Education Malaysia

2.4.2 Graduation in First Degree Courses

Graduations in first degree courses in private educational institutions stand at a total of 17,786 in 2003, at 18,385 in 2004, and 20,294 in 2005. For 2005, the figures registered a drop for non-university level institutions, but a hefty increase of nearly three times in university-level institutions **(Figure 2.13)**.

Figure 2.13: Graduates in First Degree Courses in Private Educational Institutions, 2003-2005



Source: Department of Higher Education Management, Ministry of Higher Education Malaysia

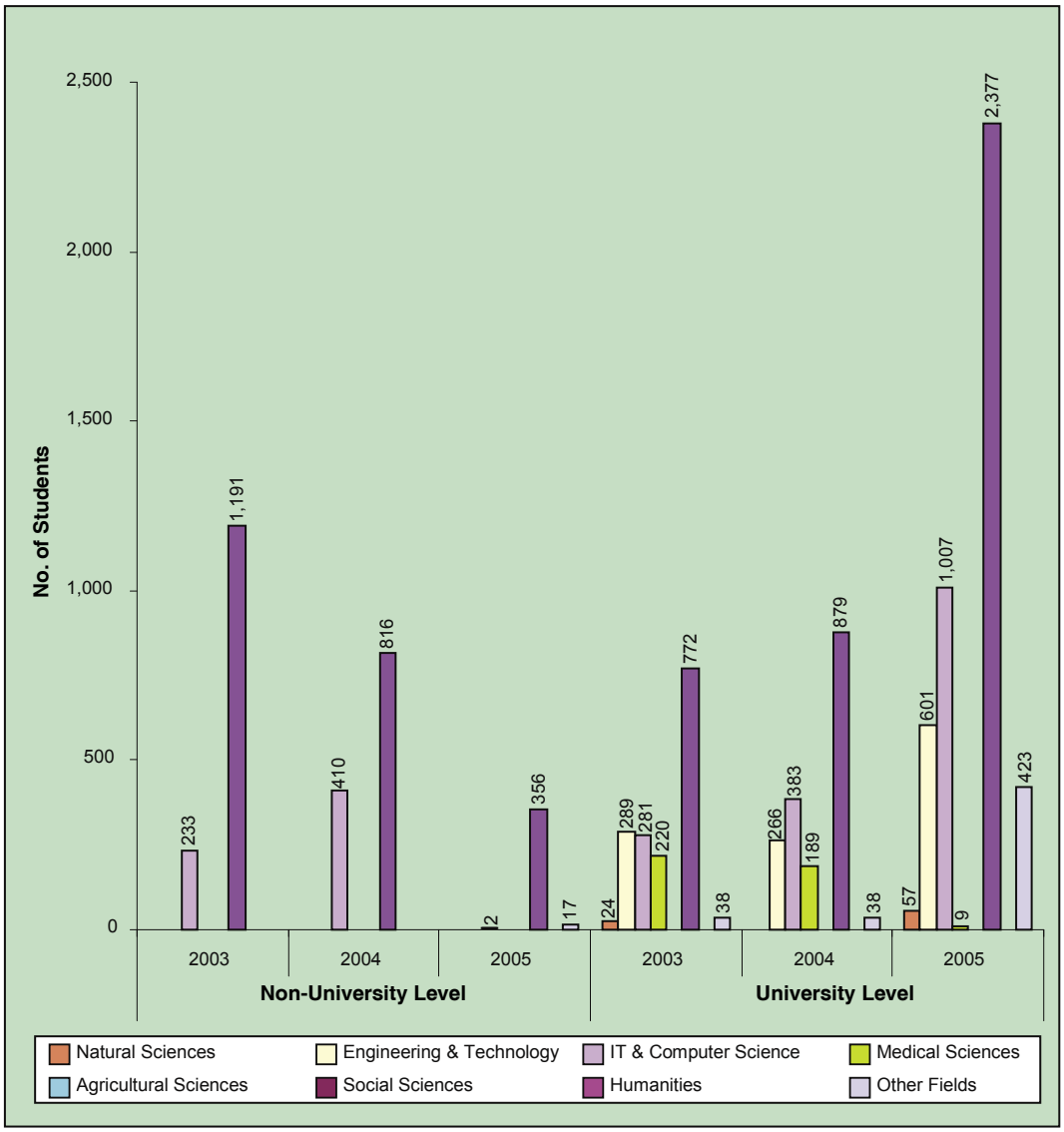
2.4.3 Enrolment in Post-Graduate Degree Courses

The post-graduate degree programs given in this section consists of the Master's degree and the PhD degree programs. Even though post-graduate degree courses are less popular in private educational institutions as compared to public educational institutions, largely because of their different orientations, they are nevertheless present, and the statistics showed that they cannot be ignored. As expected, they are more prominent in university-level private educational institutions rather than the non-university level institutions.

2.4.3.1 Enrolment in Master's Degree Courses at Private Educational Institutions, 2003-2005

The total number of Master's students enrolled in private educational institutions was 3,048 in 2003, 2,981 in 2004, and 4,849 in 2005. For university-level institutions, the social sciences registered the highest percentage of enrolment for all the three years. A detailed breakdown in terms of fields of study is given in **Figure 2.14** below.

Figure 2.14: Enrolment in Master's degree courses in Private Educational Institutions

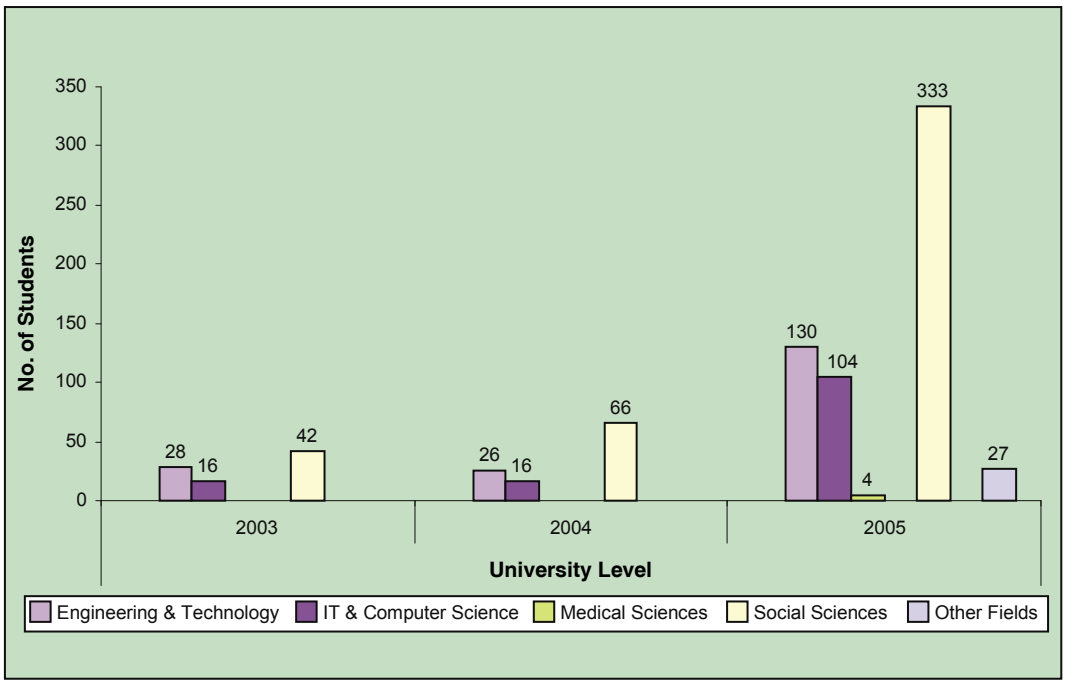


Source: Department of Higher Education Management, Ministry of Higher Education Malaysia

2.4.3.2 Enrolment in Doctoral Degree Courses at Private Educational Institutions, 2003-2005

Enrolment for all categories of courses at the doctoral degree level in private educational institutions, showed a steady increase from 2003 to 2005. However, the biggest increase was in the social sciences where the enrolment figure increased to 333 in 2005, from 66 in 2004 and 42 in 2003. Next was engineering and technology, where the enrolment stood at 130 in 2005 as compared to 26 in 2004 and 28 in 2003.

Figure 2.15: Enrolment in Doctoral Degree Courses at Private Educational Institutions, 2003-2005



Source: Department of Higher Education Management, Ministry of Higher Education Malaysia

2.4.4 Graduations in Post-Graduate Courses

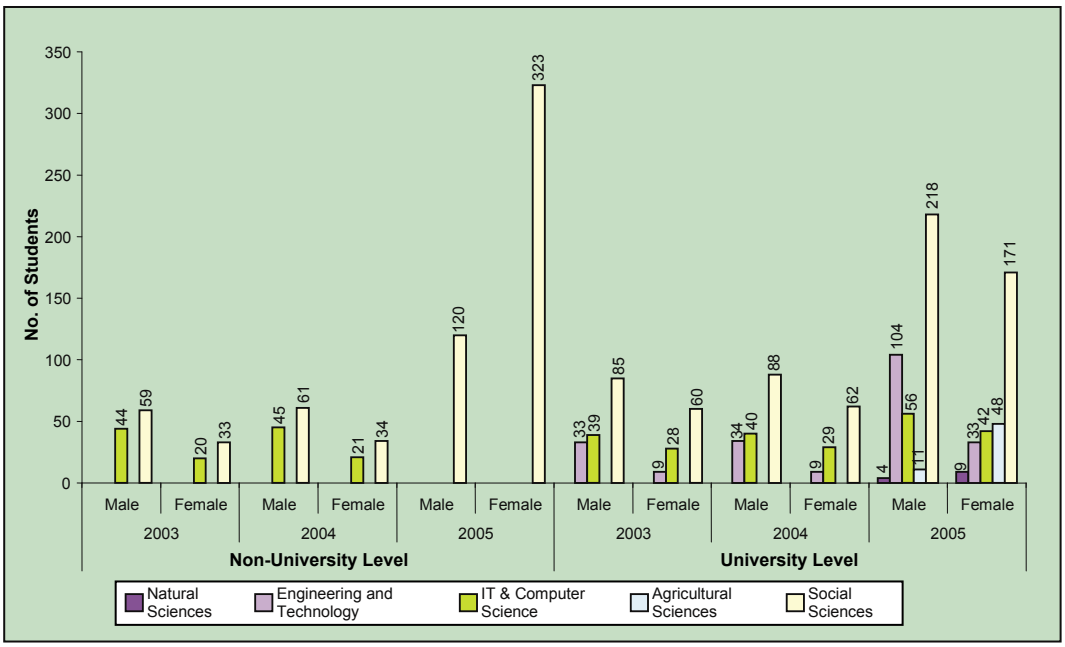
Although at the PhD level, the number of PhD graduates produced by private educational institutions seems to be rather small, the number of Master's graduates however, appears to be quite sizeable, and showed an annual increase from 2003 to 2005. A more detailed picture is given below.

Post-graduate graduations from private educational institutions, though increasing, are small (about 14% of total) when compared to output from public educational institutions

2.4.4.1 Graduations in Master's Degree Courses at Private Educational Institutions, 2003-2005

For both non-university and university-level private educational institutions, there has been a steady increase in graduations from 2003 to 2005, with the increase from 2004 to 2005 being rather significant. The total number of Master's graduates produced by private educational institutions was 410 in 2003, 423 in 2004, and 1,080 in 2005. The most popular courses were in social sciences (which includes Business Administration), IT and Computer Science, and Engineering and Technology **(Figure 2.16)**.

Figure 2.16: Graduations in Master's Degree Courses at Private Educational Institutions, 2003-2005



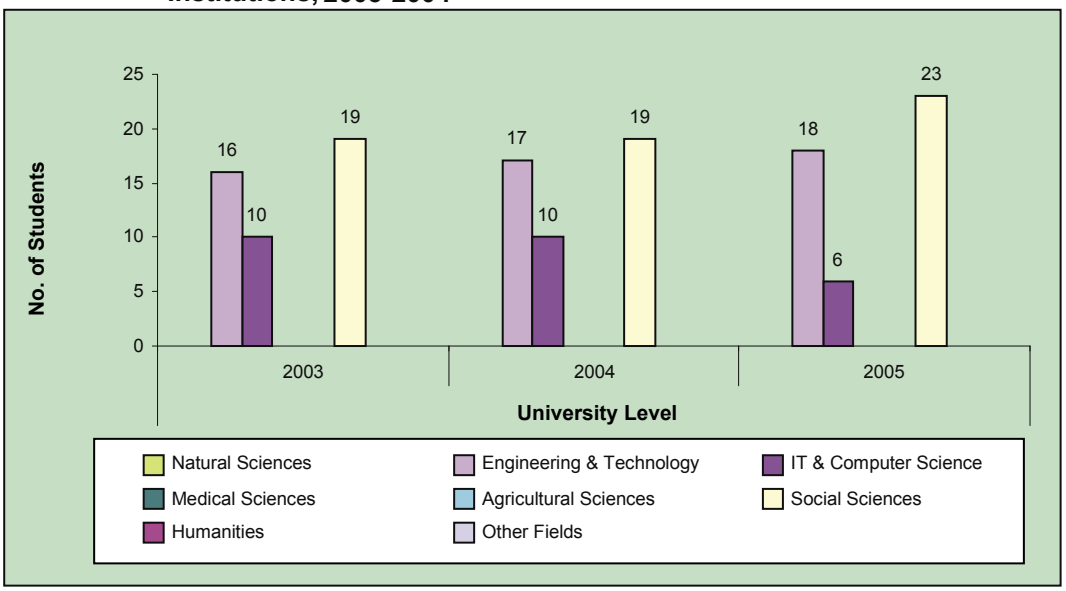
Source: Department of Higher Education Management, Ministry of Higher Education Malaysia

2.4.4.2 Graduations in Doctoral Degree Courses at Private Educational Institutions, 2003-2005

As for graduations in doctoral degree courses, only university-level private institutions recorded any graduations, with the numbers being small. A total of 45 students graduated with PhDs in 2003, the numbers increasing to 46 in 2004 and 47 in 2005 **(Figure 2.17)**. Compare this with the number of PhDs produced by public educational institutions, which stands at 518 in 2003, 616 in 2004, and 835 in 2005.

The foregoing figures demonstrate that as for post-graduate degree courses, public educational institutions provide the main contribution in terms of enrolment and graduation, as compared to private educational institutions. Thus it can be seen that the nation's research agenda in S&T has to be spearheaded by the government through the public universities, since the private sector is unlikely to invest money in research which might not produce immediate financial returns, and involves high expenditure.

Figure 2.17: Graduations in Doctoral Degree Courses at Private Educational Institutions, 2003-2004

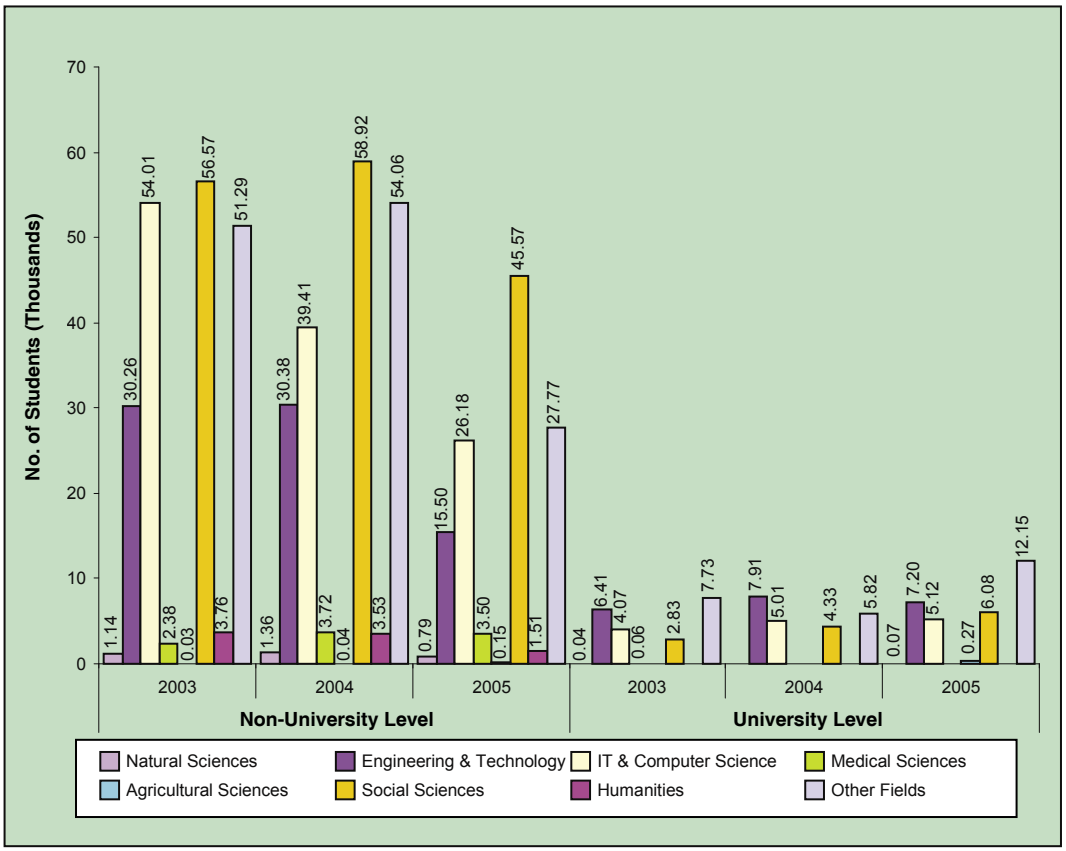


Source: Department of Higher Education Management, Ministry of Higher Education Malaysia

2.4.5 Enrolment in Other Programs (Certificate / Diploma / Advanced Certificate / Advanced Diploma) at Private Educational Institutions, 2003-2005

The total enrolment at private educational institutions for Diploma-level programs and its equivalent, stands at 220,579 in 2003, 214,477 in 2004, and 151,862 in 2005. Thus, there has been a steady decline in enrolment for such programs at private educational institutions from 2003 to 2005 **(Figure 2.18)**.

Figure 2.18: Enrolment in Other Programs (Certificate / Diploma / Advanced Certificate / Advanced Diploma) at Private Educational Institutions, 2003-2005

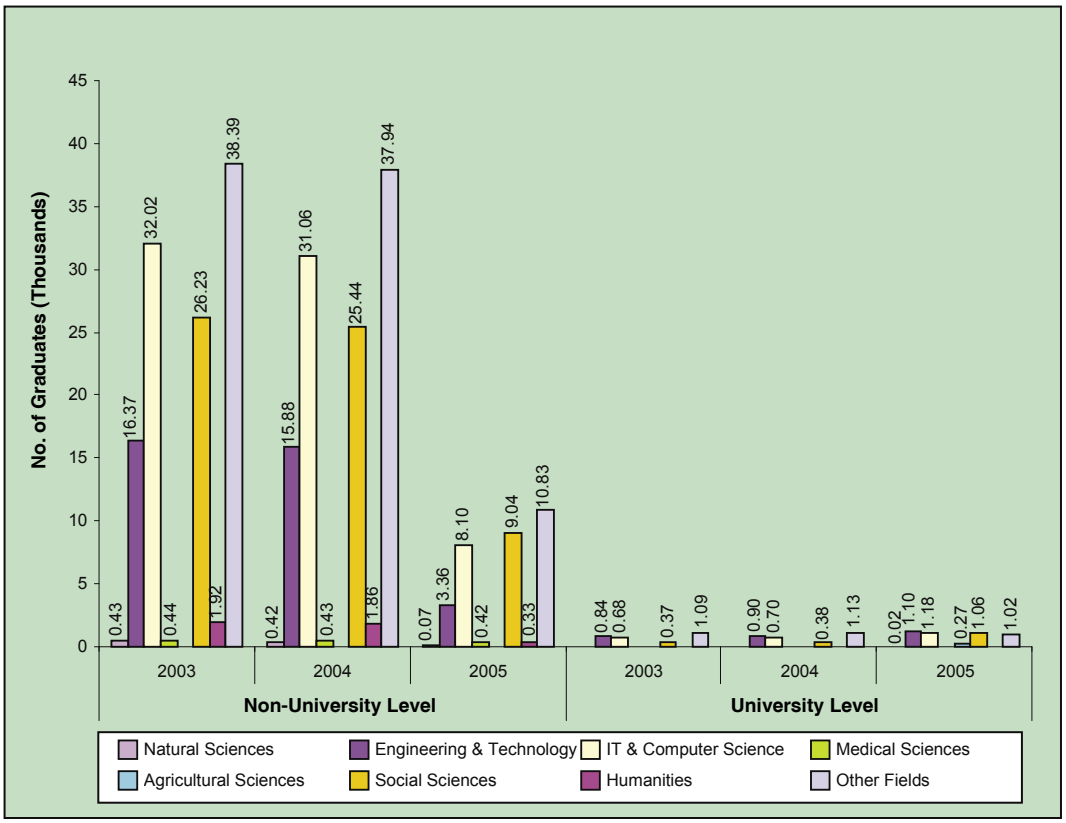


Source: Department of Higher Education Management, Ministry of Higher Education Malaysia

2.4.6 Graduations in Other Programs (Certificate / Diploma / Advanced Certificate / Advanced Diploma) at Private Educational Institutions, 2003-2005

The total number of graduates for diploma-level courses produced by private educational institutions was 118,777 in 2003, 116,133 in 2004 and 36,532 in 2005. Thus, there was a marked drop in graduations in 2005 as compared to 2004. A detailed breakdown in terms of fields of study is given in **Figure 2.19** below.

Figure 2.19: Graduations in Other Programs (Certificate / Diploma / Advanced Certificate / Advanced Diploma) at Private Educational Institutions, 2003-2005



Source: Department of Higher Education Management, Ministry of Higher Education Malaysia

2.5 SOME GENDER COMPARISONS

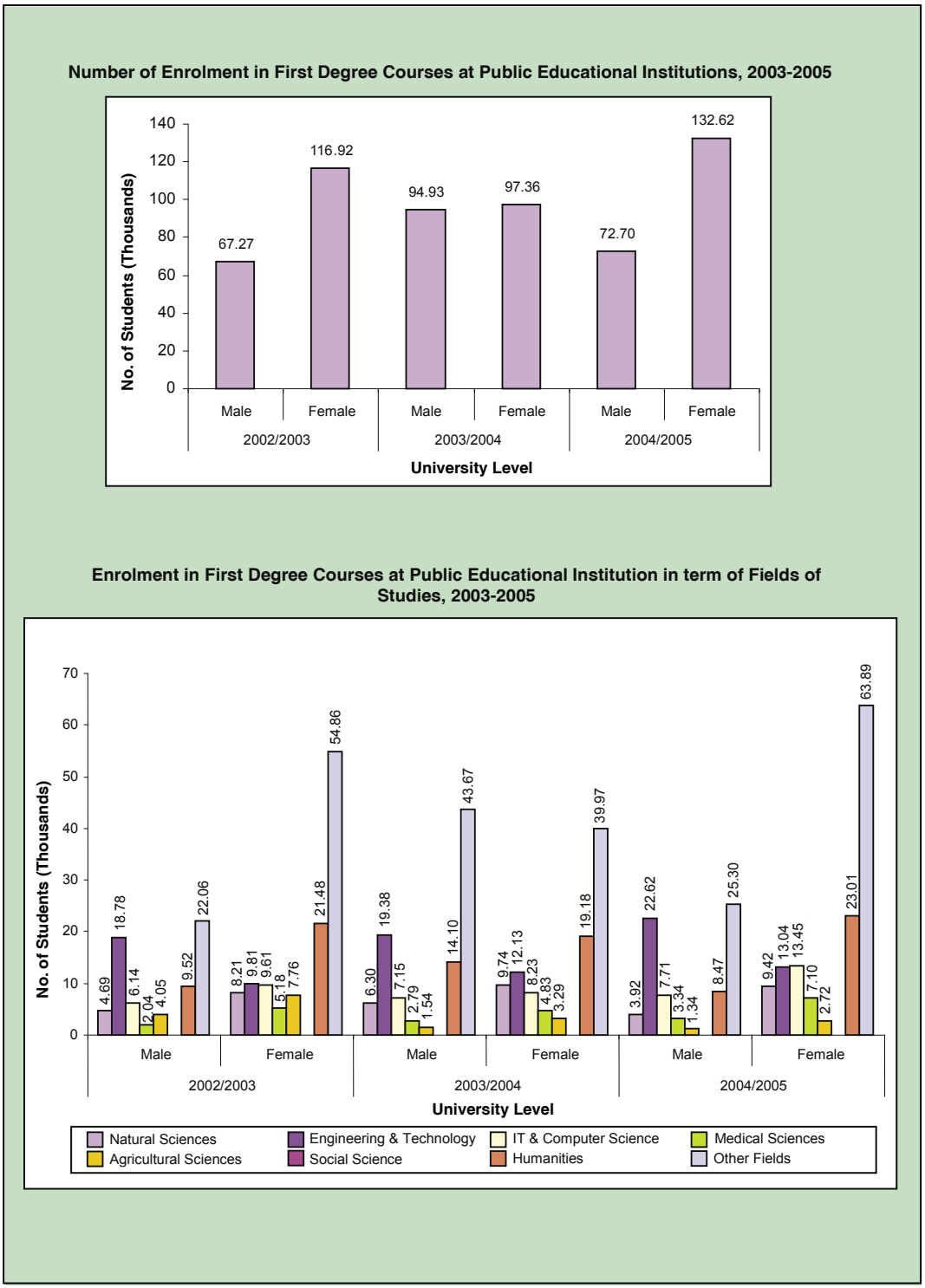
Females outnumber males in undergraduate enrolment in both public and private IHLs

It is interesting to note that the figures of undergraduate student enrolment, given in terms of breakdown according to gender, showed some interesting patterns. The data available covered the period from 2003 to 2005. According to the statistics given, for both the public and private educational sectors, the overall enrolment figures were higher for females as compared to males. In terms of breakdown according to fields of study, in most fields, females outnumbered males.

2.5.1 Gender Comparison for Enrolment in First Degree Courses in Public Educational Institutions from 2003 to 2005

As can be seen from **Figure 2.20** below, females outnumber males in all fields of study except for Engineering and Technology, for the years 2003, 2004 and 2005. For the 2002/2003 academic session, the number of males enrolled was 67,271 (36.5%) as against 116,919 (63.5%) - almost twice higher - for females. For 2003/2004, the number of males enrolled was 94,926 as against 97,362, indicating a near balance in gender distribution. However, for the 2004/2005 academic year, the enrolment figure for females shot up to 132,618 (64.6%) as compared to 72,696 (35.4%) for males, indicating a swing back to the trend found earlier.

Figure 2.20: Gender Comparison for Enrolment in First Degree Courses in Public Educational Institutions from 2003 to 2005

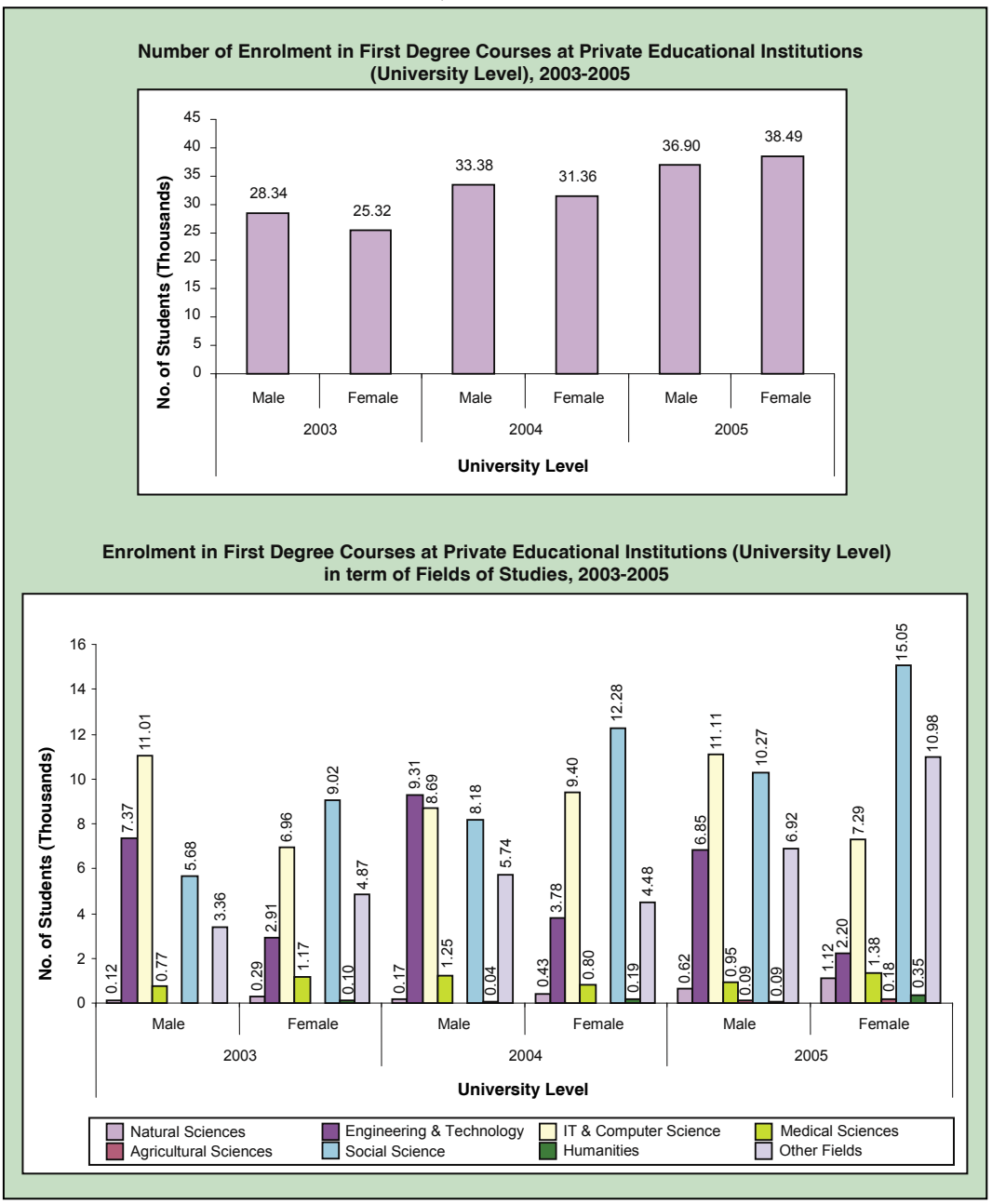


Source: Department of Higher Education Management, Ministry of Higher Education Malaysia

2.5.2 Gender Comparison for Enrolment in First Degree Courses in Private Educational Institutions from 2003 to 2005

Looking at the figures for enrolment in private educational institutions which are at the University level (see **Figure 2.21**), we can see that in terms of fields of study, females outnumber males for all the three years in the following fields: (i) natural sciences (ii) medical sciences (except 2004) (iii) social sciences (iv) humanities. However, in terms of total enrolment, unlike in public educational institutions, there were more males than females in 2003 and 2004. In 2003 there were 28,335 males as compared to 25,324 females and in 2004 there were 33,376 males as compared to 31,362 females. However, like in the public educational sector, there was a swing towards higher women enrolment for the year 2005 where there were 38,486 women as compared to 36,897 men.

Figure 2.21: Gender Comparison for Enrolment in First Degree Courses in Private Educational Institutions, 2003 - 2005



Source: Department of Higher Education Management, Ministry of Higher Education Malaysia

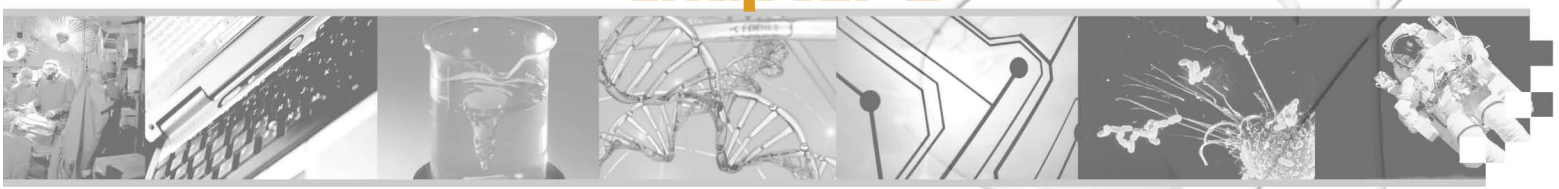
2.6 CONCLUSION

Overall, there has been a steady increase in the enrolment for first degree courses in both public as well as private educational institutions over the last ten years or so, with enrolment in the public sector being about twice that of the private sector. In the public sector especially, the percentage of enrolment in the Sciences has increased relative to the Arts, which augurs well for the government's target of having a Science: Arts ratio of about 60:40. At the postgraduate level, that is, at the Master's and Doctoral levels, there has also been a steady increase in enrolment, but more so in public educational institutions as compared to private educational institutions, in which the enrolment for PhD courses is rather low.

In terms of graduation, post-graduate graduations from private educational institutions, though increasing, are small (about 14% of total) when compared to output from public educational institutions. In public educational institutions, the number of graduates in the Arts is still higher than in the sciences, at the post-graduate level, but this is not true in the case of private educational institutions

On gender distribution, there is a noticeable trend towards higher enrolment of females as compared to males in public educational institutions over the period 2003-2005, and in private educational institutions beginning from 2005.

Chapter 3



HUMAN RESOURCE FOR SCIENCE AND TECHNOLOGY

3.1 INTRODUCTION

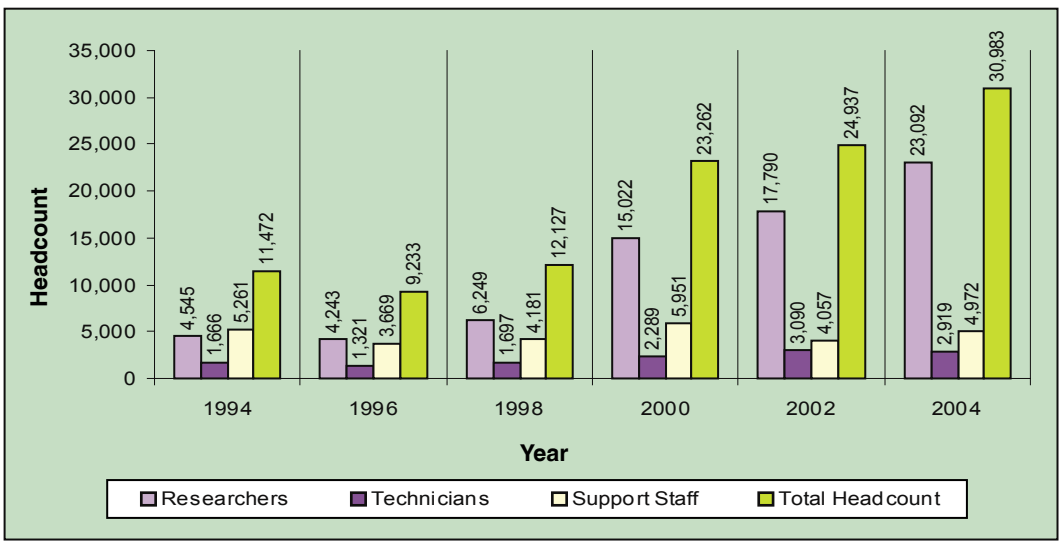
This chapter deals with the aspect of human resource for science and technology (S&T) over the period of 1996 to 2004, both in the national context as well as at the sectoral levels of the GRIs, IHLs and the private sector. It provides the status and trend study of the various categories of R&D personnel in terms of size, gender composition, qualifications and nationality engaged in the public and private sectors. In this regard, data and information of this report were derived from the National Survey of Research and Development 2006 Report of MASTIC, Ministry of Science, Technology and Innovation.

3.2 NATIONAL HEADCOUNT AND FTE

Sharp increase in number of researchers but number of technicians remain stagnant

The national R&D headcount continues its rising trend since 1998. There has been a steady increase in S&T personnel that comprises researchers, technicians and support staff from 12,127 in 1998 to 24,937 in 2002, and a further increase of 6,046 (24.2%) from 2002 to 30,983 in 2004 **(Figure 3.1)**. This upward trend is prominently exhibited in the case of researchers which showed an increase from a low of 6,249 in 1998 to 23,092 in 2004. However, technician headcount remains fairly stable, which may be attributed to fewer job openings for this position. The headcount of support staff showed a small increase, from 4,057 in 2002 to 4,972 in 2004 **(Figure 3.1)**. The number of researchers per 10,000 labour force has increased to 21.3 in 2004 from 18.0 in 2002 **(Figure 3.2)**.

Figure 3.1: National Headcount of R&D personnel, 1994 to 2004



Source: National Survey on Research & Development 2006 Report

Figure 3.2: Ratio of Researchers to Labour Force/Population, 1996 to 2004

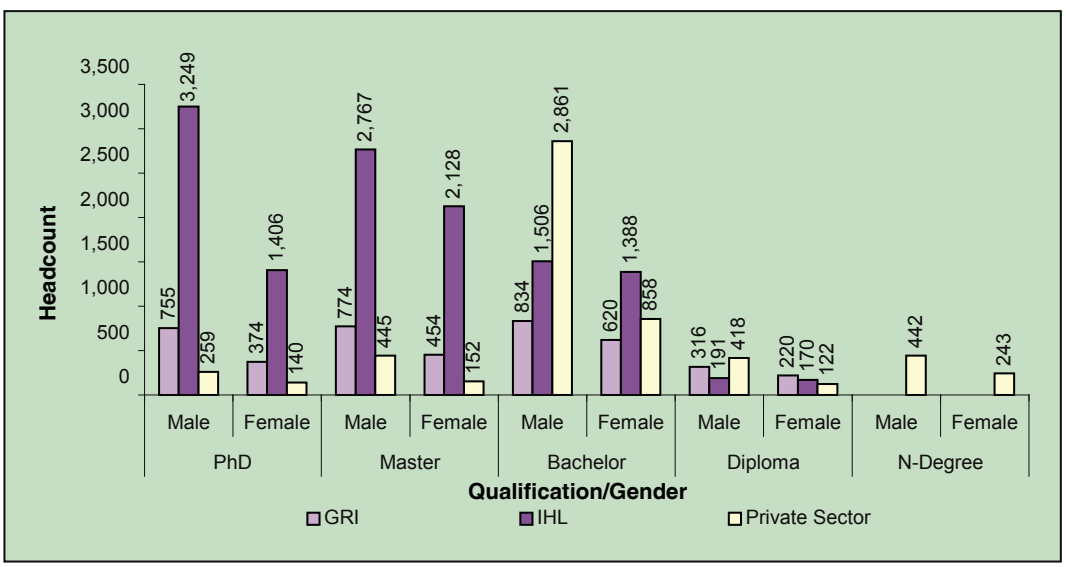
Source: National Survey on Research & Development 2006 Report

3.2.1 Human Resource by Qualification

With respect to qualification of the R&D personnel, the number of doctorates has increased to 6,183 in 2004 from 5,575 in 2002; Masters degree holders has increased from 4,736 in 2002 to 6,720 in 2004, and bachelor degree holders has increased from 6,241 in 2002 to 8,067 in 2004 **(Figure 3.3)**. The IHLs have the most PhDs followed by the GRIs. The private sector has the smallest number of PhDs.

Increasing qualification of researchers who are mainly located in IHLs.

Figure 3.3: R&D Researchers (Headcount) by Sector, Qualification and Gender in 2004



Source: National Survey on Research & Development 2006 Report
Note: For 2002; No. of PhD - 5,575; Master - 4,736; Bachelor - 6,241

3.2.2 Human Resource by FTE

Increasing involvement of researchers in IHLs and GRIs in research but decline in industry

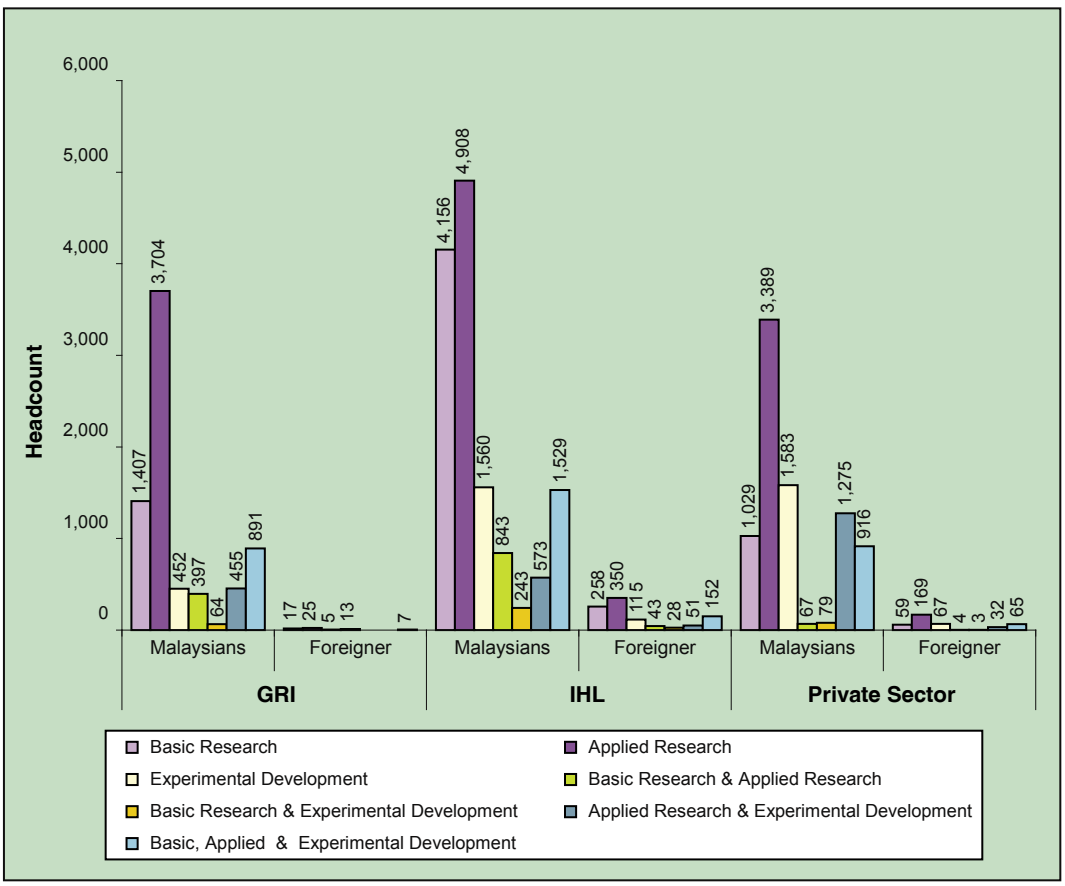
The trend in FTE of R&D personnel shows a steady increase over the years. Indeed, there is a marked increase in FTE from 10,730.95 in 2002 to 17,886.55 in 2004. The FTEs per researcher in 2004 at 0.55 as compared to 0.40 in 2002 indicate the increased involvement of researchers in R&D. However, the FTE per researcher of the private sector showed a decrease from 0.83 in 2002 to 0.69 in 2004. This may be explained that some of the major work of R&D in the private sector have been shared or taken up by the other personnel such as technicians or support staff.

3.2.3 Research Personnel (headcount) by Sector, Nationality and Types of Research (2004)

Majority of researchers located in IHLs and are largely engaged in applied research

Figure 3.4 shows the distribution of research personnel (headcount) by Sector, Nationality and Types of Research. Overall, the IHLs employed the most R&D personnel followed by the private sector and the GRIs. Out of the total personnel involved in R&D, 1,463 are foreigners (4.72%). The IHLs employed the most foreigners at 997, whilst the GRIs have the lowest number at 67. With regard to the types of research undertaken by the three sectors, most personnel were engaged in applied research followed by basic and experimental development research. Headcount of basic, applied and experimental development research constituted 75.05% of the total R&D personnel in 2004.

Figure 3.4: Research Personnel (Headcount) by Sector, Nationality & Types of Research in 2004



Source: National Survey on Research & Development 2006 Report

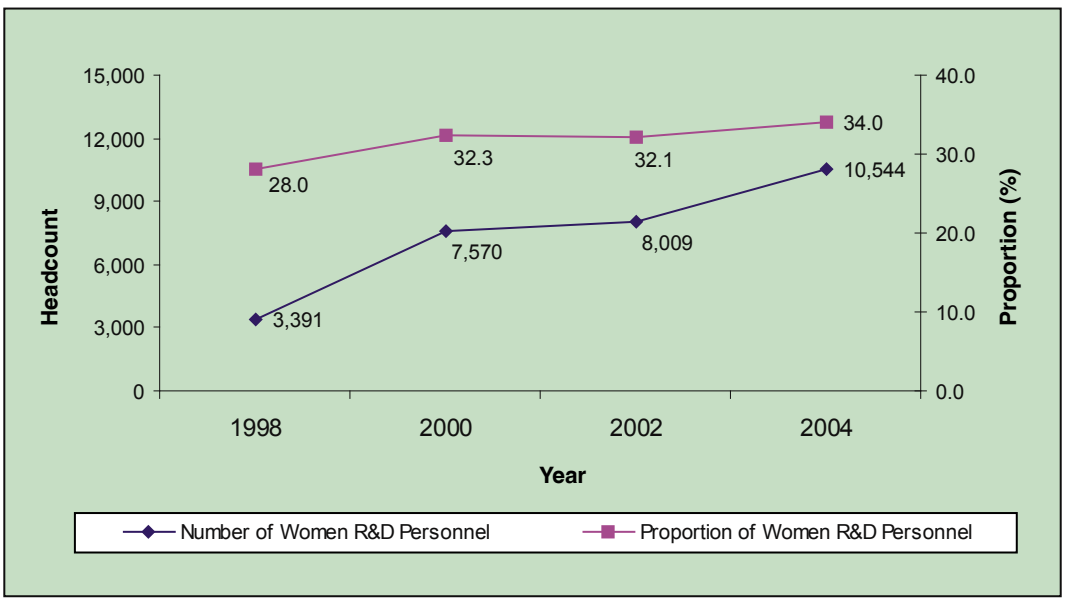
3.2.4 Participation of Women in R&D

Women constitute 34% of total R&D personnel and are located mainly in IHLs

The total number of women R&D personnel increased from 8,009 in 2002 to 10,544 in 2004 **(Figure 3.5)** and this represents 34% of the national R&D personnel. Researchers constitute the highest total headcount in all the three sectors of GRI, IHL and private, while technicians being the least **(Figure 3.3)**. The number of women researchers increased from 5,996 in 2002 to 8,275 in 2004 **(Figure 3.5)**. The IHLs have the highest number of women researchers followed by the GRIs and the private sector **(Figure 3.3)**. In terms of qualification, the majority of women researchers have bachelor degrees, followed by master degrees and doctorates. There were 2,866 bachelor degree holders, 2,734 master degree holders and 1,920 PhDs **(Figure 3.8)**.

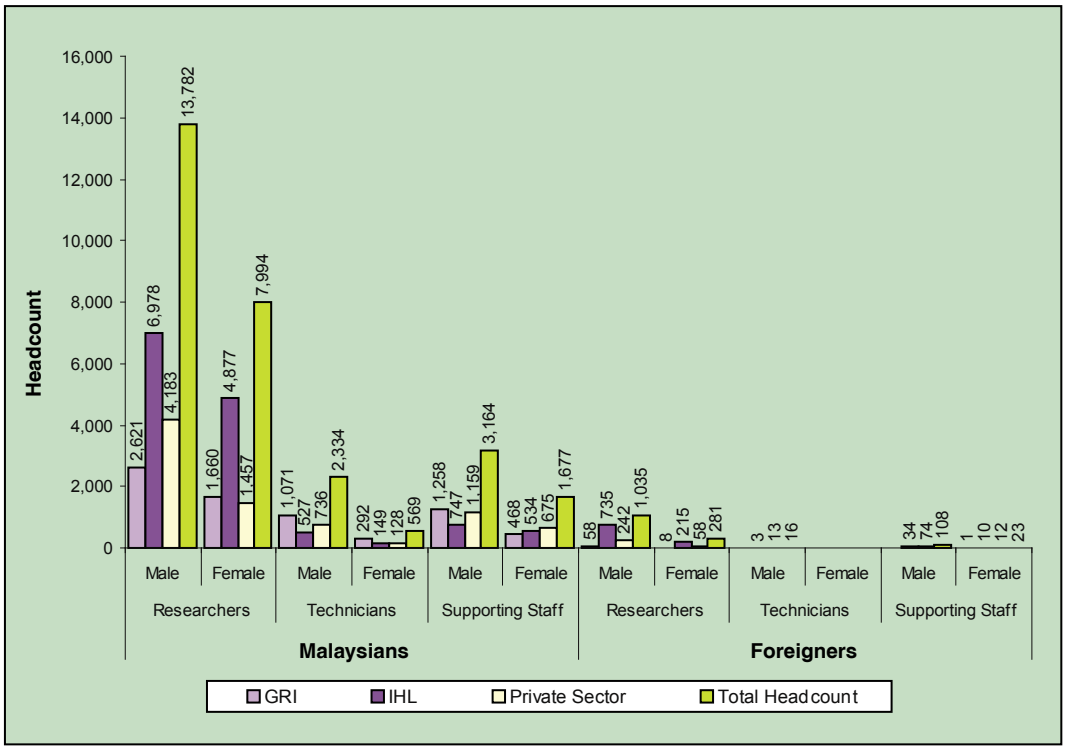
Malaysia's proportion of women researchers – which stood at 35.8% in 2004 – is at par or close to that of Spain, Turkey, Greece, Hungary and Ireland and ahead of countries like Japan (13%), Republic of Korea (13%), Austria (21%) and Switzerland (21%) **(Figure 3.9)**.

Figure 3.5: Women R&D Personnel, 1998 - 2004



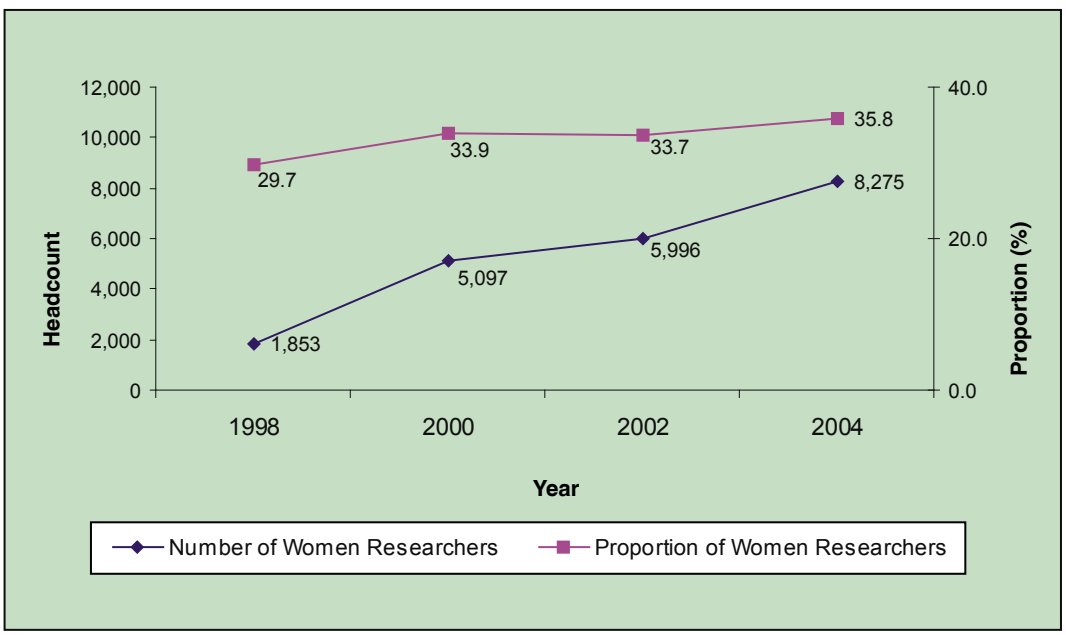
Source: National Survey on Research & Development 2006 Report

Figure 3.6: R&D Personnel (Headcount) by Sector, Nationality and Gender in 2004



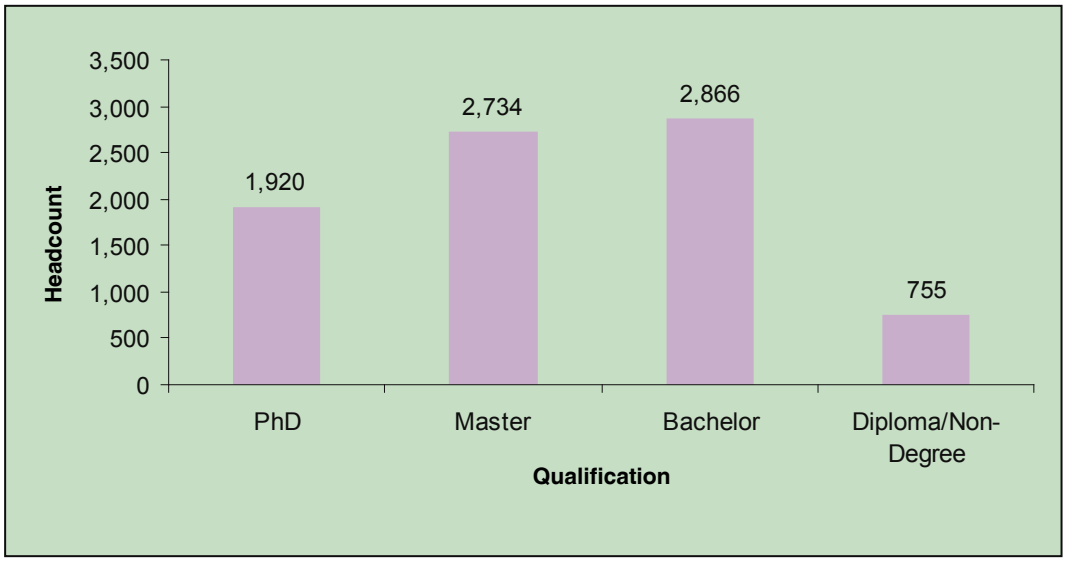
Source: National Survey on Research & Development 2006 Report
Note:Total Female R&D Personnel - 10,544

Figure 3.7: Women Researchers in R&D, 1998 - 2004



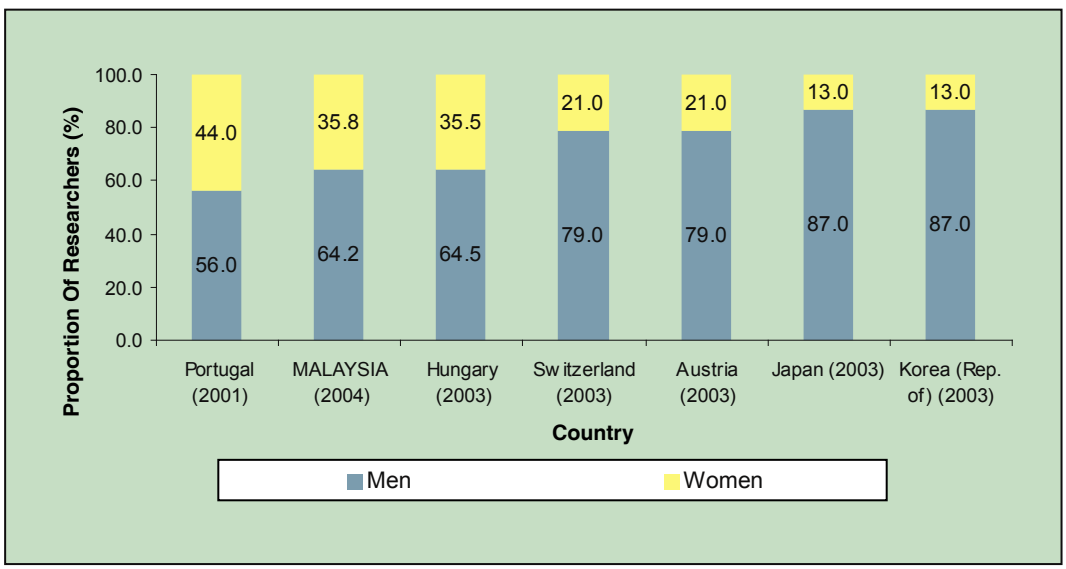
Source: National Survey on Research & Development 2006 Report

Figure 3.8: Number of Researchers by Qualification for Women Researchers in Malaysia, 2004



Source: National Survey on Research & Development 2006 Report

Figure 3.9: International Comparison of Gender Profile of Researchers by FTE



Sources: OECD Statistics Portal

3.2.5 Researchers by Selected Field of Research (FOR), 2004

In terms of FOR, most researchers engaged in ICT, engineering sciences and social sciences.

Figure 3.10 shows the number of researchers for the top six fields of research (FOR) of the three major sectors in the economy. In 2004, the field of research that has the most researchers was information, computer and communication technologies (4,141), followed by engineering sciences (3,749), and social sciences (2,150). The top two positions are consistent with the 2002 rankings. The two fields of research that had the least number of researchers were marine sciences and forestry sciences.

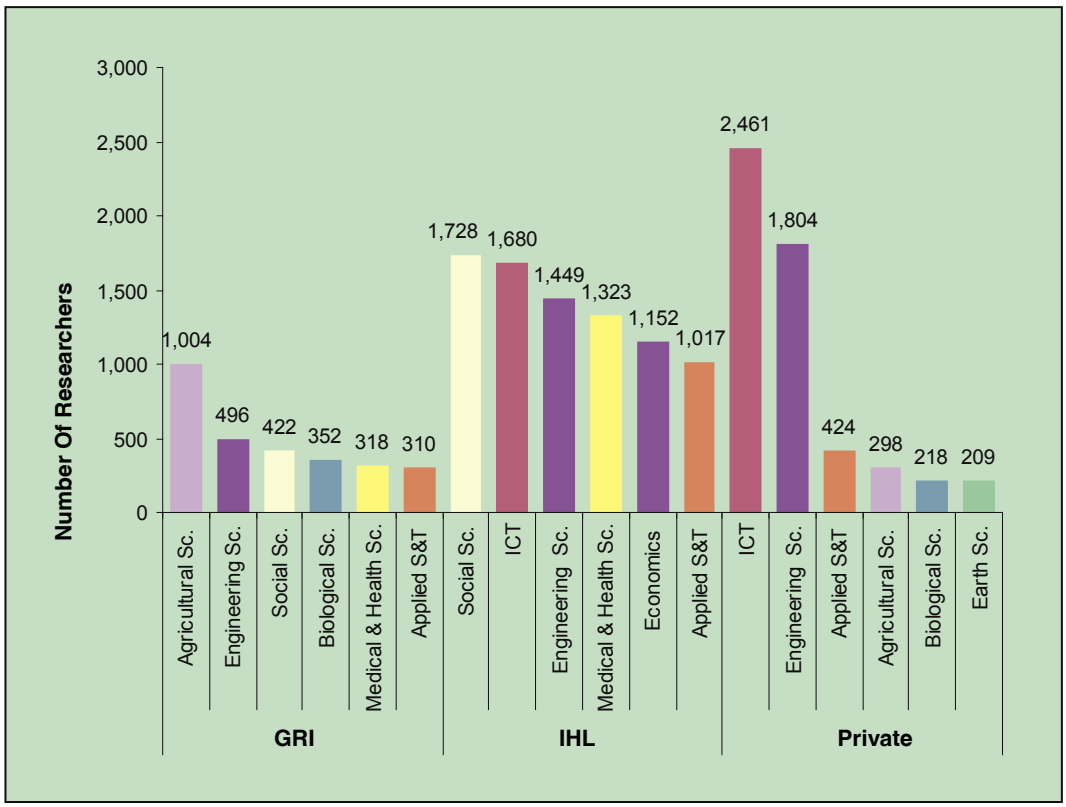
The distribution of researchers among the three sectors **(Figure 3.10)** indicated that the private sector R&D is market-driven and sensitive to the existing market trend and needs, whereas GRIs and IHLs undertake research in areas that the private sector does not emphasise such as social sciences and humanities. In this regard, for the private sector in

2004, the fields of research that had the largest number of researchers were information, computer and communication technologies (2,461), engineering sciences (1,804) and applied sciences and technologies (424).

For GRIs, since a number of large institutions such as MARDI, MPOB and FRIM are agriculture-based, thus the concentration of researchers was in agriculture sciences (1,004) and engineering sciences (496).

In the case of IHLs, the distribution of researchers was well spread across all fields, and the top six FORs in 2004 had over 1,000 researchers each. The fields with the highest number of researchers were social sciences (1,728), followed by information, computer and communication technologies (1,680) and engineering sciences (1,449).

Figure 3.10: Sectoral Comparison and Ranking of Top Six FORs, 2004



Source: National Survey on Research & Development 2006 Report

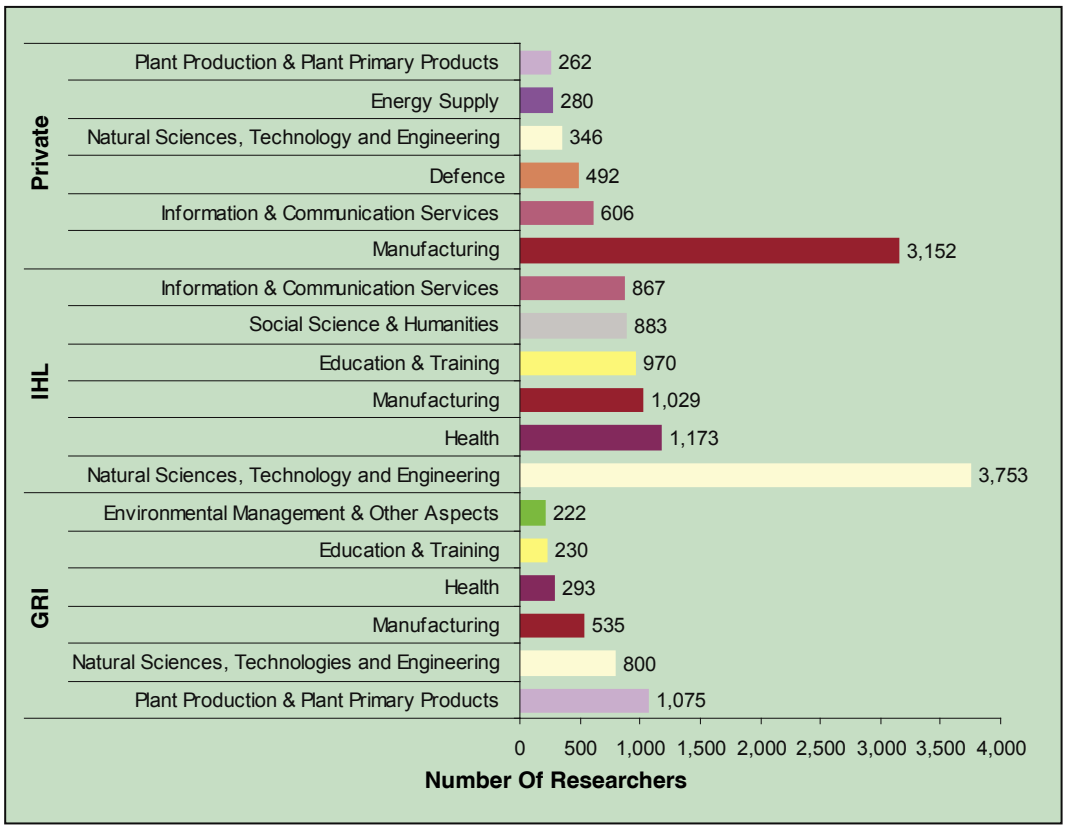
3.2.6 Researchers by Selected Socio-Economic Objectives (SEO), 2004

The socio-economic objectives or SEOs of R&D indicate the purpose of R&D being undertaken. **Figure 3.11** illustrates the number of researchers (in bracket) of the top six SEOs of the three sectors in 2004. Natural sciences, technology and engineering has the highest total number of researchers (4,899). This is followed by manufacturing (4,716) and plant production and plant primary products (1,337). It is interesting to note that the top five SEOs of 2004 were similar to those of the 2002, except the ranking.

In terms of SEO, most research undertaken for purpose of natural sciences, technology and engineering as well as manufacturing.

For GRIs, 1,075 researchers were involved in plant production and plant primary products, whilst natural sciences, technologies and engineering had 800 researchers. In the case of IHLs, natural sciences, technology and engineering had the highest number of researchers (3,753), followed by health (1,173) and manufacturing (1,029). In tandem with the national core industrial activities, the private sector R&D was conducted mainly for the purpose of manufacturing (3,152) and information and communication services (606).

Figure 3.11: Sectoral Comparison and Ranking of Top Six SEOs, 2004



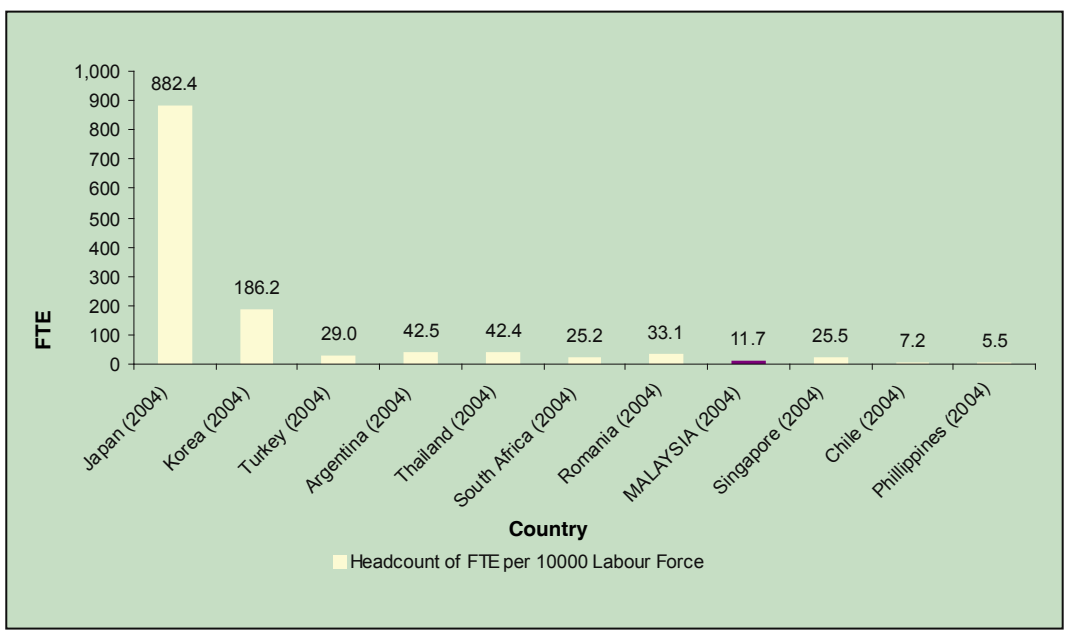
Source: National Survey on Research & Development 2006 Report

3.2.7 International Comparison

Malaysia's researcher FTE per 10,000 labour force was 11.7 in 2004 as compared to 7.2 in 2002. This places Malaysia close to South Africa (25.2), and ahead of Chile (7.2), and the Philippines (5.5). However, Malaysia is behind Romania (33.1), Turkey (29.0), Argentina (42.5) and Singapore (25.5) as shown in **Figure 3.12**.

Our researcher FTE per 10,000 labour force has increased to 11.7 in 2004 from 7.2 in 2002

Figure 3.12: International Comparison of Total FTE of Researchers - 2004



Source:IMD World Competitiveness Year Book 2006

3.3 HUMAN RESOURCE IN GRIs

By Headcount

Number of R&D personnel (headcount) has increased slightly in GRIs but in terms of FTE there has been a sharp increase

The total number of personnel working in the GRIs showed an increase from a total of 7,222 in 2002 to 7,437 in 2004. The number of researchers increased from 3,914 in 2002 to 4,347 in 2004, while the number of technicians decreased from 1,413 to 1,363, and the supporting staff from 1,895 to 1,727. PhD holders accounted for 26.0% of the total GRI researcher headcount, 28.2% possessed masters and 33.4% bachelors degrees respectively and 12.3% with diploma. Male researchers increased from 2,438 to 2,679 in 2004 while female researchers increased from 1,397 to 1,668. There was a drop in the number of technicians from 1,413 in 2002 to 1,363 in 2004. By gender, 78.6% of the total number of technicians was male. The total number of support staff decreased from 1,895 in 2002 to 1,737 in 2004. Out of this number, 72.8% were male.

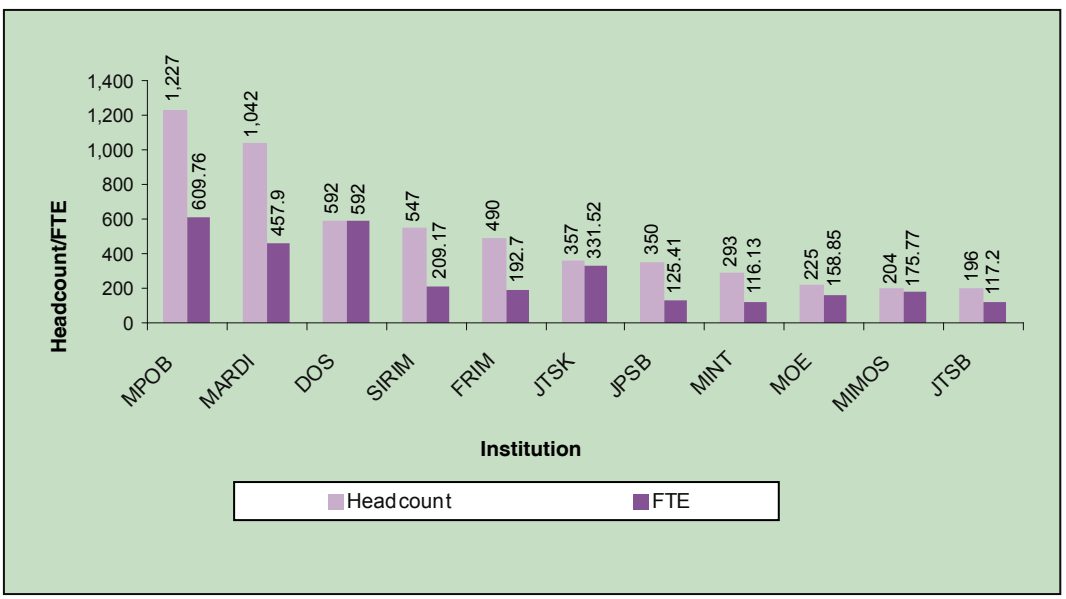
By FTE

The total FTE for personnel in the GRIs increased from 2,652.4 in 2002 to 4,021.3 in 2004. The FTE for researchers increased by 77.1% from 1,203.5 in 2002 to 2,130.8 in 2004. The FTE for technicians increased from 508.1 in 2002 to 682.2 in 2004. The FTE for support staff increased from 940.8 in 2002 to 1,208.3 in 2004.

R&D Personnel in Selected GRIs

Figure 3.13 shows the distribution of R&D personnel (Malaysians and foreigners) in selected GRIs in 2004. In terms of headcount and FTE, the majority of R&D personnel were found in the agriculture sector. The highest numbers were from the Malaysian Palm Oil Board (MPOB) at 1,227 and Malaysian Agricultural Research and Development Institute (MARDI) at 1,042.

Figure 3.13: R&D Personnel (Malaysians & Foreigners) (Headcount & FTE) in selected GRIs, 2004

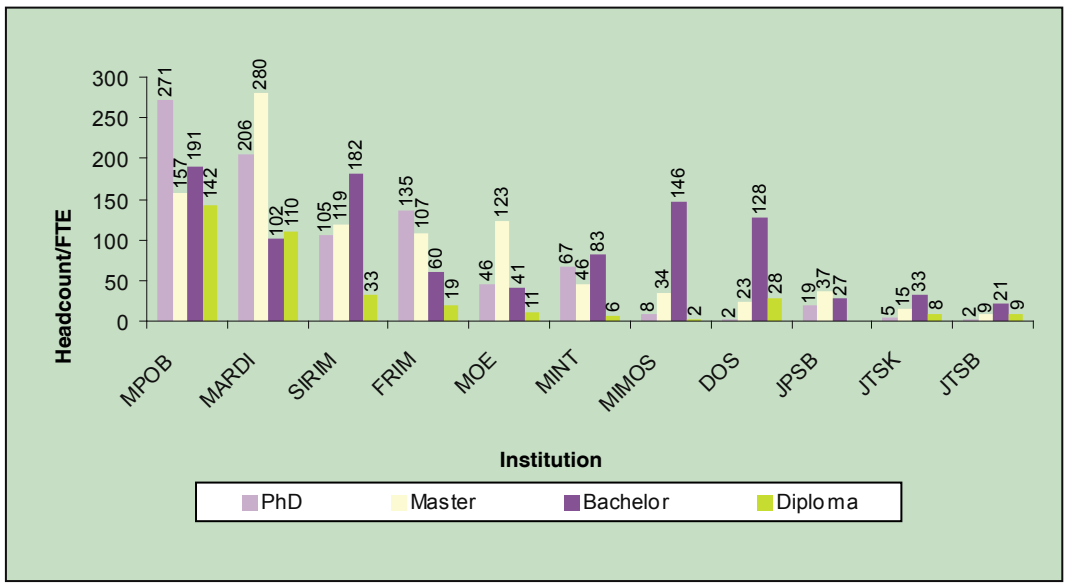


Source: National Survey on Research & Development 2006 Report

Researchers by Qualification in Selected GRIs

Figure 3.14 shows the distribution of Malaysian researchers by qualification in selected GRIs in the year 2004. MPOB, MARDI and SIRIM had the highest total number of researchers of various qualification at 761, 698 and 439 respectively. Most of the researchers with PhD were employed by MPOB (271), MARDI (206) and FRIM (135). MARDI ranked first in terms of researchers with masters degree (280), followed by MPOB (157) and MOE (123). There were only 28 foreign researchers of all categories employed by the GRIs.

Figure 3.14: Researchers (Malaysians) (Headcount) by Qualification in Selected GRIs, 2004

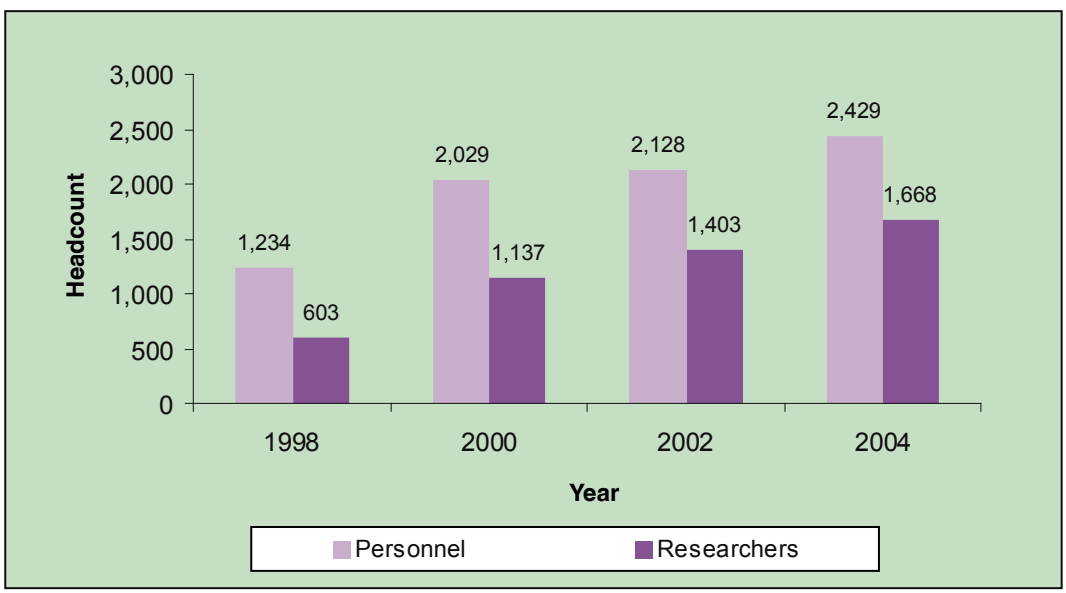


Source: National Survey on Research & Development 2006 Report

Women Participation in R&D

There is a consistent upward trend in terms of the number of women personnel; from 2,029 in 2000 to 2,128 in 2002 and finally to 2,429 in 2004. The number of researchers rose from 1,403 in 2002 to 1,668 in 2004 **(Figure 3.15)**. The majority of these researchers were Bachelor degree holders (37.2%), followed by Masters (27.2%), and PhD (22.4%).

Figure 3.15: Women R&D Personnel and Researchers in GRI, 1998 - 2004



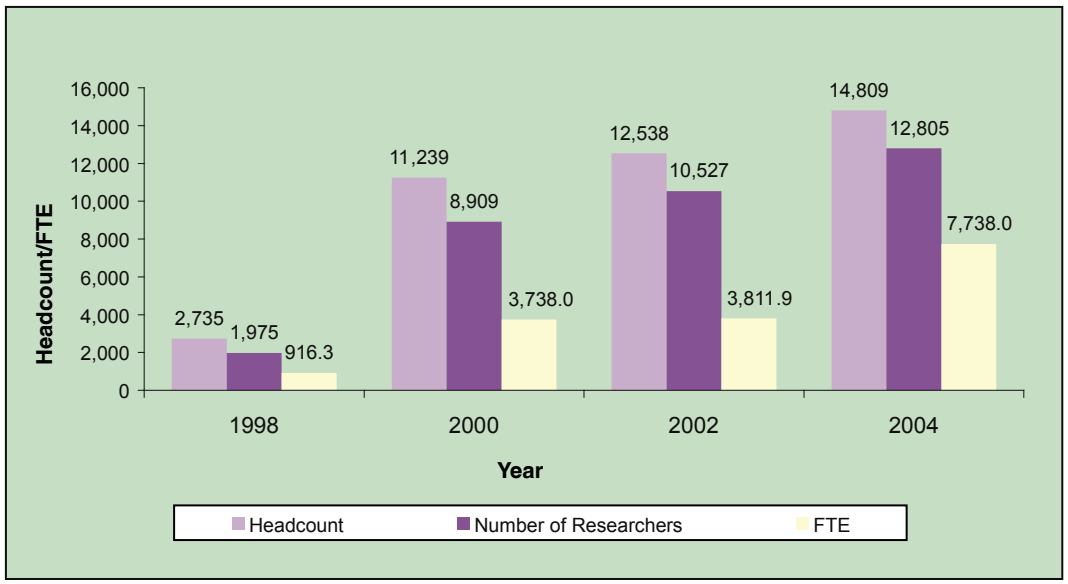
Source: National Survey on Research & Development 2006 Report

3.4 HUMAN RESOURCE IN IHLs

By Headcount

The headcount of R&D personnel in IHLs increased from 11,239 in 2000 to 12,538 in 2002 and 14,809 in 2004. Researchers form the main bulk of the human resource, with 8,909 in 2000, 10,527 in 2002 and 12,805 in 2004 **(Figure 3.16)**. By qualification, most of the researchers hold doctoral degrees. However, in 2004 the proportion decreased from 41.9% in 2002 to 36.4%. However, the proportion of researchers with master degrees rose from 30.6% in 2002 to 38.2% in 2004. The technicians comprised of less than 10% of the total number of R&D personnel. Support staff decreased from 13.5% in 2000 to 8.9% in 2004. The total number of foreign R&D personnel stood at 997, or 6.73% of the total employed in 2004.

Figure 3.16: R&D Personnel in IHLs by Headcount and FTE, 1998 - 2004



Source: National Survey on Research & Development 2006 Report

By FTE

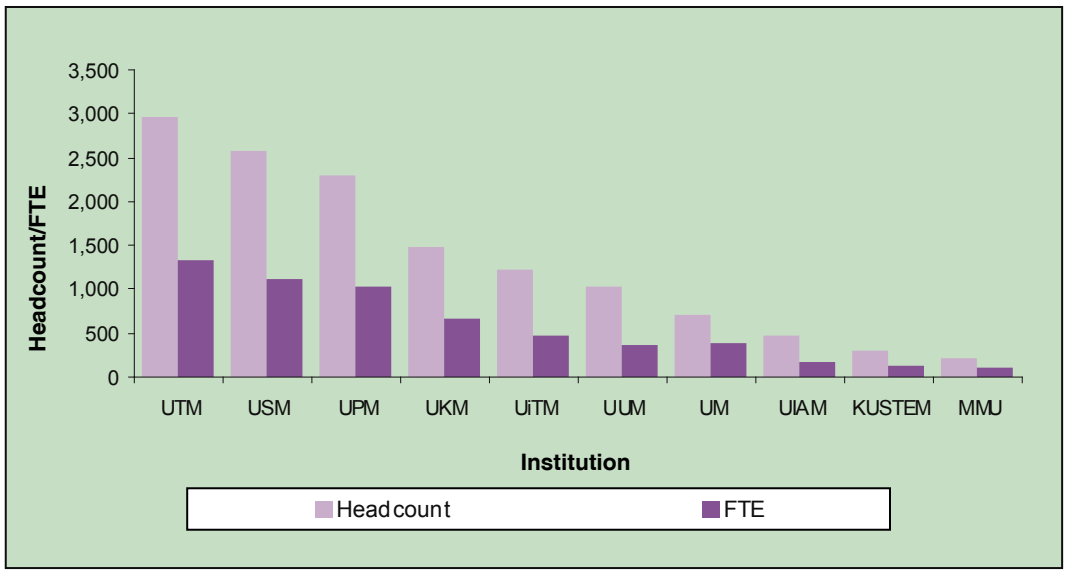
The total FTE in IHLs has shown a 4-fold increase from 1998 to 2000, and a 2-fold increase from 3,811.9 in 2002 to 7,738.0 in 2004 **(Figure 3.16)**. Researchers account for more than 75% of the total FTE. There was a 2-fold increase from 3,187.0 in 2002 to 6,434.4 in 2004. The technicians accounted for the lowest FTE both in terms of total and proportion of FTE. The FTE of support staff increased from a low of 376.2 in 2002 to 1,035.8 in 2004.

Significant increase in R&D personnel (headcount) in IHLs from 2002 but sharp rise in terms of FTE. Decline in support staff numbers

R&D personnel in selected IHLs

In terms of headcount, Universiti Teknologi Malaysia (UTM) had the largest number of researchers (2,972), followed by Universiti Sains Malaysia (USM) (2,586) and Universiti Putra Malaysia (UPM) 2,299. USM (279) and UPM (205) were the two leading universities that employed the most foreign R&D personnel in 2004. The distribution of R&D personnel in the top ten IHLs in 2004 is shown in **Figure 3.17**.

Figure 3.17: R&D Personnel (Malaysians & Foreigners) (Headcount & FTE) in selected IHLs, 2004

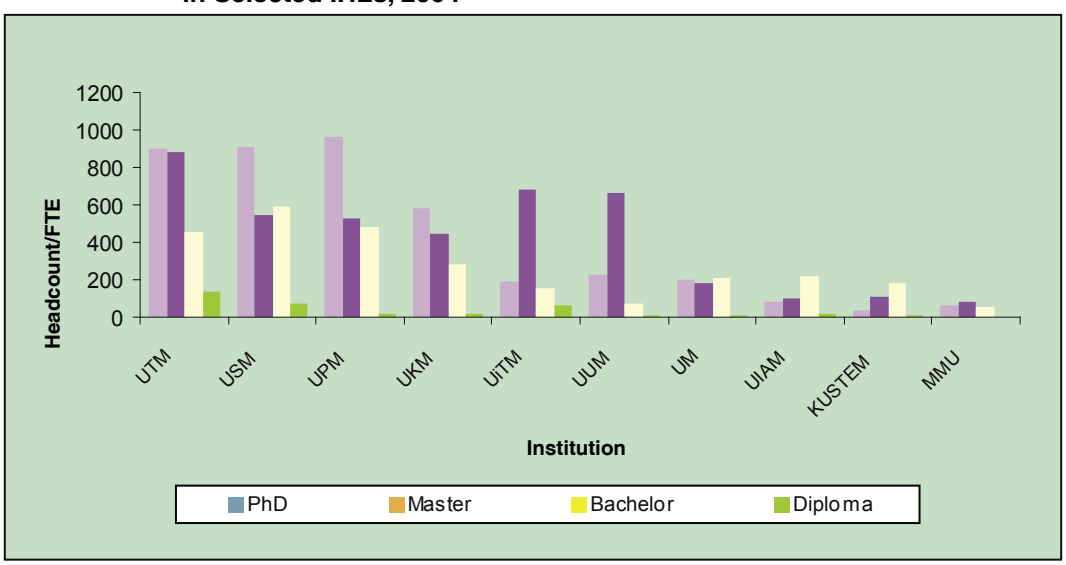


Source: National Survey on Research & Development 2006 Report

Researchers by Qualification in Selected IHLs

Figure 3.18 shows the distribution of researchers (headcount) by qualification in selected IHLs in 2004. In terms of number, UTM with a total of 2,369 researchers with various qualifications was highest among IHLs, followed by USM (2,121) and UPM (1,991). UPM had the most researchers (local and foreign) with PhDs (967), followed by USM (911) and UTM (904). UTM ranked first in terms of researchers with masters degree (881), followed by UiTM (684) and UUM (665).

Figure 3.18: Researchers (Malaysians & Foreigners) (Headcount) by Qualification in Selected IHLs, 2004



Source: National Survey on Research & Development 2006 Report

Women Participation in R&D

The number of female R&D personnel showed a dramatic 5-fold increase from 1,009 in 1998 to 5,785 in 2004. Women researchers increased from 3,772 in 2002 to 5,092 in 2004. The proportion of women to male researchers also increased from 35.8% in 2002 to 39.8% in 2004.

5-fold increase in women research personnel in IHLs since 1998

3.5 HUMAN RESOURCE IN PRIVATE SECTOR

By Headcount

There was a steady increase in the headcount of R&D personnel in the private sector from 4,246 in 2000 to 5,177 in 2002 and 8,737 in 2004. The headcount for researchers increased from 3,349 in 2002 to 5,940 in 2004 with the majority were men at 4,425. There were 399 foreign researchers in 2004. By qualifications, the majority of the researchers were bachelor degree and non-degree or diploma holders at 3,719 and 1,225 respectively. There were a total of 877 technicians (128 women) in 2004 as compared to 764 in 2002. In 2004, there were 1,920 support staff, out of which 687 were women.

Steady increase in headcount of R&D personnel in industry but more marked increase in terms of FTE

By FTE

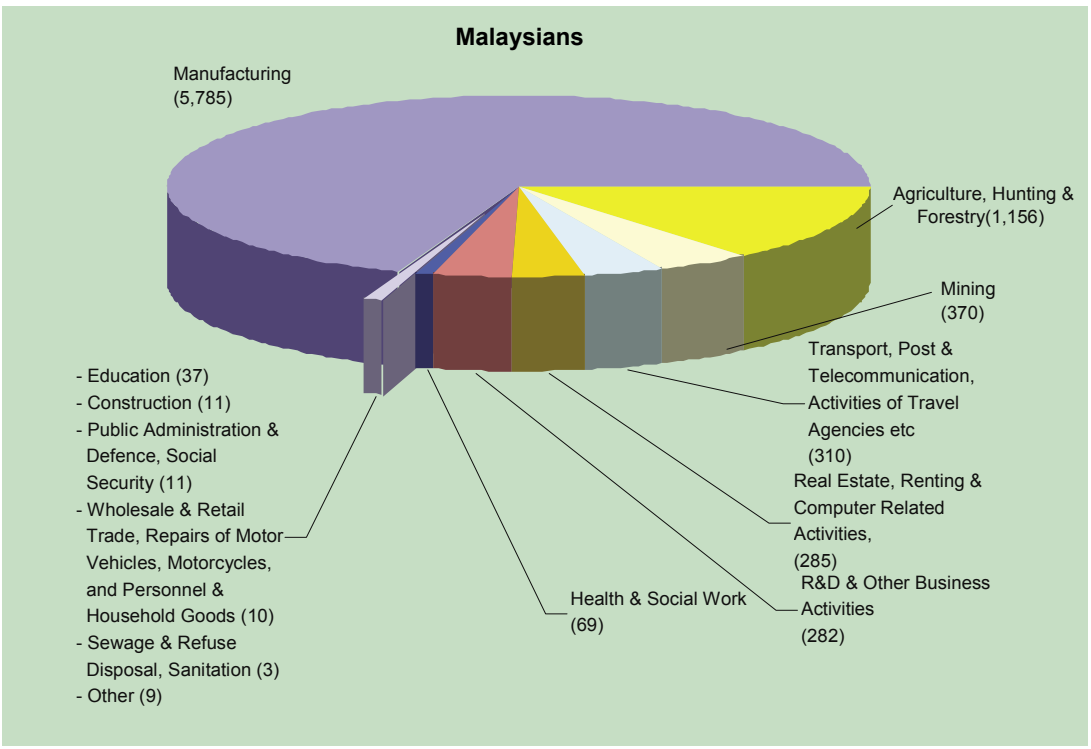
The total FTE was 6,127.2 in 2004 as compared to 4,266.7 in 2002. Researcher FTE increased from 2,767.1 in 2002 to 4,104.3 in 2004. Technician FTE also increased from 621.9 in 2002 to 647.7 in 2004. There was also an increase of support staff FTE from 877.7 in 2002 to 1,375.2 in 2004.

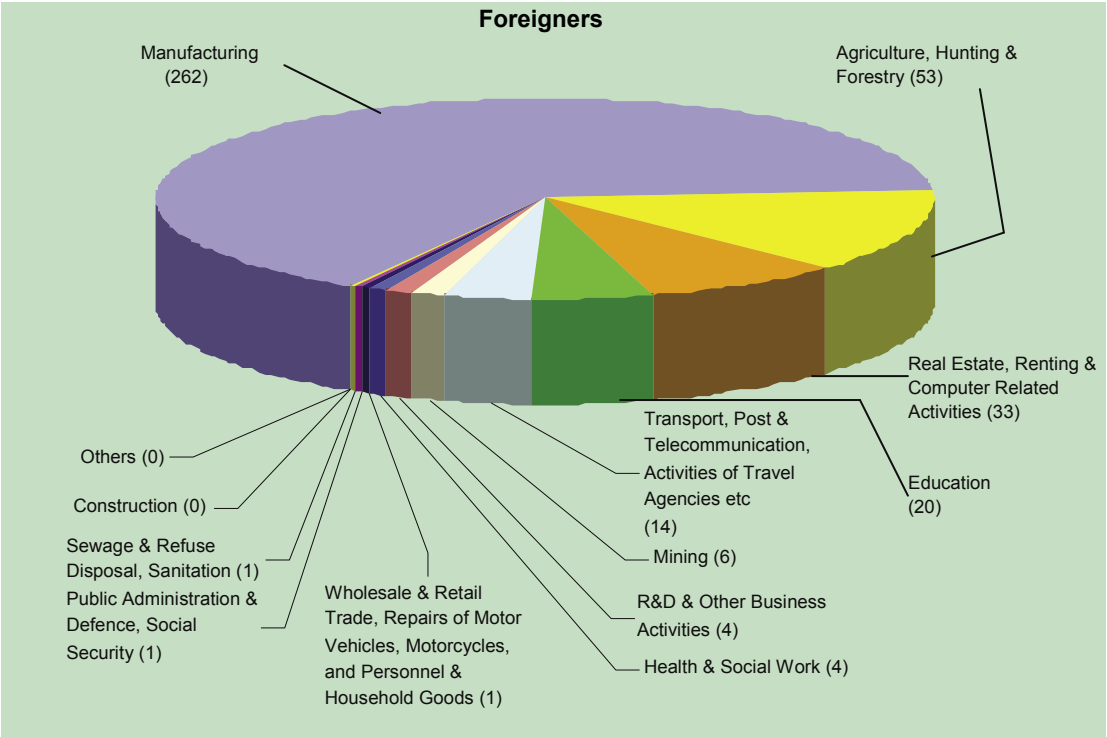
Private Sector R&D Personnel by Industry and Nationality

Private sector R&D personnel were mainly involved in the manufacturing industry in 2004 **(Figure 3.19)**. They were mainly employed in the manufacture of radio, television and communication equipment and apparatus industry (1,439), manufacturing of office, accounting and computing machinery industry (1,413) and manufacture of motor vehicle, trailers and semi-trailers (647). The second largest group of R&D personnel was found in the agriculture, hunting and forestry industry. In terms of nationality, only 4.56% 0f the R&D personnel were foreigners.

Industry R&D personnel largely engaged in manufacturing. Majority of them only possess first degree qualifications

Figure 3.19: Private Sector R&D Personnel (Headcount) by Industry, 2004



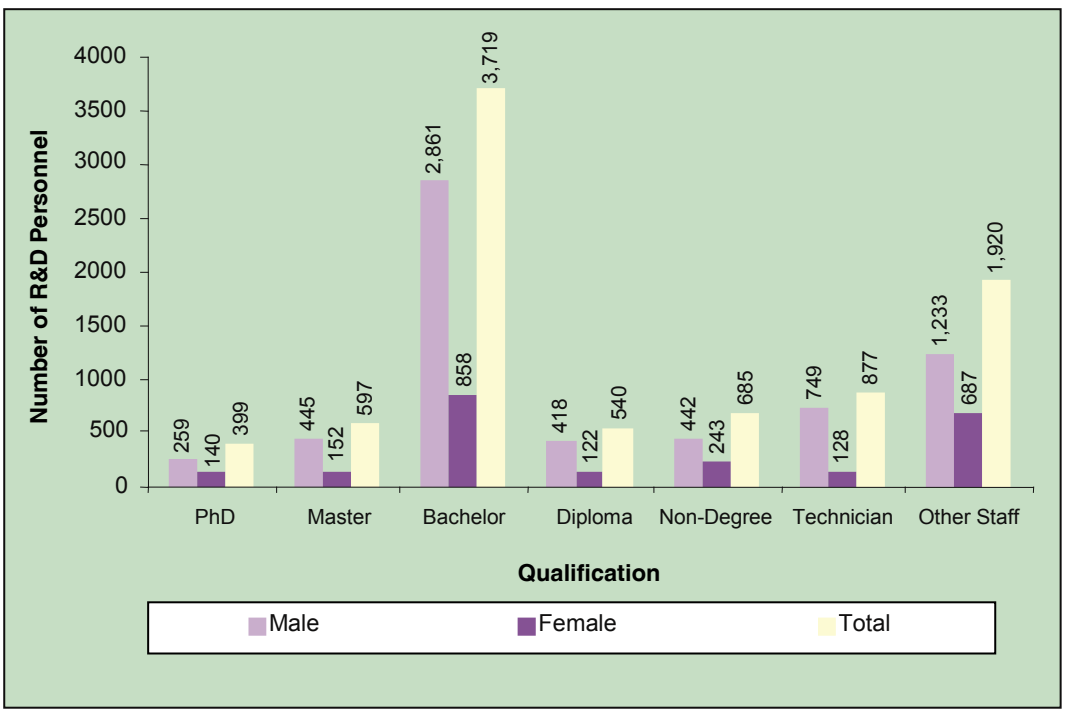


Source: National Survey on Research & Development 2006 Report
*Number for researchers in ( )

Private Sector R&D Personnel by Qualification

Figure 3.20 shows the distribution of private sector R&D personnel by qualification and gender. Those with bachelor degree (3,719) constituted the largest number of R&D personnel in 2004. PhD holders which represented only 4.56% of the total R&D personnel in the private sector were largely found in the manufacturing industry, while those with masters degrees (6.83%) were also mainly employed in the manufacturing industry.

Figure 3.20: Private Sector R&D Personnel by Qualification & Gender, 2004



Source: National Survey on Research & Development 2006 Report

Women Participation in R&D

The total number of women R&D personnel has increased from 1,504 in 2002 to 2,330 in 2004, however there was a drop in proportion in relation to male personnel from 29.1% to 26.7% during the same period. Similarly, women researchers have increased from 821 in 2002 to 1,515 in 2004.

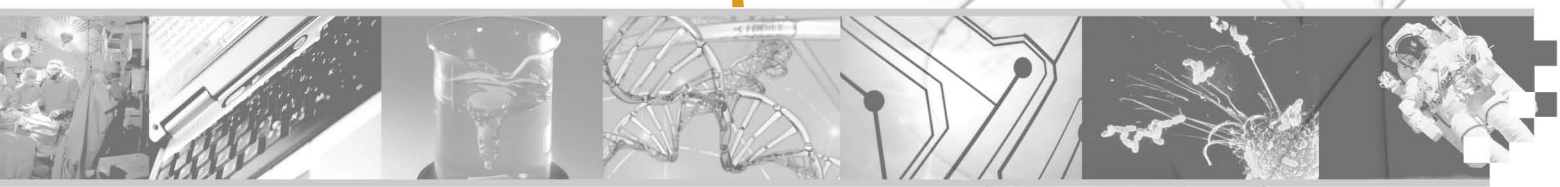
3.6 CONCLUSION

This chapter has provided an overview of Malaysia's R&D personnel in terms of size, gender composition, qualifications, participation by type of research and nationality engaged in the public and private sectors. The survey findings have revealed an upward trend in all these categories. The number of R&D personnel in terms of both headcount and FTE has increased by more than 150% since 1998. The number of technicians, however, has remained fairly stable and a small increase was noted in the support staff category. Foreigners accounted for 4.72% of the total R&D personnel while a sizeable proportion (34%) of the nation's research workforce were women. Despite this rising trajectory of research personnel, Malaysia still lags behind her nearest competitors in international comparisons of R&D personnel both in terms of headcount and FTE.

The increase in the quantity of research personnel has also been accompanied by an increase in quality in terms of qualifications during the period under review. The number of doctorates has increased from 5,575 in 2002 to 6,183 in 2004, MSc. from 4,736 to 6,720, and BSc. from 6,241 to 6,543 during the same period. IHLs have the most PhDs, followed by GRIs, while the private sector has the least.

Most R&D personnel were engaged in applied research followed by basic and experimental development research. The top three FORs in terms of R&D personnel in 2004 were Information, Computer and Communication Technology (ICCT) (4,141), Engineering Science (3,749) and Social Science (2,150). By sector, the GRIs were more represented in Agriculture, the IHLs were well spread across all areas, while the private sector was more active in ICCT. Similarly, the top three SEOs were Natural Sciences, Technology and Engineering (4,899), Manufacturing (4,716) and Plant Production and Plant Primary Products (1,903). By sector, the GRIs were more involved in Plant Production and Plant Primary Products, IHLs more into Natural Sciences, Technology and Engineering, while the private sector was more engaged in Manufacturing.

Chapter 4



RESEARCH AND DEVELOPMENT ACTIVITIES

4.1 INTRODUCTION

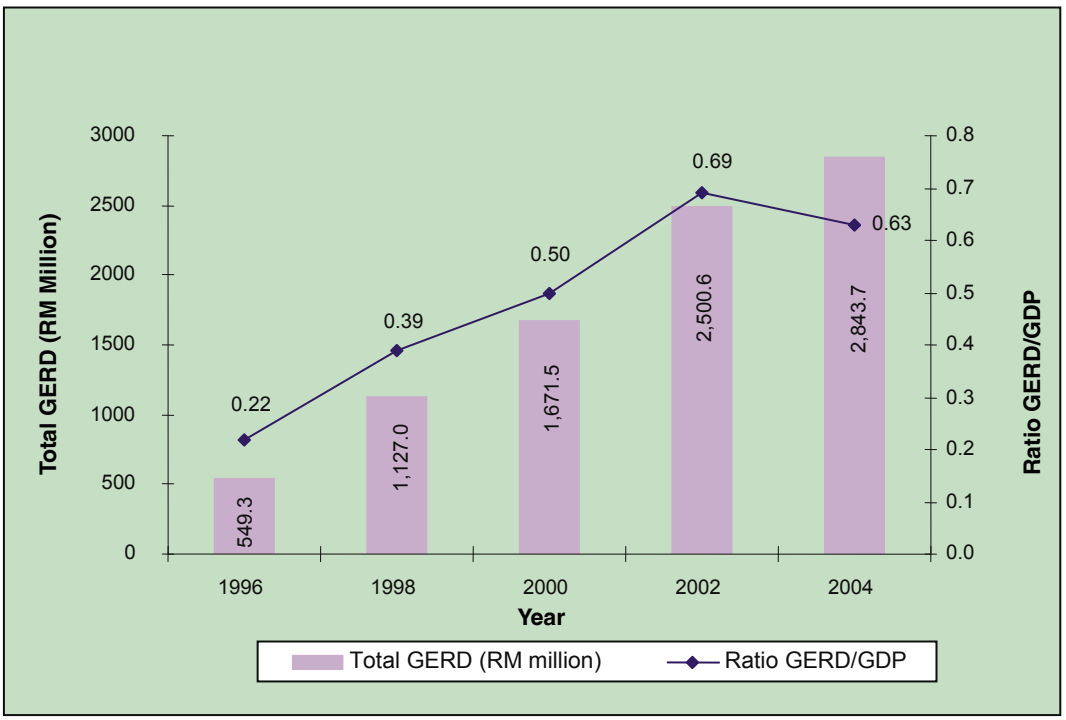
This chapter deals with the research and development (R&D) activities conducted by the public and private sectors in Malaysia from the year 1996 to 2004. Data obtained from the biennial national R&D Survey 2006 were reviewed and analysed to reflect the status and trend of R&D activities of the country. The scope of the chapter covers a national overview of expenditure and activities of R&D, sectoral R&D activities of GRIs, IHLs and private sector pertaining to types and fields of research, socio-economic objectives, sources of funding, R&D outsourcing, and international comparisons. Lastly, suggestions on some key performance indicators (KPIs) that are useful and relevant for future indicator reports are presented.

4.2 NATIONAL OVERVIEW OF R&D EXPENDITURE AND ACTIVITIES

Research intensity (GERD/GDP) has declined marginally to 0.63 in 2004

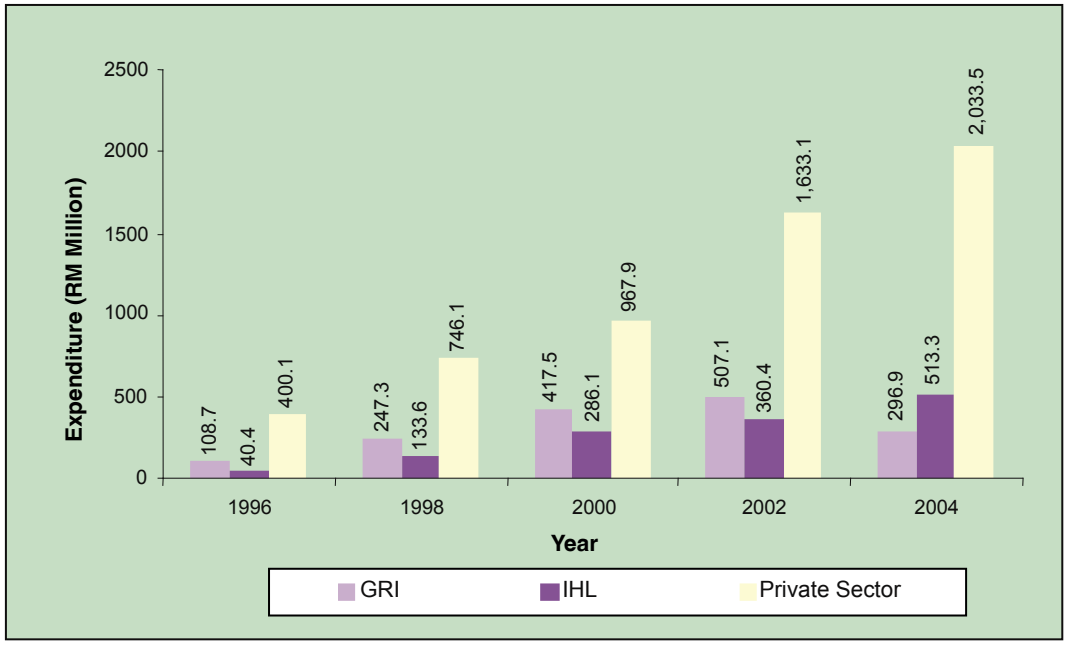
The national GERD has been steadily on the rise since 1996. From RM549.3 million in 1996, it grew to RM1.13 billion in 1998, RM1.67 billion in 2000, and RM2.5 billion in 2002. In tandem with the upward trend, the GERD continued to increase by RM0.34 billion to RM2.84 billion in 2004 **(Figure 4.1)**. However, the research intensity (GERD/GDP ratio) has declined from 0.69 in 2002 to 0.63 in 2004 due primarily to the faster expansion of the national GDP from RM360 billion in 2002 to RM450 billion in 2004 following the increased pace of economic growth during the same period.

Figure 4.1: National GERD and Ratio GERD/GDP, 1996-2004



Source: National Survey on Research & Development 2006 Report

Figure 4.2: R&D Expenditure by Sectors, 1996-2004



Source: National Survey on Research & Development 2006 Report

As shown in **Figure 4.3,** current expenditure that comprises labour and operating costs has been on the upward trend. From a low of RM329.1 million in 1996, it has increased to RM1,375.2 million in 2002 and subsequently to RM2,196.6 million in 2004. However, there was a marked decrease in capital expenditure from RM1,125.4 million in 2002 to RM647.2 million in 2004 a decrease of 42.5% or RM478.2 million.

Slight increase in total R&D expenditure in 2004. Major emphasis devoted to applied research. Industry accounted for almost 72% of total R&D expenditure

With respect to expenditure provided for the three types of research, the trend of emphasis to Applied Research, followed by Experimental Research and Basic Research continued in 2004. The overall GERD of the public and private sectors has shown an increase from RM2,500.6 million in 2002 to RM2,843.7 million in 2004 with the private sector contributing 71.5% of the total expenditure**(Figure 4.1)**.

Based on the R&D classification, the three main FORs for 2004 were Engineering Science, Information, Computer & Communication Technology and Applied Sciences & Technology. In terms of SEO categories, the top five in 2004 were Manufacturing, Information and Communication Services, Natural Science, Technology & Engineering, Plant Production & Plant Primary Products as well as Energy Resources.

The bulk of the R&D in 2004 was conducted in Malaysia. Of the total national R&D expenditure, only RM33 million was outsourced, a significant decline from RM306 million (or 89.2%) outsourced in 2002 **(Figure 4.9).**

In the international arena, Malaysia's GERD in 2004 of RM2.84 billion trailed far behind that of the United States at RM1.1 trillion, the EU15 at RM649.9 billion, Japan at RM459.2 billion and China at RM69 billion.

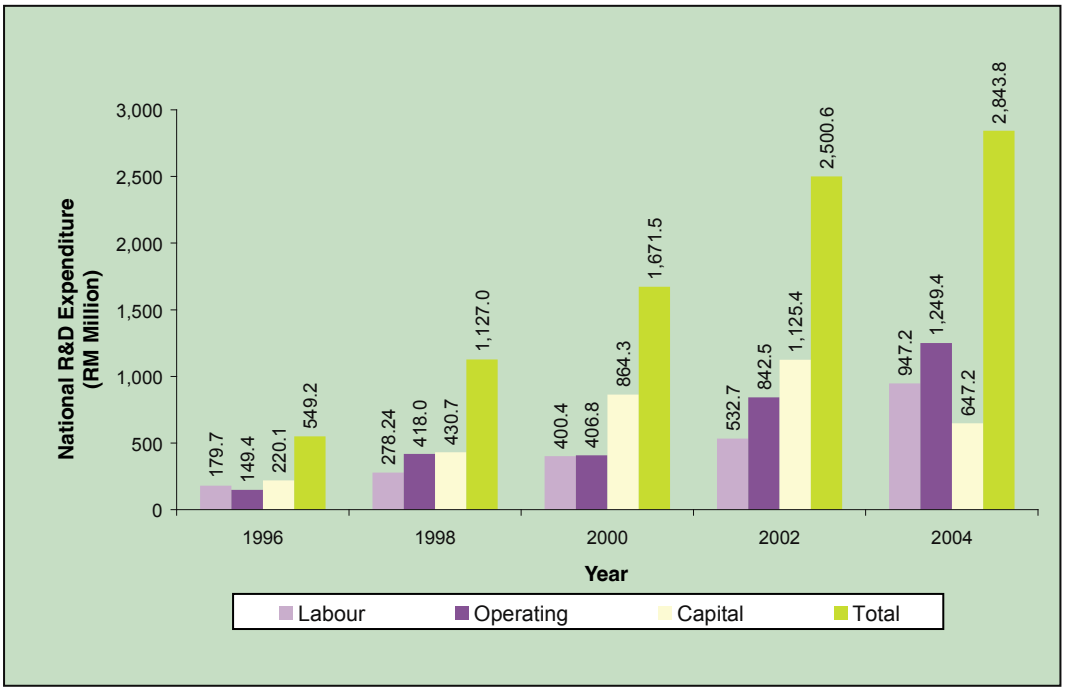
4.2.1 R&D Expenditure by Sectors, Types, Field of Research and Socio-Economic Objectives

Expenditure by Sector

Figure 4.2 shows the breakdown of the sectoral R&D expenditure of 1996 to 2004. Of the amount spent on R&D in 2004, the IHLs showed an increase of RM152.9 million (29.8%) over 2002, amounting to RM513.3 million, while the GRIs spent RM296.9 million, a decrease of RM210.2 million (41.5%). The private sector remained as the major contributor to the increase in GERD during the years from 1996 to 2004. Its contribution to the national GERD increased by RM400.4 million, from RM1.6 billion in 2002 to RM2.03 billion in 2004

(24.5%). The overall increase in GERD could be attributed to two main reasons; namely, more funds had been allocated for the public sector in the 8MP, in particular to areas such as Agriculture, ICT and Manufacturing. The improved foreign investments brought upon by the improved economic conditions had resulted in more funds made available to the private sector.

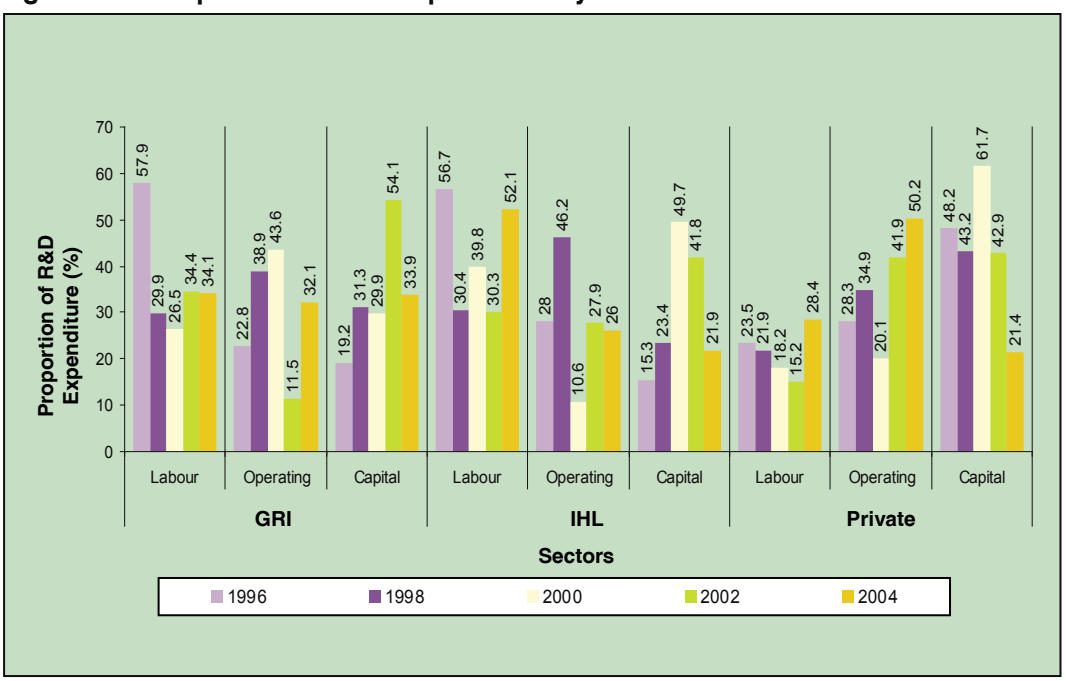
Figure 4.3: Expenditure by Type of Cost (RM million), 1996 - 2004



Source: National Survey on Research & Development 2006 Report

Current expenditure (labour and operating) accounted for 77.2% **(Figure 4.3 & 4.4)** of the total national GERD in 2004. It showed an uptrend, from RM329.1 million in 1996 to RM2,196.6 million in 2004 **(Figure 4.3).**

Figure 4.4: Proportion of R&D Expenditure by Sectors



Source: National Survey on Research & Development 2006 Report

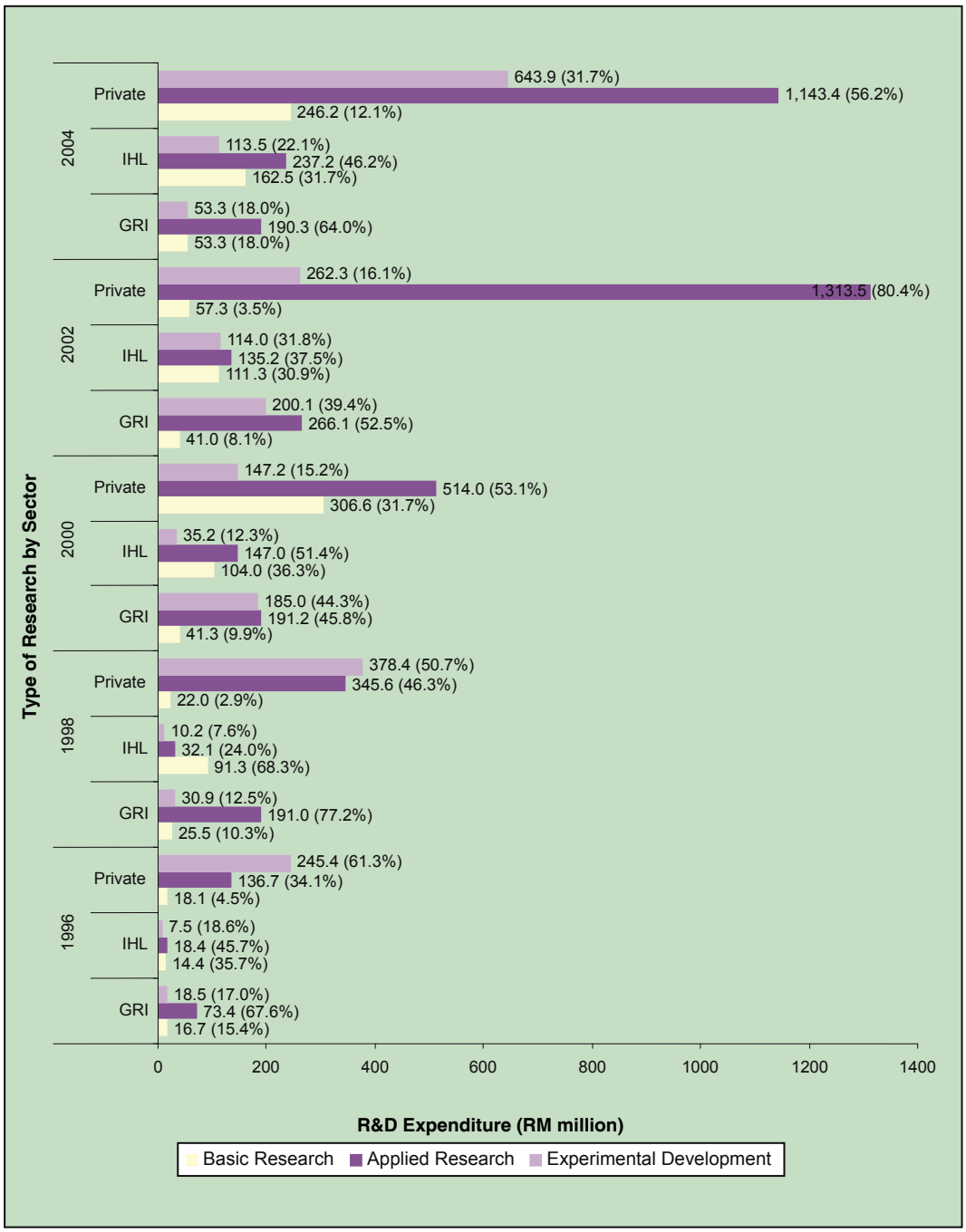
Capital expenditure (land, building machinery and equipment) has also been on the upward trend since 1996, reaching RM1,125.4 million in 2002. The decline to RM647.2 million in 2004 was due to the long term commitment of the capital investment which would not likely to recur again in 2004 **(Figure 4.3)**.

Expenditure by Type of Research

Most of the R&D expenditure is of the applied R&D type

Since 1998, the thrust has been on Applied Research, followed by Experimental Development and Basic Research for the three sectors **(Figure 4.5)**. This trend continued to 2002, with a slight drop in 2004 with Applied Research contributing 55.4% of the national GERD, followed by Experimental Development (28.5%) and Basic Research (16.1%).

Figure 4.5: R&D Expenditure by Sector & Type of Research (1996-2004) - by Value and Proportion



Source: National Survey on Research & Development 2006 Report
* Figure in ( ) indicates the proportion of R&D expenditure by sector

The thrust of private sector was on Applied Research followed by Experimental Development. It spent the least on Basic Research. This trend indicated that the private sector was more keen to invest in R&D that could lead to commercialization of the R&D results. GRIs shared the same trend as the private sector, focusing more on Applied and Experimental Development. The IHLs, however, emphasized on Applied and Basic Research to reflect on their role as knowledge generators.

Expenditure by FOR

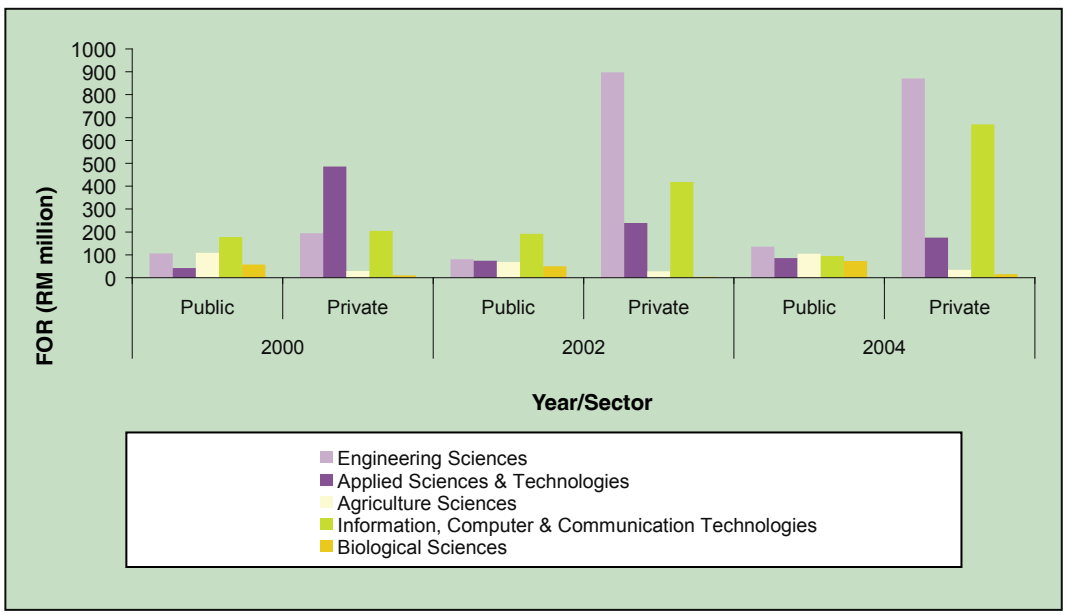
The top five key FOR categories of research in 2004 were:

1. Engineering Sciences;
2. Information, Computer & Communication Technology (ICCT);
3. Applied Sciences & Technologies;
4. Agricultural Sciences;
5. Biological Sciences.

The top three FORs of 2004 were similar to those of 2002. Engineering Sciences had the highest expenditure of RM1.006 billion, an increase of RM28.6 million as compared to RM977.9 million in 2002. ICCT recorded an increase of RM154.5 million, from RM610.1 million in 2002 to RM764.6 million in 2004. In both cases, the Private Sector contributed a major proportion of the expenditure.

In contrast, Applied Sciences & Technologies showed a decline, from RM313.9 million in 2002 to RM260.9 million in 2004, a drop of RM53 million **(Figure 4.6).**

Figure 4.6: R&D Expenditure by FOR (RM million), 2000 - 2004



Source: National Survey on Research & Development 2006 Report

Expenditure by SEO

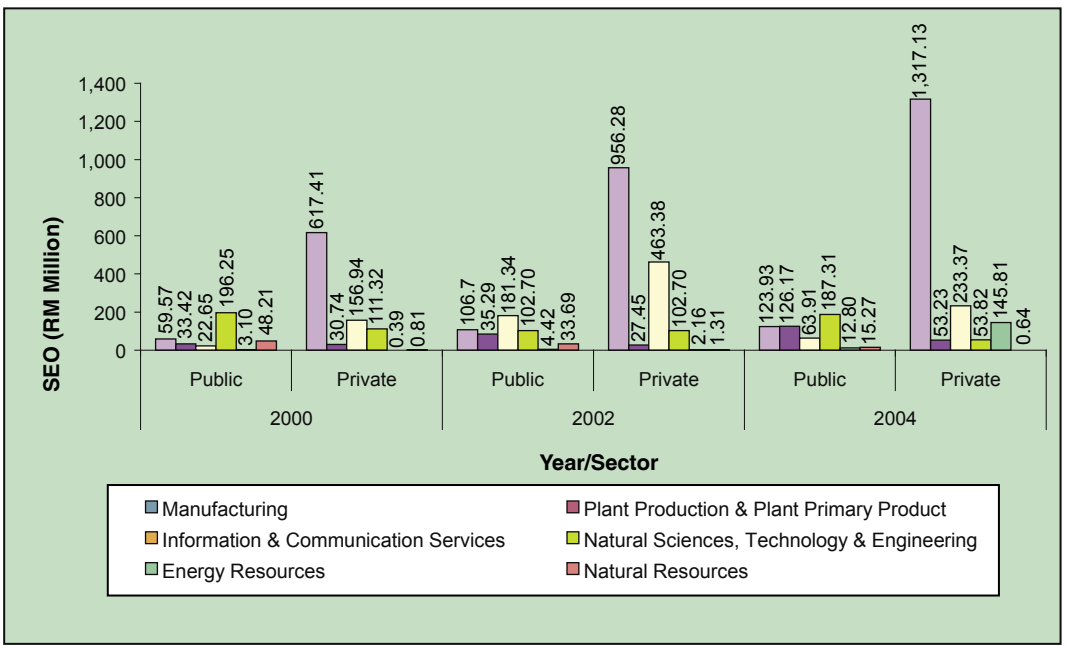
The top five SEOs in terms of expenditure in 2004 were:

1. Manufacturing;
2. Information and Communication Services (ICS);
3. Natural Science, Technology & Engineering;
4. Plant Production and Plant Primary Products; and
5. Energy Resources.

The ranking of the top three SEOs was similar to that in 2002. Two new SEOs (Plant Production & Plant Primary Products and Energy Resources) made up the top five SEOs in 2004.

Manufacturing which occupied the top SEO position in 2004 with an expenditure of RM1.441 billion has shown an increase of RM378 million as compared to that of 2002 (RM1.062 billion). Natural Science, Technology & Engineering showed an increase of RM35.9 million, from RM205.15 million in 2002 to RM241.13 million in 2004. However, ICS has reduced by RM347.44 million from RM644.72 million in 2002 to RM297.28 million in 2004 **(Figure 4.7)**.

Figure 4.7: R&D Expenditure by SEO (RM million), 2000 - 2004

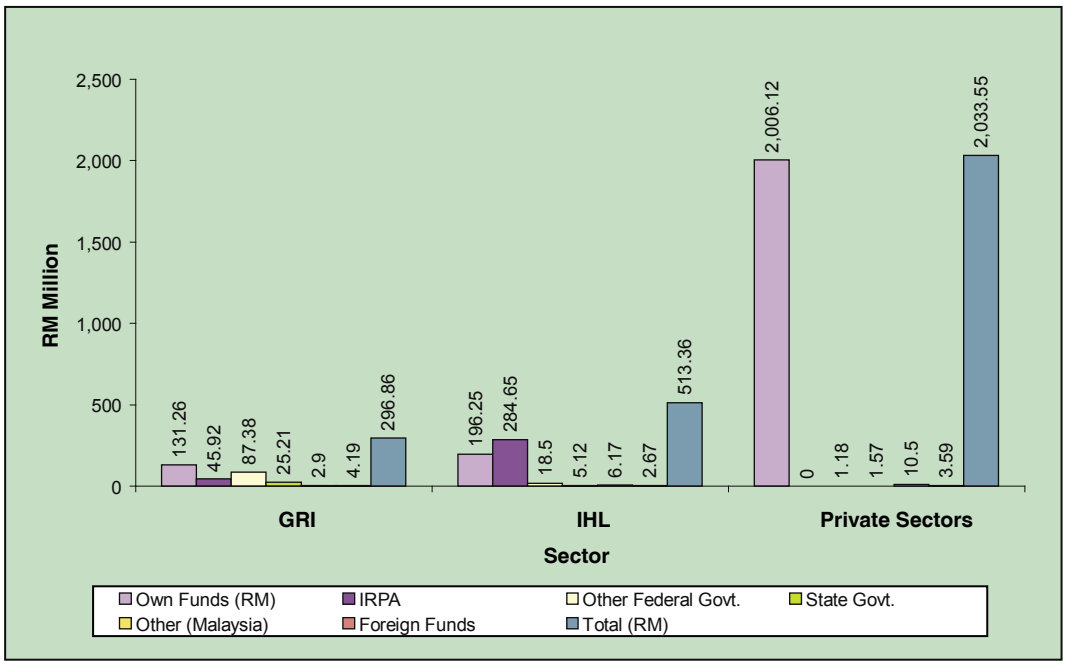


Source: National Survey on Research & Development 2006 Report

4.3 SOURCES OF FUND IN 2004

The Private Sector depended on its own fund for R&D (98.7%). In 2004, from the total expenditure of RM2.033 billion, a sum of RM2.006 billion was from its own fund. The GRIs spent 44.2% (RM131.26 million out of RM296.86 million) of their own fund and 15.5% from IRPA and 29.4% federal fund respectively. The IHLs relied more on IRPA and their own fund for R&D **(Figure 4.8).**

Figure 4.8: Source of Fund (RM Million) in 2004



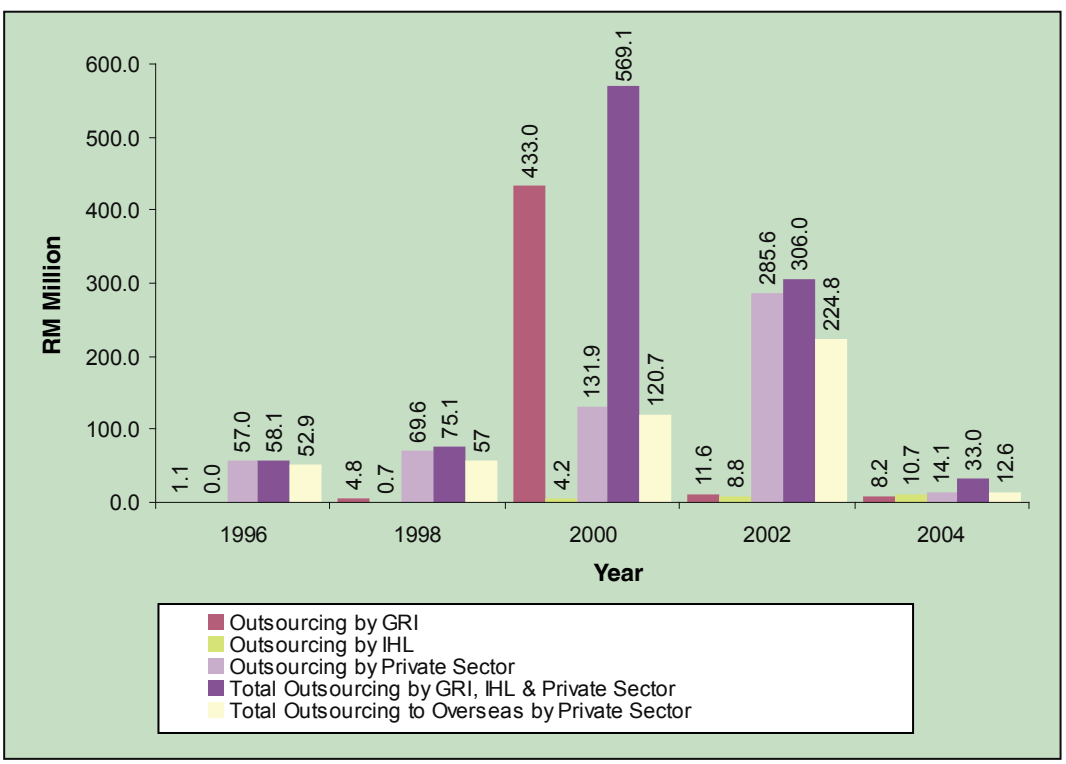
Source: National Survey on Research & Development 2006 Report

4.4 OUTSOURCED R&D

Total outsourcing of R&D showed a significant decline from a total of RM306 million in 2002 to RM33 million in 2004 **(Figure 4.9)**. The private sector showed the biggest drop in outsourcing, from RM285.6 million in 2002 to RM14.1 million in 2004. Meanwhile, GRIs showed a slight decline. The private sector spent the most in outsourcing outside Malaysia.

Sharp decline in outsourcing of R&D particularly by industry

Figure 4.9: Outsourcing of R&D by Sector, 1996-2004



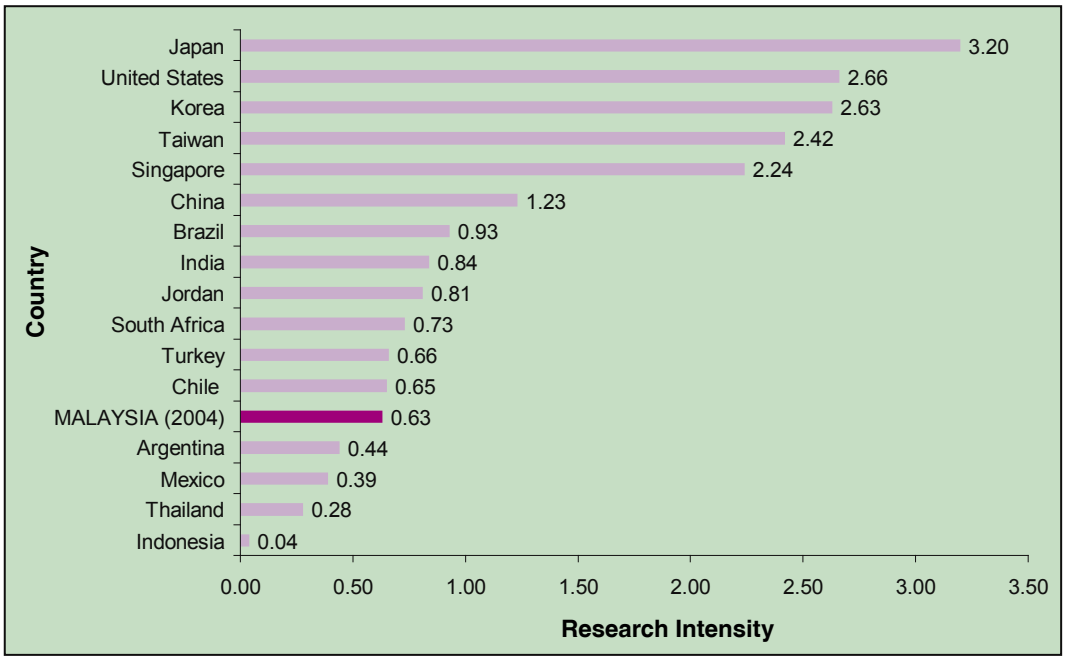
Source: National Survey on Research & Development 2006 Report

4.5 INTERNATIONAL COMPARISON OF RESEARCH INTENSITY

As shown in the **Figure 4.10**, Japan, Republic of Korea, the United States, Taiwan and Singapore were some of the leading countries with regard to research intensity. Malaysia's research intensity of 0.63% placed her with Turkey and Chile. Malaysia research intensity surpassed that of Mexico, Argentina, Thailand and Indonesia, but she was way behind countries such as Japan (3.2), which ranked highest and Singapore (2.24).

Our research intensity is less than a third of the average for developed countries

Figure 4.10: International Comparison of Research Intensity (2004)



Source:IMD World Competitiveness Yearbook 2006

4.6 R&D IN THE PRIVATE SECTOR

The following data were obtained from 230 companies in the National Survey of R&D 2004 as compared to 198 companies in 2002.

Expenditure by Industry

In 2004, the top three industries in terms of R&D expenditure were as follows:

1. Manufacture of motor vehicles, trailers and semi-trailers – RM646.3 million (31.8% of the total private sector expenditure).
2. Manufacture of office, accounting and computing machinery – RM414.5 million (20.4% of the total private sector expenditure).
3. Manufacture of radio, television and communication equipment and apparatus – RM396.3 million (19.5% of the total private sector expenditure).

Expenditure by company revenue

In 2004, companies earning less than RM10 million spent 13.3% on R&D or a total of RM269.5 million. The middle bracket companies earning RM11 million – 100 million spent 10.2% on R&D or a total expenditure of RM207.6 million. Companies in the highest bracket of RM100 million and above spent RM1.56 billion or 76.5% of the company revenue on R&D.

Expenditure by ownership

Both foreign and local companies are engaged in R&D. Decline in R&D expenditure by Malaysian controlled firms.

Except for the Malaysian controlled companies, the other four types of ownership demonstrated a significant increase in expenditure from 2002 to 2004. The Malaysian controlled companies showed a decline of expenditure from RM713.4 million in 2002 to

RM541.1 million in 2004 (24.2% of total expenditure). The status of the four types of ownership were as follows:

- Malaysian owned companies showed an increase from RM280.2 million in 2002 to RM394.2 million in 2004 or 19.4% of total expenditure;
- Foreign owned companies showed an increase from RM866.4 million in 2002 to RM888.4 million in 2004 or 43.7% of total expenditure;
- Foreign controlled companies showed an increase from RM58.4 million in 2002 to RM208.9 million in 2004 or 10.3% of expenditure;
- Finally, for equal ownership companies, there was an increase of 0.7 million over that of 2002 accounting for 0.05% of the total expenditure by ownership.

Expenditure by Type of Research

Although focus of industry's research was on applied and experimental development, growing expenditure on basic research was noted

Applied research and experimental development were the two main research types conducted. RM1,143.4 million was spent on applied research in 2004, a decrease of 12.9% from 2002 (RM1,313.4 million). Experimental development increased from RM262.3 million in 2002 to RM644.0 million in 2004, an increase of 145.5%. The total for basic research was RM246.2 million in 2004 as compared to RM57.3 million in 2002, an increase of 329.6%.

Expenditure by FOR

The top three FORs for 2004 were similar to those reported in 2002 and consistent with the trend since 2000. They are:

1. Engineering Sciences;
2. Information, Computer & Communication Technology; and
3. Applied Sciences & Technology.

In terms of expenditure, Engineering Sciences dropped from RM897.1 million in 2002 to RM871.2 million in 2004. Applied Sciences & Technology dropped from RM239.4 million in 2002 to RM175.2 million in 2004, while Information, Computer & Communication Technology increased from RM417.8 million in 2002 to RM670.4 million in 2004.

Expenditure by SEO

The top three SEOs for 2004 were as follow:

1. Manufacturing;
2. Information and Communication Services (ICS) and
3. Energy Resources.

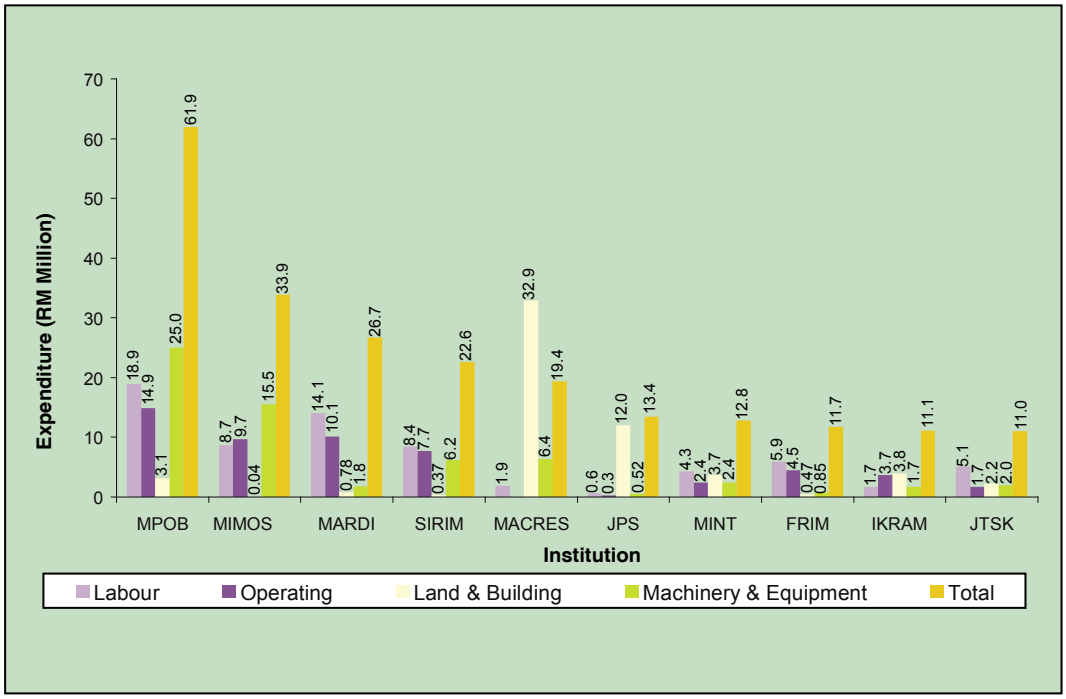
In terms of expenditure, Manufacturing being the main sector increased from RM956.3 million in 2002 to RM1.32 billion in 2004, while ICS showed a decline from RM463.4 million in 2002 to RM233.4 million in 2004. Finally, Energy Resources with an expenditure of RM145.8 million in 2004 (RM2.2 million in 2002), made its debut into the third position.

4.7 R&D IN GRIs

There was a decline in current and capital expenditure in 2004 as compared to 2002. Current expenditure decreased from RM232.7 million in 2002 to RM196.3 million in 2004, and similarly, capital expenditure from RM274.4 million to RM100.6 million.

Figure 4.11 presents the expenditure by the types of cost of the top 10 GRIs in 2004. MPOB, MIMOS and MARDI were the three top GRIs with the highest expenditure.

Figure 4.11: Expenditure by Types of Cost (Top 10 GRIs) - 2004

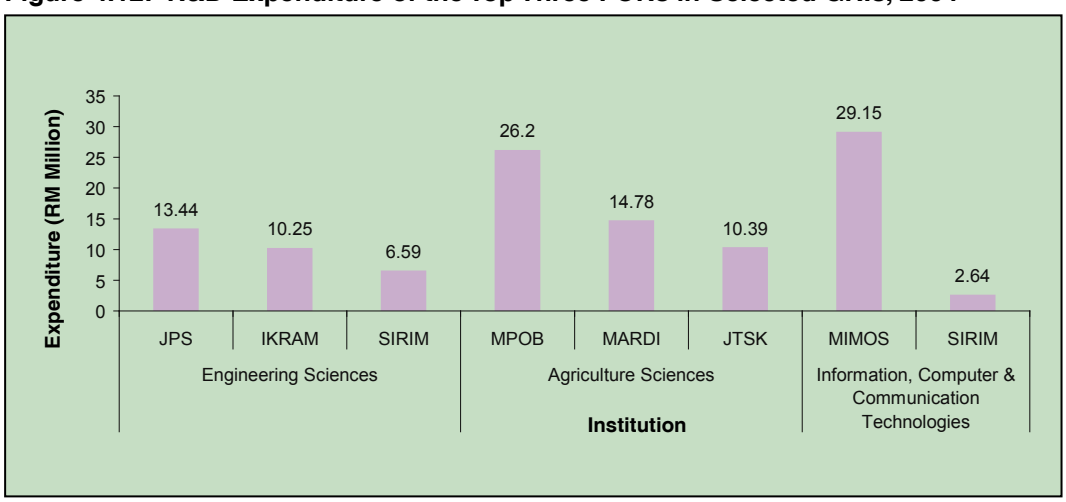


Source: National Survey on Research & Development 2006 Report

Expenditure by FOR

In terms of expenditure by FOR **(Figure 4.12)**, the overall trend was consistent with the government emphasis and involvement in agriculture, engineering and ICT. This was reflected in the top three FOR categories of engineering sciences in JPS, IKRAM and SIRIM, agriculture sciences in MPOB, MARDI and JTSK and information, computer & communication technologies in MIMOS and SIRIM.

Figure 4.12: R&D Expenditure of the Top Three FORs in Selected GRIs, 2004

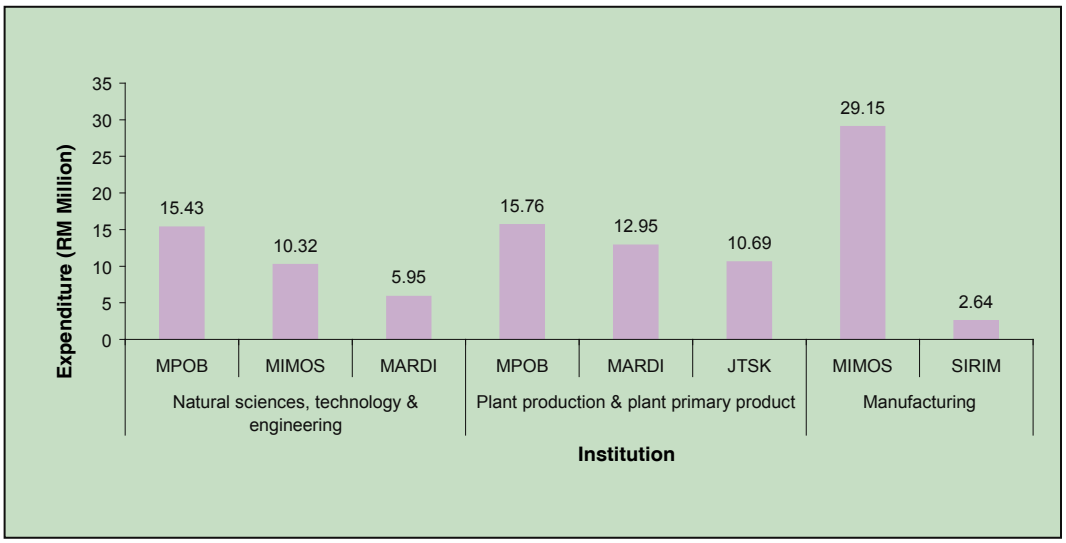


Source: National Survey on Research & Development 2006 Report

Expenditure by SEO

For SEOs, the three major categories were natural sciences, technology & engineering, plant production & plant primary products and manufacturing. These categories reflect the thrusts of the major GRIs, namely, MPOB, MARDI and MIMOS. **Figure 4.13** shows the institutions with the highest SEO expenditure.

Figure 4.13: R&D Expenditure of the Top Three SEOs in Selected GRIs, 2004



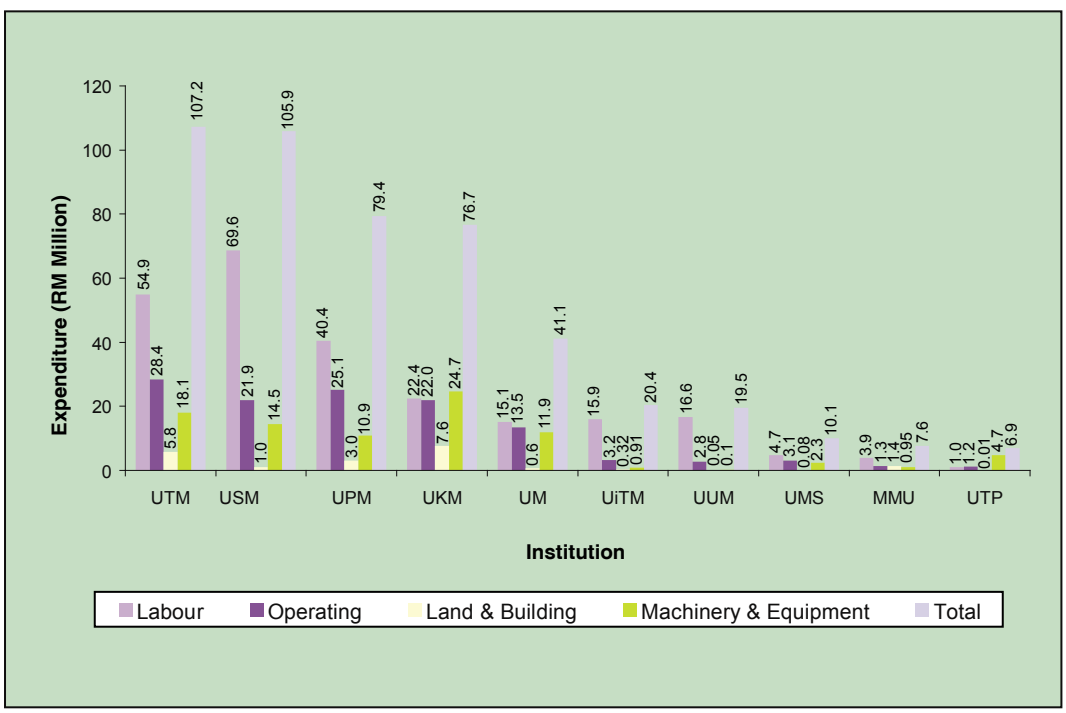
Source: National Survey on Research & Development 2006 Report

4.8 R&D IN IHLs

There was a substantial increase in the total expenditure of the IHLs since 1996; from a low of RM40.3 million in 1996 to RM360.4 million in 2002 and subsequently to RM513.3 million in 2004. Since 2000, IHLs have emphasized more on applied and basic research, spending RM162.6 million and RM237.2 million in 2004 on basic and applied research respectively.

Figure 4.14 shows the types of expenditure of the top 10 IHLs in 2004. In terms of total expenditure in 2004, the top five IHLs, i.e. UTM, USM, UPM, UKM and UM, remained unchanged as in 2002. UTM which occupied the fifth position in total expenditure in 2002 behind USM, UPM, UM and UKM, has shown the highest growth from RM40 million in 2002 to RM107.2 million in 2004. The rest of the IHLs, besides the top 10, contributed lesser amount to the GERD.

Figure 4.14: Expenditure by Types of Cost (Top 10 IHLs), 2004

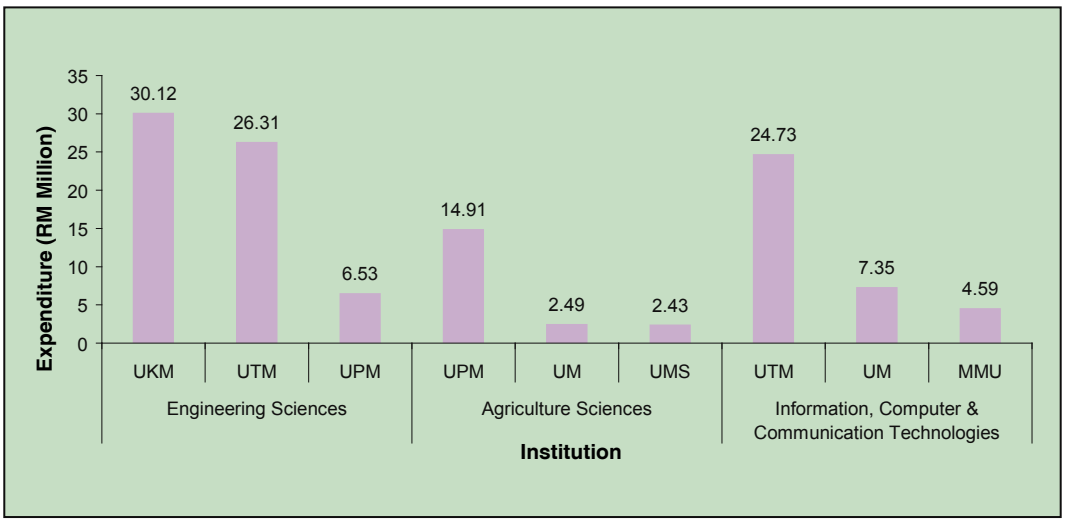


Source: National Survey on Research & Development 2006 Report

Expenditure by FOR

In terms of FORs, the top three categories in 2004 were engineering sciences, agriculture sciences and information, computer & communication technologies. **Figure 4.15** shows the institutions with the highest FOR expenditure.

Figure 4.15: R&D Expenditure of the Top Three FORs in Selected IHLs, 2004

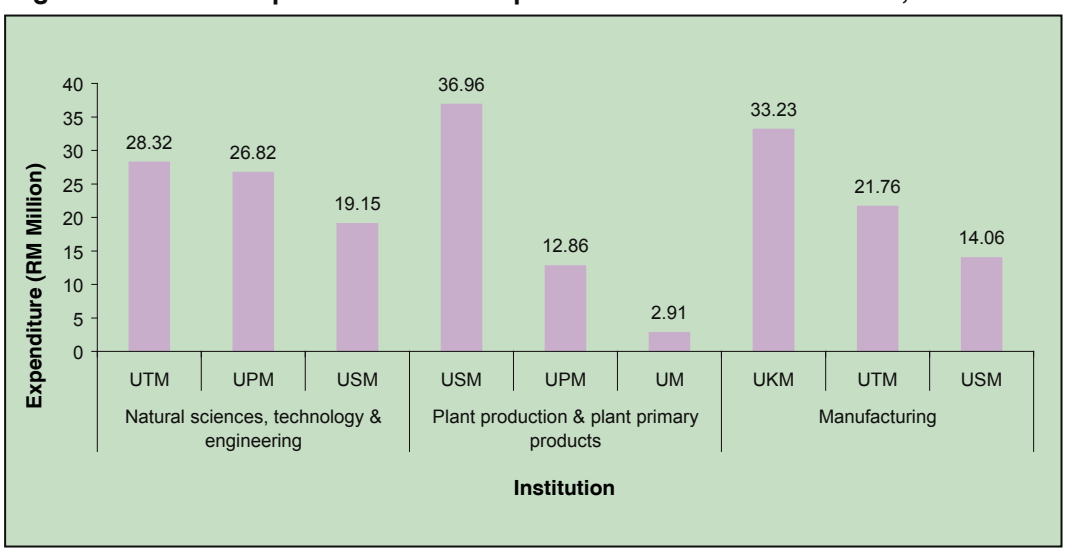


Source: National Survey on Research & Development 2006 Report

Expenditure by SEO

For SEOs, the three major categories were natural sciences, technology & engineering, plant production & plant primary products and manufacturing. **Figure 4.16** shows the institutions with the highest SEO expenditure.

Figure 4.16: R&D Expenditure of the Top Three SEOs in Selected IHLs, 2004



Source: National Survey on Research & Development 2006 Report

4.9 SOME SUGGESTED KEY PERFORMANCE INDICATORS (KPIs)

Funding agencies recognise the need of performance measures to demonstrate the effectiveness and efficiency of research. Generally quantitative or key performance indicators (KPI) are developed and used for R&D performance measurement. Their choice as indicators rests on a sound knowledge covering their validity, fairness, transparency, independence, cost and the impact they will have on the research enterprise. A list of KPIs for R&D impact assessments on publication, IPR, HRD, R&D facilities utilisation,

research collaboration, social betterment and welfare, and involvement in prestigious and strategic international research in the immediate term is suggested as follows:

- Number of journal publications per researcher or scientist as a direct measurement of publication impact;
- Number of journal publications per R&D expenditure (RM100,000) that provides productivity measurement of scientific refereed journal publications in terms of efficiency of utilising R&D funds;
- Number of patents per researcher and number of patents per RM100,000 R&D expenditure that provides productivity measurement of IPR protection in terms of efficiency of utilising R&D funds;
- Number of PhD graduates per project that measures the role of the research project towards HRD;
- Number of professional training courses conducted per project that measures contribution of the project towards transfer of technology (competencies) and capacity building in the specialised area of research;
- Capacity utilisation of facilities acquired by the research project (average hours of laboratory utilised or number of researchers having accessed to the laboratory) that measures the rate of utilisation of the capacities of research facilities;
- Technical capabilities checklist of facilities that measures the degree of which the equipment is up-to-date and fit for the research purpose in mind;
- Value of research grants from industry and non-governmental organisations that measures their confidence on researchers' capability;
- Proportion of value of research grant from industry and NGOs over total research grants received that measures relative importance of source of grants from industry and NGOs;
- Proportion of research grants allocated for social welfare objectives over total research grant. This measures importance given by Government on meeting social welfare functions;
- Number of research collaborations/individual assignments from international sources that measures international stature of research team; and
- Proportion of value of research collaboration/individual assignment to total research grants received as another measure of international stature of research team.

Eventually as more data is available and as R&D and commercialisation efforts mature in RIs and IHLs, the following KPIs are also recommended:

- Number of citation index journal publications per researcher or scientist that provides publication impact in terms of quality and international acceptance;
- Number of citation index journal publications per R&D expenditure (RM100,000) that provides information on how cost efficient in producing quality and internationally recognised citation;
- Number of commercialised patents per researcher as a measure of performance since the patent leads to commercialization;
- Number of commercialised patents per RM100,000 R&D expenditure that measures performance since the patent leads to commercialization; and

- Proportion of license income received to total research expenditure to measure the efficiency of generating income.

The above KPIs are useful to gauge performance based on individual output and outcome.

4.10 CONCLUSION

The national GERD has been steadily on the rise since 1998 from RM1.13 billion in 1998 to RM2.84 billion in 2004. However, the research intensity (GERD/GDP ratio) has declined from 0.69 in 2002 to 0.63 in 2004 due primarily to the larger increase of the national GDP during the same period following the strong pace of economic growth.

With respect to expenditure provided for the three types of research, the trend of emphasis to Applied Research, followed by Experimental Research and Basic Research continued to 2004.

The overall GERD of the public and private sectors has shown an increase from RM2,500.6 million in 2002 to RM2,843.8 million in 2004 with the private sector contributing 71.5% of the total expenditure. The bulk of the R&D in 2004 was conducted in Malaysia. Of the total national R&D expenditure, only RM33 million was outsourced, a significant decline (or 89.2%) from the RM306 million outsourced in 2002. In the international arena, Malaysia's GERD in 2004 of RM2.84 billion trailed far behind that of the United States at RM1.1 trillion, the EU15 at RM649.9 billion, Japan at RM459.2 billion and China at RM69 billion.

Based on the R&D classification, the three main FORs for 2004 were Engineering Science, Information, computer & Communication Technology and Applied Sciences & Technology. In terms of SEO categories, the top five in 2004 were Manufacturing, Information and Communication Services, Natural Science, Technology & Engineering, Plant Production & Plant Primary Products as well as Energy Resources.

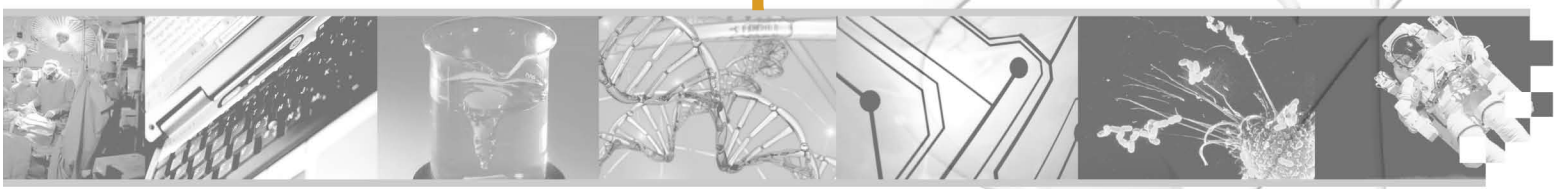
In 2004, applied and experimental development research were the two main research types conducted by the private sector, and the top three FORs were Engineering Sciences, Information, Computer & Communication Technology; and Applied Sciences and Technology. RM1,143.4 million was spent on applied research, RM644.0 million on experimental development research and RM246.2 million for basic research. The top three SEOs were Manufacturing, ICS, and Energy Resources.

For GRIs, the overall trend was consistent with the government emphasis and involvement in agriculture, engineering and ICT. This was reflected in the top three FOR categories of engineering sciences in JPS, IKRAM and SIRIM, agriculture sciences in MPOB, MARDI and JTSK and information, computer & communication technologies in MIMOS and SIRIM. And the top three SEOs were Natural Sciences, Technology and Engineering, Plant Production and Plant Primary Product, and Manufacturing. There was a decline in current and capital expenditure. Current expenditure decreased from RM232.7 million in 2002 to RM196.3 million in 2004, and similarly, capital expenditure from RM274.4 million to RM100.6 million.

There was a substantial increase in the total expenditure of the IHLs from a low of RM40.3 million in 1996 to RM513.3 million in 2004. Since 2000, IHLs have emphasized more on applied and basic research, spending RM162.6 miilion and RM237.2 million in 2004 on basic and applied research respectively. In terms of FORs, the top three categories in 2004 were Engineering Sciences, Agriculture Sciences and Information, Computer & Communication Technologies. For SEOs, the three major categories were Natural Sciences, Technology & Engineering, Plant Production & Plant Primary Products and Manufacturing.

A list of KPIs for R&D impact assessments on publication, IPR, HRD, R&D facilities utilisation, research collaboration, social betterment and welfare, and involvement in prestigious and strategic international research in the immediate term was described.

Chapter 5



PUBLIC SUPPORT FOR SCIENCE, TECHNOLOGY AND INNOVATION

5.1 INTRODUCTION

Governments have a role in supporting STI including R&D given the inherent uncertainties in these activities, their high costs and their pervasive impacts on the economy

Science, technology and innovation (STI) are generally recognized as strategic factors that underpin productivity growth, competitiveness of firms, economic performance and the achievement of social objectives of nations. The development of capabilities in STI as well as the transformation of ideas into innovations are costly as well as fraught with numerous risks. Given these uncertainties, firms generally under-invest in R&D activities compared to what is socially optimally. This situation is even worse in the developing world where there is little tradition of undertaking R&D. Arising from this market failure, it is widely accepted that governments have a role in promoting R&D in particular and the development of scientific, technical and innovative capabilities in general. Many countries have introduced a number of measures – both fiscal and non-fiscal – to promote greater R&D and innovative activities; attract foreign knowledge-intensive companies; promote technology diffusion and acquisition of technologies. Factors peculiar to each country will determine the choice of measures, that is, whether tax incentives, direct grants, loans, patent rights or other instruments that will be adopted to stimulate research and innovative investments.

While role of Government is acknowledged in promoting STI, the success of these support efforts is dependent on the effectiveness of their implementation

Several studies have revealed that these support measures such as R&D tax incentives can be an effective instrument for inducing a certain degree of private investments in research. However, the effectiveness of these support measures depends not only on how well they are designed in alignment with policy objectives but also on the administrative capacity and capabilities of the agency entrusted to administer the incentives. **Box 5.1** provides a brief description of the various direct and indirect support measures adopted in a number of countries to promote R&D and innovation activities.

This chapter describes the various public schemes in place to promote STI. It provides an account on the status of these schemes in terms of number of applications as well as the quantum approved. Additional details pertaining to feedback from industry are also provided to present an account on the appropriateness of the incentives as well as their administration.

ARTICLE BOX 5.1: Selected Literature Reviews on Adoption of Fiscal Incentives, Support Measures and R&D Fiscal Policy for promotion of R&D and Innovation activities

In recent years, the generation and diffusion of innovations have assumed increasing importance in the economic agendas facing many countries. In an effort to expand their level of innovation, several countries have turned to fiscal incentives which can be of two kinds, namely, direct support and indirect support. The direct governmental support mechanisms to business R&D can, according to Van Pottelsberghe et al. (2003), be grouped into two categories. Firstly, there are fiscal incentives, which stimulate business R&D through a reduction on the tax burden. Secondly, governments can stimulate R&D even more directly through financial support which takes the form of grants, loans and subsidies given to selected companies in order to perform specific R&D activities. Some negative issues arising from direct support incentives need to be recognised. Firstly, there is a risk of substitution, that is, financially rewarding business R&D that would have taken place even without these support incentives. Secondly, there is a risk of crowding out through prices which may decrease the volume of R&D undertaken. Thirdly, there is a possibility of allocative distortions since some projects supported by the government exclude others from being undertaken.

Despite these negative sentiments, a vast plethora of literature finds that direct support measures including use of fiscal incentives appear to expand the net amount of business R&D. The study by Van Pottelsberghe et al has also examined the differences between fiscal measures and direct financial support to R&D and made the following observations:

(i) Fiscal incentives are more neutral than direct R&D grants regarding recipient companies;
(ii) The administrative cost of running a fiscal incentive programme is lower than a

financial one;
(iii) Fiscal incentive schemes are more accessible than direct governmental support.
(iv) Fiscal incentives can be more predictable from a corporate perspective than direct grants.
(v) Unlike direct R&D funding programmes, which are usually endowed with fixed annual resources, a fiscal incentive policy does not allow for an evenly tight budget control.

There is no uniform R&D fiscal policy adopted across countries. Despite this diversity in R&D fiscal systems, an OECD (1996) study concluded that with regard to best practices in designing and implementing R&D tax provisions, the following have been identified:

(i) R&D tax policy should be designed as part of an overall strategy to stimulate innovation in industry and should complement other science and technology policies;
(ii) The R&D tax policy should be simple, comprehensive and incur minimal administrative and compliance costs;
(iii) The R&D tax policy should be flexible in order to accommodate firms at different stages of development.
(iv) R&D tax policy should consider incorporating special provisions relating to small and/or new firms in order to encourage entrepreneurship and innovative start-ups.

An evaluation of the R&D tax incentives available in Malaysia would be timely in order to ensure that such incentives contribute towards greater R&D and innovative activity particularly among local companies. The redesign of our incentive system can draw lessons from the best practices as described in the OECD study. Ultimately, however, choice of R&D fiscal incentives will depend on country-like variables such as overall innovation performance, industrial structure, size of firms etc.

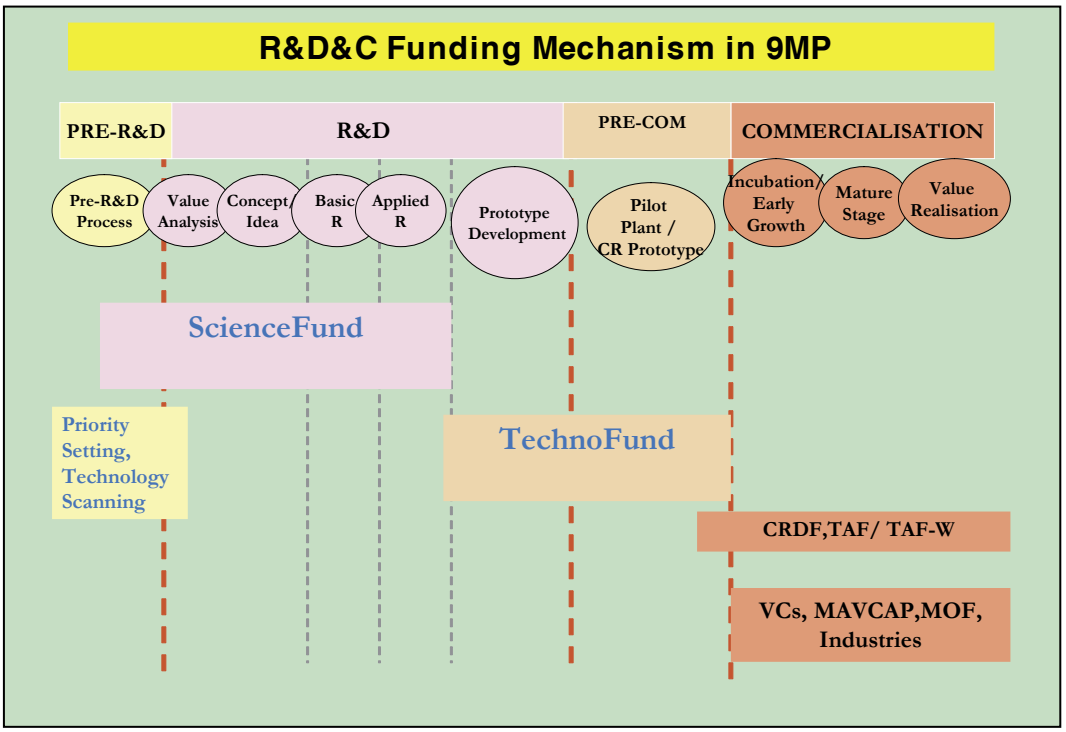
Source: Van Pottelsberghe, B., Nysten, S., Megally, E. (2003*), 'Evaluation of Current Fiscal Incentives for Business R&D in Belgium*' Working Paper, Solvay Business School, Universite libre de bruxelles, http://www.belspo/stat/rap/fiscRDJune03.pdf OECD (1996) *Fiscal Measures to Promote R&D and Innovation*. http://www.oecd.org/dataoecd/35/15/2101604.pdf

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

Funding for STI is implemented through various grants and incentives encompassing the whole range of activities from the stage of idea generation to commercialisation and marketing as depicted in **Figure 5.1.** This section will examine the performance of the various grant schemes as follows:

- Technology Acquisition Fund (TAF);
- Commercialisation of R&D Fund (CRDF);
- Demonstrator Application Grant Scheme (DAGS);
- Multimedia Super Corridor R&D Grant Scheme (MGS);
- Industry Grant Scheme (IGS)
- Industrial Technical Assistance Fund (ITAF)

Figure 5.1: The spectrum of public funding of R&D and commercialisation



Source: MOSTI

5.2.1 Technology Acquisition Fund (TAF)

Technology Acquisition Fund (TAF) is a scheme administered by the Malaysian Technology Development Corporation (MTDC). The main object of this scheme is to facilitate the acquisition of strategic technologies by the industrial sector. The TAF provides partial grants to further promote efforts by the private sector to acquire new technology and to enhance their technological capabilities and production processes. The eligible activities covered under the TAF include, among others, the following:

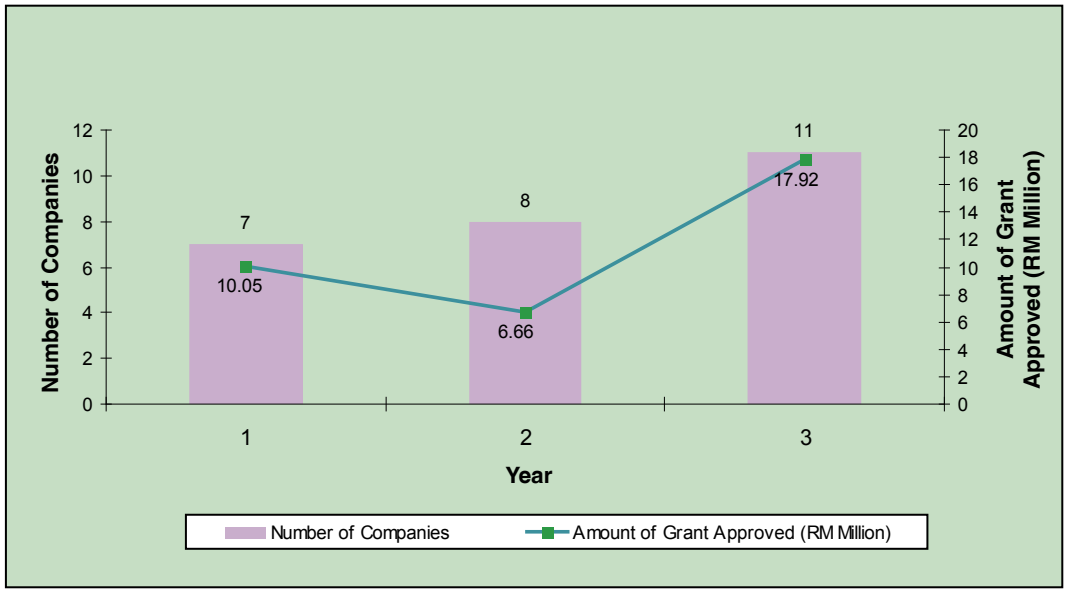
- Purchase of high technology equipment and machinery;
- Technology licensing;
- Acquisition of patent rights, prototypes and designs;
- Training in foreign companies for high technology; sourcing of experts; and
- Organising of seminars on technology by industry associations

During the period 2003-2005, a total of 60 applications were made by companies from several industries. This number of applications did not depart considerably from the figure applied during the period 2000-2002. Most of the applications received were related to electrical and electronics, advanced materials, machinery, industrial products and biotechnology as these sectors exhibit dynamic technical innovations.

Sharp decline in TAF approvals during period under review

The number of approvals granted during the period 2003-2005 was 26 – a sharp drop from the 38 approvals recorded during the period 2000-2002. **Figure 5.2** illustrates the number of projects as well as the total amount approved during the period 2003-2005.

Figure 5.2: Summary of TAF approvals, 2003-2005



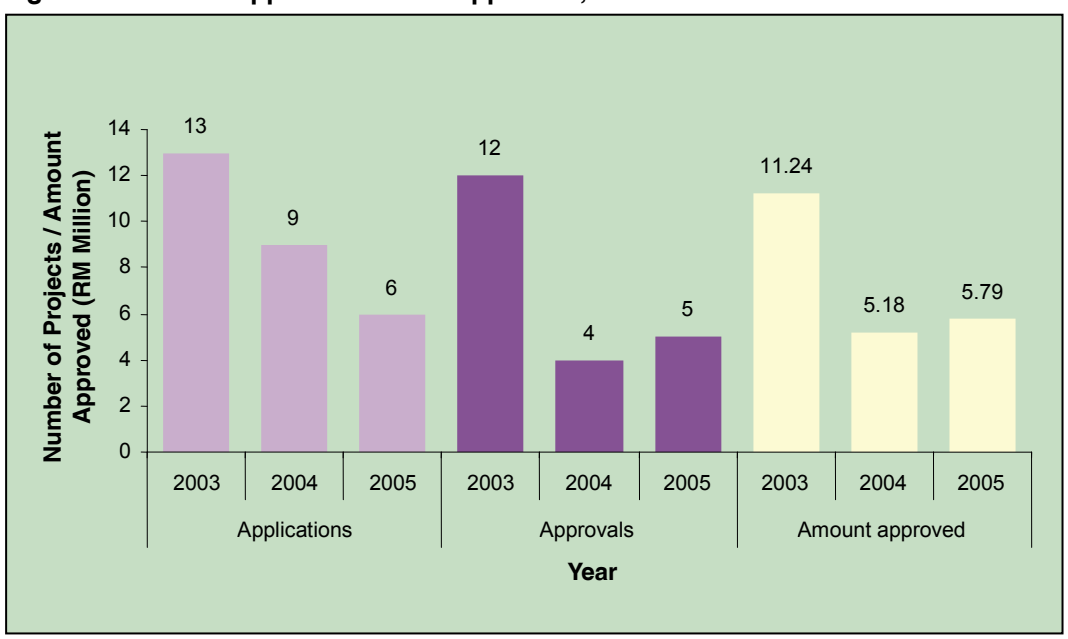
Source: MTDC

5.2.2 Commercialisation of R&D Fund (CRDF)

Decrease in number of CRDF applications as well as approvals

The CRDF was established to provide grants to qualified R&D projects (undertaken by local tertiary institutions, research institutes and industry) for commercialisation. Prior to this scheme, there were no support measures to commercialise the findings of the various research projects sponsored under the IRPA programme. Despite the introduction of the CRDF, the number of applications and approvals under this scheme has stagnated in recent years as revealed in **Figure 5.3**. The number of applications stood at 28 for the period 2003-2005 while a total of 21 projects costing some RM 22.21 million were approved during the same period. Almost a third of the approved projects were from the electrical and electronic cluster. Although the number of approved projects is higher than that recorded during the period 2001-2002 (10 projects), the paucity in both the number of applications and approvals is disconcerting given the huge number of projects funded under the IRPA programme.

Figure 5.3: CRDF Applications and Approvals, 2003-2005



Source: MTDC

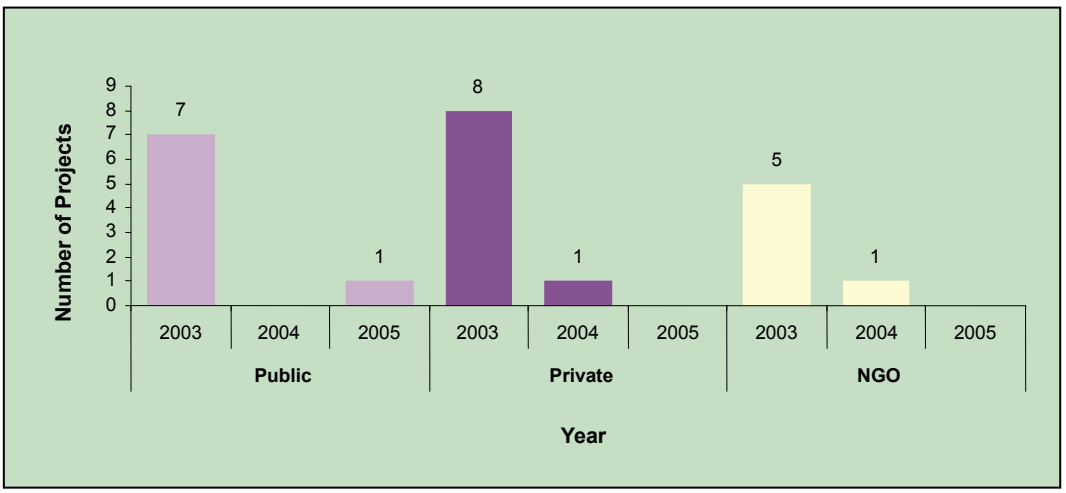
5.2.3 Demonstrator Application Grant Scheme (DAGS)

DAGS was introduced in 1998 with an initial allocation of RM 50 million to encourage Malaysians to adapt and customise existing IT and multimedia technologies in applications compatible with local culture and to promote the development of local software and content industries for greater competitiveness in global markets. Under the Eighth Malaysia Plan (2001-2005), the amount of allocation was increased to RM 100 million.

Steep decline in DAGS project approvals from 20 in 2003 to only 1 in 2005

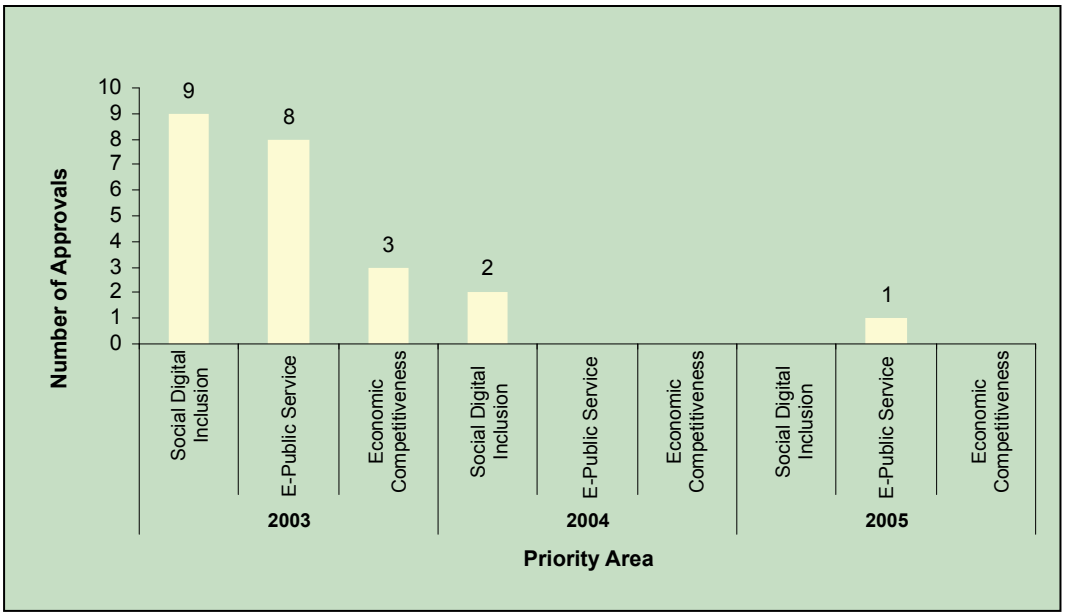
Figure 5.4 shows the quantum of grant approved for the period 2003-2005 by each of the three sectors, namely, public, private and non-government organisation. There is a more balanced distribution in the amount approved by sector unlike the period of 2000-2002 where the private sector was the more dominant player. From an analysis on the data on approvals by priority area, it is evident that most of the projects approved were orientated towards Social Digital Inclusion and E-Public Services **(Figure 5.5)**. A disturbing observation is the paucity in the number of projects approved during the last two years, namely, 2004-2005. This poor approval rate does not bode well for the success of the scheme.

Figure 5.4: Summary of DAGS approvals by sector, 2003-2005



Source: MIMOS

Figure 5.5: Summary of DAGS approvals by priority area, 2003-2005



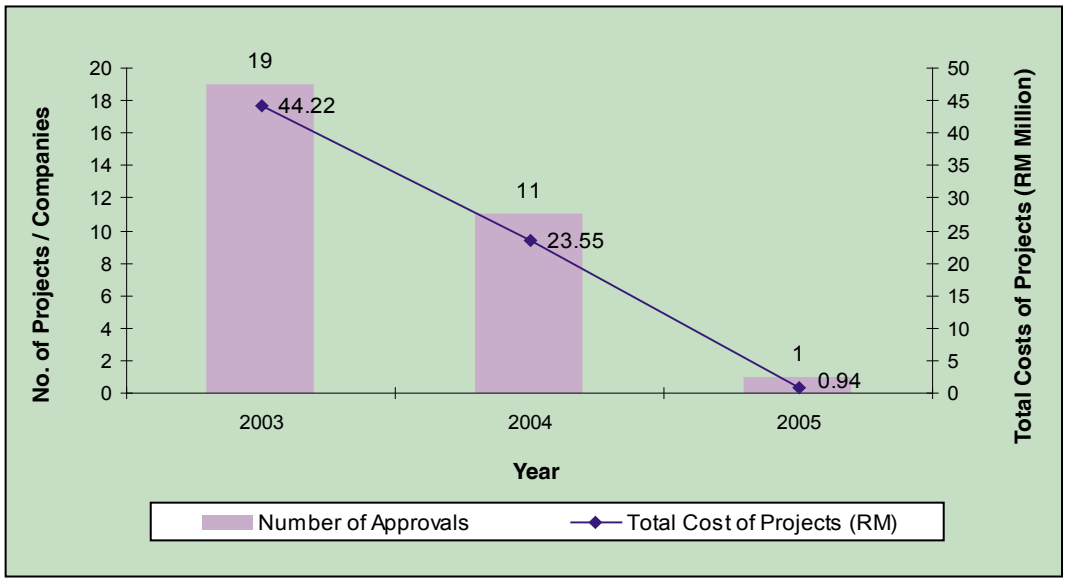
Source: MOSTI

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

Declining trend in number of MGS approvals with only 1 approval in 2005

The MGS is a scheme administered by the Multimedia Development Corporation (MDeC) aimed at assisting local or joint-venture companies in developing multimedia technologies and applications which would contribute to the overall development of the MSC. **Figure 5.6** reveals starkly the declining trend in the number of approvals made under this scheme where only one project approval was given throughout the year 2005. Such a low approval figure may have counterproductive effect in terms of attracting firms to submit more applications under the scheme. Most of the applications and approvals made under this scheme were for projects focused on business applications, engineering applications as well as wireless development.

Figure 5.6: Summary of MGS approvals, 2003-2005



Source: MDeC

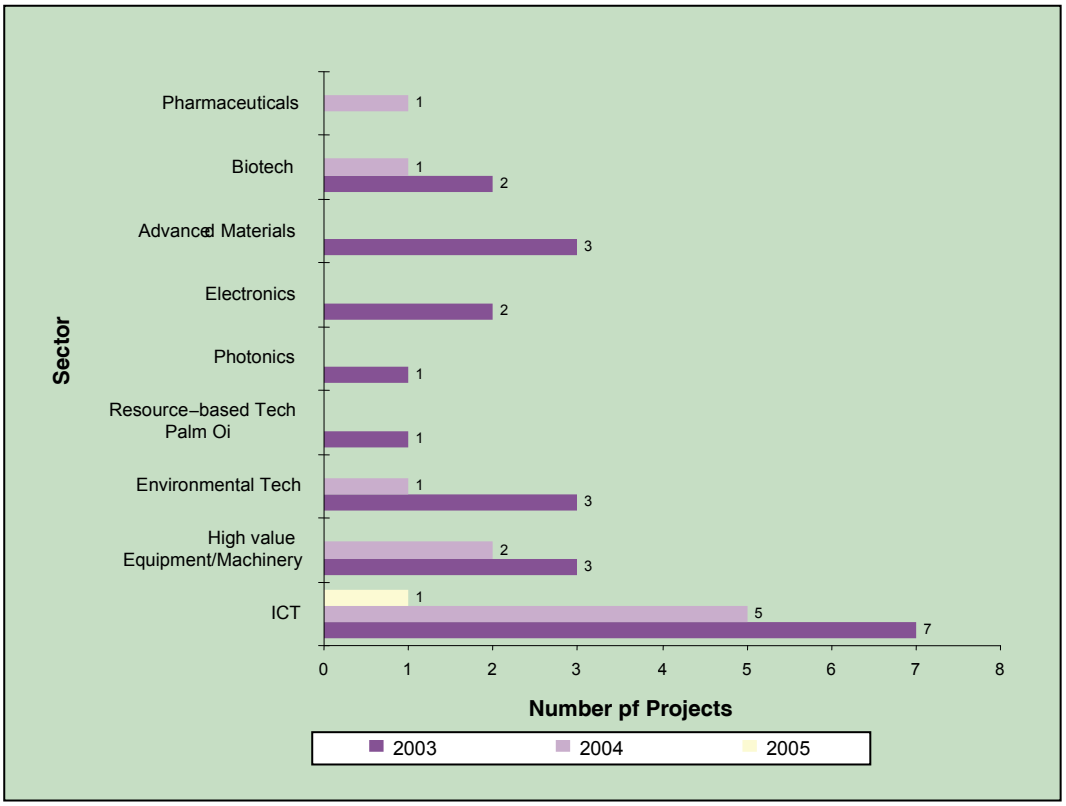
5.2.5 Industry R&D Grant Scheme (IGS)

Slump in IGS project approvals from 22 in 2003 to only 1 in 2005

The IGS is administered by MOSTI with the objective of supporting industry's efforts in research and development. **Figure 5.7** illustrates the number of projects approved by sector for the period 2003-2005. Most of the projects approved were from the information and communication technology sector. As in the other grant schemes, there is a sharp decline in the number of approvals particularly in the year 2005 where only one project was approved. This slump in approvals does not augur well for the enhancement of public sector-industry engagement in R&D. Support from schemes such as the IGS has contributed to the success stories of a number of local firms in the international arena. The case of Flex-P Industries Sdn Bhd as described in **Box 5.2** demonstrates what is possible given support from public funding.

Source: MOSTI

Figure 5.7: Number of Projects approved under IGS by sector, 2003-2005



Source: MOSTI

ARTICLE BOX 5.2: Flex-P's Compact Flash Card

Flex-P Industries Sdn Bhd was founded in 1999 specializing in the design, development and marketing of mobile flash memory storage solutions. Realizing the ever increasing need for higher density storage and high data transfer rates to complement the continuously improving hand-held consumer electronic products market, Flex-P has developed and produced its own proprietary flash memory controller. It obtained an IGS grant of RM 7.9 million in 2001 for the design and development of a new compact-flash (CF) controller chip and memory card that offered significant improvements in performance characteristics over existing CF controller chips and memory cards available in the market. The project was both a technical and financial success. The newly developed CF controller is able to control up to 16 flash memory modules compared to the industry standard of eight. This new product has enabled Flex-P to design flash memory cards with higher density and rapid transfer rates than those in the market thus enabling it to be a leading market player in the memory storage market. The company has employed the design of this controller in the development of two other storage devices, namely, USB drive and Flash card. Flex-P's Compact Flash Card is a non-volatile storage solution that does not require a battery to retain data indefinitely. It is a solid-state storage product that contains no moving parts, and provides users with much greater protection of their data than conventional magnetic disk drives. They are much more rugged and reliable than disk drives, consuming less than five percent of the power required by small disk drives.

The company has filed three patents in the United States on the design and architecture of its newly developed controller.

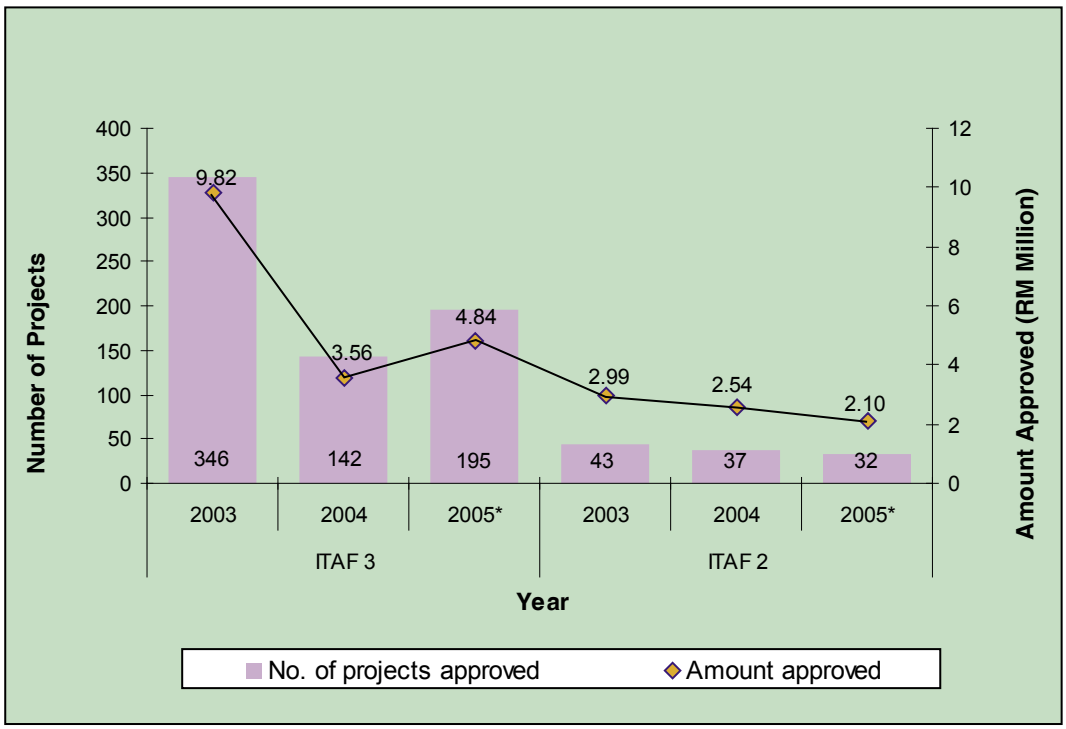
Source: MOSTI

5.2.6 Industrial Technical Assistance Fund (ITAF)

Sharp drop in ITAF 3 approvals in 2004

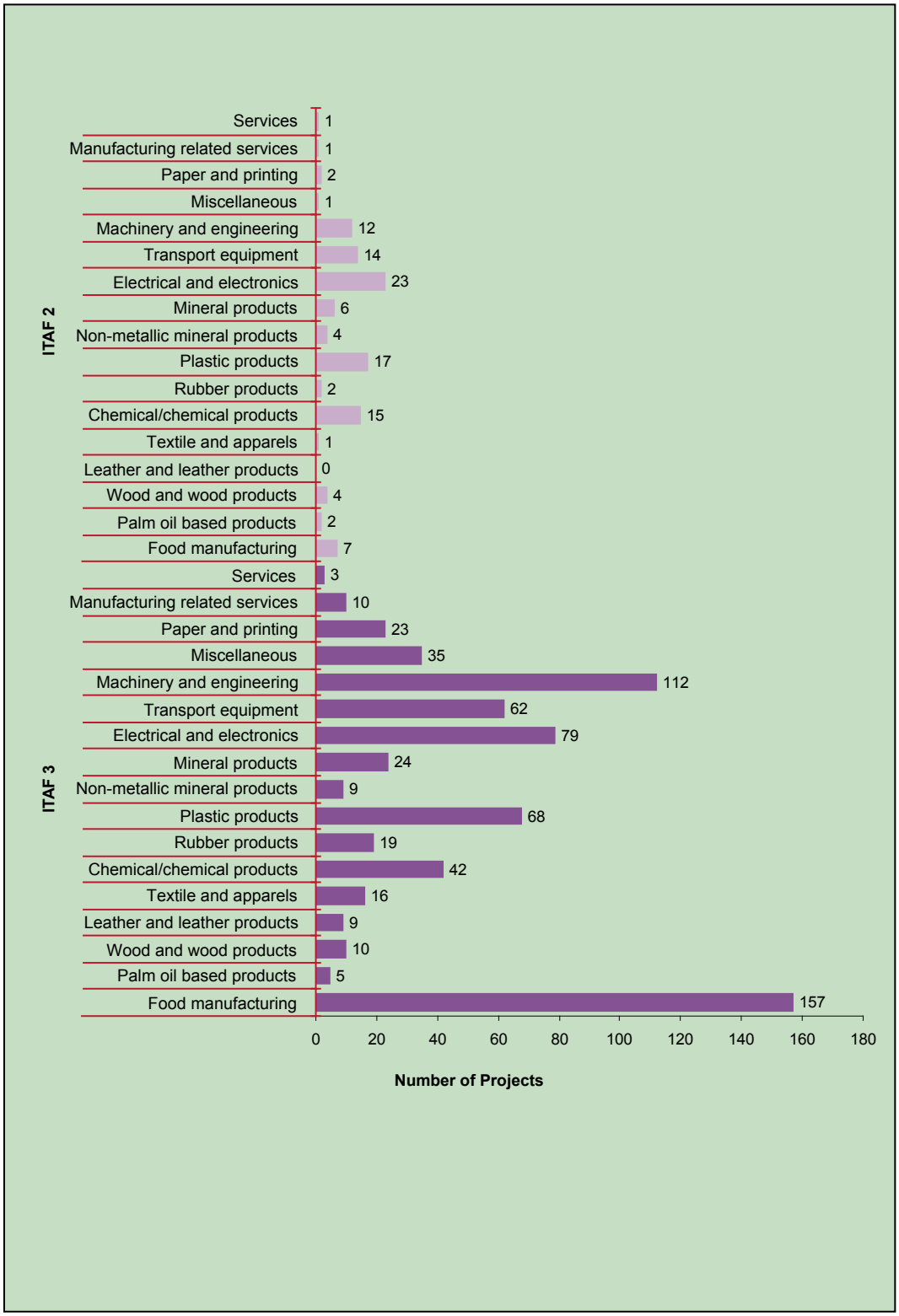
The Industrial Technical Assistance Fund (or ITAF) was established in 1990 to assist small and medium enterprises (SMEs) to become technologically proficient as well as cost competitive. Several sub-categories of this fund have been established to address specific requirements of SMEs such as studies in business planning, technology and market development (ITAF 1); assistance to improve and upgrade existing product, product design and processes (ITAF 2); assistance for productivity and quality improvement and to achieve international quality standards and certification (ITAF 3); and assistance for market development (ITAF 4). In 2003, the number of approvals for ITAF3 was 346. However, the number of approvals for ITAF 3 dropped drastically to 142 in the year 2004. Corresponding to this negative growth, the amount approved under ITAF3 declined from RM9.82 million in 2003 to RM3.56 million in 2004. A similar downward trend, albeit less pronounced, was observed for approvals under ITAF 2. **Figure 5.8** provides a summary of the approvals for the period 2003-2005 for both these sub-categories of ITAF. Most of the projects approved under ITAF 2 and ITAF 3 were from the electrical and electronics, plastic products, chemical/chemical products, machinery and engineering, food manufacturing and transport equipment sectors as indicated in **Figure 5.9.**

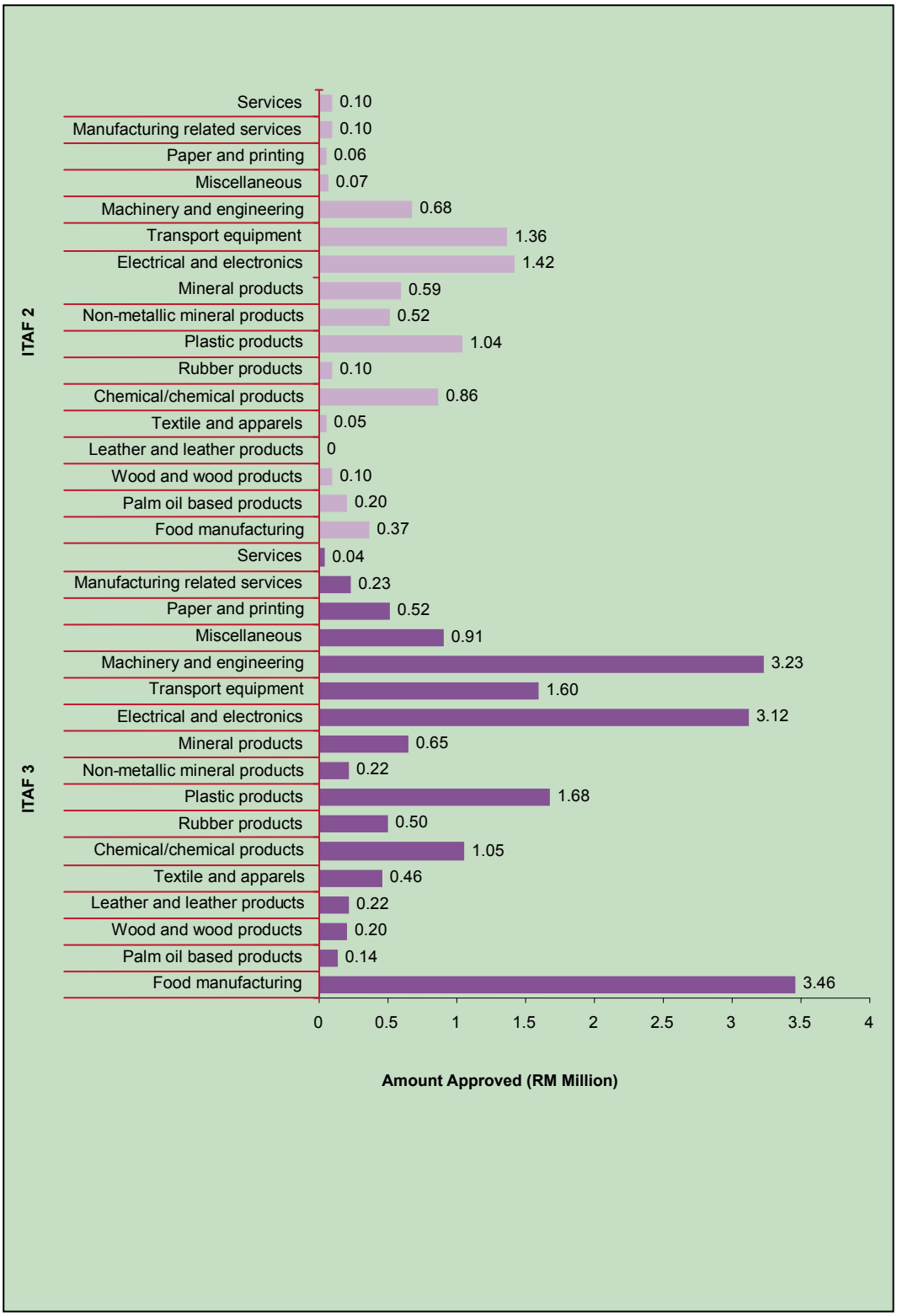
Figure 5.8: Approvals under ITAF 2 and ITAF 3, 2003-2005*



* As at July 2005
Source: SMIDEC

Figure 5.9: Cumulative approvals and amount approved under ITAF 2 and ITAF 3 by sector, 2003-2005*





* As at July 2005
Source: SMIDEC

5.3 DOUBLE DEDUCTION FOR TAX PURPOSES

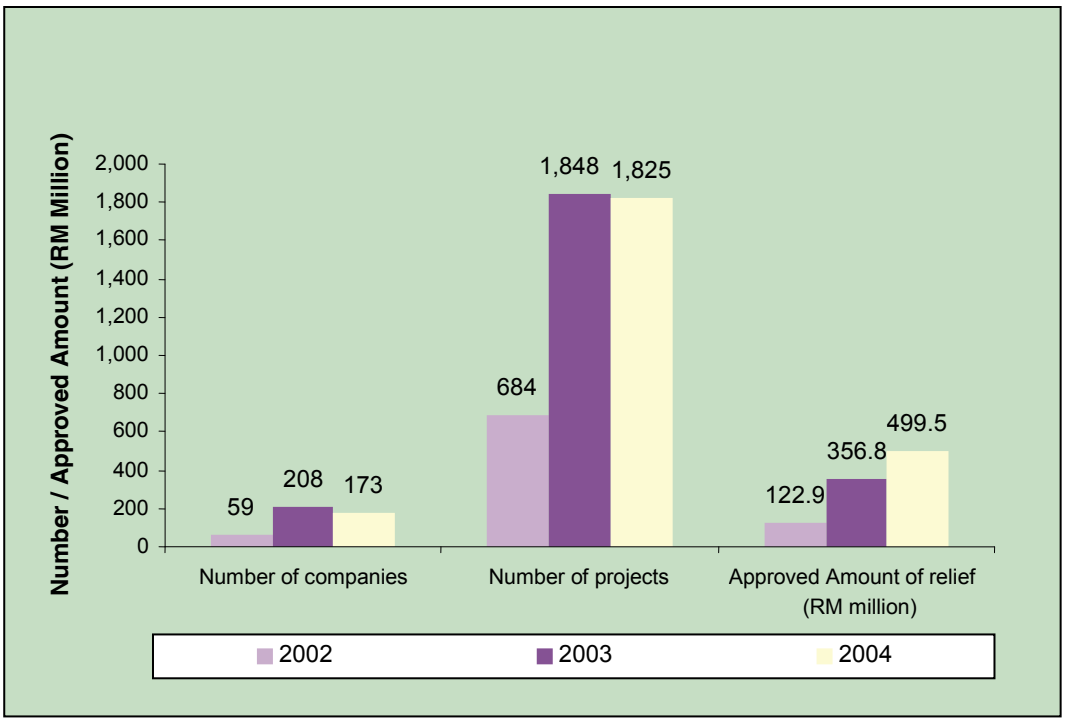
Rapid increase in amount granted under double deduction tax relief reflecting greater R&D activity by firms

There was a sharp increase in the amount of expenses granted for double deduction relief for income tax purposes during the period 2002-2004 as compared to the period of 2000 -2002. The amount granted under this incentive increased dramatically from RM 122.9 million in 2002 to RM 499.5 million in 2004 as indicated in **Figure 5.10**. This sudden increase can be attributed to the increasing number of companies submitting projects for relief under this incentive scheme. It reflects the growing importance attached to R&D by firms given the increasing competitive international environment.

The two main recipients of this income tax relief for the period 2002-2004 were the automotive and parts and automobile sectors. These two sectors accounted for almost 62% of the total amount of tax relief granted under this fiscal incentive. The other beneficiaries of this tax relief included the agricultural, agro-chemicals, electrical products, electrical components and IT/Telecommunication sectors. **(Figure 5.11)**

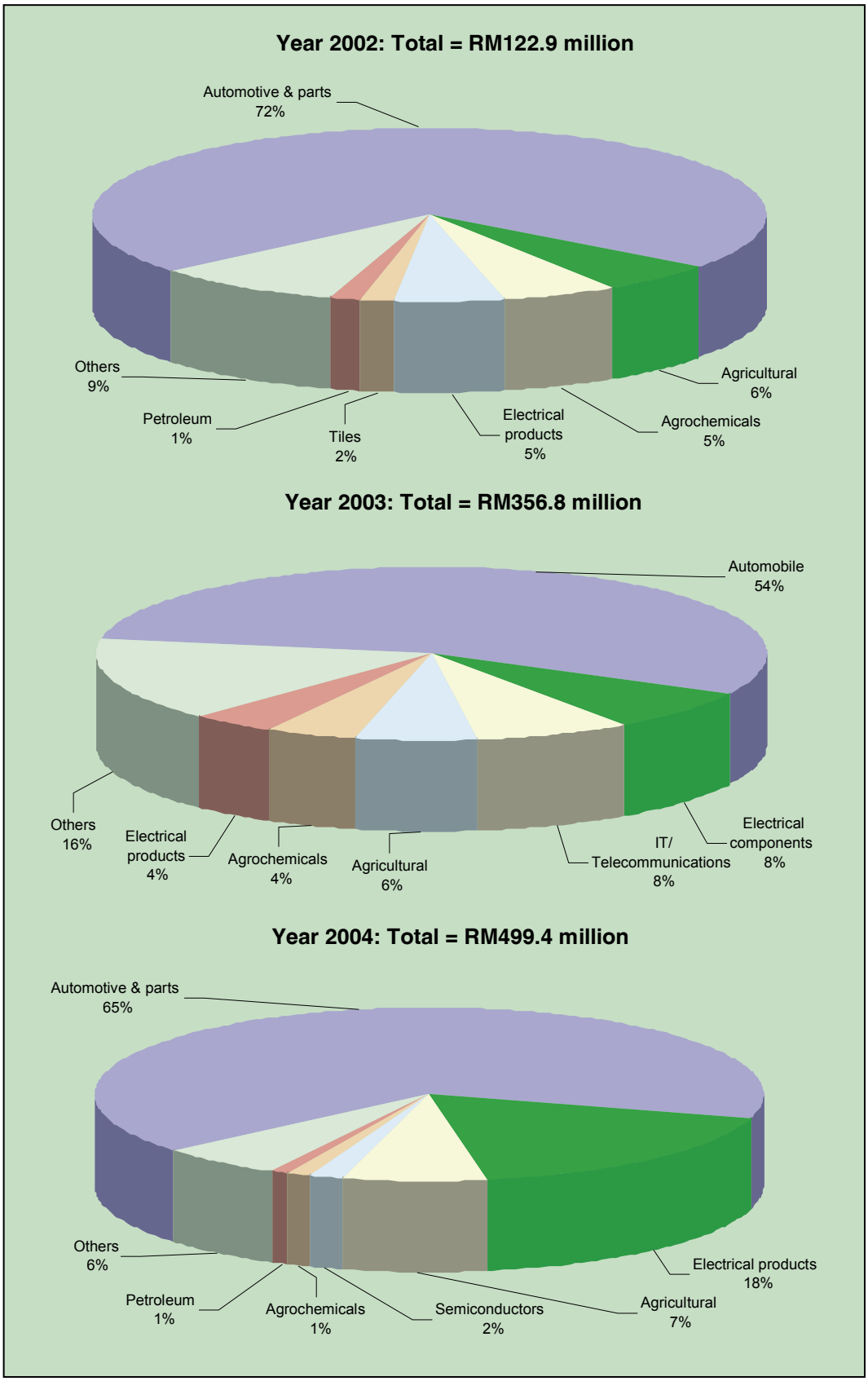
An examination of the double deductions approved by type of expenditure for the years 2003 and 2004 reveals that the largest amount has been expended on export promotion reflecting the trading position of the national economy **(Figure 5.12)**. A sharp increase in approvals for promotion of tourism is noted in 2004 when compared to the preceding year. This increase can be attributed to the aggressive efforts undertaken by the government in promoting the tourism sector.

Figure 5.10: Approved Double Deduction Relief for R&D, 2002-2004



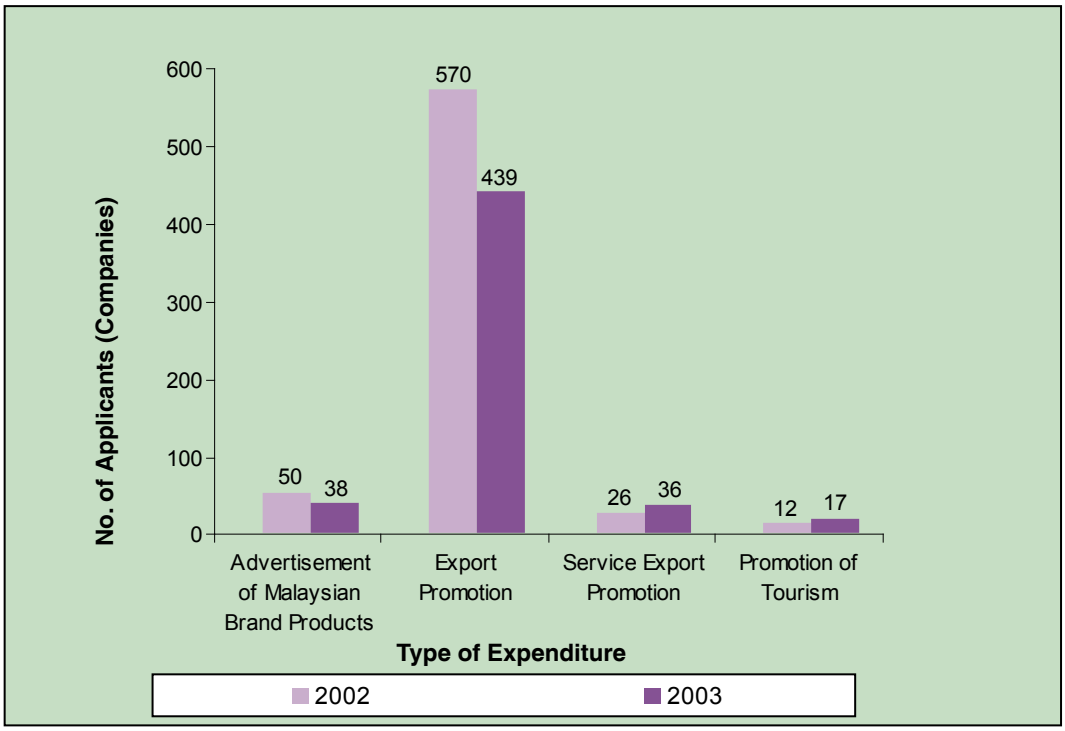
Source: Inland Revenue Board

Figure 5.11: Leading Recipients of Double Deduction Relief for R&D by Industry Sector, 2002-2004



Source: Inland Revenue Board

Figure 5.12: Number of Applicants (Companies for Double Deduction) by Type of Expenditure, 2003-2004



Source: Inland Revenue Board

5.4 R&D INVESTMENT INCENTIVES

R&D investment incentives have been introduced in recent years which have yielded substantial capital investments, both by local and foreign firms.

The involvement of industry in R&D activities is vital to the nation's innovation agenda. To further stimulate industry's participation in undertaking R&D, the government has in recent years expanded the range of incentives for R&D activities. Under the Promotion of Investments Act 1986, various incentives have been introduced to promote R&D activity particularly by companies in the manufacturing sector. These incentives include, among others, the following:

(i) Contract R&D Company

A contract R&D Company (i.e. a company that provides R&D services in Malaysia only to companies other than its related companies) is eligible to apply for Pioneer Status with full income tax exemption at statutory income level for five years or an Investment Tax Allowance (ITA) of 100% on qualifying capital expenditure incurred within 10 years. The ITA can be utilised to offset against 70% of the statutory income in the year of assessment.

(ii) R&D Company

An R&D company (i.e. company which provides R&D services in Malaysia to its related companies or to any other company) is eligible to apply for an ITA of 100% on qualifying capital expenditure incurred within 10 years. The ITA can be utilised to offset against 70% of the statutory income in the year of assessment. The related companies concerned will not enjoy double deduction for payments made to the R&D Company for the use of its services, unless the R&D Company opts not to avail itself to the ITA.

(iii) In-House Research

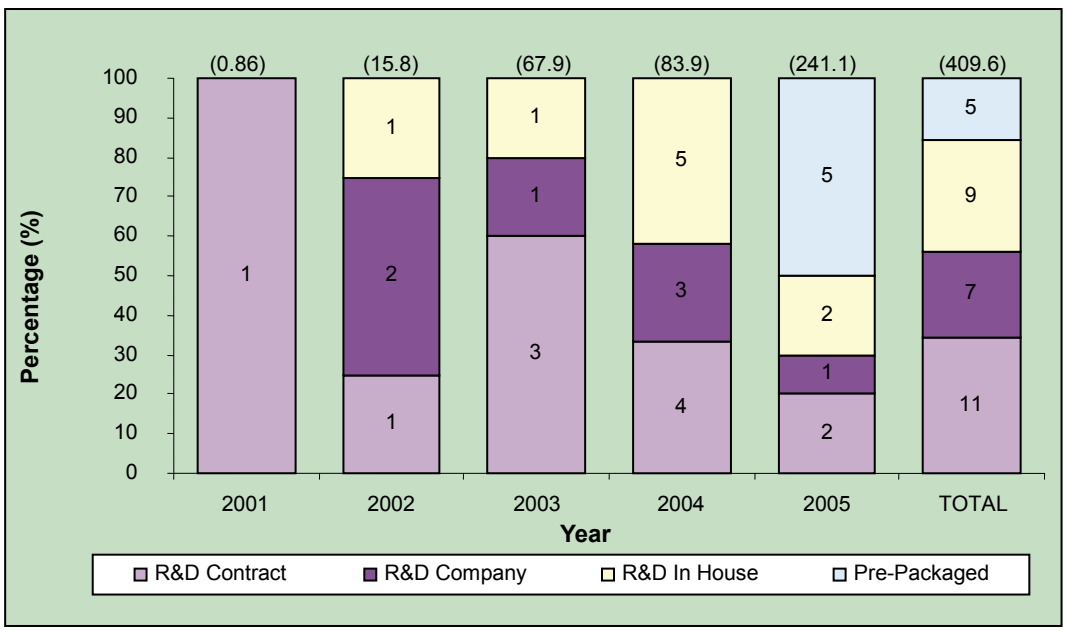
Companies that carry out in-house research in Malaysia (i.e. R&D undertaken within a company for the purpose of its own business) are eligible to apply for ITA of 50% on qualifying capital expenditure incurred within 10 years. The ITA can be utilised to offset 70% of the statutory income in the Year of Assessment.

(iv) Pre-Packaged Incentives

These are customised incentives granted to selected projects which are capital, technology and R&D intensive and skills driven and which promise significant linkages as well as contributing to the development of manufacturing support services in the country.

Figure 5.13 reveal that there has been a steady increase in the approval of such R&D projects under the various categories of investment incentives as described earlier. From just one approved project in 2001 with total investment of RM 865,000, the number of such approved R&D projects has surged to 32 in 2005 with almost RM 409.6 million in total capital investment of which RM 311.8 million or almost 76% is accounted by foreign direct investment. These approved projects promise potential employment to highly skilled Malaysians. Given the growing global trend in outsourcing R&D, there is potential for Malaysia to position itself strategically, through adoption of customised incentives as well as the supply of well-trained manpower, to seize the opportunities afforded by this trend.

Figure 5.13: Number of R&D Project by Types of Incentives, 2001-2005



*Figures in parentheses refer to total capital investment (RM million)
Source: MIDA

5.5 PROBLEMS FACED BY INDUSTRY IN APPLYING FOR R&D INCENTIVES

Industry has expressed unhappiness over some of the requirements for accessing the R&D incentives

The earlier discussion has provided an overview of the various incentives on R&D – fiscal and financing – available to industry, non-governmental organizations and public research institutions including universities. The diversity and attractiveness of these schemes are evident. However, success of these schemes is determined, among others, by the competence and responsiveness of the administration of these schemes. A survey undertaken by MOSTI in 2004 revealed that a considerable number of firms reported facing problems when applying for R&D incentives. The same survey revealed a number of grouses on these incentives including the following:

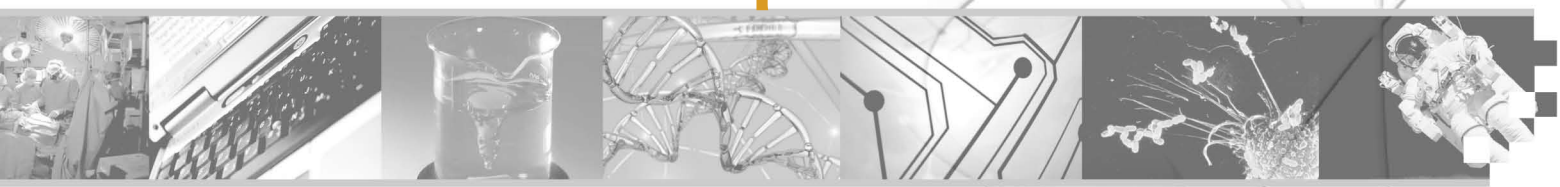
- Procedures for the application of these incentives are not clear;
- Information requested in the application for some of these incentives are company secrets;
- The scope of eligibility of some of these incentives are too narrow;
- The definition of R&D for these incentives is not clear.

These problems and issues raised by industry need to be addressed by the relevant institutions so as to ensure that these incentives achieve their desired objectives equitably as well as effectively. Such feedback suggests that constant monitoring and evaluation of these incentives schemes are crucial towards a dynamic R&D support system.

5.6 CONCLUSION

This chapter has revealed that the government has introduced both fiscal and non-fiscal incentives to promote R&D in the country. There has been a tremendous upsurge in approvals for double deduction tax relief granted to firms during the period 2003-2004 when compared to the preceding two years. This sharp increase suggests that more firms are accessing these fiscal incentives to engage in R&D activities. Accessibility is vital since the effectiveness of several R&D incentive schemes – both fiscal and non-fiscal – is dependent on their administrative design. The easier the administrative processes involved in seeking these incentives, the greater will be the number of firms seeking such incentives. There has been a noticeable decline in the number of applicants and approvals for almost all the R&D grant schemes. Such a decline does not bode well in our quest to strengthen the capacity and capabilities of our firms to compete in the global markets.

Chapter 6



INNOVATION IN THE MANUFACTURING SECTOR

6.1 INTRODUCTION

This chapter provides the state of innovation in the manufacturing sector in Malaysia, including changes from the previous years. The data used in this chapter draws largely from the survey on innovation undertaken for the period 2002-2004 by MASTIC in 2006. The chapter addresses the following innovation-related dimensions in the manufacturing sector:

- Share of innovating firms.
- Changes in the share of innovating firms.
- Innovation drivers
- Innovation-related investment
- Innovation effects
- Innovation obstacles
- Longitudinal trends

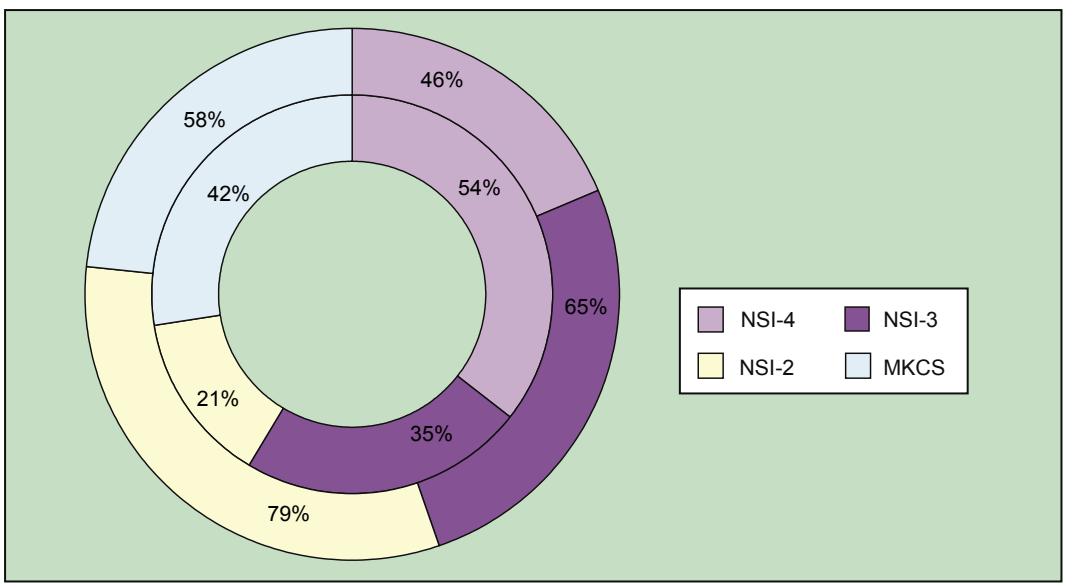
Comparisons of the survey results must be treated with caution owing to changes in the sampling procedure and the period of coverage used over the previous survey[1]. In addition to information carried in the previous report, this chapter also presents information on innovation indicators such as intellectual property registration, which was not included in the previous study by MASTIC.

6.2 SHARE OF INNOVATING FIRMS

Share of firms reporting innovation in 2002-2004 survey (54%) significantly higher than in earlier surveys

The share of firms innovating in the 2002-2004 survey (NSI-4) amounted to 54% of the 486 firms that responded to the survey, which is significantly higher than the 35% reported in the 2000-2001 survey (NSI-3). This figure was also much higher than the share of 42% reported by the Malaysian Knowledge Content Survey (MKCS) carried out by the Economic Planning Unit (EPU) in 2003 **(Figure 6.1)**.

Figure 6.1: Share of Innovating firm in the Manufacturing Sector



Source: National Survey of Innovation 2002-2004
Note: The outer ring refers to the share of non-innovating firms and the ring inside refers to the share of innovating firms

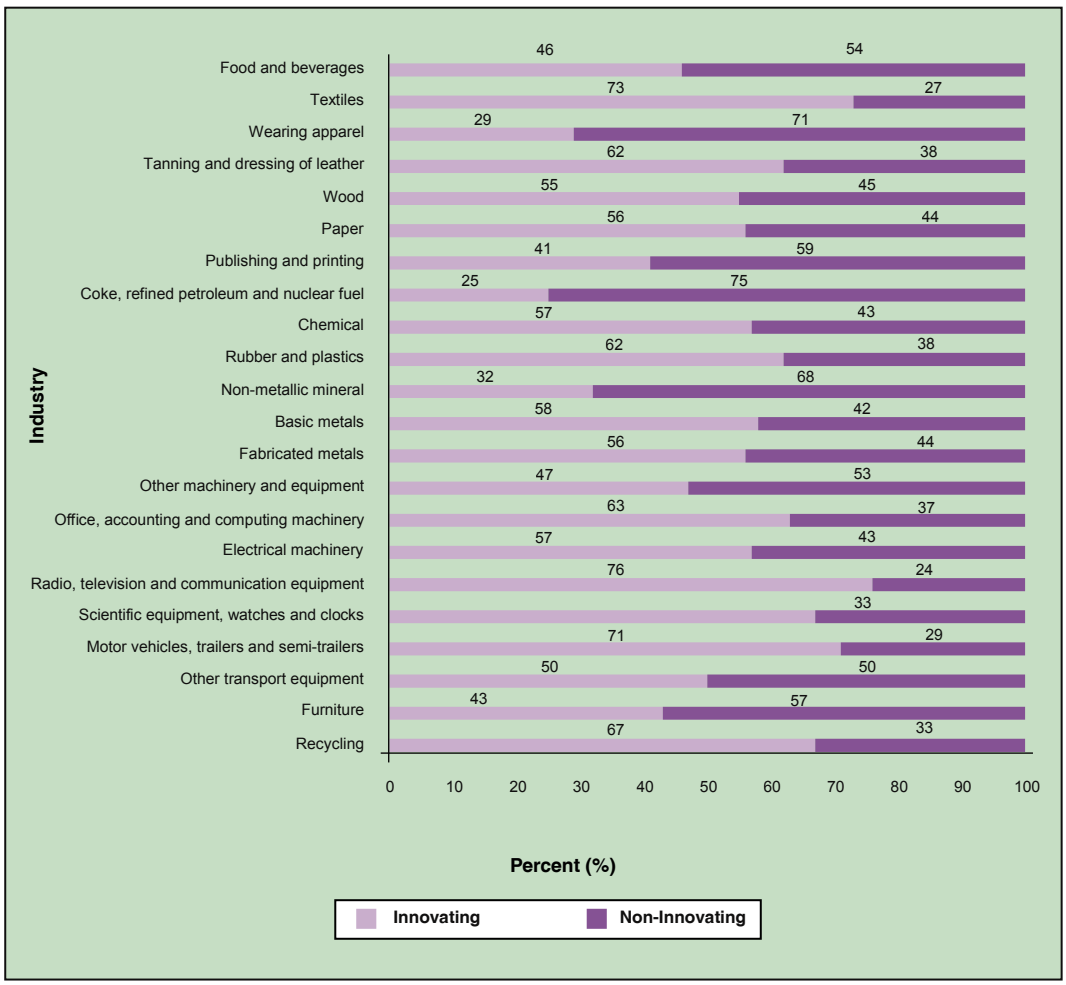
6.2.1 Industry Distribution

A significant number of firms reported participation in innovative activities in 2002-2004. The share of innovating firms rose in most manufacturing industries over the 2000-2001 and 2002-2004 surveys.

Radio, television and communications equipment (76%), textiles (73%) and motor vehicles, trailers and semi-trailers (71%) recorded the highest incidence of innovation in the manufacturing sector in the 2002-2004 survey .The lowest share of firm-level innovation was reported by the coke, refined petroleum products and nuclear fuel (25%), wearing apparel and dressing and dyeing of fur (29%) and non-metallic mineral products (32%) **(Figure 6.2)**.

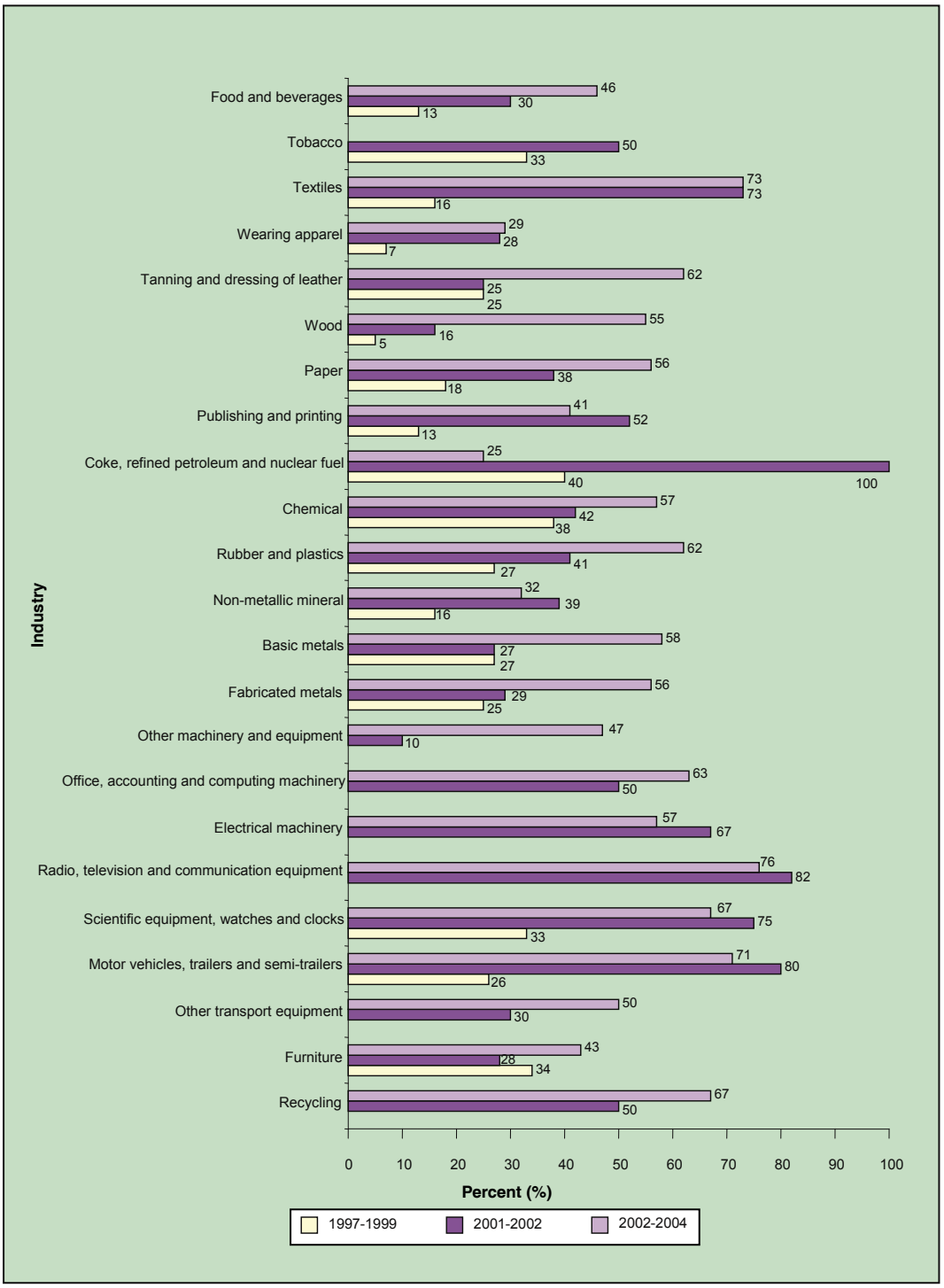
The share of innovation reported by radio, television and communication fell between the periods 2000-2001 (82%) and 2002-2004 (76%) **(Figure 6.3)**. The incidence of firms reporting innovation in paper, food and beverages, wearing apparel, furniture, rubber and plastics, chemicals, fabricated metals, basic metals and leather increased over 1997-2004.

Figure 6.2: Incidence of Innovation by Industry



Source: National Survey of Innovation 2002-2004

Figure 6.3: Changes in the Incidence of Innovation by Industry

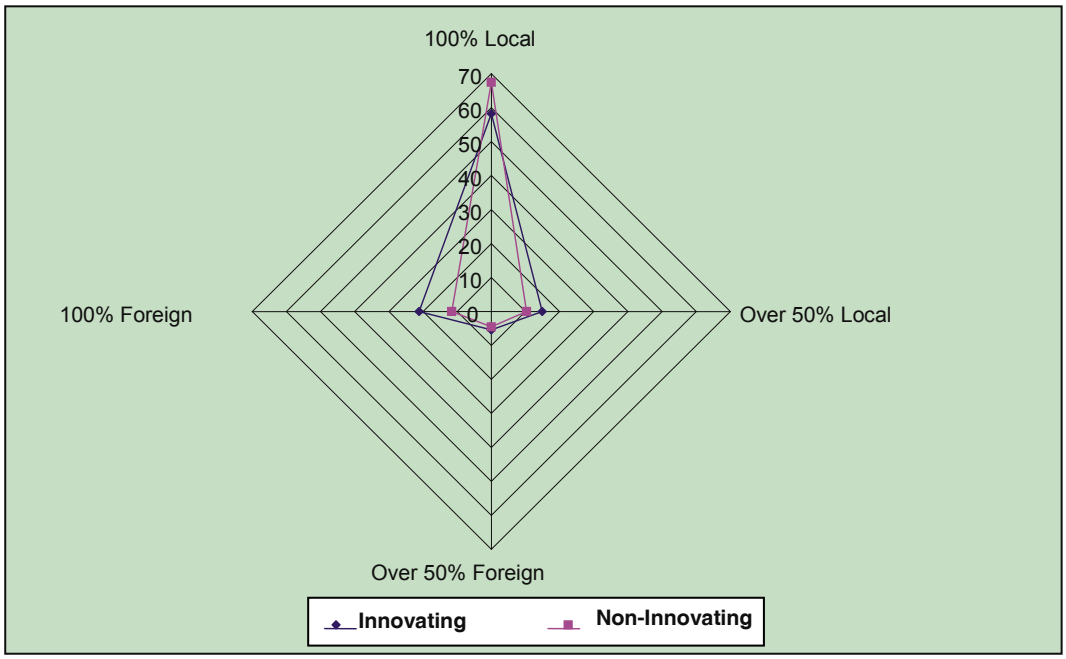


Source: National Survey of Innovation 2002-2004

6.2.2 Ownership Distribution

Ownership in the chapter refers to equity shares. The high share of local firms in the 2002-2004 survey is reflected in high incidence of local firms reporting participation in both innovation and non-innovation. Firms with 100% local equity accounted for 67.4% of the non-innovating firms and 58.2% of innovating firms. Totally foreign owned firms accounted for 21% and 11.6% respectively of innovating and non-innovating firms.

Figure 6.4: Share of Innovation by Ownership



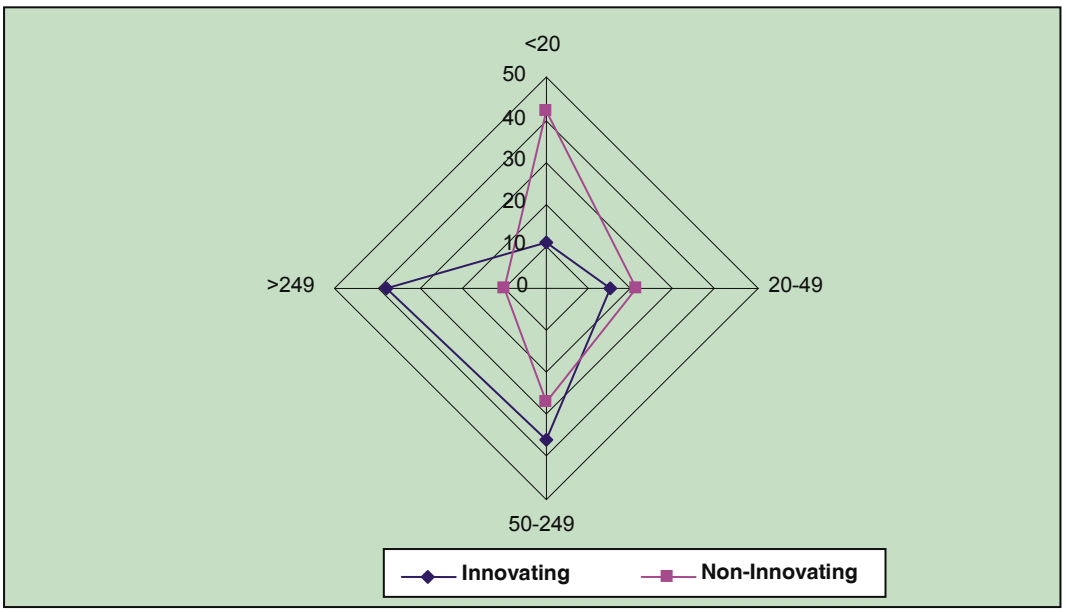
Source: National Survey of Innovation 2002-2004

6.2.3 Size Distribution

Larger firms registered higher incidence of innovation than smaller firms

This section uses employment figures as the basis of size. Larger firms show higher incidence of innovation than smaller firms. Firms with employment size less than 20 employees accounted for 42% of the non-innovating firms. This size category accounted for only 11% of the innovating firms **(Figure 6.5)**. In contrast, firms with employment size of 250 and more accounted for an incidence of 38% in innovation. This size category also accounted for only 10% of the non-innovating firms. Indeed, the incidence of innovation actually rises progressively with size in the 2002-2004 survey.

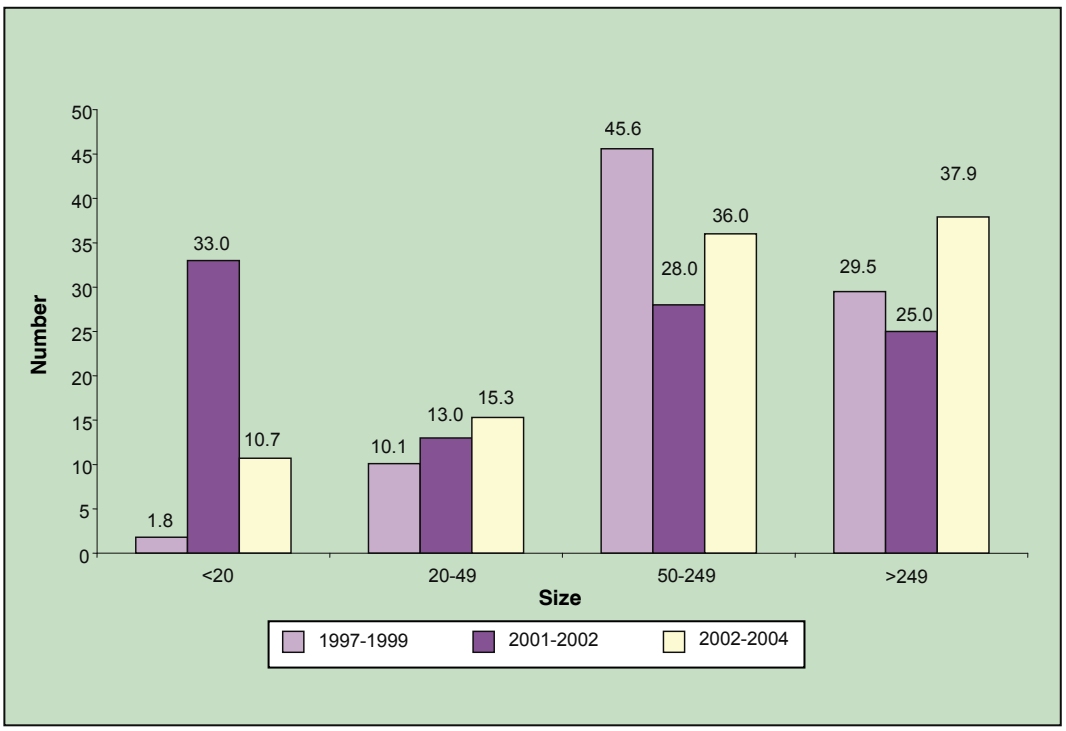
Figure 6.5: Incidence of Innovation by Size, Manufacturing



Source: National Survey of Innovation 2002-2004

The percentage of firms reporting innovations has only risen systematically in the 20-49 employment category in the three survey periods surveyed **(Figure 6.6)**. In the less than 20 employees category it fell from 33.0% in 2001-2002 firms to 10.7% in 2002-2004. Firms reporting innovations in the employment category exceeding 50 employees rose between the periods 2001-2002 and 2002-2004.

Figure 6.6: Percentage of Firms Innovating, 1997-2004



Source: National Survey of Innovation 2002-2004

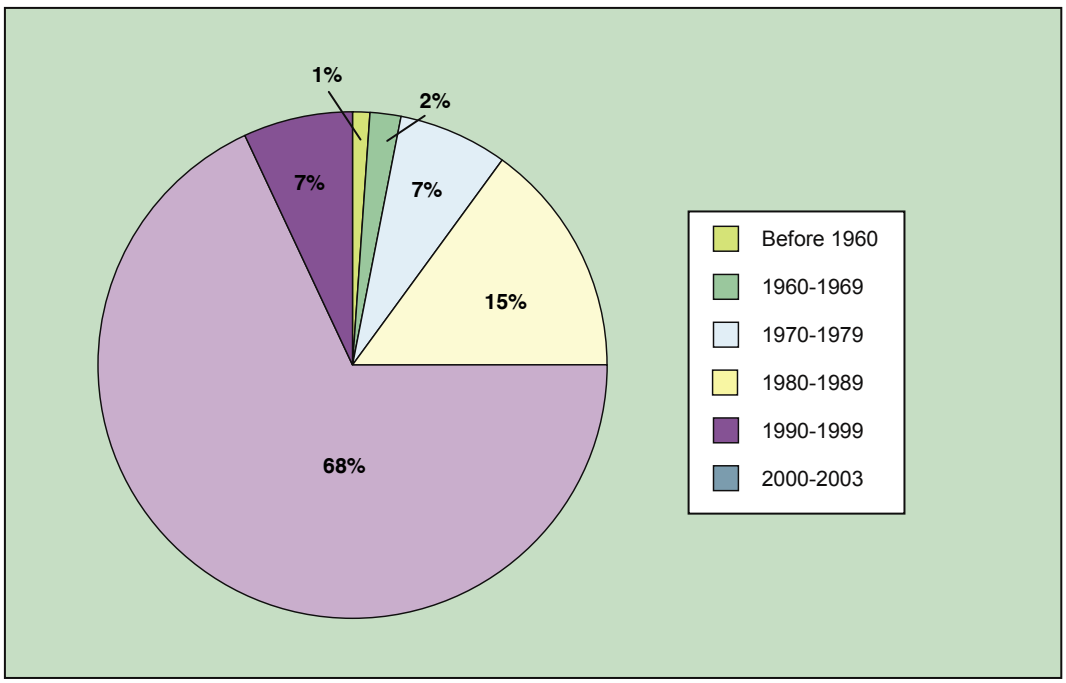
6.2.4 Age Distribution

About two-thirds of the innovating firms were established between 1990 and 1999

The infant nature of manufacturing in the 1950s and 1960s is reflected in the participation of older firms in innovative activities. Only 2.6% of the manufacturing firms reported participation in innovative activities was established before 1970 **(Figure 6.7)**.

The share of innovating firms reported in the 2002-2004 survey was highest among firms that opened in the period 1990-1999 (68%) followed by the period 1980-1989 (15%). The commensurate figures in this age category were 39 and 25% respectively in the 2001-2002 survey.

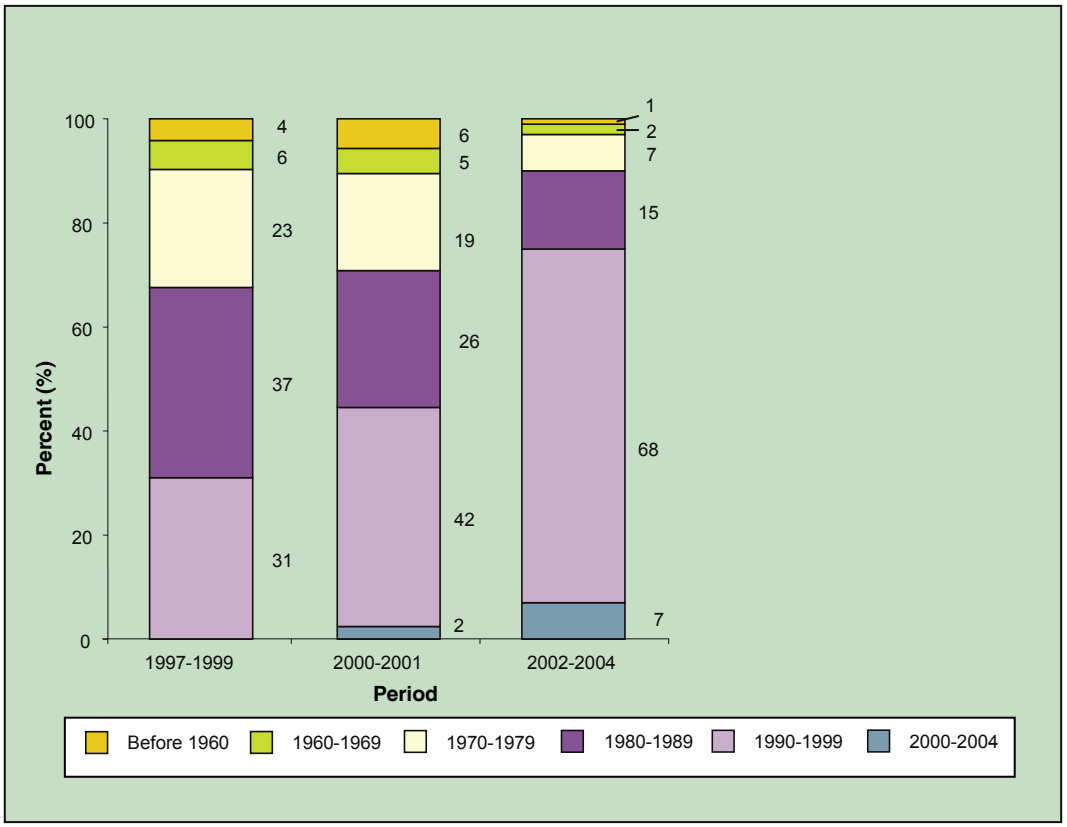
Figure 6.7: Innovating Firms by Age, 2002-2004



Source: National Survey of Innovation 2002-2004

Firms started in the period 1990-99 have shown the highest increase in the share of innovating firms over the period 1997-2004 rising from 31%, 42% and 68% over the three periods **(Figure 6.8)**. The share of firms in the 1960-69, 1970-79 and 1980-89 age groups have fallen over the same periods.

Figure 6.8: Innovating Firms by Age, 1997-2004



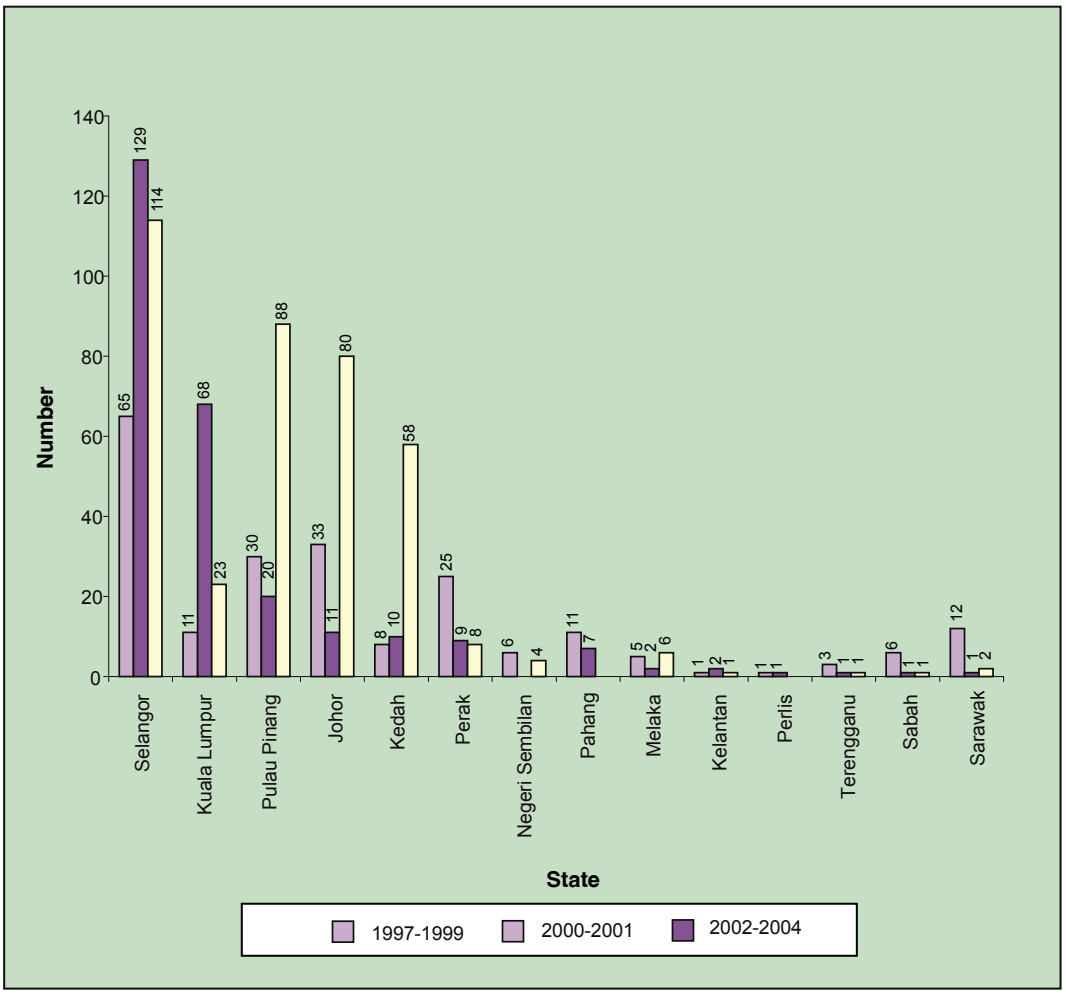
Source: National Survey of Innovation 2002 - 2004

6.2.5 Geographical Distribution

The distribution of firms reporting participation in innovation over the period 2002-2004 is shown in **Figure 6.9.** Selangor (114), Pulau Pinang (88), Johor (80) and Kedah (58) accounted for most of these firms. No firms reported any innovation in Perlis and Pahang while the share of innovating firms was extremely low in Kelantan, Sabah and Terengganu with one firm reporting participation in such activities in each of these states.

Pulau Pinang, Johor, Kedah, Negeri Sembilan, Melaka and Sarawak reported an increase in the number of firms reporting an increase in innovations between the period 2001-2002 and 2002-2004 **(Figure 6.9)**. The number of firms reporting innovation fell in Selangor, Kuala Lumpur, Pahang, Kelantan, Perak and Perlis.

Figure 6.9: Number of firms reporting Innovations by State, 2002-2004



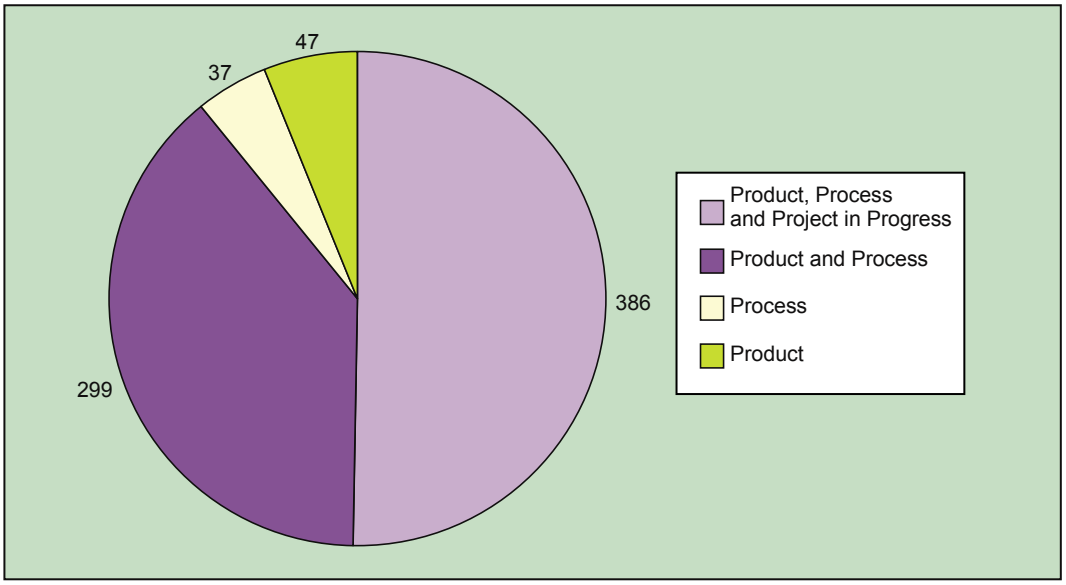
Source: National Survey of Innovation 2002-2004

6.2.6 Innovation Types

The share of firms reporting innovation in process, product and project in progress remained strong in the 2002-2004 survey. Three hundred and eighty six firms (79.6% of surveyed firms) reported generating innovation in process, product and project and progress activities **(Figure 6.10)**. The share of firms reporting product and process innovations was also high totaling 299 firms (61.6% of surveyed firms). The shares for product and process only categories were much smaller demonstrating that manufacturing firms in Malaysia generally innovate on a wider range of activities.

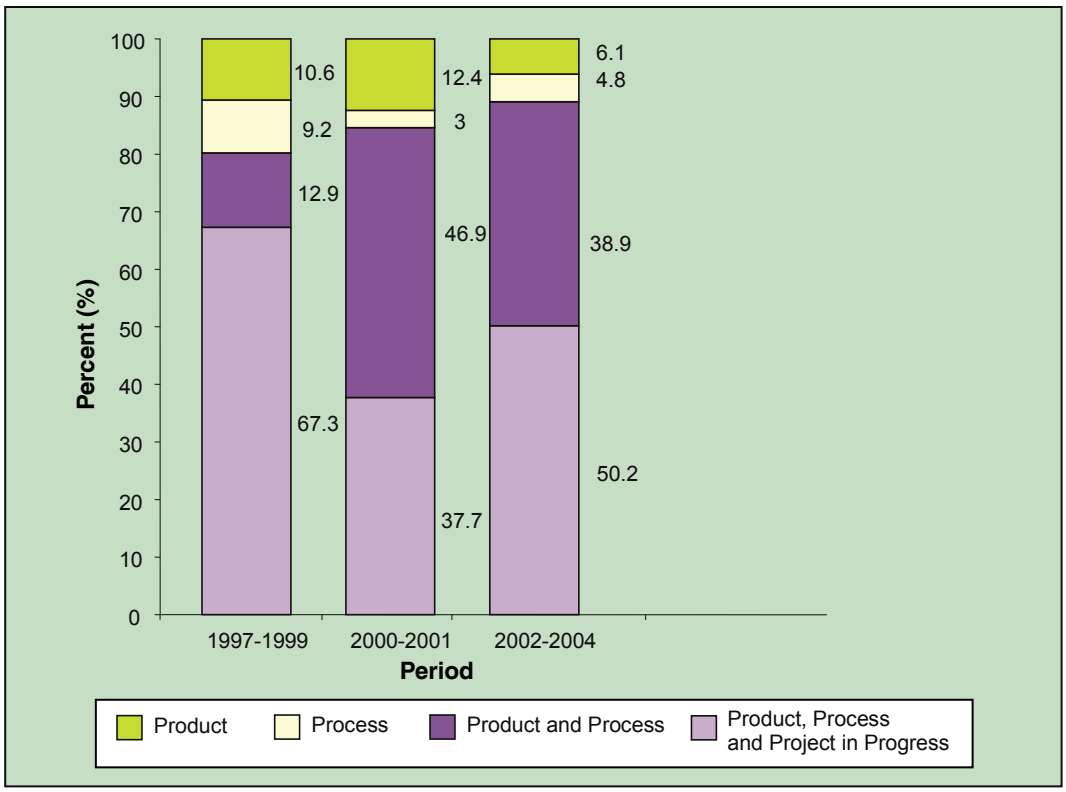
The share of firms participating in product, process and on-going project innovations fell over the period 1997-1999 and 2000-2001 but rose again in 2002-2004 **(Figure 6.11)**. Firms jointly producing product and process innovations fell over the period 2000-2001 and 2002-2004 but remained strong at 38.9%.

Figure 6.10: Innovation Type, 2002-2004



Source: National Survey of Innovation 2002 - 2004

Figure 6.11: Innovation Type, 1997-2004

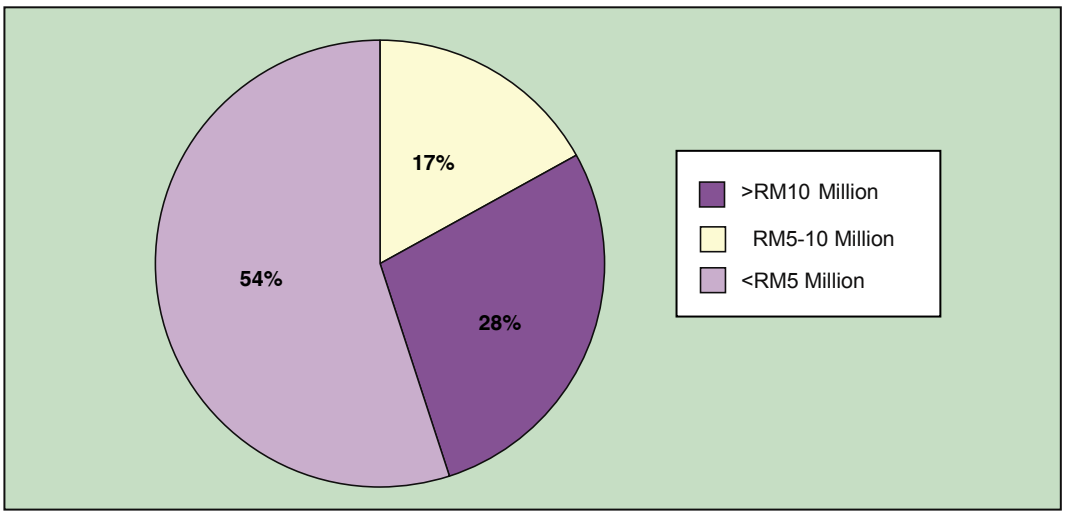


Source: National Survey of Innovation 2002-2004

6.2.7 Turnover Distribution

Around 54% of innovating firms had annual turnover of less than RM5 million in 2002-2004 (see **Figure 6.12**). The remaining shares were 17% and 28% for firms with annual turnover of between RM5 million-10 million and over RM10 million respectively.

Figure 6.12: Innovating Firms by Turnover, 2002-2004

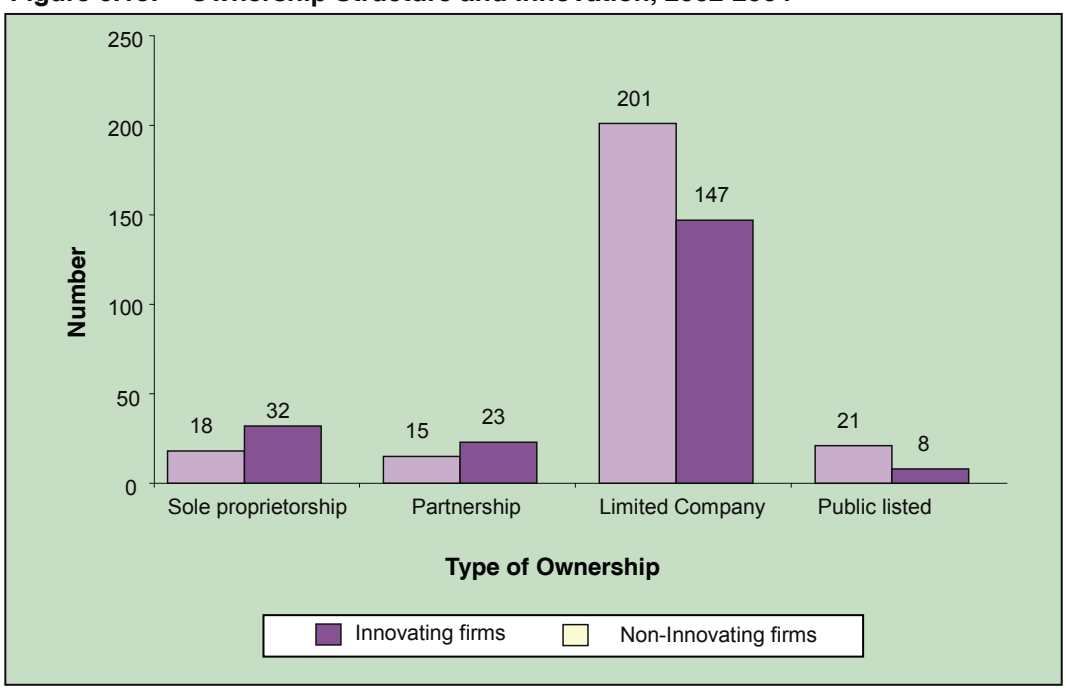


Source: National Survey of Innovation 2002 - 2004

6.2.8 Ownership Structure

Most innovations in the 2002-2004 occurred in limited companies **(Figure 6.13)**. In percentage terms public listed firms enjoyed the highest incidence (72.4%) followed by limited companies (57.8%).

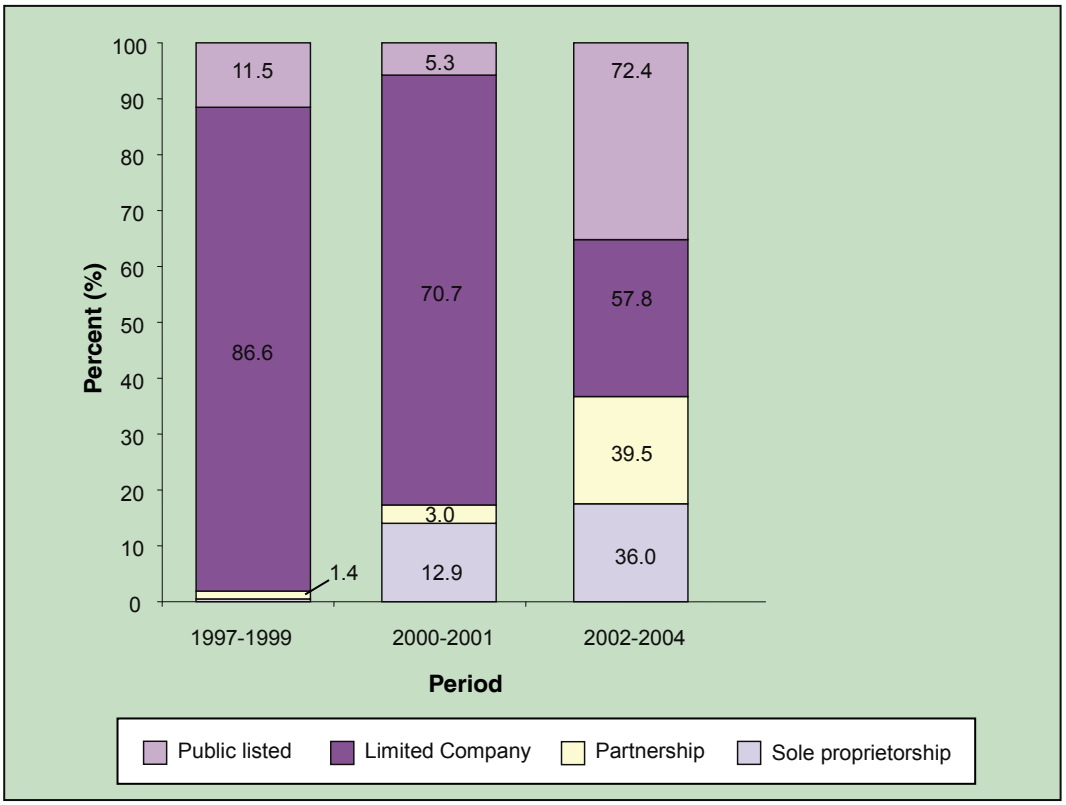
Figure 6.13: Ownership Structure and Innovation, 2002-2004



Source: National Survey of Innovation 2002-2004

The incidence of innovation among public listed companies recorded a big rise over the 2000-2001 and 2002-2004 periods **(Figure 6.14)**, the share rising from 5.3% to 72.4%. The incidence involving limited companies fell from 70.7% in 2000-2001 to 57.8% in 2002-2004. The innovation incidence for partnership and sole proprietorship firms rose over all three periods.

Figure 6.14: Ownership Structure and Innovation, 2002-2004



Source: National Survey of Innovation 2002 - 2004

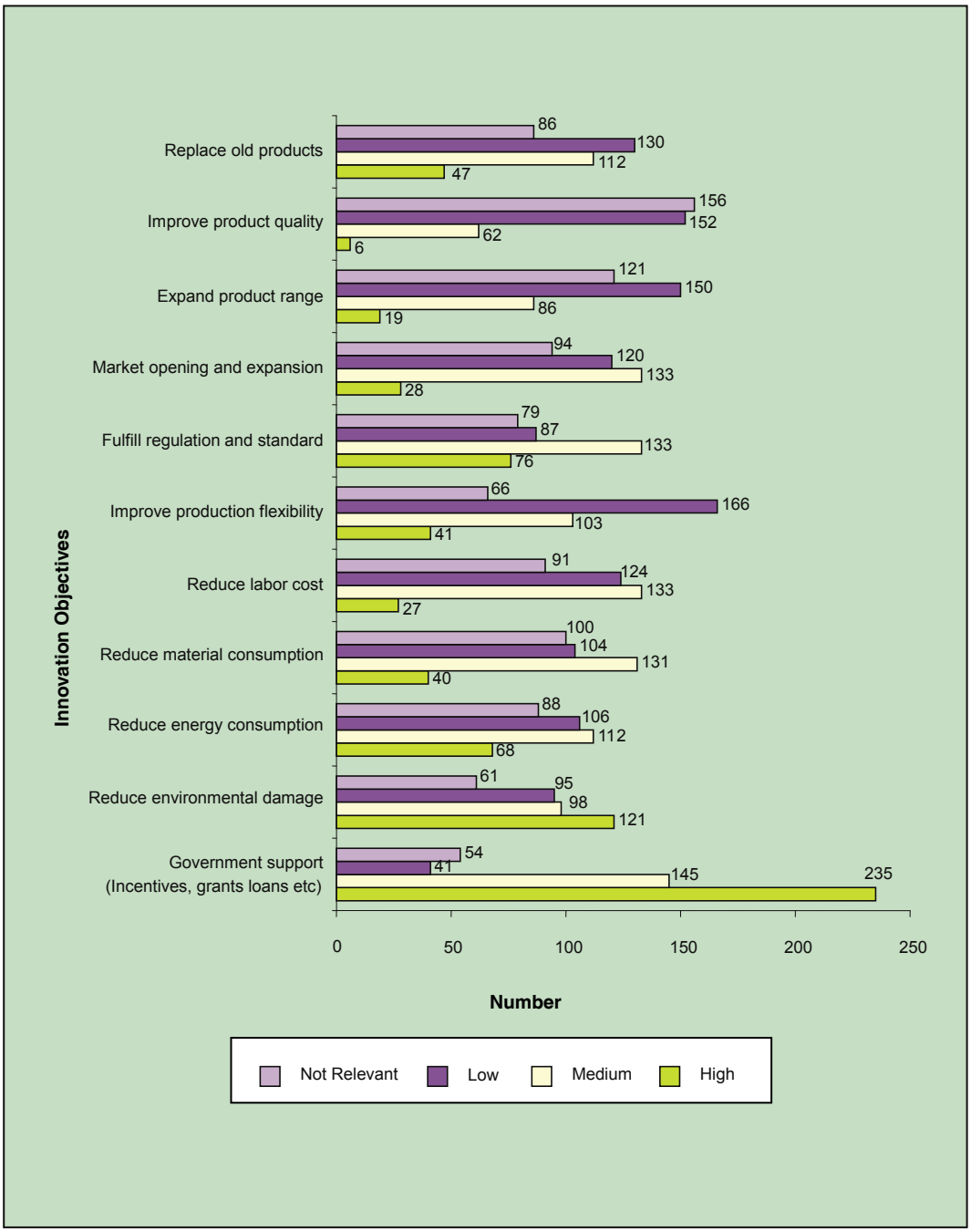
6.3 INNOVATION DRIVERS

Innovation drivers in the manufacturing sector take account of both firm-level objectives as well as the sources stimulating such activities in manufacturing firms. This section provides the range of responses given by firms from surveyed firms.

6.3.1 Innovation Objectives

Firms reported a number of reasons to explain the motivation for generating innovations. Government support (incentives, grants, loans and other inducements) scored the highest (235 firms) in 2002-2004 in the category of high importance **(Figure 6.15)**. The next highest was for reducing environmental damage (121 firms) followed by efforts to meet regulations and standards (76 firms).

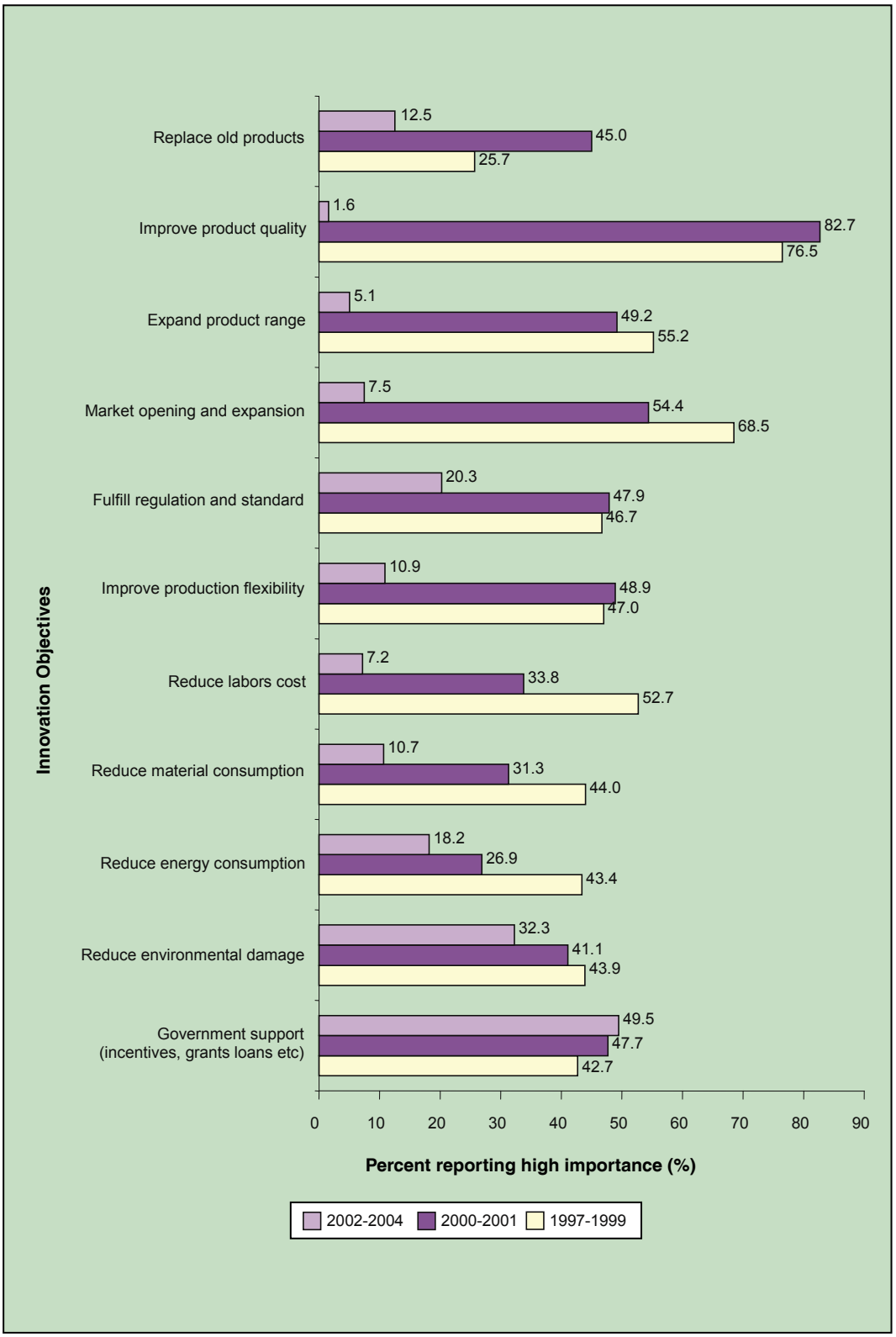
Figure 6.15: Innovation Objectives, 2002-2004



Source: National Survey of Innovation 2002-2004

Government support emerged as the biggest stimulant in raising firms' participation in innovation activities over the years 1997-2004 **(Figure 6.16)**. The remaining drivers faced a fall in importance in the same period. The most significant fall in significance involves efforts to raise product quality.

Figure 6.16: Innovation Objectives, 1997-2004

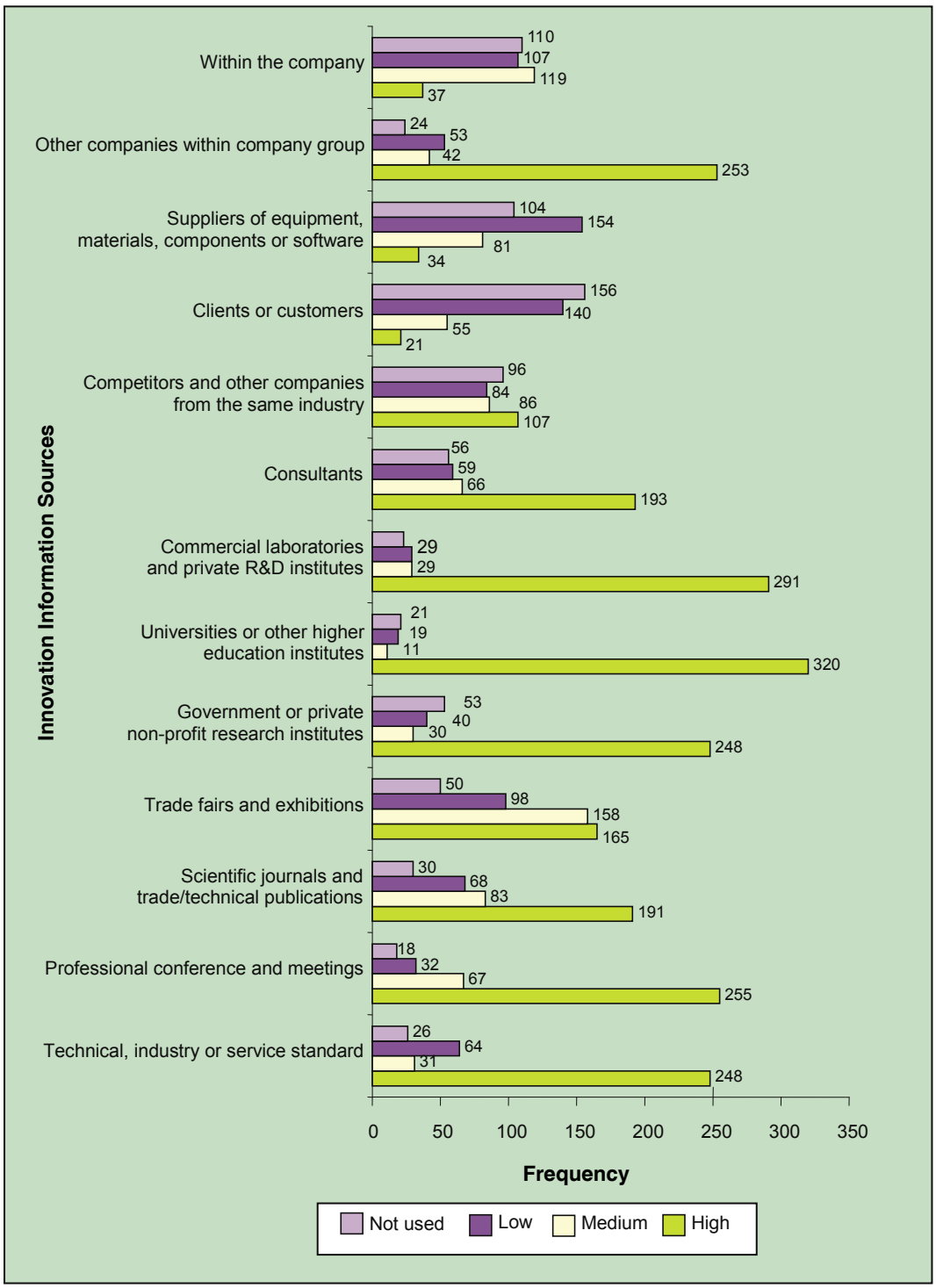


Source: National Survey of Innovation 2002 - 2004

6.3.2 Sources of Information for Innovation

Universities or other higher education institutions emerged as the most important source of innovation in the period 2002-2004 with 320 firms reporting high importance in driving innovation **(Figure 6.17)**. Commercial and private laboratories (291 firms) and professional conferences and meetings (255 firms) came out second and third respectively. These developments suggest that industry-university collaboration initiatives – both public and private – have increased connections and coordination between supporting high tech institutions and manufacturing firms.

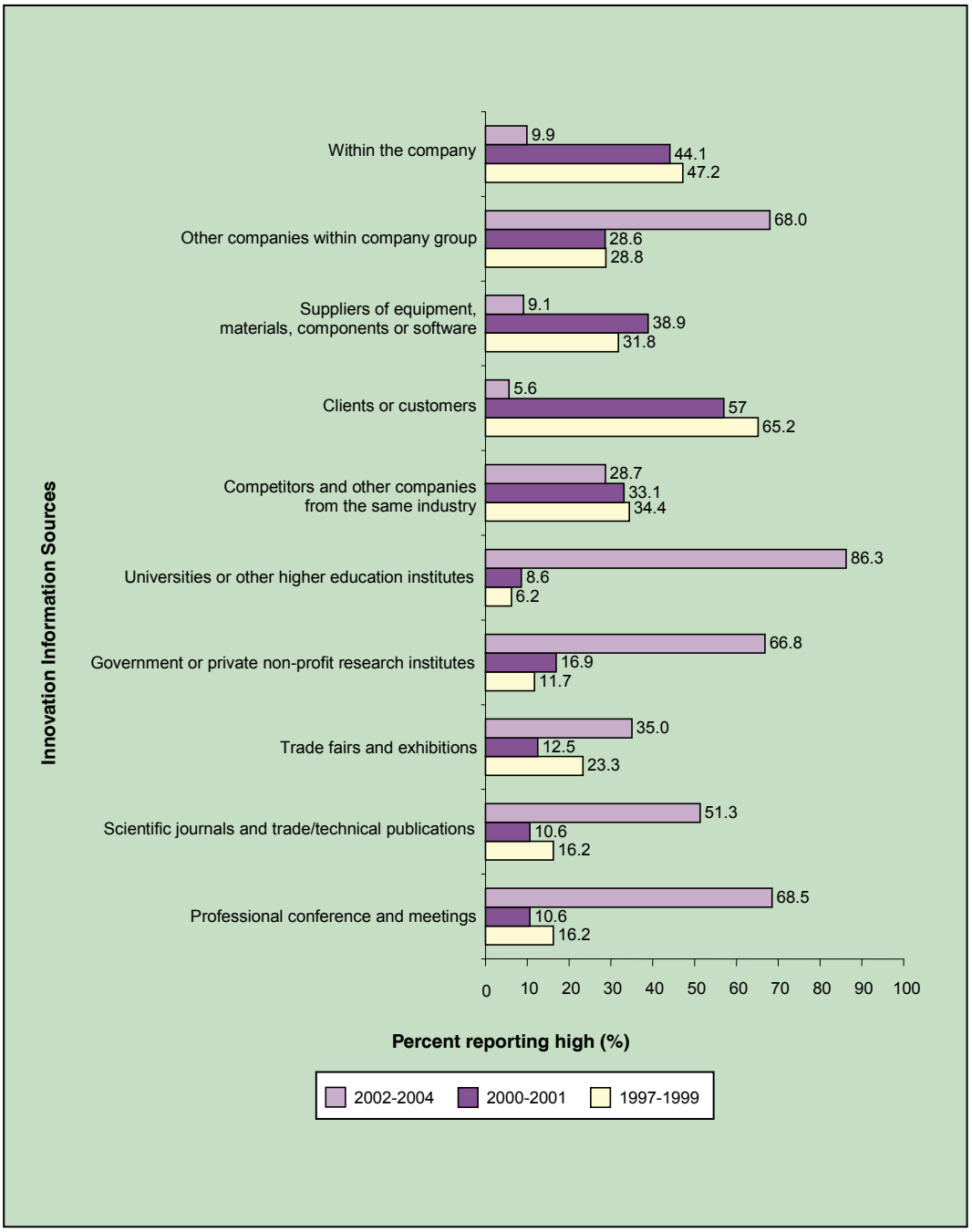
Figure 6.17: Sources of Innovation Information, 2002-2004



Source: National Survey of Innovation 2002 - 2004

Universities and other education institutions enjoyed the highest increase in importance (86.3% in 2002-2004) for participation in innovation activities over the 1997-2004 period **(Figure 6.18)**. Professional conferences and meetings (68.5% in 2002-2004), other companies within groups (68.0% in 2002-2004) and government and private profit research institutes (66.8% in 2002-2004) followed next.

Figure 6.18: Innovation Information Sources, 1997-2004



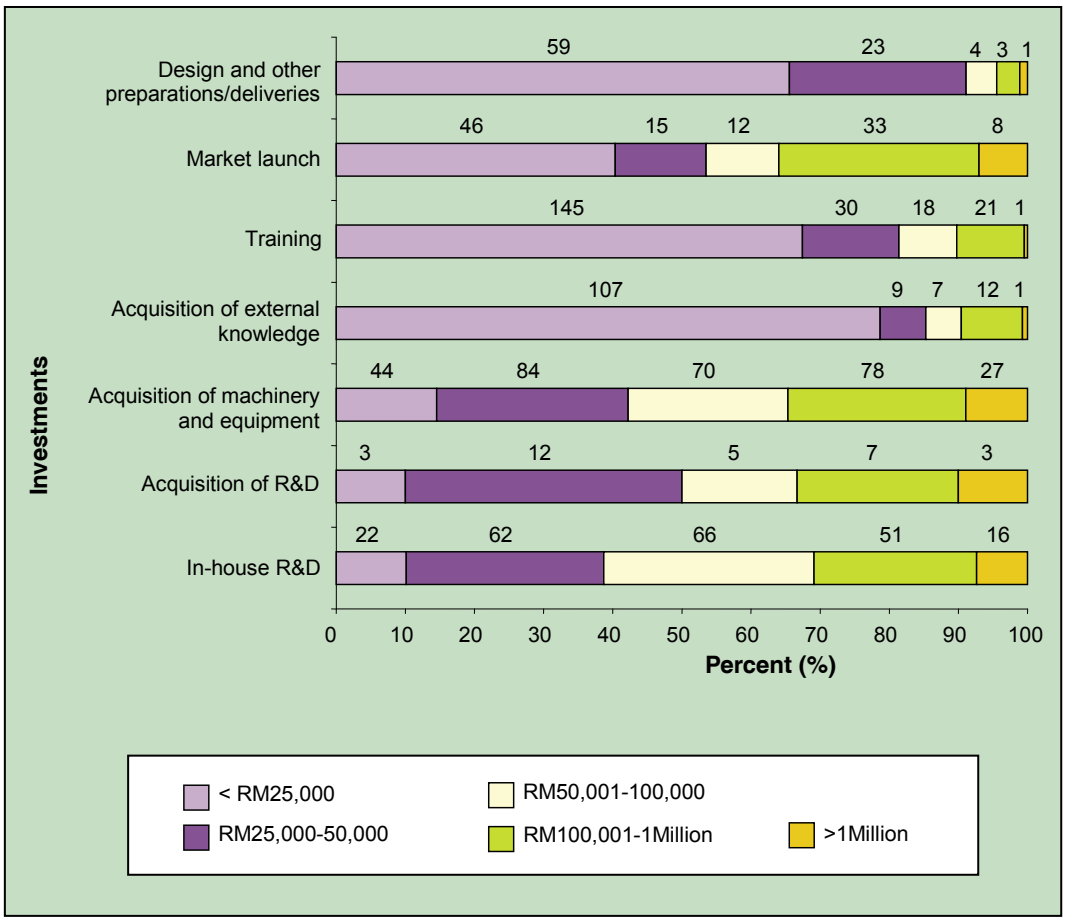
Source: National Survey of Innovation 2002 - 2004

6.4 INNOVATION-RELATED INVESTMENT

A significant number of firms reported investment in innovation-related activities. The most widely reported innovation-related activity was the acquisition of machinery and equipment (303 firms) followed by in-house R&D activities (217 firms) and training (215 firms) **(Figure 6.19)**.

The share of firms engaged in in-house R&D activities was fairly high in 2002-2004 where 44.7% of the surveyed firms reported investing in in-house R&D activities. However, 92.6% of these firms invested less than RM1million in in-house R&D activities. Only 7.4% of the firms invested more than RM1million in in-house R&D activities.

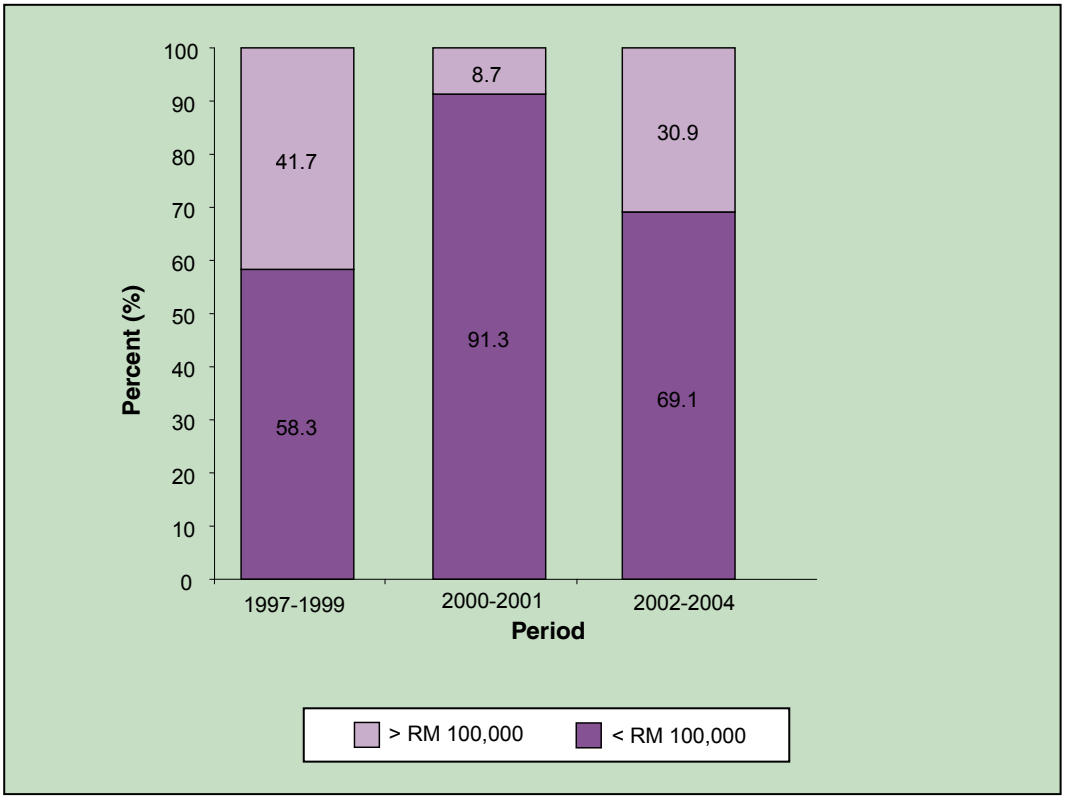
Figure 6.19: Innovation related Investment, 2002-2004



Source: National Survey of Innovation 2002-2004

The share of firms investing in R&D activities experienced an increase in investment exceeding RM100,000 over the periods 2000-2001 (8.7%) and 2002-2004 (30.9%) **(Figure 6.20)**. The share in 1997-1999 (41.7%) remained highest in all the periods.

Figure 6.20: Investment in In-house R&D, 1997-2004



Source: National Survey of Innovation 2002-2004

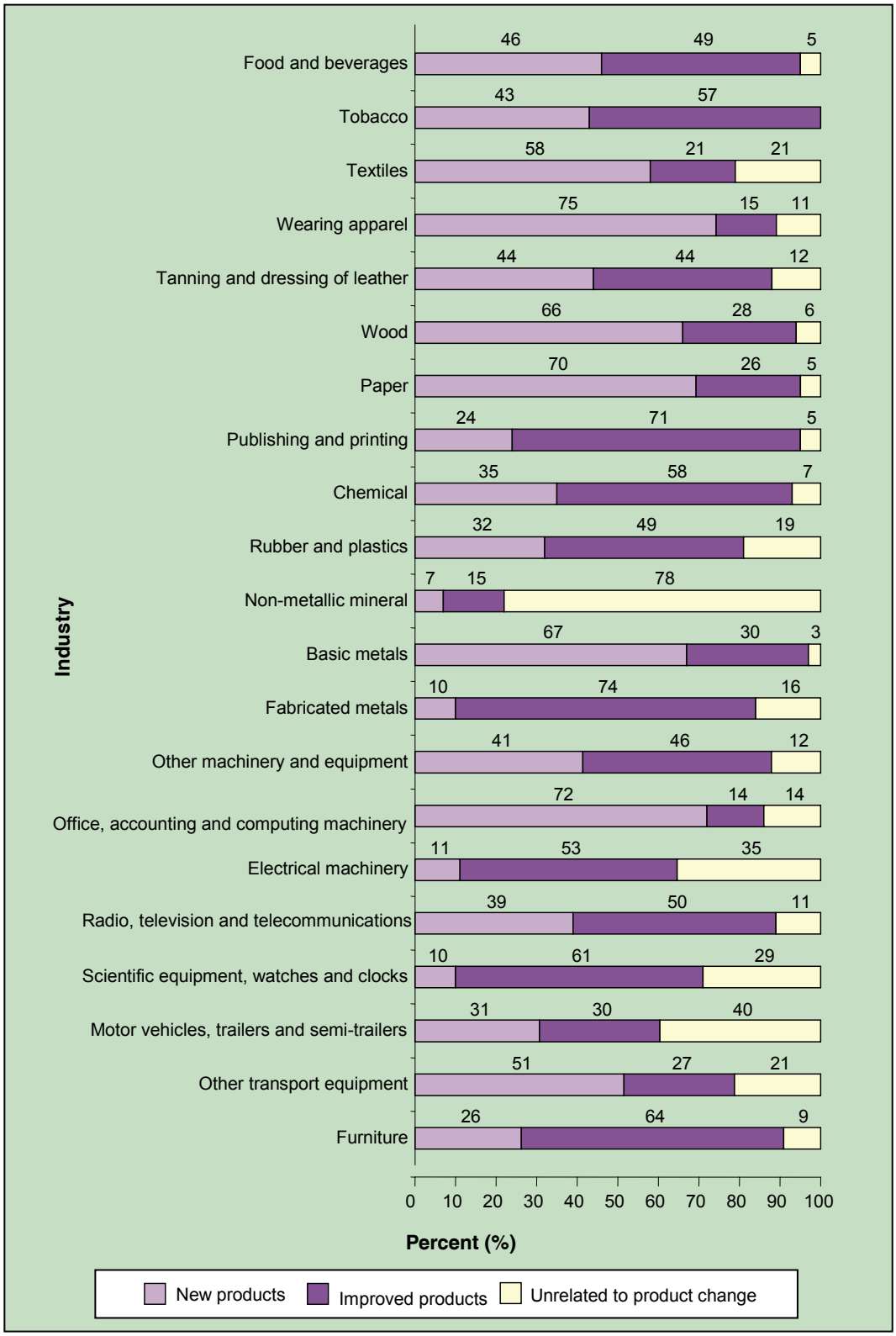
6.5 INNOVATION EFFECTS

The most significant impact of innovation activities reported by firms relate to improvements in production coordination and turnover as the applications of patents, industrial designs, copyright and trademarks in the manufacturing sector remained low.

6.5.1 Innovation-related Turnover

Firms reported strong turnover in new products in the wearing apparel, dressing and drying of fur (75%), office, accounting and computing machinery (72%), and paper and paper products (70%) in 2002-2004 **(Figure 6.21)**. Fabricated metals (74%), publishing, printing and reproduction of recorded media (71%), and furniture manufacturing (64%) enjoyed the highest contribution to the turnover of improved products.

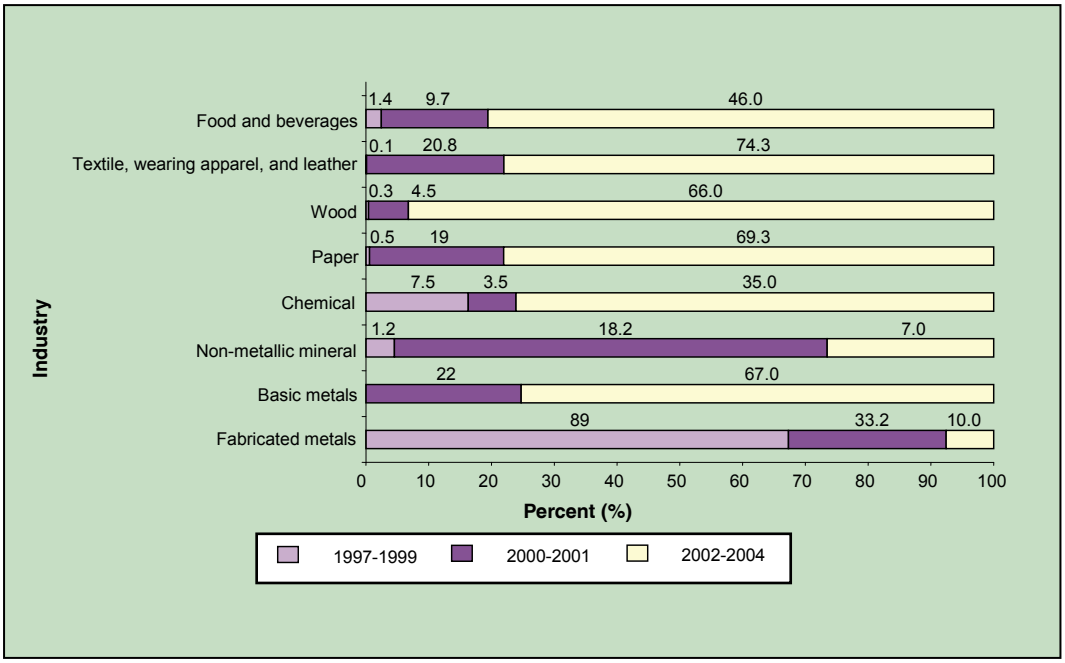
Figure 6.21: Innovation-related Turnover, 2002-2004



Source: National Survey of Innovation 2002-2004

Over the period 1997-2004 the industries of textile, wearing apparel and leather, paper, basic metals and wood experienced the highest growth in turnover related to new product development **(Figure 6.22)**.

Figure 6.22: Innovation-related Turnover, 1997- 2004



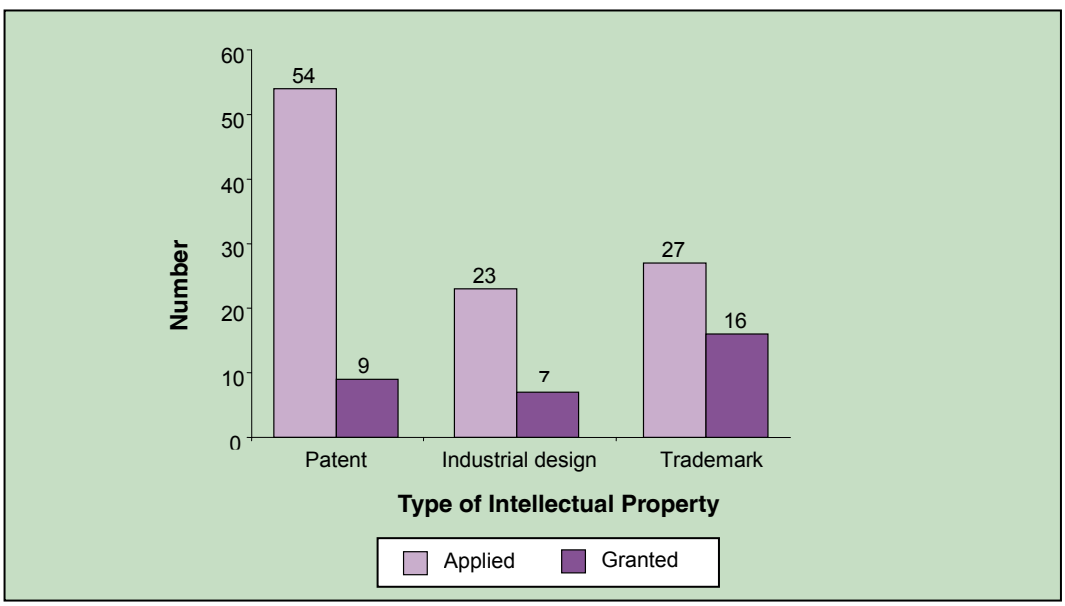
Source: National Survey of Innovation 2002-2004

6.5.2 Intellectual Property Registration

The sampled information used in this section does not provide an exhaustive list of patents, industrial designs, copyrights and trademarks applied and granted in the manufacturing sector. The data captured by the 2002-2004 survey offer an indication of the state of intellectual properties (IP) applied and granted in the manufacturing sector. Not many firms reported applying for patents, industrial designs, copyrights and trademarks in the manufacturing sector in 2002-2004. Firms reporting the granting of these instruments was even less.

All in all 25 firms reported applying for 54 patents in 2002-2004. The number of patents granted was 9 from 6 firms **(Figure 6.23)**. There were 23 and 7 industrial designs applied and granted respectively in the same period. Trademarks recorded 27 (from 14 firms) applications and 16 (from 11 firms) were granted.

Figure 6.23: Intellectual Property Registration, 2002-2004

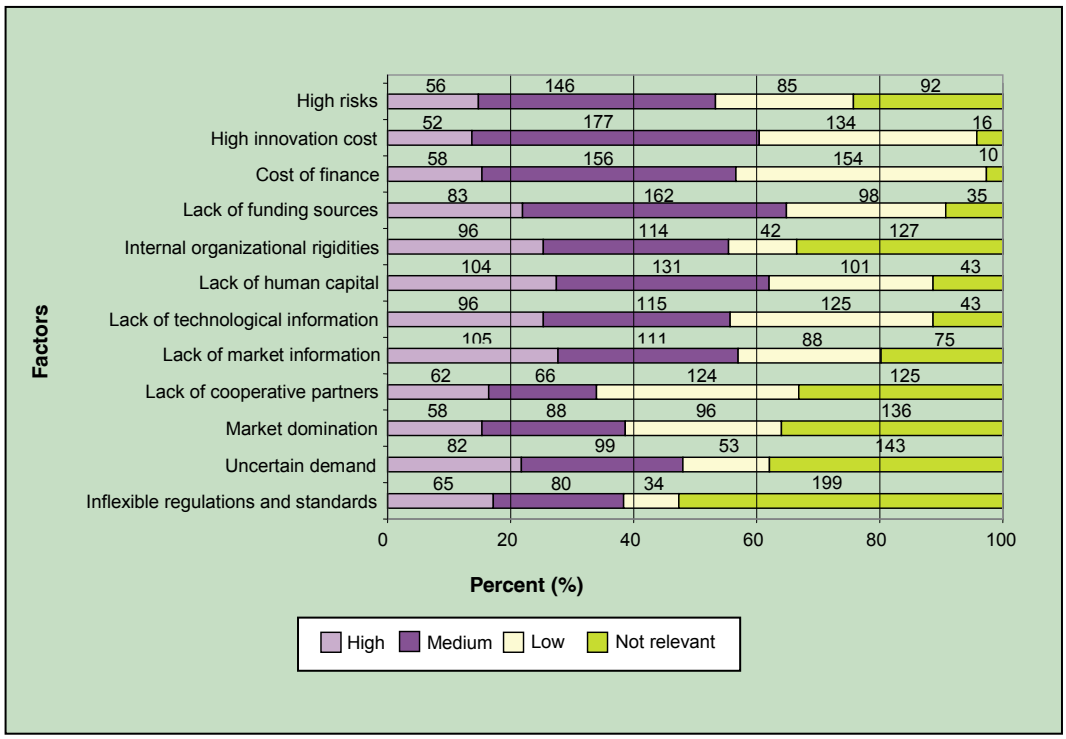


Source: National Survey of Innovation 2002-2004

6.6 INNOVATION OBSTACLES

Lack of market information (105 firms) and human capital (104 firms) were reported as the main obstacles hampering innovation in the surveyed firms in 2002-2004 **(Figure 6.24)**. Lack of information on technology (96 firms) and internal organizational rigidities (96 firms) also figured high among the factors hampering innovation.

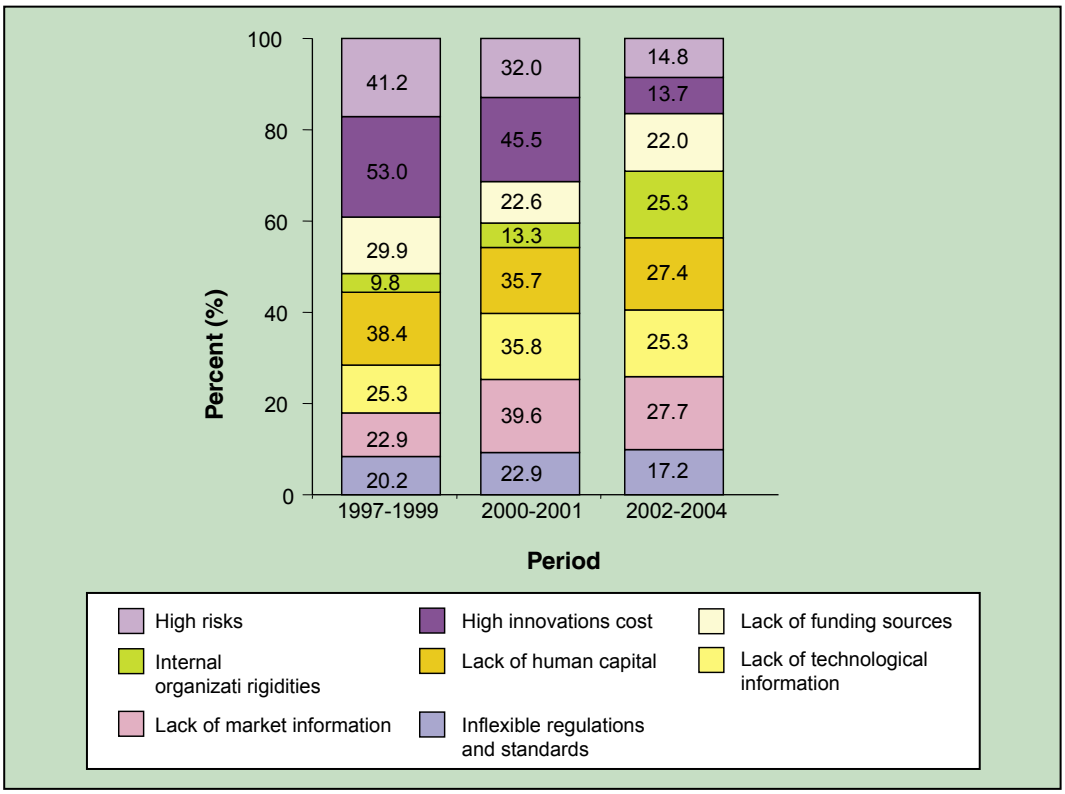
Figure 6.24: Factors Hampering Innovation, 2002-2004



Source: National Survey of Innovation 2002-2004

Significant changes have taken place over the period 1997-2004 on the importance of obstacles inhibiting innovation in manufacturing firms. High innovation costs has fallen dramatically in importance from 53.0% in 1997-1999 to 45.5% in 2000-2001 and 13.7% in 2002-2004 **(Figure 6.25)**. Internal organization rigidities faced a sharp rise from 9.8% in 1997-1999 and 13.3% 2000-2001 to 25.3% in 2002-2004.

Figure 6.25: Obstacles hampering innovation, 1997-2004

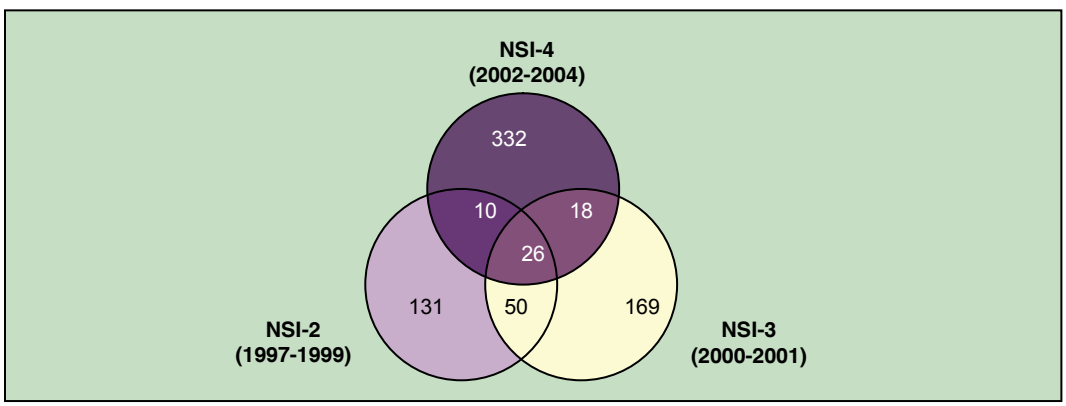


Source: National Survey of Innovation 2002-2004

6.7 LONGITUDINAL EVIDENCE: 1997-1999, 2000-2001 and 2002-2004 Surveys

The data available for longitudinal analysis of innovating firms was much less than that available for the assessments carried out above. Indeed only 26 firms appeared consistently in all three surveys. The number of firms appearing in the 2000-2001 and 2002-2004 surveys was 44 **(Figure 6.26)**.

Figure 6.26: Distribution of Respondents, NSI-2, NSI-3 and NSI-4 Surveys

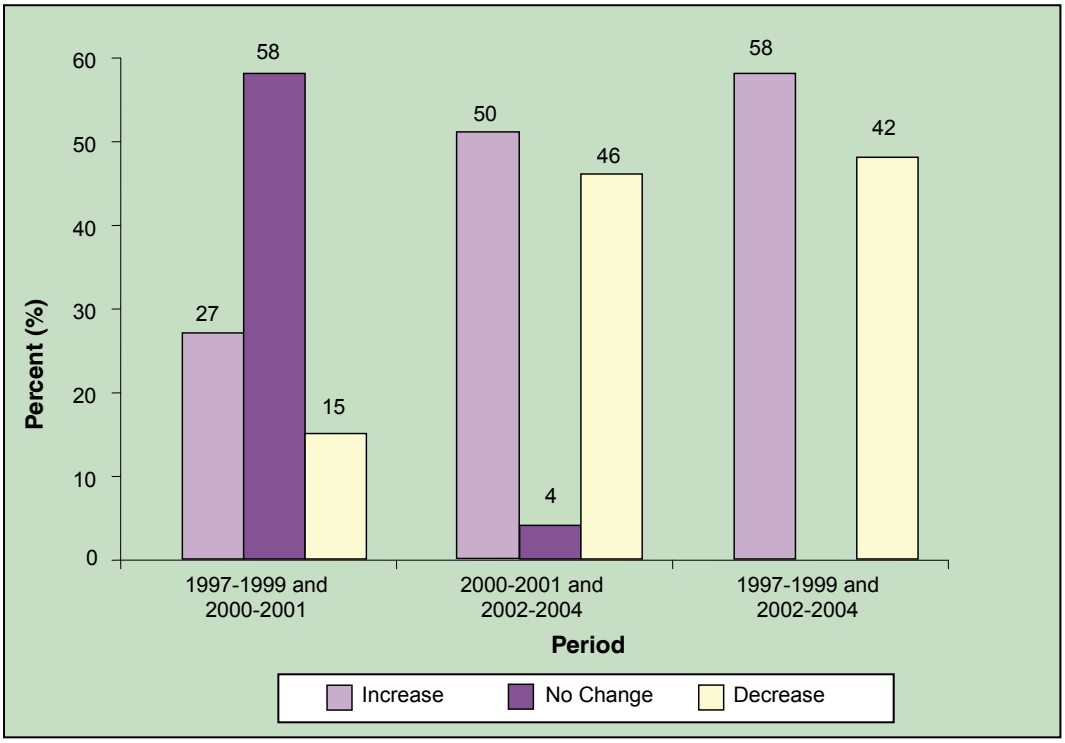


Source: National Survey of Innovation 2002-2004

6.7.1 Size Distribution

Using the 26 firms that appeared in all three surveys, 27% of firms grew in size while 15% of the firms contracted in size over the 1997-1999 and 2000-2001 period **(Figure 6.27)**. Around 50% of the firms grew in size and another 46 % fell in size over the period 2000-2001 and 2002-2004. Taken together 58% and 42% grew and contracted in size respectively over the three periods.

Figure 6.27: Size changes in Innovating Firms, 1997-2004

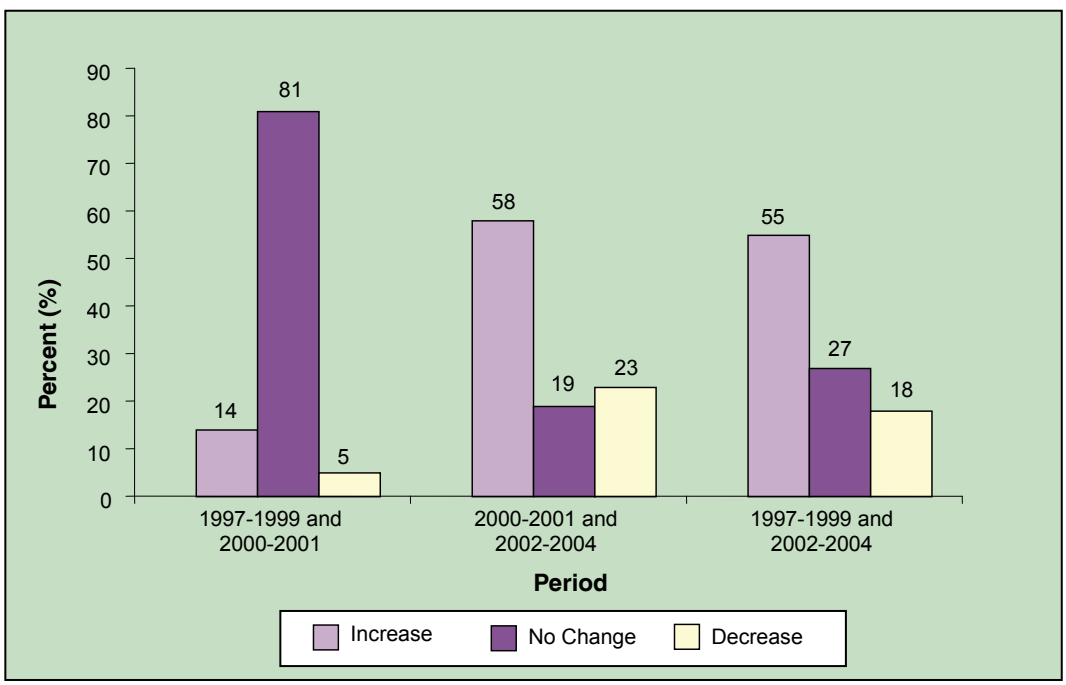


Source: National Survey of Innovation 2002-2004

6.7.2 New Products

The longitudinal sample of firms over the period 1997-2004 reported a significant increase in new product innovation between the first (14%) and second (58%) period falling subsequently slightly over the third (55%) period **(Figure 6.28)**.

Figure 6.28: Changes in New Product Innovation, 1997-2004

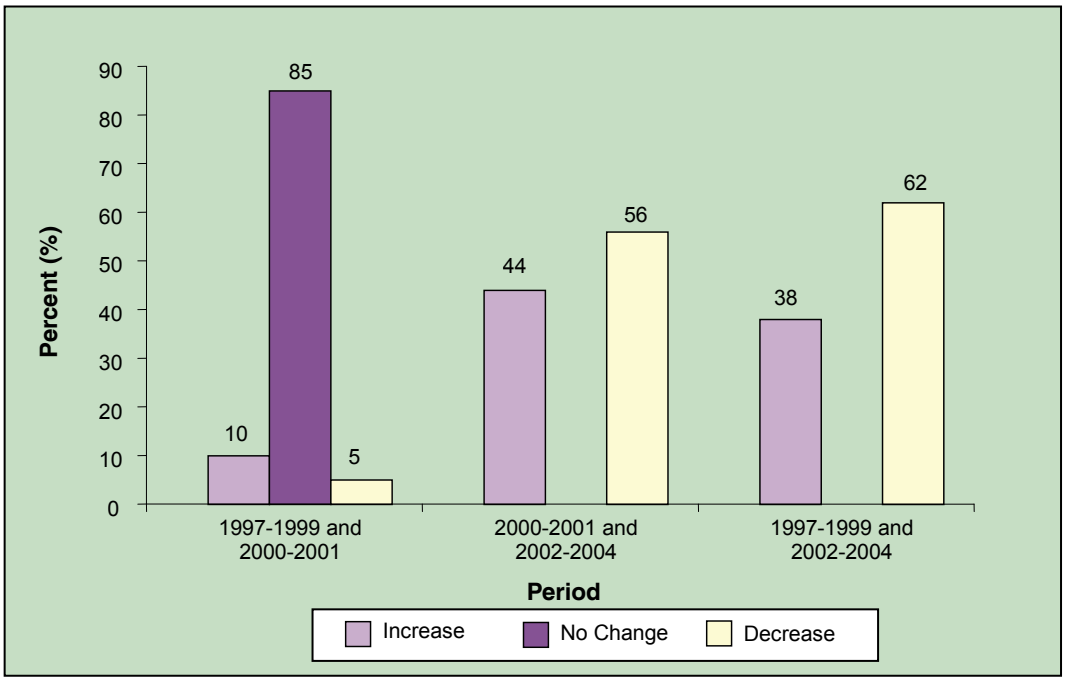


Source: National Survey of Innovation 2002-2004

6.7.3 Innovation Expenditure

Innovation expenditure incurred by firms recorded in the three surveys rose between the periods 1997-1999 and 2000-2001 from 10% to 44% respectively **(Figure 6.29)**. The share fell in 2002-2004 to 38%. Firms reporting a decrease in innovation expenditure rose sharply from 6% in 1997-1999 to 56% in 2000-2001 and 62% in 2002-2004.

Figure 6.29: Changes in Innovation Expenditure, 1997-2004



Source: National Survey of Innovation 2002-2004

6.8 CONCLUSION

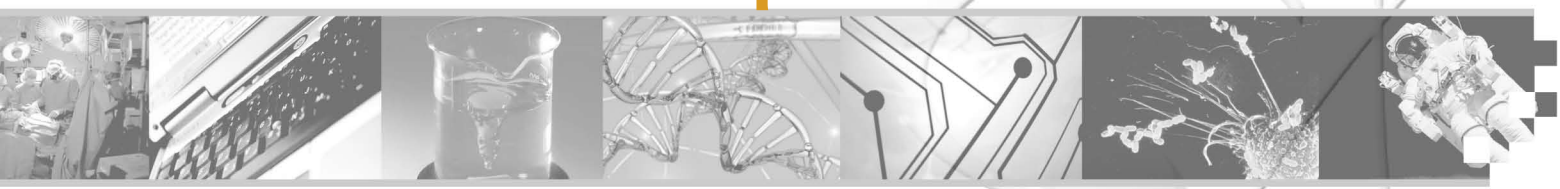
The 2002-2004 survey reported in this chapter showed marked improvements in the incidence of the surveyed manufacturing firms reporting innovation over the previous two periods of 1997-1999 and 2000-2001. The industries of paper, food and beverages, wearing apparel, furniture, rubber and plastics, chemicals, fabricated metals, basic metals and leather faced an increase in firms reporting innovations over the period 1997-2004.

The NSI-4 took a cut off point of 5 or more employees compared to the NSI-3 and NSI-2 when no such specifications were included. Also the NSI-4 used a coverage period of 3 years when compared to the 2 years used in NSI-3.

There was a sharp rise in firms reporting joint participation in product, process and on-going project innovations in 2000-2004. Inter-temporarily innovating firms in the manufacturing sector either experienced an increase or a decrease in size over the period 1997-2004. However, there was a fall in firms reporting an increase in new product development over the period 2000-2204. There was also a substantial increase in firms reporting falling innovation-related expenditure.

The data on supporting institutions offer two positive developments. Firstly, the share of firms reporting an important role played by universities and other higher education institutions, and government public and private research institutes rose sharply over the period 2000-2004. Secondly, government support through incentives, grants, loans and other inducements has emerged as the most important innovation stimulant in the 2002-2004 survey. These developments suggest that government initiatives to resolve market failure in firm-level innovation activities are beginning to take effect in the manufacturing sector.

Chapter 7



TRADE IN TECHNOLOGY

7.1 INTRODUCTION

The previous chapter largely presented a rosy account about the state of innovation in the manufacturing sector, though the share of firms reporting a decrease in innovation expenditure rose strongly between 2002 and 2004. Given that firms learn and innovate throughout the technology trajectory the trade balance in especially royalties will show Malaysian firms' closeness to the global technology frontier. Economies dominated by firms innovating at the technology frontier will show strong positive balances in royalty balance of payments. This chapter presents the state of technology trade of Malaysia focusing on merchandise trade, and on services. The issues addressed are the following:

- Composition and trends in merchandise trade by the OECD-defined technological categories of high tech, medium-high tech and others.
- Composition and trends in royalty payments, receipts and balance.
- Composition and trends in contracts and professional fee payments, receipts and balance.
- Composition and trends in construction and engineering fee payments, receipts and balance.

To retain comparative significance to the statistics used in the past this chapter uses the classifications defined in the previous reports.

7.2 TRADE IN MANUFACTURED GOODS

Increased participation in high tech export manufactures is considered an indicator of the state of science and technology of manufacturing firms in a country though it is often in the labour-intensive segments of these industries such as assembly and test that firms in Malaysia operate. The following OECD classifications on technological intensities are drawn:

High Technology manufactures:

- Aircraft and spacecraft
- Pharmaceuticals
- Office, accounting and computing machinery
- Radio, television and communications equipment
- Medical, precision and optical instruments

Medium-High Technology manufactures:

- Electrical machinery and apparatus
- Motor vehicles, trailers and semi-trailers
- Chemicals (excluding pharmaceuticals)
- Machinery and equipment
- Railroad and transport equipment

7.2.1 Manufactured Exports

Malaysia has traditionally dominated in low value added segments of high tech manufactured exports such as office, accounting and computing machinery, radio television and telecommunication equipment, and medical, precision and optical instruments. The period 2003-2004 saw some improvements in aircraft and spacecraft exports. This section examines the growth trends in high tech and medium-high tech manufactured exports, and their shares in overall exports.

In 2003-2004 radio, television and telecommunications equipment contributed most to high tech manufactured exports followed by office, accounting and computing machinery and medical, precision and optical instruments **(Figure 7.1)**. All high tech sub-sectors experienced nominal growth over the period 2003-2004 except for pharmaceuticals which remained the same.

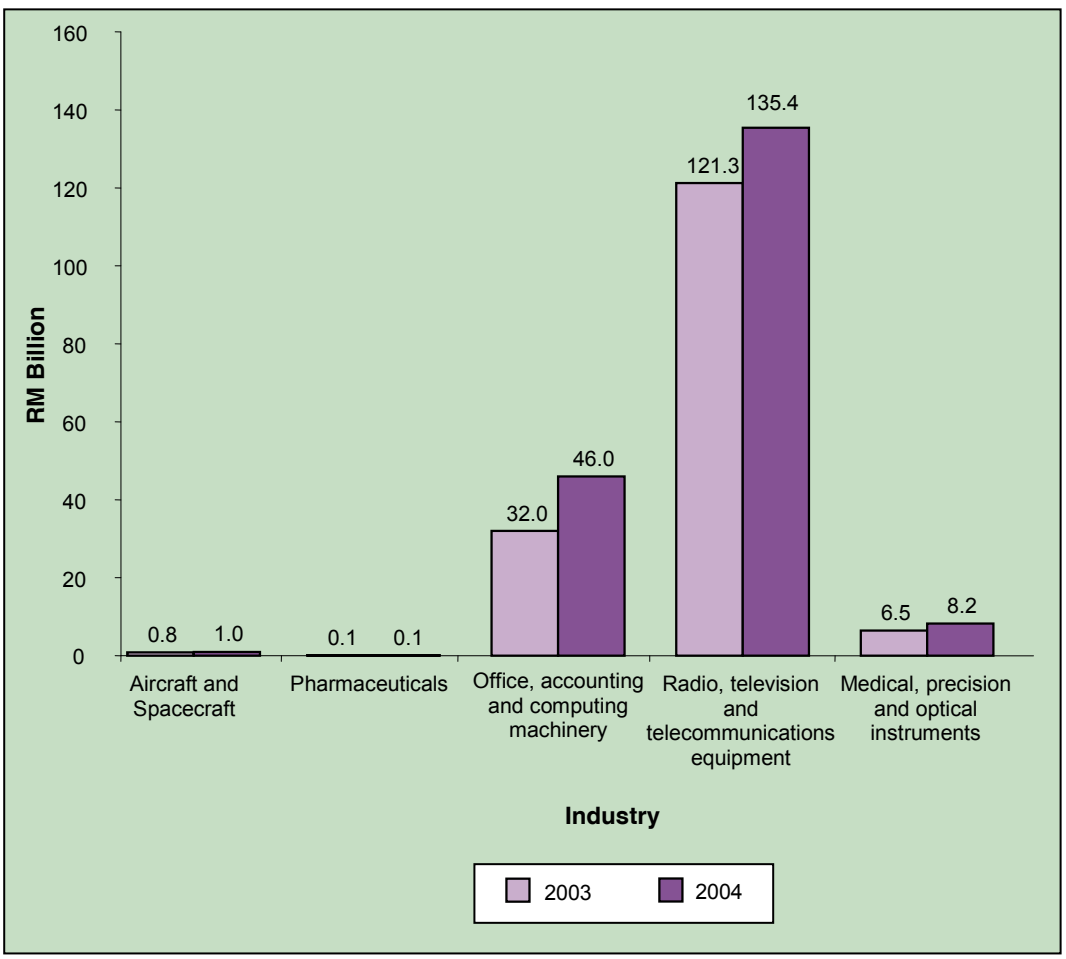
Motor vehicles, trailers and semi-trailers contributed most to medium-high tech manufacturing exports followed by electrical machinery and apparatus, chemicals, railroad and transport

equipment, and machinery and equipment in 2003-2004 **(Figure 7.2)**. All the sub-sectors enjoyed nominal growth in the period 2003-2004.

The manufactured export structure of Malaysia is still dominated by high tech goods rising marginally in share from 55.9 to 56.1 percent in 2003-2004 **(Figure 7.3)**. The contribution of medium-high tech manufactured goods was extremely small rising slightly from 1.4 to 1.6 percent in the same period.

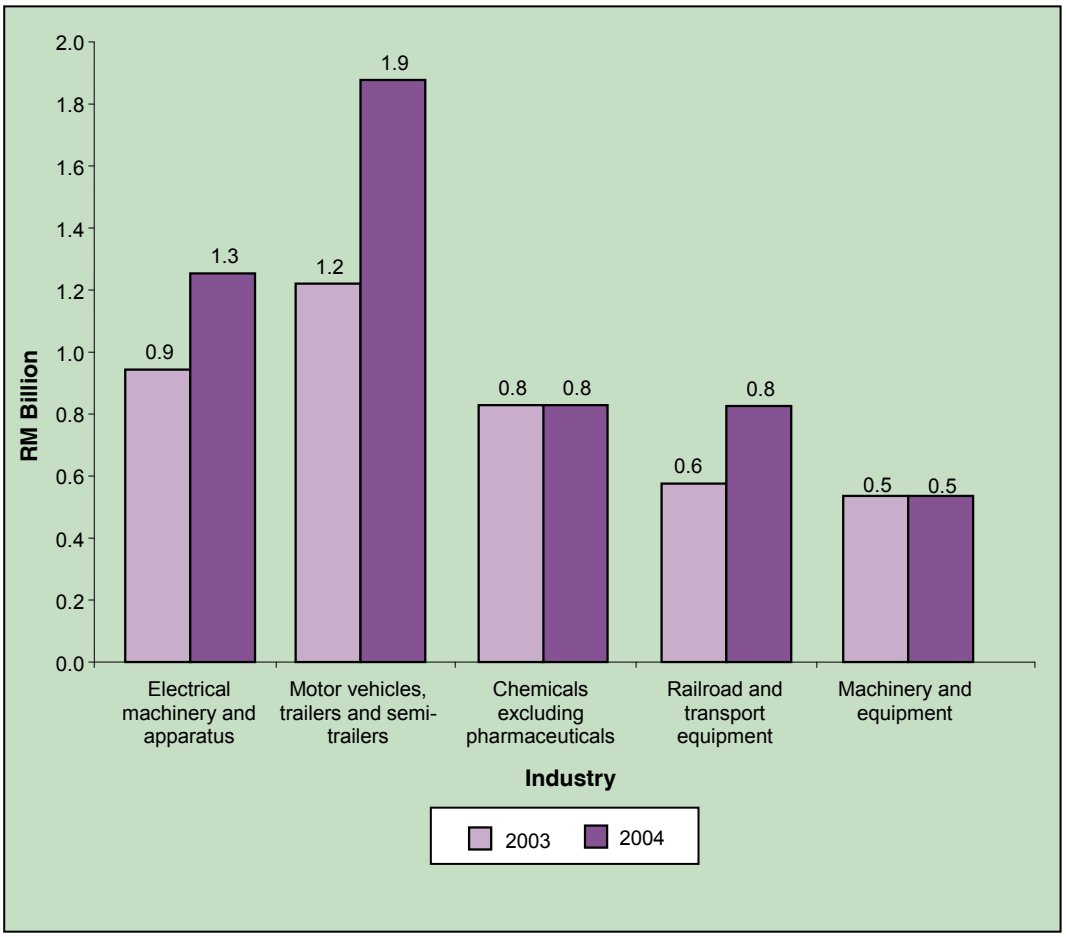
Slight increase in share of high-tech and medium-high tech goods in Malaysia's manufactured exports structure in 2003-2004.

Figure 7.1: High Tech Manufactured Exports, 2003-2004



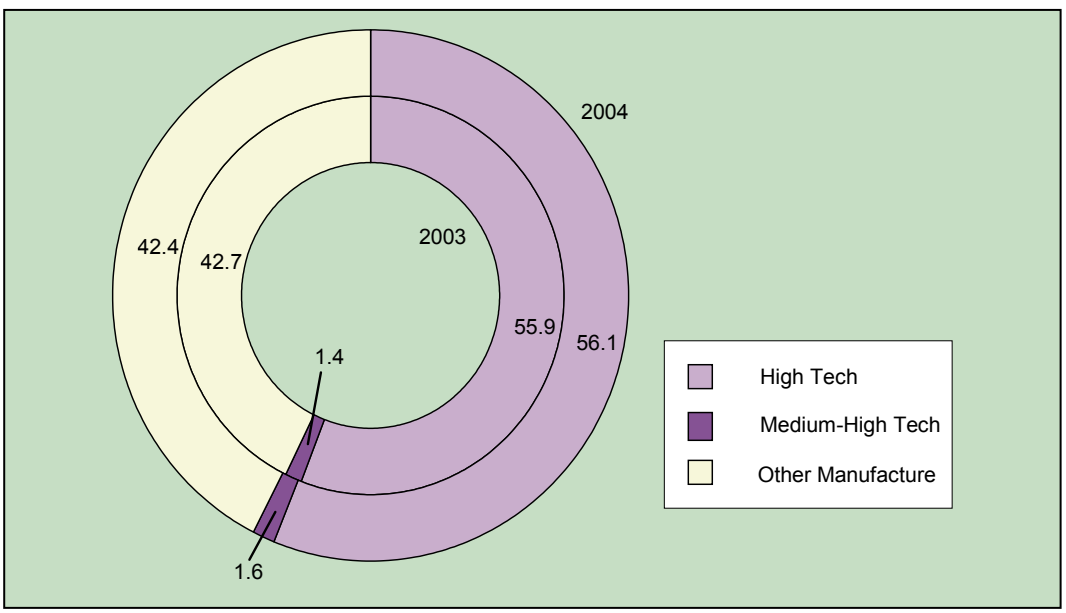
Source: Department of Statistics Malaysia

Figure 7.2: Medium High Tech Manufactured Exports, 2003-2004



Source: Department of Statistics Malaysia

Figure 7.3: Structure of Manufactured Exports, 2003-2004



Source: Department of Statistics Malaysia

7.2.2 Manufactured Imports

Share of high-tech goods in manufactured imports declined, while that of medium-high tech goods rose slightly in 2003-2004.

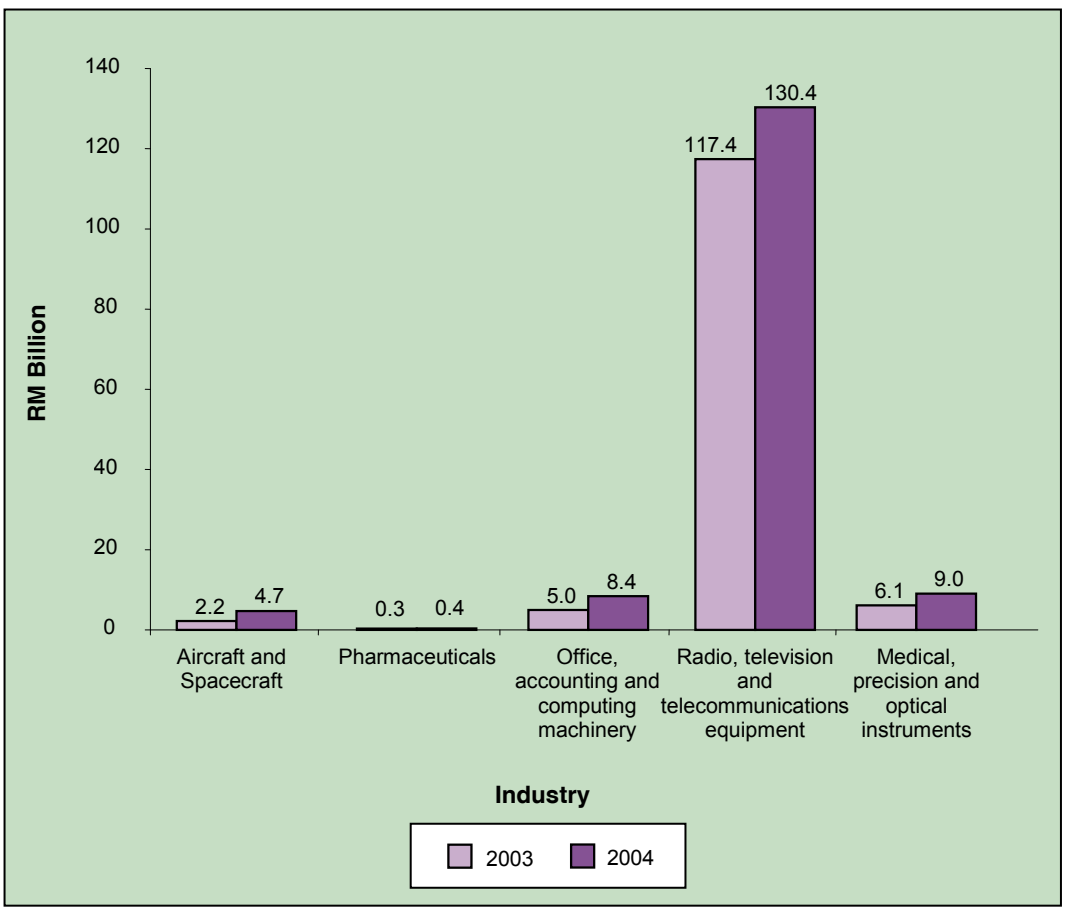
This section presents data on high and medium-high tech manufactured imports. Like exports, imports of high and medium-high tech imports rose in the period 2003-2004.

Imports of high tech manufactured goods was dominated by radio, television and telecommunications equipment followed by medical, precision and optimal instruments, office, accounting an computing machinery, aircraft and spacecraft and pharmaceuticals**(Figure 7.4)**. All high tech manufactured imports enjoyed nominal growth in 2003-2004.

Motor vehicles, trailers and semi-trailers was the prime medium-high tech manufacturing import in 2003-2004 followed by machinery and equipment, chemicals (excluding pharmaceuticals), railroad and transport equipment and electrical machinery and apparatus. **(Figure 7.5)**. All medium-high tech manufactured imports also experienced nominal growth in 2003-2004.

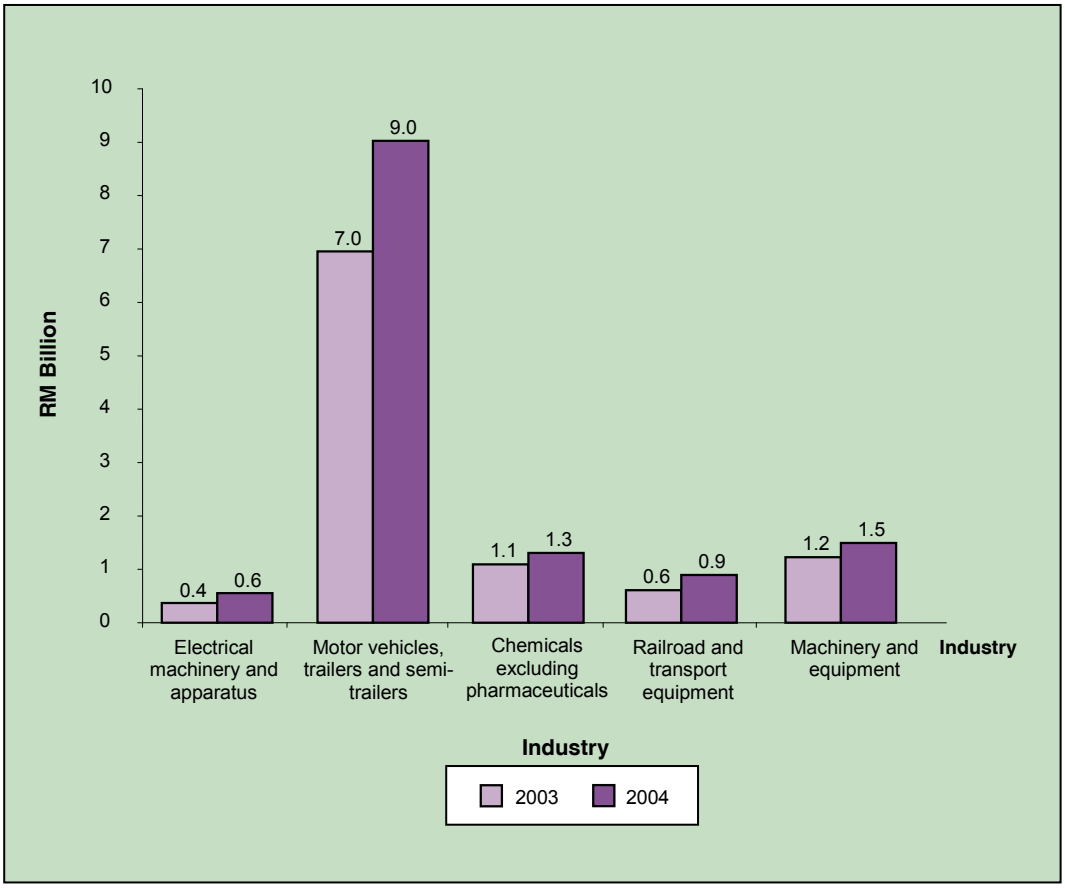
High tech goods accounted for over half of manufactured imports with the share falling from 53.7 to 51.0 percent in 2003-2004 **(Figure 7.6)**. The share of medium-high tech imports rose from 4.2 to 4.4 percent over the same period.

Figure 7.4: High Tech Manufactured Imports, 2003-2004



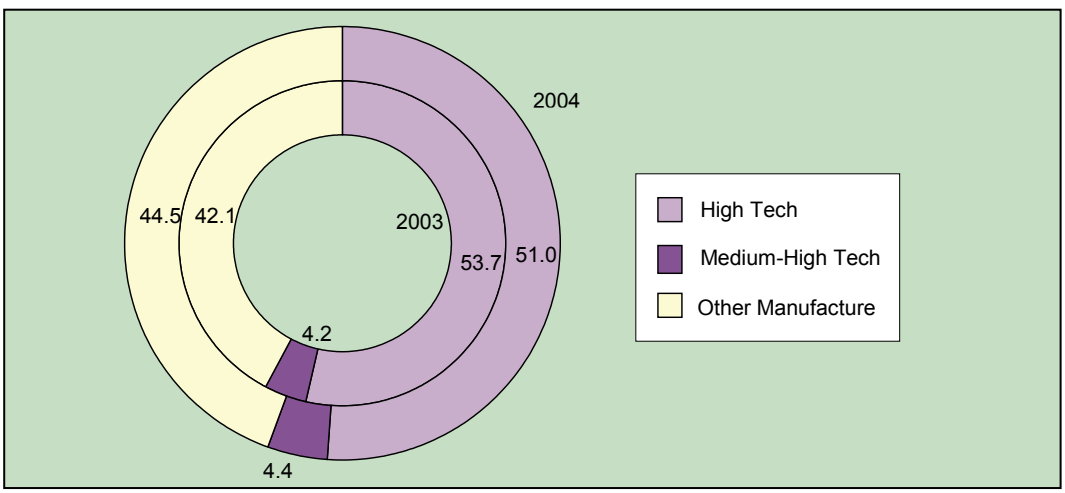
Source: Department of Statistics Malaysia

Figure 7.5: Medium High Tech Manufactured Imports, 2003-2004



Source: Department of Statistics Malaysia

Figure 7.6: Structure of Manufactured Imports, 2003-2004



Source: Department of Statistics Malaysia

7.2.3 Manufacturing Trade Balance

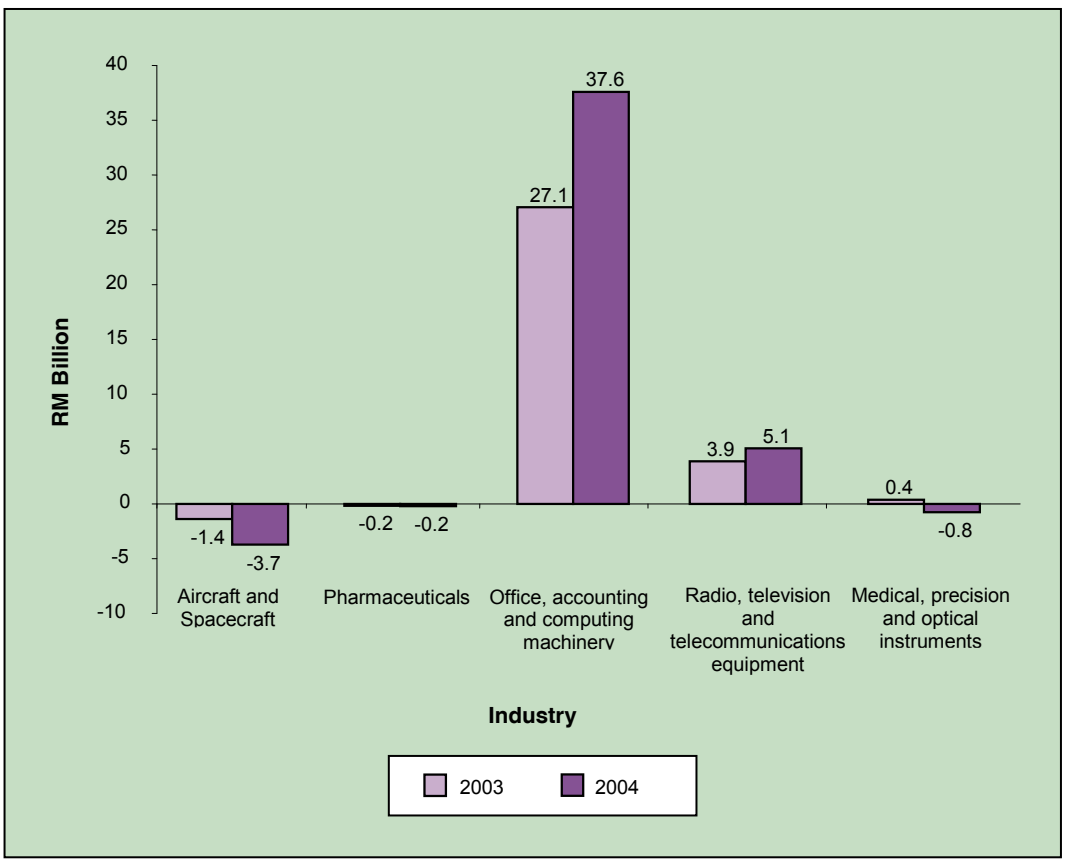
Whilst the trade balance (derived by deducting imports from exports) of the key high tech exports was positive that of the key medium-high tech industries was negative in the period 2003-2004. Unlike large economies with strong domestic demand, manufactured trade in Malaysia has been characterized by few domestic linkages.

Office, accounting and computing machinery enjoyed the highest positive trade balance among the high tech manufacturing industries with the nominal surplus growing significantly from 2003 to 2004 **(Figure 7.7)**. Radio, television and telecommunications equipment recorded the second highest trade balance with the nominal surplus also growing strongly in 2003-2004. However, the trade balance of aircraft and spacecraft and pharmaceuticals was not only negative but the nominal balance got worse in 2003-2004. Medical, precision and optical instruments recorded a negative trade balance in 2004 from a positive balance in 2003.

Positive trade balance achieved by high tech goods while medium-high tech goods recorded negative and worsening balance during 2003-2004

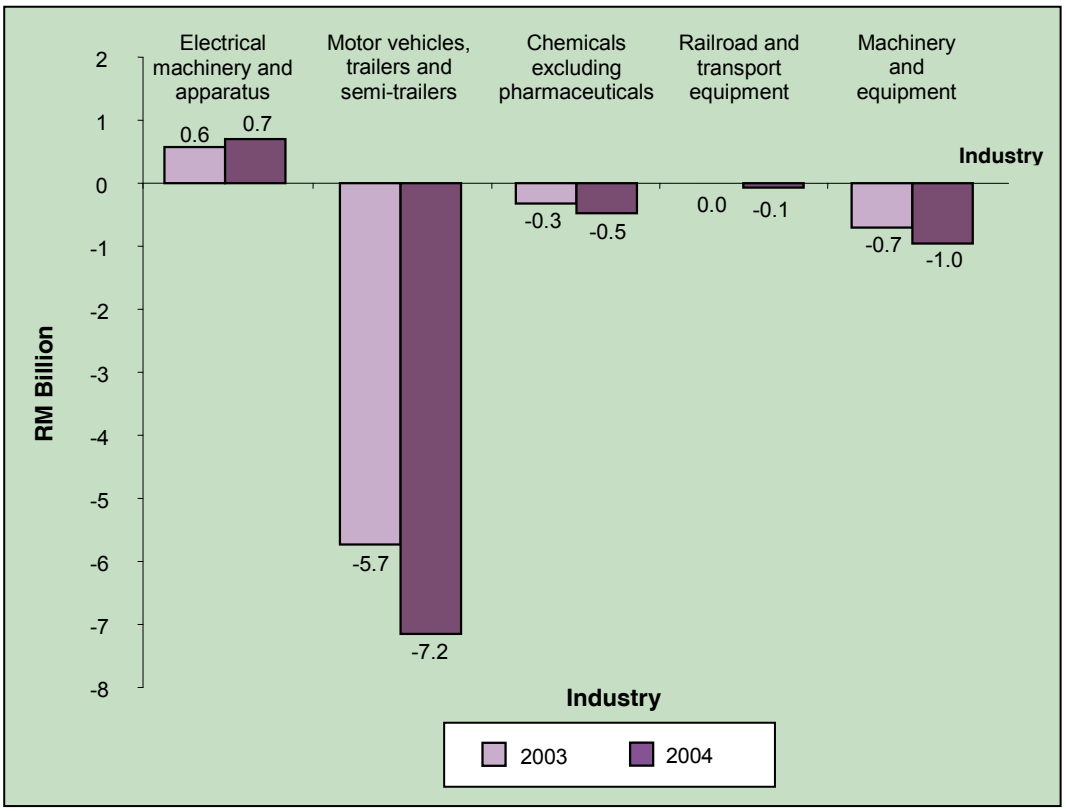
Electrical machinery and apparatus recorded the only positive trade balance among the medium-high tech manufactured goods in 2003-2004 **(Figure 7.8)**. The nominal surplus of this industry also rose in 2003-2004. However, the trade balance of all other medium-high tech manufacturing industries was negative with the nominal values worsening in 2003-2004. A key feature to note here is that Malaysia is still strongly dependent on automobile imports as the trade deficit involving the motor vehicles, trailers and semi-trailer industry was high and worsened nominally from -RM5.7 billion in 2003 to -RM7.5 billion in 2004.

Figure 7.7: High Tech Manufacturing Trade Balance, 2003-2004



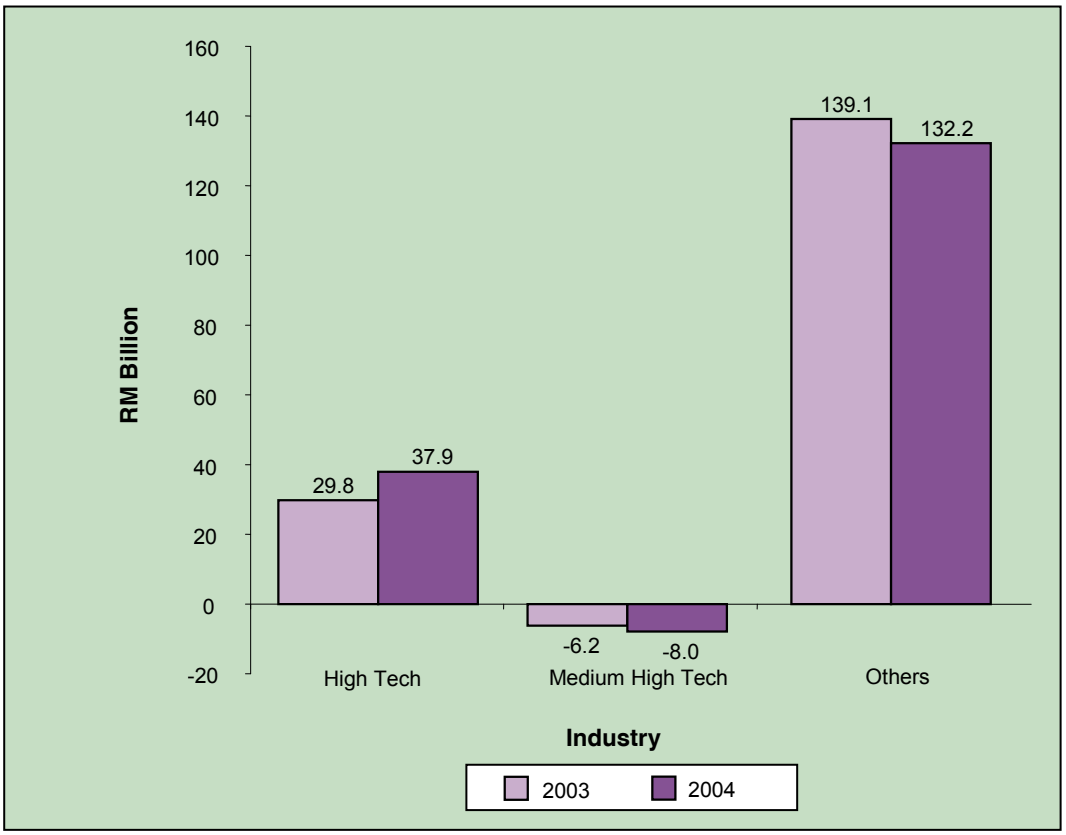
Source: Department of Statistics Malaysia

Figure 7.8: Medium-High Tech Manufacturing Trade Balance, 2003-2004



Source: Department of Statistics Malaysia

Figure 7.9: Structure of Overall Trade Balance, 2003-2004



Source: Department of Statistics Malaysia

7.3 TRADE IN SERVICES

In the absence of data compiled along the OECD Technology Balance of Payments (TBP) manual, this section relies on transaction information on royalties, contract and professional charges, and construction and engineering fees across national borders supplied by Bank Negara Malaysia.

7.3.1 Payments and Receipts

Deficits in the royalty account grew further in 2002-2004. Although receipts grew during the period, the deficit widened because of faster growth in payments

Royalty payments abroad made by Malaysian residents in the period 1999-2004 fell in 2002 but rose sharply again in 2003-2004 (see **Figure 7.10**). Because receipts collected from abroad by residents in Malaysia only grew slightly over the same period, the balance of payments in the royalty account improved only in 2002 worsening in the subsequent years. An important point to note is that receipts from abroad remained extremely low demonstrating that little innovations in the country are occurring at the technology frontier.

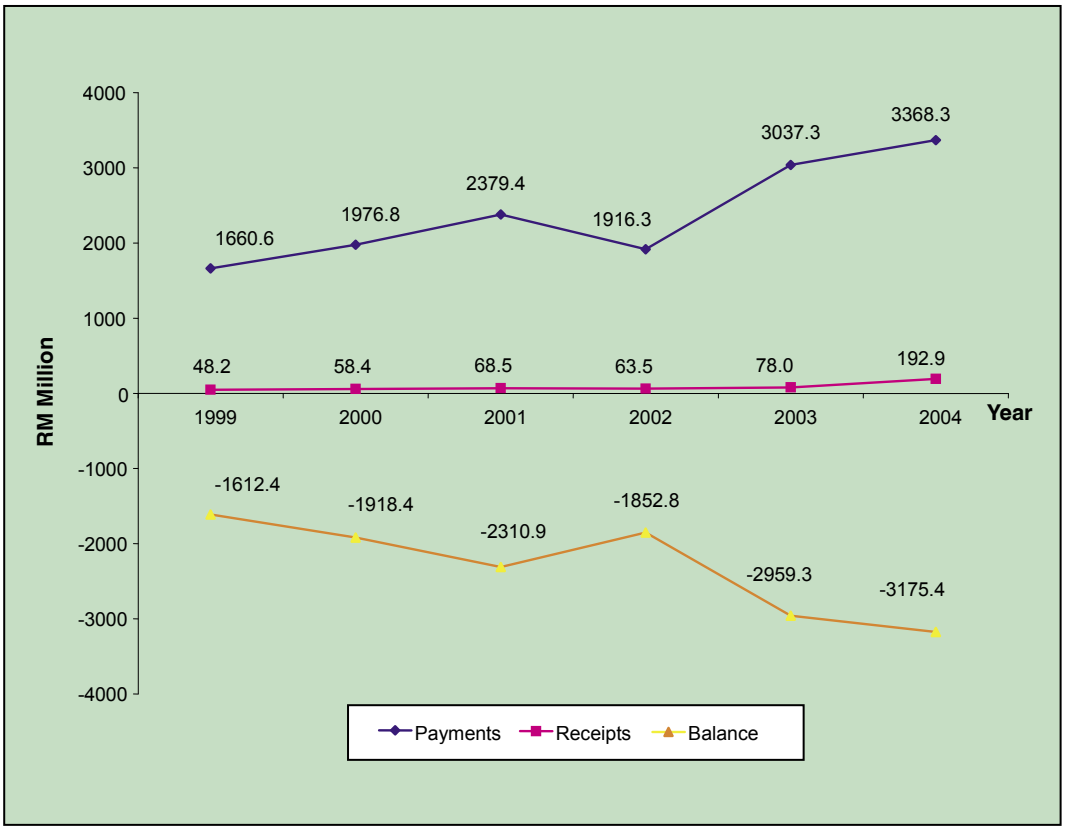
Charges incurred and collected on contract and professional fees fared differently. Payments rose steadily over the period 1999-2004 except for 2002-2003 when it recorded a big jump **(Figure 7.11)**. Receipts collected rose gradually over the same period except for 2001-2002 when it fell slightly. The overall balance fell in 2001-2003 before showing an improvement in 2004.

The prime source of improvement in the services account came from construction and engineering. The receipts received from this account grew significantly faster than the payments in 2003-2004.

Construction and engineering payments fell in the period 1999-2002 **(Figure 7.12)**. Although payments rose in 2003 it fell again in 2004. Indeed, the most significant improvement in the services account was recorded in construction and engineering fees. Following a slight worsening in 1999-2001, receipts have steadily risen since 2001 with the figures growing more rapidly towards 2004. With the exception of 2003 these developments translated in a rise in the construction and engineering balance over the period 1999-2004.

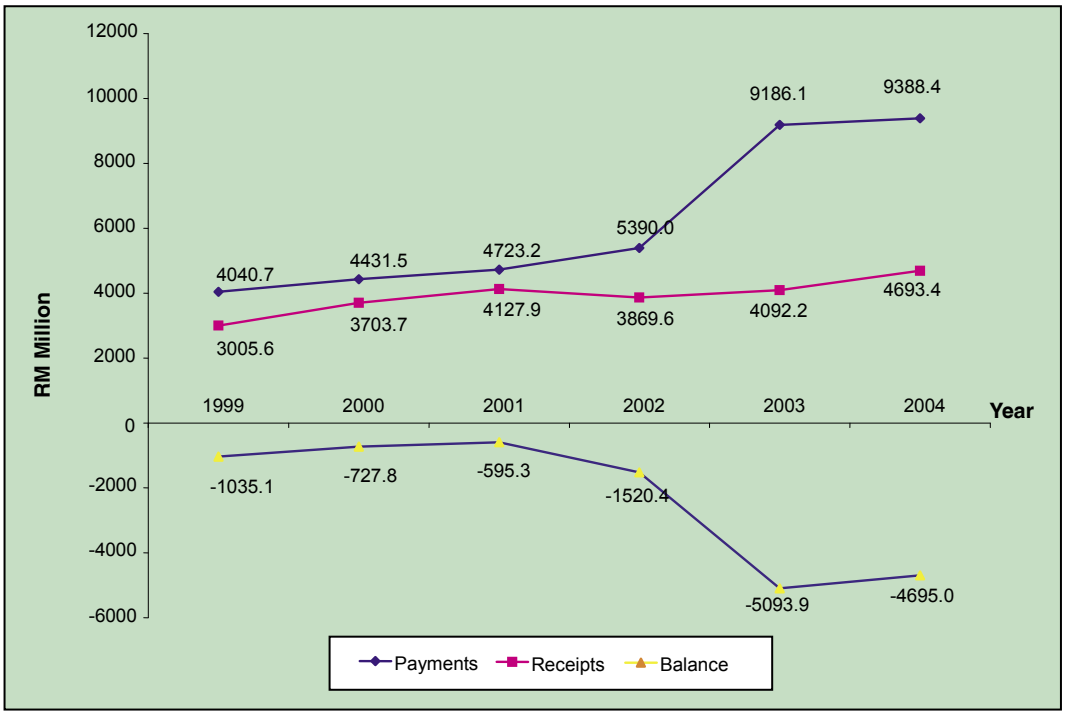
The overall trade in service account showed improvements in payments in the period 1999-2002 before rising sharply in 2003 **(Figure 7.13)**. Except for 2001, receipts rose over the period 1999-2004. Apart from a sharp fall in 2003 the overall trade in services balance improved in the rest of 1999-2004. The composition of construction and engineering in the overall payment account of trade in services fell sharply over the period 1999-2004 **(Figure 7.14)**.Contract and professional charges in the payment account continued to rise in this period. Contract and professional fees accounted for the biggest share of receipts in the trade in services account though the composition of construction and engineering fees has risen steadily since 2001 in the face of a falling share in the former **(Figure 7.15)**. Royalty receipts remained extremely small in the trade in services account throughout 1999-2004.

Figure 7.10: Total Royalty Payments, Receipts and Balance, Malaysia



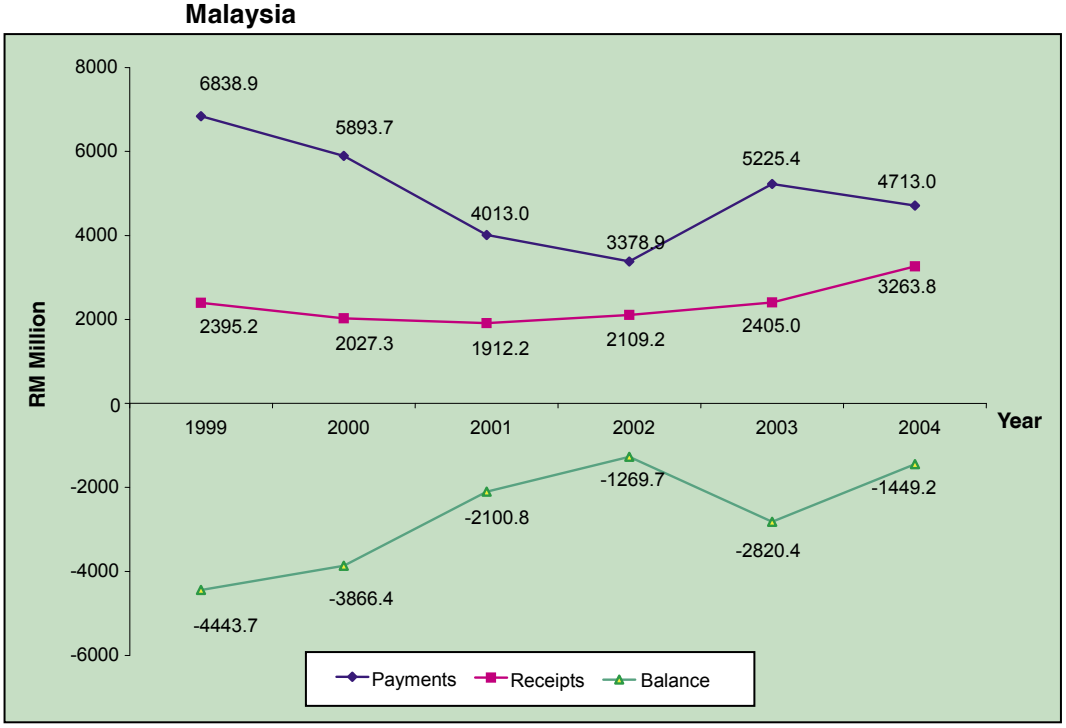
Source: Bank Negara Malaysia

Figure 7.11: Total Contracts and Professional Fee Payments, Receipts and Balance, Malaysia



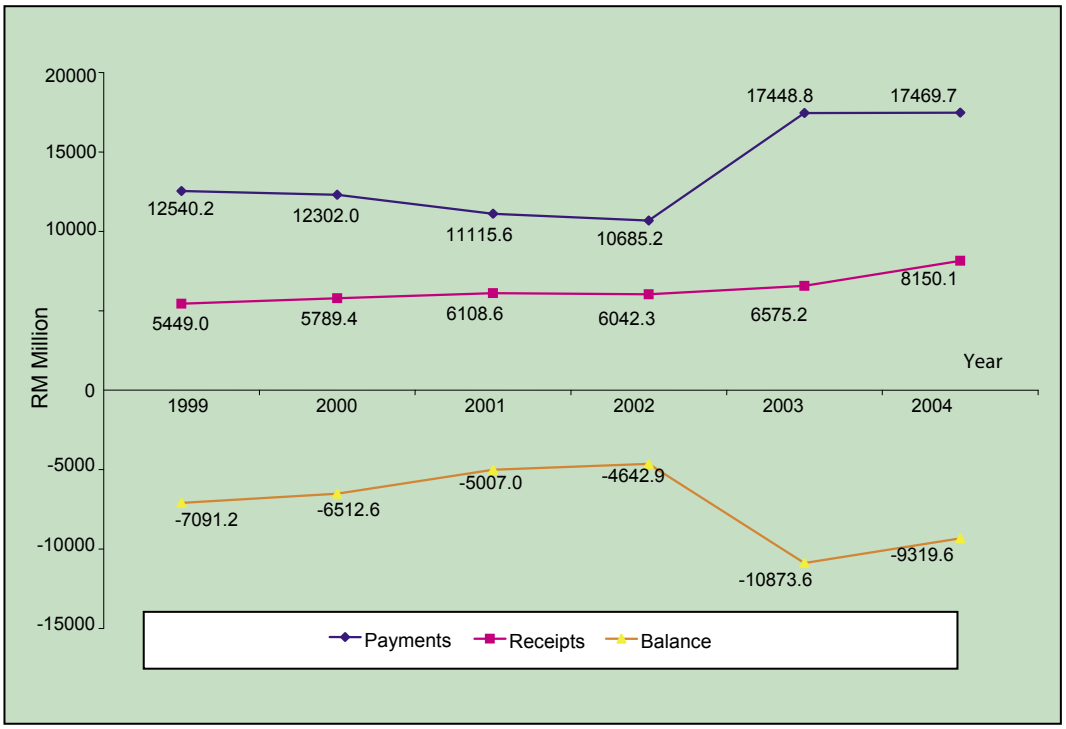
Source: Bank Negara Malaysia

Figure 7.12: Construction and Engineering Payments , Receipts and Balance, Malaysia



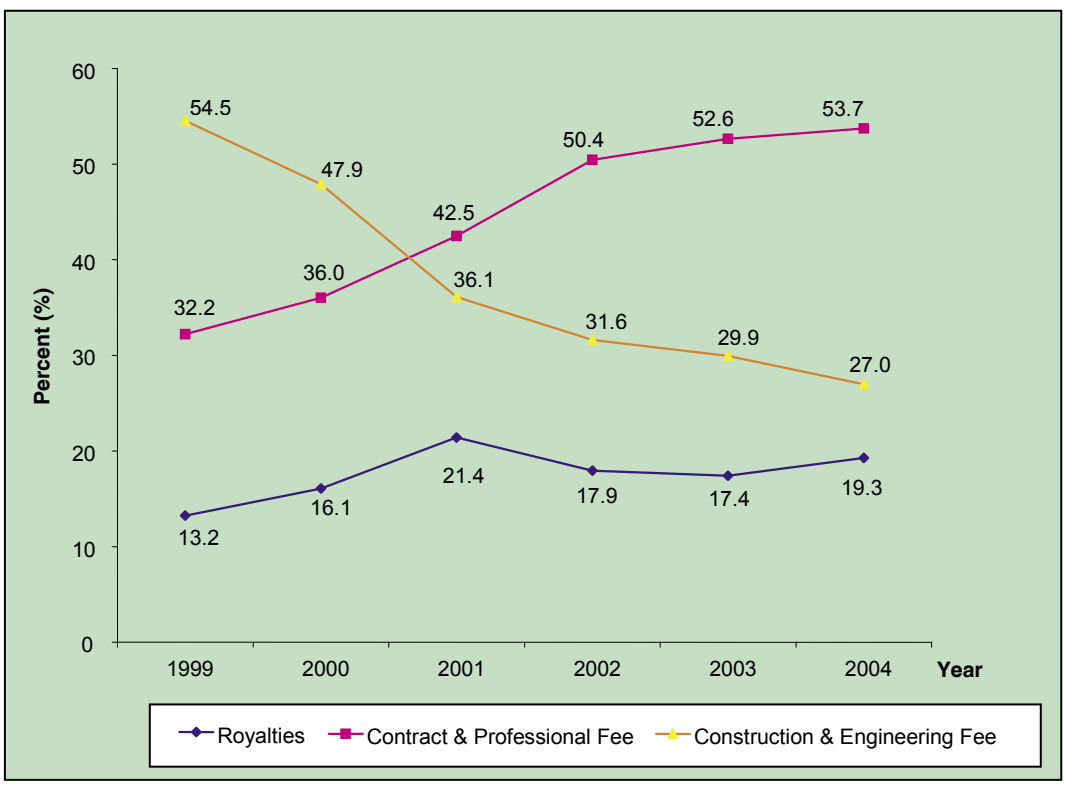
Source: Bank Negara Malaysia

Figure 7.13: Total Payments, Receipts and Balance in Trade in Services, Malaysia



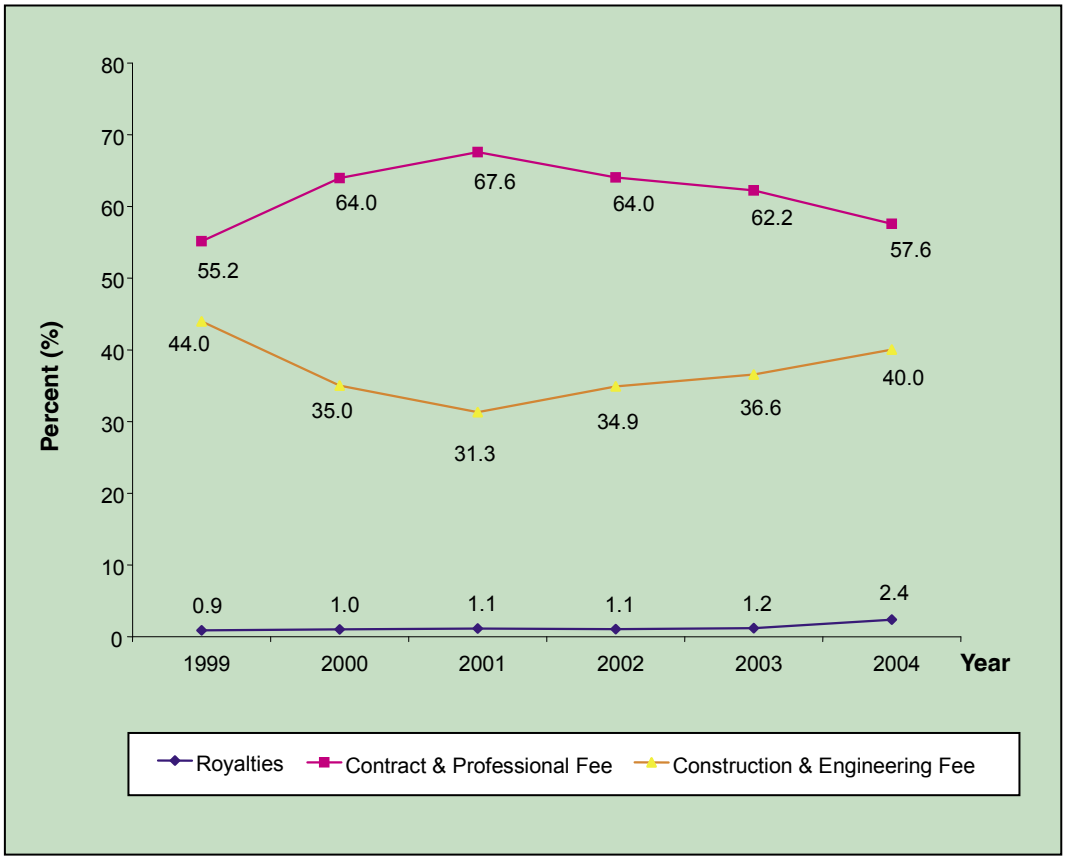
Source: Bank Negara Malaysia

Figure 7.14: Composition of Payments in Services Trade, Malaysia



Source: Bank Negara Malaysia

Figure 7.15: Composition of Receipts in Services Trade, Malaysia



Source: Bank Negara Malaysia

7.3.2 Main Contributors to Payments and Receipts

This section presents the royalty, contract and professional charges, and construction and engineering fee payments, receipts and balances by the leading contributors.

7.3.2.1 Royalties

The United States remained the largest recipient of royalty payments from Malaysia over the period 1999-2004 but the share in the total has started falling since 2002 **(Figure 7.16)**. Japan, the United Kingdom and Singapore remained important payment destinations over this period. The others category has particularly expanded since 2002 with increasing flows to Hong Kong, Korea and Germany.

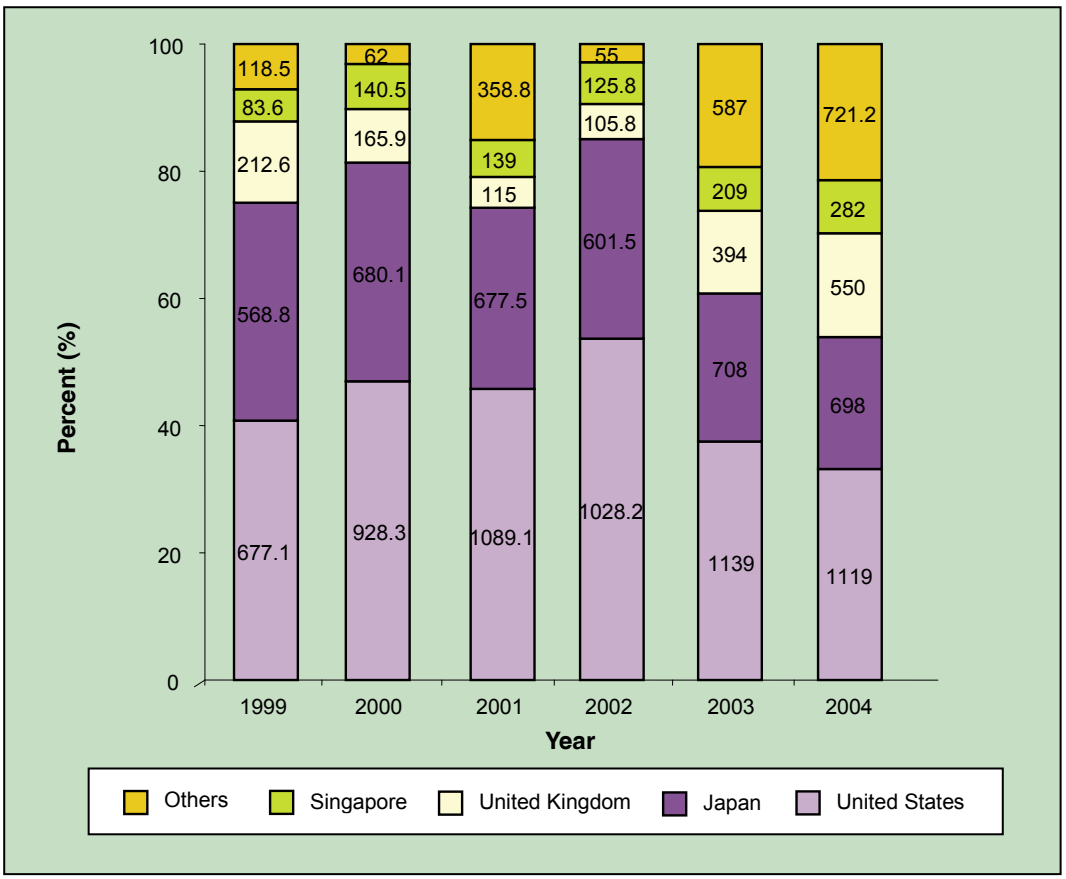
As noted earlier, royalty receipts received by Malaysia have been extremely low. The United States contributed most to the royalty receipts exceeding 30 percent in 1999-2003 **(Figure 7.17)**. The share from United States has fallen since 2001 dipping below 10 percent in 2004. The Japanese share, which was second highest in 2000, has fallen since to dip below 1 percent in 2004. The share from United Kingdom rose strongly in 2004. The others category has expanded sharply throughout the period 1999-2004 to become the leading contributor in 2004. Hong Kong has become a major contributor of receipts to Malaysia accounting for 28.9 percent of total receipts received in 2004.

The trade deficit involving royalties with Malaysia remained highest with the United States exceeding over 50 percent in 2002 **(Figure 7.18)**. Although the United States' percentage share has fallen since 2002 the absolute figures worsened in 2003 and only fell marginally in 2004. The royalty deficit trend appeared similar with Japan while with United Kingdom has risen since 2000. The royalty deficit with Singapore has risen since 2002. These results obviously show not only that payments on royalties (for copyrights, patents, industrial designs and other intellectual properties) have continued to dwarf receipts received but also that the trends against the leading trading partners have not improved significantly.

Deficits in the royalty account grew further in 2002-2004 because of faster growth in payments. The royalty balance involving the main trading partners worsened in 2002-2004 despite some improvements from 2003.

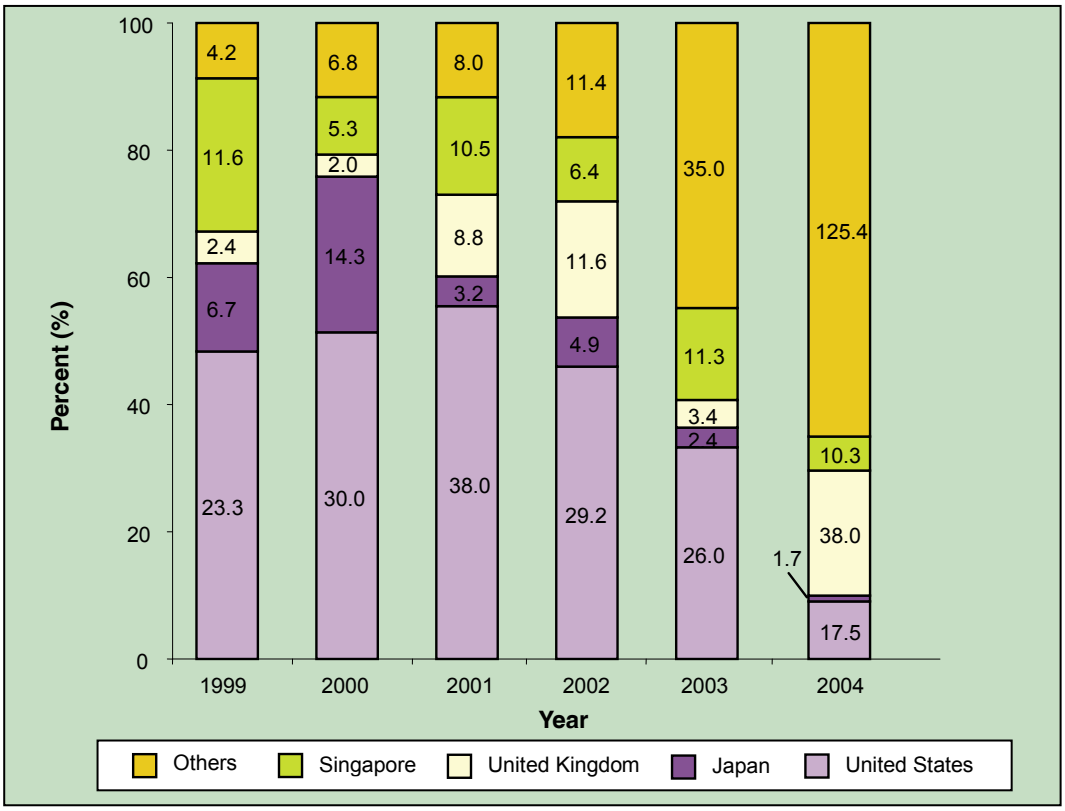
The evidence in this section simply shows that Malaysia is still highly dependent on foreign technology demonstrating that much of the innovations taking place in the manufacturing sector in the country are not new to the universe.

Figure 7.16 Royalty Payments (RM Million), Malaysia (1999-2004)



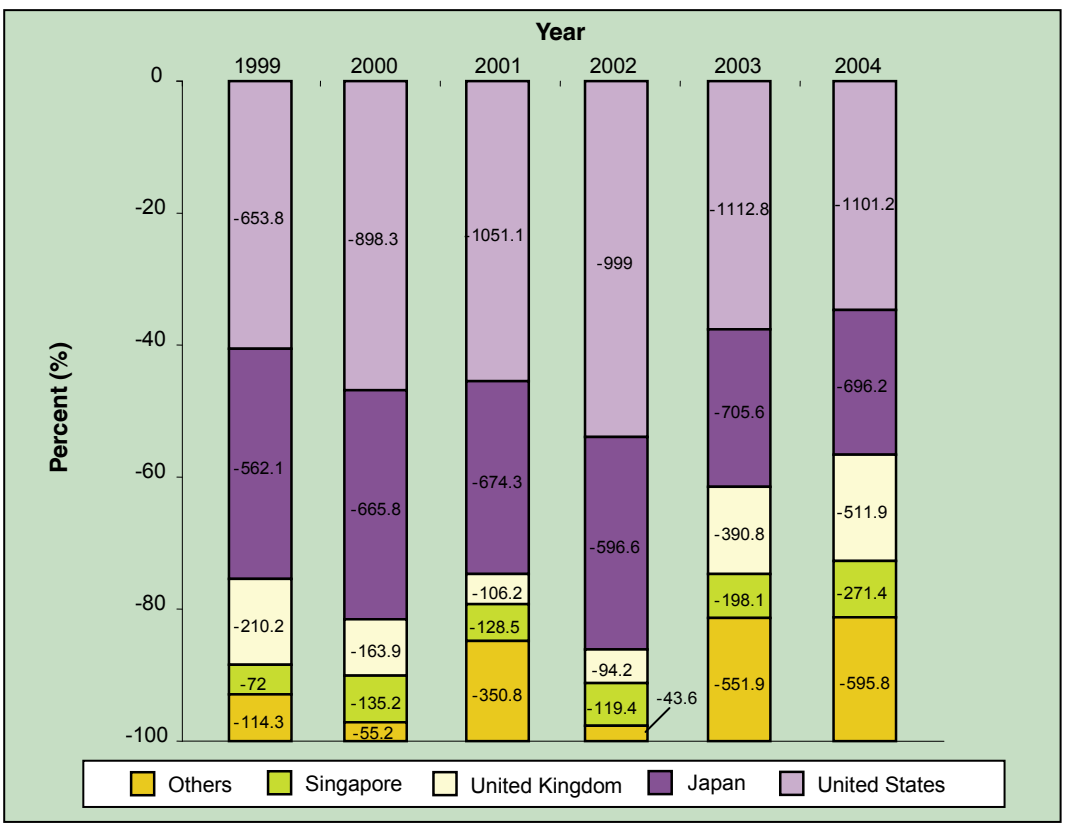
Source: Bank Negara Malaysia

Figure 7.17: Royalty Receipts (RM Million), Malaysia (1999-2004)



Source: Bank Negara Malaysia

Figure 7.18: Royalty Balance of Payments (RM Million), Malaysia (1999-2004)



Source: Bank Negara Malaysia

7.3.2.2 Contract and Professional Charges

Overall, there has been an increase in the deficit in the contract and professional charges account during the period 2003-2004 where the others category - with Australia as the main contributor – accounted for over 40 percent of the deficit professional and contract charges

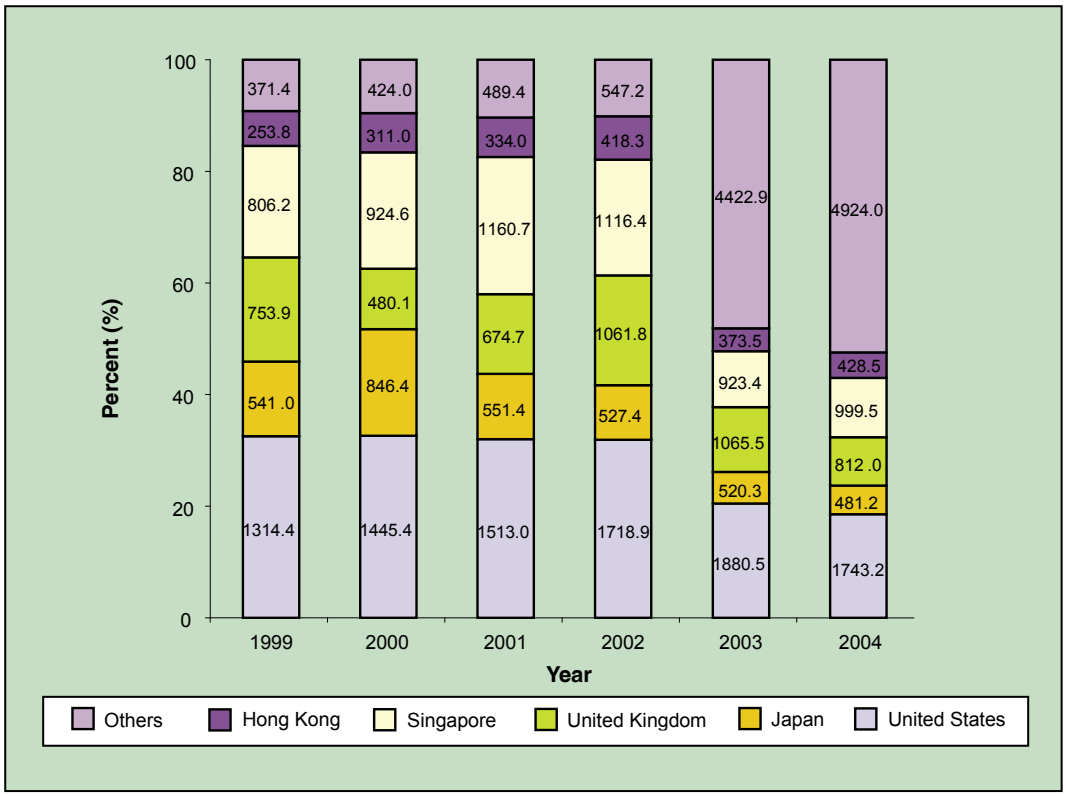
The United States remained the biggest recipient of contract and professional payments over the period 1999-2004, though its share in the total has fallen since 2002 (see **Figure 7.19**). Japan was the second biggest recipient in 2000 but the figures have contracted sharply between the years 2000 and 2004 to occupy fourth place behind United Kingdom and Singapore. Hong Kong was the next biggest recipient. The share of the others category has risen sharply to become the biggest in 2003-2004.

Receipts from contracts and professional fees to Malaysia were more substantial than royalties. The United States was the biggest contributor accounting for over the 45 percent of the receipts in 2000-2002 **(Figure 7.20)**. Both the absolute and relative shares have fallen since to dip below 20 percent in 2004. Hong Kong has been the second largest provider in 1999-2003 overtaking the United States in 2004. The United Kingdom and Singapore were the next important contributors. The others category accounted for most of the receipts recorded in Malaysia in 2003-2004.

The larger receipts received from contracts and professional fees compared to royalty receipts helped keep the deficits in the trade balance low, though there was a sharp rise in 2003-2004. The United Kingdom accounted for the biggest deficit faced by Malaysia in contract and professional fee account in 1999 and 2002-2003 **(Figure 7.21)**. Japan accounted for the biggest deficit in 2000. The United States accounted for the highest Malaysian deficit in 2004, but provided Malaysia with a positive balance in 2000-2002. Malaysia also enjoyed a positive balance with Hong Kong in 1999. The others category exploded to record over 40 percent of the deficit in 2003-2004 which was accounted by several economies expanding their share of contract and professional trade with Malaysia. Australia emerged as the biggest in this category accounting for 13.2 and 11.8 percent respectively of the Malaysian deficit in 2003 and 2004.

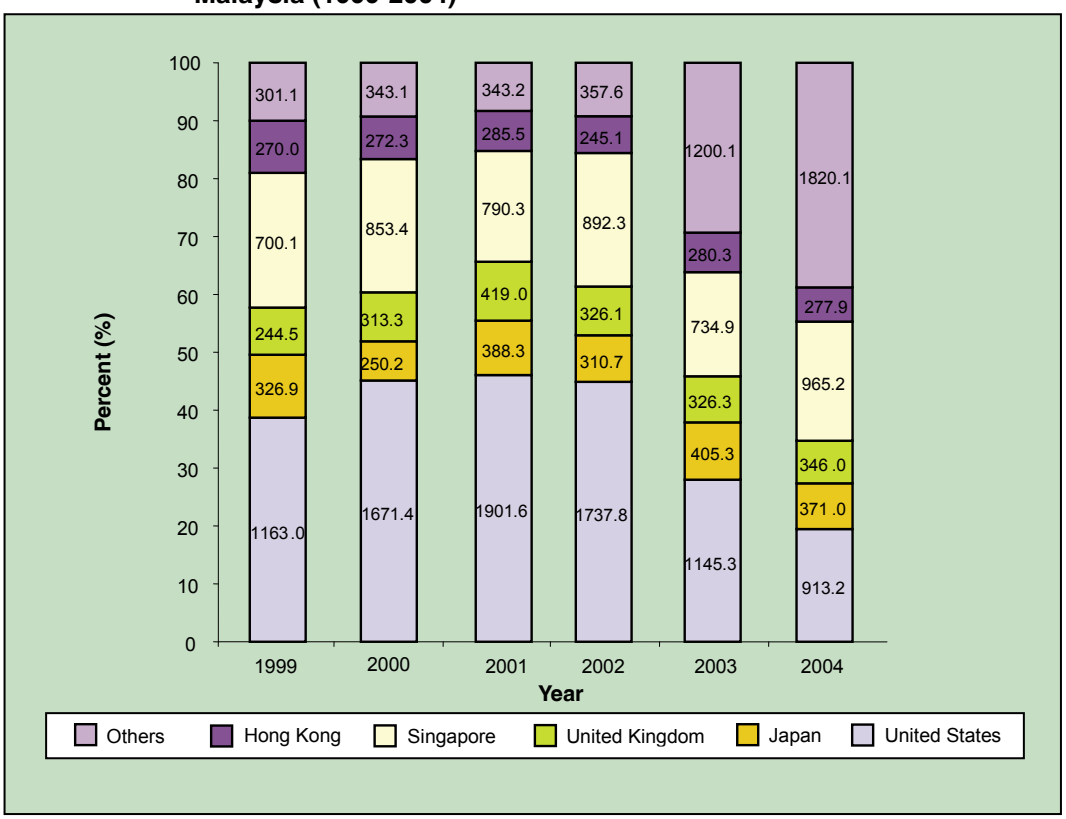
Overall, it can be seen that Malaysia has performed better in contract and professional fees than the royalty trade accounts, though the deficit has risen sharply in 2003-2004. However, Malaysia's positive trade balance with the United States over 2000-2002 fell into deficit in 2003-2004. There has also been considerable diversification in the trading partners in the contract and professional services market.

Figure 7.19: Contracts and Professional Fee Payments (RM Million), Malaysia (1999-2004)



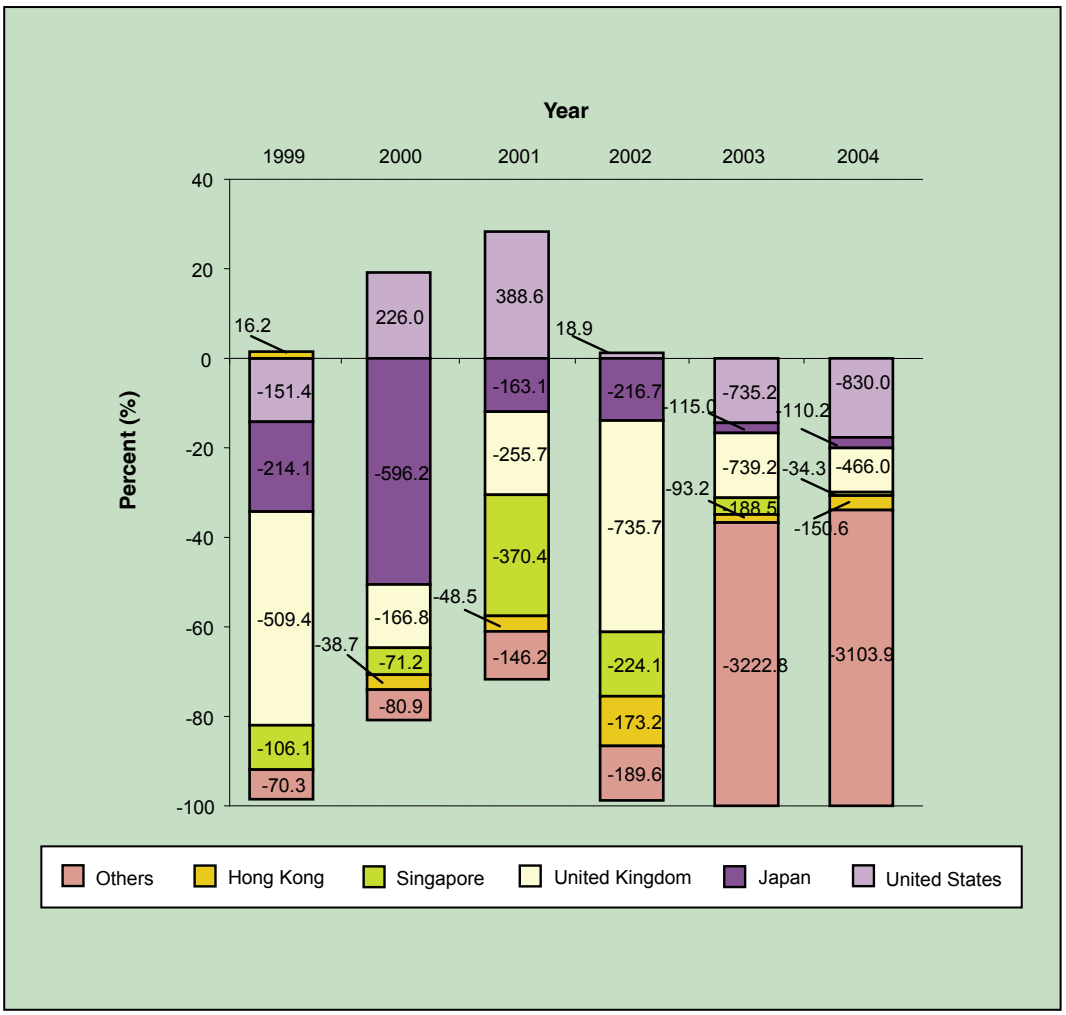
Source: Bank Negara Malaysia

Figure 7.20: Contracts and Professional Fee Receipts (RM Million), Malaysia (1999-2004)



Source: Bank Negara Malaysia

Figure 7.21: Contracts and Professional Fee Balance of Payments (RM Million), Malaysia (1999-2004)



Source: Bank Negara Malaysia

7.3.2.3 Construction and Engineering Fees

Japan has been the biggest recipient of construction and engineering payments from Malaysia over the period 1999-2004 (see **Figure 7.22**). Apart from 2001, the next highest recipient of payments from Malaysia was the United States. The United Kingdom was third highest recipient in 1999 and 2003-2004. Singapore occupied third place in 2000 and 2002, second place in 2001 and fourth place in 2003-2004. Germany was third in 1999. The others category expanded sharply in 2003-2004 but no single member enjoyed over 4.9 percent of the total share of construction and engineering payments.

The receipts received from construction and engineering grew significantly faster than the payments in 2003-2004. Although this account involving important trading partners worsened between 2002 and 2004, the deficit with Singapore fell considerably and the balance with others had become positive in 2004;

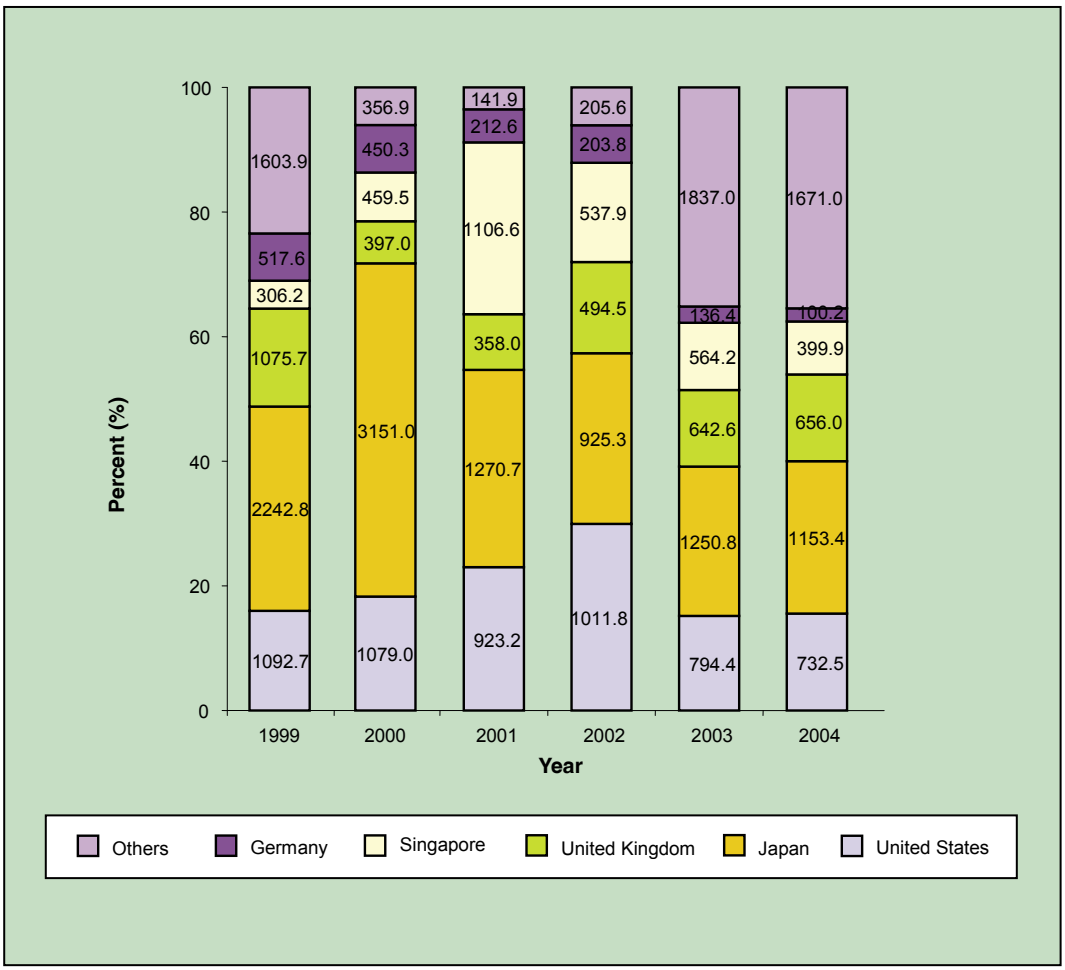
Malaysia has also been receiving significant amount of receipts from construction and engineering over the period 1999-2004 (see **Figure 7.23**). The United States was the largest single contributor in this period but both its absolute and relative shares have fallen in 2002-2004. Singapore was the next highest contributor in 1999-2004, sharing second place with Japan in 2001-2002. United Kingdom and Germany were the next highest contributors. The others category enjoyed a big expansion in 2003-2004 but no single contributor provided more than 4.2 percent of the construction and professional fee receipts.

The higher amount of receipts enjoyed by Malaysians helped keep the overall deficits low. The highest deficit was recorded against Japan over the period 1999-2004 (see **Figure 7.24**). The construction and engineering deficit with Singapore was the next highest in 2001 but has improved considerably in the following years. The percentage share of deficits with Germany has continued to grow over the 1999-2004, but the absolute figure improved in 2004. Malaysia

recorded a positive balance in the others category in 2004. The biggest positive balance in 2004 was recorded with France (RM180 million), Hong Kong (RM81 million) and Myanmar (RM56.9 million).

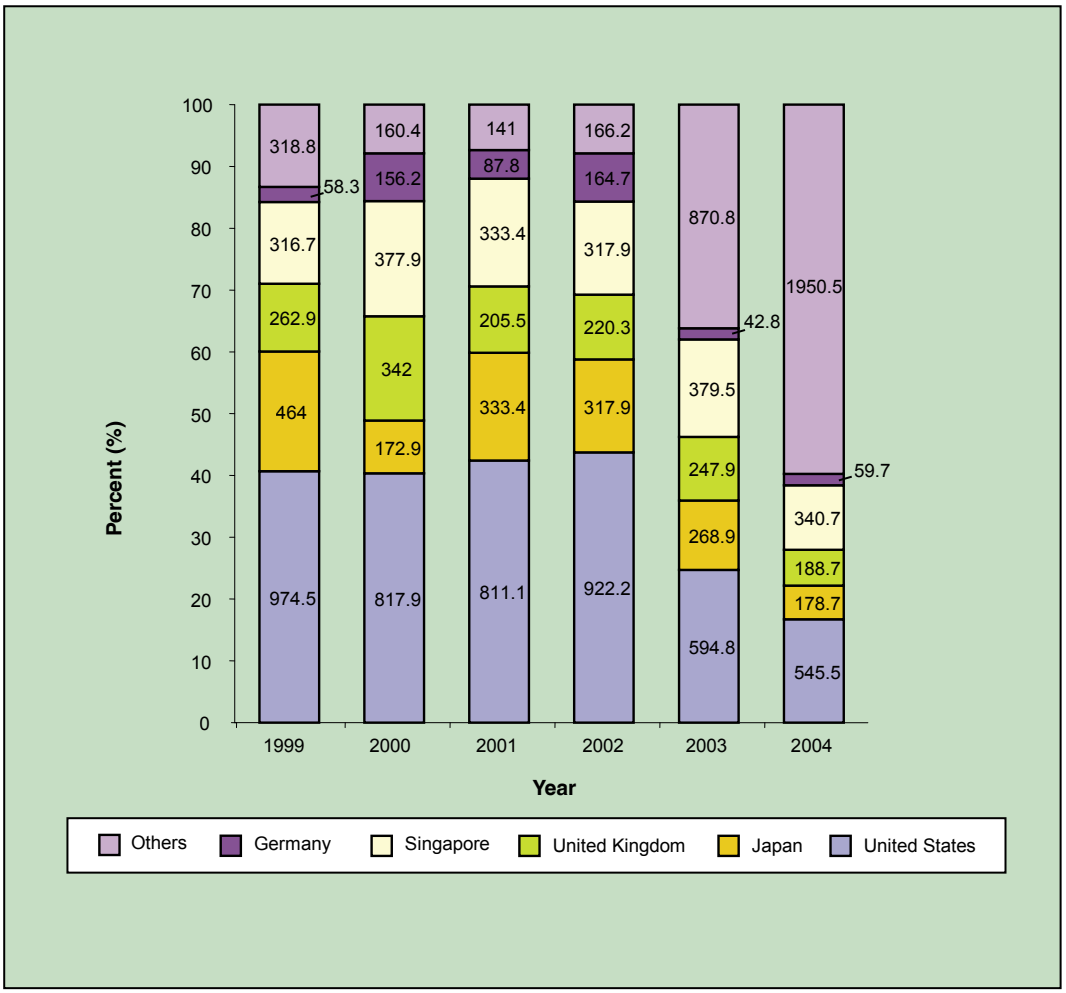
Taken together the construction and engineering trade account has shown significant increase in receipts and a positive balance in the others category in 2004. Interestingly the positive balance was recorded not just in more underdeveloped economies such as Myanmar but also in more developed economies such as France and Hong Kong

Figure 7.22: Construction and Engineering Payments (RM Million), Malaysia (1999-2004)



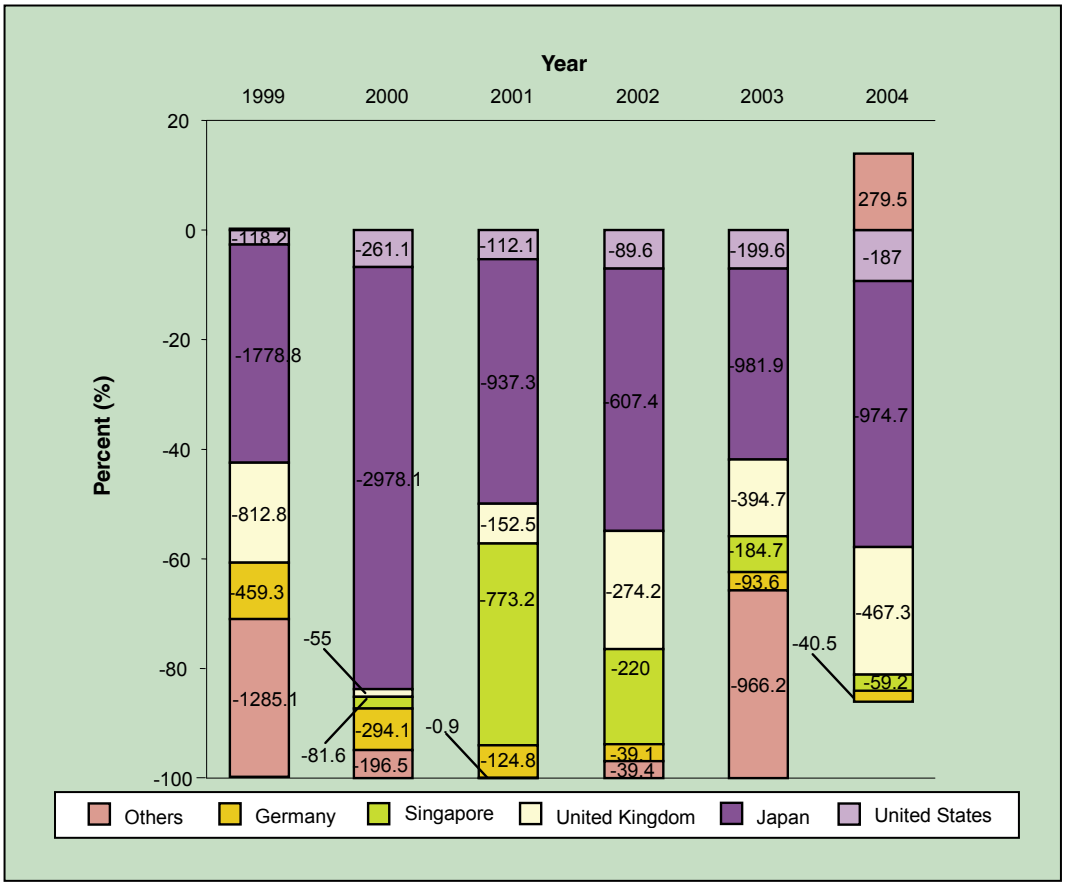
Source: Bank Negara Malaysia

Figure 7.23: Construction and Engineering Receipts (RM Million), Malaysia (1999-2004)



Source: Bank Negara Malaysia

Figure 7.24: Construction and Engineering Balance of Payments (RM Million), Malaysia (1999-2004)



Source: Bank Negara Malaysia

7.4 CONCLUSION

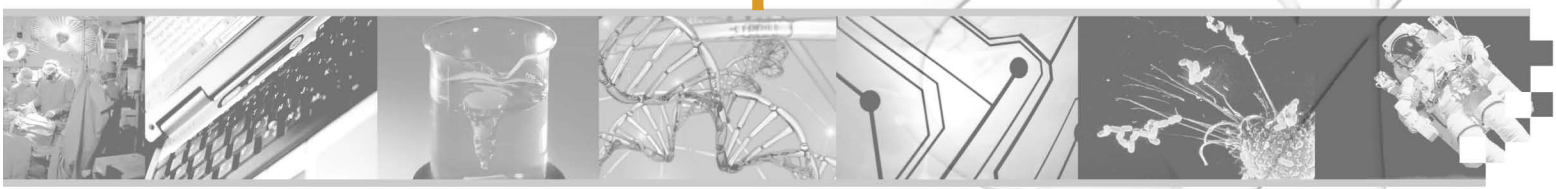
Malaysia's position as a specialized location for export-oriented high tech manufacturing has continued in 2003-2004, albeit much of the production is located in labour-intensive assembly and test activities. The erosion in labour endowments however is not reflected in any slowdown in high tech exports. However, imports have also been high in these industries.

Whereas the trade balance of the key high tech exports was positive that of the key medium-high tech industries was negative in the period 2003-2004. Office, accounting and computing machinery, and radio, television and telecommunication equipment recorded the highest trade surpluses among the high tech manufacturing industries in 2003-2004. Electrical machinery and apparatus recorded the only positive trade balance among the medium-high tech manufactured goods in 2003-2004. However, the trade balance of all other medium-high tech manufacturing industries was negative with the nominal values worsening in 2003-2004. A key feature to note here is that Malaysia is still strongly dependent on automobile imports as the trade deficit involving the motor vehicles, trailers and semi-trailer industry was not only high but continued to worsen in the period 2003-2004.

The trade in services account improved in 2003-2004, though royalty payments continued to remain high against extremely low amounts of receipts received. The prime source of improvement in the services account in 2003-2004 came from construction and engineering. There was greater diversification in the participation of trading partners in contract and professional fee and construction and engineering services.

Despite some improvements it can be seen that the overall picture in the services account has been negative with the deficits remaining high. The high deficits in royalty payments for intellectual property suggests that Malaysia is still a net technological learner typical of economies still located low in the technological ladder.

Chapter 8



PUBLICATIONS AND CITATIONS

8.1 INTRODUCTION

It has been just over two years since the monumental Bibliometric Study of National Science and Technology Knowledge Productivity 2003 was released by MASTIC. The three main objectives of the Study attempted to identify S&T outputs by Malaysian scientists measured by the number of published papers at international levels; to identify strengths and weaknesses of the performances of institutions and individuals in relevant fields of research and to identify the extent of collaboration among institutions and countries.

The findings indicate an urgent need for Malaysia to take steps to increase S&T knowledge outputs so as to achieve better status in world science, as well as fulfill the country's Vision 2020…

(The Bibliometric Study of Science and Technology Knowledge Productivity in Malaysia 2003)

In one of its findings, it was revealed that among ASEAN nations (excluding Singapore), Malaysia lags behind Thailand in S&T international publications and with other Asian countries such as in terms of citations. These indicators for R&D output as measured by the productivity of the researchers and the quality of their publications is a useful barometer to monitor for policy makers as well as funding bodies.

This report on Publications and Citations presents a status-quo view of the contribution of Malaysian scientists and researchers to the intellectual contribution of scientific knowledge for the period 2001-2005 as well as focus on the overall progress since the 2004 Indicators Report. However, caution must be exercised when comparing various international trends as the data and comparisons are weak in the statistical sense.

The Thomson ISI® is the leading database with more than 6000 mainstream journals in the Science Citation Index. It is also the most reliable source for citation counts.

8.2 METHODOLOGY

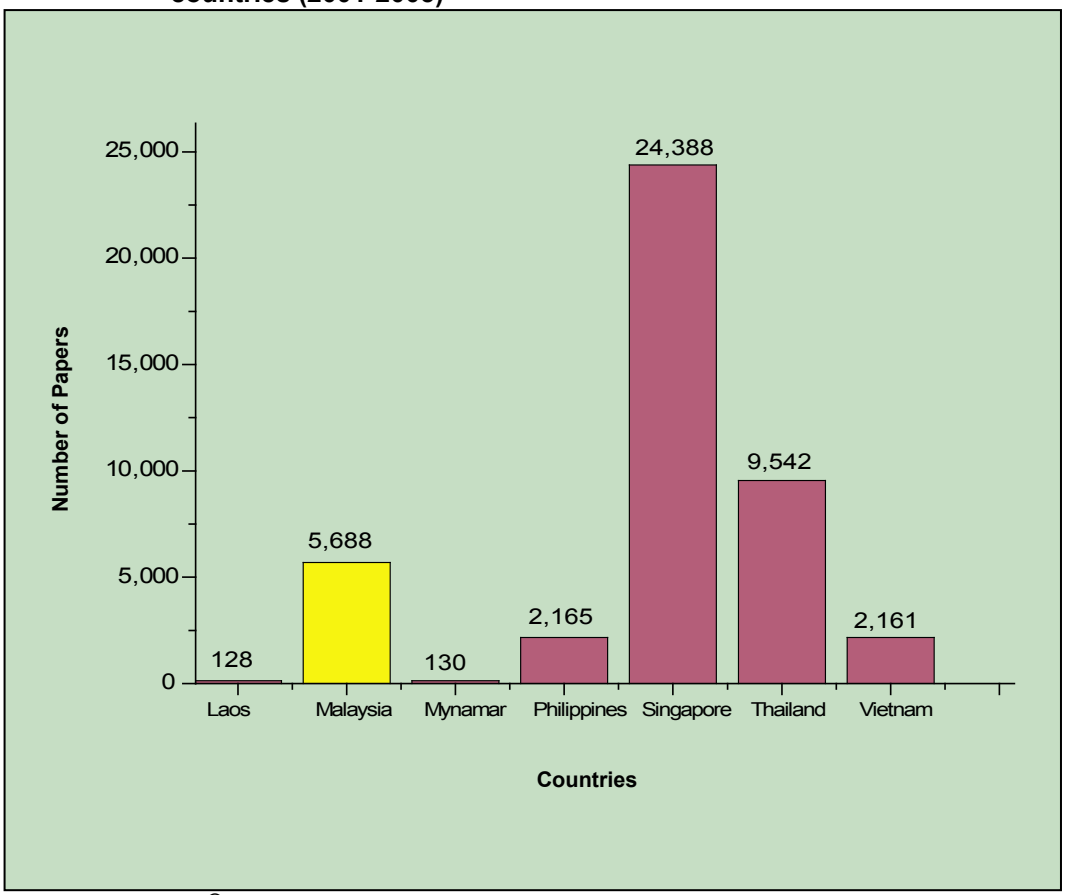
As of now, it is undisputed that the Institute of Scientific Information (ISI) or more commonly known now as the Thomson ISI® is the most widely accepted bibliographic database. In recent years, we have seen the emergence of the Scopus database or even the free to use Google Scholar database, but the quality and accuracy of these databases are limited (Péter Jacsó, Keynote Address, INFOPRO 2005, Japan November 2005) and must be treated with caution.

Thus, as in the 2004 S & T Indicators Report, the present study will concentrate on the S&T output for the period 1981-2005 using the Thomson ISI® National Science Indicators Deluxe 2006 edition (NSIOD) and the Thomson ISI® National Citation Report for Malaysia (NCR-Malaysia) for the period 1981-2005 (See Appendix 8.1). In this deluxe edition of the NSIOD, a total of 105 subfields in the Science Citation Index (SCI), Social Sciences Citation Index (SSCI) and the Arts and Humanities Citation Index (AAHI) were compared on their overall performance. This NSIOD deluxe edition contains the number of ISI indexed papers (which includes from each nation and region) and the number of times the papers were cited through 2005. The NCR-Malaysia consists of all Malaysian addressed-based articles in the SCI, SSCI and the AAHI. The details of the fields and subfields are given in Appendix 8.1. In the present report, the focus is on Malaysia in the ASEAN & Asia-Pacific region as well as in the Global scenario.

8.3 OVERVIEW OF PUBLICATIONS OF MALAYSIA AND ASEAN

Singapore's continued dominance in the ASEAN R&D knowledge output **(Figure 8.1)** has been long acknowledged since the 1990s but the fast growth of the Thai scientific output in the last 5 years (see **Figure 8.2**) serves as a wake-up call that Malaysia cannot ignore to compete in an ever challenging global environment.

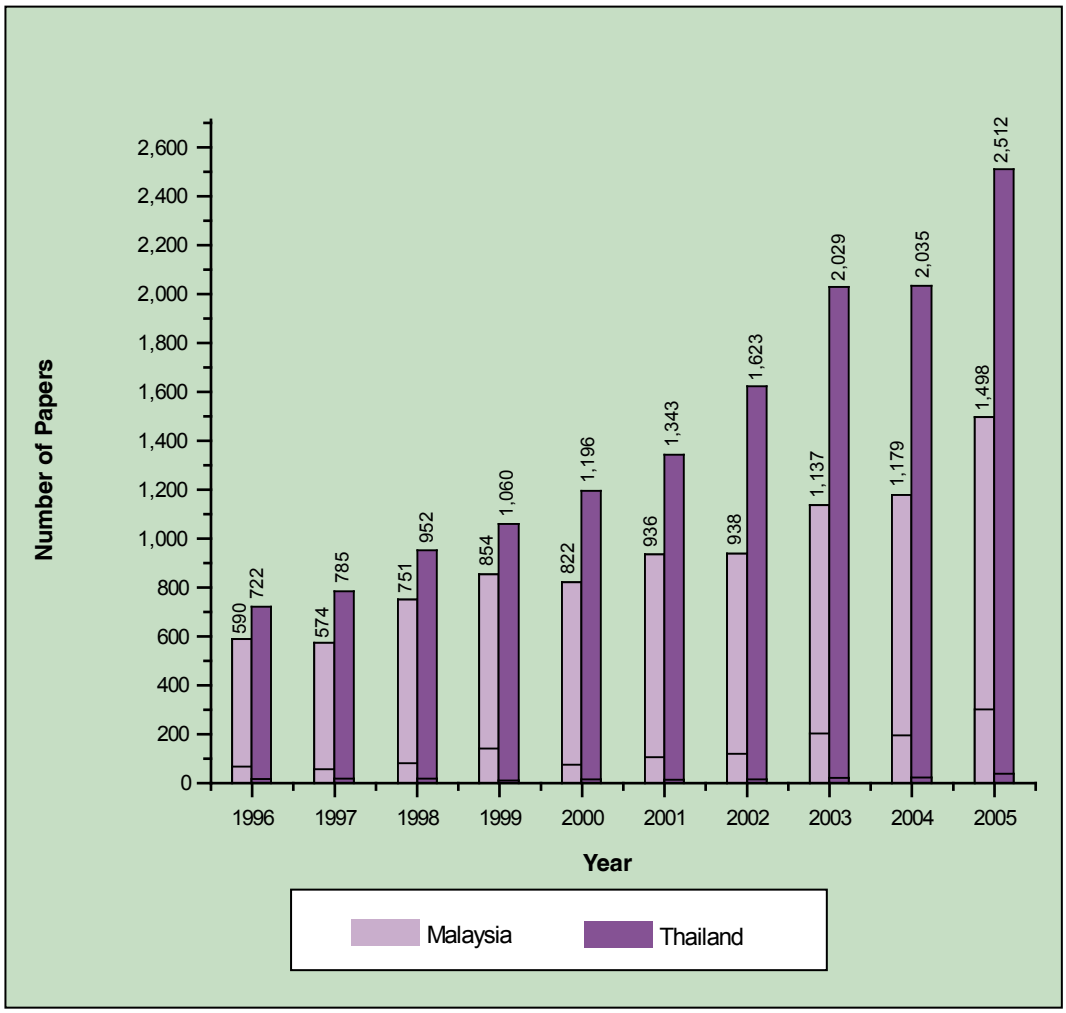
Figure 8.1: Publication of Scientific Papers in selected ASEAN countries (2001-2005)



Source: Thomson ISI® National Science Indicators Deluxe 2006 edition (1982-2005)

Figure 8.2 illustrates the slow growth in Malaysia ISI output for the RMK 7 and 8 periods. Thai scientific output tripled from 1996 to 2005 whereas Malaysia only managed to double its output.

Figure 8.2: Comparison of Publications between Malaysia and Thailand (1996-2005)



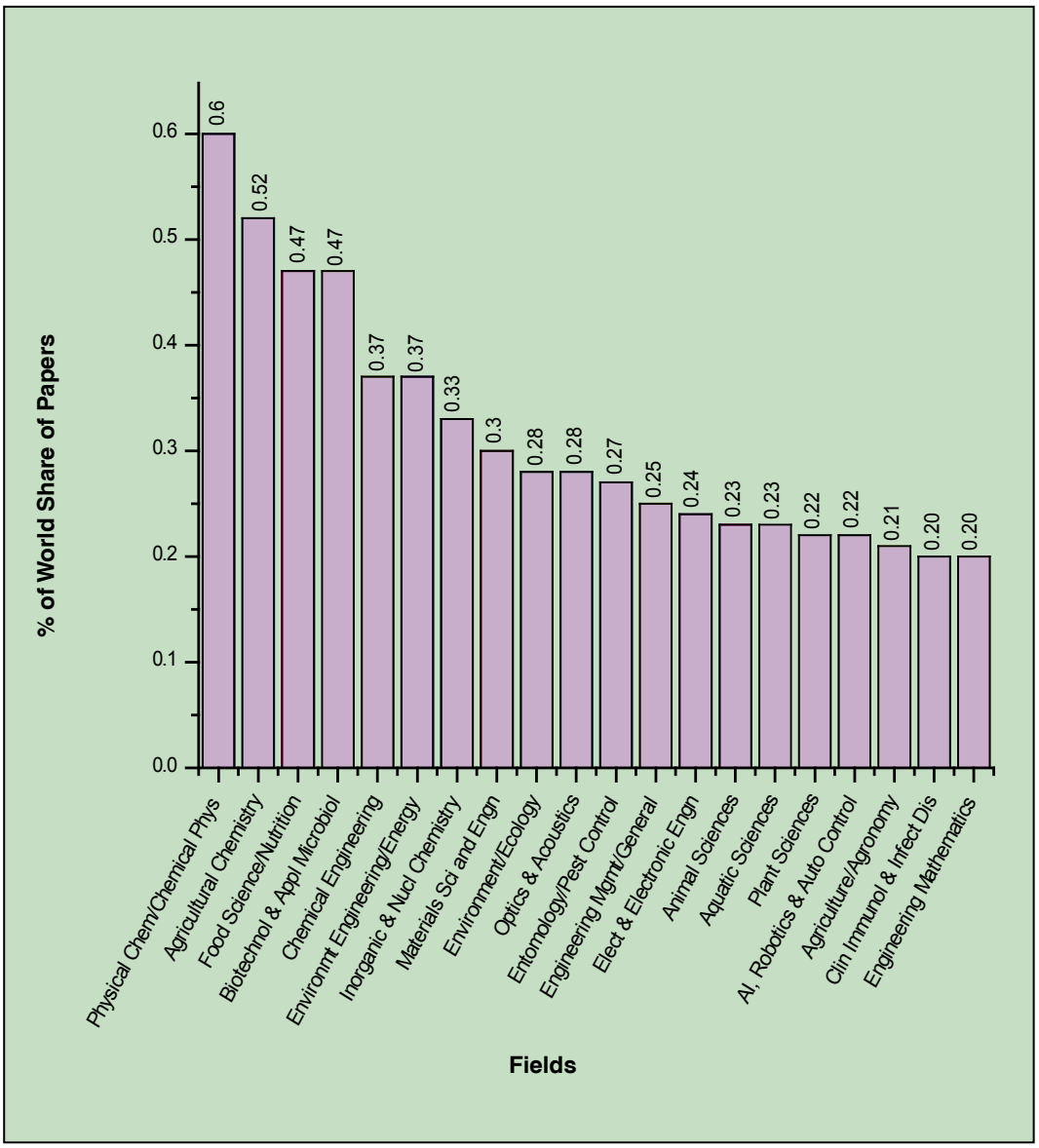
Source: Thomson ISI® National Science Indicators Deluxe 2006 edition (1982-2005)

8.4 STRATEGIC FIELDS OF RESEARCH IN MALAYSIA (2001-2005)

In **Figure 8.3**, Malaysia's Top 20 Fields of Research in 2001-2005 by world share of ISI publications is shown. Physical Chemistry continues to be the most productive field with world contribution of 0.6%. Agricultural Chemistry is next with about 0.52%. In comparing the present graph to the **Figure 8.6(b)** of the S&T Indicators 2004 report, there have been many significant changes in the last 5 years. It must be noted that Material Science & Engineering and Artificial Intelligence, Robotics & Auto-Control are strategically new entrants. The emphasis on Biotechnology & Applied Microbiology, may have led to a 0.47% Malaysia's share of the world papers in this field for this period.

The majority of the papers in Physical Chemistry /Chemical Physics are published in the journal, Acta Crystallographica E, which has a Impact Factor of 0.49 (2004).

Figure 8.3: Top 20 fields of Research in Malaysia for 2001-2005 by Percentage of World Share of Papers



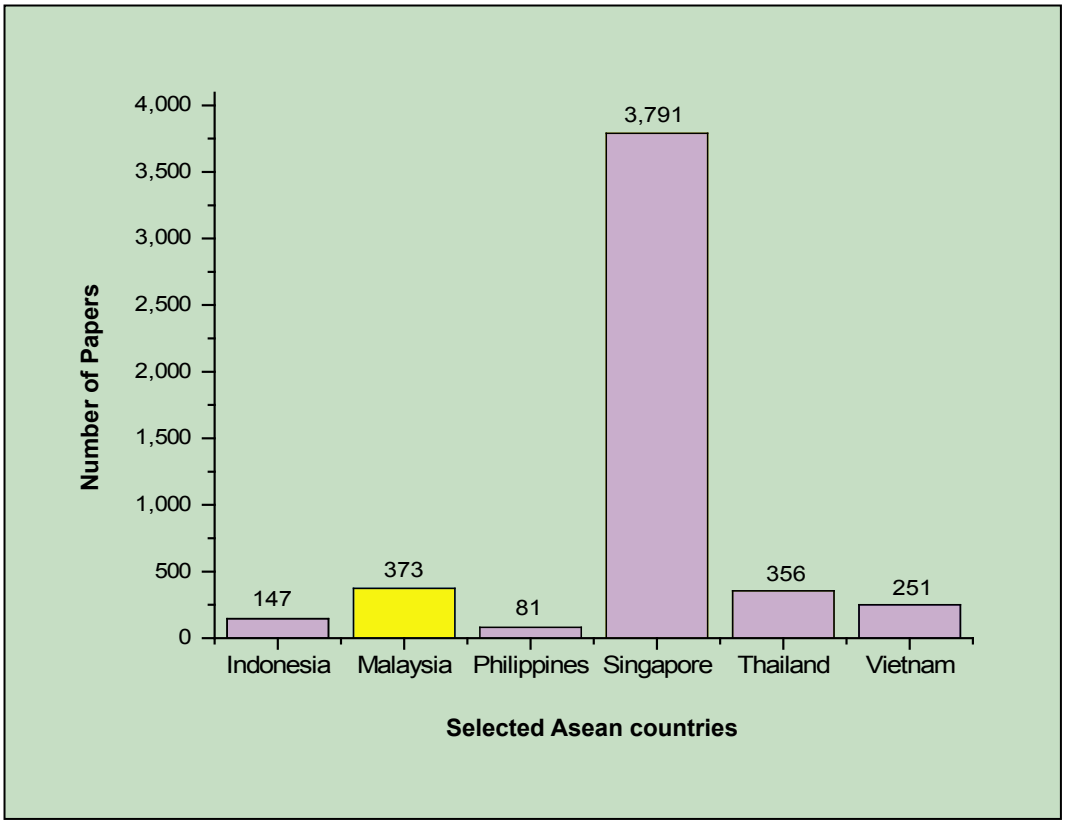
Source: Thomson ISI®National Science Indicators Deluxe 2006 edition (1982-2005)

To provide a more in-depth analysis, the following strategic fields will be studied in the context of ASEAN countries and where possible with selected Asia-Pacific countries.

8.4.1 Applied Physics/Condensed Matter/Material Sciences

In comparing with developed countries, a useful indicator of R&D technological leadership in S&T can be gauged by the quantity and quality of output in the Applied Physics, Condensed Matter and Material Sciences. **Figure 8.4** glaringly illustrates the efforts needed by countries like Malaysia and Thailand to do the catching-up scenario. The emerging Vietnam in this field of research is quite noticeable.

Figure 8.4: Number of Papers in Applied Physics/Condensed Matter/ Material Sciences among selected Asean countries



Malaysia's share of world output in the Applied Physics/ Condensed Matter/ Material Sciences has doubled from 0.06% world share in 1996 to 0.14% in 2005.

Source: Thomson ISI®National Science Indicators Deluxe 2006 edition (1982-2005)

Space Physics & Aerospace Engineering

Space Physics & Aerospace Engineering can be considered as a newly emerging field in Malaysia and its overall contribution in the 2001-2005 is compared with other significant ASEAN contributors. The thrust emphasis on this field as accentuated in the 9MP would possibly help to develop this strategically infant research area in Malaysia. Out of the 57,229 papers published worldwide, Malaysia's contribution was 0.09%, while Thailand and Singapore were 0.065% and 0.11% respectively.

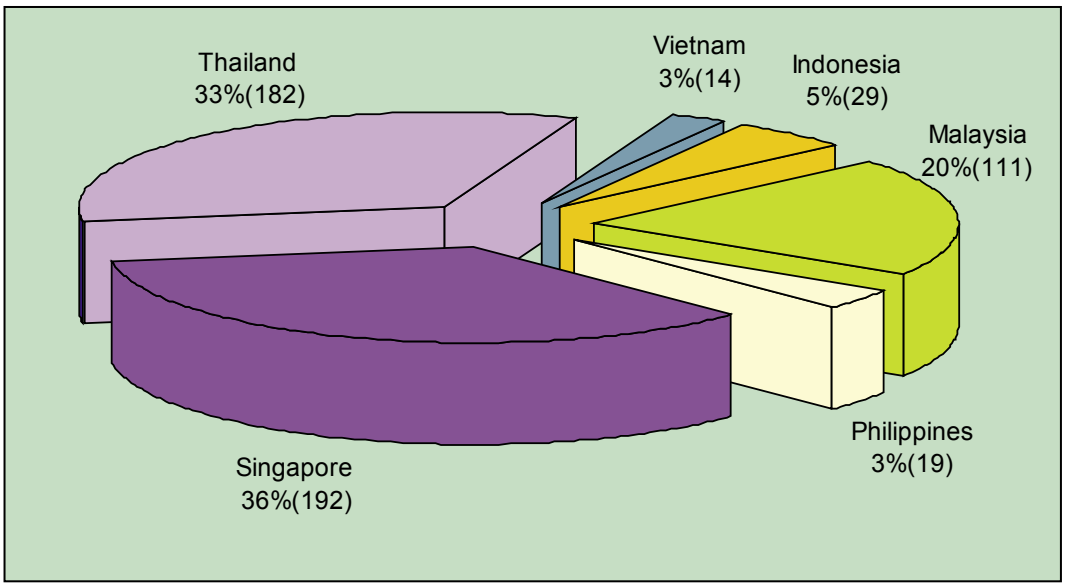
8.4.2 Biotechnology & Applied Microbiology

Biotechnology has been identified as one of main thrust areas of the 9MP and is expected to be a main driver of economic growth in the NSTP2. It must be noted that the comparison below in this thrust area may not reflect the true picture of the extensiveness of the applied Biotechnology field. However, the ISI classification based on the NSIOD 2006 for Biotechnology and Applied Microbiology would provide a useful tool to assess the output in the subfield of Biotechnology and Applied Microbiology. In Figure 8.5, it is found that the gap in the number of ISI® based publications between Thailand and Singapore is surprisingly small considering the emphasis and investments that Singapore has accorded to this sector. It is pertinent to note that much effort is obviously needed by Malaysia to join the ranks of these 2 ASEAN giants in this field. Among other ASEAN countries not shown in Figure 8.5, there is no contribution from Cambodia and Laos while Myanmar's contribution is negligible at about 0.2%.

In the field of Biotechnology & Applied Microbiology, Malaysia's world contribution has gone up from 0.32% in 2001 to 0.70% in 2005. In the case of Thailand, it reached a peak of 0.93% in 2003 and declined to 0.75% of the world share in 2005.

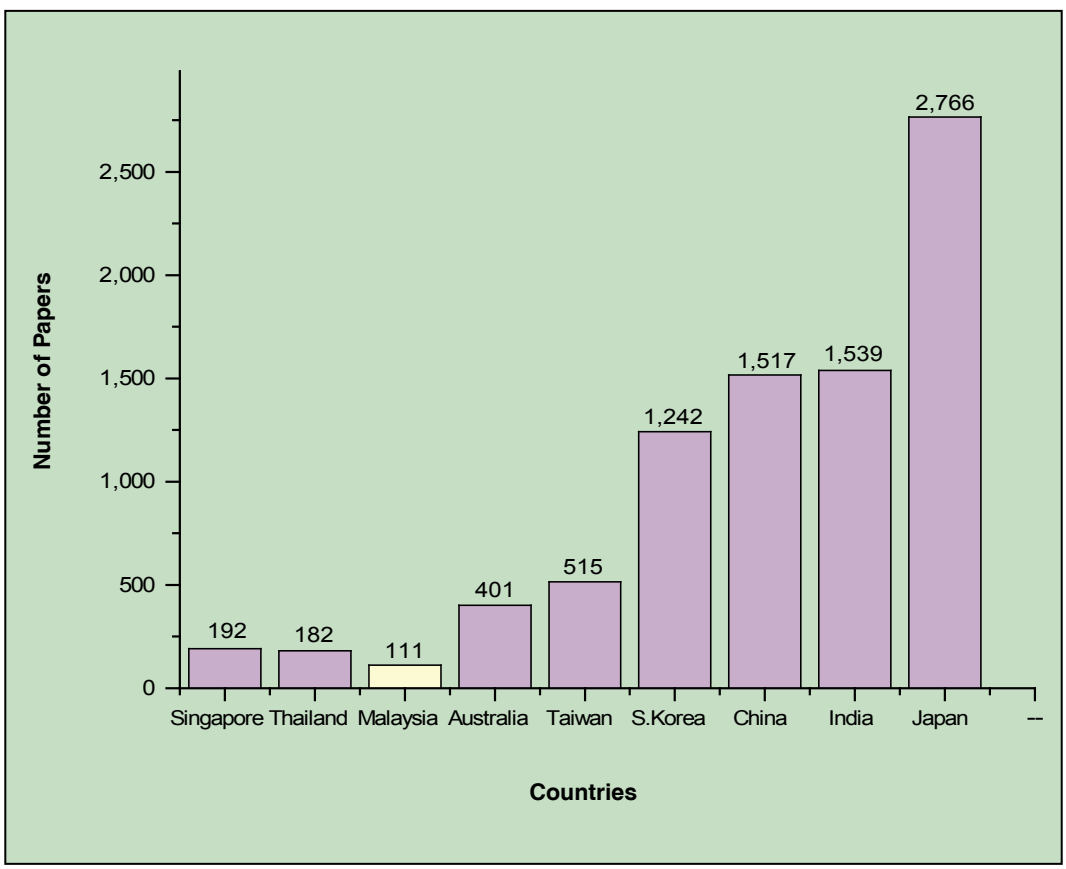
A vital comparison in **Figure 8.6** is the ever-widening gap between the ASEAN countries and some Asia-Pacific countries and India. The indications are very clear about the challenges ahead for Malaysia in the ASEAN or in the Asian-Australia region

Figure 8.5: Number of Papers in the field of Biotechnology and Applied Microbiology in ASEAN (2001-2005)



Source: Thomson ISI® National Science Indicators Deluxe 2006 edition (1982-2005). (The numbers in bracket represent the number of papers)

Figure 8.6: Number of Papers in the field of Biotechnology and Applied Microbiology between selected ASEAN Countries, Asia-Pacific countries and India



Source: Thomson ISI®National Science Indicators Deluxe 2006 edition (1982-2005)

8.5 GLOBAL COMPARISON OF PUBLICATIONS

In Appendix 8.2, the list of top 20 nations and other selected nations in the output of ISI® based publications using the NSIOD 2006 for the 1981-2005 is shown. Malaysia is ranked 56th with a total of 14,606 publications in all fields among the 179 countries covered in the NSIOD. In the Bibliometric Study 2003, Malaysia was reported as ranked 55th in the World for the period (1981-2002) with a contribution of 0.08% of the total World publications for that period. The present study also shows that Malaysia has contributed to 0.14% of the total ISI® publications (4,019,419) in the last 5 years covered (Appendix 8.3)

The world share of S & T output of USA has declined from 40.34% in 1981 to 33.05% in 2005. In the same period, the European Union witnessed a 7% rise; Singapore rose from 0.04% to 0.67% and Malaysia from 0.05% to 0.17%.

However, in comparing with ASEAN countries, Singapore and Thailand are placed higher in the list. Singapore is ranked 38th and Thailand is ranked 51st. The present findings are similar in trend as in the Malaysian S & T Indicators 2000 and 2004 reports. **Figure 8.7** shows the Top 10 countries in the world's scientific publications output.

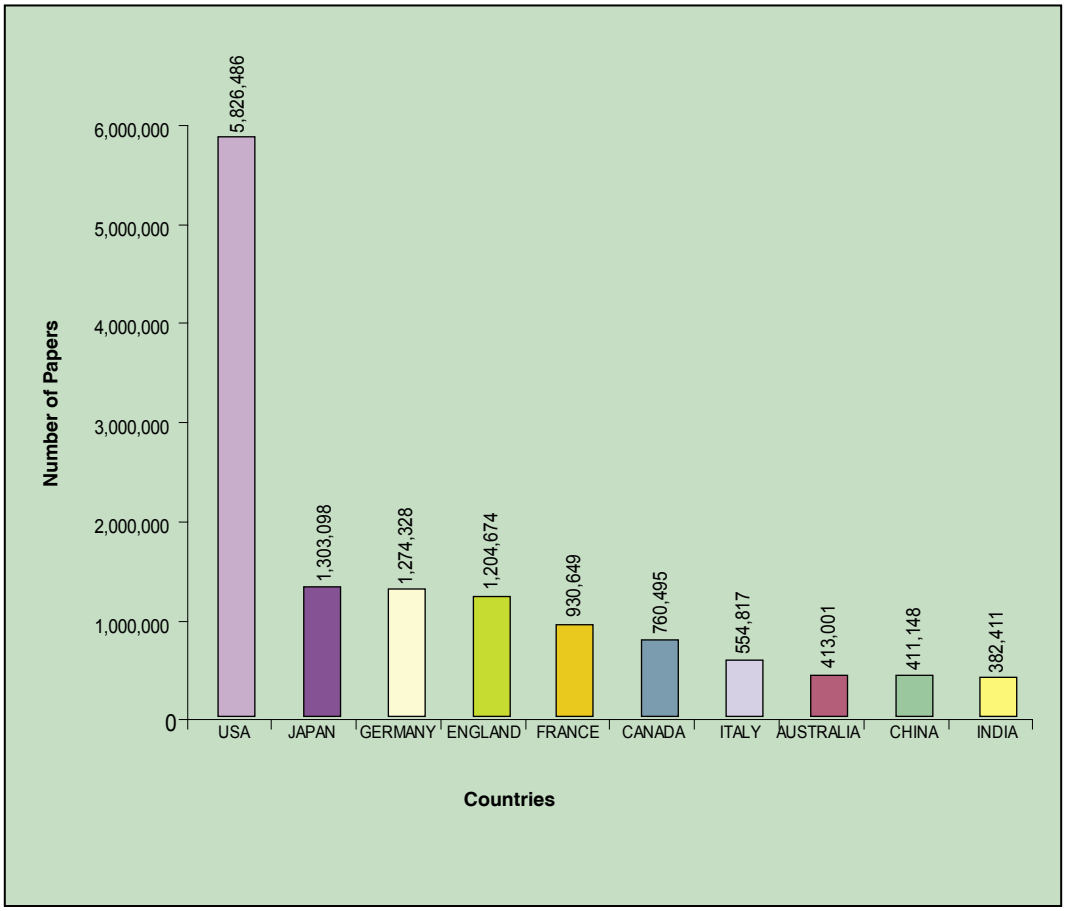
In terms of global output, Singapore contributed nearly 0.61% of the total world papers for the period 2001-2005, while Thailand and Malaysia contributed 0.24% and 0.14% respectively. As a comparative indicator, China's world contribution in the same period is about 5.2% and United States of America was 33.6%. The outputs of ASEAN countries excluding Singapore are falling behind the economic powerhouses of Asia such as China, India, Taiwan and South Korea.

China's spectacular growth in S & T output can be gauged from its 1.99% world share (1981-2002) to the 2.59% world share (1981-2005). The same comparison for Malaysia shows a nearly flat growth from 0.08% to 0.09%.

The U.S is still leading the pack with about 36.7 % of the overall contribution to 15,871,022 ISI papers for the period 1981-2005. Japan, Germany, United Kingdom are the closest with at about 8-9% each. China (8th) and India (9th) are the next closest Asian nations with 2.59% and 2.41% overall contribution respectively.

The top ten fields of research in the world (1981-2005) are depicted in **Figure 8.8**. The Applied Physics/Condensed Matter/Material Science contributes the most at 18% followed by Physics (12%) and Biochemistry and Biophysics (11%). A detailed analysis with some nations below such as Taiwan, Singapore and Japan highlights the important areas that need to be refocused in the step towards attaining a developed nation status.

Figure 8.7: The Top Ten countries in terms of Total Share of World Papers for the period 1981-2005



Source: Thomson ISI® National Science Indicators Deluxe 2006 edition (1982-2005)

In Table 8.1, the Top 10 fields of research in the world for 2001-2005 shows that the Applied Physics/Condensed Matter/ Materials Science is still the leading field with Physics just behind. **Figure 8.9** shows the trends of some ASEAN nations in the selected Top Ten Fields of Research in the world for the period 2001-2005. Except for the Physical Chemistry & Chemical Physics, Malaysia lags behind Thailand in the fields of Physics, Biochemistry & Biophysics, Material Science & Engineering and Organic Chemistry & Polymer Chemistry. Malaysia's contribution to the above fields suggests that tremendous efforts must be made in the next few years. In the field of Physics, Singapore contributed to 0.3% of the world output in the 2001-2005 whereas Malaysia had only produced 0.04%. An examination of the publishing trends of Taiwan, South Korea, Australia, Singapore, Ireland and Japan as depicted in Figures 8.10 - 8.15, might provide a template for the focus areas that Malaysia need to develop in her quest to achieve a developed economic power in the next 15 years.

Malaysia's share of papers in Materials Science worldwide has decreased from about 9.28% share in 2002 to 6.48%.

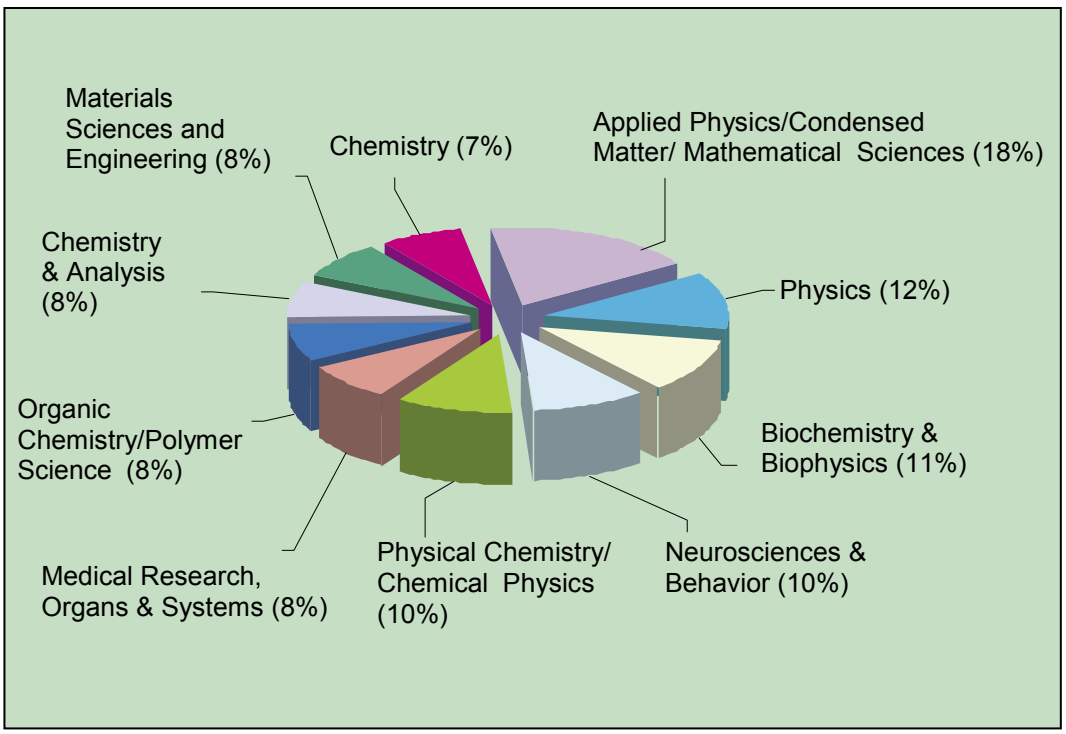
Out of the 70 odd journals in the field of Physics listed in the NSIOD, Malaysia authors contributed only 13 out of the 42,532 papers in 2005. In 1981, there were 9 papers out of the 19,699 papers.

Table 8.1: Comparison of Top 10 fields relative to World Papers (2001-2005)

Field	% Contribution to Total papers	No. of Papers
Applied Physics/Condensed Matter/Mat Science	7.4	297,411
Physics	4.54	182,550
Physical Chemistry/Chemical Phys	3.86	155,139
Neurosciences & Behavior	3.76	150,988
Biochemistry & Biophysics	3.51	141,113
Materials Science and Engineering	3.42	137,580
Organic Chemistry/Polymer Science	2.85	114,688
Medical Research, Organs & Systems	2.8	112,367
Chemistry & Analysis	2.78	111,842
Earth Sciences	2.73	109,705

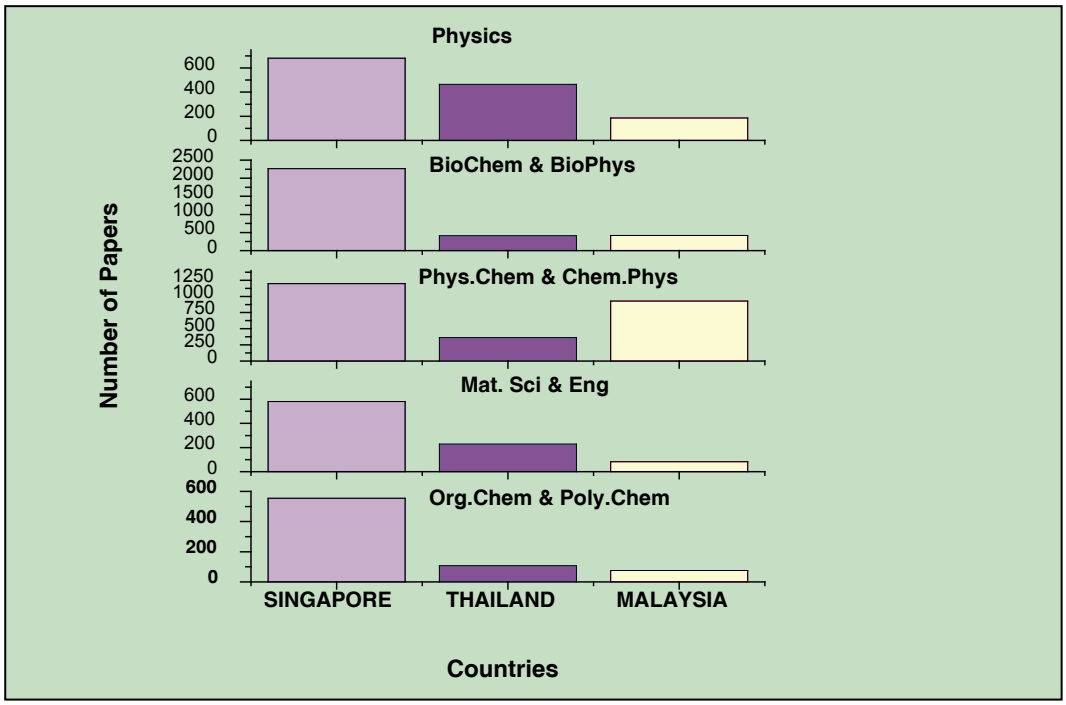
Source: Thomson ISI℠ National Science Indicators Deluxe 2006 edition (1982-2005)

Figure 8.8: Top Ten Fields of Research (1981-2005) by World Share of papers



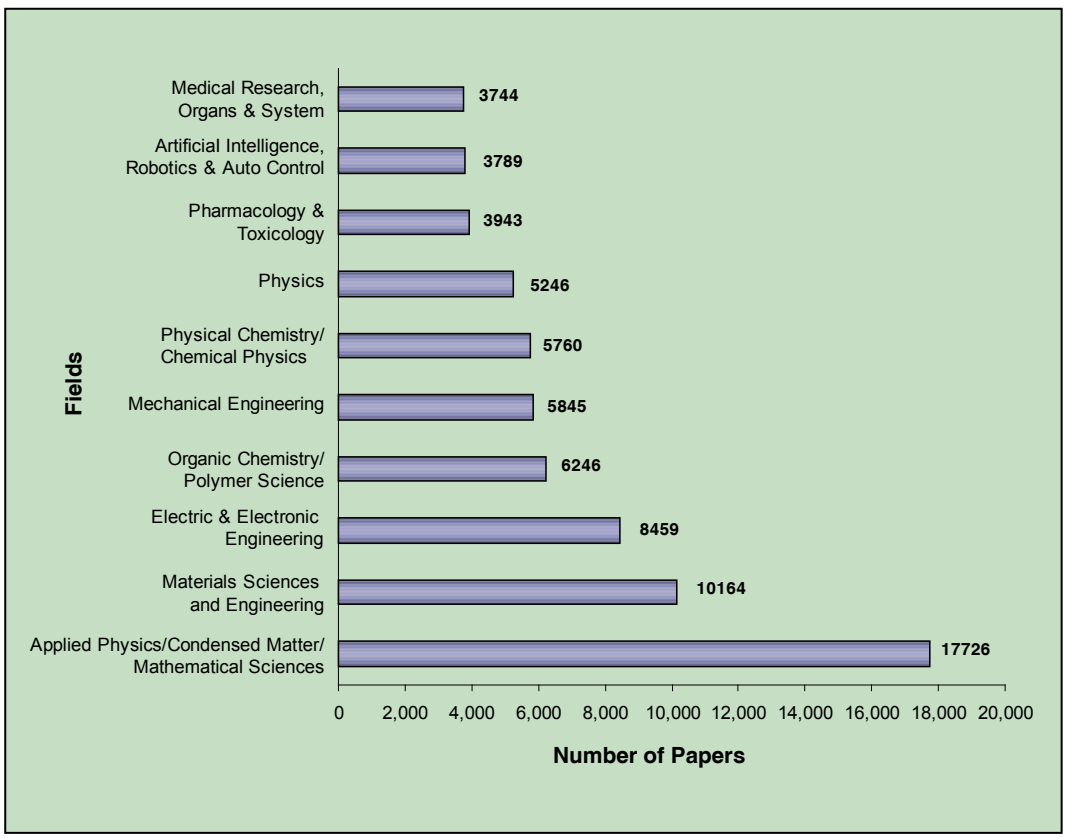
Source: Thomson ISI® National Science Indicators Deluxe 2006 edition (1982-2005)

Figure 8.9: Comparison of selected Top Research fields by Number of Papers for selected ASEAN countries (2001-2005)



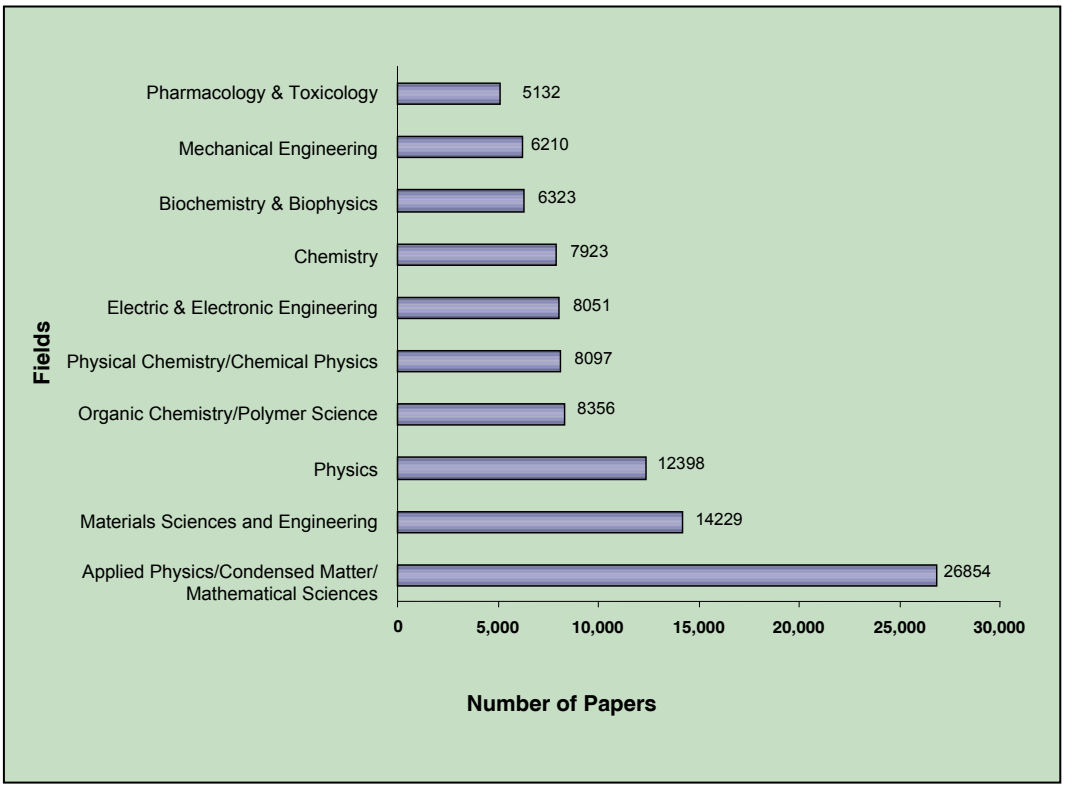
Source: Thomson ISI® National Science Indicators Deluxe 2006 edition (1982-2005)

Figure 8.10: Taiwan's Top Ten Fields of Research by Number of Papers



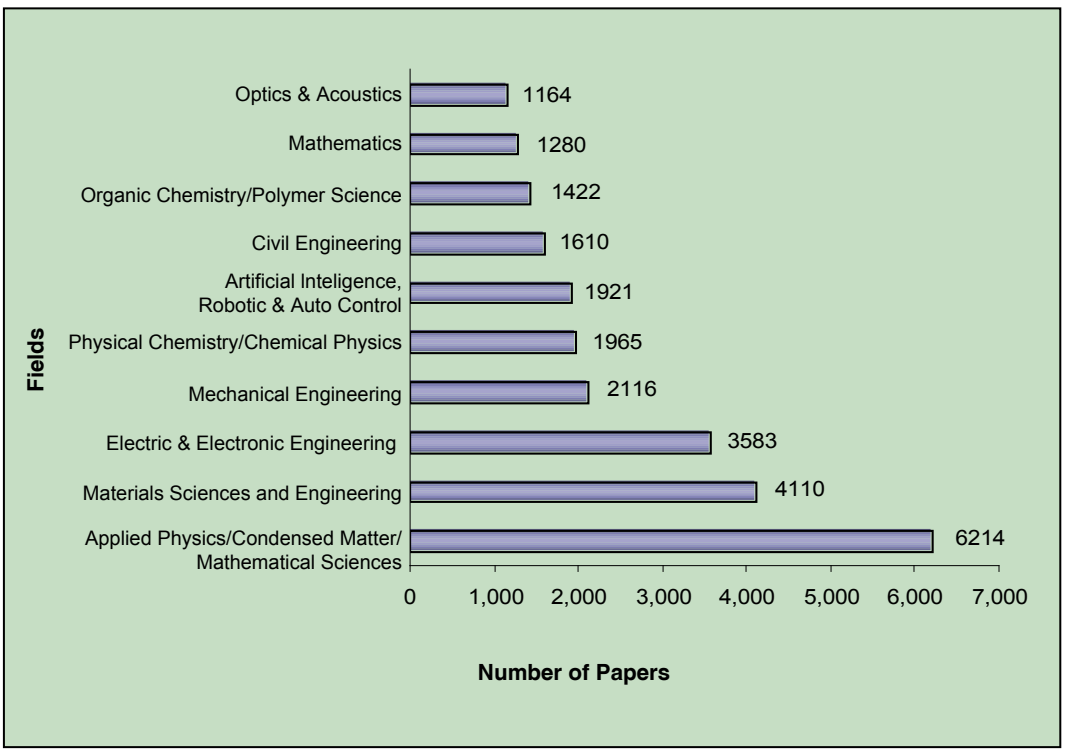
Source: Thomson ISI® National Science Indicators Deluxe 2006 edition (1982-2005)

Figure 8.11: Republic of Korea's Top Ten Fields of Research by Number of Papers



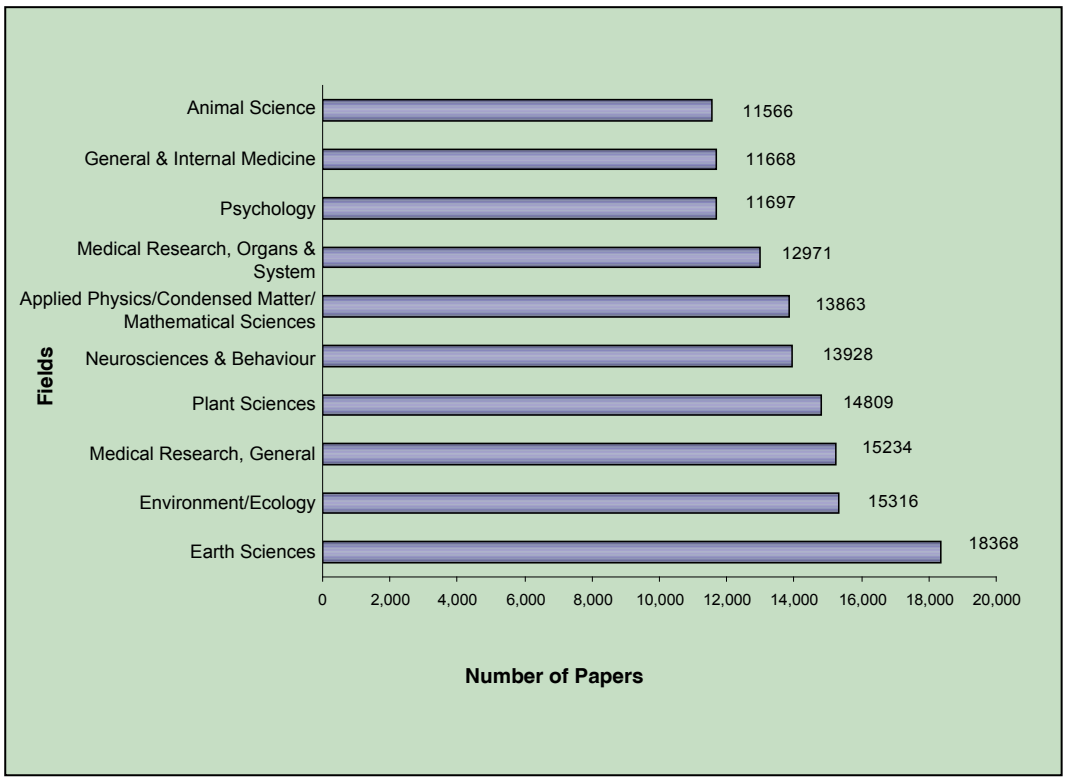
Source: Thomson ISI® National Science Indicators Deluxe 2006 edition (1982-2005)

Figure 8.12: Singapore's Top Ten Fields of Research by Number of Papers



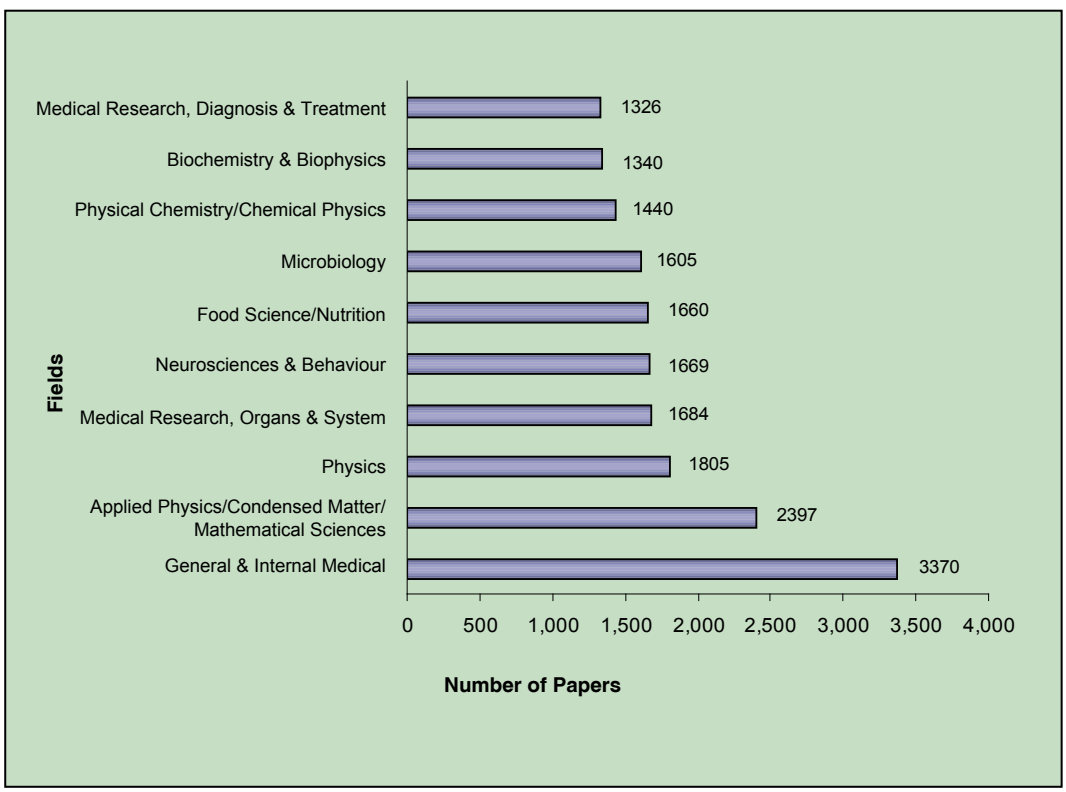
Source: Thomson ISI® National Science Indicators Deluxe 2006 edition (1982-2005)

Figure 8.13: Australia's Top Ten Fields of Research by Number of Papers



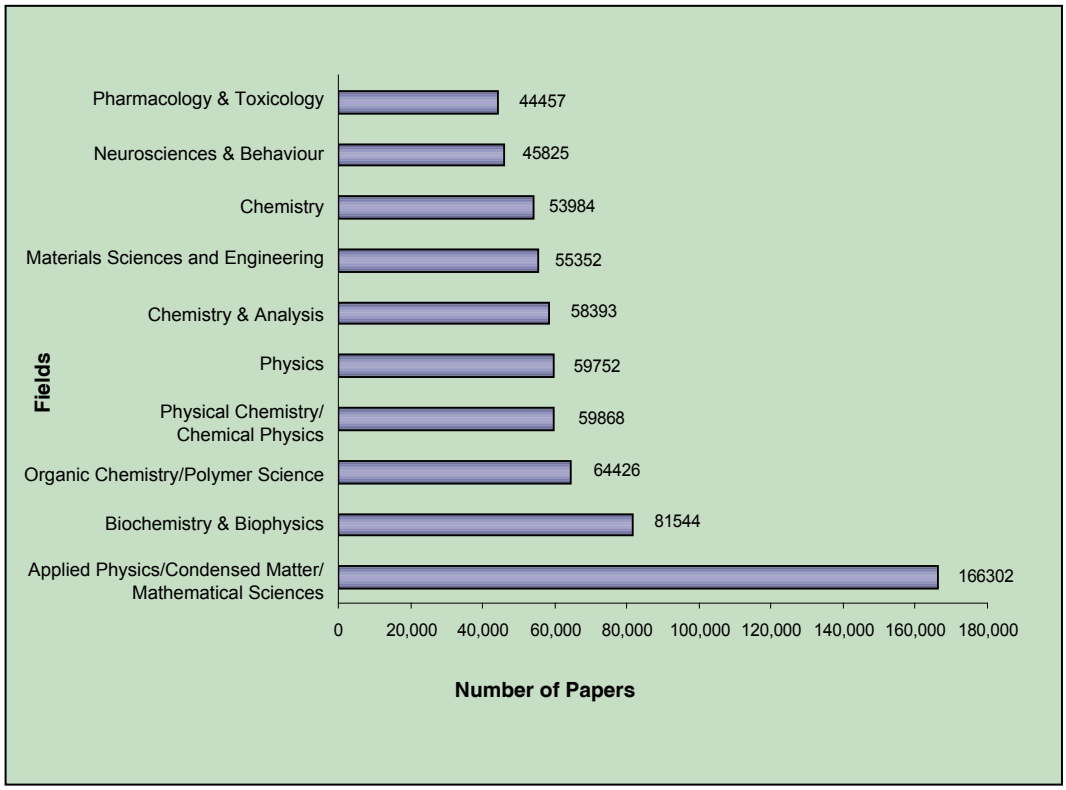
Source: Thomson ISI® National Science Indicators Deluxe 2006 edition (1982-2005)

Figure 8.14: Ireland's Top Ten Fields of Research by Number of Papers



Source: Thomson ISI® National Science Indicators Deluxe 2006 edition (1982-2005)

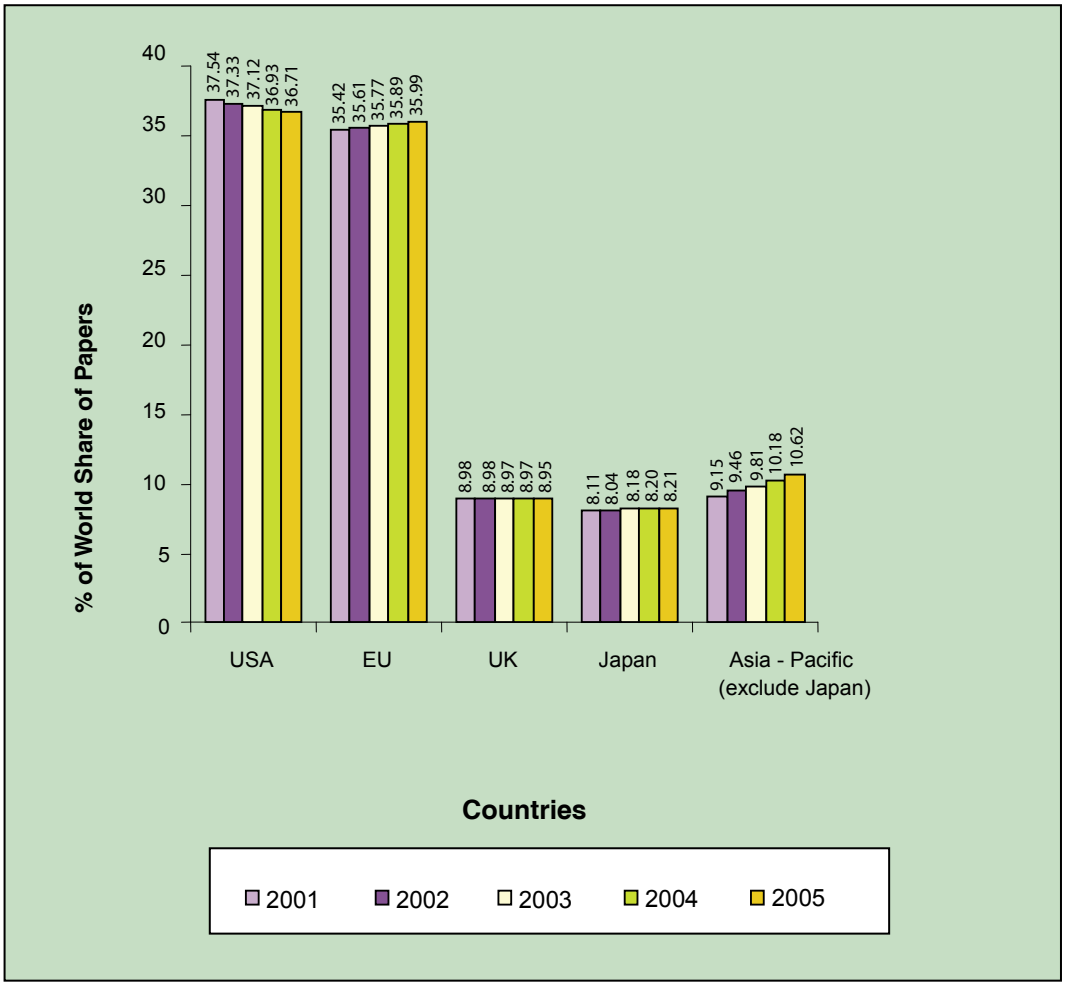
Figure 8.15: Japan's Top Ten Fields of Research by Number of Papers



Source: Thomson ISI® National Science Indicators Deluxe 2006 edition (1982-2005)

In **Figure 8.16**, the contribution by USA, UK, EU, Japan and Asia-Pacific (excluding Japan) shows that in the last 5 years, there has been a visible growth of papers from the Asia-Pacific region and EU. The USA's share of world papers dropped from 37.54% in 2001 to 36.71% in 2005 whereas in the Asia-Pacific increased from 9.15% to 10.62%. This increase is possibly due to the fast growth in China's contribution from 1.98% to 2.59%. Malaysia's share of world papers has actually stagnated at 0.08-0.09% during the same period. During the same period, the Thai's contribution showed a slow growth from 0.1% to 0.13% and Singapore grew from 0.23% to 0.31%. There has been rising concerns in US, about the decreasing share of its world dominance in S&T publications as detailed in the NSB 2006 S&E Indicators.

Figure 8.16: Percentage of World Share of Papers for 2001-2005 for selected Countries and Regions



Source: Thomson ISI®National Science Indicators Deluxe 2006 edition (1982-2005)

Malaysia's academic organizations are the continuing drivers of the nation's S&T output as measured using the NCR-Malaysia. In **Figure 8.17**, the top Malaysian organizations in terms of papers & citation output are depicted for 2001-2005. Universiti Malaya continues to be the leading player with 1,665 papers and followed closely by Universiti Sains Malaysia at 1,395 papers. Universiti Putra Malaysia and Universiti Kebangsaan Malaysia follow next.

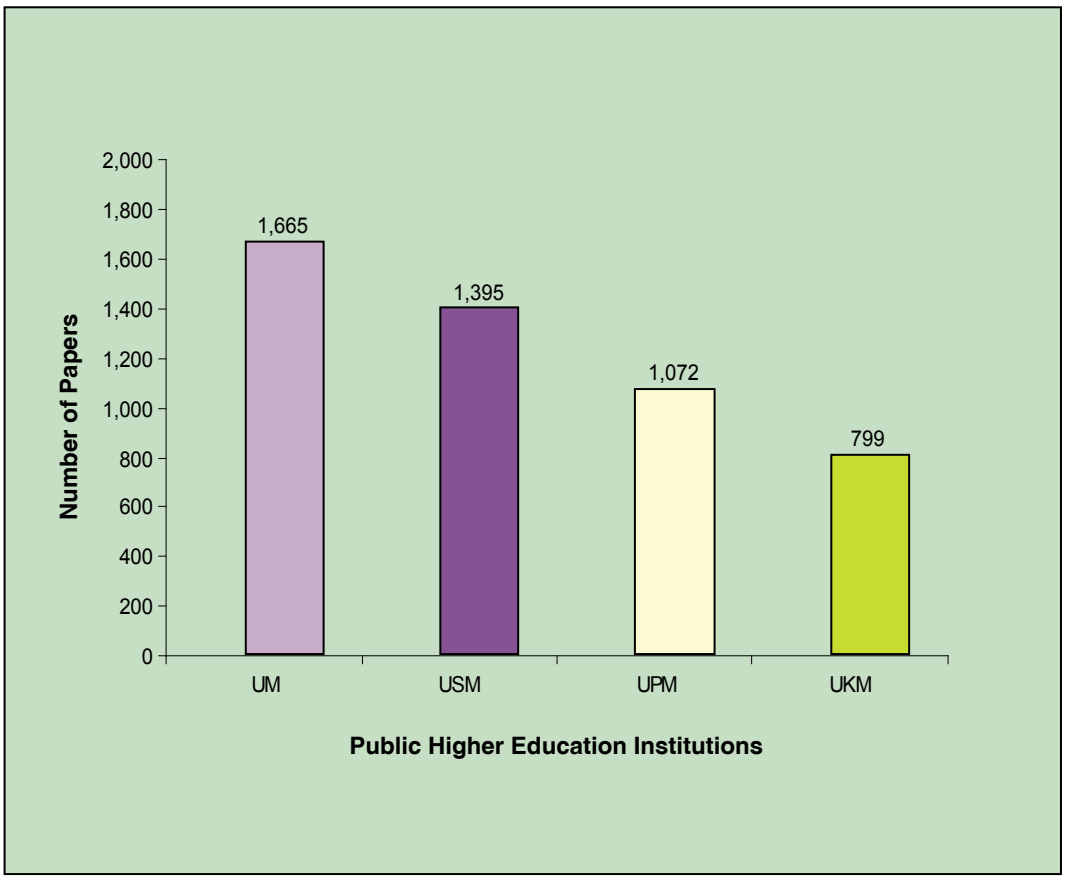
The present study also analysed the papers published by Malaysian scientists/authors in some of the top journals by the 2004 impact factors (IF). Table 8.2 shows the journals and the quantity of papers for the period 2001-2005. There are some significant points to be noted. In 2005, there were 4 papers published in Science originating from the National Museum, UKM and UPM (2 papers). The two 2005 papers in Nature were from the Dept of Survey & Mapping-UTM and the Sabah Park. The papers in the top medical journal, Lancet, were mainly from Universiti Malaya.

Table 8.2: Quantity of papers published by Malaysian scientists/authors in High impact Journals such as Nature, Science and Lancet

Journal	No. of Papers (2001 -2005)	1981 -2000
NATURE (Impact factor: 32.18)	2	5
SCIENCE (Impact factor:31.85)	6	4
LANCET (Impact Factor:21.71)	14	38

Source: Thomson ISI® National Citation Report for Malaysia

Figure 8.17: Publication output in Malaysia by academic organizations (2001-2005)



Source: Thomson ISI® National Citation Report for Malaysia

Among the GRI's, Forest Research Institute of Malaysia, Malaysian Palm Oil Board and the Institute of Medical Research are among the top 3 institutions but the ISI publications of these GRI's are still lagging behind the older academic organizations in Malaysia.

8.6 CITATION TRENDS IN MALAYSIA

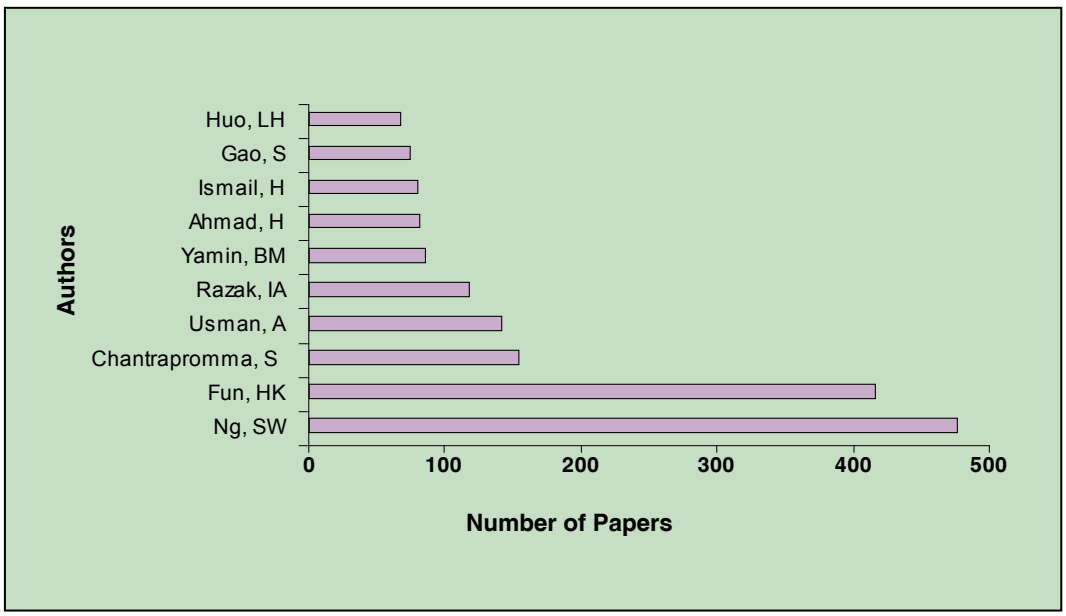
Another important bibliometric indicator is citation counts. The citation counts of a paper reflect the impact of the paper in the particular field or subfield. Caution is also needed to fully study the actual impact of the paper as self-citations can skew the interpretation. However, the general use of citation counts in comparing across organizations, nations and authors can provide a useful indicator, albeit its weaknesses.

The article Expression of Epstein-Barr virus-encoded proteins in nasopharyngeal carcinoma, Intl. J. of Cancer, (1988), 42, pg 329) has the most citations (327) in Malaysia as of 2005. M.Yadav of University of Malaya is one of the co-authors of this paper.

8.7 AUTHORS' CONTRIBUTION AND IMPACT

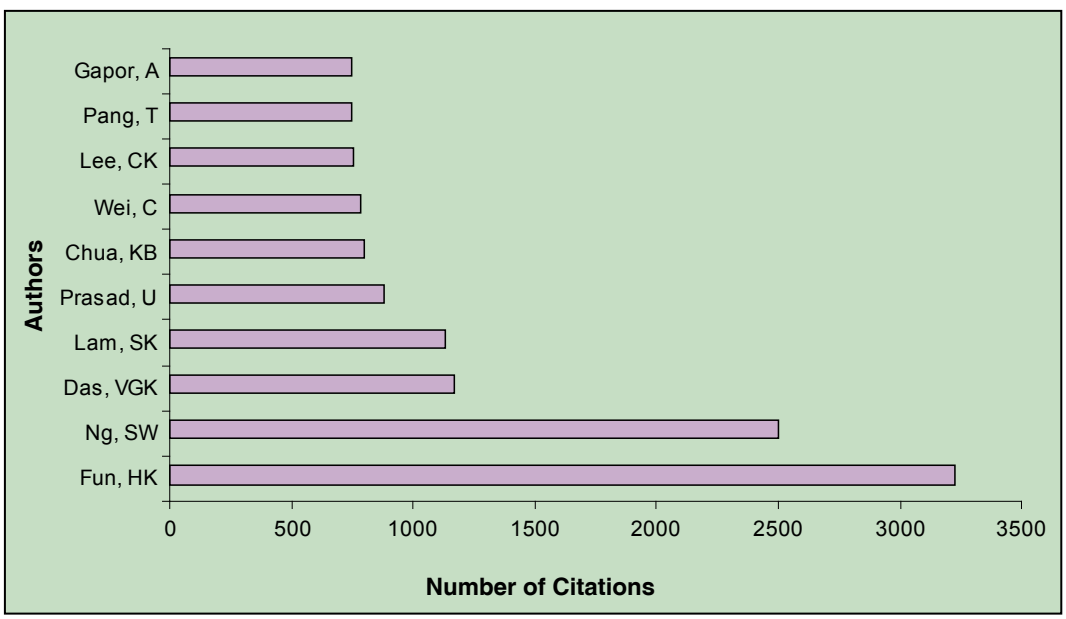
Ng Seik Weng of Universiti Malaya continues to be the most productive Malaysian author followed by Fun Hoong Kun of Universiti Sains Malaysia for 2001-2005 with Fun Hoong Kun as the most cited for the period 1981-2005.(see **Figures 8.18 & 8.19**).

Figure 8.18: Top 10 individual Scientists by Number of Publications (2001-2005)



Source: Thomson ISI®National Citation Report for Malaysia

Figure 8.19: Top 10 individual Scientists by Citation Counts (1981-2005)

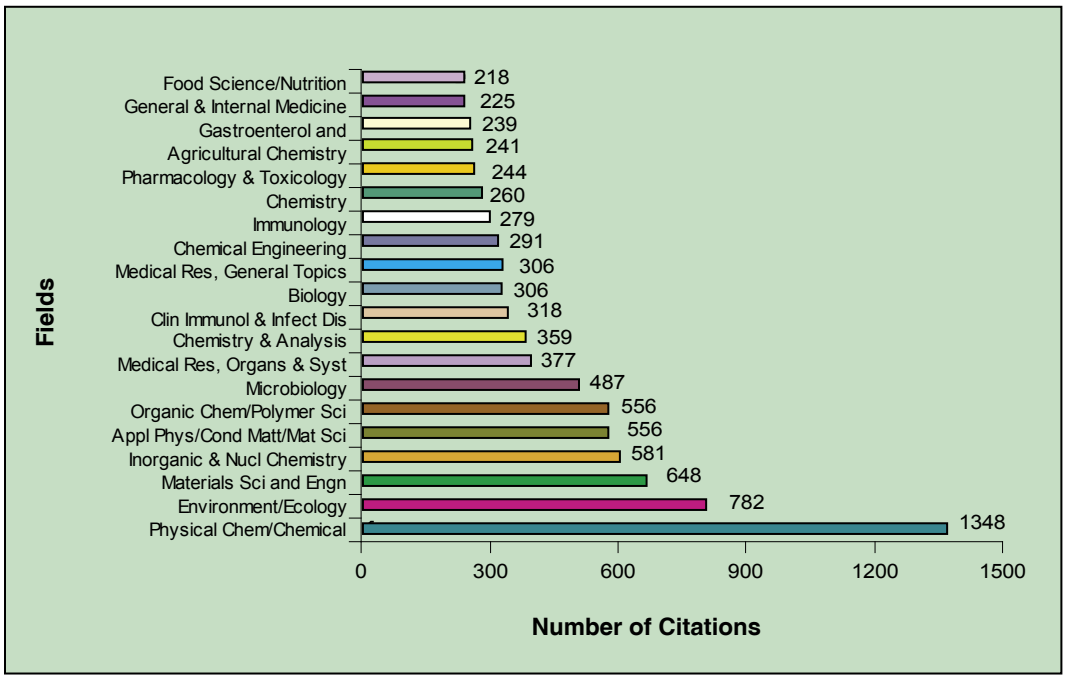


The 2000 Science article on Nipah Virus by K. B. Chua et. al has 158 citations up to 2005.

Source: Thomson ISI®National Citation Report for Malaysia

Figure 8.20 illustrates the Top 20 fields ranked by the number of citations in Malaysia for 2001-2005. Physical Chemistry/Chemical Physics is the most highly cited field during this period followed by Environment/Ecology and Material Science & Engineering.

Figure 8.20: Top 20 fields in Malaysia (2001-2005) ranked by Citation Count

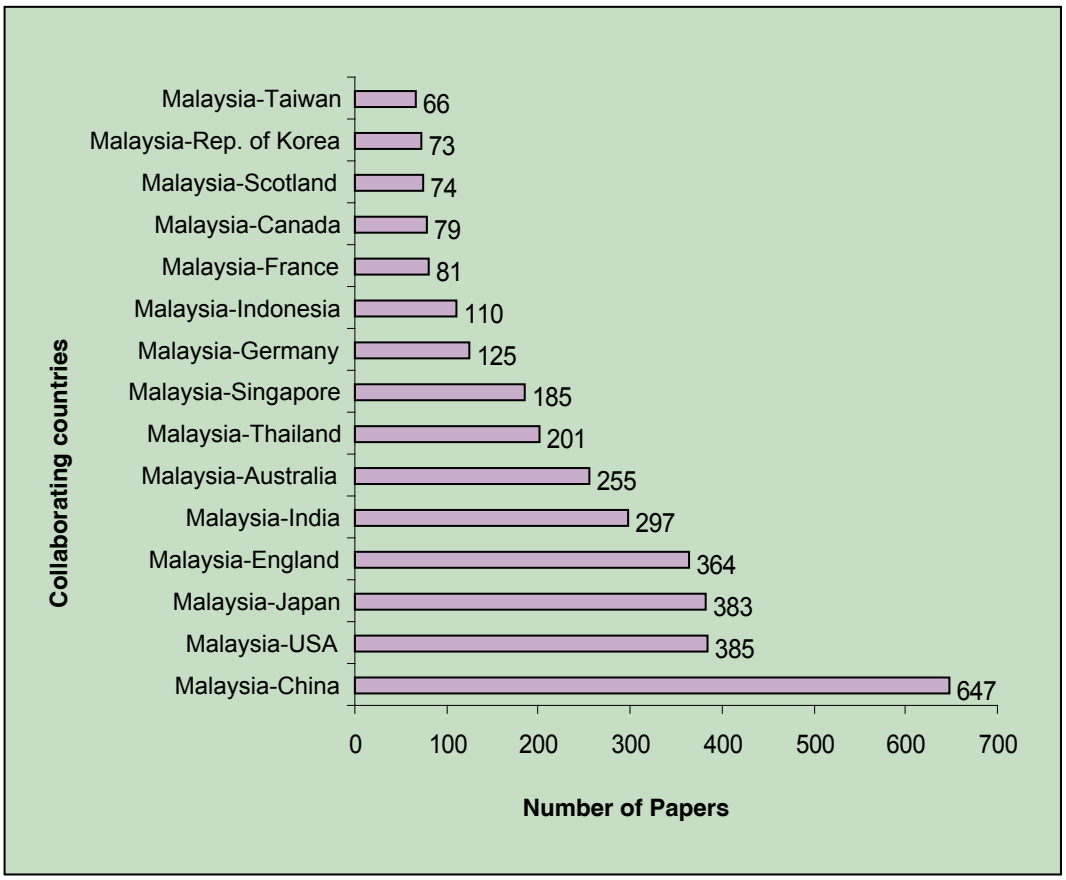


Source: Thomson ISI® National Science Indicators Deluxe 2006 edition (1982-2005)

8.8 SCIENTIFIC COLLABORATION AND COOPERATION

Another useful analysis that can be done with the NCR-Malaysia is the identification of other collaborating countries and organizations with Malaysia's ISI publications. **Figure 8.21** shows the top collaborating country with Malaysian authors is China for the period 2001-2005. There is a growing scientific relationship with South Korea and Taiwan as they are among the top 15 collaborating countries with Malaysia. Data continues to show that USM and Nanjing University of PRC have the highest productivity as found in the 2004 S&T Indicators with 210 papers for the 2001-2005. This is followed by USM-Prince Songkla University with 133 papers and USM-Madras University with 127 papers.

Figure 8.21: Countries that collaborated with Malaysian-based authors sorted by Total Number of Publications (2001-2005)

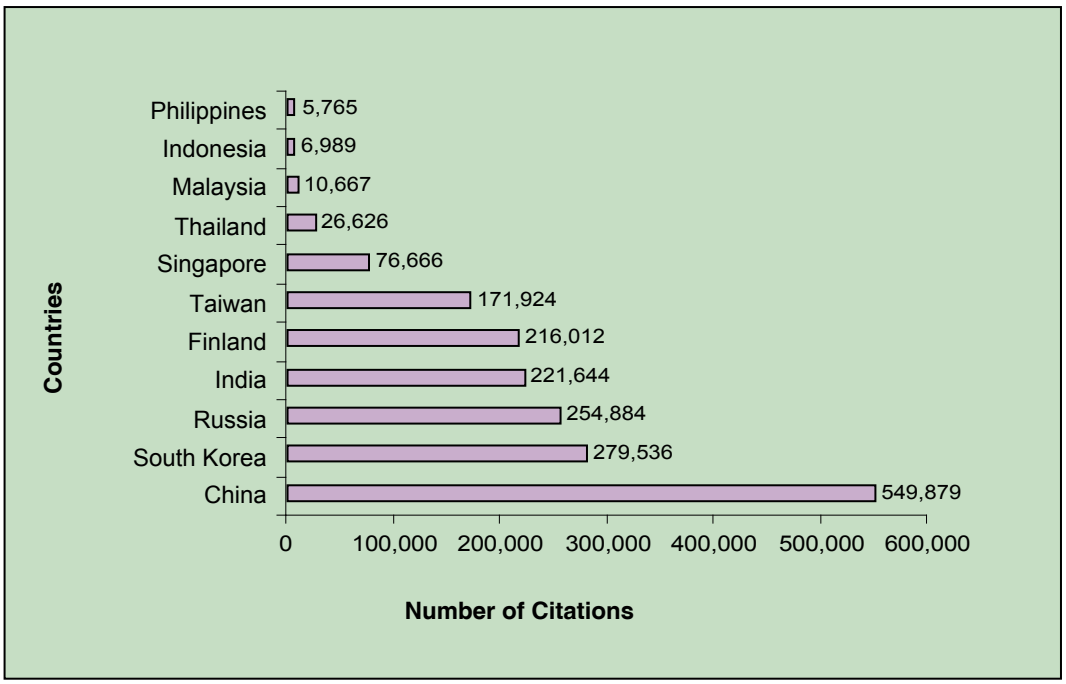


Source: Thomson ISI® National Citation Report for Malaysia

8.9 SOME CITATION TRENDS

It cannot be denied that USA is the leading influence in the S&T knowledge output as clearly seen in the total number of citations in all fields in the NSIOD 2006 (See Appendix 8.3). For the period 2001-2005, it accounted for more than 47% of the total world citations. For the focus of the present study, it will be useful to compare Malaysia's share of the citation count (10,667 citations) with some of its neighbouring countries **(Figure 8.22)**. As in the scientific publication output indicators, Malaysia lags behind Singapore and Thailand in terms of citations. It is evident from these comparisons that the Malaysian scientific and research community need to publish more and in reputed journals.

Figure 8.22: Comparing Citations for Selected Countries (2001-2005)

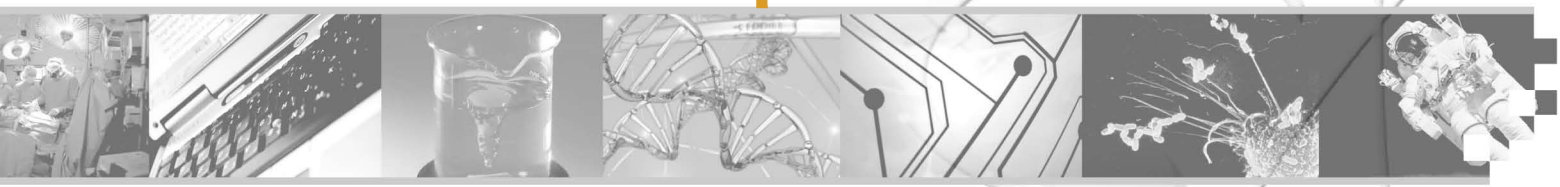


Source: Thomson ISI® National Science Indicators Deluxe 2006 edition (1982-2005)

8.10 CONCLUSION

In the global comparison, Malaysia's share of the S&T knowledge output can be seen as stagnating by comparing Malaysia's share of the world output for the 1981-2005 period against the period of 1981-2002. Malaysia is now ranked 56th (0.09% world share) whereas in the previous 1981-2002 period, it was ranked 55th (0.08% world share). There are some positive indications with the growth in output for some strategic fields such as Applied Physics/Condensed Matter/Materials Science and Material Science & Engineering as well as in Biotechnology and Applied Microbiology. Nevertheless, policy makers and other relevant organizations must take cognizance of the trends of scientific output in Malaysia in realizing the objectives of Vision 2020 and the NSTP2.

Chapter 9



PATENTING IN MALAYSIA

9.1 INTRODUCTION

Patent statistics are increasingly recognized as useful indicators of inventive activity, economic activity and of technology flows. Patents are a unique source of technical information because they contain very detailed, publicly available information about inventions which can be matched with other indicators to provide insights into the evolution of technology in a country. This chapter describes the patenting trend in Malaysia, ASEAN and selected countries as well as a brief write-up on the international awards received by Malaysian inventors.

9.2 PATENT APPLICATIONS FILED AND GRANTED IN MALAYSIA FROM 1996 – 2005

9.2.1 Patent Applications Filed in Malaysia, 1996-2005

Table 9.1 shows the number of patent applications filed by Malaysians and Non-Malaysians at the Intellectual Property Corporation of Malaysia (MyIPO) for the period 1996–2000 and 2001–2005.

8% decline in patent applications during period 2001-2005 when compared to period of 1996-2000

Table 9.1: Patent Applications Filed in Malaysia for period 1996-2000 and 2001-2005

	1996 - 2000	2001 - 2005	Variation (Percentage increase or decrease during the two 5-year period under review)
Malaysian	1,017	2,013	+ 97.9%
Non-Malaysian	29,039	25,648	- 11.7%
Total applications	30,056	27,661	- 8%

Source: MyIPO

During the periods under review, the total number of patent applications filed has declined by about 8%. The total number of patent applications applied for the period 2001–2005 has dropped compared to the number of patent applications applied for the period 1996–2000. A total of 27,661 applications were received for the period 2001-2005 compared to 30,056 applications for the period 1996–2000. This decline is largely due to the decrease in the number of applications filed by non-Malaysians. The reasons for this decline were first, the world economic slow-down following the 1997-1998 financial crisis and secondly, the migration of multinational companies from Malaysia to the neighbouring countries.

98% increase in patent applications filed by Malaysians during period 2001-2005.
Government R&D institutions and IHLs secured 20 patents during period of 1996-2005

On the other hand, the number of patent applications filed by Malaysians for the period 2001-2005 has increased by 97.9% compared to the period 1996-2000. The total number of patent applications filed by Malaysians for the period 2001–2005 was 2,013 applications compared to 1,017 applications for the period 1996-2000. The reasons for this increase were first, more people were aware of protecting their inventions due to the Government efforts in promoting intellectual property rights protection through intellectual property awareness campaigns, secondly, the tax incentives and rebates schemes for protecting intellectual property announced during the 2001/2002 Budget Session, and thirdly, patent applications filed by Government Research Institutions and public universities funded under IRPA programme. The increase in patenting activity by Malaysians is a good sign as it reflects the higher level of R&D activities in the country, in particular Government R&D institutions and public universities. According to the IRPA Intellectual Property Database maintained by the IRPA IP Secretariat in SIRIM, Government Research Institutions and public universities filed a total of 158 patent applications at the Intellectual Property Corporation of Malaysia (MyIPO) during the period 1996-2005. Of the 158 patent applications filed, 20 have been granted patents.

9.2.2 Patents Granted in Malaysia, 1996-2005

Table 9.2 shows the number of patents granted to Malaysians and Non-Malaysians by the Intellectual Property Corporation of Malaysia (MyIPO) for the period 1996–2000 and 2001–2005.

Table 9.2: Patents Granted by the Intellectual Property Corporation of Malaysia (MyIPO) for period 1996-2000 and 2001-2005

	1996 - 2000	2001 - 2005	Variation (Percentage increase or decrease during the two 5-year period under review)
Malaysian	215	142	- 34%
Non-Malaysian	4,067	9,253	+ 127%
Total granted	4,282	9,395	+ 119%

Source: MyIPO

Increase in total number of patents granted from 4,282 for the period 1996-2000 to 9,395 during 2001-2005

On the whole, the total number of patents granted to Malaysians and Non-Malaysians has increased from 4,282 to 9,395 for the period 1996–2000 and 2001–2005. The increase is largely due to the increase in the number of patents approved for non-Malaysian. While the number of patent applications filed by Malaysians for the period 2001–2005 had increased by 97.9% compared to the 1996-2000 period, there was no corresponding increase in the number of approvals. The number of patents granted to Malaysians was 215 for the period 1996–2000 compared to 142 for the period 2001–2005.

9.2.3 Patents Granted in Malaysia by Field of Technology

Most patents granted in the fields of chemistry/ metallurgy and electricity

Figure 9.1 shows the number of patents granted in the country by the Intellectual Property Corporation of Malaysia (MyIPO) according to the field of technology. A detailed description on the classification of the field of technology according to the International Patent Classification is given in Appendix 9.1.

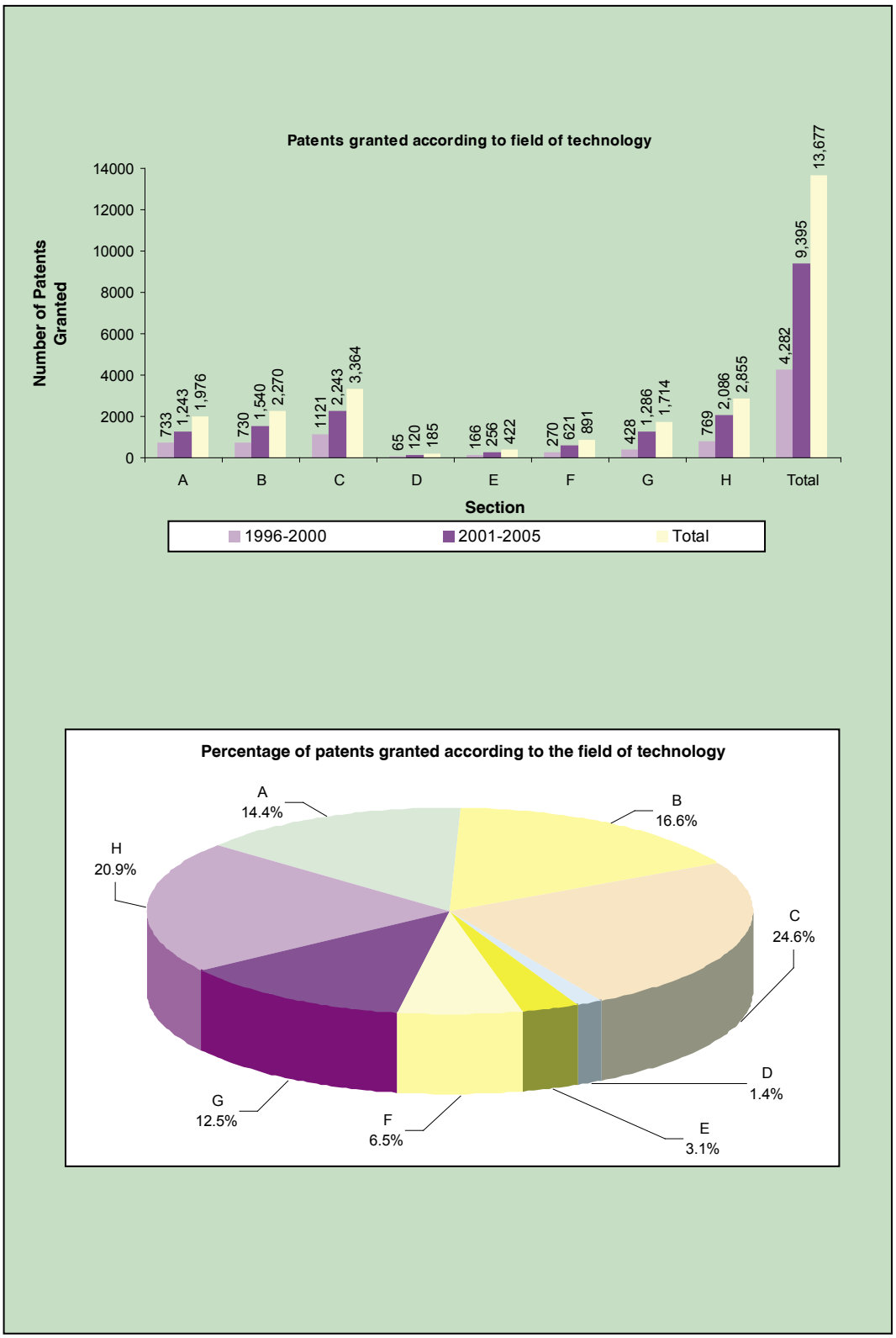
The field of chemistry and metallurgy has the highest number (3,364 or 24.6%) of patents granted for period 1996–2005. Electricity had the second highest number (2,855 or 20.9%) of patents granted, followed by performing operations and transporting (2,270 or 16.6%). Human necessity had the fourth highest number (1,976 or 14.4%) and the field with the least number of patents granted was textiles and paper (185 or 1.4%).

The number of patents granted in the field of chemistry and metallurgy for the period 2001-2005 was 2,243 compared to 1121 for the period 1996–2000. This represents a 100% increase in the number of patents granted in the field of chemistry and metallurgy. Similarly, the number of patents granted in the field of electricity for period 2001-2005 was 2,086 compared to 769 for the period 1996–2000. This represents a nearly three-fold increase in the number of patents granted in the field of electricity.

Increase in patent filings for biotechnology and ICT inventions

The reason for the big jump in the number of patents granted in the field of chemistry and metallurgy, and in the field of electricity is largely due to the increase in the number of patent filing for biotechnological inventions, and information and communication technology (ICT) inventions. Biotechnology inventions are classified under the field of chemistry and metallurgy and ICT (including software) inventions are classified under electricity. This trend reflects the importance of biotechnology and ICT in Malaysia and the overlapping of biotechnology and ICT applications in industries. Analyzing the patent documents granted during the last decade reveal that ICT is now widely used in biotechnology processes as well as in biotechnology equipment.

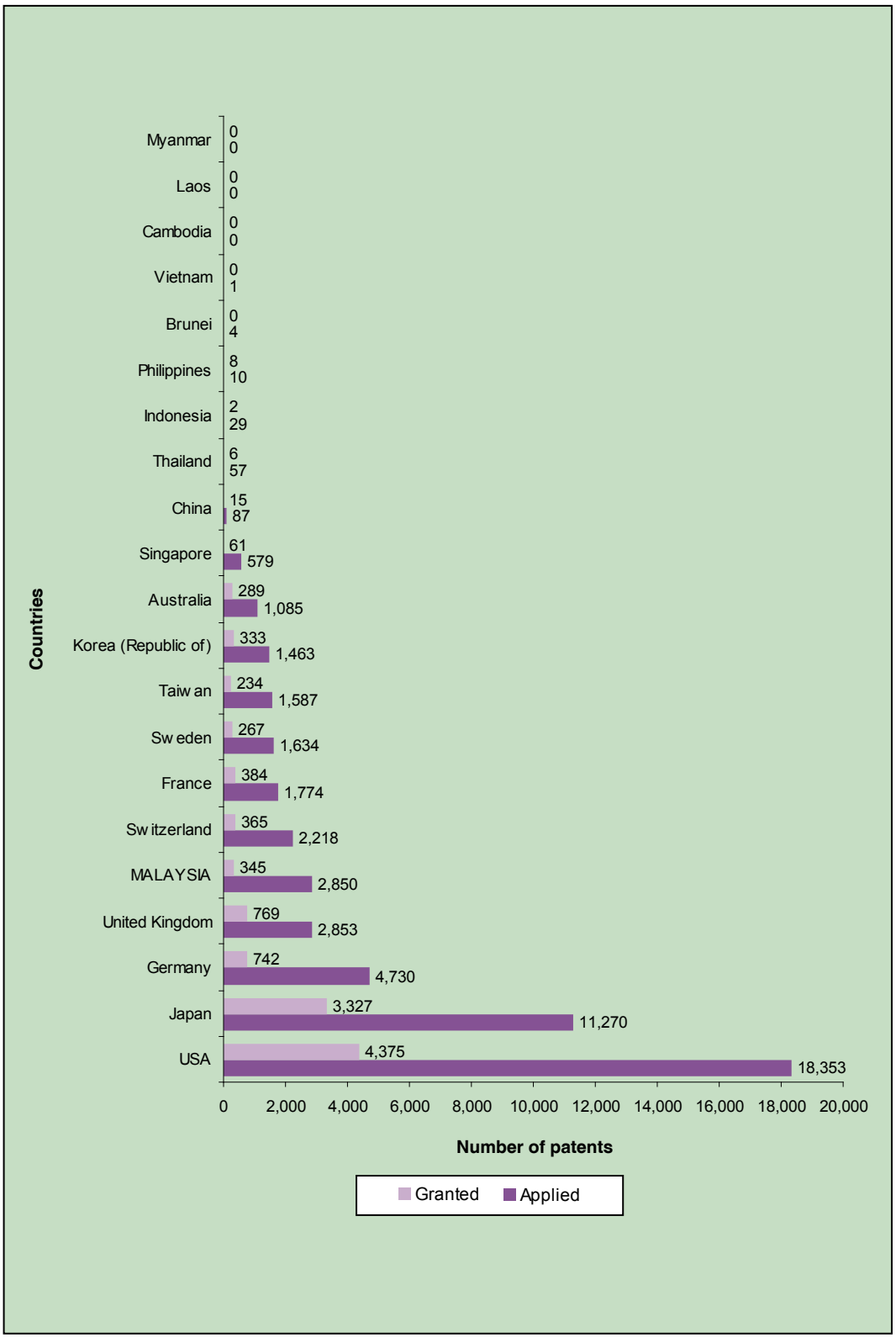
Figure 9.1: Patents Granted Based on Field of Technology Classified According to the International Patent Classification (IPC) System, 1996-2005



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

Source: MyIPO

Figure 9.2: Number of patent applications applied for and granted in Malaysia for 20 selected countries for period 1996-August 2005



Source: MyIPO

9.2.4 Patent Applications and Patents Granted in Malaysia by Country

Figure 9.2 shows the number of patent applications applied for and granted to foreign applicants in Malaysia for 20 selected countries for period 1996 – August 2005 when compared with Malaysia.

US, Japan, UK and Germany were the leading countries in terms of patent applications filed and granted in Malaysia for the period 1996 – August 2005

For patent applications filed in Malaysia, United States of America had the highest number, followed by Japan and Germany. For the period 1996–August 2005, the number of patent applications filed in Malaysia by applicants from United States of America, Japan and Germany was 18,353, 11,270 and 4,730 respectively. United Kingdom (2,853) ranked fourth ahead of Switzerland (2,218), France (1,774), Sweden (1,634) and Taiwan (1,587) in terms of the number of patent applications filed in Malaysia.

For patents granted in Malaysia, United States of America had the highest number, followed by Japan and United Kingdom. For the period 1996–August 2005, the number of patents granted to applicants from United States of America, Japan and United Kingdom was 4,375, 3,327 and 769 respectively. Germany (742) ranked fourth ahead of France (384), Switzerland (365), Korea (Republic of) (333) and Australia (289) in terms of the number of patents granted in Malaysia.

Large number of patent filings in Malaysia from Taiwan. Among ASEAN countries, Singapore has the highest number of patent applications filed in

Interestingly, one should take note of Taiwan, a non-Paris Convention and a non-Patent Cooperation Treaty country where a total of 1,587 patent applications were filed during the period 1996–August 2005. This places Taiwan way ahead of Korea (Republic of), Australia and China who are signatories to the Paris Convention and the Patent Cooperation Treaty. This is impressive especially when compared with China, Taiwan is a small country with a small population and it reflects the importance of Taiwanese industries, in particular technologies relating to ICT in Malaysia.

Among the ASEAN countries, Singapore has the highest number of patent applications filed in Malaysia followed by Thailand, Indonesia and Philippines. For the period 1996 - August 2005, the number of patent applications filed in Malaysia by applicants from Singapore, Thailand, Indonesia and the Philippines was 579, 57, 29 and 10 respectively. During the period 1996–August 2005, no patent applications were received from Cambodia, Laos and Myanmar.

While the foregoing data about the status of patent applications and patent granted were obtained from the Intellectual Property Corporation of Malaysia (MyIPO), it should be noted that patents granted during the period 1996-2000 were actually patent applications filed before 1996. Similarly, patents granted during the 2001-2005 period were actually patent applications filed before 2000.

9.3 TIMELINE IN GRANTING OF PATENT IN SELECTED COUNTRIES

Time taken for a patent to be granted in Malaysia is around 4 – 5 years.
In Singapore, it takes from 2 – 4 years whilst in the US, it is about 3 – 4 years

The time taken for a patent application to mature to grant in Malaysia is about 60 months or 5 years. Table 9.3 shows the time taken for a patent to be granted in the European Patent Office, Japan, Singapore, the United Kingdom and the United States of America. Malaysia ranked somewhere in between these countries in terms of time taken for a patent to be granted.

In recent years, the World Intellectual Property Organization (WIPO) has been working very closely with both national and regional offices to reduce the time taken for the grant of a patent. Towards this end, more and more patent offices worldwide are opting to join the Patent Cooperation Treaty (PCT) administered by WIPO and recognize the use of corresponding search reports issued for essentially the same invention filed in different countries. However, due to the time bar imposed under the various national patent laws, the European Patent Convention and the Paris Convention (of which Malaysia is a member), patent can only be granted to an invention at least two years after the filing of the patent application at the Patent Office.

In Malaysia, patent grant can be expedited by submitting to the Malaysian Patent Office search reports or granted patents issued by the European Patent Office, the Australian Patent Office, the United Kingdom Patent Office, the Korea (Republic of) Patent Office and the United States Patent and Trade Mark Office. Malaysia deposited the instrument of accession to the PCT on 16 May 2006 and began accepting PCT applications as from 16 August 2006.

Table 9.3: Time Taken for a Patent to be granted in Selected Countries

Country	Time Taken for granting of Patent	Remarks
European Patent Office	7 - 8 years	Request for examination must be filed within 2 years from the filing date of the European Patent application. Substantive examination normally commences after the expiry of the 2 years after the filing of the application subject to payment of annuity.
Japan	7 - 12 years	Request for examination can be filed up to 7 years from the filing date of the Japanese Patent application. Applicant will normally request for substantive examination when there is an impending infringement or dispute.
Malaysia	4 - 5 years	Request for examination must be filed within 2 years from the filing date of the Malaysian Patent application. Substantive examination normally commences after the expiry of the 2 years after the filing of the application.
Singapore	2 - 4 years	Request for examination must be filed within 2 years from the filing date of the Singapore Patent application. Examination of patent applications is outsourced to overseas patent offices.
United Kingdom	4 years	Request for examination must be filed within 2 years from the filing date of the UK Patent application. All applications must be put into order for grant or refusal within 48 months after the filing of the patent applications.
United States of America	3 - 4 years	No need to request for examination. However applicant must provide the US Patent Office all the disclosures in order to expedite grant and lengthy prosecution of the application by the patent agent is not encouraged.

Source: Manual for the Handling of Applications for Patents, Designs and Trade Marks Throughout the World, Kluwer Law International, 2005 and Guide for Applicants from the National and Regional Patent Offices

9.4 PATENTS GRANTED BY THE UNITED STATES PATENT AND TRADE MARK OFFICE (USPTO) FOR SELECTED COUNTRIES

According to the United States Patent and Trade Mark Office (USPTO) Patent Technology Monitoring Branch Report, a total of 3,891,901 patents were granted by the USPTO for the period 1 January 1977–31 December 2005. Of the total, 1,808,122 patents were granted to applicants of US origin and the balance 1,451,328 patents were granted to applicants of foreign origin. Figure 9.3 below shows the percentage of US patents granted to selected countries for the period 1977-2005.

Almost 59% of the 645 patents Malaysia received from USPTO were granted to multinational companies based in Malaysia while Malaysian research institutions and universities were granted a total of 21 patents or 0.03% of the total received.

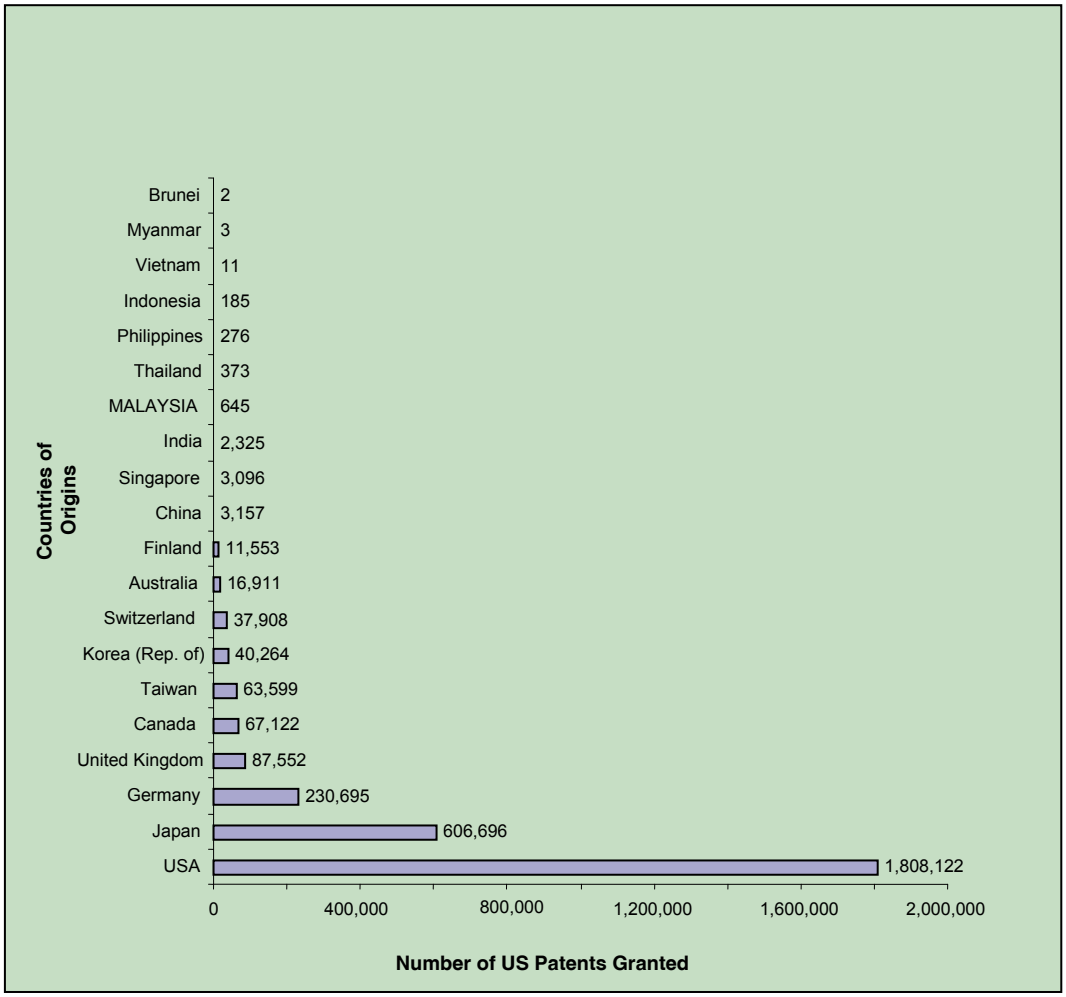
The high number of US patents issued is due to the fact that USPTO issues several different types of patent documents offering different types of protection and covering different types of subject matter. For a detailed description of the types of patents, please refer to Appendix 9.2. The most common type of patent granted by the USPTO is the utility patent (what we call "patent" in Malaysia). The next common types of patents issued by the USPTO are the design patents (what we call "industrial designs" in Malaysia) and the plant patents (Malaysia does not have a law to protect plant per se but she has a law to protect plant varieties).

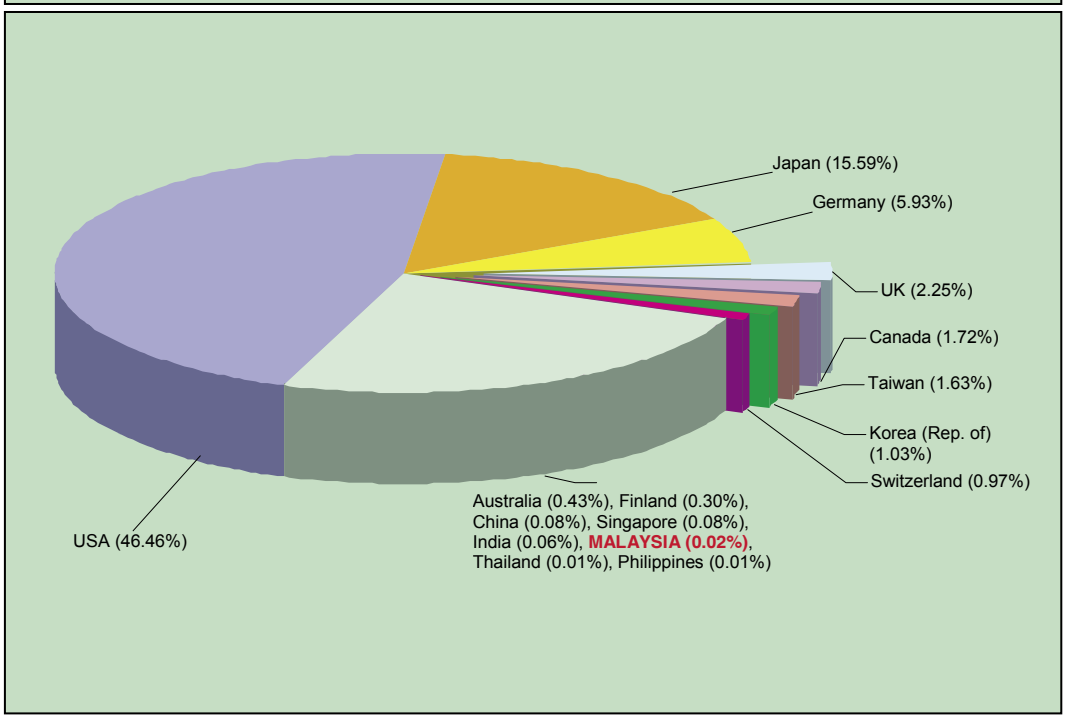
About 46.46% of the total patents granted by the USPTO are issued to US applicants, 5.93% are issued to German applicants and 2.25% are issued to UK applicants. Among the Asian countries, 15.59% of the total patents granted by the USPTO are issued to Japanese applicants, 1.63% are issued to Taiwanese applicants and 1.03% to Korea (Republic of) applicants. On the other hand, Chinese applicants received 0.08% of the total patents granted by the USPTO.

Among the ASEAN countries, Singapore received 3,096 patents (0.08%), Malaysia received 645 patents (0.02%), Thailand received 373 patents (0.01%) and Philippines received 276 patents (0.01%). Although Malaysia is far behind Singapore, it is still ahead of Thailand and the Philippines.

It is interesting to note that of the 645 patents granted to Malaysia, 378 patents were granted to multinational companies based in Malaysia, 138 patents were granted to Malaysian companies, 108 patents were granted to individual Malaysian inventors, and 21 patents were granted to Malaysian research institutions and universities. Of the 378 patents granted to multinational companies based in Malaysia, 278 patents were from inventions relating to semiconductor, electric and electronics technology [Section H (Electricity) of the International Patent Classification]. Of the 21 patents granted to Malaysian research institutions and universities, 5 patents were granted to the Malaysian Palm Oil Board, 5 were granted to Petroliam Nasional Berhad (Petronas), 4 were granted to Universiti Putra Malaysia, 3 were granted to Universiti Sains Malaysia, 2 were granted to the Rubber Research Institute Malaysia and 1 each was granted to University of Malaya and the Institute for Medical Research (IMR).

Figure 9.3: Number of US Patents Granted to Selected Countries from 1977 - 2005





Source: MyIPO

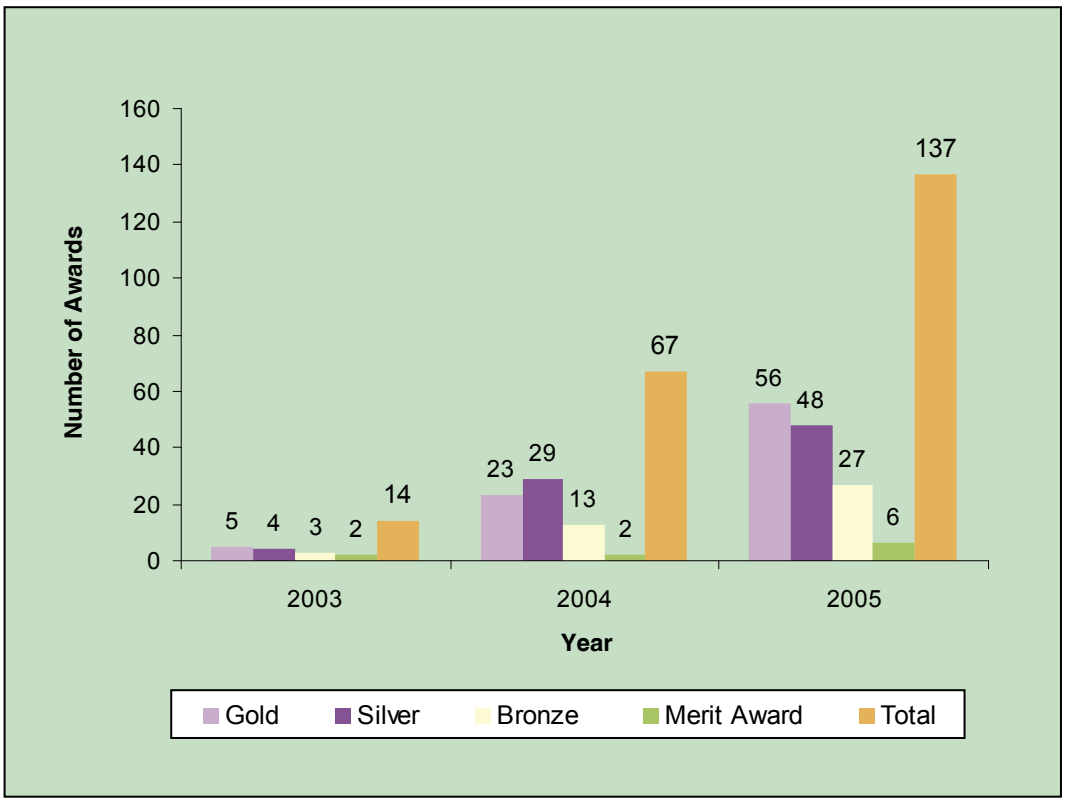
The high number of patents granted to Japan reflects the importance of Japanese technology in the American market. Although the percentage of US patents captured by Taiwan and Korea (Republic of) is small, it is nevertheless significant particularly the growing importance of ICT technologies of these two countries in the US market.

9.5 INVENTOR AWARDS

Increasing trend of winning international inventor awards by Malaysian inventors in recent years

International inventor awards won by Malaysians have increased sharply in recent years as evident in the Geneva International Invention Exhibition where the number of awards secured by Malaysians rose from 13 in 2003 to 137 in 2005 **(Figure 9.4)**. Of the 137 awards, 56 were golds, 48 silvers, 27 bronzes and 6 merit awards. Malaysians also secured international awards on invention conducted by the World Intellectual property Organisation, the Taiwan Special Award, Korean Invention Promotion Association award, Geneva City award, Croatia Special Award and the Geneva Automobile Association Award. This increasing trend in winning international awards reflects a positive trend in inventiveness capacity. However, the challenge remains to translate these inventions to products, processes, services and solutions that can be translated into the marketplace.

Figure 9.4: Inventor Awards Received by Malaysian Inventors at Geneva International Invention Exhibition, 2003-2005



Source: MINDS

9.6 CONCLUSION

The overall patent filing in Malaysia by Malaysians has increased by 97.9% during the past five years. This indicates that there is an increase use of the patent system by Malaysians and an increase in domestic inventive activity. However during the past five years, the overall patent filing in Malaysia has decreased by 8%. This is largely due to a decrease in filing by Non-Malaysians in Malaysia by about 11.7%. This decrease could be attributed to the decline in economic activity in the country due to the 1997-1998 financial crisis and the migration of multinational companies from Malaysia to neighbouring countries.

On the patenting trend in Malaysia, the distribution of patent filings is skewed towards the USA, Japan and the European States. Among the Asian countries, Taiwan ranked first followed by Republic of Korea. The distribution of patent filings based on technology field in Malaysia is concentrated on Section C and Section H of the International Patent Classification. This correlates with the increase in the number of biotechnology and ICT inventions generated by local universities and Government research institutions following the Government's push to make biotechnology and ICT as the main areas of growth over the next decade.

The distribution of patent filings worldwide is, however, very uneven. A small number of countries account for the majority of patent filings, both by residents and non-residents. Applicants from Japan and the United States of America are the largest filers of patent applications, followed by the large industrialized European countries. This distribution is expected to change over time, in particular, as Republic of Korea and China are becoming major industrial economies and the use of the patent system is expected to grow quickly in these countries. Among the ASEAN countries, Singapore has the highest number of filings in Malaysia.

There is a positive trend of inventiveness capacity among Malaysian inventors as evident by the sharp increase in awards secured at international competitions. However, much more needs to be done in transforming these inventions into forms that could be readily introduced into the market.

Chapter 10

INFORMATION AND COMMUNICATION TECHNOLOGY IN MALAYSIA

10.1 INTRODUCTION

The rapid development of Information and Communication Technologies (ICTs) and their pervasive impacts, particularly in terms of accelerating the nation's economic growth, social development and governance has triggered a demand for statistical information on the diffusion of ICT-related activities. ICT statistics are important because they assist in identifying areas where governments can employ ICT to improve and implement their development strategies. Additionally, these statistics provide governments with objective assessments on the ICT development of their countries as well as comparisons with other countries.

In response to this increasing demand, a separate chapter on ICT Indicators has been included, for the first time, in the production of the Malaysian S&T Indicators Report. This chapter will explore the current status of ICT development in Malaysia. The ICT indicators adopted in this chapter can be grouped into three categories, namely, indicators on ICT infrastructure and access, ICT industry and E-commerce.

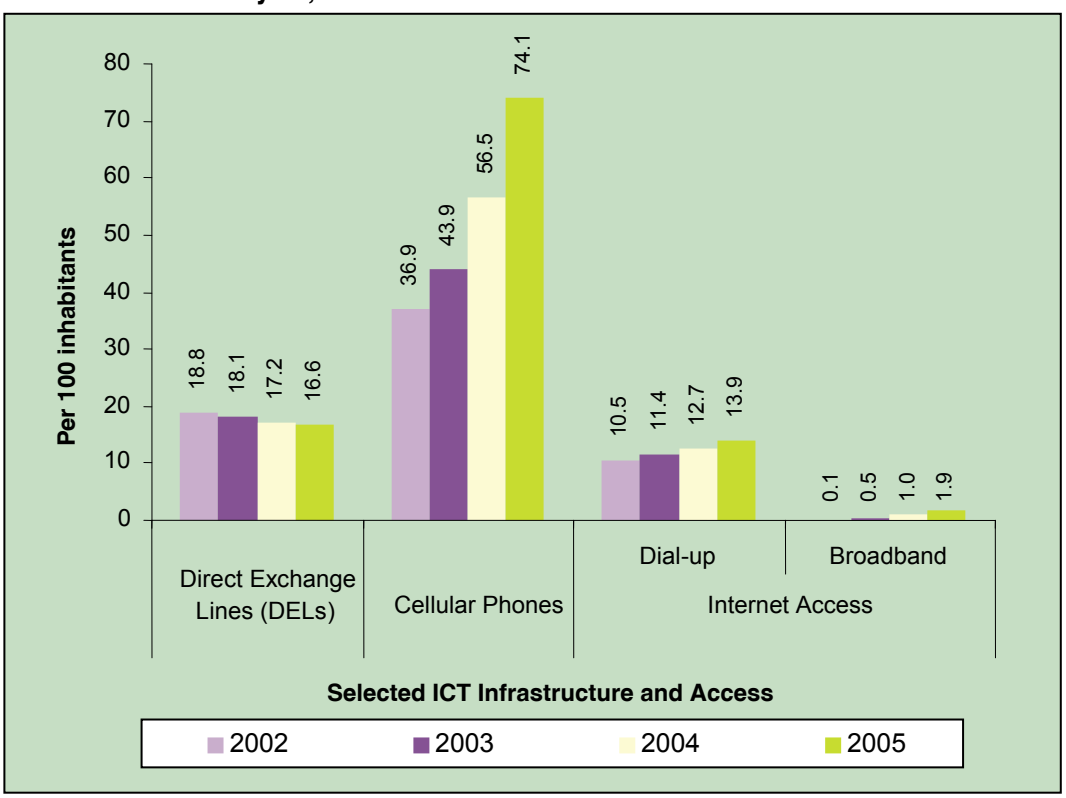
10.2 ICT INFRASTRUCTURE AND ACCESS

Malaysia's ICT infrastructure and access characterized by dramatic growth in cellular phones and steady growth in internet access where dial up is still the main internet access mode.

Figure 10.1 provides an overview on Malaysia's penetration rates for Direct Exchange Line (DEL), cellular phone and Internet access for the period 2002-2005. Some of the recent trends in Malaysia ICT infrastructure and access, which can be drawn from these figures, are:

(a) The penetration rate for DELs is on a downward trend since 2002, suggesting market saturation for this segment;
(b) The penetration rate for cellular phone increased two-fold since 2002, indicating rapid growth;
(c) The penetration rate for Internet access, for both dial-up and broadband, has shown steady increase during the period; and
(d) Dial-up is still the main Internet access mode in Malaysia.

Figure 10.1: Penetration Rates for DELs, Cellular Phones and Internet Access in Malaysia, 2002 - 2005



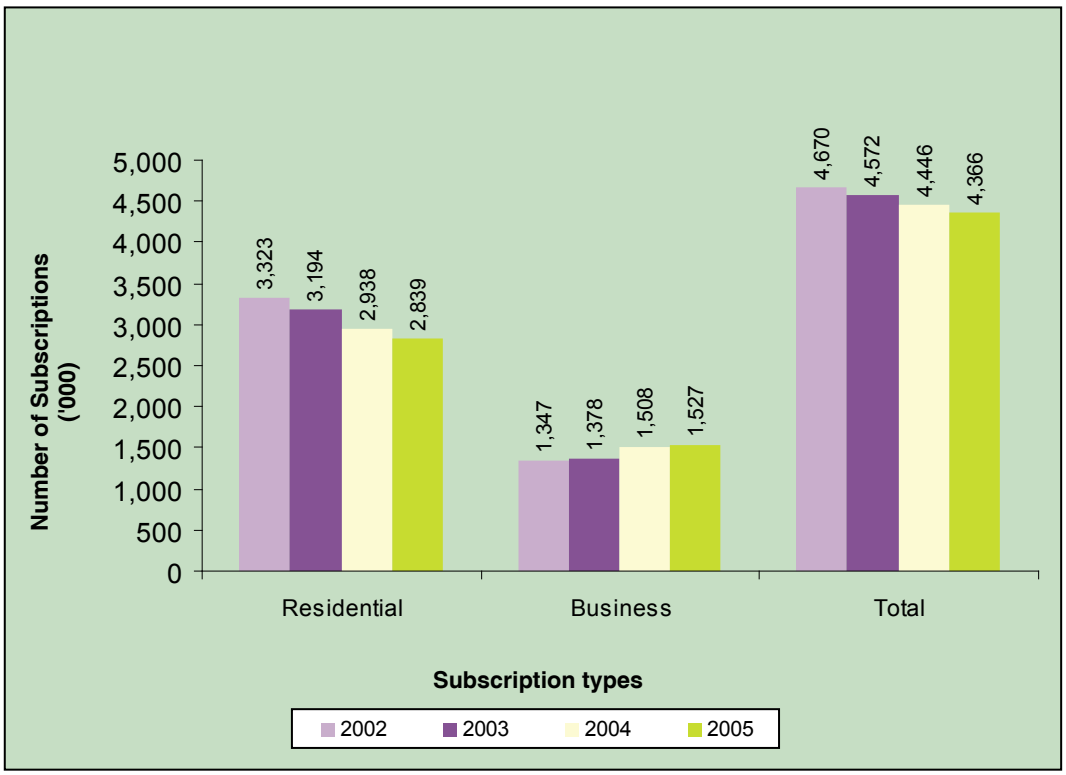
Source: Communication and Multimedia: Selected Facts and Figures (Q1)
Malaysian Communications and Multimedia Commission, 2006

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. Currently there are five DEL licensees in Malaysia, namely Telekom Malaysia Bhd., Celcom Transmission (M) Sdn. Bhd., DiGi Telecommunications Sdn. Bhd., Maxis Broadband Sdn. Bhd., and TT dotCom Sdn. Bhd.

The total number of subscribers and penetration rate for DELs in Malaysia recorded a slight decrease in 2002- 2005.

As shown in **Figure 10.2**, DELs in Malaysia can be classified into residential-owned and business-owned. These two categories of DELs experienced different trends during the period 2002-2005. The number of residential DELs subscribers experienced about 14.6% decline from 3,323,000 in 2002 to 2,839,000 in 2005. In contrast, the number of business DELs subscribers recorded a 13.4% increase in the same period. Overall, the total number of subscriptions for DELs in Malaysia recorded a slight decrease from about 4.67 million to 4.37 million during the period 2002-2005.

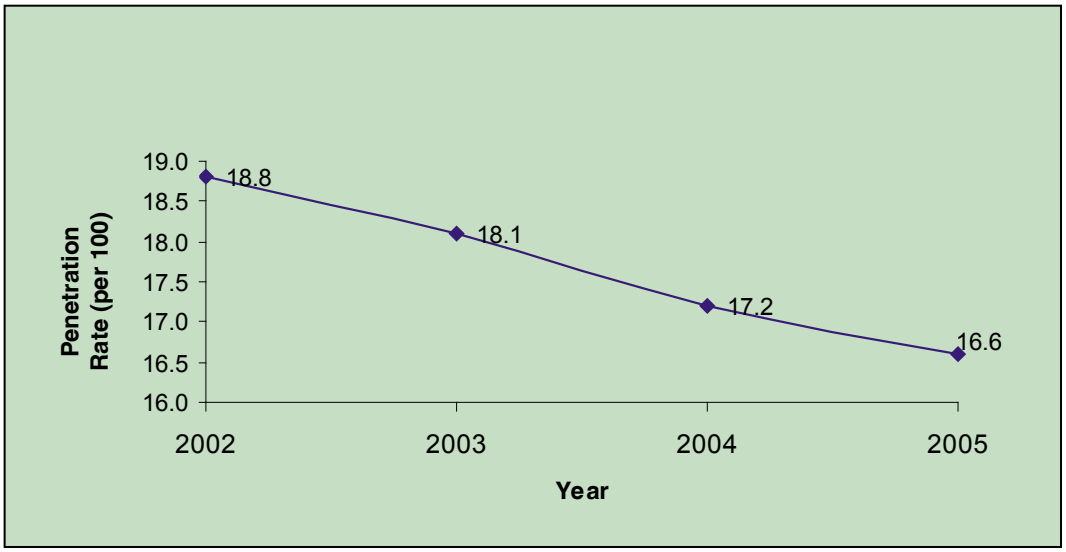
Figure 10.2: Number of Subscriptions ('000) for DELs in Malaysia, 2002 - 2005



Source: Communication and Multimedia: Selected Facts and Figures (Q1)
Malaysian Communications and Multimedia Commission, 2006

Following the decline in subscriptions, the penetration rate for DELs experienced a slight decrease from 18.8 per 100 inhabitants to 16.6 per 100 inhabitants during the period of 2002-2005 (Figure 10.3).

Figure 10.3: Penetration Rate (per 100) for DELs in Malaysia, 2002 - 2005



Source: Communication and Multimedia: Selected Facts and Figures (Q1)
Malaysian Communications and Multimedia Commission, 2006

Surge in number of cellular phone subscribers in Malaysia during 2002-2005. Prepaid cellular phone subscribers comprise 85% of Malaysia's cellular phone market.

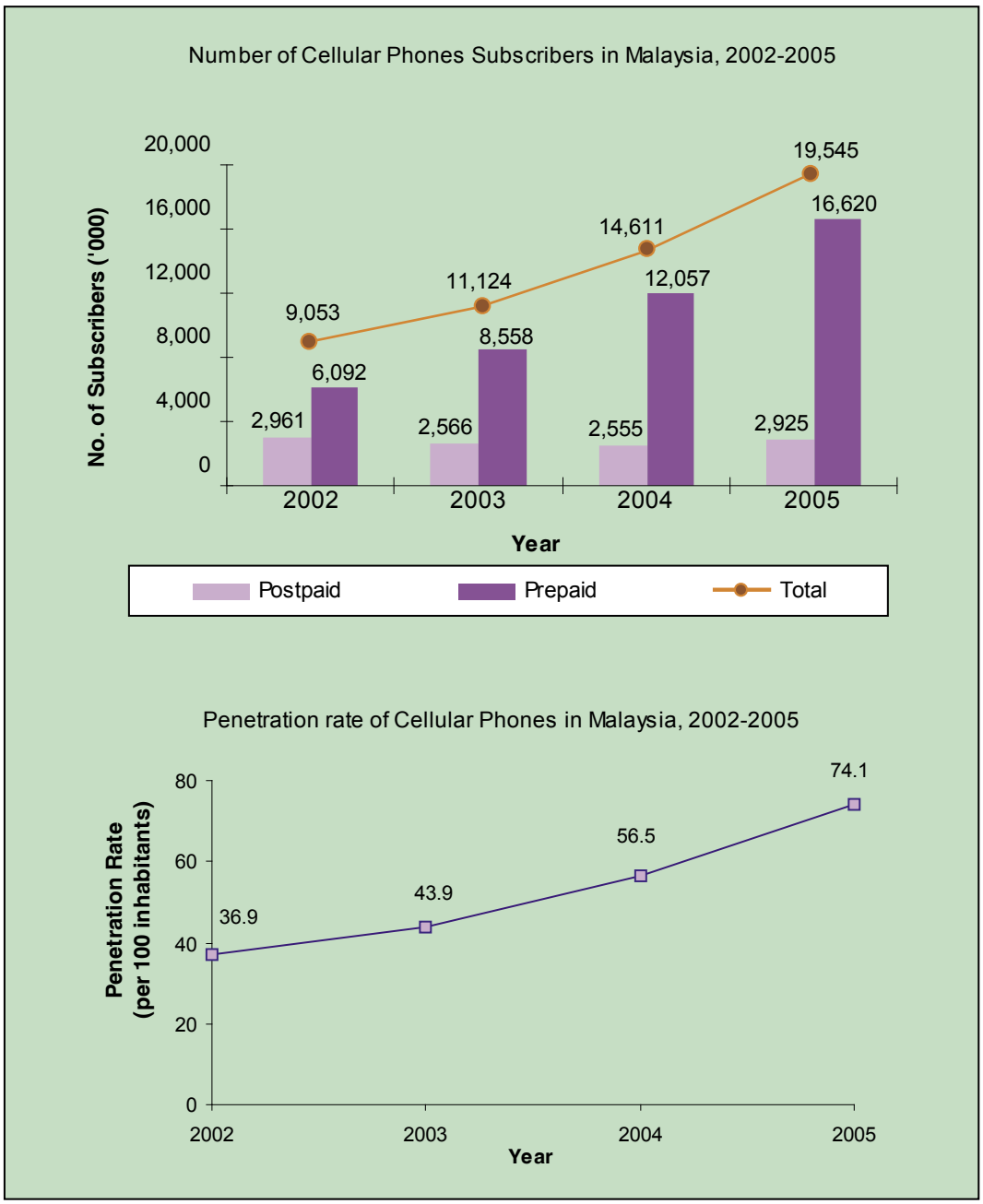
The Information Economy Report 2005 published by the United Nations Conference on Trade and Development revealed that one of the most significant developments in the spread of ICTs during the past few years is the spectacular growth of mobile phone access in all parts of the world, surpassing the number of fixed telephone lines in many countries. A similar development can also be observed in Malaysia, where there has been an explosion in the number of cellular phone subscribers during the period 2002-2005 while the total number of DELs experienced a decline in the same period.

Currently, there are three service providers for cellular phone in Malaysia, namely, Maxis Mobile Sdn. Bhd., Celcom (M) Sdn. Bhd., and DiGi Telecommunication Sdn. Bhd. **Figure 10.4** reveals that the penetration rate of cellular phone subscribers increased sharply from 36.9 per 100 inhabitants in 2002 to 74.1 in 2005. Also, the total number of cellular phones subscribers in Malaysia experienced a two-fold increase in the past four years, that is, from 9,053,000 in 2002 to 19,545,000 in 2005. While the number of postpaid cellular phone subscribers remained constant during 2002-2005, the number prepaid cellular phone subscribers increased more than two-fold in the same period. As a result, prepaid cellular phones accounted for 85% of the Malaysia cellular phone market in 2005, compared to 67% in 2002.

Exponential growth in SMS usage in 2005.

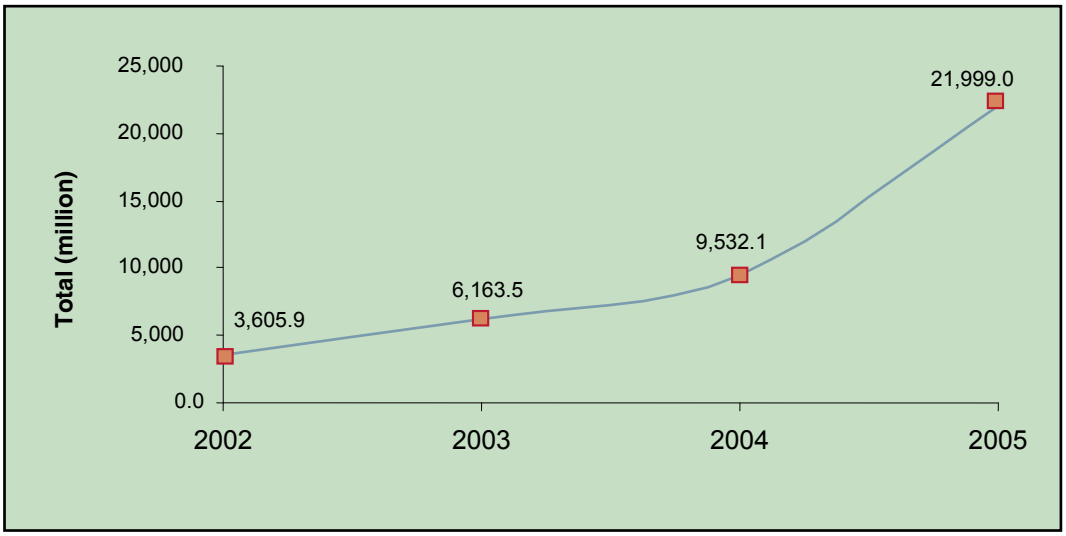
With regard to Short Message Service (SMS) usage in Malaysia, **Figures 10.5** shows that there was a noticeable high national usage of the SMS throughout the country in the year 2005. The total number of SMS messages sent by cellular phone subscribers rose sharply in tandem with the increase in SMS contests in the country. This is evident from the relatively big jump in the number of SMS messages in 2005 (21,999.0 million) compared to the preceding year (9,532.1 million).

Figure 10.4: Cellular Phones in Malaysia, 2002-2005



Source: Communication and Multimedia: Selected Facts and Figures (Q1)
Malaysian Communications and Multimedia Commission, 2006

Figure 10.5: SMS usage in Malaysia, 2002-2005



Source: Communication and Multimedia: Selected Facts and Figures (Q1)
Malaysian Communications and Multimedia Commission, 2006

As highlighted in the Information Economy Report 2005, computers are still indispensable for the development of the information economy and in particular for the application of ICT in e-business processes, even though the Internet is increasingly being accessed through a variety of devices. Rising computer ownership can be observed in Malaysia where the number of computers per 1,000 people increased by almost 58% from 137 in 2002 to 216 in 2005. However, it is important to note that these figures do not represent the number of computer users. This is because computers are often shared and the rate of sharing computers in Malaysia is high.

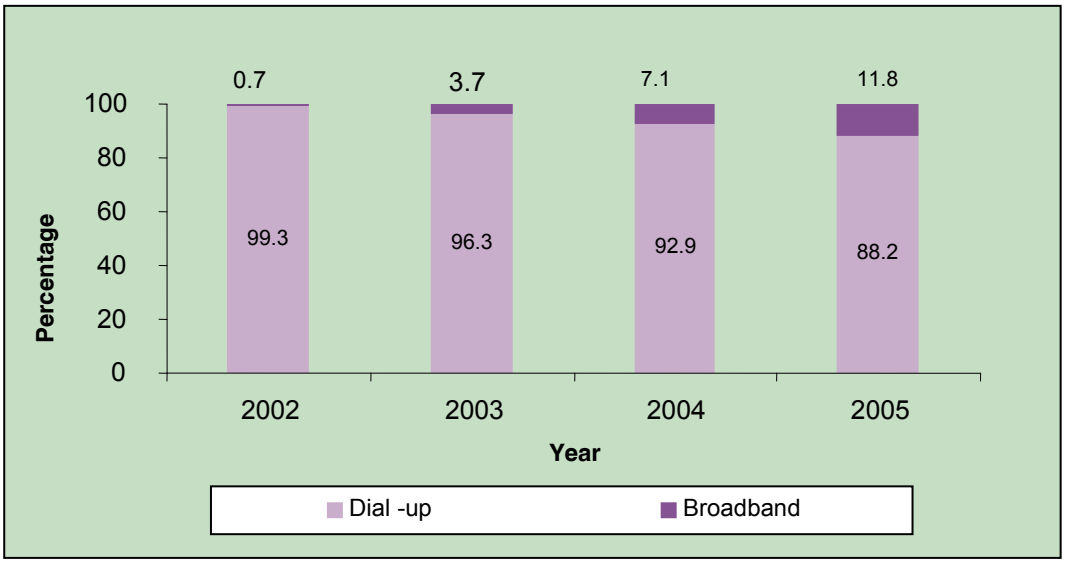
The number of computers per 1,000 people in Malaysia increased to 216 in 2005 - a 57.7% increase over the 2002 figure.

In term of Internet access in Malaysia, currently there are two types of Internet access mode available in Malaysia, namely, dial-up and broadband. For dial-up subscription, the service providers are Telekom Malaysia Bhd. (TMnet), MIMOS Bhd. (Jaring), DiGi Telecommunications Sdn. Bhd. (DiGiNet), and TT dotCom Sdn. Bhd. (TimeNet). On the other hand, TMnet Streamyx, Time Broadband and Maxis Broadband are among the main service providers for broadband services in Malaysia.

As shown in **Figure 10.6**, dial-up is the main Internet access mode in Malaysia during the period of 2002-2005. For instance, almost 88% of Internet subscribers in Malaysia access the Internet through the dial-up mode in the year 2005.

Dial-up is the main internet access mode in Malaysia.

Figure 10.6: Internet Access Modes in Malaysia, 2002-2005

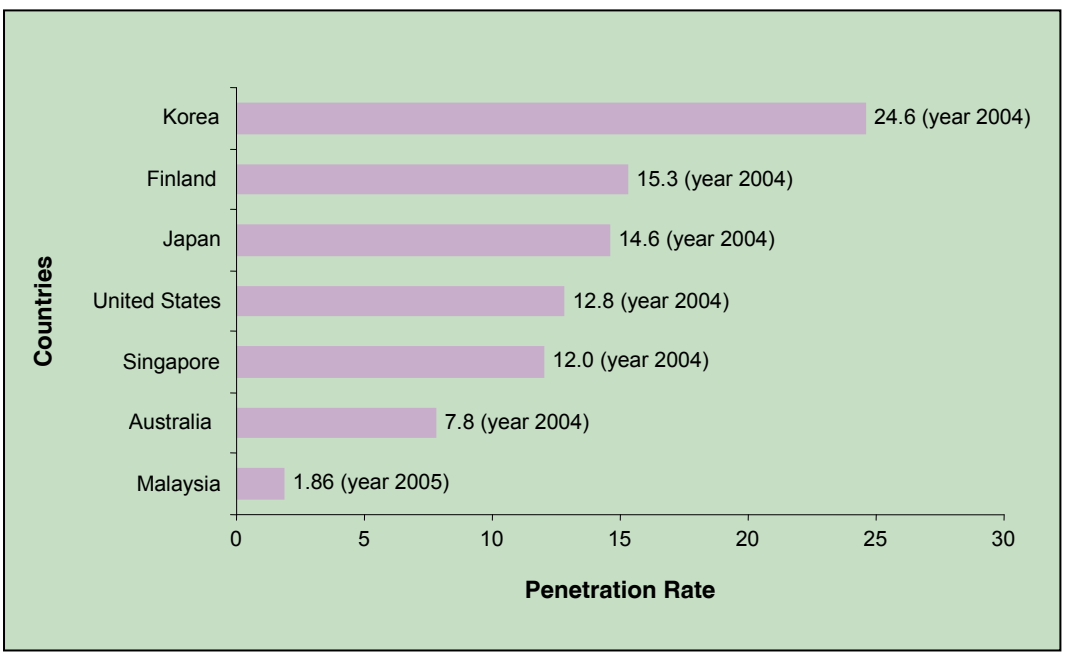


Source: Communication and Multimedia: Selected Facts and Figures (Q1)
Malaysian Communications and Multimedia Commission, 2006

Malaysia's broadband penetration rate, although improving, is well below levels reached by developed countries

Although broadband subscription and penetration rate in Malaysia has increased sharply over the past four years they are still very low compared to other developed countries. For instance, as shown in **Figure 10.7**, the penetration rate for broadband subscription in Malaysia is 1.86 in 2005. This is very low compared to broadband penetration rate for year 2004 in countries like Republic of Korea (24.6), Japan (14.6), United States (12.8), and Singapore (12.0). The digital divide in terms of broadband could have serious implications for Malaysian enterprises to be globally competitive.

Figure 10.7: Broadband Penetration Rates for Malaysia and Selected Countries



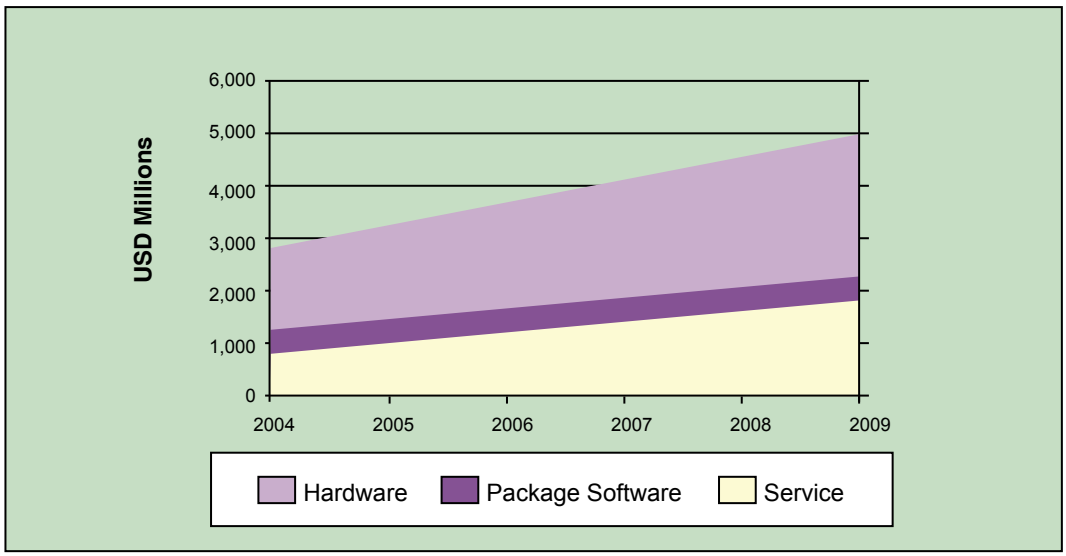
Source: Information Economy Report 2005

10.3 ICT INDUSTRY

Malaysia's ICT market continues to register double digit growth.

Survey findings by IDC Market Research (M) Sdn. Bhd. revealed that Malaysia's ICT market continues to show remarkable growth and dynamism in various areas. ICT spending in Malaysia has reached US$3,261 million in 2005 and IDC forecasts that this market will experience a compound annual growth rate (CAGR) of over 12% from 2004 to 2009. The survey also showed that the highest percentage of ICT spending was in the field of hardware (61.5%); followed by IT services (25.3%), and packaged software (13.2%) **(Figure 10.8)**.

Figure 10.8: Malaysia's IT Spending by Hardware, Software, and Services 2004-2009

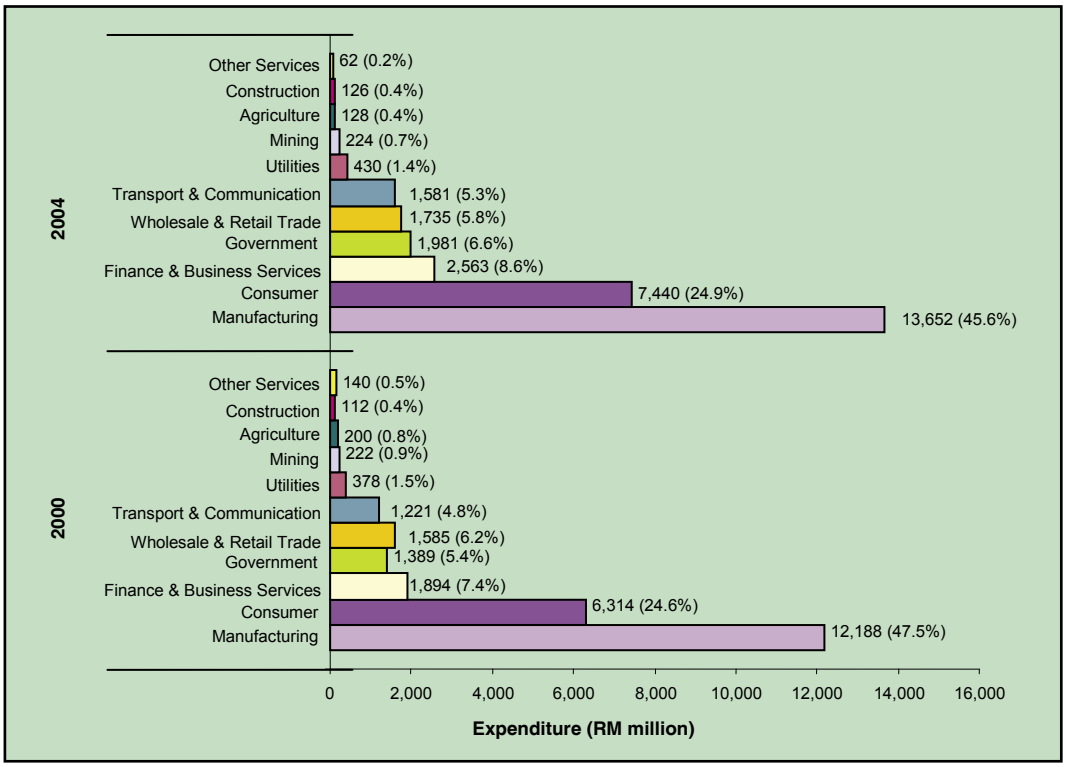


Source: IDC Market Research (M) Sdn. Bhd.

ICT expenditure increased 16.7% during period 2000 – 2004 with the government sector recording the largest growth rate.

Figure 10.9 provides further details on Malaysia's ICT expenditure by sector for the years 2000 and 2004. The total ICT expenditure in 2004 was RM 29,922 million, an increase of RM 4,279 million or 16.7% from 2000. Of this amount, manufacturing sector was the major contributor which constituted 45.6% of total expenditure. Other main contributors were consumer (24.9%), finance and business services (8.6%), and government (6.6%). The growth of ICT expenditure in the government sector (42.6%) was the largest among the sectors reflecting strong government drive to utilize ICT in its operations. This was followed by finance and business services (35.3%). The Global Competitiveness Report 2005-2006 ranked Malaysia 2nd among 117 countries in terms of government programmes promoting the use of ICT.

Figure 10.9: ICT Expenditure by Sector in Malaysia, 2000 - 2004

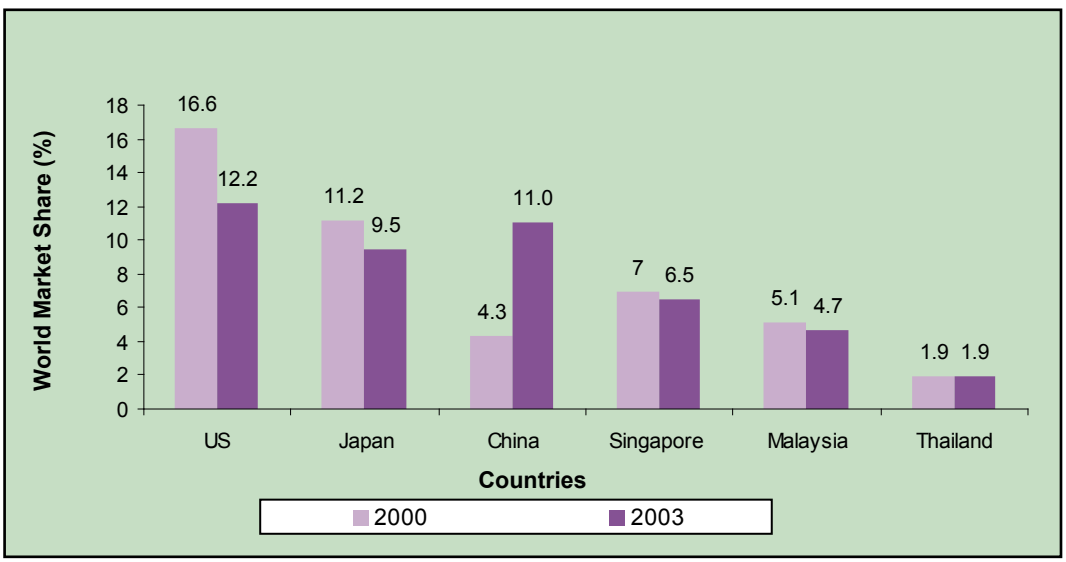


Source: Ninth Malaysia Plan 2006-2010
* Figure in bracket indicate percentage of total expenditure

The Information Economy Report 2005 classifies Malaysia as one of the major exporters in ICT goods in 2003. As illustrated in **Figure 10.10**, Malaysia contributed about 5% of the total ICT goods in the world market. However, its share of the global market has declined in recent years due to relocation of ICT manufacturing businesses to lower wage countries such as China.

Malaysia's global market share of ICT goods has reduced in recent years due to industry dynamics.

Figure 10.10: Selected Major Exporters of ICT Goods, 2000 and 2003

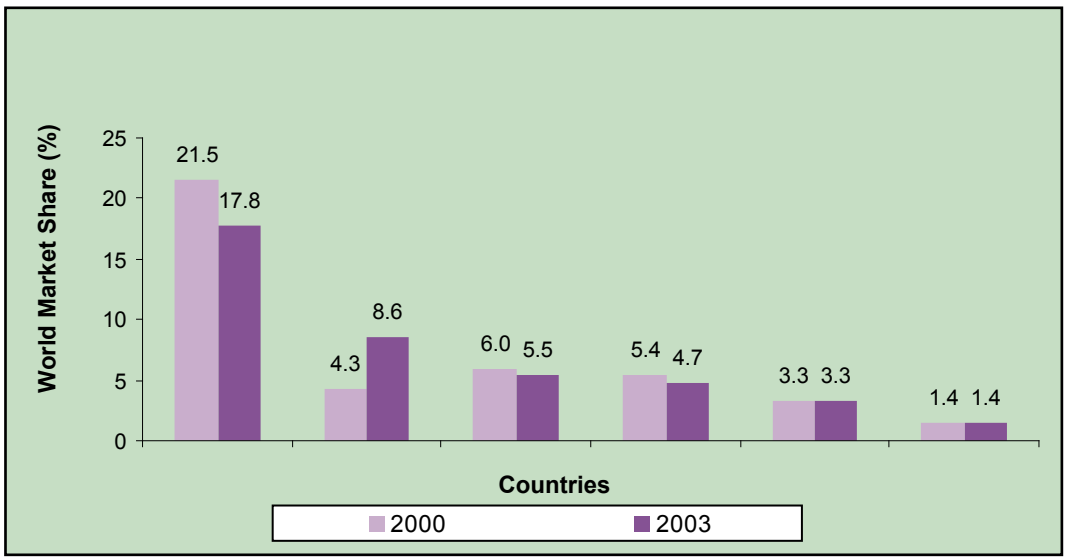


Source : Information economy report 2005, UNCTAD.

Malaysia is also one of the major importers of ICT goods accounting for 3.3% of the global market share in importing ICT goods for the years 2000 and 2003 **(Figure 10.11).**

Malaysia is a major importer of ICT goods in 2003 accounting for some 3.3% of global ICT imports.

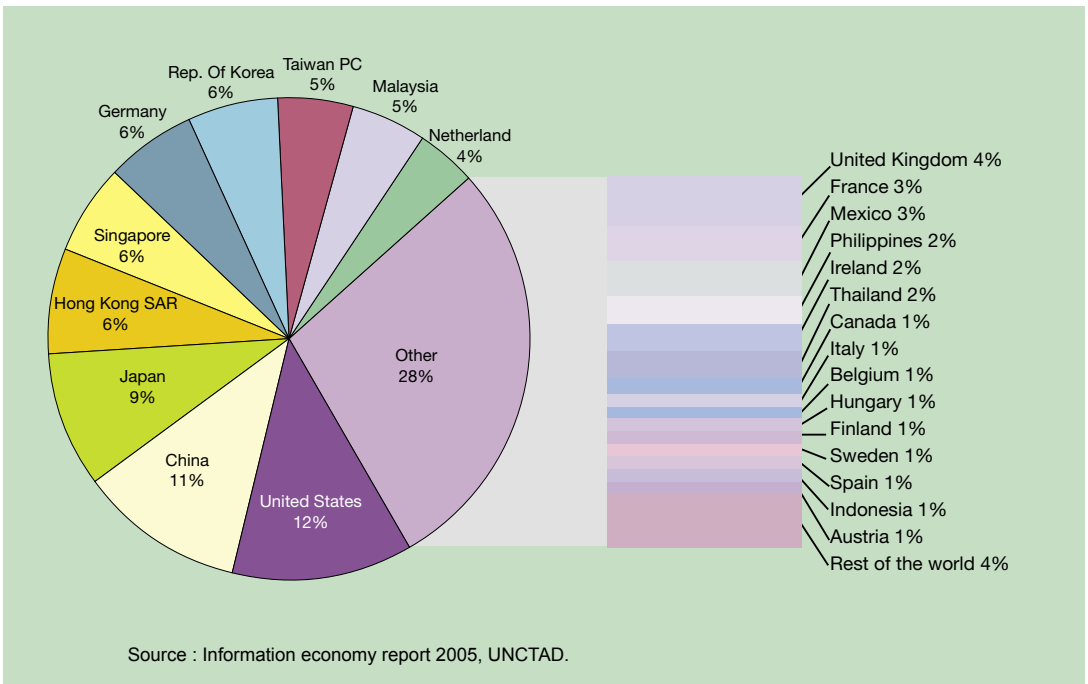
Figure 10.11: Selected Major Importers of ICT Goods, 2000 and 2003



Source : Information economy report 2005, UNCTAD.

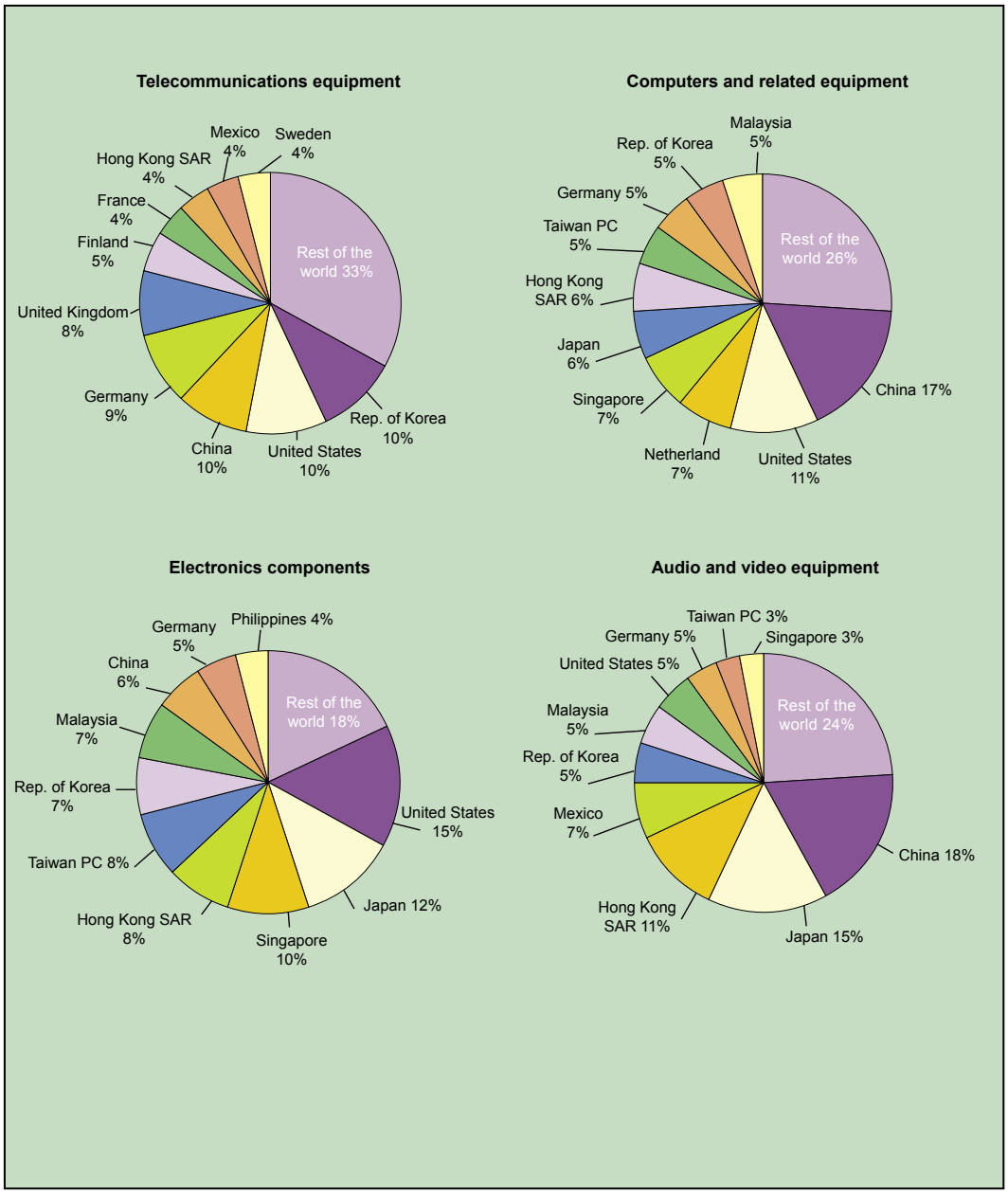
Figure 10.12 illustrates the major exporters of ICT goods (including Malaysia) in 2003. In terms of ICT goods by category, Malaysia was one of the main exporters for computers and related equipment, electronic components, and audio and video equipment in 2003 (see **Box 10.1**). Additionally, Malaysia emerged as one of the major importers of electronic components for the same year **(Box 10.2)**.

Figure 10.12: Major exporters of ICT goods, 2003



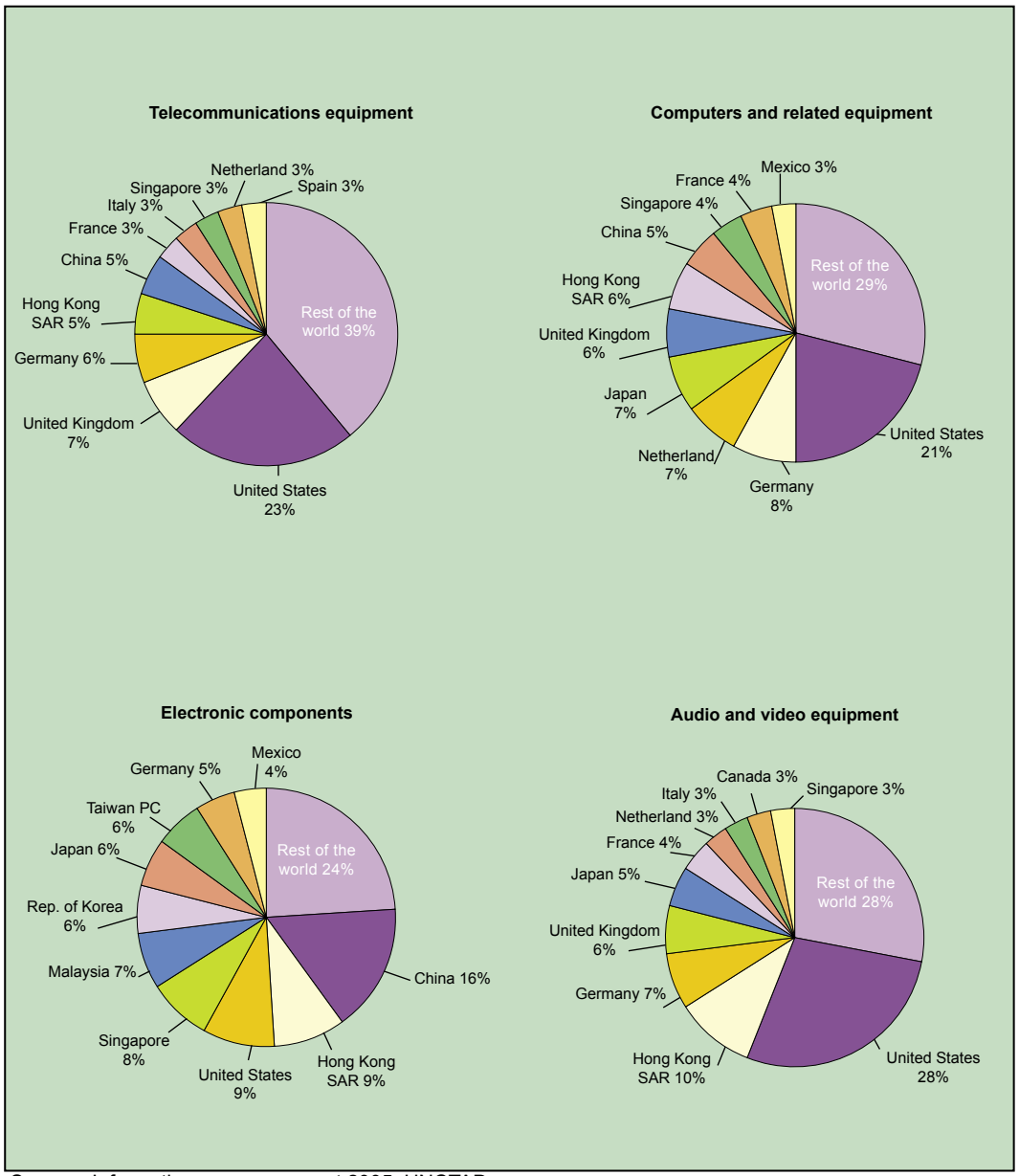
Source : Information economy report 2005, UNCTAD.

Box 10.1: Major exporters by category of ICT goods, 2003 (million USD)



Source : Information economy report 2005, UNCTAD.

Box 10.2: Major importers by category of ICT goods, 2003 (million USD)



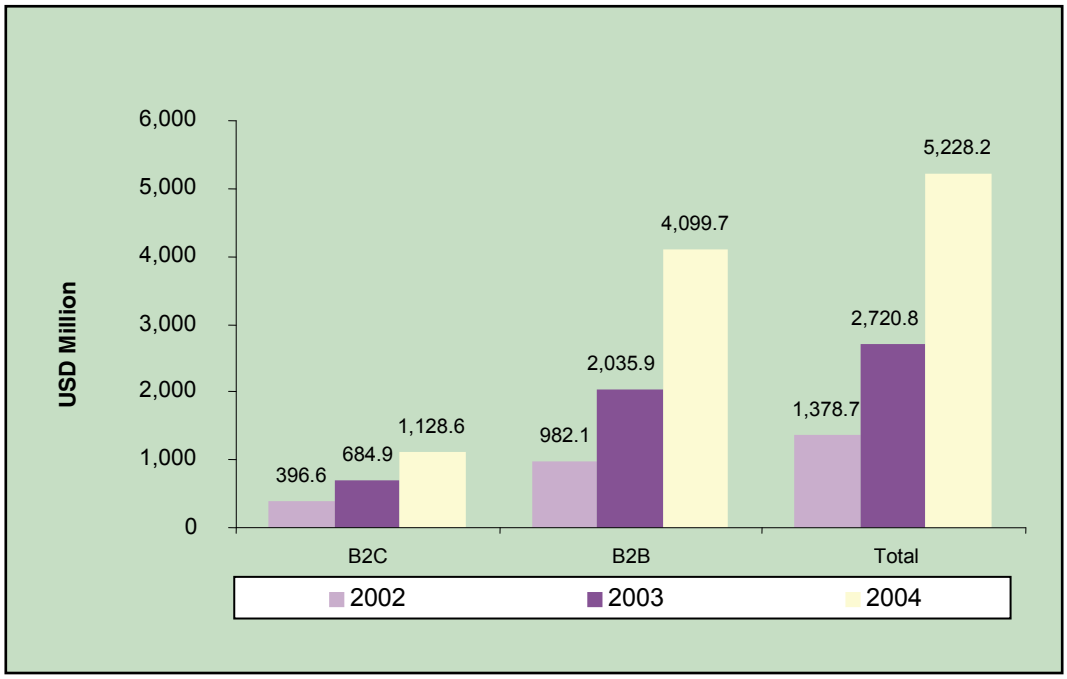
Source : Information economy report 2005, UNCTAD.

10.4 E-COMMERCE

E-commerce is rapidly gaining acceptance in Malaysia. Most of the e-commerce activities are B2B based.

The substantial increase in e-commerce in Malaysia from US$1,376.7 million in 2002 to US$2,720.8 million in 2003, and US$5,228.3 million in 2004 demonstrates the growing acceptance of e-commerce in Malaysia **(Figure 10.13)**. In terms of e-commerce activities, most of the e-commerce activities were business-to-business (B2B) based compared to business-to-customer (B2C) based. B2B activities made up almost 70% to 78% of the e-commerce market from 2002 until 2004, and these trends are expected to continue for the coming years.

Figure 10.13: Electronic Commerce in Malaysia, 2002-2004



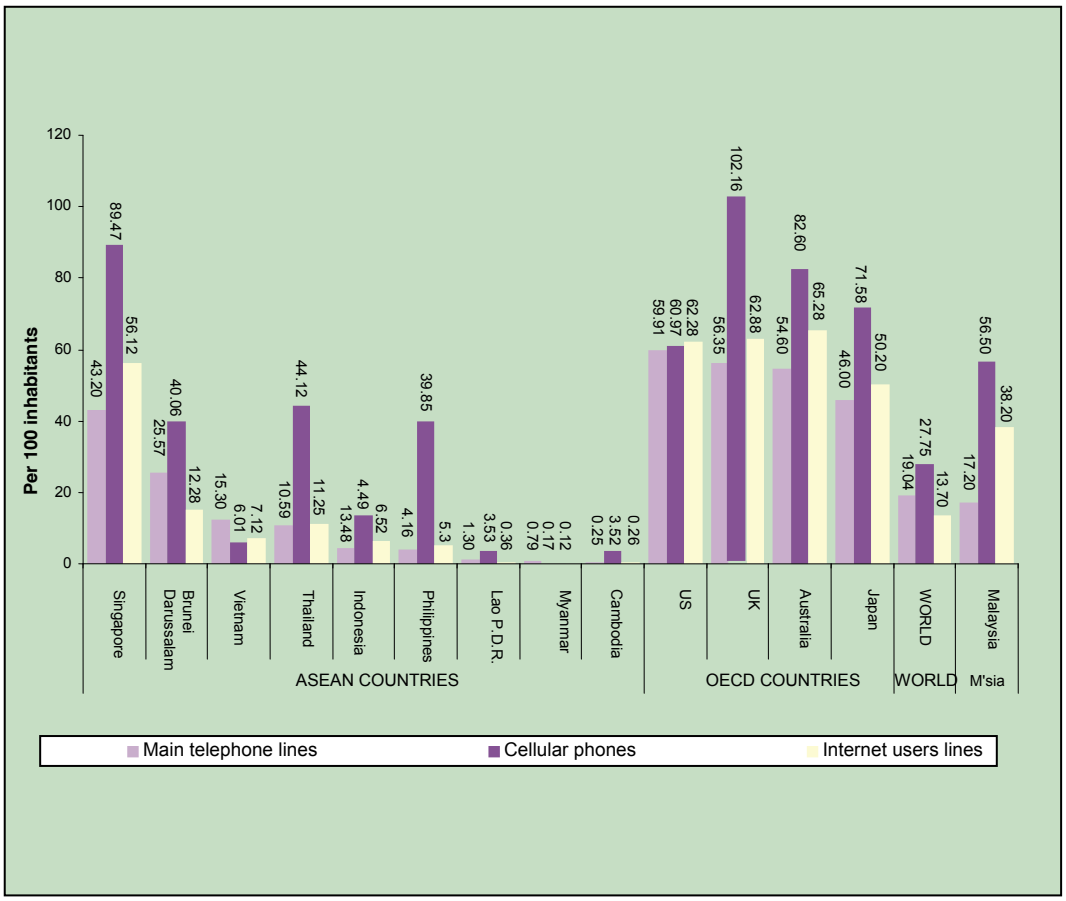
Source: IDC September 2003; MSC Facts & Figures 2004

10.5 INTERNATIONAL COMPARISONS

Regionally, Malaysia is one of the top three ASEAN countries in terms of penetration rates in main telephone lines, cellular phones and Internet subscription per 100 inhabitants as indicated in **Figure 10.14**. Malaysia's position in these selected indicators, with the exception of cellular phone penetration, is well below the level observed in OECD countries such as US, UK, Australia and Japan.

Malaysia is one of the top three ASEAN countries in terms of main telephone lines, cellular phones and internet subscription per 100 inhabitants.

Figure 10.14: Main Telephones Lines, Cellular Phones and Internet Users per 100 inhabitants in ASEAN and Selected OECD Countries, 2004

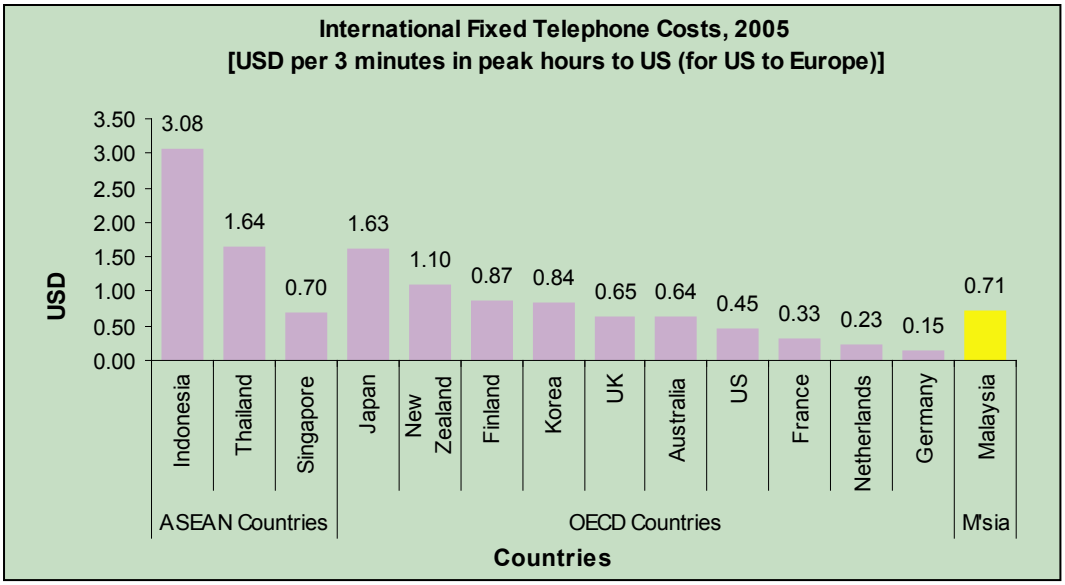


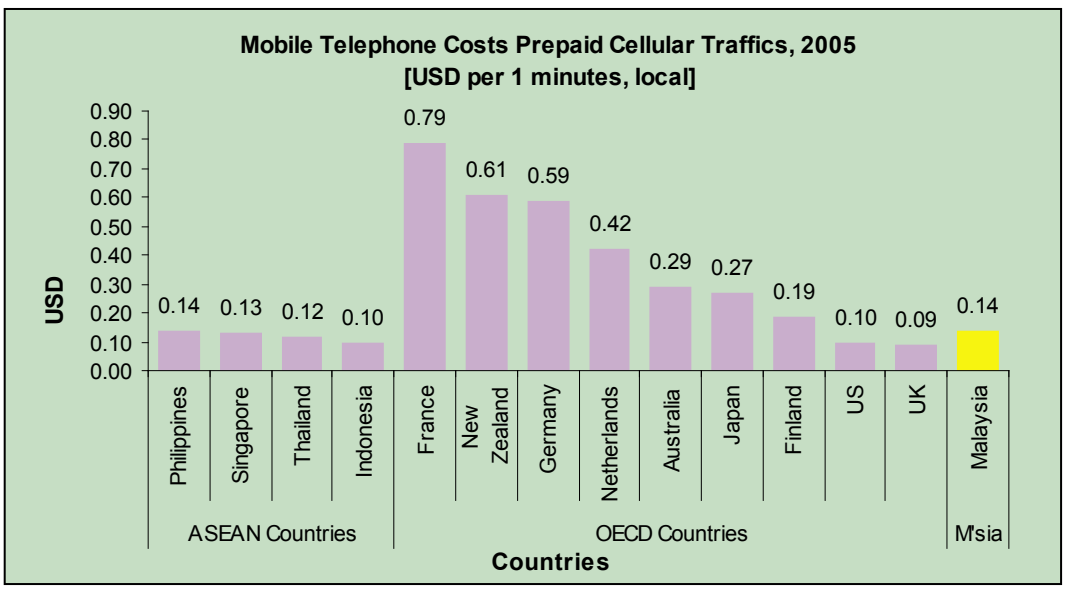
Source: Communication and Multimedia: Selected Facts and Figures (Q1)
Malaysian Communications and Multimedia Commission, 2006

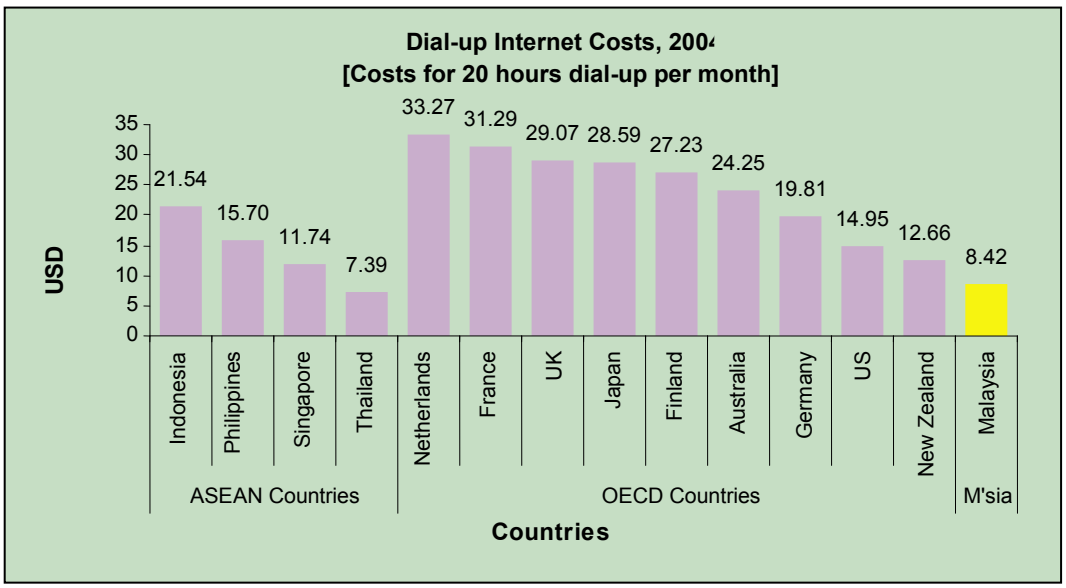
Figure 10.15 provides a comparative survey of Malaysia's ICT tariffs in relation to that found in other countries. Malaysia is competitive against other ASEAN countries (Indonesia, Philippines, Singapore and Thailand) in terms of international fixed line costs and dial-up Internet costs, but not in terms of mobile telephones costs and broadband costs (compared to Singapore). In comparison to other OECD countries, Malaysia is competitive in terms of dial-up Internet costs, international fixed telephones costs and mobile telephone costs. However, broadband costs in Malaysia are much more expensive compared to most of the OECD countries.

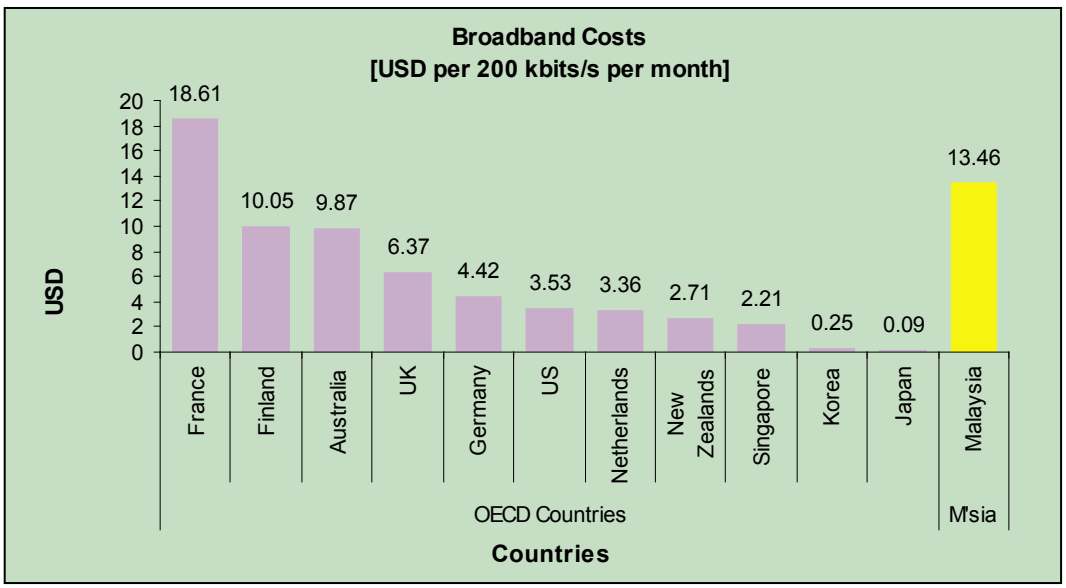
Malaysia's ICT tariffs are competitive in most indicators except broadband costs where we are even more expensive than those found in most OECD countries.

Figure 10.15: ICT Tariffs in Selected ASEAN and OECD Countries







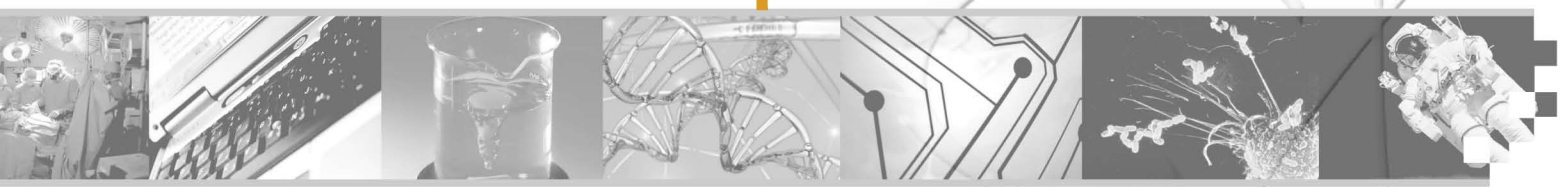


Source: Communication and Multimedia: Selected Facts and Figures (Q1), Malaysian Communications and Multimedia Commission, 2006 and World Competitiveness Yearbook 2006

10.6 CONCLUSION

ICT usage and diffusion in all sectors of the economy is fundamental to the growth of a knowledge-intensive economy. The growing adoption of ICT in the economy is reflected in the increasing expenditure of ICT by both the public sector and industry. Increasing e-commerce transactions is evident of a growing acceptance to harness the potentials of ICT in business operations. Malaysia is serious about strengthening her basic ICT infrastructure as reflected in the improving penetration rates of telephone lines, Internet subscription, cellular phones and computer ownership achieved by the nation over the past 4 years which are well above the global average although below that of the levels present in the developed countries. We need to pay attention to increasing the broadband penetration rate in the country which will be aided by charges that are less prohibitive than the presently prevailing rates. Malaysia has been a major player of the ICT industry for several years but her leading position particularly in terms of exports has declined gradually in recent years due to industry dynamics particularly relocations to more cost competitive economies. This global industry shift suggests that Malaysia must pay careful attention towards developing more value added goods in this dynamic sector.

Chapter 11



PUBLIC AWARENESS, KNOWLEDGE AND ATTITUDE TOWARDS SCIENCE AND TECHNOLOGY

11.1 INTRODUCTION

The 2004 survey is the sixth in a series of surveys on The Public's Awareness of S&T. It was aimed at assessing the public's awareness and understanding of, interest in, and attitudes towards S&T. International comparisons were also made to see how we fare against advanced countries such as Japan and USA.

The objectives of the 2004 study were: (i) to compare the results obtained for 2004 and that obtained in previous surveys in order to see whether there has been an appreciable difference in the public's attitude, interest in, and understanding of S&T (ii) to carry out international comparisons (iii) to provide recommendations on how to improve public awareness of S&T, based on the analysis of the findings.

The methodology of the study involves conducting a nationwide survey on a random sample of 6,896 respondents, using standard questionnaires. The parameters included in the sampling are: (i) geographical distribution in terms of the following zones; Central (Perak, Selangor and Kuala Lumpur), Eastern (Kelantan, Terengganu and Pahang), Northern (Penang, Kedah and Perlis), Southern (Negeri Sembilan, Malacca and Johore), Sabah and Sarawak (ii) ethnic group (iii) gender and (iv) age, based on the 2000 Population Census.

11.2 THE FINDINGS

The findings of the study were given in terms of the following categories:

(i) Perceived interest in science and technology
(ii) Perceived knowledge of science and technology
(iii) Attitudes towards science and technology
(iv) Public understanding of science and technology
(v) Sources of information and awareness of S&T

The information in this chapter is solely based on the Public Awareness of Science and Technology Malaysia 2004 Report by MASTIC. Thus the data given in the figures below has the given report as its source. The data was obtained through a set of questionnaires covering the following areas:

1. Perceived knowledge of science and technology—related and general issues. About 11 issues will be covered through the questions given, for example: nuclear technology, information and computer technology, and the environment.
2. Attitudes towards science and technology. The questionnaire has about 15 questions which test public attitude towards science and technology. One example is the question whether they agree with the statement that, "Science and technology is very important for social advancement".
3. Understanding of scientific terms and concepts. This is designed to test scientific literacy amongst the public by asking them questions which test their understanding of basic scientific concepts most of which find applications in daily life. For example, the statement: "The oxygen we breathe comes from plants", to which they have to give a true/false answer.

The study carried out under the auspices of MASTIC and published in the Public Awareness of Science and Technology Malaysia 2004 Report, involved a nationwide survey involving 6,896 respondents, stratified across parameters such as (i) gender (ii) age group (iii) rural-urban location (iv) ethnicity (v) geographical zones, i.e. Central, Eastern, Northern, Southern, and East Malaysia. The purpose was to obtain representative sampling, so that the results obtained from the sample group match and reflect that of the Malaysian population as a whole. Apart from intra-country stratification and comparisons, international comparisons were also made. The objective of the study was to assess the public's awareness of S&T, captured through three main components, namely: (i) Attitude towards S&T (ii) Interest in S&T, and (iii) Understanding of S&T.

Malaysians display good understanding of scientific concepts and knowledge but weak on questions involving higher level scientific knowledge. However, international comparisons on scientific understanding may not be valid due to peculiarities in each country

An analysis of the trends from 1998 to 2004 shows that the interest of the Malaysian public towards S&T has remained relatively constant. This is revealed by the mean scores obtained throughout the given period: a mean score of 2.74 for 1998, 2.42 for 2000, 2.41 for 2002, and 2.40 for 2004.

The 2004 survey also reveals that Malaysians have a relatively good understanding of scientific concepts and knowledge. For example the percentage of those giving correct responses to given statements was quite high as in the case of statements such as, and 'Smoking causes lung cancer. However, they do not fare as well on questions involving a higher level of scientific knowledge, such as 'Milk that is contaminated by radioactivity will be safe to drink after boiling' (15.1%), and 'electrons are smaller than atoms' (26.4%). However, there is a controversial aspect to the study, with regard to 2 questions particularly, involving the following statements: (i) the universe began with a huge explosion (ii) Man, as we know him today, originated from an earlier animal species. For these two statements, the 'Malaysian' answer is 'False', while the Americans and Europeans gave 'True' as the answer. This has to do with religious sensitivities, since Muslims reject Darwin's theory of evolution and has a theistic theory of the origin of the universe (as opposed to the Big Bang theory). The implication is that: international comparisons might not be valid.

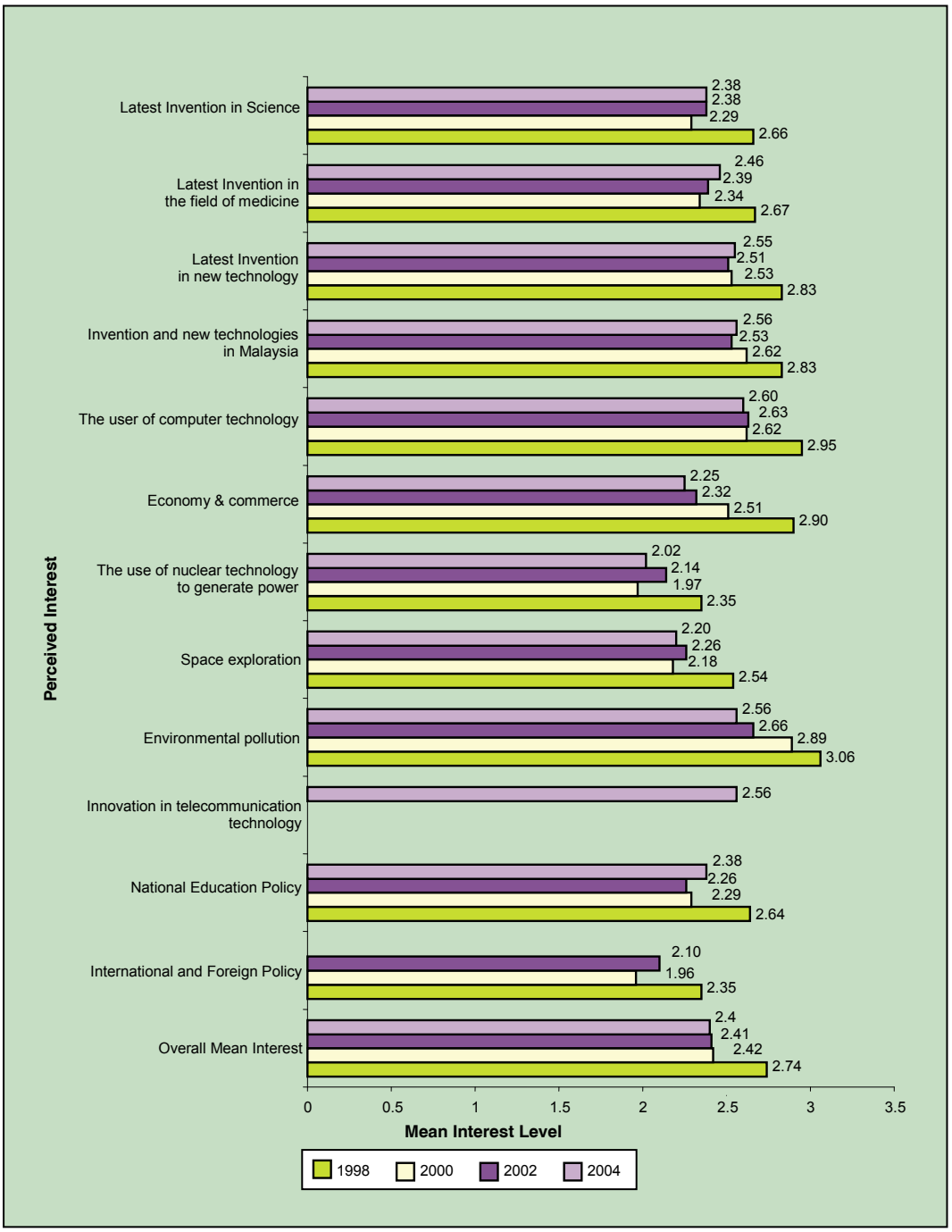
11.2.1 Perceived Interest in Science and Technology

Perceived interest of Malaysian public towards S&T has remained constant over the period 2000-2004. Computer technology registered highest interest among respondents whilst nuclear technology and space exploration were of least interest

Perceived interest refers to what the respondent has professed or reported to be his or her interest in S&T. It is measured by the respondents' responses to 11 items in Question 14 of 'The Public's Awareness of Science and Technology Malaysia 2004 Questionnaire' in which they were asked to state whether they were very interested, interested, not sure, or not interested with regard to the 11 issues.

Overall, the perceived interest of the Malaysian public in S&T has remained relatively constantly from 2000 to 2004, in which the mean score was 2.42 for 2000, 2.41 for 2002, and 2.40 for 2004 (See **Figure 11.1** below). A score between 2.0 and 3.0 indicates that the level of interest was between 'slightly interested' and 'moderately interested'. Lower levels of interest as compared to 2002, were recorded in 5 items, namely environmental pollution (2.56/2.66), space exploration (2.20/2.26), the use of nuclear technology to generate power (2.02/2.14), economy and commerce (2.25/2.32), and the use of computer technology (2.60/2.63). Part of the reason for the decline in the level of interest can be explained by the slightly different code used in the 2004 survey in which a score of 4=very interested, 3=interested, 2=not sure, and 1=not interested, while the code used in the previous surveys gave a score of 4=interested, 3=moderately interested, 2=slightly interested, and 1=not interested.

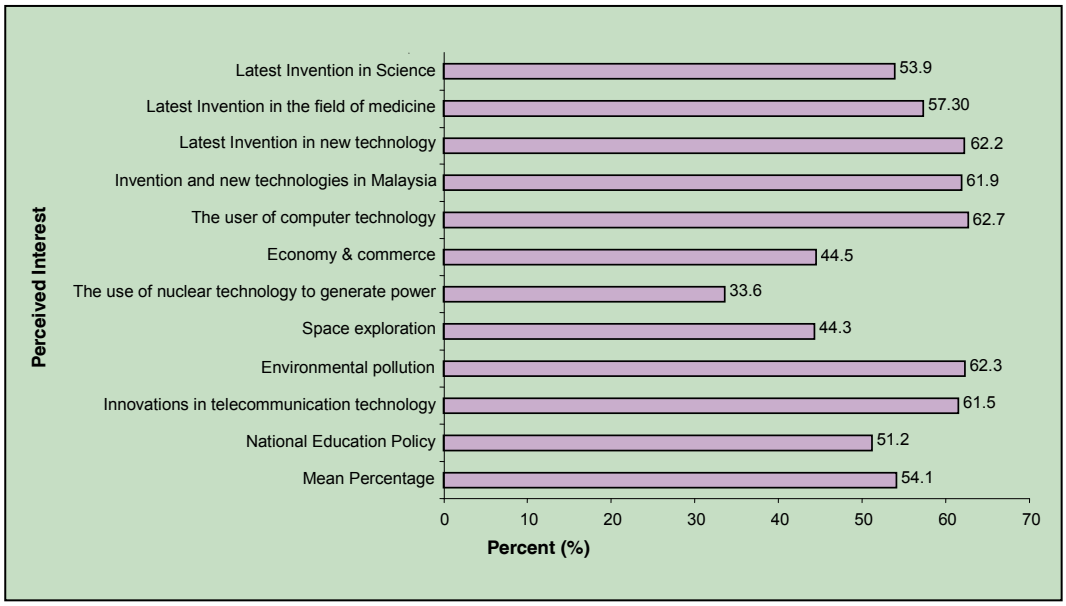
Figure 11.1: The Public's Perceived Interest in S&T Issues - Data Series



Source: Public Awareness of Science and Technology Malaysia 2004 Report

As for the individual items in the 2004 survey, the mean percentage across 11 items for 'interested +very interested' was 54.1 (**Figure 11.2**), which indicates that slightly more than half of the Malaysian public were interested in S&T and S&T-related issues. Of all the 11 items on which the respondents were surveyed, computer technology recorded the highest level of interest among the respondents (62.7% in the interested and very interested category), followed by 'environmental pollution' (62.3%), 'the latest inventions in new technology' (62.2%), and 'inventions and new technologies in Malaysia' (61.9%). Malaysians were least interested in 'the use of nuclear technology' (where only 33.6% were in the interested and very interested category), followed by space exploration (44.3%), and economy and commerce (44.5%).

Figure 11.2: The Public's Perceived Interest in S&T Issues 2004



Source: Public Awareness of Science and Technology Malaysia 2004 Report

In terms of demographic distribution, we see differences between the various groups in terms of their professed or perceived interest in S&T, as shown in the 2004 survey results. In terms of gender, more men reported interest in S&T as compared to women. In terms of locality, urban residents professed a higher interest in S&T as compared to rural residents. In terms of age group, youth expressed the highest interest in S&T followed by children and adults. In terms of ethnicity, Malays showed the highest interest in S&T as compared to other races. And as expected, in terms of educational background, those with tertiary education expressed the highest interest as compared to those with lesser academic qualifications.

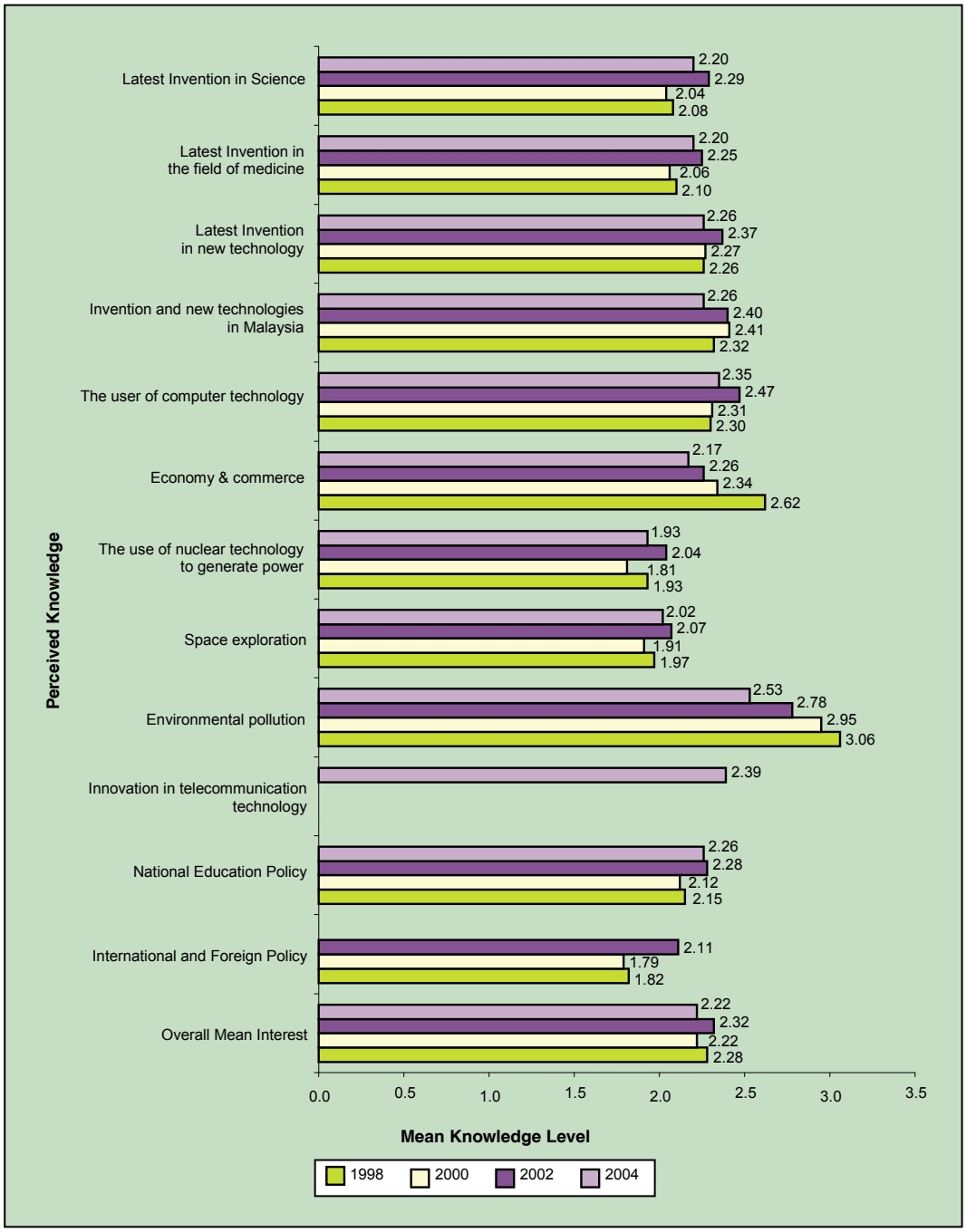
11.2.2 Perceived Knowledge in Science and Technology

Perceived knowledge is defined as 'the public's perceptions of what they know about science and technology', and is measured by the respondents' responses to 11 items in Question 14 of the 'Public's Awareness of Science and Technology Malaysia 2004' in which they were asked to state whether they had good, average, weak, or no knowledge at all on the 11 issues.

Malaysians perceived themselves as having between poor and average knowledge of S&T. This perception has not changed much over the period 1998-2004. It was also found that perceived knowledge is lower than level of interest.

The survey from 1998 to 2004 showed that Malaysians perceived themselves as having between a 'poor and average knowledge of S&T', as indicated by an overall mean score of 2.28 for 1998, 2.22 for 2000 and 2004, and 2.32 for 2002 (**Figure 11.3**). There seems to be no significant change over the years in their perceived knowledge in S&T. However, it should be noted that a slightly different scale was used in 2004 as compared to the previous years. While the scale used in 1998, 2000 and 2002 used 1 to denote 'no knowledge', 2 to denote 'poor knowledge', 3 to denote an 'average knowledge', and 4 to denote 'excellent knowledge', the scale in 2004 used 1 to denote 'no knowledge', 2 to denote 'weak knowledge', 3 to denote 'average knowledge' and 4 to denote 'good knowledge'.

Figure 11.3: The Public's Perceived Knowledge in S&T Issues - Data Series

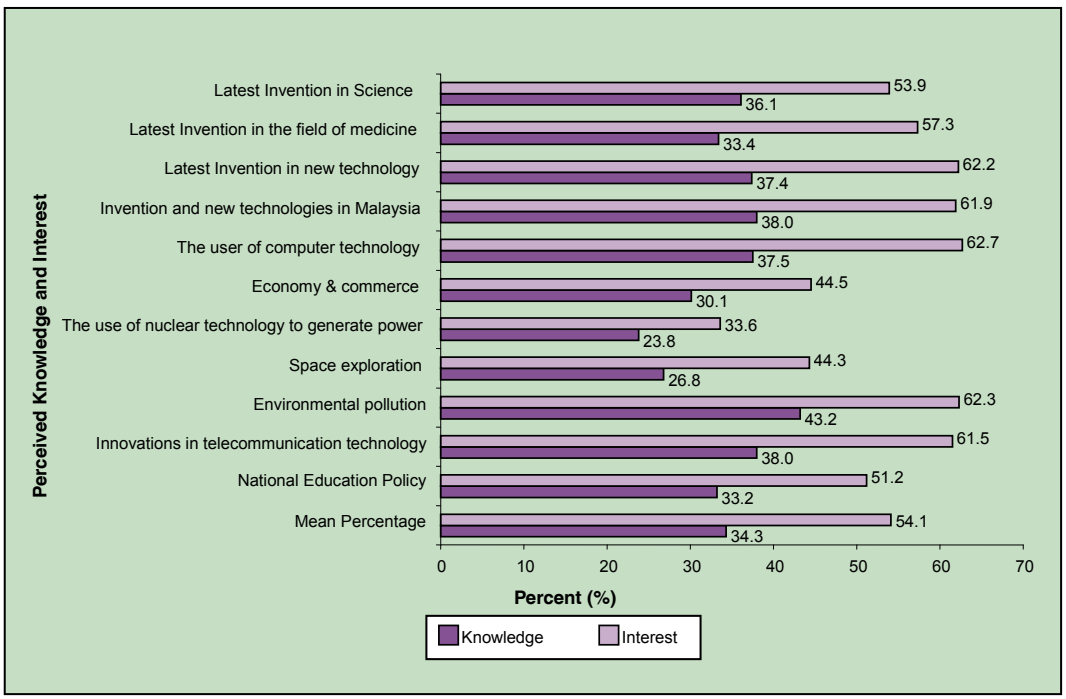


Source: Public Awareness of Science and Technology Malaysia 2004 Report

Out of the 12 items surveyed in 2004, 10 recorded a decrease in level of perceived knowledge when compared to the 2002 data (See **Figure 11.3** above), while the item on 'innovation in telecommunications technology' was only introduced in the 2004 survey. This systematic overall decrease can be partly explained by the new scale used for 2004. However, the decrease in each item was so slight that it does not amount to anything significant. However, the fact that it occurred across almost all the items surveyed, is a matter of concern.

When their perceived knowledge in S&T is compared to their level of interest, it was found that their perceived knowledge is lower than their level of interest in the items surveyed, as shown in the 2004 survey. For example, 37.5% of the respondents reported that they had average knowledge of the use of computer technology compared to 62.7% who said that they were interested to very interested in the issue. 37.4% said that they had average knowledge of the latest inventions in new technology compared to the 62.2% who said that they were interested to very interested in the issue. The mean percentage for perceived knowledge was 34.3, as compared to the score for perceived interest which was higher at 54.1 (**Figure 11.4**). This indicates that even though inculcating interest in S&T is important, interest is not a sufficient indicator of knowledge in a given field, and that the inculcation of interest should be followed by attempts to create a truly S&T knowledgeable society.

Figure 11.4: Comparison between Perceived Knowledge and Perceived Interest 2004



Source: Public Awareness of Science and Technology Malaysia 2004 Report

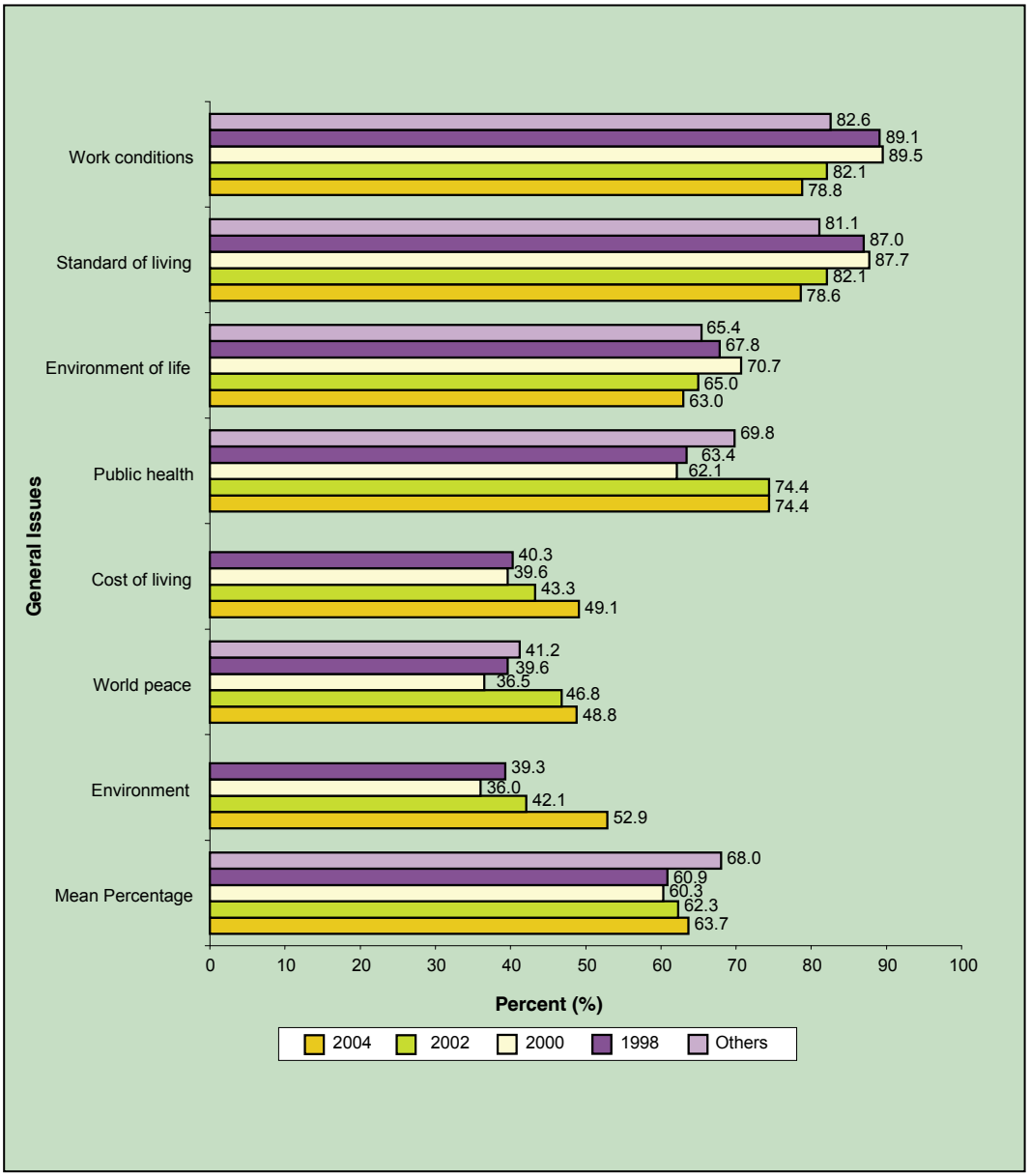
11.2.3 Attitude Towards Science and Technology

Attitude of Malaysians towards S&T has improved appreciably over the period 1996-2004

The attitude of Malaysians towards S&T was measured in terms of their responses to Questions 16, 17, 18, 20 and 21 of 'The Public's Awareness of Science and Technology Malaysia 2004' questionnaire.

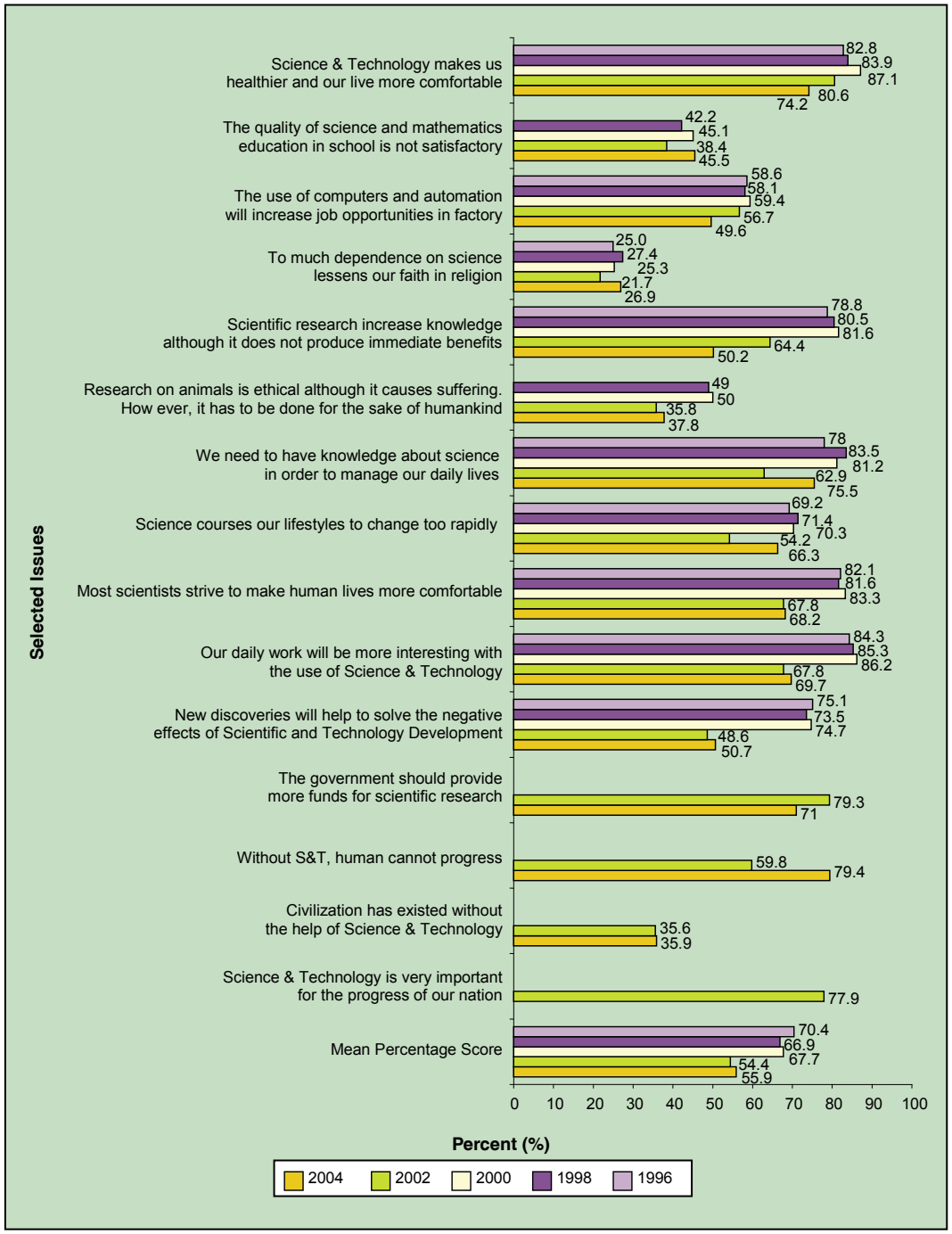
In general, public attitude towards S&T can be gauged from the results of surveys carried out from 1996 to 2004 on (i) public attitudes towards S&T on general issues, and (ii) public attitudes on S&T on selected issues. For (i), the data series gave a mean score of 68.0 percentage points for 1996, 60.9 for 1998, 60.3 for 2000, 62.3 for 2002, and 63.7 for 2004, indicating a slight improvement from 2000 to 2004 **(Figure 11.5**). The results for (ii) gave a mean score of 70.4 for 1996, 66.9 for 1998, 67.7 for 2000, 54.4 for 2002, and 55.9 for 2004 (**Figure 11.6**). Although there seems to be no consistent pattern here, the 2004 score showed a slight improvement over the previous 2002 survey.

Figure 11.5: Public Attitudes Towards S&T on General Issues - Data Series



Source: Public Awareness of Science and Technology Malaysia 2004 Report

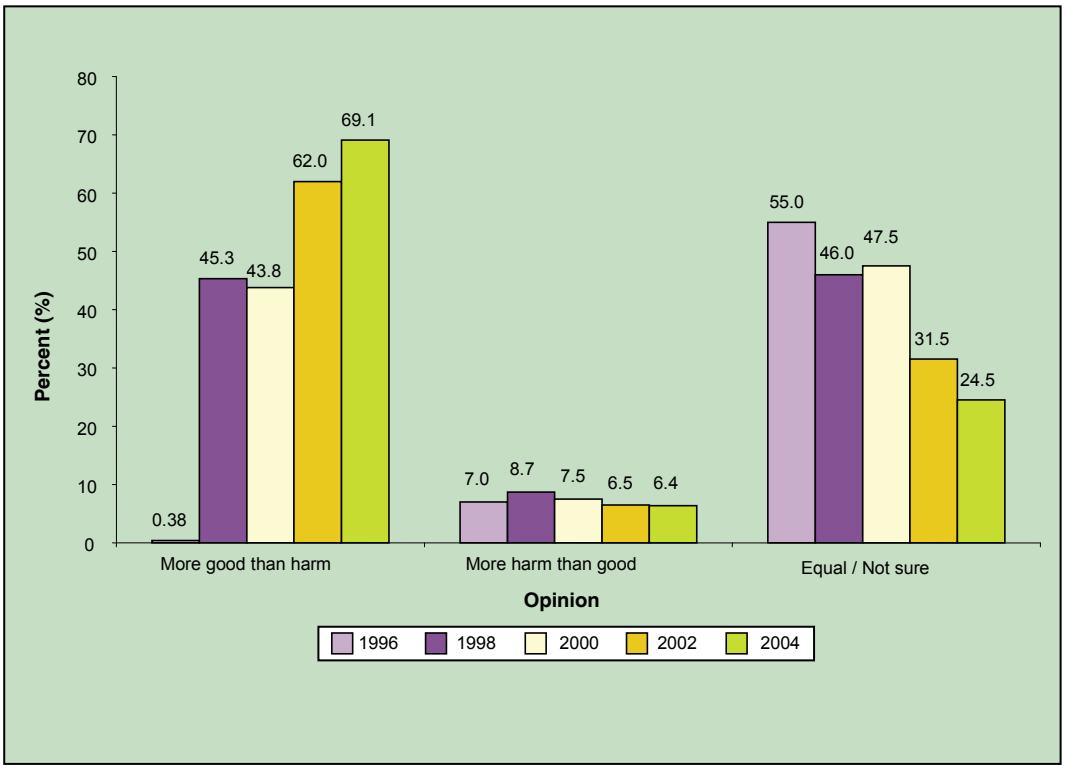
Figure 11.6: Public Attitudes Towards S&T on Selected Issues - Data Series



Source: Public Awareness of Science and Technology Malaysia 2004 Report

Other indicators also seem to support the conclusion that the attitude of Malaysians towards S&T has improved over the years. One example is shown by the scores obtained in tests conducted on attitudes towards scientific research. For instance in 2004, 69.1% of Malaysians agreed that scientific research has more positive than negative effects, compared to 62.0% who agreed with that statement in 2002, 43.8% in 2000, 45.3% in 1998 and 38% in 1996 (**Figure 11.7**).

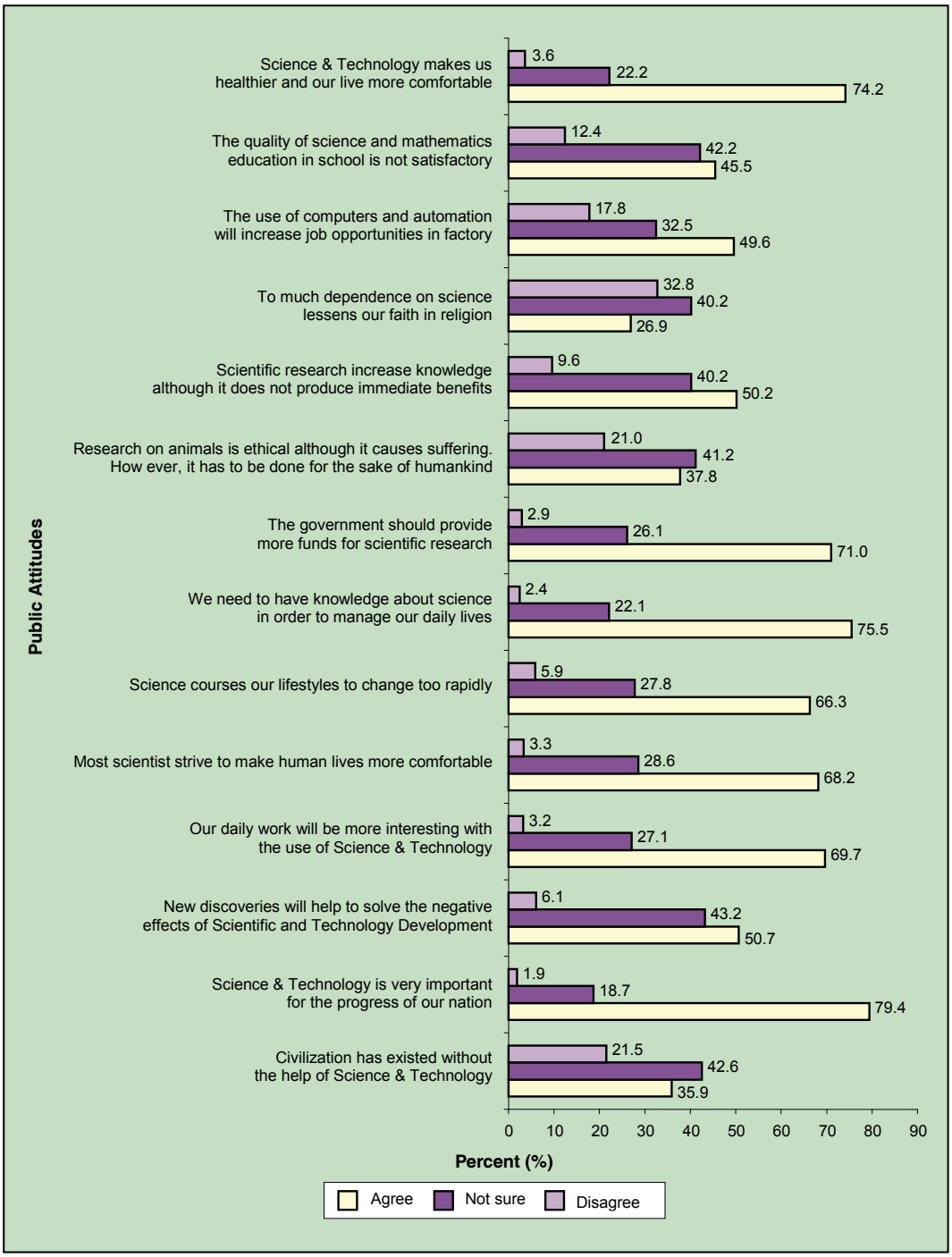
Figure 11.7: Opinions of Public on Effects of S&T - Data Series



Source: Public Awareness of Science and Technology Malaysia 2004 Report

Responses to Q 21 in the 2004 survey, which consists of 14 statements to which they have to state their response in terms of: (i) agree (2) (ii) not sure (2), and (iii) disagree (1), is also indicative of their attitude towards S&T (**Figure 11.8**). The statement which records the highest percentage of agreement was 'Science and Technology is very important for the progress of our nation' (79.4%), followed by 'We have to have knowledge about science in order to manage our daily lives' (75.5%), 'Science and Technology makes us healthier and our lives more comfortable' (74.2%), 'The government should provide more funds for scientific research' (71.0%), 'Our daily work will be more interesting with the use of science and technology' (69.7%), 'Most scientists strive to make human lives more comfortable' (68.2%). All in all, these responses indicate a positive attitude amongst Malaysians towards S&T.

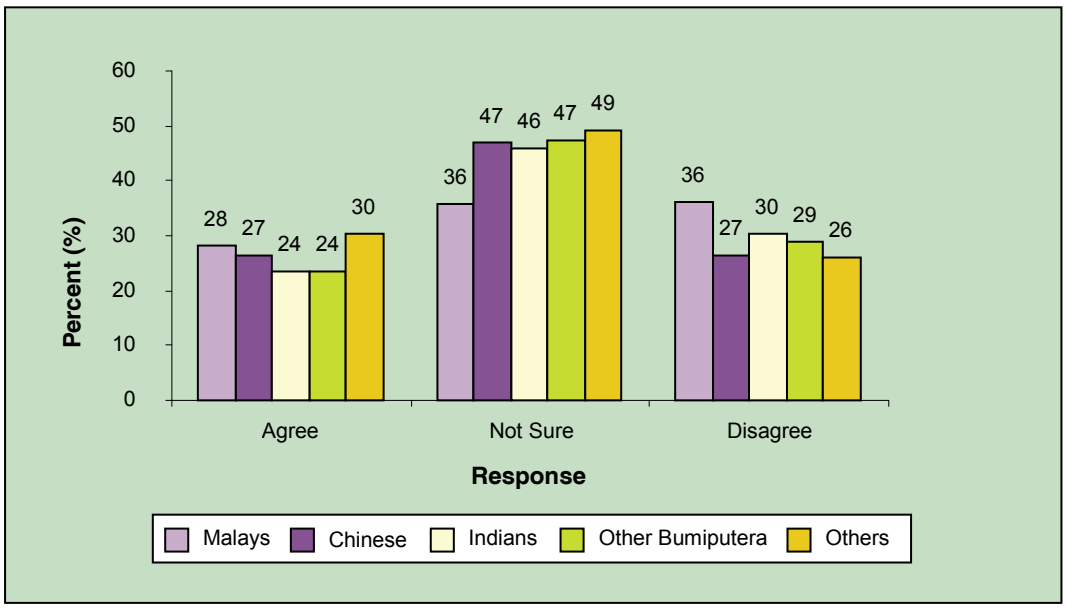
Figure 11.8 Public Attitudes Towards S&T Issues 2004



Source: Public Awareness of Science and Technology Malaysia 2004 Report

The response towards S&T, in relation to religious and ethnic factors, is also an interesting field of study, in which some of the survey results on attitudes towards S&T, can throw some light. For the statement, "Too much dependence on science lessens our faith in religion" in Question 21, the response by ethnicity is as shown in **Figure 11.9** below:

Figure 11.9: The response by ethnicity to the statement "Too much dependence on science lessens our faith in religion"



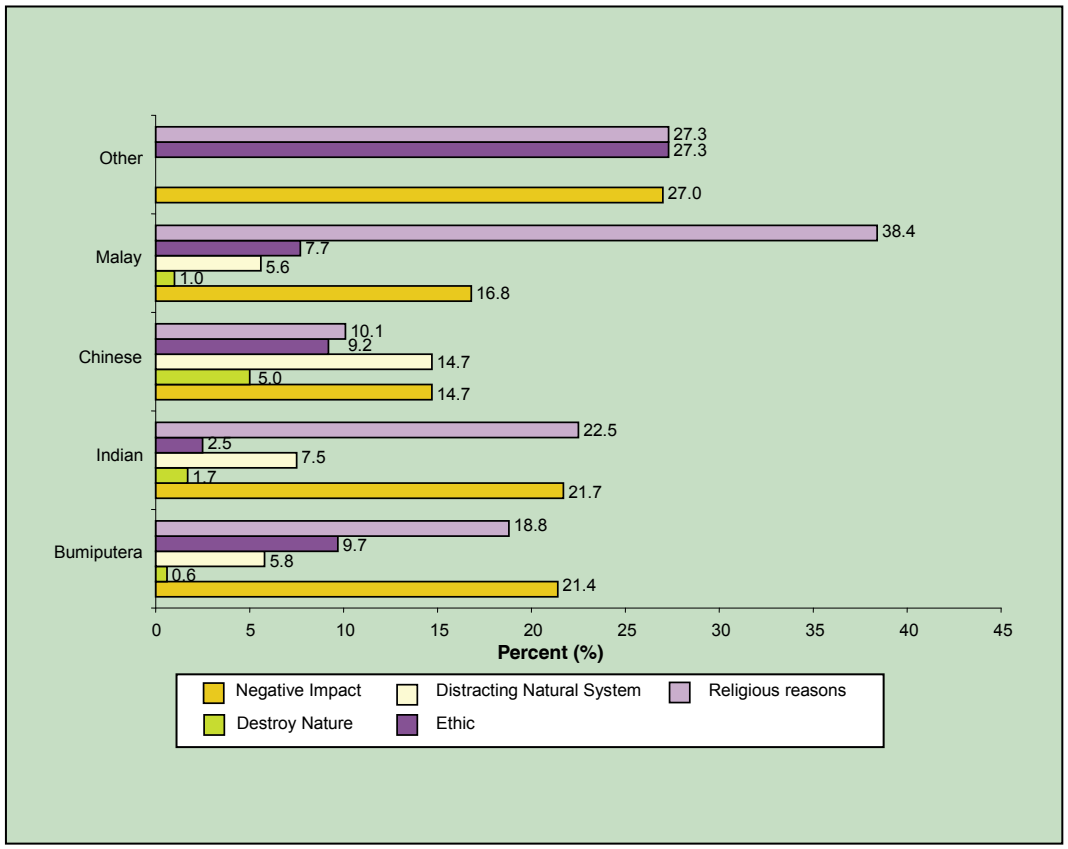
Source: Public Awareness of Science and Technology Malaysia 2004 Report

Malaysians generally do not regard science as incompatible with their respective religions

For the Malays the majority (36%) disagreed with that statement, and an almost equal number (35.7%) said they were 'not sure'. Only a minority group of about 28.3% said that they agreed that 'too much dependence on science lessens our faith in religion'. This goes to show that Malays generally, do not regard science as being incompatible with Islam. Compared to the Chinese and Indians, there do not seem to be much difference in the percentage of those who agreed that 'too much dependence on science lessens our faith in religion'. However, for the Chinese and Indians, the majority of them (47.1% for the Chinese and 46.0% for the Indians) said that they were not sure whether dependence on science lessens their faith in their respective religions.

However, with respect to the 'reasons for disagreement with genetic engineering' (2004), 38.4% of Malays stated 'religious reasons' as their response, while only 10.1% of the Chinese and 22.5% of the Indians said so (Figure 11.10). This goes to show the strong influence of Islamic ethics on scientific practice among Muslims.

Figure 11.10: Reasons for Disagreement with Genetic Engineering 2004



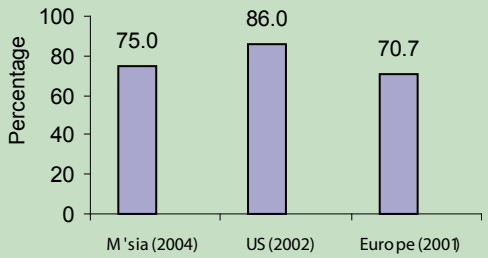
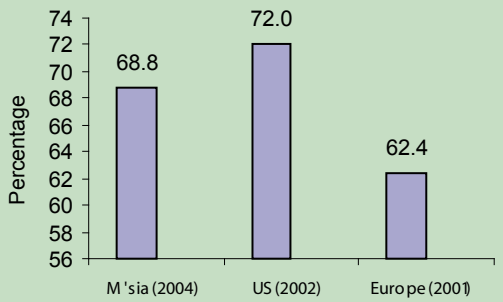
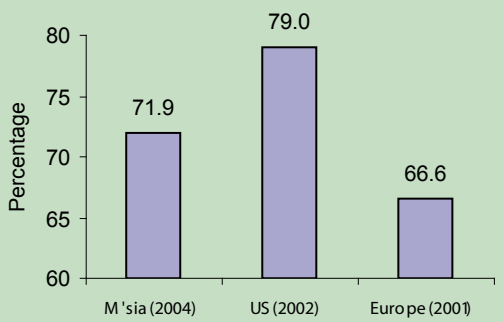
Source: Public Awareness of Science and Technology Malaysia 2004 Report

In terms of demographic distribution, the results of the 2004 survey on 'Public Attitudes Towards S&T Issues', gave the following results. In terms of age group, youths scored the highest followed by children and adults. This augurs well for the future of S&T in the country. In terms of educational level, those with tertiary education scored higher than those with secondary and primary education, in that order. In terms of locality, in general urban residents showed a more favourable attitude when compared to their counterparts in the rural areas. In terms of gender, there does not seem to be much difference in the attitudes of males and females towards S&T. In terms of ethnicity, there does not seem to be much difference in their attitudes, except on questions of science, religion and ethics as mentioned above.

11.2.4 International Comparisons in Public Attitude Towards S&T

International comparisons on public attitude towards S&T also provides an interesting picture. Two indices, namely: (i) Index of Scientific Promise, and (ii) Index of Scientific Reservation were first developed by the National Science Foundation of the USA to track trends in public attitudes towards S&T. In combination, they give us an overall picture of the attitude of the public towards S&T. Index of Scientific Promise gives us an idea of the extent to which the public is upbeat about S&T, while the Index of Scientific Reservation gives us an idea of the extent to which the public is cautious about S&T. The results of the international comparisons made for both indices are given in **Figures 11.11** and **11.12** below:

Figure 11.11: Index of Scientific Promise

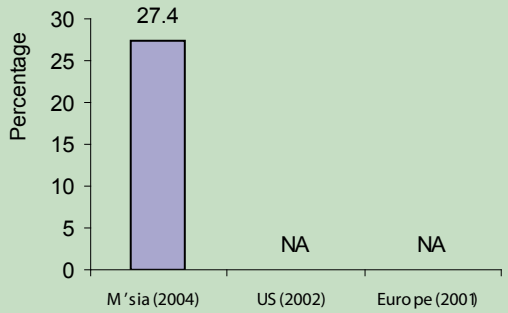
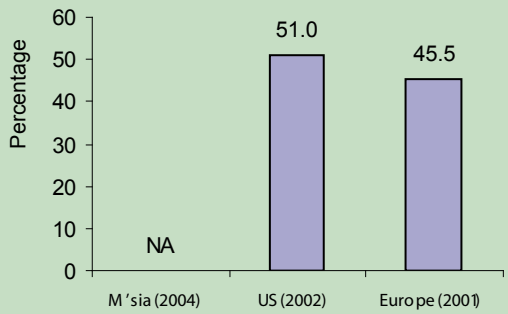
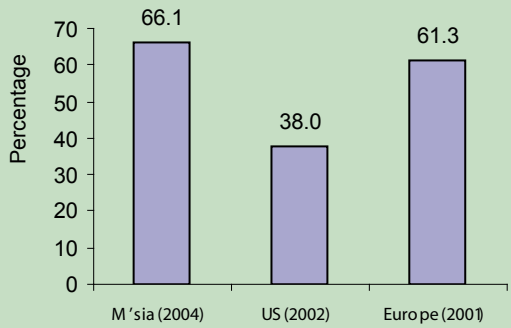
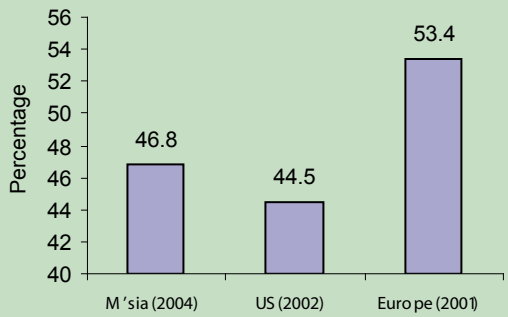
Item	Issues	Percentage
A	Science and technology makes us healthier and our lives more comfortable	
B	Our daily work will be more interesting with the use of Science and Technology	
	Mean Percentage	

Source:
1. Science & Engineering Indicators, 2004
2. Standard Euro barometer 55.2,2001

The index of scientific promise for Malaysia is lower than that of USA by about 7 % points, but higher than Europe by about 5% points.

The index of scientific reservation is higher for Malaysia than for USA, but is lower than that of Europe indicating that Europeans have more reservations than Malaysians on S&T (**Figure 11.12**).

Figure 11.12: Index of Scientific Reservation

Item	Issues	Percentage
C	Too much dependence on science lessens our faith in religion	
	We depend too much on science and not enough on faith	
D	Science causes our lifestyles to change too rapidly	
	Mean Percentage	

Source:
1. Science & Engineering Indicators, 2004
2. Standard Euro barometer 55.2,2001

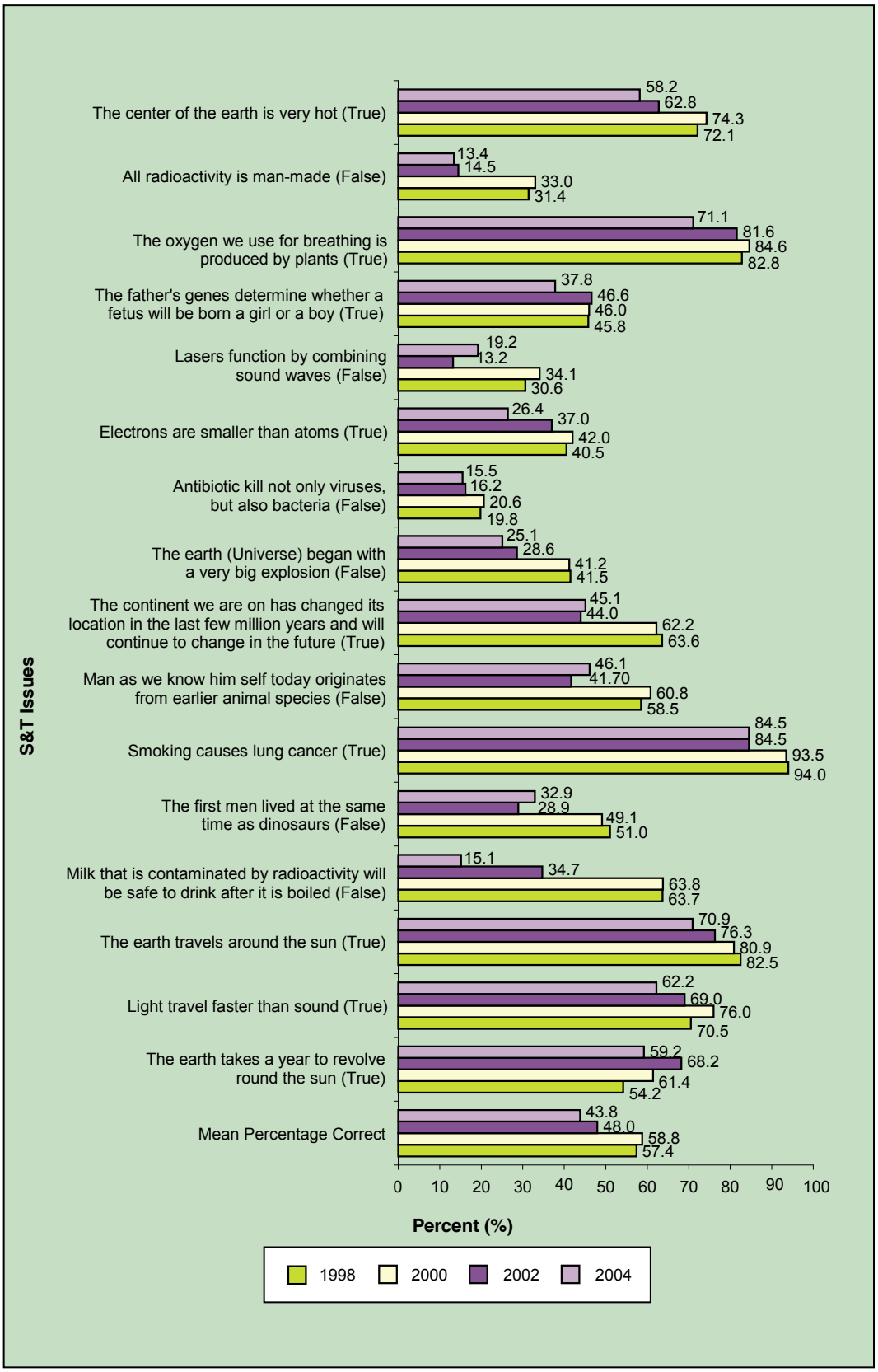
The results shown by both these indices indicate that, internationally Malaysians compare quite well with USA and Europe in terms of public attitude towards science and technology.

11.2.5 Public Understanding of Science and Technology

The term 'understanding' in this study refers to assessed or objective understanding and is defined and measured by the respondents' responses to 10 items in Question 13 and 16 items in Question 15 of 'The Public's Awareness of Science and Technology Malaysia 2004' questionnaire, in which respondents were asked to state whether the statements were TRUE, FALSE, or whether they were NOT SURE if the statements were true or false. This term is used in the same sense as it was used in the Public Awareness Studies from 1996 to 2002.

The data series on 'Public Understanding of S&T issues' from 1996 to 2004, gave a score for mean percentage of correct answers of 53.4% for 1996, 57.4% for 1998, 58.8% for 2000, 47.9% for 2002 and 43.8% for 2004 (see **Figure 11.13**). This seems to suggest that since 2000, there has been a decline in public understanding of S&T issues. However, this conclusion has to be re-examined in the light of responses given to 2 questions in the questionnaire, namely on the origin of man and the origin of the universe, and what was deemed to be the correct answers.

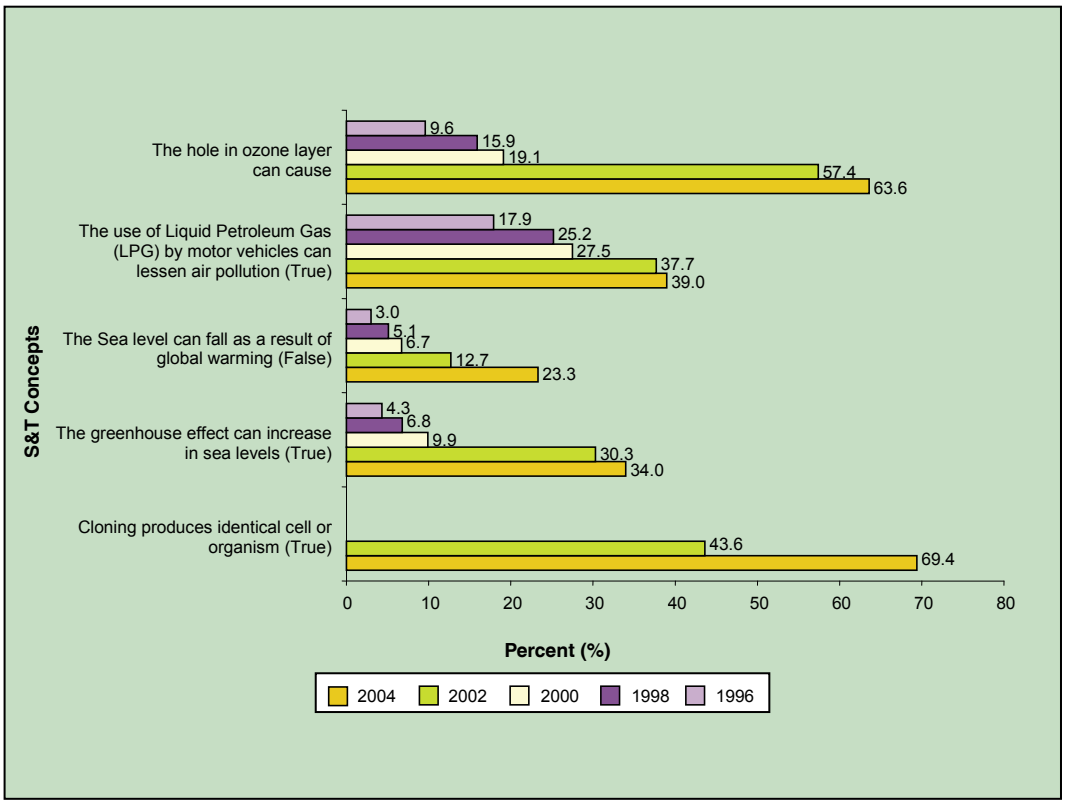
Figure 11.13: Public Understanding of S&T Issues - Data Series



Source: Public Awareness of Science and Technology Malaysia 2004 Report

However, a different picture was obtained from the results of the survey on 'Objective Understanding of S&T Concepts' as measured by respondents' responses to Question 13, carried out from 1996 to 2004, which showed an improvement over the years (**Figure 11.14**). On all ssues which were common to those items in the surveys of the previous years, the results show that there has been a steady improvement in their understanding.

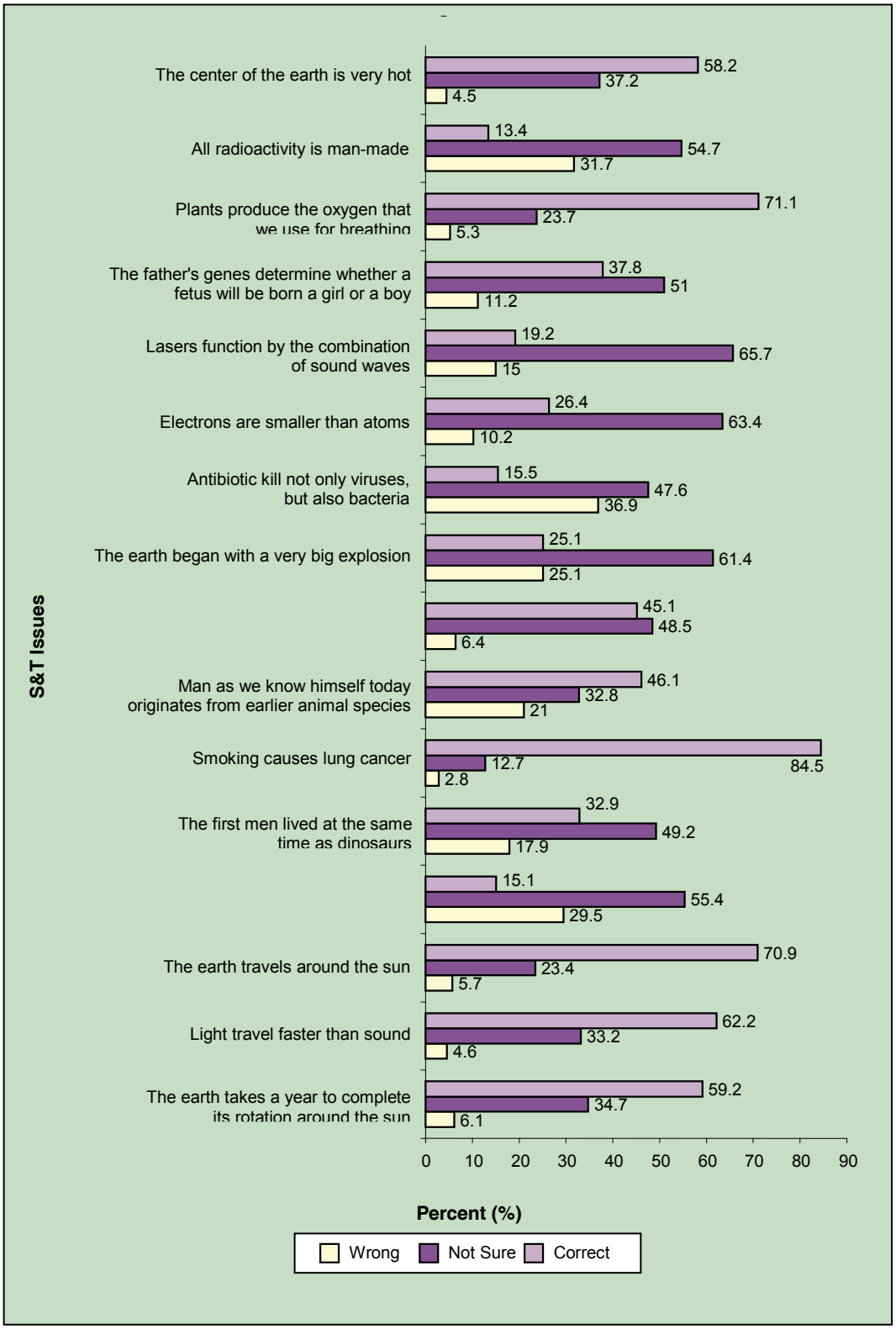
Figure 11.14 Objective Understanding of S&T Concepts - Data Series



Source: Public Awareness of Science and Technology Malaysia 2004 Report

The 2004 survey results on 'Public Understanding of S&T issues' vary according to the items on which they were tested. They scored highest for the statement 'smoking causes lung cancer' for which 84.5% gave the correct answer (see **Figure 11.15**). This was followed by the statement 'Plants produce the oxygen that we use for breathing ' (71.1%), 'The earth travels around the sun' (70.9%), and 'Light travels faster than sound' (62.2%). However, they do not fare as well on questions involving a higher level of scientific knowledge, such as 'All radioactivity is manmade' (13.4%), 'Milk that is contaminated by radioactivity will be safe to drink after boiling' (15.1%), 'Antibiotics kill not only viruses, but also bacteria' (15.5%), 'lasers function by combining sound waves' (19.2%), and 'electrons are smaller than atoms' (26.4%). However, there is a controversial aspect to the study, with regard to 2 questions particularly, involving the following statements: (i) the universe began with a huge explosion (ii) Man, as we know him today, originated from an earlier animal species. For these two statements, the 'Malaysian' answer is 'False', while the Americans and Europeans gave 'True' as the answer. This has to do with religious sensitivities, since Muslims reject Darwin's theory of evolution and has a theistic theory of the origin of the universe (as opposed to the Big Bang theory). The implication is that: international comparisons involving these two statements might not be valid.

Figure 11.15: Public Understanding of S&T Issues 2004

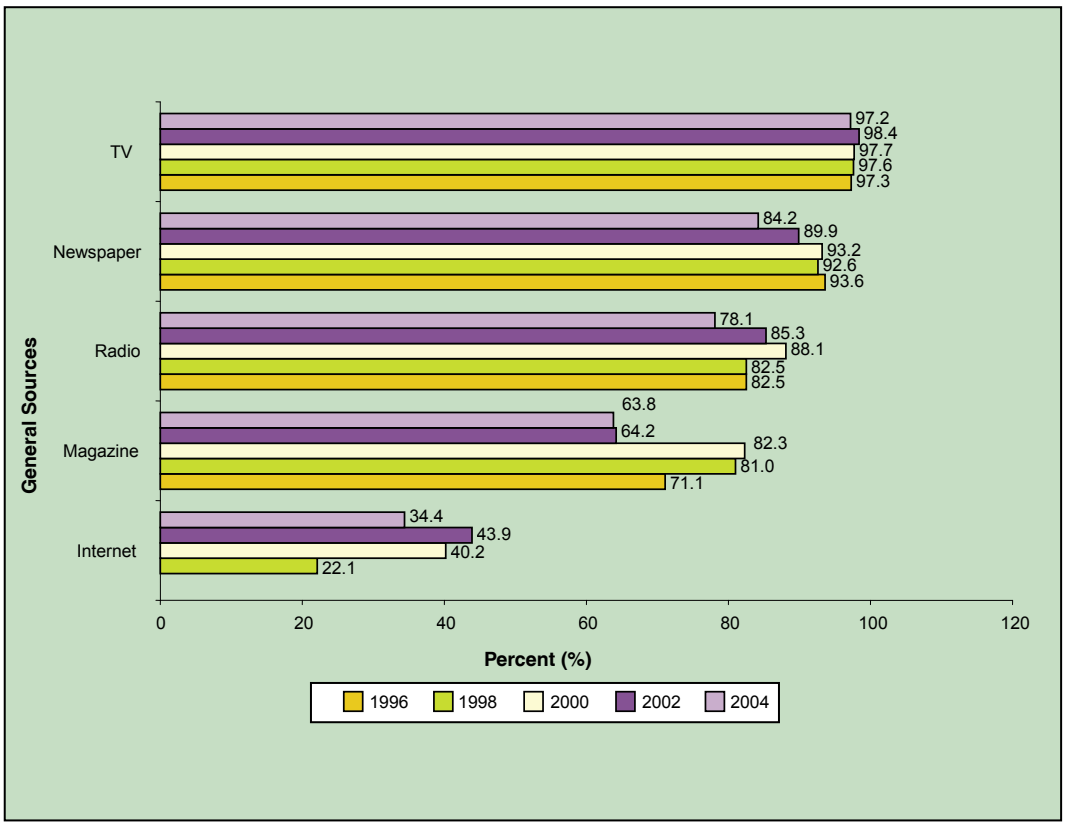


Source: Public Awareness of Science and Technology Malaysia 2004 Report

11.2.6 Sources of Information and Awareness of Science & Technology

As for sources of information, the data from 1996 to 2004 (see **Figure. 11.16**) showed that television has been the most popular source of information for Malaysians (about 97% to 98% on average), followed by newspapers (about 92% on average), radio (85%), magazines (64%), and internet being the least popular. This suggests that we should capitalise on using media such as television, newspapers, radio and magazines to improve public awareness of S&T.

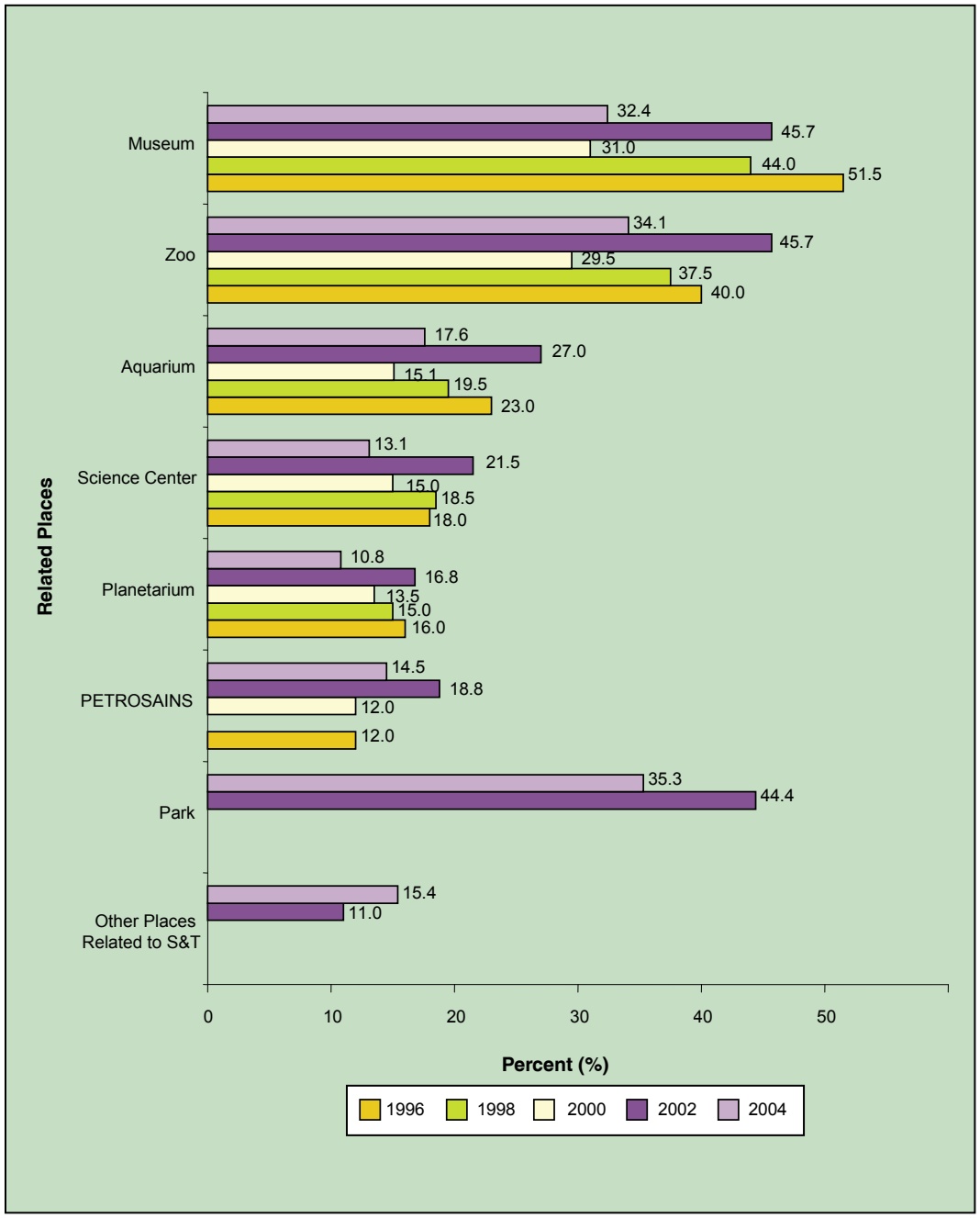
Figure 11.16: General Sources of Information - Data Series



Source: Public Awareness of Science and Technology Malaysia 2004 Report

With regard to visits, the data from 1996 to 2004 (see **Figure 11.17**) showed that the Malaysian public is more interested in visiting museums, parks and zoos (averaging at about 40%), as compared to places such as the aquarium, science centre, Planetarium, and Petrosains (average of about 20%).

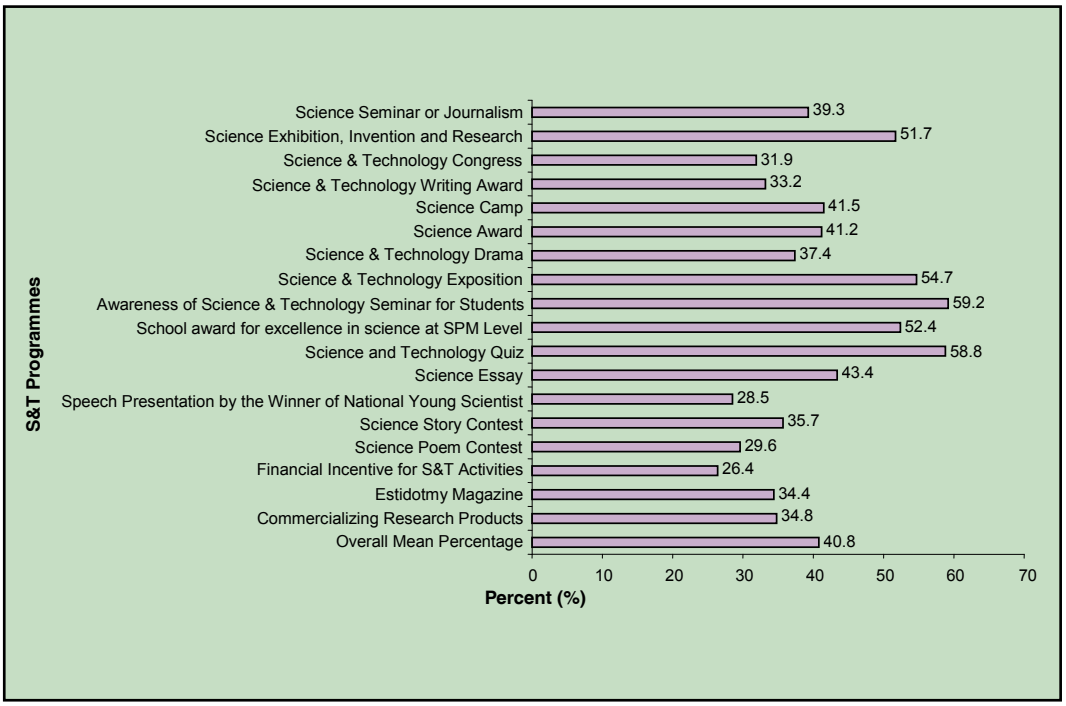
Figure 11.17: Visits to S&T Related Places - Data Series



Source: Public Awareness of Science and Technology Malaysia 2004 Report

Concerning awareness and involvement in S&T programs, a survey was carried out on 1295 youth who were asked about their knowledge of, and involvement in, 18 S&T programs. The results of the survey showed that in general, less than half (40.8%) indicated that they were aware of the programs (see **Figure 11.18**). The S&T programme which was most well known was the "Awareness of S&T Seminar for Students" (59.2%), followed by the "Science and Technology Quiz" (58.8%), and "Science and Technology Exposition" (54.7%). The program which was least known was the "Financial Incentive for S&T activities" (26.4%).

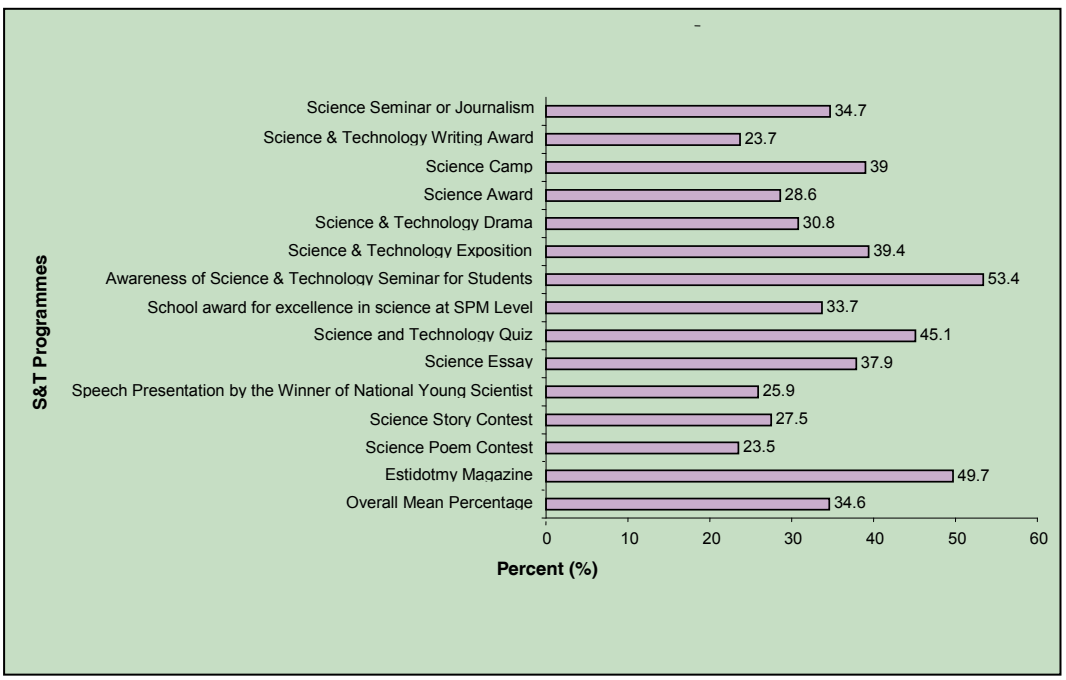
Figure 11.18: Awareness of S&T Programmes by the Public and Age Group 2004



Source: Public Awareness of Science and Technology Malaysia 2004 Report

As for the overall participation of the youths who were aware of these programs, in general, the overall mean percentage score was 34.6%, implying that on average, only one third of the respondents who were aware of the programs, got to participate in any of the 18 programs. The program which received the most participation was the "Awareness of S&T Seminar for Students" (53.4%), followed by the "Estidotmy Magazine" (49.7%). The survey results over 14 items are given in **Figure 11.19** below:

Figure 11.19: Participation in S&T Programmes by the Public and Age Group 2004

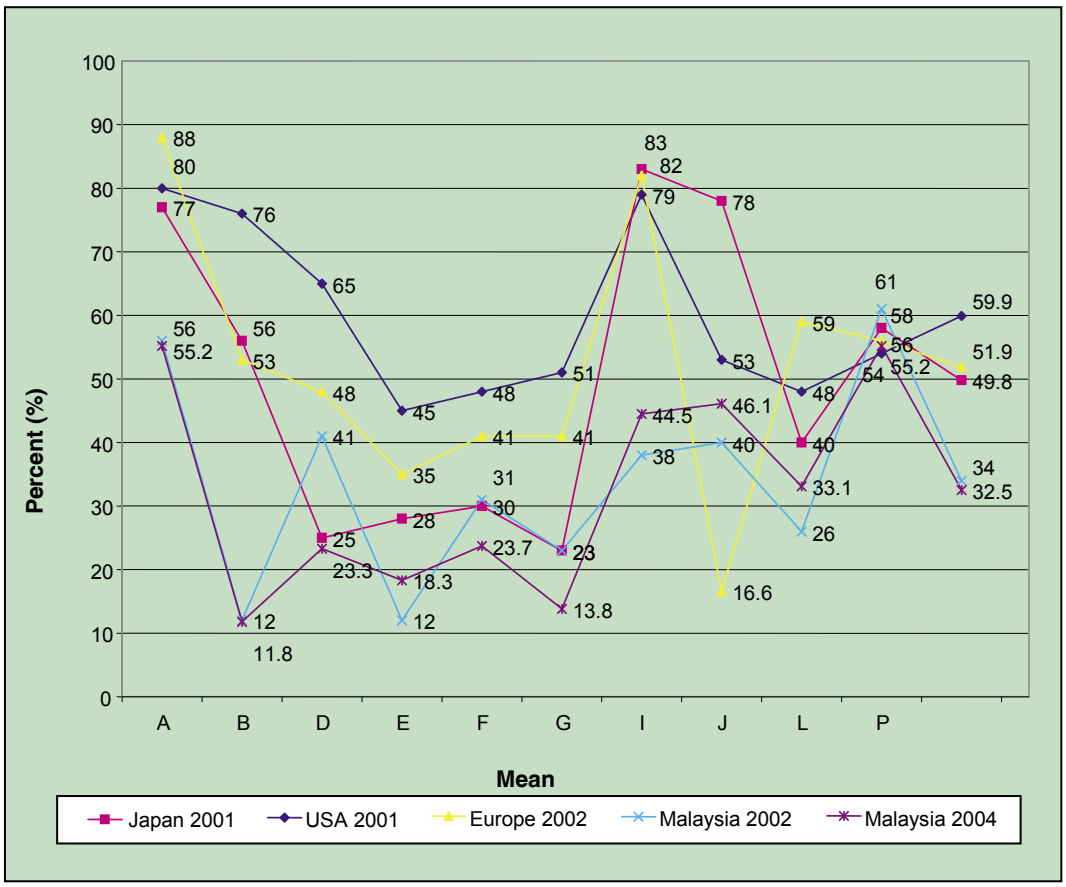


Source: Public Awareness of Science and Technology Malaysia 2004 Report

11.2.7 International Comparisons

In terms of public interest in S&T, both the Malaysian and American public seem to register a similar level of interest, that is, at 42.8% and 41.4% respectively. As for understanding of S&T, the data showed that Malaysians seem to have a lower level of understanding of S&T when compared to Europe, the USA, and Japan (**Figure 11.20**). This is based on a survey involving understanding of S&T concepts among adults, computed on 10 comparable statements (**Figure 11.21**).

Figure 11.20: Public Understanding of S&T Issues - International Comparison



Source: Public Awareness of Science and Technology Malaysia 2004 Report

Figure 11.21: Test Items for International Comparison

	Item	USA 2001	Japan 2001	Europe 2002	Malaysia 2002	Malaysia 2004
A	The center of the earth is very hot (True)	80	77	88	56	55.2
B	All radioactivity is man-made (False)	76	56	53	12	11.8
D	It is the father's genes determine whether a fetus will be born a girl or a boy (True)	65	25	48	41	23.3
E	Lasers work by focusing sound waves (False)	45	28	35	12	18.3
F	Electrons are smaller than atoms (True)	48	30	41	31	23.7
G	Antibiotic kill not only viruses, but also bacteria (False)	51	23	41	23	13.8
I	The continents on which we live have been moving their location for millions of years and will continue to move in the future (True)	79	83	82	38	44.5
J	Human being, as we know them today, developed from earlier species of animal (True)	53	78	16.6	40	46.1
L	The earliest humans lived at the same time as dinosaurs (False)	48	40	59	26	33.1
P	The earth takes one year to revolve round the sun (True)	54	58	56	61	55.2
	Mean	**59.9**	**49.8**	**51.9**	**34**	**32.5**
	Sample Size	**1574**	**2146**	**16029**	**6910**	**4932**

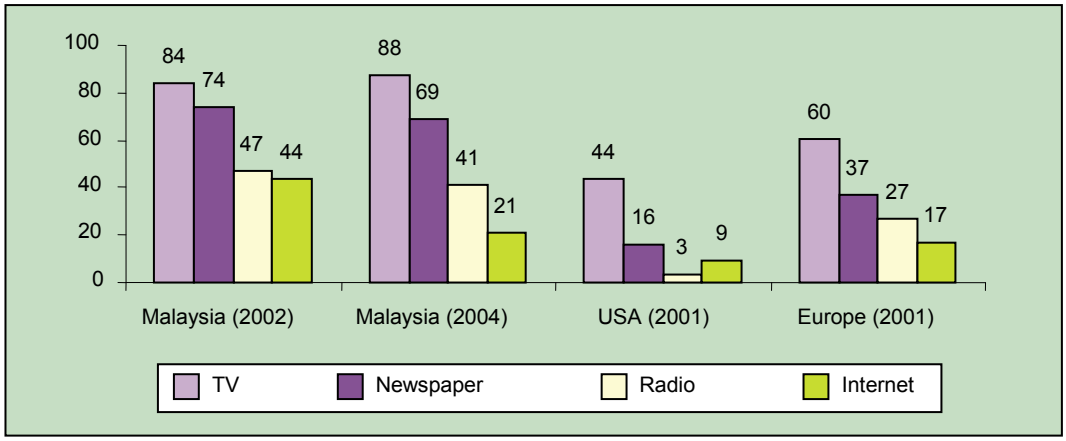
Source: Public Awareness of Science and Technology Malaysia 2004 Report

A comparison of the attitudes of Malaysians, Americans and Europeans towards S&T shows that Malaysians have a generally positive attitude towards S&T and strongly believe in the promise and benefits of science and technology, as indicated by the index of scientific promise of 71.9%, which is higher than that of Europe (66.6%) but lower than America (79%) (See **Figure 11.11**). A comparison of the index of scientific reservation shows Malaysians (46.8%) and Americans (44.5%) having less reservations as compared to Europeans (53.4%) (See **Figure 11.12**).

The fact that Malaysians register a lower score for understanding of S&T, compared to Europeans and Americans, despite having a relatively high score in terms of interest in, and attitude towards, S&T shows that the interest and attitude factor is not sufficient to bring about an increased understanding of S&T. This necessitates more proactive measures to increase public awareness of S&T, and to review the effectiveness of the programs.

In terms of the main sources of information on S&T, the scores (percentage) for the various sources is given in **Figure 11.22**.

Figure 11:22: Main sources of information on S&T



Source: Public Awareness of Science and Technology Malaysia 2004 Report

For all the countries surveyed, television was reported as the main source of information on S&T, followed by newspapers. Internet seems to be the least popular source of information on S&T in Europe and Malaysia, although for USA it is more popular than radio. The difference in the percentage points in the above comparison is probably due to the different ways of framing the questions on sources of information. In the Malaysian survey, the question asked was "Where do you get most of your S&T information?", and that it allows for more than one source to be given by each respondent. In the case of USA, it was probably in response to questions such as "What is the leading source of S&T news?" which allows for only one source to be given.

11.3 CONCLUSION

Public interest in science and technology has remained relatively constant over the years, with the level of interest recorded between 'slightly interested' to 'moderately interested' as shown by the score of between 2 to 3.

A similar situation exists with regard to perceived knowledge of S&T, where there has not been much change from 1998 to 2004, with the score ranging from 2 to 3, indicating a level of perceived knowledge of between 'poor' and 'average' knowledge of S&T.

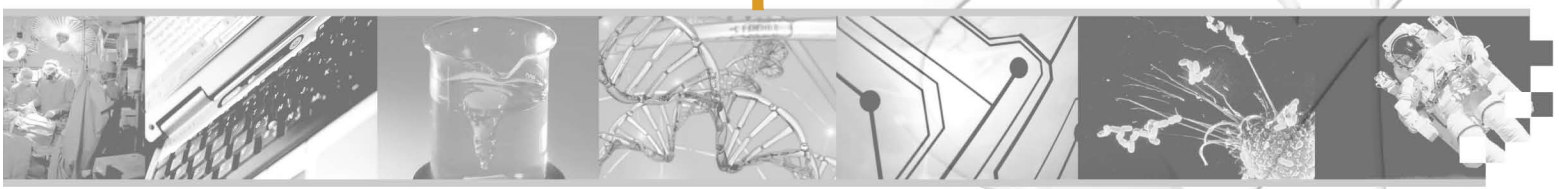
With regard to public attitude towards S&T, there seems to be an overall improvement in the results of the 2004 survey as compared to that of 2002 and 2000.

With regard to public understanding of S&T, although the results of the survey on 'public understanding of selected issues on S&T', showed a drop in 2004 as compared to the improvements recorded in the previous years, other indicators seem to support the conclusion that there has been an overall improvement in public understanding of S&T over the years.

As for the public's sources of information on S&T, television and newspapers are the two most popular sources, in that order. Malaysians, especially the youths, are generally aware of S&T programs organized by the government with a participation rate of more than 50% in the most popular program.

Internationally, Malaysians also compare favourably in terms of attitude and interest in S&T, but not in terms of understanding of S&T, when compared to the Japanese, Europeans and Americans.

Chapter 12



MALAYSIA'S STI SCORECARD 2006 AND WAY FORWARD

12.1 INTRODUCTION

This concluding chapter presents an overview of the STI system of Malaysia based on the various categories of R&D expenditure, S&T human resource development, public support for STI, innovation in the manufacturing sector, trade in technology, publications and citations, patents, ICT investments and public awareness in S&T. A scorecard is presented to indicate the nation's performance in these categories since the publication of the previous edition of this report. Some international comparisons are made to gauge our STI performance against selected countries. It must be stressed here that this report presents a partial overview as much information, for example, on financing, management of STI, assessments of research and incentives and collaboration in S&T is not provided. These aspects need to be addressed in the next edition of this report. Despite these limitations, this report provides readers with the opportunity to make observations on the state of STI in Malaysia.

This report also highlights some key messages that emerged from the findings on the various categories as described above. They provide some useful inputs for policy makers particularly in our efforts to become proficient in STI.

12.2 ABOUT THE SCORECARD

The scorecard presented in Table 12.1 introduces a set of indicators by which the STI performance of Malaysia is compared to that achieved in the previous report (2004) and the trends (whether increase or decline) indicated thereof. Additionally, comparisons with selected countries are also made. The scorecard categorisation and the leading indicators used are as follows:

Knowledge creation

- Overall R&D Intensity (R&D expenditure as a % of GDP)
- Industry Expenditure of R&D as % of total GERD

Human Resources

- Researchers per 10,000 labour force
- Science, engineering and technical enrolment as % of total first degree enrolment in public universities
- Science, engineering and technical enrolment as % of total post-graduate enrolment
- Proportion of postgraduate enrolment to undergraduate enrolment
- Women researchers as % of total researchers

Interactions and Partnerships

- % of public R&D financed by industry and other sources

Knowledge Infrastructure and Diffusion

- Internet users per 100 population
- Cellular phone subscribers per 100 inhabitant
- Telephone lines per 100 inhabitants

Outputs and Outcomes

- Total number of ISI-indexed publications
- Total number of citations
- Total number of patents granted to Malaysians
- Total number of USPTO patents granted

Knowledge Understanding and Awareness

- Mean score of understanding of S&T
- Mean score of public interest towards S&T
- Attitude towards S&T

As mentioned earlier the above categorisation is not comprehensive due to lack of data in a number of areas. The next section provides a brief discussion of the scorecard results.

12.3 SUMMARY OF MALAYSIA'S PERFORMANCE AGAINST EACH CATEGORY

12.3.1 Knowledge Creation

Malaysia's R&D intensity (R&D expenditure relative to GDP) stood at 0.63% in 2004 – a decline of 0.06% from the 0.69% achieved in 2002. This decline can be attributed to the faster expansion in the GDP than the pace of increased expenditure on R&D during the period of 2002-2004. Industry R&D intensity has increased from 65.3% in 2002 to 71.5% in 2004. Increased R&D expenditure by industry is reflective of growing competitiveness of international markets as Malaysia is a leading trading nation. Additionally, the increased expenditure is also the product of more generous and liberal R&D incentives (both fiscal and financing) provided by the government for industry to access. In terms of international comparison, Malaysia's R&D intensity is well below that of the average 2.33 recorded by OECD countries although in ASEAN we are leading the pack after Singapore.

12.3.2 Human Resources

The number of R&D personnel has increased by almost 24% from 24,937 in 2002 to 30,983 in 2004.researchers. Similarly, the number of researchers per 10,000 labour force has risen from 18 to 21.3. Despite this increase we are considerably behind the OECD countries' average of around 61 researchers per 10,000 labour force. The FTE per researcher has increased significantly from 0.40 in 2002 to 0.55 in 2004 suggesting that researchers are devoting more time to research activity. Science and engineering enrolment as a proportion of total undergraduate enrolment has declined slightly from 51.8% in 2002 to 48.2% in 2004. There has been a noticeable increase in post-graduate enrolment as reflected in the increasing ratio of postgraduate to undergraduate enrolment from 1:8.4 in 2002 to 1:6.6 in 2004. However, the science and engineering postgraduate enrolment as a proportion of total postgraduate enrolment has declined during the period under review. Women researchers are increasing and they constitute a significant 36% of the total researchers in this country.

12.3.3 Interactions and Cooperation

Although there is no comprehensive record on number of joint research projects between public sector organisations and industry, it is envisaged that the number is on the increase given the opening up of several public grant schemes for industry to access. The 2004 R&D survey findings revealed that almost 2% of public R&D expenditure was funded by industry and external funding sources. China has emerged as the leading collaborating country with Malaysian authors.

12.3.4 Knowledge Infrastructure and Diffusion

The chapter on ICT is a new addition to this edition of the report. Malaysia's ICT infrastructure as reflected in indicators such as number of computers per 1000 people, number of cellular phone and main line subscribers per 100 people and number of internet users per 100 population is on the upward trend. Although the figures are below that of the OECD average, Malaysia's ICT infrastructure particularly that of cellular phones is experiencing rapid expansion and is fast approaching OECD levels. However, our broadband penetration rate is still well below the level reached in many developed countries.

12.3.5 Outputs and Outcomes

Malaysia is ranked 56th with a total of 14,606 ISI-based publications (or 0.08% of world's output) for the period 1981-2005. This performance is below that of Singapore (0.31%) and Thailand (0.13%). Similarly, we lag behind these two countries in terms of citations. Although the number of patents (522) granted to Malaysians has increased by almost 62% in 2004 from the total attained in 2002, our patenting record is extremely low when compared to the levels reached in the developed countries. For example, the number of USPTO patents secured by Malaysia (92) in 2004 is minuscule when compared to the number achieved by Republic of Korea (4,428), Taiwan (5,938) and Singapore (449) for the same year.

12.3.6 Knowledge Understanding and Awareness

Perceived interest and knowledge on S&T has not changed much since 2002. However, attitude towards S&T has improved appreciably over the years.

12.4 SUMMARY

Malaysia has improved its STI performance in 2004 compared to the levels achieved in 2002 for most of the indicators as given in the scorecard (Table 12.1). This achievement is commendable particularly our efforts in expanding the number of researchers as well as the number of students with tertiary qualifications. However, it must be stressed that the scorecard is limited in scope and a number of other indicators that capture the performance of the STI system are not included. Additionally, we must recognise that in a number of key areas of publishing and patenting, Malaysia is well behind that of her ASEAN neighbours. The challenge for the policy-makers is to build on the gains and address the deficiencies of the system. The competition in developing, harnessing and mastery of STI is becoming intense and countries that are not committed to this quest will find themselves increasingly left behind.

Table 12.1: STI Performance Scorecard 2006

Category	Indicator	Year 2004	Year 2002	Trend	Average/Selected OECD
R&D Investments and expenditure	Overall R&D Intensity	0.63	0.69	-ve	2.33[1]
	Industry R&D expenditure as % of GERD	71.5	65.3	+ve	> 62[2]
Human Resources	Total R&D Personnel (Headcount)	30,983	24,937	+ve	> 100,000[3]
	Researchers per 10,000 labour force	21.3	18.0	+ve	61[4]
	Total FTE per researcher	0.55	0.40	+ve	0.74[5]
	Science and engineering enrolment as % of total first degree enrolment	48.2	51.8	-ve	44.6[6]
	Science and engineering enrolment as % of total post-graduate enrolment	40.6	44.2	-ve	32.4[7]
	Proportion of postgraduate enrolment to undergraduate enrolment	1: 6.6	1:8.4	+ve	1:11.6[8]
	Women researchers as proportion of total researchers (%)	35.8	33.7	+ve	27[9]
Interaction and Cooperation	% of public R&D financed by industry/external funds	2.0	NA	-	>10[10]
Outputs and Outcomes	Total number of publications in ISI-indexed journals, (1981-2005)	1179	938	+ve	16,628[11]
	Total Citations (2001-2005)	1360	2716	-ve	37,502[12]
	No of patents applied (Malaysians)	522	322	+ve	> 10,000[13]
	No. of patents granted (Malaysians)	24	32	-ve	> 6,300[14]
	No of USPTO patents granted per million population	3.6	2.5	+ve	152[15]
Knowledge Infrastructure and Diffusion	No. of computer per 1000 people	192	137	+ve	> 500[16]
	Internet users per 100 population	38.2	31.9	+ve	> 60[17]
	Cellular phone subscription per 100 inhabitants	56.5	36.9	+ve	> 60[18]
S&T Knowledge, Understanding and Awareness	Mean Score of perceived interest in S&T	2.40	2.41	-	NA
	Mean Score of perceived knowledge in S&T	2.22	2.32	-	NA
	Attitude towards S&T[#] Index of Scientific Promise[#]; Index of Scientific Reservation[#]	63.7; 71.9; 47	62.3; -	+ve	 US (79); Europe (67); US(45); Europe (53)

See Survey on Public Attitudes towards S&T; (MASTIC, 2005); *Data for this section taken from various sources principally from OECD Main S&T Indicators; 1 Average OECD However, countries like Korea and Nordic countries report higher values; 2 Average OECD. Japan (75); 3 Many OECD countries have more than 100,000 researchers. For example, Korea has 210,000 researchers in 2004; 4 Average OECD; 5 Figure for Korea's researchers (2004); 6,7,8 Figures on Korean Education from Korea Educational Development Institute (2005) 9 Average value for EU/EFTA (UNESCO Institute for Statistics, 2006); 10 average of selected OECD 11&12Average no. of ISI papers for Australia, Korea and Finland (NSIOD,2006); 13 & 14 Average value for figures for Germany, France, UK (OECD); 15 weighted average OECD; 16, 17, 18 Figures from IMD World Competitiveness Report 2006

12.5 WAY FORWARD

This report has provided a partial snapshot of Malaysia's STI performance during the period 2002-2004. We have recorded improvements in several areas but there are ominous signs that we need to address. The findings of this report reveal a number of weak spots or areas of concern as follows:

(i) The number of post-graduate enrolment, though increasing, is still small. In fact, the figure for post-graduate enrolment in science, engineering and technical fields is even less. More efforts will have to be made to entice the brighter undergraduate students to pursue their post-graduate studies particularly in the science and engineering disciplines. Additionally private IHLs need to be supported in expanding their postgraduate enrolment since almost 88% of total postgraduate population in the country come from public IHLs. Post-graduate students are crucial for the healthy functioning of a dynamic national innovation system;

(ii) There is a noticeable decline in the enrolment of students for Further Mathematics T at the STPM level. This subject has attracted the least number of student enrolment. This small number will impact on the flow of students who can undertake more demanding mathematical challenges at the undergraduate and post-graduate levels;

(iii) There is a continuation of the trend of increasing women enrolment and graduates at the first-degree level. The increasing gender bifurcation at the tertiary educational level needs to be addressed to forestall any unwarranted social consequences;

(iv) Although numbers of researchers have registered impressive gains, the number of support staff has stagnated and even declined in some instances.
Adequate and well-trained support staff is indispensable for a vibrant research system;

(v) Foreign-owned firms account for the largest share of industry R&D. Also, most industry R&D is performed by large firms. The participation by small firms in R&D is very small. Additionally, proportion of public R&D funding from industry and other external sources is small. These trends need to be reversed to ensure that the STI landscape in Malaysia is driven by domestic firms as well as engendering a more collaborative mode of operations. R&D is becoming increasingly globalised where several multinationals have established their R&D operations abroad particularly in Asia. New approaches need to be adopted to engage more small firms in R&D as well as foster greater R&D partnerships between public sector and industry including enticing and forging increasing international collaborations in research and technology development;

(vi) The sharp decline in approvals in the various grant schemes does not bode well for industry to seek such funding. Accordingly, the administration of these schemes needs to be enhanced so as to inspire confidence among the intended beneficiaries to apply for these grants;

(vii) Royalty payments for intellectual property are on the increase and suggest that most of our firms are still low in the technological ladder of sophistication. Extensive efforts must be initiated to enhance the technological capabilities of our firms so that they will be less reliant on foreign sources of technology and instead be active players in the global technology markets. The decline in our share of global ICT goods suggests that we need to strengthen our efforts in moving up the value chain whether in terms of product development or in supply and logistics as the global competition in many sectors becomes even more intense in the coming years;

(viii) Our publication and citation performance is weak when compared to Singapore and Thailand. The publication performance by our GRIs is low. We are also poor in terms of publishing in the high-impact journals. Much needs to be done at the institutional level to promote publishing particularly in the international refereed journals;

(ix) Although remarkable strides have been made in our ICT infrastructure a glaring deficiency is our Internet access which continues to be largely based on the dial-up mode. Broadband tariff costs continue to be among the highest in the ASEAN region. These trends need to be reversed if we are to keep pace with the rapid ICT developments being undertaken by neighbouring countries particularly Singapore;

(x) STI are increasingly becoming globalised and policies for innovation have been slow to address this rapid pace of globalisation. Most countries recognise that the best way to confront these challenges is to strengthen domestic innovation capabilities and develop indigenous talent. According to a recent OECD (2006) report, few countries have determined how best to adapt national policy frameworks to a more global innovation system, but small, open economies, such as Finland and Ireland, appear to be leading the way. The central message from the survey on innovation policies, is the need for policy makers in Malaysia to initiate regular evaluation of policies and programmes so as to improve the efficiency of the national STI system.

The deficiencies as described above are not insurmountable. They can be negotiated successfully given our avowed commitment towards proficiency in STI. We have achieved considerable successes over the past two years. Much more, however, remains to be done. We need to press ahead farther and faster in our various STI initiatives and programmes as the competition for mastery in STI becomes even more intense in the coming years. Given sustained commitment and self-belief we can look ahead with confidence towards achieving competency in STI.

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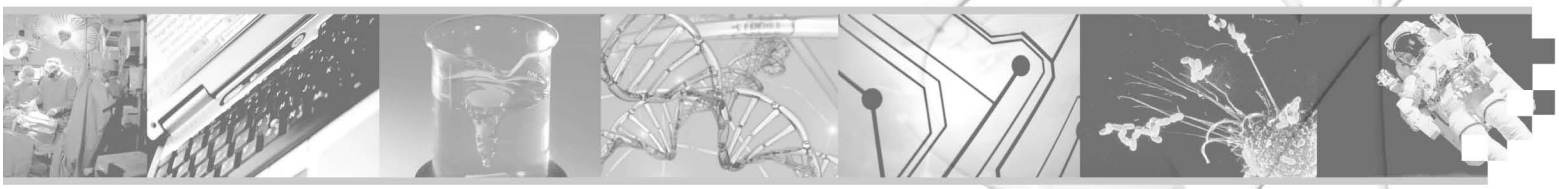

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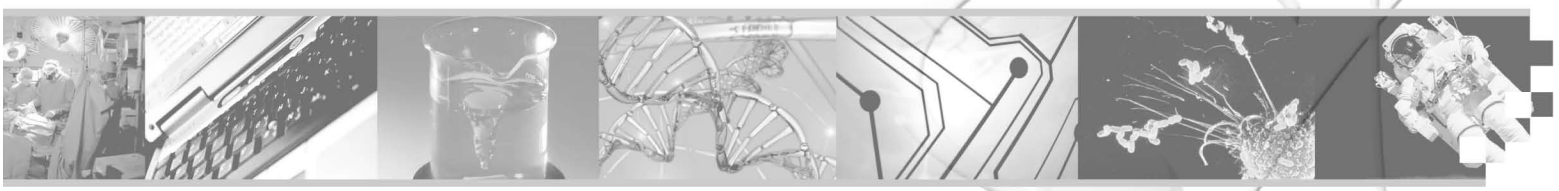
APPENDIX



APPENDIX

Appendix 8.1:

Country List & Fields (NSIOD 2006)

The National Science Indicators includes data on over 170 countries that published 100 or more papers during the 25-year period, as well as four major geopolitical regions: Asia Pacific, Asia Pacific/without Japan, European Union, and Latin America.
The database is available in two versions: a Standard dataset with 24 broad fields in the sciences and social sciences, and a Deluxe dataset of 106 narrower fields in the Sciences, Social Sciences, and Arts and Humanities corresponding to Thomson Scientific's Current Contents® (CC®) categories (See below for List of Fields for the Deluxe Indicators used in the present study).

ALBANIA
ALGERIA
ARGENTINA
ARMENIA
ASIA PACIFIC (WO/JAPAN)
ASIA PACIFIC
AUSTRALIA
AUSTRIA
AZERBAIJAN
BAHRAIN
BANGLADESH
BARBADOS
BELARUS
BELGIUM
BENIN
BERMUDA
BOLIVIA
BOSNIA & HERCEGOVINA
BOTSWANA
BRAZIL
BRUNEI
BULGARIA
BURKINA FASO
BURUNDI
CAMEROON
CANADA
CENTRAL AFR REPUBL
CHILE
CHINA
COLOMBIA
CONGO DEM REP
CONGO PEOPL REP
COSTA RICA
CROATIA
CUBA
CYPRUS
CZECH REPUBLIC
CZECHOSLOVAKIA
DENMARK
DOMINICAN REP
ECUADOR
EGYPT
EL SALVADOR
ENGLAND
ESTONIA
ETHIOPIA
EUROPEAN UNION
FIJI
FINLAND
FR POLYNESIA
FRANCE
FRENCH GUIANA
GABON
GAMBIA
GERMANY
GHANA
GREECE
GUADELOUPE
GUATEMALA
GUINEA
GUINEA BISSAU
GUYANA
HAITI
HONDURAS
HUNGARY
ICELAND
INDIA
INDONESIA
IRAN
IRAQ
IRELAND
ISRAEL
ITALY
IVORY COAST
JAMAICA
JAPAN
JORDAN
KAZAKHSTAN
KENYA
KUWAIT
KYRGYZSTAN
LATIN AMERICA
LATVIA
LEBANON
LESOTHO
LIBERIA
LIBYA
LIECHTENSTEIN
LITHUANIA
LUXEMBOURG
MACEDONIA
MALAGASY REPUBL
MALAWI
MALAYSIA
MALI
MALTA

MARTINIQUE
MAURITIUS
MEXICO
MOLDOVA
MONACO
MONGOL PEO REP
MOROCCO
MOZAMBIQUE
MYANMAR
NAMIBIA
NEPAL
NETH ANTILLES
NETHERLANDS
NEW CALEDONIA
NEW ZEALAND
NICARAGUA
NIGER
NIGERIA
NORTH IRELAND
NORWAY
OMAN
PAKISTAN
PANAMA
PAPUA N GUINEA
PARAGUAY
PERU
PHILIPPINES
POLAND
PORTUGAL
QATAR
REP OF GEORGIA
REUNION ISLAND
ROMANIA
RUSSIA
RWANDA
SAUDI ARABIA
SCOTLAND
SENEGAL
SENEGAMBIA
SIERRA LEONE
SINGAPORE
SLOVAKIA
SLOVENIA
SOLOMON ISLANDS
SOMALIA
SOUTH AFRICA
SOUTH KOREA
SPAIN
SRI LANKA
SUDAN
SWAZILAND
SWEDEN
SWITZERLAND
SYRIA
TAIWAN
TAJIKSTAN
TANZANIA
THAILAND
TOGO
TRANSKEI
TRINIDAD & TOBAGO
TUNISIA
TURKEY
TURKMENISTAN
U ARAB EMIRATES
UGANDA
UK
UKRAINE
URUGUAY
USA
USSR
UZBEKISTAN
VANUATU
VENEZUELA
VIETNAM
WALES
WORLD
YEMEN
YUGOSLAVIA
ZAIRE
ZAMBIA
ZIMBABWE

APPENDIX

STANDARD FIELDS	DELUXE FIELDS
Agricultural Sciences	Agricultural Chemistry Agriculture / Agronomy Food Science / Nutrition
Astrophysics	Space Science
Biology & Biochemistry	Biochemistry & Biophysics Biology, General Biotechnology & Applied Microbiology Endocrinology, Nutrition & Metabolism Experimental Biology Physiology
Chemistry	Chemical Engineering Chemistry & Analysis Chemistry Inorganic & Nuclear Chemistry Organic Chemistry / Polymer Science Physical Chemistry / Chemical Physics Spectroscopy / Instrumentation / Analytical Science
Clinical Medicine	Anesthesia & Intensive Care Cardiovascular & Hematology Research Cardiovascular & Respiratory Systems Clinical Immunology & Infectious Disease Clinical Psychology & Psychiatry Dentistry / Oral Surgery & Medicine Dermatology Endocrinology, Metabolism & Nutrition Environmental Medicine & Public Health Gastroenterology & Hepatology General & Internal Medicine Health Care Sciences & Services Hematology Medical Research, Diagnosis & Treatment Medical Research, General Topics Medical Research, Organs & Systems Neurology Oncogenesis & Cancer Research Oncology Ophthalmology Orthopedics & Sports Medicine Otolaryngology Pediatrics Pharmacology/Toxicology Radiology, Nuclear Medicine & Imaging Reproductive Medicine Research/Lab Medicine & Medical Technology Rheumatology Surgery Urology & Nephrology
Computer Sciences	Computer Science & Engineering Information Technology & Communications Systems
Ecology / Environment	Environment / Ecology
Economics & Business	Economics Management
Education	Education

Engineering	Aerospace Engineering AI, Robotics & Automatic Control Civil Engineering Electrical & Electronics Engineering Engineering Management/General Engineering Mathematics Environmental Engineering / Energy Instrumentation / Measurement Mechanical Engineering Nuclear Engineering
Geosciences	Earth Sciences Geological, Petroleum & Mining Engineering
Immunology	Immunology
Law	Law
Materials Science	Materials Science & Engineering Metallurgy
Mathematics	Mathematics
Microbiology	Microbiology
Molecular Biology & Genetics	Cell & Developmental Biology Molecular Biology & Genetics
Multidisciplinary	Multidisciplinary Excludes the majority of articles from Science, Nature and PNAS. Articles from these journals have been reassigned to specific categories.
Neurosciences	Neurosciences & Behavior
Pharmacology	Pharmacology & Toxicology
Physics	Applied Physics / Condensed Matter / Materials Science Optics & Acoustics Physics
Plant & Animal Sciences	Animal & Plant Sciences Animal Sciences Aquatic Sciences Entomology / Pest Control Plant Sciences Veterinary Medicine / Animal Health
Psychology/Psychiatry	Psychiatry Psychology
Social Sciences, General	Anthropology Communication Environmental Studies, Geography & Development Library & Information Science Political Science & Public Administration Public Health & Health Care Science Rehabilitation Social Work & Social Policy Sociology and Social Sciences
Arts & Humanities categories are not included in the Standard Indicators database	Archaeology Art & Architecture Classical Studies General History Language & Linguistics Literature Performing Arts Philosophy Religion & Theology

Appendix 8.2:

Table on the International Comparison of the Top 20 and selected nations to ISI publications (1981-2005) in all fields

World Rank	Countries	Contribution (%)	Total papers
1	USA	36.71	5,826,486
2	JAPAN	8.21	1,303,098
3	GERMANY	8.03	1,274,328
4	ENGLAND	7.59	1,204,674
5	FRANCE	5.86	930,649
6	CANADA	4.79	760,495
7	ITALY	3.5	554,817
8	AUSTRALIA	2.6	413,001
9	CHINA	2.59	411,148
10	INDIA	2.41	382,411
11	NETHERLANDS	2.31	366,401
12	SPAIN	2.22	353,006
13	RUSSIA	2.07	329,101
14	SWEDEN	1.85	293,888
15	SWITZERLAND	1.64	260,788
16	ISRAEL	1.22	194,117
17	BELGIUM	1.19	188,265
18	SCOTLAND	1.15	183,161
19	POLAND	1.13	178,954
20	SOUTH KOREA	1.03	163,824
21	BRAZIL	0.96	152,586
23	TAIWAN	0.9	143,088
32	MEXICO	0.46	72,321
37	CZECH REPUBLIC	0.32	51,244
38	SINGAPORE	0.31	49,026
39	EGYPT	0.3	48,086
46	NORTH IRELAND	0.18	28,923
47	SAUDI ARABIA	0.17	27,137
48	NIGERIA	0.15	23,929
50	IRAN	0.13	19,867
51	THAILAND	0.13	21,234
55	CROATIA	0.09	14,381
56	MALAYSIA	0.09	14,303
58	PAKISTAN	0.08	12,159
63	CUBA	0.05	8,113
66	PHILIPPINES	0.05	7,394
69	INDONESIA	0.04	6,716

Notes on the above table:

United Kingdom: Data can appear in two forms –
(1) the United Kingdom as a whole and
(2) the constituent parts of the United Kingdom: **England, Scotland, Wales,** and **Northern Ireland.** But in the table above, only the constituent parts are listed.
Germany: Data represent West Germany and East Germany combined for the entire period.
USSR: Data end in 1992. From 1993 onwards, the user will find separate statistics for the following 15 countries. For all of the following except Russia, there is also data from 1981-1984
Armenia, Estonia, Kyrgyzstan, Moldova, Turkmenistan, Azerbaijan, Rep. of Georgia, Russia, Ukraine, Belarus, Kazakhstan, Lithuania, Tajikstan, Uzbekistan

Bosnia & Herzegovenia: data begin in 1993;
Croatia: data begin in 1993;
Czech Republic: data begin in 1994;
Czechoslovakia: data end in 1993;
Gambia: data begin in 1995;
Macedonia: data begin in 1993;
Namibia: added in 1989;
Senegal: data begin in 1995;
Senegambia: data end in 1994;
Slovakia: data begin in 1994;
Slovenia: data begin in 1993;
Transkei: added in 1989.

APPENDIX 8.3: **Table of Top 100 countries and regions ranked by Number of Citations for the period 2001-2005 (extracted from the NSIOD 2006). A total of 4,019,419 papers were published worldwide during this period.**

Countries	Total Citations	Total Papers
USA	8664518	1352443
EUROPEAN UNION	7384927	1544513
ASIA PACIFIC	3380838	972877
UK	2074086	358674
ASIA PACIFIC(WO JAPAN)	1928200	635246
GERMANY	1877895	340882
ENGLAND	1815590	307201
JAPAN	1559097	360880
FRANCE	1232069	244825
CANADA	963926	184378
ITALY	862178	174322
NETHERLANDS	646372	103477
AUSTRALIA	567794	116954
CHINA	549879	210099
SPAIN	544220	126583
SWITZERLAND	525870	74041
SWEDEN	466652	78715
LATIN AMERICA	420827	142896
BELGIUM	306555	56446
SCOTLAND	295183	47864
SOUTH KOREA	279536	91888
DENMARK	263869	41102
ISRAEL	259473	50398
RUSSIA	254884	120367
INDIA	221644	98859
FINLAND	216012	38578
AUSTRIA	212430	39661
BRAZIL	181372	64111
POLAND	174374	57147
TAIWAN	171924	62996
NORWAY	139537	27544
GREECE	100220	30683
TURKEY	92645	49428
NEW ZEALAND	92260	23404
HUNGARY	89459	21476
CZECH REPUBLIC	80930	24735
MEXICO	80136	29030
PORTUGAL	77994	20670
IRELAND	77170	16063
SINGAPORE	76666	24388

WALES	74931	15793
ARGENTINA	74425	23401
SOUTH AFRICA	63878	20586
CHILE	46806	12109
UKRAINE	33910	17837
NORTH IRELAND	33122	7888
THAILAND	26626	9542
SLOVAKIA	25999	9491
SLOVENIA	24443	8039
IRAN	23246	13041
EGYPT	23227	13261
ROMANIA	22225	10129
BULGARIA	19122	7296
CROATIA	16472	6817
VENEZUELA	13268	4773
ESTONIA	12129	3176
ICELAND	11978	1976
SAUDI ARABIA	11331	6776
KENYA	11236	2917
COLOMBIA	10680	3641
MALAYSIA	10667	5688
SERBIA & MONTENEGRO	9277	5100
MOROCCO	8917	5044
BELARUS	8084	4454
LITHUANIA	7619	3208
PAKISTAN	7583	3953
CUBA	7305	2914
VIETNAM	7080	2161
INDONESIA	6989	2487
COSTA RICA	6621	1383
ARMENIA	6592	1765
TUNISIA	6147	4196
NIGERIA	5940	3739
URUGUAY	5828	1782
PHILIPPINES	5765	2165
PERU	5744	1431
BANGLADESH	5209	2253
LEBANON	4838	1949
PANAMA	4799	702
TANZANIA	4555	1318
ALGERIA	4406	2784
UGANDA	4388	1059
KUWAIT	4236	2348
LATVIA	4069	1596
UNITED ARAB EMIRATES	3616	2116

JORDAN	3605	2693
CAMEROON	3537	1276
REP OF GEORGIA	3382	1245
CYPRUS	3263	1082
ZIMBABWE	2920	1042
GHANA	2907	942
SENEGAL	2864	918
ETHIOPIA	2765	1303
ECUADOR	2713	708
SRI LANKA	2620	1130
LUXEMBOURG	2569	655
MALAWI	2466	569
OMAN	2220	1237
GAMBIA	2181	339

Appendix 9.1: The International Patent Classification (IPC)

The Strasbourg Agreement concerning the International Patent Classification provides for a common classification for patents for invention including published patent applications, utility models and utility certificates. The International Patent Classification (IPC) is a hierarchical system in which the whole area of technology is divided into a range of sections, classes, subclasses and groups. This system is indispensable for the retrieval of patent documents in the search for establishing the novelty of an invention or determining the state of the art in a particular area of technology.

The eight sections are entitled as follows:

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

The Classification is periodically revised in order to improve the system and to take account of technical development. The current, **eight**, edition of the IPC entered into force on 1 January, 2006.

Appendix 9.2: Types of Patent According to the United States Patent and Trade Mark Office (USPTO)

The USPTO issues several different types of patent documents which offer different kinds of protection and covers different types of subject matter, as follows:

a). Utility Patent – Issued for the invention of a new and useful process, machine, manufacture, or composition of matter, or a new and useful improvement thereof, it generally permits its owner to exclude others from making, using, or selling the invention for a period of up to twenty years from the date of filing of the patent application*, subject to the payment of maintenance fees. Approximately 90% of the patent documents issued by the USPTO in recent years have been utility patents, also referred to as "patents for invention".

b). Design Patent – Issued for a new, original, and ornamental design for an article of manufacture, it permits its owner to exclude others from making, using, or selling the design for a period of fourteen years from the date of patent grant. Design patents are not subject to the payment of maintenance fees.

c). Plant Patent – Issued for a new and distinct, invented or discovered asexually reproduced plant including cultivated sports, mutants, hybrids, and newly found seedlings, other than a tuber propagated plant or a plant found in an uncultivated state. It permits its owner to exclude others from making, using, or selling the plant for a period of up to twenty years from the date of filing the patent application*. Plant patents are not subject to the payment of maintenance fees.

d). Reissue Patent – Issued to correct an error in an already issued utility, design, or plant patent, it does not effect the period of protection offered by the original patent.

e). Defensive Publication (DEF) – Issued instead of a regular utility, design, or plant patent, it offers limited protection, defensive in nature, to prevent others from patenting an invention, design, or plant. The Defensive Publication was replaced by the Statutory Invention Registration in 1985/86.

f). Statutory Invention Registration (SIR) – This document replaced the Defensive Publication in 1985/86 and offers similar protection.

Note: (*) - Although, the length of utility and plant patent protection (patent term) was previously seventeen years form the date of patent grant, utility and plant patents filed after June 8, 1995 now have a patent term of up to twenty years from the date of filing of the earliest related patent application. Utility and plant patents which were applied for prior to June 8, 1995, and which were or will be in force after June 8, 1995, now have a patent term of seventeen years from the date of patent grant or twenty from the date of filing of the earliest related patent application, whichever is longer. Utility patents are subject to the payment of periodic maintenance fees to keep the patent in force. Patent terms can be extended under some specific circumstances.

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