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LIST OF ABBREVIATIONS

ASEAN	Association of South East Asian Nations
DAGS	Demonstrator Application Grant Scheme
FOR	Field of Research
FOS	Field of Study
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GNP	Gross National Product
GERD	Gross Domestic Expenditure on R&D
GRIs	Government Agencies and Research Institutes
ICT	Information and Communication Technology
IGS	Industrial R&D Grant Scheme
IHLs	Institutes of Higher Learning
IRPA	Intensification of Research in Priority Areas Program
ISCED	International Standard Classification for Education
IT	Information Technology
ITA	Investment Tax Allowance
ITAF	Industrial Technical Assistance Fund
MASTIC	Malaysian Science and Technology Information Centre
MDC	multimedia Development Corporation
MiGHT	Malaysian Industry – Government Group for High Technology
MIMOS	Malaysian Institute of Microelectronic Systems
MINT	Malaysian Institute for Nuclear Technology Research
MOSTE	Ministry of Science, Technology, and the Environment
MSC	Multimedia Super Corridor
MTDC	Malaysian Technology Development Corporation
MTSF	Malaysia Toray Science Foundation
NITC	National Information Technology Council
NPO	Non-Profit Organization
NSE	Natural Sciences and Engineering
OECD	Organization for Economic Co-operation and Development
PECC	Pacific Economic Cooperation Council
R&D	Research and Development
RM	Ringgit Malaysia
S&T	Science and Technology
S&T HRD Fund	Science and Technology Human Resource Development Fund
SEO	Socio-economic Objective
SME	Small and Medium Enterprise
SMI	Small and Medium Industry
SPM	Sijil Pelajaran Malaysia
SSH	Social Sciences and Humanities
STPM	Sijil Tinggi Pelajaran Malaysia
TAF	Technology Acquisition Fund
TBP	Technology Balance of Payment
TCS	Teaching Company Scheme
TPM	Technology Park Malaysia
TQM	Total Quality Management
TV	Television

COUNTRY ABBREVIATIONS

AU	Australia
CA	Canada
D	Germany
DN	Denmark
FR	France
IN	Indonesia
JP	Japan
KR	Korea, Rep.
MY	Malaysia
NO	Norway
NZ	New Zealand
PH	Philippines
SG	Singapore
SW	Switzerland
TH	Thailand
UK	United Kingdom
US	United States

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EXECUTIVE SUMMARY

This science and technology (S&T) indicators report continues a tradition that began in 1992. Published once every two years, it chronicles recent trends in selected indicators that reflect Malaysia's achievement in S&T. In an age of accelerated technological change and globalization, S&T reports have increasingly important. At the dawn of a new millennium, Malaysia stands ready to embark on a new stage of growth and development that is envisaged to propel it into the ranks of developed nations. A key element in this process is science and technology. As the landscape of science and technology is not static but a dynamic one, there is an added urgency to keep track of the country's achievements in S&T.

In the aftermath of the Asian economic crisis in 1997 there were fears about whether the S&T base of Malaysia has been eroded. Such fears, if true, would irreparably damage the country's long-term growth prospects. The trends of S&T indicators in this report dispel such fears. There are discernible improvements in various aspects of S&T base in Malaysia – in education, human resource, public awareness of S&T, research and development and trade.

The sciences' share of students at the secondary school and pre-university – at around 20% to30% - is still low. First degree enrolment in S&T related fields (pure sciences, engineering, IT and computer science) at public tertiary institutions is around 40%. However, enrolment in key S&T fields such as engineering and technology, information technology and computer science at public tertiary institutions are on the rise. Enrolment in S&T-related fields is even more encouraging in private tertiary institutions.

The amount of human resources devoted to R&D increased during 1996-98. In terms of R&D personnel, the number of researchers per 10,000 labor increased from 5.1 to 7.0 in 1998. An even larger increase is observed during this period when R&D personnel is measured in terms of full time equivalent (FTE). In terms of FTE, about 53% of R&D personnel come from the private sector. The gender composition of R&D personnel varies from sector to sector. The highest level of female participation in R&D is 38% (in institutes of higher learning). Malaysia is moderately dependent on foreign researchers – the ratio of foreign to local researchers is 1:7.5.

CHAPTER 1

INTRODUCTION

As we approach a new millennium, it is now standard practice for most countries to keep track of their achievements in science and technology (S&T) via a series of formal reports on S&T indicators. These indicators are compiled either annually, bi-annually or every few years. Supra-national agencies such as OECD and ASEAN that represent regional or global interests also compile S&T indicators on a regular basis. In an era of increasingly rapid technological changes S&T is assuming a greater role in ensuring sustainable economic growth and improvement in human welfare. At the national level, S&T indicators report provides countries with opportunity to not only take stock of their S&T capabilities and capacities, but to use this information as inputs into policy formulation and decision-making.

The present S&T indicators report is the fourth one to be published under the aegis of the Malaysian Science and Technology Information Centre (MASTIC) – a one-stop information center for the Ministry of Science, Technology and the Environment Malaysia. Published every two years since 1992, the S&T indicators report chronicles recent trends in selected indicators that captures the status of science and technology in the country. A wide range of data is included in the S&T indicators report. They range from data that cover the "input" aspects of S&T such as education and R&D, to "output" aspects of S&T such as patents and technology balance of payments.

In a way, the S&T indicators report attempts to comprehensively collect, in one place, all the available information on S&T status in the country. It includes not only secondary data that are collected from various ministries and private organizations in the country but primary data that are sourced from S&T-related surveys carried out by MASTIC. The three major surveys from which primary information is obtained include *The National Survey of Research and Development* (R&D Survey), *The National Survey on Public Awareness of Science and Technology Malaysia* (Public Awareness Survey) and *The National Survey of Innovation* (Innovation Survey). All the three surveys have not always run concurrently in the past. Both the R&D Survey and the Public Awareness Survey have been carried out four times (1992, 1994, 1996, and 1998), and the Innovation Survey, once in 1994. Additional information on S&T at the international level can also be obtained from publications of international organizations such as the

OECD, ASEAN and the World Bank. Overall, in order to enable comparison with previous S&T indicators reports, this report has endeavored to present the same type of data. However, in an effort to improve upon previous reports, additional data and information have been collected.

1.1 Basic Structure of the Report

The basic structure of the present S&T indicators report is similar to that of the previous reports. However, three new chapters have been added to the report. They are chapters seven, eight, and nine. In addition, a methodological appendix has been added to the report. These changes and their rationales are discussed in the next section. With these changes, the report now has a total of nine chapters. They are:

- Chapter 1 - Introduction
- Chapter 2 - General Overview of Trends in S&T
- Chapter 3 - Education in Science and Technology
- Chapter 4 - Human Resources for Science and Technology
- Chapter 5 - Awareness, Knowledge, and Attitude Towards Science and Technology
- Chapter 6 - Research and Development Activities
- Chapter 7 - Trade in Technology
- Chapter 8 - International Comparisons
- Chapter 9 - Public Policies and Incentives for S&T

The earlier chapters (such as chapter three to chapter six) cover indicators that are of the "input" type – i.e. S&T-related inputs to system of science, technology and innovation. These include enrolment in S&T-related courses in institutions of higher learning, personnel involved in R&D in various institutions, the stock of knowledge and attitude of the general public, as well as the mount spent on R&D. Part of chapter six and the entire of chapter seven deal with S&T "outputs" i.e. consequences of applying S&T inputs. The relevant indicators under this category include patents, bibliometric trends, and technology balance of payments. The chapter eight on international comparisons pulls together some of the basic indicators from the previous chapters and compares it with other countries' achievements. Finally, a picture of Malaysia's achievements in S&T would not be complete without an inventory of S&T enabling factors such as public institutions and policies that are put in place to encourage S&T development in the country. Chapter nine takes care of this.

1.2 New Features of the Report

Compared to previous S&T indicators reports, the present one has been re-organized to reflect the changes in the Malaysia economy as well as transformations she will undergo in the near future. Three new chapters and a methodology index have been added to the present report. The rationales for these changes are as follows.

In the era of globalization and liberalization of trade, the topic of international trade and its relation to S&T merits a separate treatment. In the previous reports, issues pertaining to trade in technology were subsumed under broad headings such as "Science and Technology for Industry" (MASTIC, 1994). In light of the importance of trade in technology the topic is covered separately as chapter seven in the present report. It is hoped that this arrangement will bring greater clarity to the interested readers. In addition, it will provide an avenue for an ever more sophisticated treatment of the subject in future volumes of the S&T indicators report.

Similarly, there is a need for some form of benchmarking of the Malaysia's achievements in S&T vis-à-vis other countries' experience, both developed and developing. It is for this reason that a new chapter eight on international comparisons is offered in this report. This chapter provides not only a quick look at the country's achievements in S&T at the international level but an opportunity to reflect on where the country wishes to be in the future. In this regard, Malaysia has aspirations to become a developed nation by the year 2020. Exactly what this entails in terms of S&T capabilities and capacities can now be impressed upon policy makers when they look at this chapter.

An important component of S&T development in a country is the environment in which it operates. Policies and institutions are important factors that promote development of S&T. In light of this, a new chapter on institutions and policies that are related to S&T development in Malaysia is included in this report. This chapter replaces the chapter on future developments (Chapter 6) in the previous issue of the S&T indicators report. Such changes were made to ensure that the report is faithful to the philosophy of S&T indicators report - to report on the current status of S&T rather than to make policy recommendations for future development of S&T. The role of the report should be one of input into policy work rather than policy work per se. Thus, readers – whether they are policy makers or researchers - who are interested in the "enabling" factors for S&T development in Malaysia will find this chapter useful.

Finally, a methodology appendix is long overdue. It is now a standard practice in indicators report of any kind to have such an appendix. Without such an appendix, readers are apt to be confused especially when they attempt to make some international comparisons between the data reported herein with those from other sources. The methodology appendix will also serve as a disciplinary mechanism on data presentation and collection. This will ensure that any data collected is clearly defined in terms of their sources and nature. Hence, the usefulness or limitations of any data for the purpose of assessing S&T achievements can be clearly delineated.

CHAPTER 2

GENERAL OVERVIEW OF MALAYSIA'S ACHIEVEMENTS IN SCIENCE AND TECHNOLOGY

This chapter presents a general overview of Malaysia's achievements in science and technology (S&T). Only major S&T indicators from each of the core chapters in the report are highlighted to give the reader an idea of the current status of S&T in the country. For a more detailed look at S&T indicators the reader is invited to refer to relevant chapters of this report.

Overall, despite the economic crisis in 1997, there was progress in Malaysia's S&T status in 1997 and 1998. Enrolment in key S&T-related field of studies such as information technology (IT) and computer science is on the rise. Both total R&D personnel and R&D expenditure increased during the period 1996-98. The general public's awareness and knowledge of S&T-related issues have also risen. While the country's technology of balance is still weak in some categories, exports in high technology goods are becoming increasingly more important. At the international level, the country still lags behind the S&T achievements of major OECD countries. However, Malaysia's S&T achievements as a developing country match the achievements of smaller OECD countries.

2.1 Education

There are substantially more students at the secondary school and pre-university level that are enrolled in the arts compared to the sciences. Less than 20% of pre-university students take core natural sciences subjects such as physics, chemistry and biology. A similar situation is observed in tertiary education in Malaysia. Both the humanities and social sciences accounted for between 40-60% of total enrolment at different levels of education (first degree, master, Ph.D.) at public tertiary institutions. However, there is gradual shift towards more emphasis on S&T-related subjects such as engineering and technology and IT and computer science.

Enrolment for first degree courses in public educational institutions in both the humanities and the social sciences declined during the period between 1996 and 1998. In contrast, the enrolment in engineering and technology and information technology and computer science experienced a rapid increase, particularly the latter. For example, there were 1,901 first degree students enrolled in IT and computer science courses in 1993. By 1998, this number had increased to 6,857. Similar trends were observed for enrolment in graduate-level courses in engineering and technology and IT and computer science at public educational institutions. About a quarter of the students that enrolled in first degree students at private educational institutions in 1999 majored in IT and computer science. These trends are encouraging for a country that aspires to be a science and technology-driven developed nation by the year 2020.

2.2 Human Resource

The amount of R&D personnel devoted to R&D increased from 5.1 researchers per 10,000 labor force in 1996 to 7.0 in 1998. When R&D personnel is measured in terms of full time equivalent (FTE), a more sizable increase of 50% in R&D personnel was registered for the same period. The largest share of total R&D personnel (in terms of head count) comes from government research institutes (GRIs) (43%) followed by the private sector (34%) and institutes of higher learning (IHLs) (23%). If R&D personnel is measured in terms of FTE a different picture emerges – the private sector's share becomes larger (53%) whilst that of GRIs (33%) and IHLs (14%) become smaller.

In terms of participation in R&D by gender, between 63-76% of R&D personnel in different sectors (GRIs, IHLs, and private sector) were males. The sector with the highest female participation in R&D is the IHLs (i.e. 38% of total R&D personnel in that sector). About 46% of researchers have graduate degrees (masters and above) while 42% of researchers have only a bachelor degree. Female researchers tend to have lower academic qualifications than their male counterparts. Looking at the distribution of researchers in different sectors across different types of research, a significant portion (42%) of researchers in the private sector are involved in applied research. An even higher proportion of researchers are involved in applied research in the GRIs (about 50%). For every foreign researcher, there are on average 7.5 local researchers in Malaysia.

2.3 Public Awareness of Science and Technology

Among the 11 categories that constitute knowledge of various general S&T-related issues in the *Public Awareness of Science and Technology Survey* (MASTIC, 1998), three categories saw an increase – "economy and business", "environmental pollution", and "applications of nuclear technology". In general, males respondents in the survey showed a higher degree of knowledge of various general S&T-related issues compared to female respondents. Among the three age groups (children, youth, and adult) youth showed the highest level of "knowledge and interest" in S&T-related issues.

There is a general consensus among survey respondents that S&T has improved their lives. In terms of "perception and attitude" towards S&T, the difference between rural and urban respondents is not statistically significant. Overall, there has been an improvement in the understanding of S&T-related concepts. Not surprisingly, knowledge tends to be positively correlated to educational level of the respondents. The major sources of information are television (for 98% of respondents), newspapers (93%), and magazines (81%).

2.4 Research and Development

Despite the economic downturn in 1997, R&D expenditures in Malaysia increased substantially by 105% between 1996 and 1998. The ratio between gross expenditure on R&D (GERD) and GDP rose from 0.22% in 1996 to 0.39% in 1998. Two-thirds of the total R&D expenditure in 1998 came from the private sector even though this was a bit smaller than the corresponding figure of 73% in 1996. Between 1996 and 1998, government research institutes' (GRIs) share of total gross expenditure on R&D increased from 20% to 22%.

Much of the existing R&D expenditures are targeted at applied (50%) and experimental (37%) type. Basic research lags far behind these two categories. In terms of field of research, R&D expenditures in the country were fairly divided amongst major areas such as applied science and technology (29%), information, computer and communication technology (23%), and engineering sciences (22%). Different institutions tend to concentrate on different areas of research – the GRIs on information, computer and communication technologies and agricultural sciences; the private sector on applied science and technologies, and engineering sciences; and the institutes of higher learning (IHLs) on chemical sciences and medical sciences. Much of the funding for R&D in the private sector came from internal resources (83%), while the GRIs (65%) and IHLs (71%) relied more on public funds. A more balance distribution of researchers across the different types of research is observed in the IHLs.

2.5 Trade

There is very little information on Malaysia's technology balance of payments. What is available is information on a few items of the balance of payments that serve as proxies for the technology balance of payments. They include royalties, contracts and professional fees, and construction and engineering. The deficits on royalties flows continue to widen in recent years. At the same time, the balance of payments for contract and professional fees and for construction and engineering has improved. These two components of the balance of payments registered a surplus in 1998.

Trade in high technology good has become more important. Export of high technology goods as a percentage of total exports of manufactured goods stood at 60% in 1998. The corresponding figure for imports is 50%. About 70% of Malaysia's export of high technology goods falls in the category of radio, TV and communication equipment. The surplus in the balance of trade in high technology goods continues to increase. Malaysia continues to experience a trade surplus in high-medium technology goods.

2.6 International Comparisons

In terms of tertiary enrolment in S&T-related fields (such as natural sciences, mathematics, computer science, and engineering) Malaysia lags behind most OECD and ASEAN countries. The total R&D personnel (measured in full time equivalent, FTE) found in Malaysia, while significantly lower than countries such as Japan and the US, is very similar to that found in smaller developed nations such as Denmark, New Zealand, Norway and Switzerland. Compared to the OECD countries, the government's share of total R&D personnel is larger in Malaysia. The private sector's share of total R&D personnel in Malaysia is comparable to that found in the OECD countries. The amount that Malaysia spends on R&D (as a percentage of GDP) is higher than its neighboring ASEAN countries but significantly lower than in OECD countries. Private sector's share of R&D expenditure is comparable to that found in OECD countries while the government's share is larger in Malaysia.

The number of patents applications in Malaysia is low by international standard and is heavily dependent on foreign sources / applicants. It is however, comparable to the dependency level found in other countries such as New Zealand and Canada. Malaysia's trade profile in high-technology goods is similar to that of Japan and the Republic of Korea. Trade surpluses are recorded for office and computing machinery and electronics in these countries. In contrast, deficits are registered for aerospace and pharmaceutical industries.

2.7 Policies and Incentives

Malaysia recognizes the symbiotic relationship between the public and private sectors in S&T development. In this regard, she has put in place a plethora of policies and institutions to encourage S&T development in Malaysia. They range from general tax incentives to more specific financial incentives targeted at key industries such as IT and multimedia. Specialized statutory institutions have also been setup as catalysts for technological innovation in industries that are considered to be vital for long-term growth and competitiveness of Malaysia. They include the Malaysian Institute of Microelectronic Systems (or MIMOS, targeted at the electronic-based industry), the Multimedia Super Corridor (or MSC, to encourage the IT and multimedia industry), and the Malaysian Technology Development Corporation (or MTDC, to encourage commercialization and technological innovation and diffusion), amongst others. These incentives encourage not only S&T development but their economic spillover as well.

CHAPTER 3

EDUCATION IN SCIENCE AND TECHNOLOGY

The science and technology (S&T) base of a nation depends, to a large extent, on the level of S&T knowledge in the country. In this regard, the education system plays an important role. It is within the education system that the school-going population acquires substantive knowledge in science and technology. The education system, particularly at the tertiary level, is also an important source of new knowledge in science and technology. Breakthroughs in basic as well as applied science that emanate from the education system is as important as those from industry.

In Malaysia, both public and private sector education coexist and complement each other. Public sector education has been the traditional mainstay of the education system in the country. However, private sector education has expanded tremendously in recent years. This sector, by virtue of it being largely market-driven, poses significant challenges to policymakers interested in putting more emphasis on S&T-oriented disciplines such as the natural sciences, engineering and information technology. Student enrolment data by field of study reported in this chapter will serve as useful inputs to S&T education policy.

To enable international comparisons, education data are classified in accordance to OECD guidelines. This report utilizes, to a great extent, recommendations from the OECD's *Canberra Manual* that are used to aggregate field of study in reporting S&T-related education (OECD, 1984).[1] The *Canberra Manual* is based on the *International Standard Classification for Education* (ISCED) classification scheme. (For more details of the classification scheme see Table 3.1 and the Methodology Appendix). However, a slight modification of the Canberra Manual classification scheme is adopted - information technology and computer science will not been aggregated into the natural sciences. It is felt that the importance of this category merits a separate treatment.

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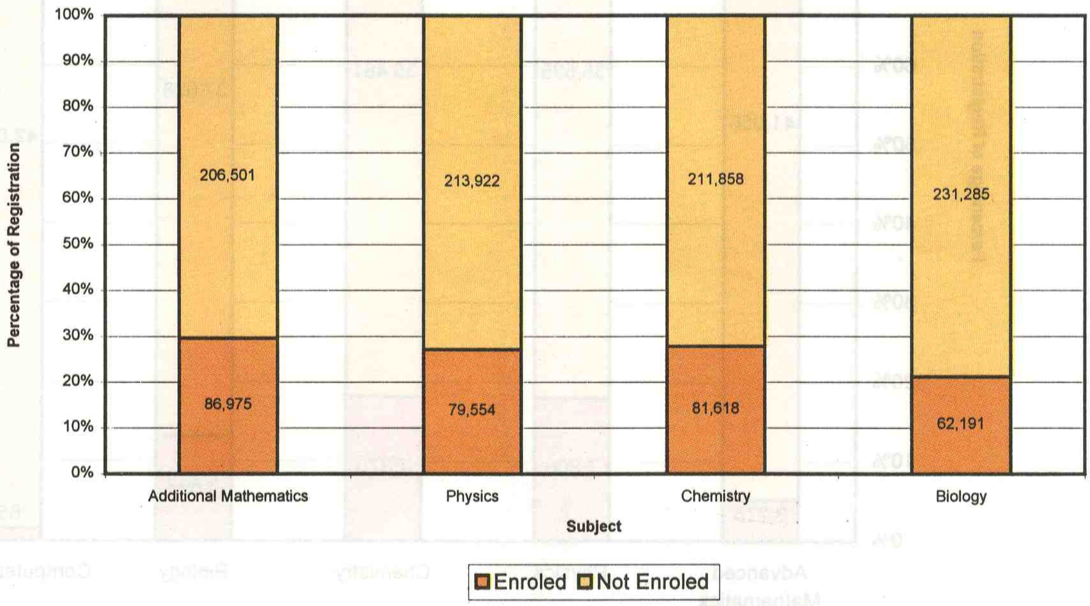
[1] Also known as the OECD *Manual on the Measurement of Human Resources devoted to S&T "Canberra Manual"*, (OECD, 1984)

3.1 Education in Science and Technology at the Secondary School and Pre-University Level

The focus on science and technology education occurs fairly early in the Malaysian education system. Streaming policies in terms of two major groups - the arts and the sciences – are implemented twice, once at the secondary four level, the other at the pre-university level.[2] The focus on science subjects can be seen from the enrolment for the two major examinations: (1) *Sijil Pelajaran Malaysia* (SPM) and (2) *Sijil Tinggi Pelajaran Malaysia* (STPM).[3] About 30% of the students who sat for the SPM examinations in 1999 took science subjects such Physics, Biology, Chemistry and Additional Mathematics (Figure 3.1).[4]

Figure 3.1: Registration for Sijil Pelajaran Malaysia, 1999



Source: Table 3.2

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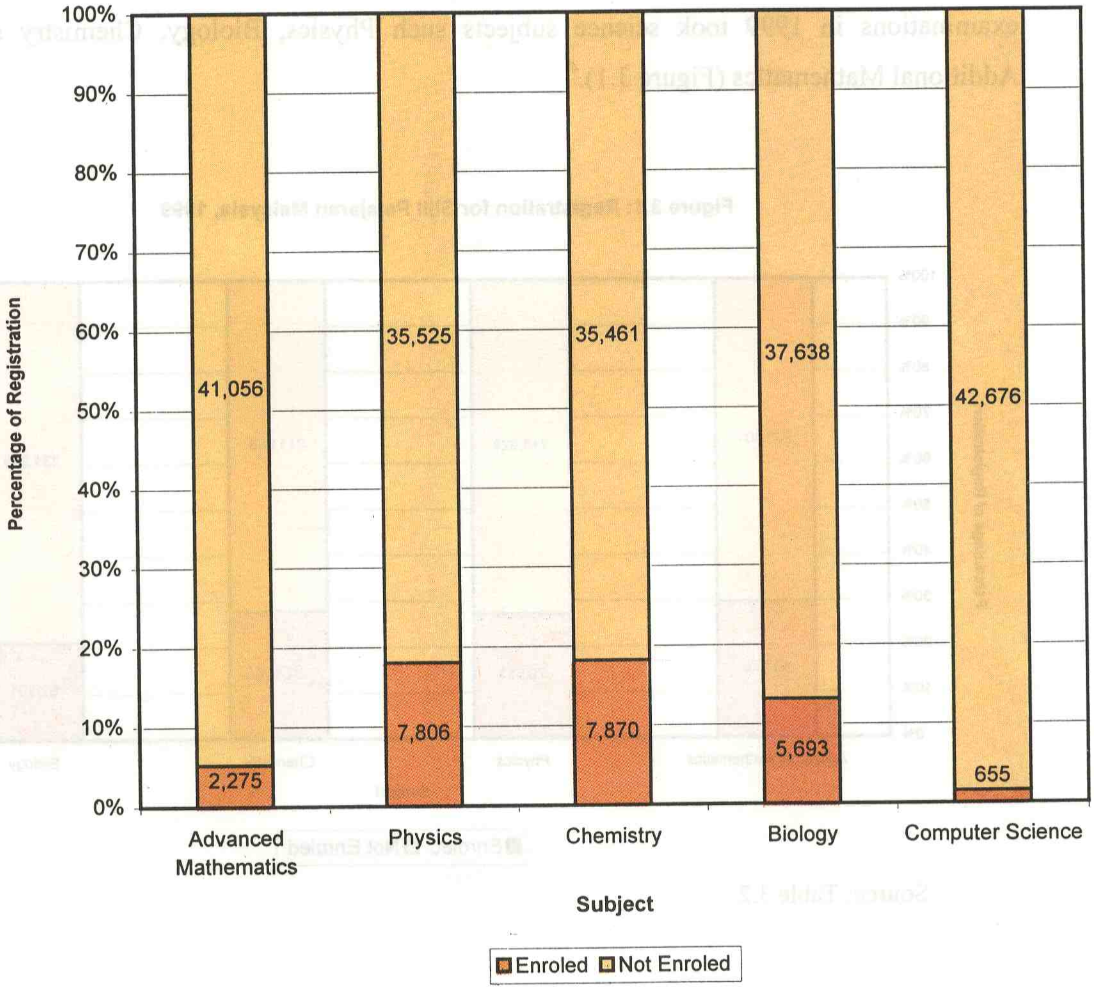
[2] The average age of a student at the secondary four level is sixteen. After pre-school, students attend nine years of primary education without streaming followed by another four years in either the arts or the sciences streams (secondary four and five, and two years of pre-university).

[3] The SPM is taken at the end of secondary five level, and the STPM at the end of pre-university level.

[4] "Additional Mathematics" is more advanced that the subject "Mathematics" in the SPM curriculum.

The percentage of students taking science subjects at the pre-university level (STPM) is even lower. Not more than 20% of the total students who sat for the 1999 STPM examinations took science subjects such as Physics, Biology, Chemistry and Advanced Mathematics (Figure 3.2). Only about 1.5% of the total students who sat for the STPM examination in 1999 took computer science.

Figure 3.2: Registration for Sijil Tinggi Pelajaran Malaysia



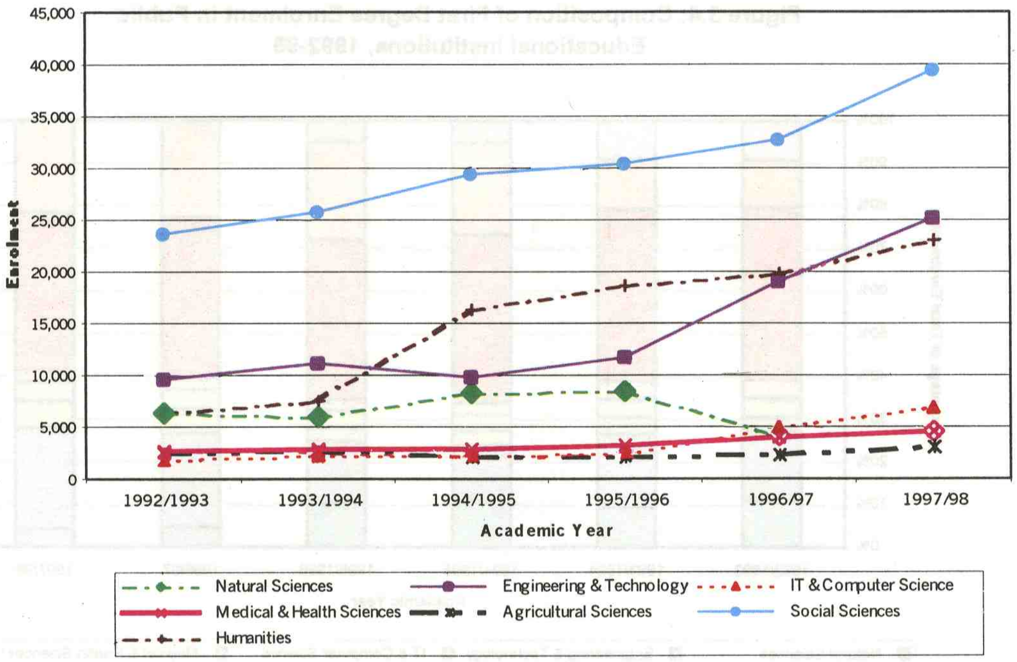
Source: Table 3.2

3.2 Tertiary Education in Science and Technology - Public Educational Institutions

3.2.1 Enrolment in First Degree Courses

Enrolment in public educational institutions for science and technology-related first degree courses such as engineering and technology saw a rapid increase in the period between 1996 and 1998 (Figure 3.3). During the same period, similar trends were observed for first-degree enrolment in the field of information technology (IT) and computer science has increased rapidly. In 1993, there were 1,901 students enrolled in IT and computer science related first degree courses in public educational institutions. By 1998, the figure had increased to 6,857 students.

Figure 3.3: Enrolment in First Degree Courses at Public Educational Institutions, 1992-98

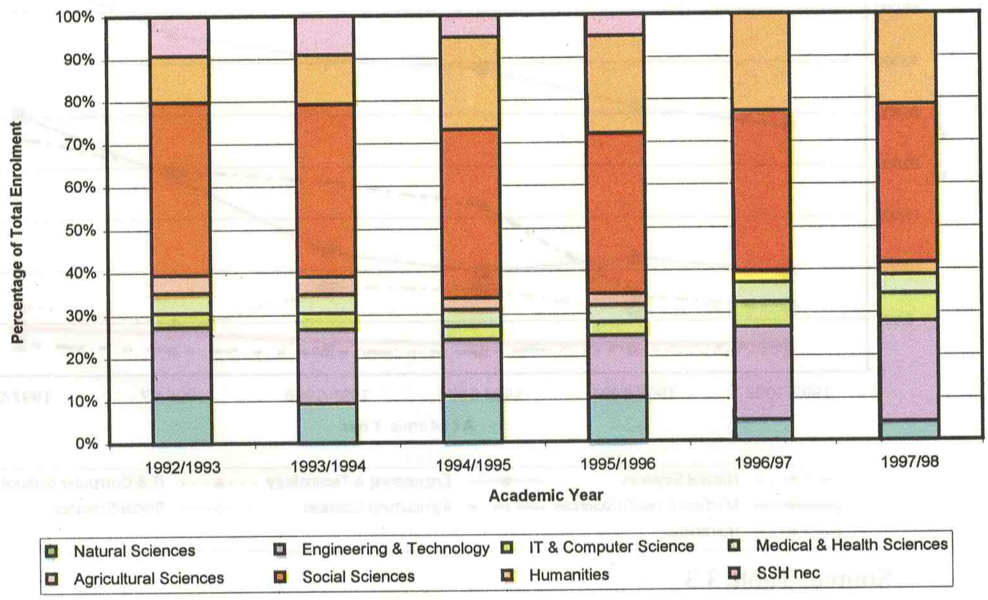


Source: Table 3.3

Enrolment in the natural sciences appears to have declined between 1995/96 to 1996/97. This trend is probably due to differences in the classification scheme adopted in this report and previous one. In the present report (which follows the OECD scheme), the category "Others – Science" falls under "Engineering and Technology" and not "Natural Sciences" (as in the previous reports).[5] Enrolment in the social sciences and humanities also increased during the 1996-98 period. By 1997, first degree enrolment in engineering and technology exceeded first degree enrolment in the humanities. First degree enrolment in the social sciences continues to enjoy the largest share in terms of the total number of students (Figure 3.3).

The dominance of the social sciences and humanities in first degree enrolment can be seen in Figure 3.4. About 60% of the total first degree enrolment at public educational institutions comes from the social sciences and humanities. However, engineering and technology, and IT and computer science's shares of enrolment are on the rise.

Figure 3.4: Composition of First Degree Enrolment in Public Educational Institutions, 1992-98



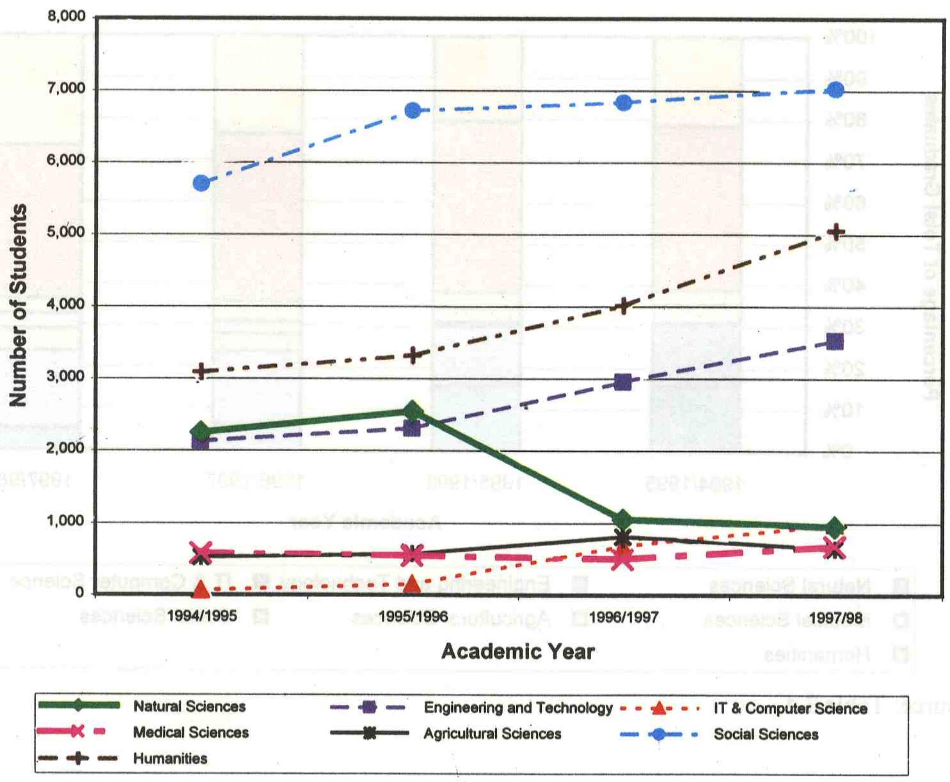
Source: Table 3.3

[5] See the Methodology appendix for more details of the OECD classification scheme. Unfortunately, it was not possible to re-tabulate old data (prior to 1996/97) using the new classification scheme.

3.2.2 Graduation in First Degree Courses

Graduation trends usually lag that of enrolment. In general, the number of students graduating in first degree course continue to increase in all field of studies (Figure 3.5).[6] One field of study that has seen a rapid increase in graduation of first year degrees is information technology (IT) and computer science. In 1995, there were only 71 first degree graduates in this disciple. By 1998, this figure had grown to 1,002 students.

Figure 3.5: Graduating Students in First Degree Courses at Public Educational Institutions, 1994-98

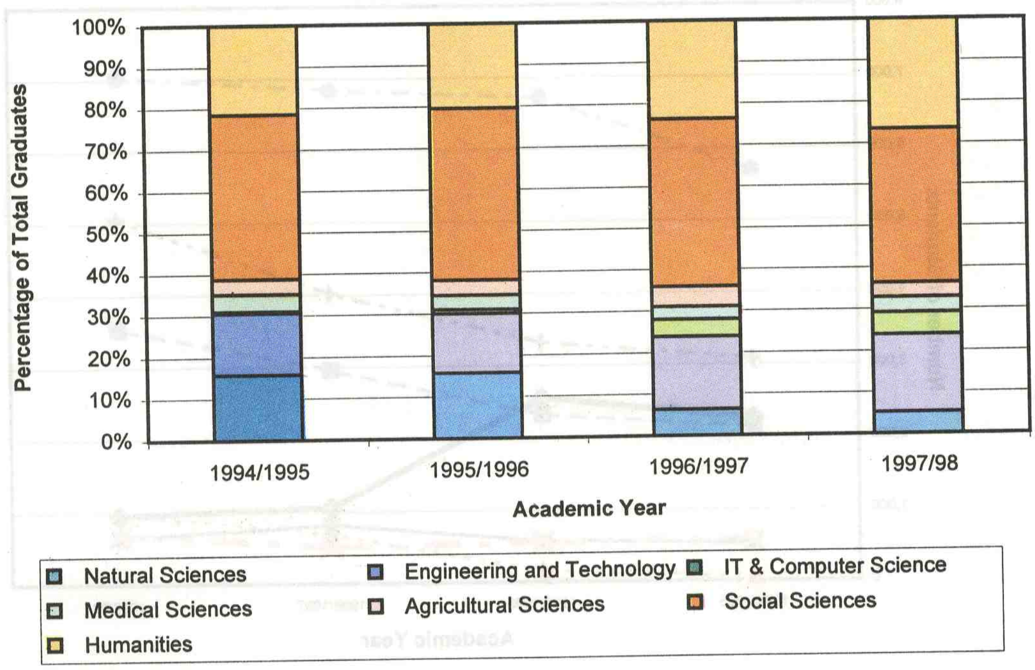


Source: Table 3.4

[6] The exception is the natural science. This is probably due to reclassification of data – see previous footnote.

The dominance of the social sciences and humanities is also evident from graduation data for first degrees at public educational institutions (Figure 3.6). Both of these fields accounted for about 60% of total first degree graduates in public educational institutions. The shares of both technology and engineering and IT and computer science in total first degree graduation have been increasing in recent years. Information technology and computer science, in particular, has seen an increase in its share of total graduation from 0.5% in 1995 to 5.3% in 1998.

Figure 3.6: Composition of First Degree Graduates at Public Educational Institutions, 1994-98



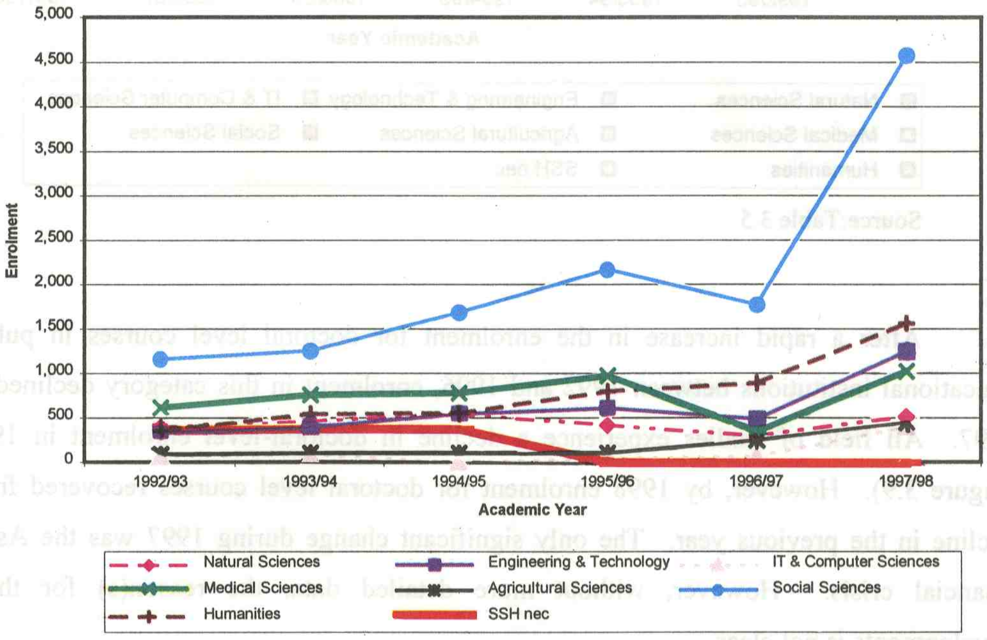
Source: Table 3.4

3.2.3 Enrolment in Graduate Degree Courses

Graduate education is an important avenue for the training of researchers. In addition, graduate schools and their laboratories are vital sources of technological advancement. New scientific discoveries and technological innovations are routinely produced as part of research carried out by graduate students. Graduate enrolment in master level courses at public educational institutions has grown rapidly in recent years.

Total enrolment in master level courses was around 3,408 students in 1992. By 1998, this figure had risen to 9,785 students. This increase in enrolment in master level courses has not been evenly spread out across the different fields of study. Enrolment in master level courses in the natural sciences has remained relatively stagnant around 400 to 500 students the early 1990s (Figure 3.7). At the same time enrolment in engineering and technology courses have increased. Rapid increases have been registered in information technology and computer science-oriented courses. Enrolments in master level courses in the social sciences and the humanities have also increased in recent years.

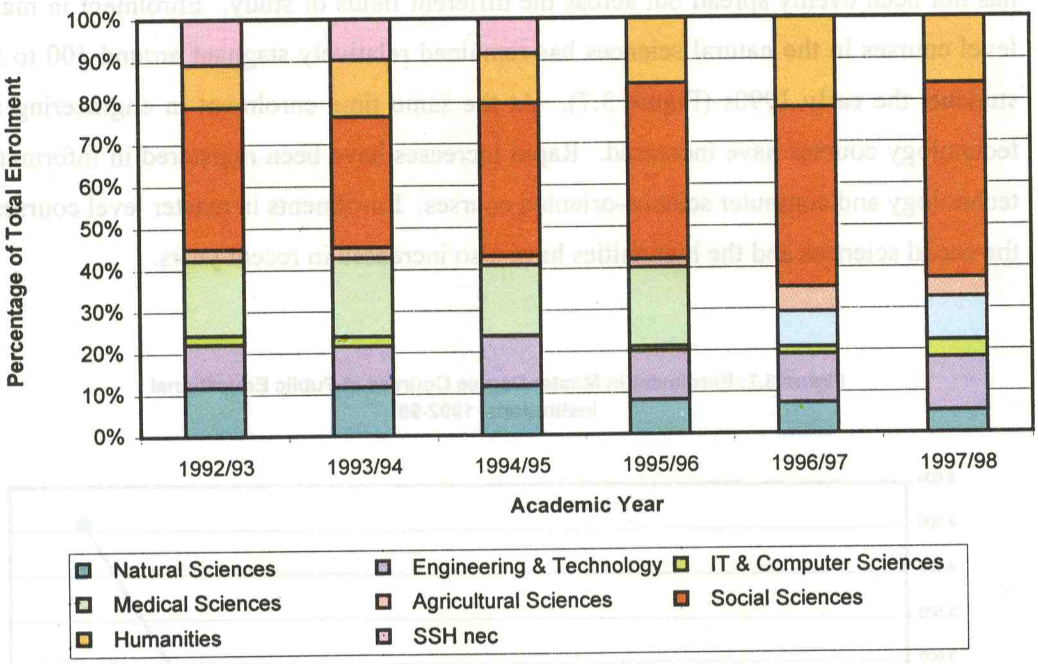
Figure 3.7: Enrolment in Master Degree Courses at Public Educational Institutions, 1992-98



Source: Table 3.5

In terms of the composition of enrolment in master level courses in the country – the largest share comes from the social sciences and humanities. Close to 60 percent of the total enrolment in master level courses in public educational institutions comes from these two fields (Figure 3.8). Between 1992 and 1998, the enrolment share of engineering and technology, and information and computer technology have increased while that of the natural sciences and medical sciences has declined.

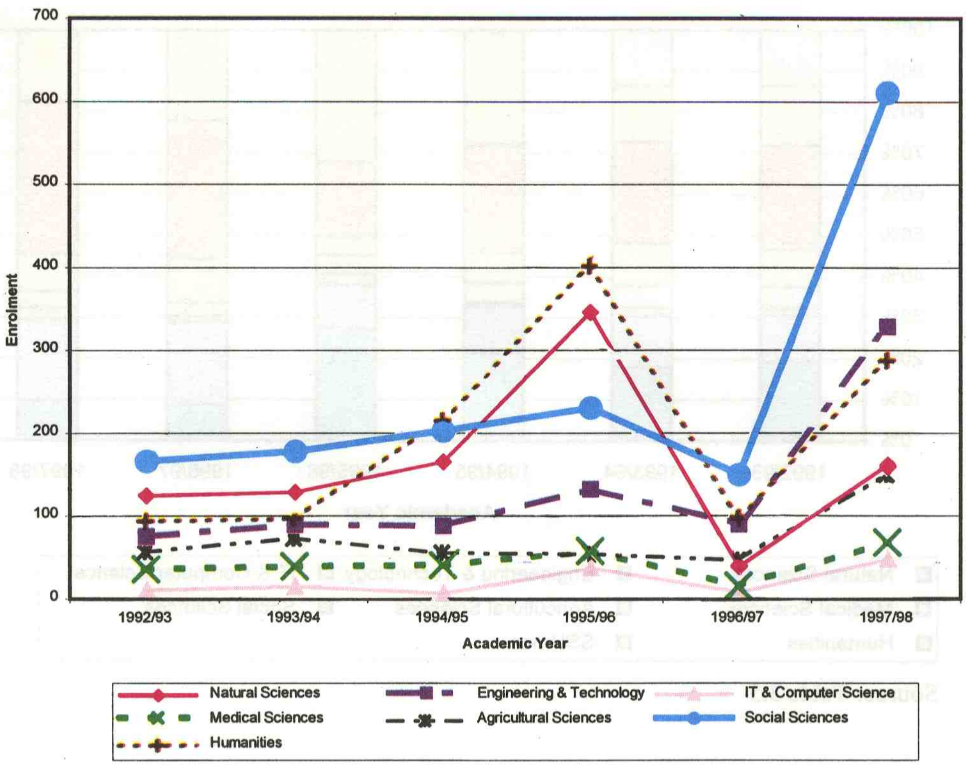
Figure 3.8: Composition of Enrolment in Master Degree Courses at Public Educational Institutions, 1992-98



Source:Table 3.5

After a rapid increase in the enrolment for doctoral level courses in public educational institutions between 1992 and 1996, enrolment in this category declined in 1997. All field of studies experience a decline in doctoral-level enrolment in 1997 (Figure 3.9). However, by 1998 enrolment for doctoral level courses recovered from decline in the previous year. The only significant change during 1997 was the Asian financial crisis. However, without more detailed data, the reason(s) for these developments is not clear.

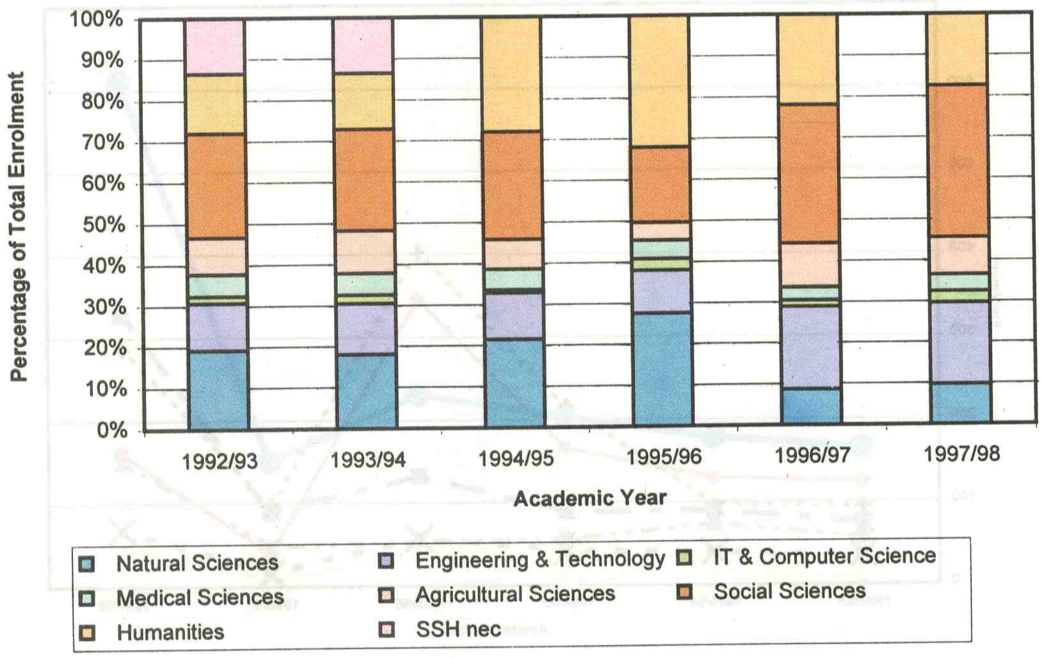
Figure 3.9: Enrolment in Doctoral Courses at Public Educational Institutions, 1992-98



Source: Table 3.5

Similar to the enrolment in master level courses, both the social sciences and the humanities' shares in total enrolment in doctoral level courses in public educational institutions are substantial. Both fields account for about 50-55% of total enrolment in doctoral level courses at public educational institutions (Figure 3.10). The natural sciences' share of total enrolment in this category declined significantly in recent years. Engineering and technology's share has increased to about 20% while that of information and computer technology has increased to about 3% in 1998.

Figure 3.10: Composition of Enrolment in Doctoral Courses at Public Educational Institutions, 1992-98

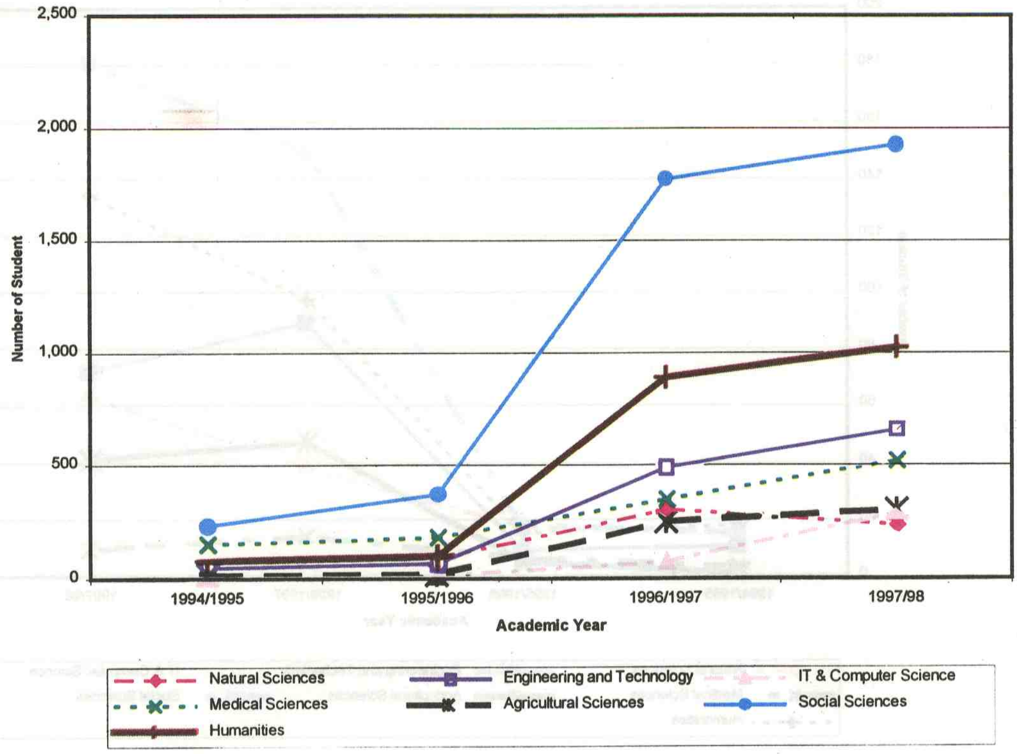


Source: Table 3.5

3.2.4 Graduation in Master and Doctoral Degree Courses

Between 1995 and 1998, the number of students graduating at master level courses in public educational institutions increased rapidly for almost all field of studies (Figure 3.11). This is a sign of the deepening of Malaysia's public educational system. In the sciences, there is a subtle shift of emphasis from the pure (natural) sciences to more applied science-oriented disciplines such as engineering and information and computer technology. In 1995, 82 students graduated with master degrees in the natural sciences compared to 45 students in engineering and technology. By 1998, the number of students graduating with master degrees in the natural sciences and engineering and technology had grown to 230 and 652, respectively.

Figure 3.11: Graduating Students in Master Degree Course at Public Educational Institutions, 1994-98

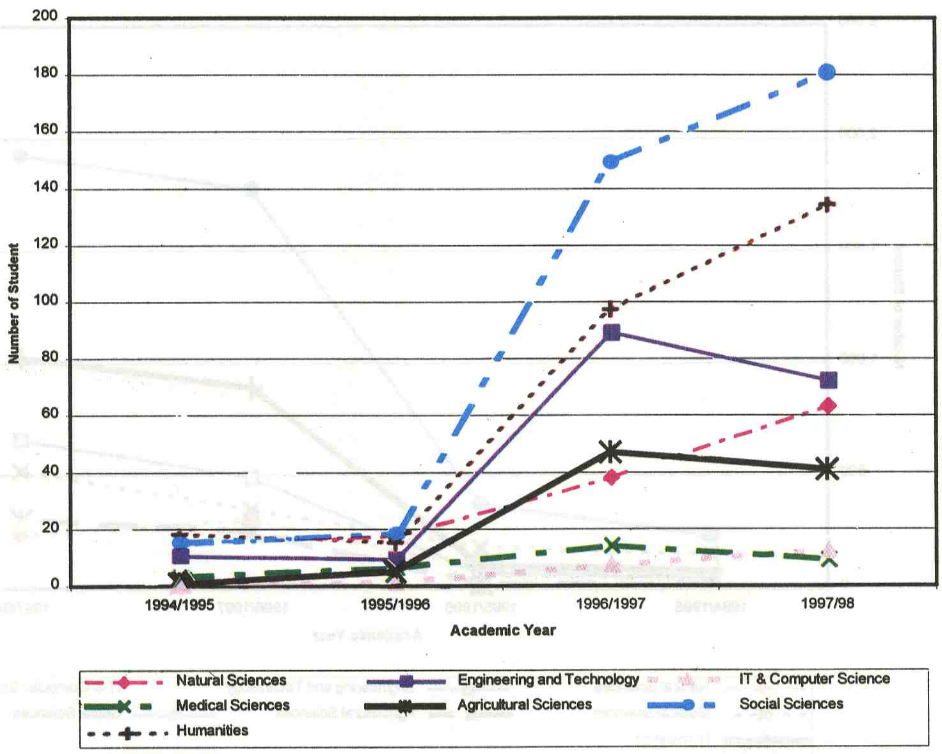


Source: Table 3.7

The graduation trends for master degree courses for information and computer technology is even more striking. In 1995 there was not a single student graduating with a master degree in information and computer technology. Within a span of four years, the number of graduating master degree students in this field had increased to 284 students.

Graduation at the doctoral level at public educational institutions followed a similar upward trend similar to that observed for the master level (Figure 3.12). However, since the number of students at the doctoral level is much smaller than say at the masters and first degree levels, total increment in the number of doctoral graduates is small.

Figure 3.12: Graduating Students in Doctoral Courses at Public Educational Institutions, 1994-98

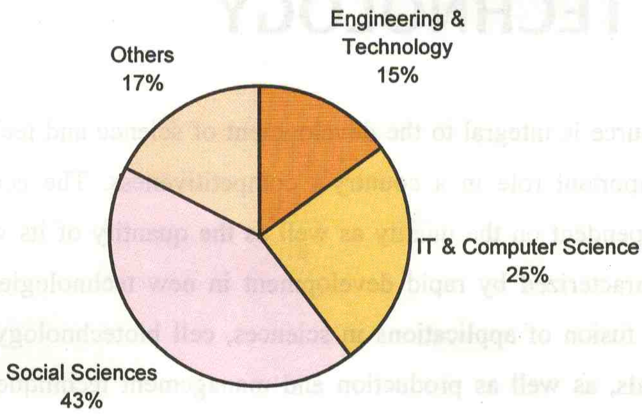


Source: Table 3.8

3.3 Tertiary Education in Science and Technology – Private Educational Institutions

There is a fair amount of emphasis on S&T-related studies at the first degree level in the private educational system. Engineering and technology's share of total first degree enrolment in private educational institutions amounts to 15% in 1999. Even more encouraging is the sector's focus on IT and computer science. About a quarter of the total first degree enrolment in private educational institutions in 1999 are in IT and computer science. The social sciences' share of total enrolment in the private educational institutions (at around 40%) is similar to the share observed in the public educational institutions.

Figure 3.13: Composition of Enrolment in First Degree Courses in Private Educational Institutions, 1999



CHAPTER 4

HUMAN RESOURCE FOR SCIENCE AND TECHNOLOGY

Human resource is integral to the development of science and technology which in turn plays an important role in a country's competitiveness. The economic potential of a nation is dependent on the quality as well as the quantity of its work force. The world today is characterized by rapid development in new technologies such as information technology, fusion of applications in sciences, cell biotechnology, genetic engineering, new materials, as well as production and management techniques. Historical evidence points clearly to the need for research and development because industries will decline if no efforts are taken to adapt, improve its products and to discover new ones. In order to do this, Malaysia needs to develop human resource in R&D to compete successfully in international market. According to the *Competitiveness Input Factors* (IMD, 1999), one of the eight factors that is used to determine national competitiveness is people. In this category, Malaysia ranked 36th in 1999 well below other countries such as Singapore (4), Thailand (33), China Hong Kong (14), Japan (13) and US (1). This shows that Malaysia has to invest more in the development of its human resource in order to bridge the competitiveness gap between the nation and other countries.

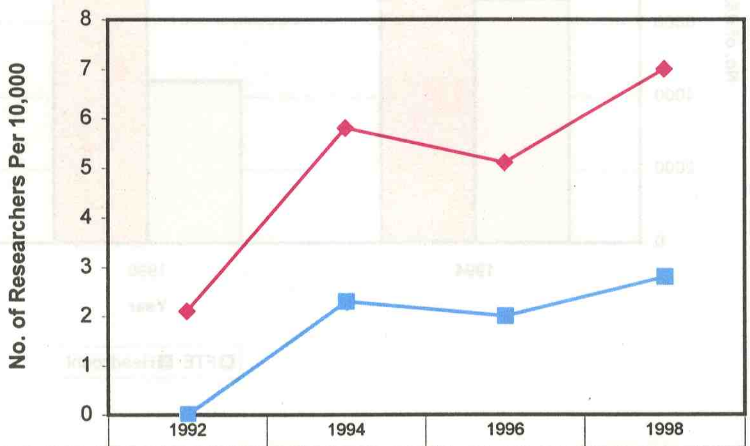
This chapter examines the characteristics of research personnel, size, gender composition as well as distribution of research personnel among the different sectors in Malaysia. It also looks into trends in research personnel employed in R&D.

4.1 Workforce in Research and Development (R&D)

The same classification of workforce in research and development as appeared in previous reports is adopted here: they are researchers and R&D personnel comprising technicians and other support staff. Headcount as well as full time equivalent (FTE) are used to measure the labor input into R&D.

Researchers per 10,000 labor force increased from 5.1 in 1996 to 7.0 in 1998 (Figure 4.1). Corresponding to this, researchers per 10,000 population also increased from 2.0 to 2.8. In terms of headcount, there has been an improvement from 9,233 in 1996 to 12,127 in 1998. Measured in FTE, it has improved from 4436.9 in 1996 to 6656.3 in 1998. However, it was slightly lower than in 1994 (6675.6). Although the manpower in R&D is low, it is an improvement over the last period especially during economic contraction that was experienced from mid-1997 to 1999.

Figure 4.1: Researchers Per 10,000 Labor Force and Population 1992-98

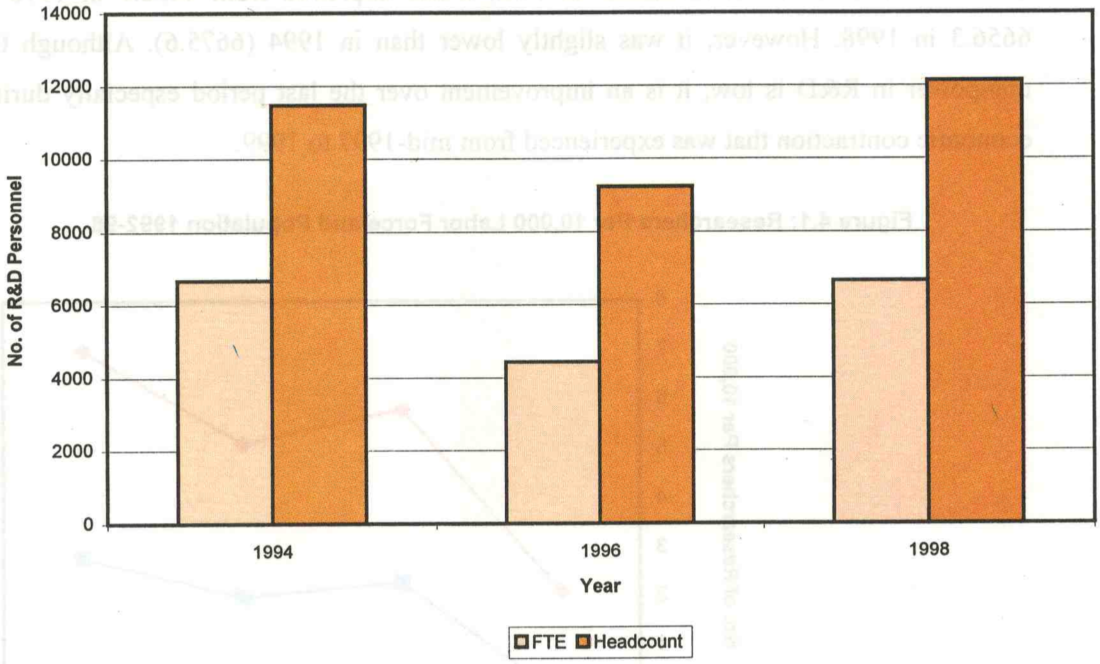


	1992	1994	1996	1998
Researchers per 10,000 labour force	2.1	5.8	5.1	7.0
Researchers per 10,000 population	0	2.3	2	2.8

Source: Table 4.1a

There was an increase in researchers and R&D personnel in terms of headcount and FTE for the period 1996-1998 compared to 1994-1996 period (Figure 4.2). The percentage increase in headcount and FTE for researchers and R&D personnel was 47.3% and 80.4%, respectively. For R&D personnel, the percentage increase was 50.0% and 31.3% for FTE and headcount, respectively. Compared to the 1994-1996 period where headcount and FTE suffered a decline in both categories of workforce (researchers and R&D personnel), the positive increase for 1996-1998 indicated that more emphasis has been given to R&D despite the economic downturn.

Figure 4.2: R&D Personnel (FTE and Headcount), 1994-98

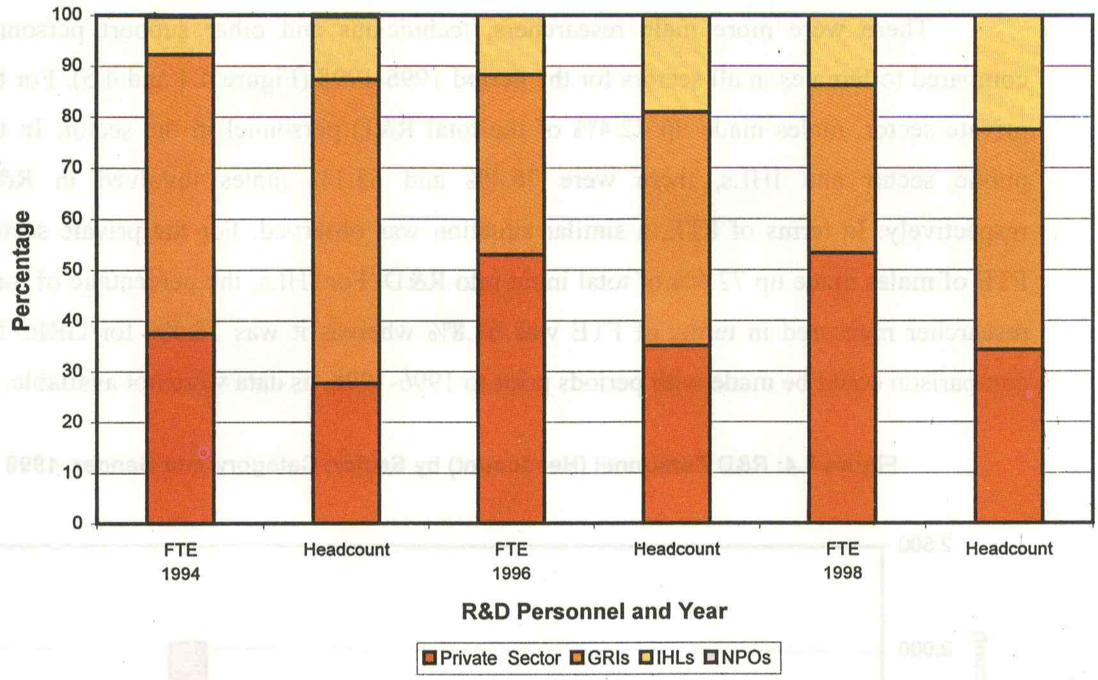


Source: Table 4.1b

Examining the trends in R&D personnel in different sectors, the private sector registered a tremendous increase in researchers and R&D personnel in terms of FTE (94.6%) and headcount (70.4%). For R&D personnel, the increase was 51% and 28.1% respectively for FTE and headcount. This clearly shows the involvement and commitment of the private sector in R&D.

For government research institutes (GRIs) and institutes of higher learning (IHLs), the increase could be described as very encouraging. More time was devoted to R&D by researchers and R&D personnel as indicated by the percentage increase from 1996 to 1998 for both sectors. However, in terms of percentage of contribution of each sector towards total R&D personnel, little changes have taken place for the period 1994-1996 and 1996-1998 (Figure 4.3).

Figure 4.3: R&D Personnel (FTE and Headcount) by Sector, 1994-98



Source: Table 4.1b

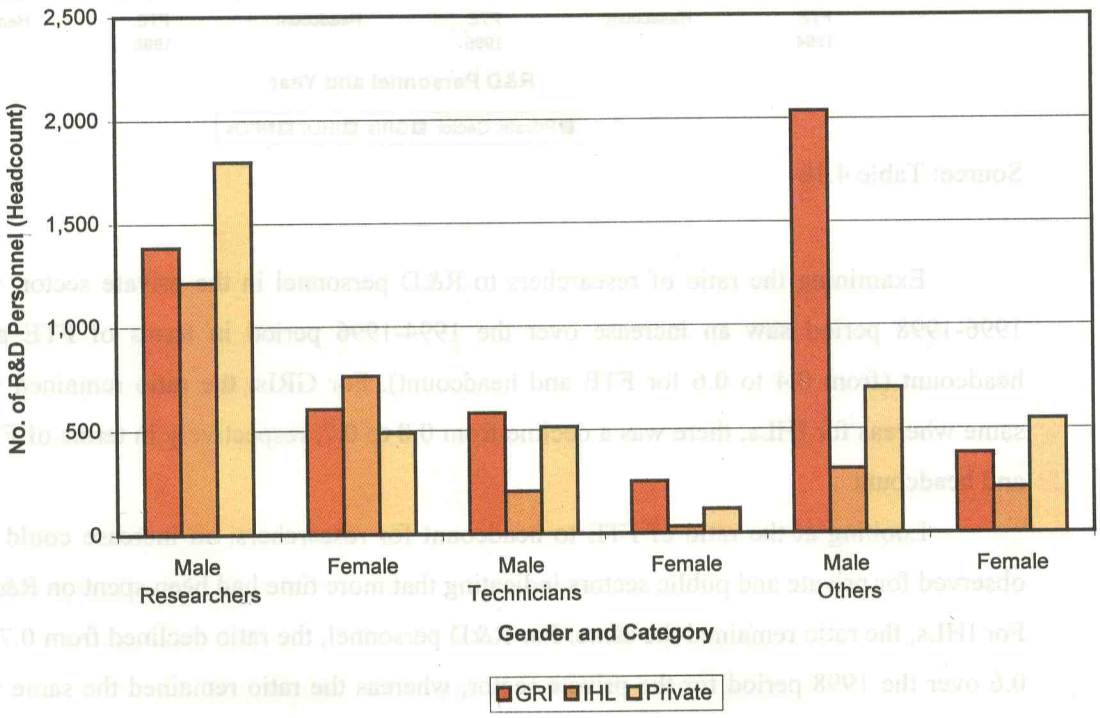
Examining the ratio of researchers to R&D personnel in the private sector, the 1996-1998 period saw an increase over the 1994-1996 period in terms of FTE and headcount (from 0.4 to 0.6 for FTE and headcount). For GRIs, the ratio remained the same whereas for IHLs, there was a decline from 0.8 to 0.7, respectively in terms of FTE and headcount.

Looking at the ratio of FTE to headcount for researchers, an increase could be observed for private and public sectors indicating that more time had been spent on R&D. For IHLs, the ratio remained the same. For R&D personnel, the ratio declined from 0.7 to 0.6 over the 1998 period for the private sector, whereas the ratio remained the same for government research institutes. An increase for IHLs can be observed during the same period (from 0.3 in 1996 to 0.7 in 1998).

4.1.1 Gender Composition of Research Personnel (Headcount and FTE) by Sector

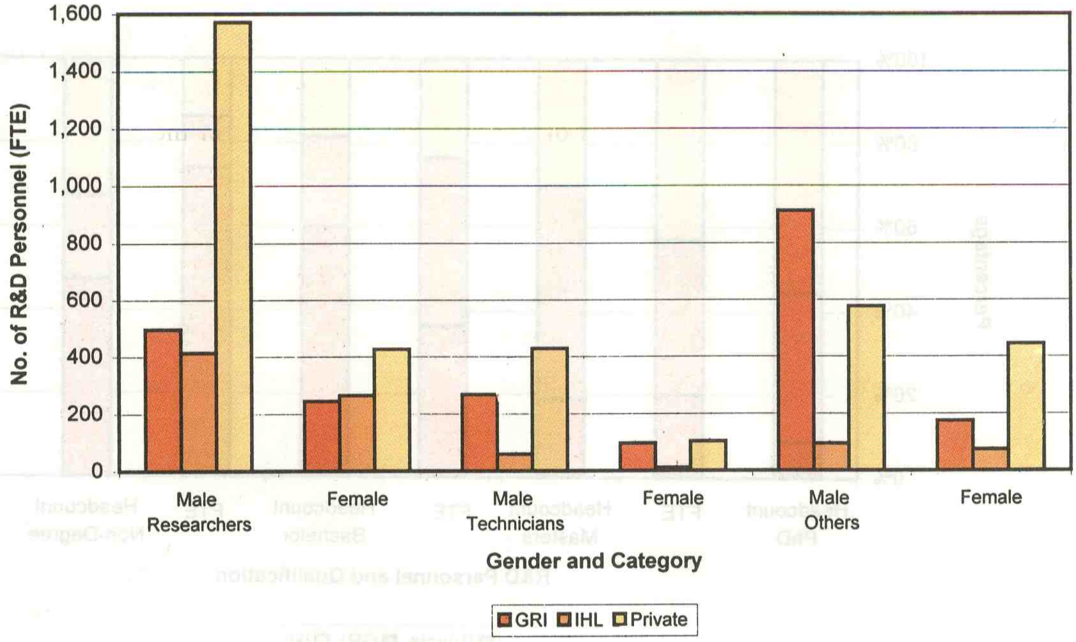
There were more male researchers, technicians and other support personnel compared to females in all sectors for the period 1996-1998 (Figure 4.4 and 4.5). For the private sector, males made up 72.4% of the total R&D personnel in the sector. In the public sector and IHLs, there were 76.4% and 63.1% males involved in R&D respectively. In terms of FTE, a similar situation was observed. For the private sector, FTE of males made up 72.6% of total input into R&D. For IHLs, the percentage of male researcher measured in terms of FTE was 61.8% whereas it was 76.5% for GRIs. No comparison could be made with periods prior to 1996-1998, as data were not available.

Figure 4.4: R&D Personnel (Headcount) by Sector, Category and Gender, 1998



Source: Table 4.2a

Figure 4.5: R&D Personnel (FTE) by Sector by Category and Gender, 1998



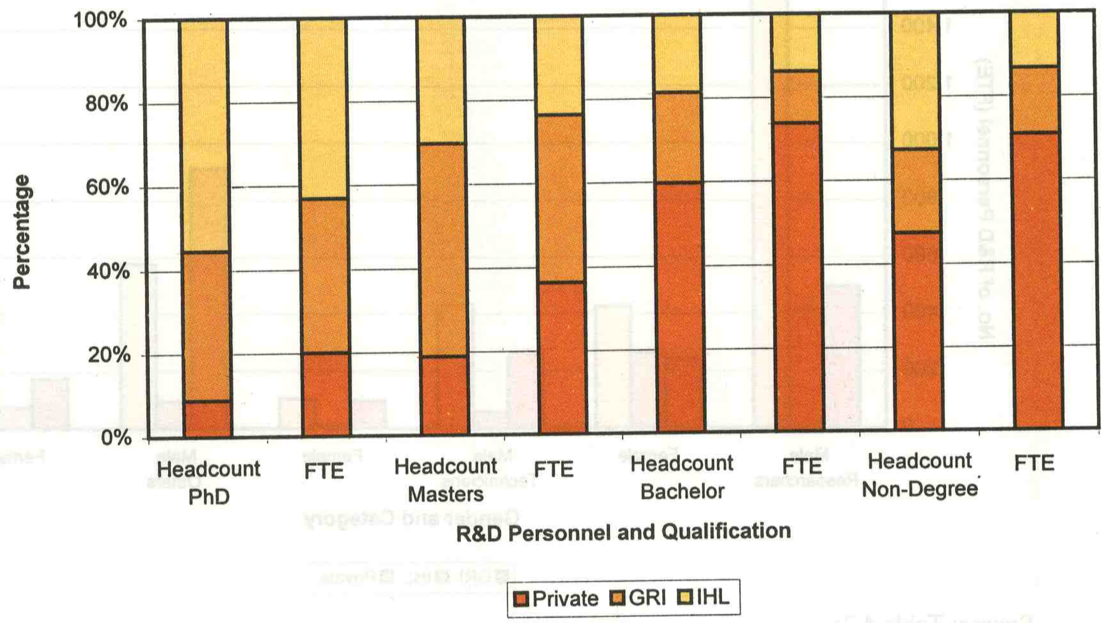
Source: Table 4.2a

4.1.2 Researchers (Head Count and FTE) by Sector, Qualification and Gender

In terms of headcount (with the sectors and qualification levels collapsed), females made up 29.7% of total researchers while males made up 70.3%. Aggregating the sectors, researchers with PhD made up 23.8% (1,486) of total researchers. Those with Masters degree made up 23.9% (1,493). Bachelor degree holders constituted 41.8% (2,614) and the remaining 10.5% (656) were non-degree holders.

For all levels of qualification, male researchers outnumbered female ones in R&D. Comparing participation in R&D in terms of gender, the percentage of female researchers with PhD was 22.7% (338). Slightly more than 30% of researchers with Masters and Bachelor degrees were females whereas those without degree made up 35.8%. This shows that females were not adequately represented in the field of R&D, in particular, at the PhD level. Reasons for the low level of female participation are well documented in gender studies and it is not within the purview of this report to analyze them.

Figure 4.6: Researchers (Headcount and FTE) by Sector and Qualification, 1998



Source: Table 4.2b and 4.2c

For the private sector, the majority of researchers have Bachelor degree (Figure 4.6). Amongst all qualification categories, female researchers have the highest participation rate in the bachelor degree category. There were very few female researchers with PhD (16 persons) and they constituted only 12.3% of total researchers with PhD in the sector. This number represented 1% of the total number of researchers with PhD in all sectors.

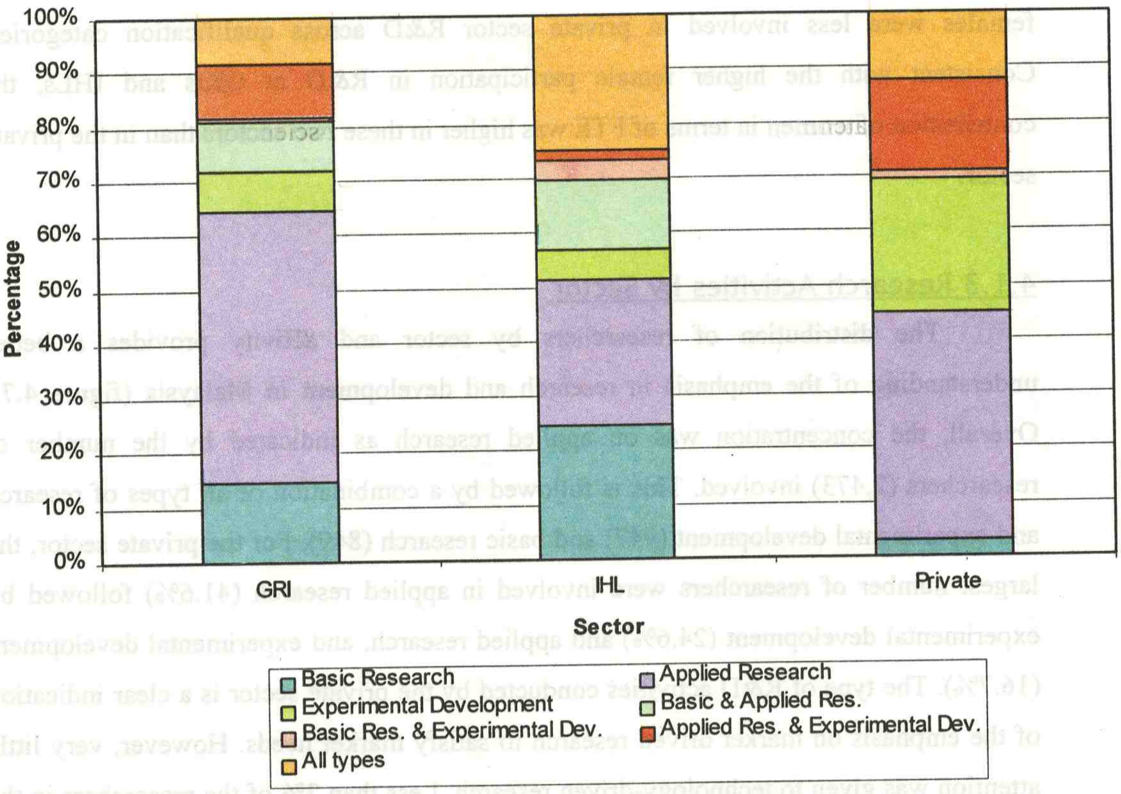
For GRIs and IHLs the female participation was higher compared to the private sector. On the whole, females made up more than 30% of researchers with qualification at the Masters and Bachelor degrees level. In fact, the percentage of female participation was higher than the males for the category of researchers without degree. By far, IHLs had the highest percentage of female researchers with PhD among the three sectors, i.e., 14.3% of total researchers with the same qualification.

In terms of FTE, overall, total female contribution was 935.65 or 27.4% whereas the males contributed the balance of 72.6% (Table 4.2c). Looking at the FTE in R&D by qualification, female researchers with PhD contributed 23.3% whereas for the Masters level, it was 26.9%. Those with Bachelor degree contributed 28.7% towards FTE for the category. Measured in FTE, the situation of male/female participation was similar to the situation under headcount. Distribution of female researchers by sector shows that females were less involved in private sector R&D across qualification categories. Consistent with the higher female participation in R&D at GRIs and IHLs, the contribution of women in terms of FTE was higher in these two sectors than in the private sector.

4.1.3 Research Activities by Sector

The distribution of researchers by sector and activity provides a better understanding of the emphasis in research and development in Malaysia (figure 4.7). Overall, the concentration was on applied research as indicated by the number of researchers (2,473) involved. This is followed by a combination of all types of research and experimental development (947) and basic research (849). For the private sector, the largest number of researchers were involved in applied research (41.6%) followed by experimental development (24.6%) and applied research, and experimental development (16.7%). The type of R&D activities conducted by the private sector is a clear indication of the emphasis on market driven research to satisfy market needs. However, very little attention was given to technology-driven research. Less than 3% of the researchers in the private sector were involved in basic research. More attention may have to be given to basic research as the largest pay-off comes from technology-driven research that generates new technologies for future new product development that harbors potential for latent market needs satisfaction.

Figure 4.7:Number of Researchers (Headcount) by Type of Research, 1998



Source: Table 4.3

For the government research institutes (GRIs), 50.1% of the researchers were engaged in applied research followed by 14.5% in basic research during 1996-1998 period. The allocation of researchers to the various types of research indicated the importance of applied research as well as basic research. The role of government agencies in basic research becomes apparent in the case of the types of research undertaken by IHLs. A more equal emphasis could be observed for basic research (24.5%), all types of research (24.9%) and applied research (26.7%).

The government's strategy of assuming more responsibilities in basic research is appropriate for the development of technological capabilities of the country. In this respect, the government has taken positive steps in providing the necessary infrastructure and implementing programs such as providing scholarship for tertiary education in science and attracting scientists from abroad.

Attracting Malaysian scientists working abroad and foreign scientists to Malaysia is a short-term measure to overcome the shortage of scientists. However, this program was not very successful. Up to date, only a total of 93 (23 locals and 70 foreigners) have responded. One possible explanation for this less than satisfactory response could be the difficulty in matching compensation and benefits enjoyed by scientists working abroad.

Another program known as the 'Young German Professionals for Employment in Malaysia' has been formulated. It is still in the initial stages of planning. As a long-term measure to develop an internal pool of scientists, a fellowship program known as the National Science Fellowship has been established for post-graduate studies in priority areas of science and technology in local universities. So far, there are 77 successful candidates.

4.1.4 Field of Research (FOR) and Qualification by Sector

Of the three major sectors in the economy, the field of research that received tremendous attention in terms of the number of researchers was agriculture (1,206) (Table 4.4). This is followed by engineering science (1,109) and information, computer and communication technologies (1,071). The two fields of research that received the least allocation of researchers were marine sciences and mathematical sciences.

The majority of researchers in the private sector are equipped with Bachelor degree (68.3%) while a smaller percentage of Masters degree (12.4%) and PhD degree (5.7%). About 13.6% of researchers in this sector did not have any degree. In contrast, companies in the developed countries such as Japan, have a large proportion of researchers with PhD (Ong and Md Nor, 1995).

In the private sector, the field of research that had a large number of researchers was: engineering sciences (757), applied sciences and technologies (574), and information, computer and communication technologies (544). Marine and physical sciences had the least number of researchers (3 and 11 respectively).

For GRIs and IHLs the percentage of researchers with PhD and Masters qualifications were higher (Table 4.4). IHLs had the highest percentage of PhD holders (41.7%) whereas GRIs had 26.8% of researchers with similar qualification. Those with Masters made up 22.8% and 38.2% of researchers in IHLs and GRIs respectively.

For IHLs the distribution of researchers in the various fields was more evenly distributed compared to the private sector as eight out of the 15 field of research had more than 100 researchers. The field with the highest number of researchers was medical and health sciences (417) followed by agriculture (273) and social sciences (208). For GRIs, the concentration of researchers was in agriculture (827) and information, computer and communication technologies (331).

The distribution suggested that private sector R&D is market-driven and customer-focused whereas government agencies and research institutes and IHLs undertake research in areas that the private sector does not emphasize.

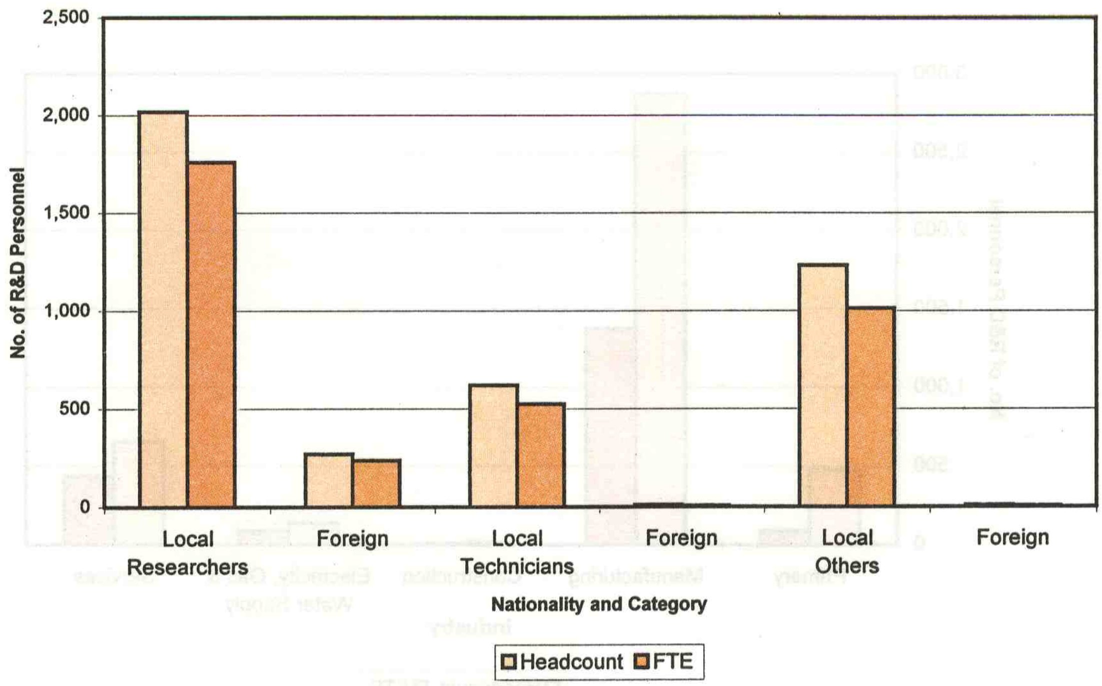
4.1.5 Socio-economic Objectives (SEO) and Qualification by Sector

Examining the socio-economic objectives of R&D provides details about the purpose for which R&D was conducted (Table 4.5). For the private sector, it is obvious that R&D was conducted mainly for the purpose of manufacturing (1,371 researchers) followed by information and communication services (320 researchers), and energy resources (238 researchers). For IHLs, the health sector had the most number of researchers (351) followed by manufacturing (282), natural science technology and engineering (243), and mineral resources (237). For GRIs, researchers were engaged in plant production and primary products (756), followed by manufacturing (301). Comparison with previous years was not possible due to the lack of information.

4.2 Private Sector R&D Personnel (Headcount and FTE)

Total R&D personnel stood at 4,158 representing an increase of 28.1% over 1994-1996. For all categories of R&D personnel, locals outnumbered foreigners (Figure 4.8). The ratio of local researchers to foreign national was 7.5. The ratio of local to foreign research personnel was much higher, consistent with the government's policy of utilizing local human resources.

Figure 4.8: Private Sector R&D Personnel (Headcount and FTE) by Nationality, 1998



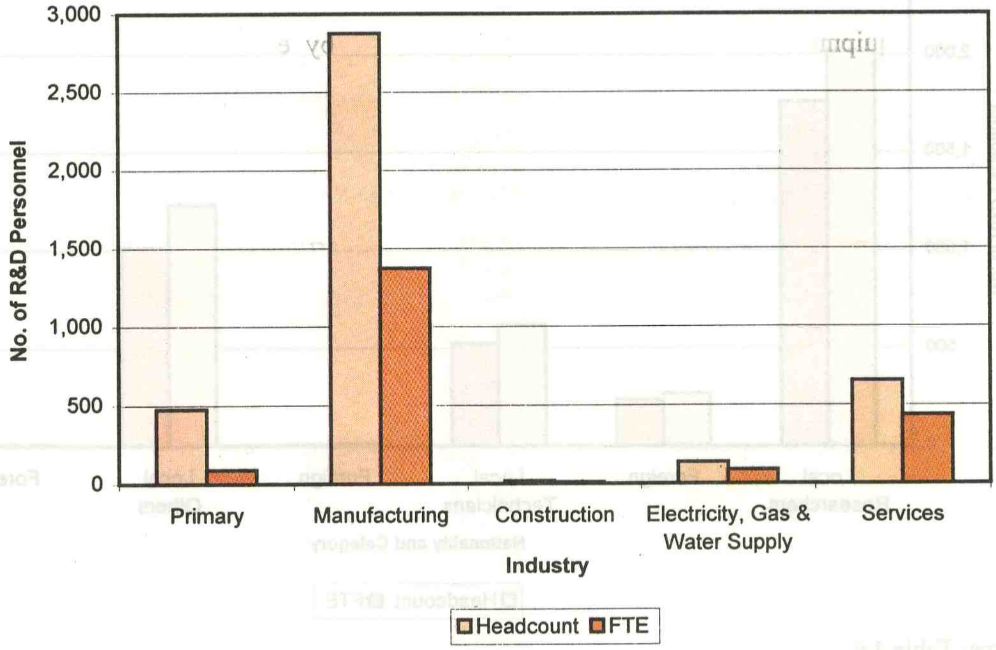
Source: Table 4.6

From the perspective of FTE, the ratio of local researchers to foreign national was 7.4. The ratio of local R&D personnel to foreign national was 13.1, similar to the ratio of local researchers to foreign ones (Table 4.6).

4.2.1 Industry, Nationality and Gender

As mentioned earlier in the chapter, private sector R&D personnel were mainly utilized for manufacturing (Figure 4.9). Within the manufacturing sector, they were mainly found in electronic equipment and component industry (752) followed by agriculture, livestock and fishery industry (475) and electrical machinery and appliances industry (342) (Table 4.7). Services (telecommunication services, computer and related services and other services) employed 654 people while the primary industry had 475 employees in R&D.

Figure 4.9: Private Sector Researchers (Headcount and FTE) by Industry, 1998



Source: Table 4.7 and Table 4.8

In terms of gender, both male and female researchers were found in the electronic equipment and components industry as well as computer and related services, and electrical machinery and appliances industry. The ratio of male to female researchers in the electronic equipment and components industry was 5.4, while the ratio was 2.7 for computer and related services indicating that there were more females in the latter. Foreign researchers were mainly engaged in the electrical machinery and appliances industry. The ratio of foreign male to foreign female researcher was 23.5 indicating that there were more foreign male researchers compared to foreign female researchers. Possible reason for the higher number of male researchers is the greater mobility of males compared to females, a universal characteristic that distinguishes male and female employees.

4.2.2 R&D Researchers (FTE) by Industry, Qualification, and Gender

Total FTE spent on R&D was 1996.93 representing an increase of 94.6% from 1996 (1,026.45) (Table 4.8). Compared this with the increase in terms of headcount, the increase in FTE is significant. The industry that spent the most effort on R&D was the electronic equipment and component industry followed by electrical machinery and appliances and computer and related services industries. Compared to 1996, agriculture was the sector that had the highest R&D effort. This was followed by the electronic equipment industry and the industry classified as "Other Services". Consistent with the government's policy of promoting the Multimedia Super Corridor and the thrust given to the IT industry to spearhead economic growth, computer and related services has been given tremendous emphasis. A more than 400 per cent increase in R&D effort in computer and related services can be observed. This trend is expected to continue with the emerging knowledge economy in which the government, the private sector and the rest of the economy will undergo changes in terms of the whole value creation chain, from the input stage to the delivery of services, payment, and etc.

In terms of qualification, researchers with Bachelor degree contributed a total R&D effort (FTE) of 1380.08 (69.1% of total FTE). Those with PhD contributed only 5% of total FTE and they were mainly found in electricity, gas and water supply industry, petroleum products and refinery and telecommunication services. Those with Masters degree were employed in similar industries except that they were also engaged in electronic equipment and components industry.

In terms of gender, there were more male than female researchers in all industries and for all categories of qualification except a few such as in chemicals and chemical products where FTE contributed by female researchers (20.60) was higher than that by male researchers (15.90).

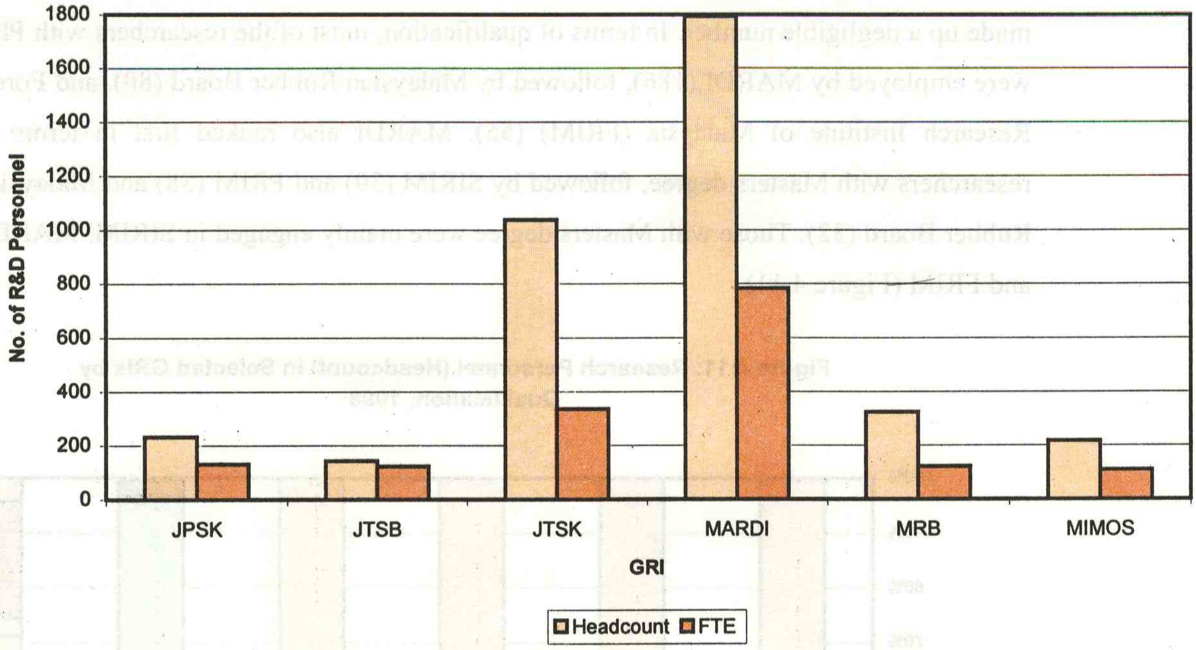
4.2.3 R&D Personnel (FTE) by Field of Research (FOR)

Table 4.9 shows the involvement of private sector in R&D in terms of field of research. The field that received the highest level of attention was engineering sciences with FTE of 718.95 followed by information, computer and communication technologies (508.88) and applied science and technologies (508.83). Compared with 1996, the field of research that received the most attention was engineering science (255.89 in FTE) that includes mechanical and industrial engineering, chemical and civil engineering, electrical and electronic engineering, food engineering, environmental engineering and other engineering services. The fields of research that received substantial FTE in 1996 were information, computer and communication technologies (254.05 in FTE) and applied science and technologies (176.94 in FTE). The top three fields of research that contributed towards R&D for 1996 and 1998 were the same except that the total FTE input by researchers was different, 1736.66 and 686.88 for 1998 and 1996, respectively, representing an increase of slightly over 150% for 1998.

4.3 R&D Personnel (Headcount and FTE) in GRIs by Institution

R&D efforts were mainly for research in the agricultural field. Majority of the research personnel were found in agriculture: Malaysian Agricultural Research Institute (1,793), the Department of Agriculture Sarawak (1,038), Malaysian Rubber Board (324), Forest Research Institute of Malaysia (283) and Agricultural Research Centre of Semonggok (231) (Figure 4.10).

Figure 4.10: R&D Personnel (Headcount and FTE) in Selected GRIs, 1998



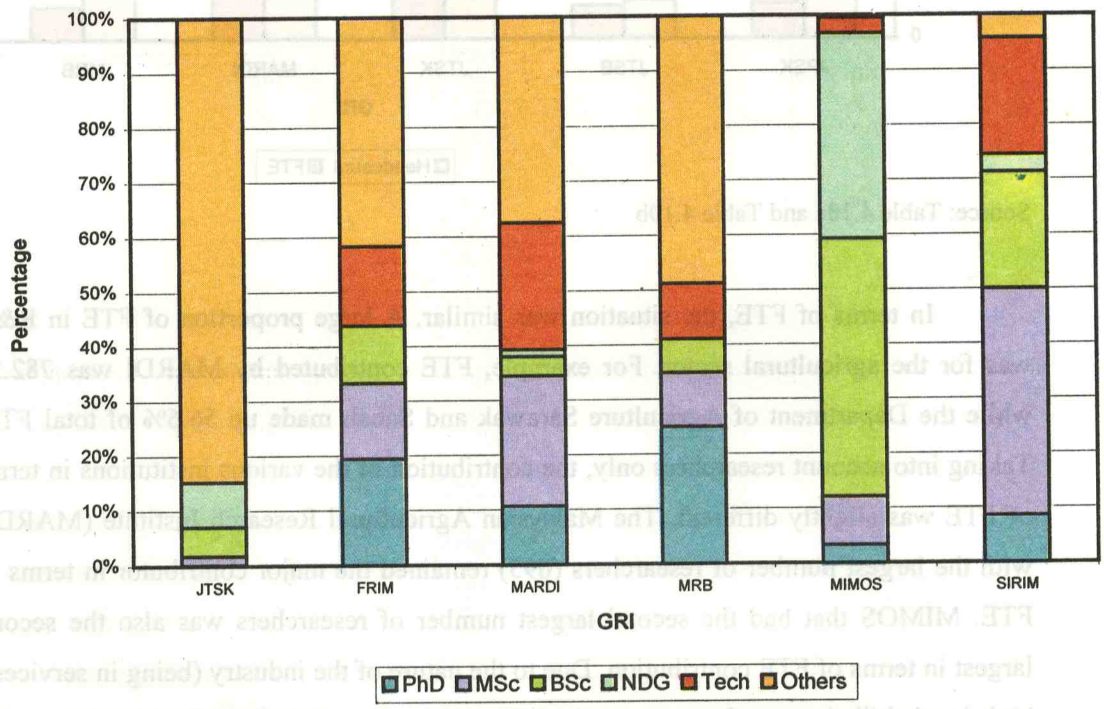
Source: Table 4.10a and Table 4.10b

In terms of FTE, the situation was similar. A large proportion of FTE in R&D was for the agricultural sector. For example, FTE contributed by MARDI was 782.54 while the Department of Agriculture Sarawak and Sabah made up 56.6% of total FTE. Taking into account researchers only, the contribution of the various institutions in terms of FTE was slightly different. The Malaysian Agricultural Research Institute (MARDI) with the largest number of researchers (695) remained the major contributor in terms of FTE. MIMOS that had the second largest number of researchers was also the second largest in terms of FTE contribution. Due to the nature of the industry (being in services), high-level skilled researchers are required. Therefore, the number of support personnel in R&D for MIMOS was very low compared to MARDI or Department of Agriculture Sarawak where the requirement and nature of research differ. The institute with the third highest number of researcher was the Malaysian Rubber Board. However, in terms of FTE, the third highest was the Institute of Medical Research (IMR) with 41.42 in FTE.

4.3.1 Research Personnel by Institute, Nationality and Qualification

The majority of research personnel were Malaysians (Table 4.11). Foreigners made up a negligible number. In terms of qualification, most of the researchers with PhD were employed by MARDI (186), followed by Malaysian Rubber Board (80), and Forest Research Institute of Malaysia (FRIM) (55). MARDI also ranked first in terms of researchers with Masters degree, followed by SIRIM (39) and FRIM (38) and Malaysian Rubber Board (32). Those with Masters degree were mainly engaged in SIRIM, MARDI, and FRIM (Figure 4.11).

Figure 4.11: Research Personnel (Headcount) in Selected GRIs by Qualification, 1998

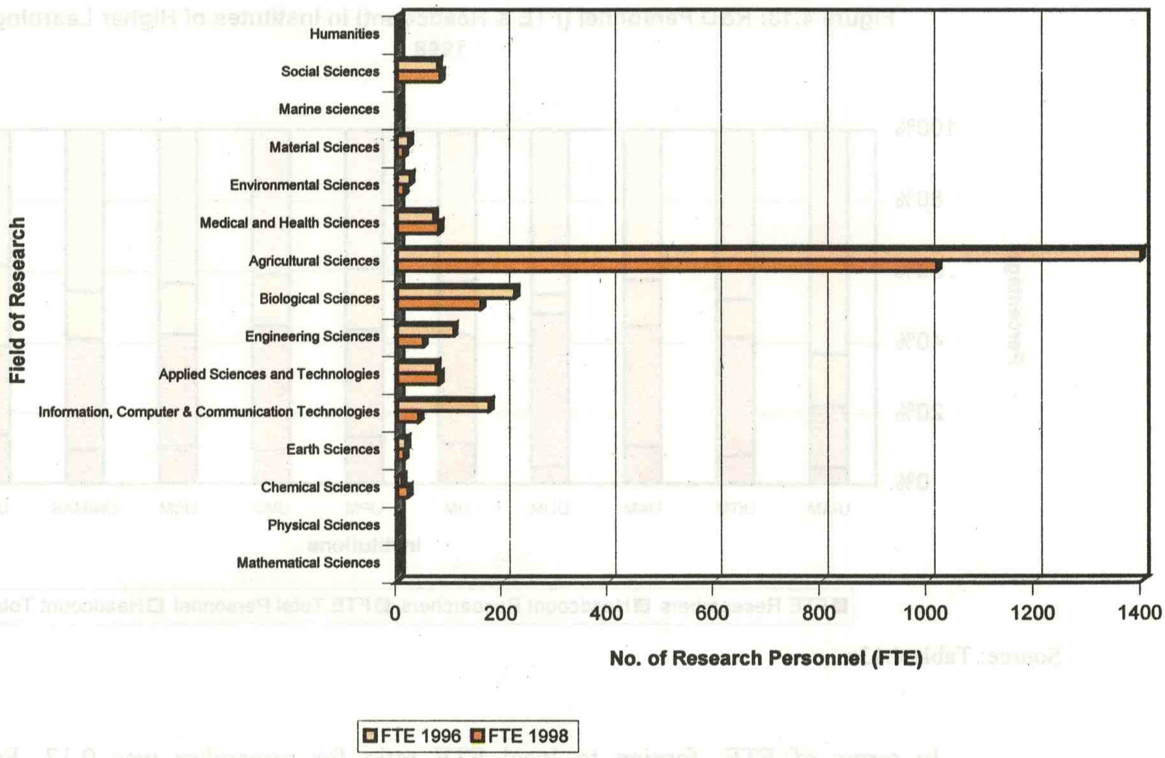


Source: Table 4.11

4.3.2 GRI Research Personnel (FTE) by Field of Research (FOR)

In terms of field of research, agriculture ranked first with FTE of 1,397.67 or 63.4% of total FTE (Figure 4.12). This indicates the importance of agriculture as seen in the emphasis given by government research institutions. Next was biological sciences, 222.54 (10.2% of total FTE) followed by information, computer and communication technologies, 173.63 (7.9% of total FTE). Comparing FTE for 1996 and 1998 by field of research, the trend was similar with agriculture having the highest level of FTE at 1,017.37 or 64.9% of total FTE for 1996. Next was biological sciences (10.1% of total FTE) followed by social sciences that received little (less than 5%) attention in 1998.

Figure 4.12: GRI Research Personnel (FTE) by Field of Research (FOR), 1996-98

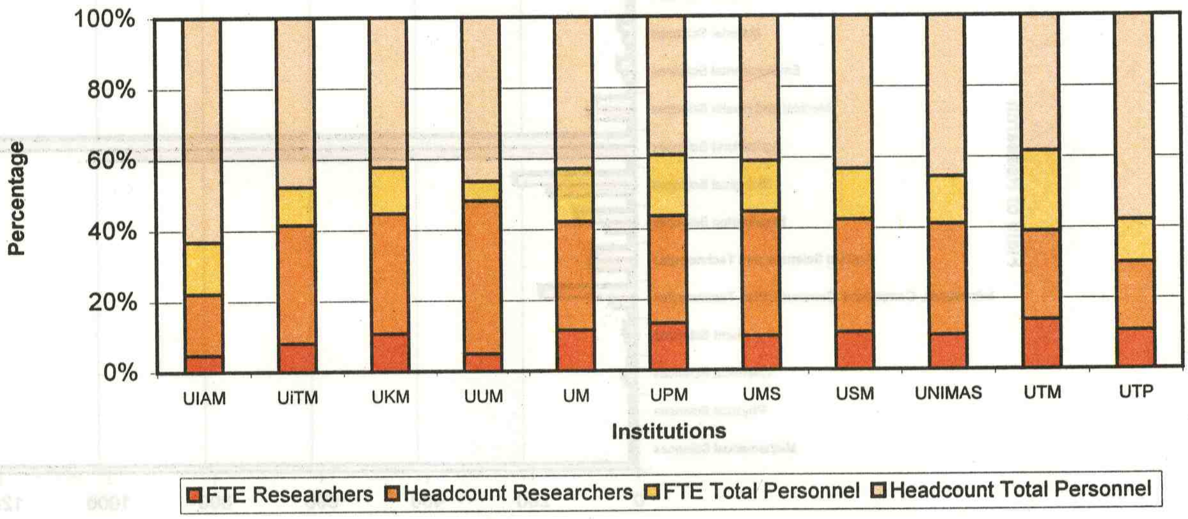


Source: Table 4.12

4.4 Research Personnel (Headcount and FTE) in IHLs by Institution and Nationality

Table 4.13a presents research personnel in IHLs in terms of headcount and FTE while Table 4.13b shows the distribution of research personnel by nationality and institution. In terms of headcount, University of Sains, Malaysia (USM) had the largest number of researchers (626), followed by National University of Malaysia (UKM) (413) and University of Malaya (UM) (230). Again, USM had the largest number (48) of foreign researchers followed by University of Putra, Malaysia (UPM) (38) and UM (34). The ratio of foreign to local researchers was low at 0.1. In terms of research personnel, locals made up 93% of total research personnel while the balance was foreign research personnel. Compared with 1996 period, the ratio of foreign to local researcher was 0.07, a slightly lower ratio than 0.1 for 1998. In terms of percentage of research personnel, locals made up 93.8% (93.0% for 1996) while foreigners made up the balance 6.2% (7% for 1996). Therefore, not much difference had taken place between 1996 and 1998.

Figure 4.13: R&D Personnel (FTE & Headcount) in Institutes of Higher Learning, 1998



Source: Table 4.13a

In terms of FTE, foreign to local FTE ratio for researcher was 0.17. For Malaysians, the lower FTE indicated that besides research and development activities, they probably had to perform managerial and administrative functions as well.

4.4.1.Researchers by Nationality, Gender and Qualification

In terms of qualification, researchers (local and foreign collapsed) with PhD made up 41.7% of total researchers (Table 4.14). Those with Masters degree made up 22.8% while 24.6% were those with Bachelor degree. The remaining 10.9% did not have any degree. There were more male researchers compared to female researchers for all categories of qualifications. However, for the category of non-degree holders, females (124) outnumbered males (91). There were more local researchers compared to foreigners.

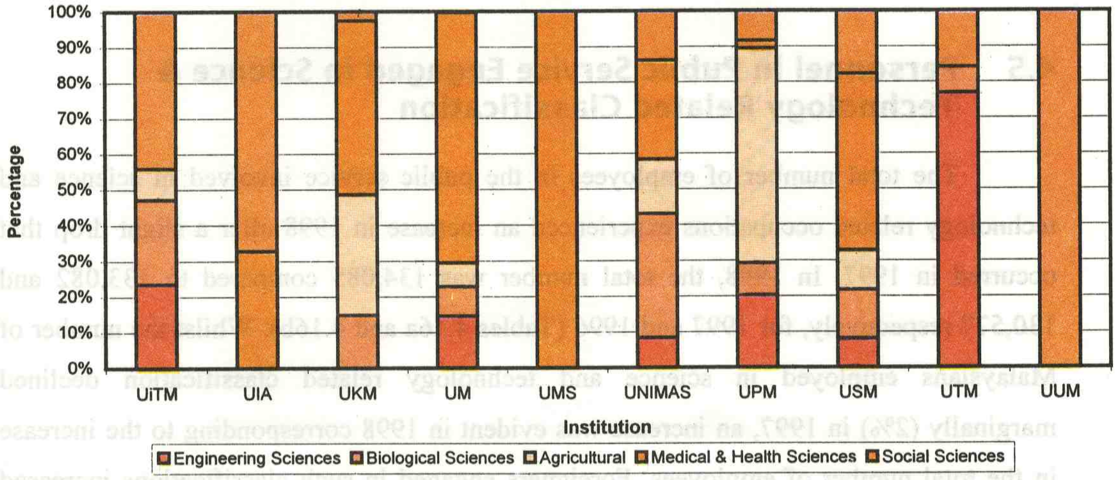
In terms of FTE, Table 4.14 shows that researchers with Bachelor degree contributed 37.9% of FTE in R&D whereas those with PhD contributed 31.4%. Those with Masters degree made up 23.1% of total FTE.

4.4.2 R&D Personnel (Headcount and FTE) by Field of Research

A total of 2,735 researchers were in institutes of higher learning for the period 1996-1998, representing an increase of 978 or 55.7% (Figure 4.14). In terms of field of research, there were 662 research personnel working on medical and health science, 360 in social science, 338 in agriculture, and 222 in chemical science. Compared with 1994-1996, the two leading fields of research measured in terms of headcount were the same; they were: medical and health sciences, and social sciences.

USM had the largest number of research personnel in medical and health science. UM was next followed by UKM. For social science, UIA had the largest number of researchers, USM was second and UUM third. UPM led in agriculture in terms of the number of research personnel followed by UKM and USM.

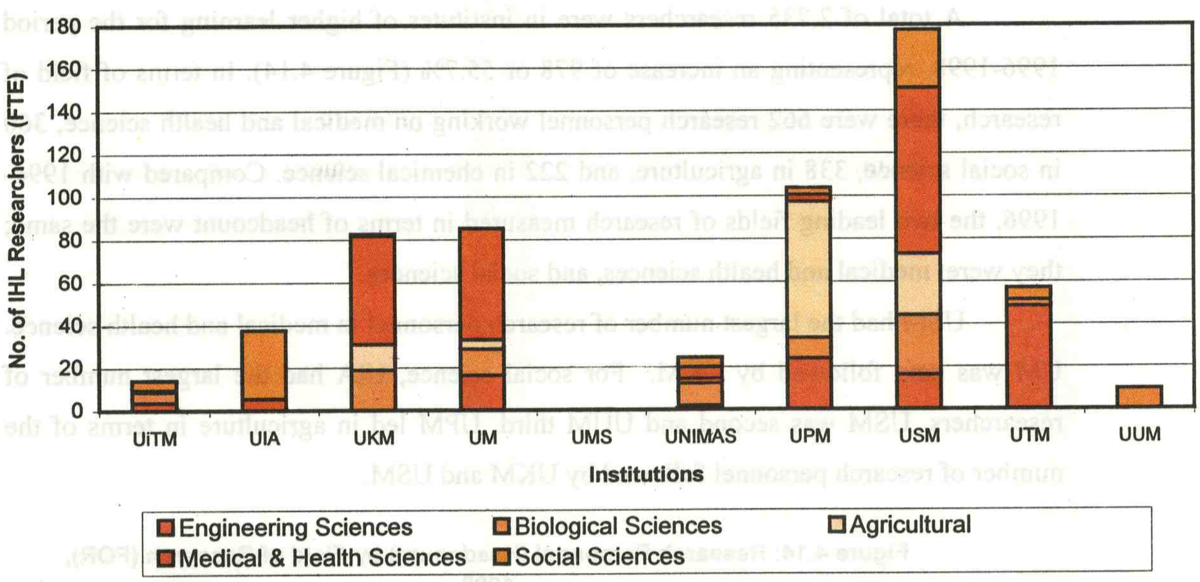
Figure 4.14: Research Personnel (Headcount) by Field of Research (FOR), 1998



Source: Table 4.15a

Measuring the human resource input in terms of FTE, the total FTE for 1998 represented an increase of 395.93 (76.1%) over the 1996 period (Figure 4.15). The fields of research that attracted attention in 1998 were medical and health sciences, agricultural sciences, engineering sciences, and social sciences. The usage of research input was similar to the allocation of researchers measured by headcount. The difference was in the field of social sciences in which the allocation of the number of research personnel was the second highest but in terms of FTE, it ranked fourth. This shows that more FTE was put into engineering although the number of researchers was lower.

Figure 4.15: IHL Researchers (FTE) by Field of Research (FOR), 1998



Source: Table 4.15b

4.5 Personnel in Public Service Engaged in Science & Technology Related Classification

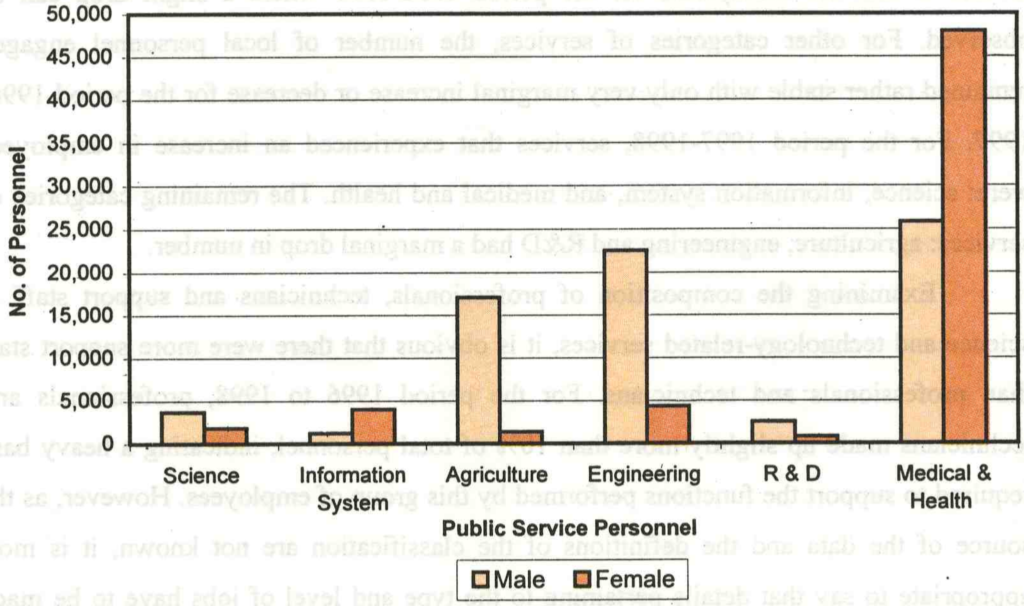
The total number of employees in the public service involved in science and technology related occupations experienced an increase in 1998 after a slight drop that occurred in 1997. In 1998, the total number was 134,085 compared to 133,082 and 130,577 respectively, for 1997 and 1996 (Tables 4.16a and 4.16b). Whilst the number of Malaysians employed in science and technology related classification declined marginally (2%) in 1997, an increase was evident in 1998 corresponding to the increase in the total number of employees. Foreigners engaged in such classifications increased significantly from 1996 to 1997 (an increase of about 150%), but the number remained stable in 1998. In 1997, for all categories of services, the number of foreigners employed has increased tremendously as the total number was larger than the number of personnel for all the years (1993-1996) combined. The reason for the sudden surge in the number of foreign personnel in S&T related classification for 1997 is not immediately known.

Services with significant increase in the number of foreigners were medical and health care, engineering and agriculture services. For the same categories of services, the reverse is true for Malaysians for the period 1996-1997 where a slight drop can be observed. For other categories of services, the number of local personnel engaged remained rather stable with only very marginal increase or decrease for the period 1996-1997. For the period 1997-1998, services that experienced an increase in employees were: science, information system, and medical and health. The remaining categories of services: agriculture, engineering and R&D had a marginal drop in number.

Examining the composition of professionals, technicians and support staff in science and technology-related services, it is obvious that there were more support staff than professionals and technicians. For the period 1996 to 1998, professionals and technicians made up slightly more than 10% of total personnel, indicating a heavy base required to support the functions performed by this group of employees. However, as the source of the data and the definitions of the classification are not known, it is most appropriate to say that details pertaining to the type and level of jobs have to be made available in the future for more useful discussions.

In terms of gender, overall, the percentage of males for all categories ranged from 54.1% to 57.2% while female employees made up 42.8% to 45.9% from 1993-1998. Figure 4.16 shows the composition of males and females in different categories of services. The sub-sectors that were male-dominated were science, agriculture, engineering and R&D, while the female employees were predominantly found in information system, and medical and health.

Figure 4.16: Public Service Personnel in S&T Related Classification by Gender, 1997



Source: Table 4.16a

CHAPTER 5

AWARENESS, KNOWLEDGE, AND ATTITUDE TOWARDS SCIENCE AND TECHNOLOGY

The survey on "Public Awareness of Science and Technology in Malaysia" marks another effort of MASTIC directed at the individual level to study people's awareness, perceived knowledge and attitude towards issues related to science and technology. Similar studies were conducted in 1994, 1996 and 1998. Its main aim is to examine the awareness, perceived knowledge, interest and attitude towards science and technology and to track any changes that may have taken place over the years.

Of particular importance and implications to this report will be the research findings on young Malaysians with regards to their awareness, perceived knowledge, interest and attitude towards S&T-related issues. An understanding of the current status and trends in the level of awareness and perceived knowledge towards S&T is of great value to policy makers as inputs to programs and strategies aimed at improving knowledge, interest and awareness towards science and technology.

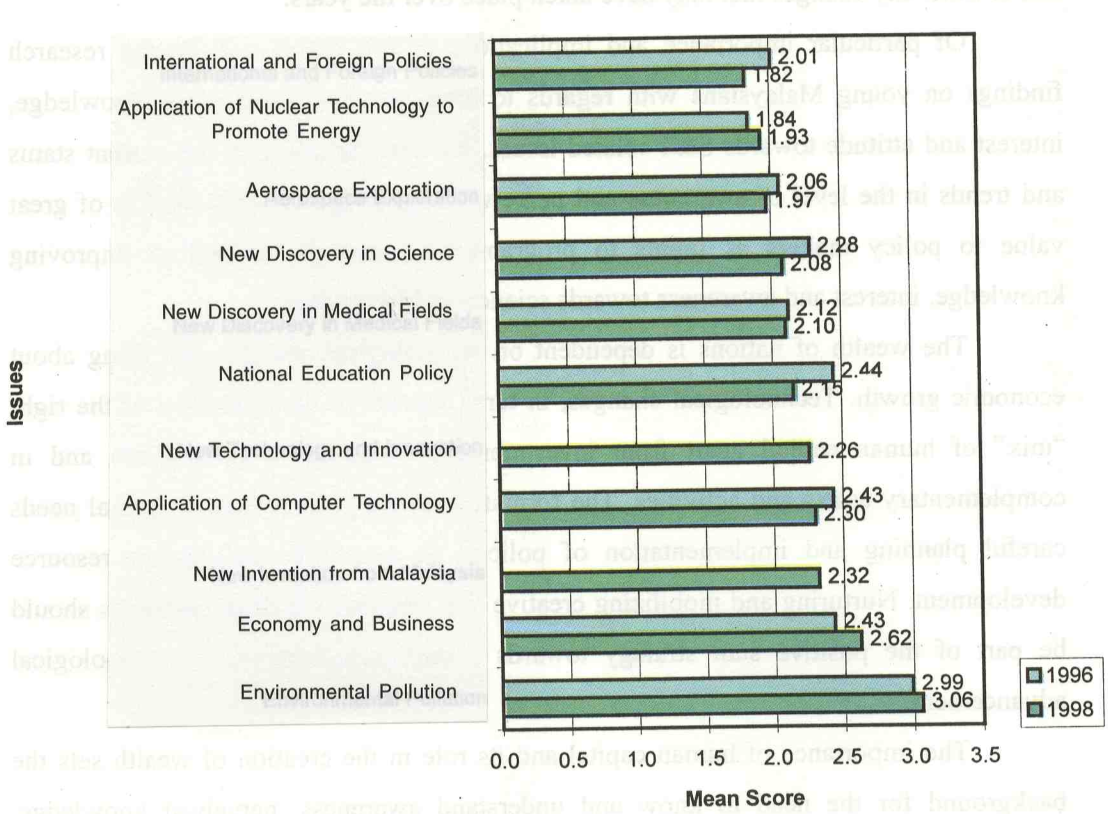
The wealth of nations is dependent on technological changes that bring about economic growth. Technological changes, in turn, depend on the formation of the right "mix" of human capital apart from investments in technical improvements and in complementary assets and activities. The formation of the pool of human capital needs careful planning and implementation of policies in education and human resource development. Nurturing and mobilizing creative and innovative human resources should be part of the positive sum strategy towards greater achievements in technological advancement.

The importance of human capital and its role in the creation of wealth sets the background for the need to know and understand awareness, perceived knowledge, interest and attitude of Malaysians towards S&T. Findings for the survey on "Public Awareness of S&T in Malaysia, 1998" will be used selectively for the purpose of this report.

5.1 Awareness and Perceived Knowledge of S&T-related and General Issues

On the whole, awareness and perceived knowledge about the various general and S&T-related issues ranged from poor to average (mean score ranged from 1.82 to 3.06). The issue of "environmental pollution" had the highest mean score of 3.06. This is followed by "economy and business" (mean = 2.62) and "new invention from Malaysia" which had a mean score of 2.32 (Figure 5.1). Perceived knowledge on international and foreign policies had the lowest mean score of 1.82.

Figure 5.1: Perceived Knowledge about Various General and S&T Issues, 1996-98



Source: Table 5.1

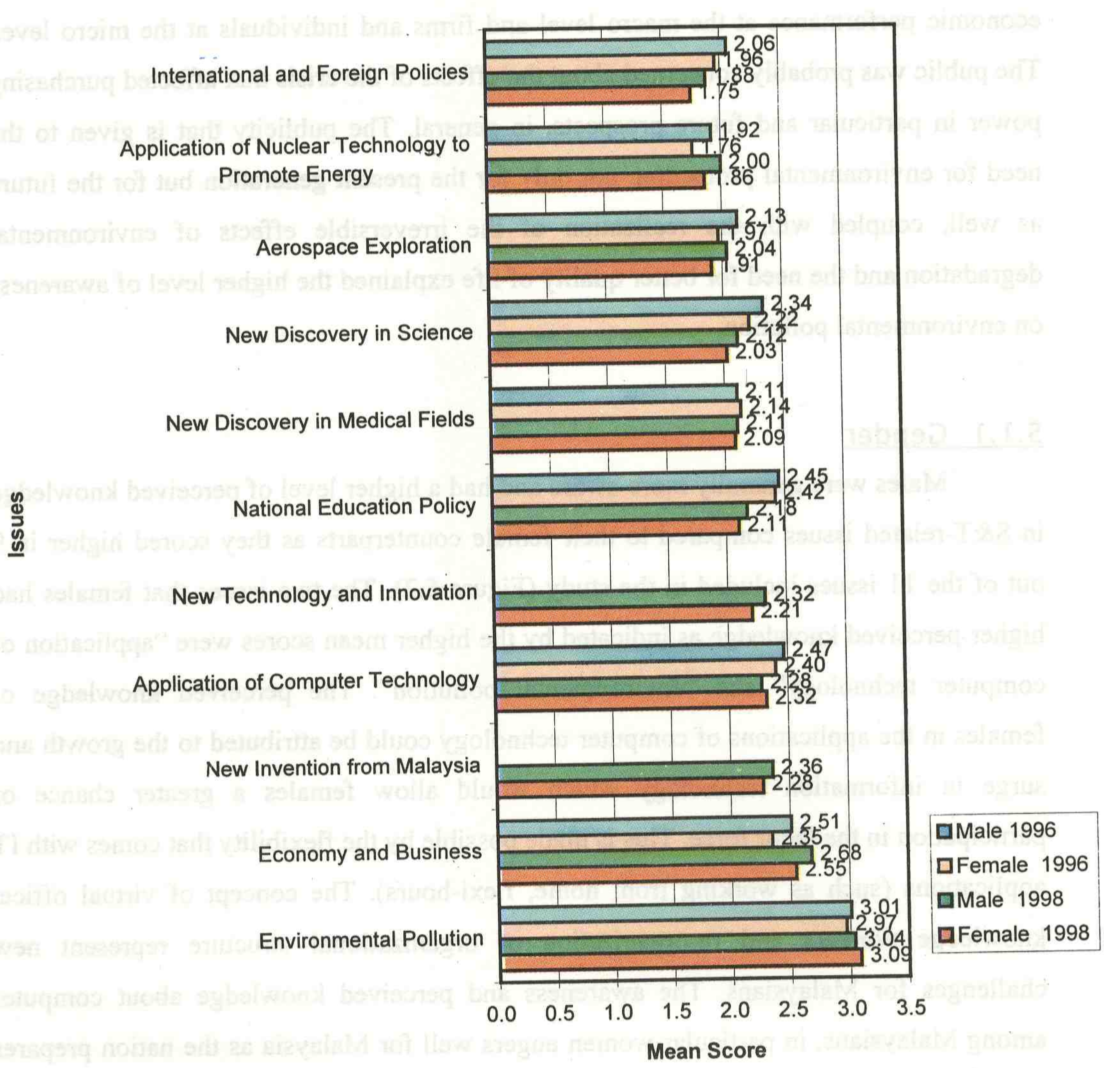
Comparing the results of the 1996 and 1998 surveys, the level of awareness and perceived knowledge was slightly higher in 1996 in all areas except "economy and business", "applications of nuclear technology" and "environmental pollution". The higher level of perceived knowledge for economy and business could be a consequence of the contagious effect of the Asian economic crisis and its impact on the national economic performance at the macro level and firms and individuals at the micro level. The public was probably concerned about the effects of the crisis that affected purchasing power in particular and future prospects, in general. The publicity that is given to the need for environmental protection, not only for the present generation but for the future as well, coupled with the realization of the irreversible effects of environmental degradation and the need for better quality of life explained the higher level of awareness on environmental pollution.

5.1.1 Gender

Males were generally more aware and had a higher level of perceived knowledge in S&T-related issues compared to their female counterparts as they scored higher in 9 out of the 11 issues included in the study (Figure 5.2). The two issues that females had higher perceived knowledge as indicated by the higher mean scores were "application of computer technology" and "environmental pollution". The perceived knowledge of females in the applications of computer technology could be attributed to the growth and surge in information technology which would allow females a greater chance of participation in the labor force. This is made possible by the flexibility that comes with IT applications (such as working from home, flexi-hours). The concept of virtual office, knowledge workers and re-organization of organizational structure represent new challenges for Malaysians. The awareness and perceived knowledge about computer among Malaysians, in particular women augers well for Malaysia as the nation prepares for IT development.

The overall results were consistent with the findings of 1996 where males were found to have a higher level of awareness and perceived knowledge compared to the females. For 1996, the females scored marginally higher compared to the males in only one issue, that is, "new discovery in medical fields".

Figure 5.2: Perceived Knowledge about Various General and S&T Issues by Gender, 1996-98



Source: Table 5.1

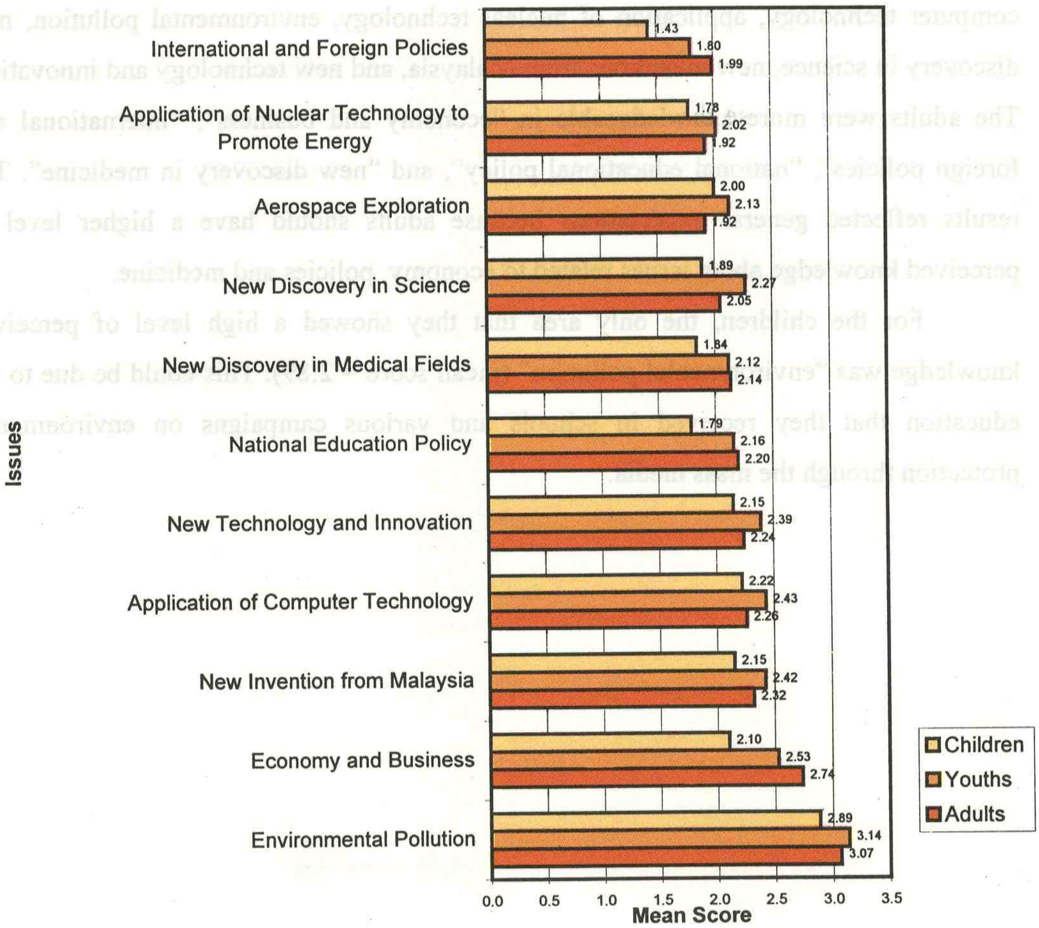
5.1.2 Age Group

It is important to analyze the level of awareness and perceived knowledge of S&T among the three distinct age groups: children (12-14 years), youths (15-20 years) and adults (21-60 years). Research findings about the level of perceived knowledge of S&T-related issues among youths and children will serve as indicators for what needs to be done for the future in order to further improve knowledge level on science and technology.

Youths scored the highest in overall knowledge as well as in seven out of the 11 issues covered in the study (Figure 5.3). They were: aerospace exploration, application of computer technology, application of nuclear technology, environmental pollution, new discovery in science, new inventions from Malaysia, and new technology and innovation. The adults were more knowledgeable in "economy and business", "international and foreign policies", "national educational policy", and "new discovery in medicine". The results reflected general expectations because adults should have a higher level of perceived knowledge about issues related to economy, policies and medicine.

For the children, the only area that they showed a high level of perceived knowledge was "environmental pollution" (mean score = 2.89). This could be due to the education that they received in schools and various campaigns on environmental protection through the mass media.

Figure 5.3: Perceived Knowledge about Various General and S&T Issues by Age Group, 1998



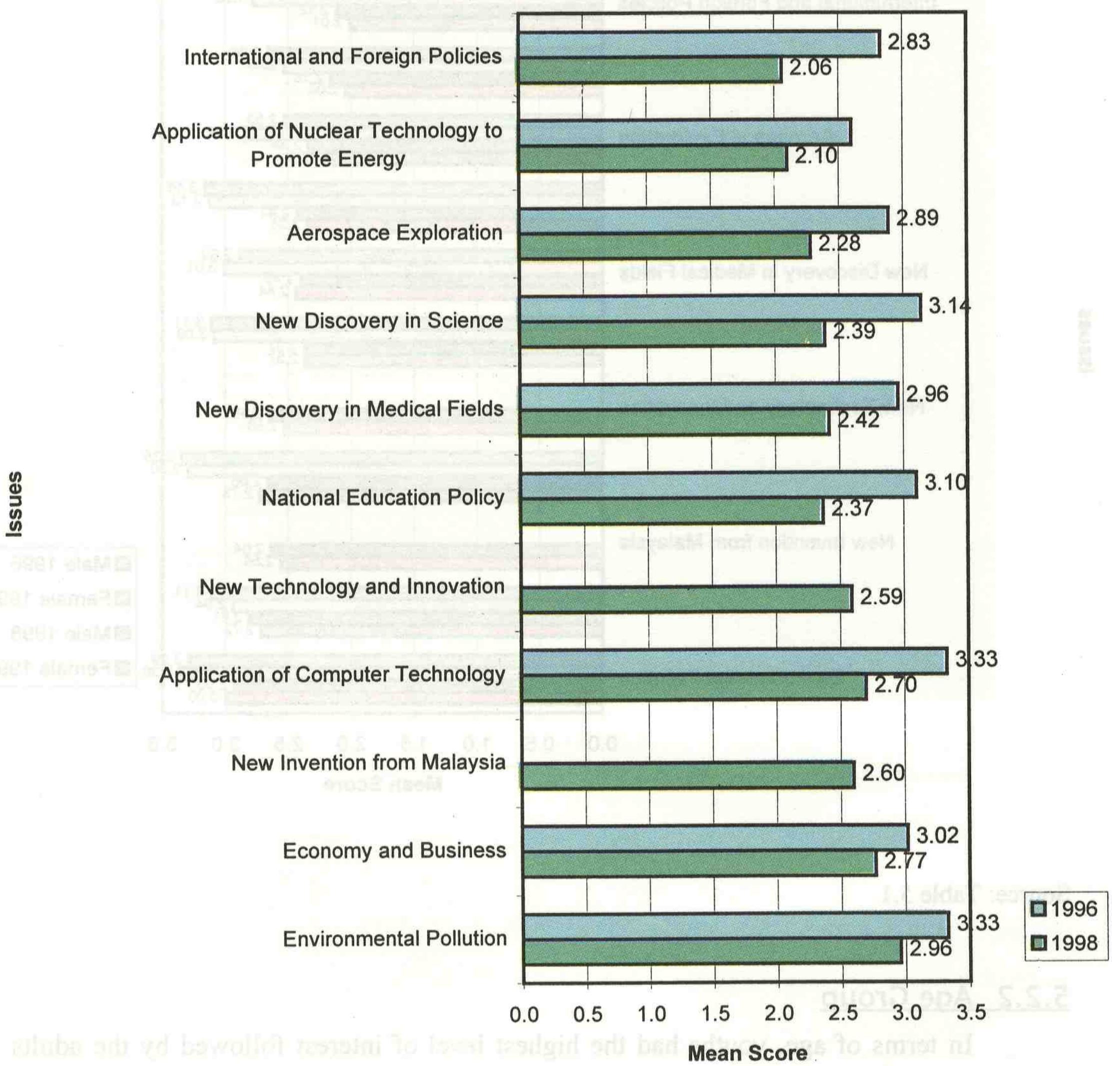
Source: Table 5.1

5.2 Stated Interest in S&T-related and General Issues

Analyses of perceived knowledge level should be accompanied by the expressed interest in the various issues covered in the study. This is important for policy decision-making in providing facilities that could help to provide the information necessary for the pursuit of interest in science and technology issues. Table 5.1 shows the overall level of interest and the gender comparison in interest level. Overall, the level of interest had declined substantially in 1998 compared to the level of interest expressed in 1996 (Figure 5.4). This could be due to the crisis experienced during the last two years that caused people to be concerned about the more immediate problems of meeting the basic needs rather than in pursuit of interest in S&T-related issues.

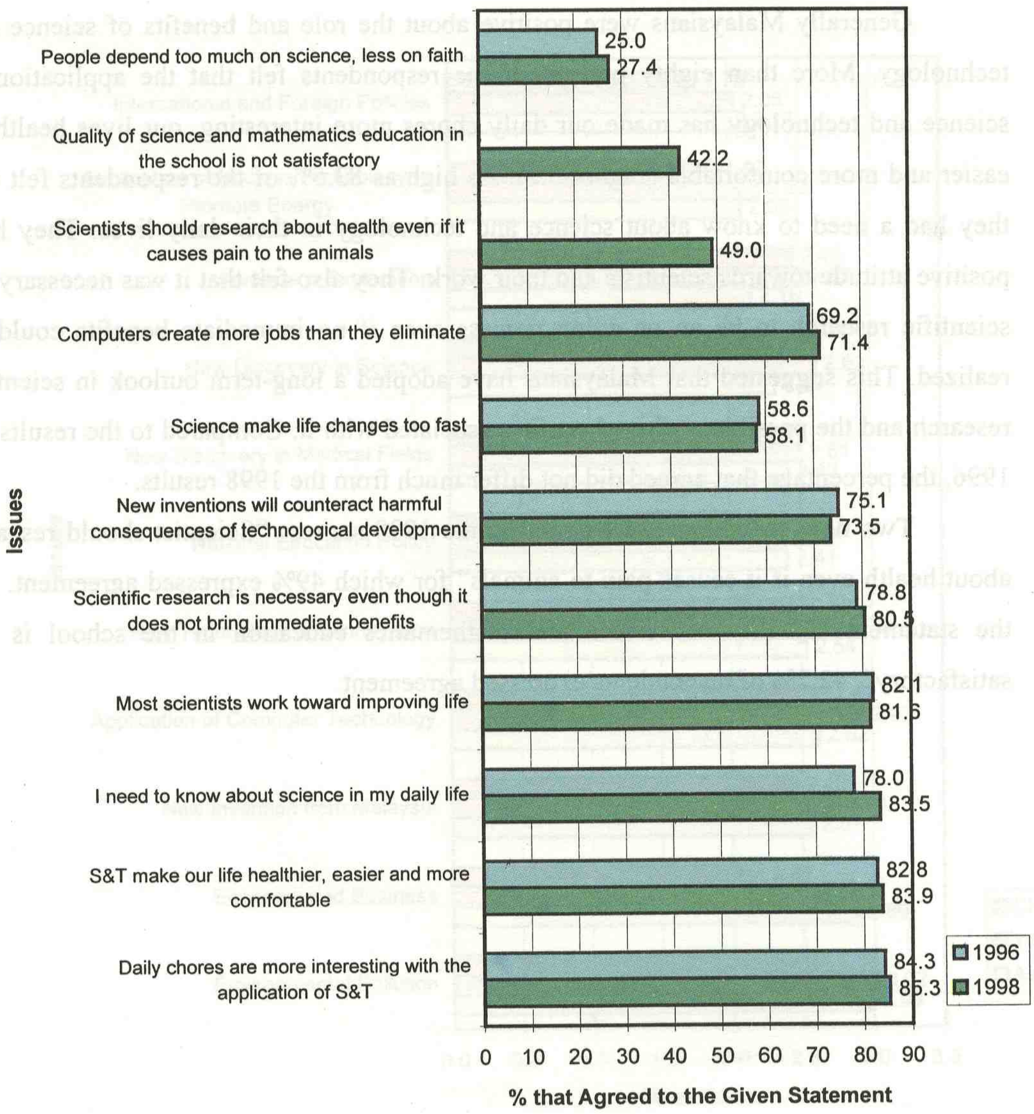
For 1998, the top three areas of interest were "environmental pollution", "economy and business" and "application of computer technology" in descending order of mean score. Of these three, two areas that enjoyed a continued level of interest were "environmental pollution" and "application of computer technology" as reported in the 1996 Report. The improved level of interest in the subject of economy and business for 1998 (ranked fifth in 1996) could be explained by the Asian economic crisis.

Figure 5.4: Interest about Various General and S&T Issues, 1996-98



Source: Table 5.1

Figure 5.7: Perception and Attitude Towards Science and Technology, 1996-98

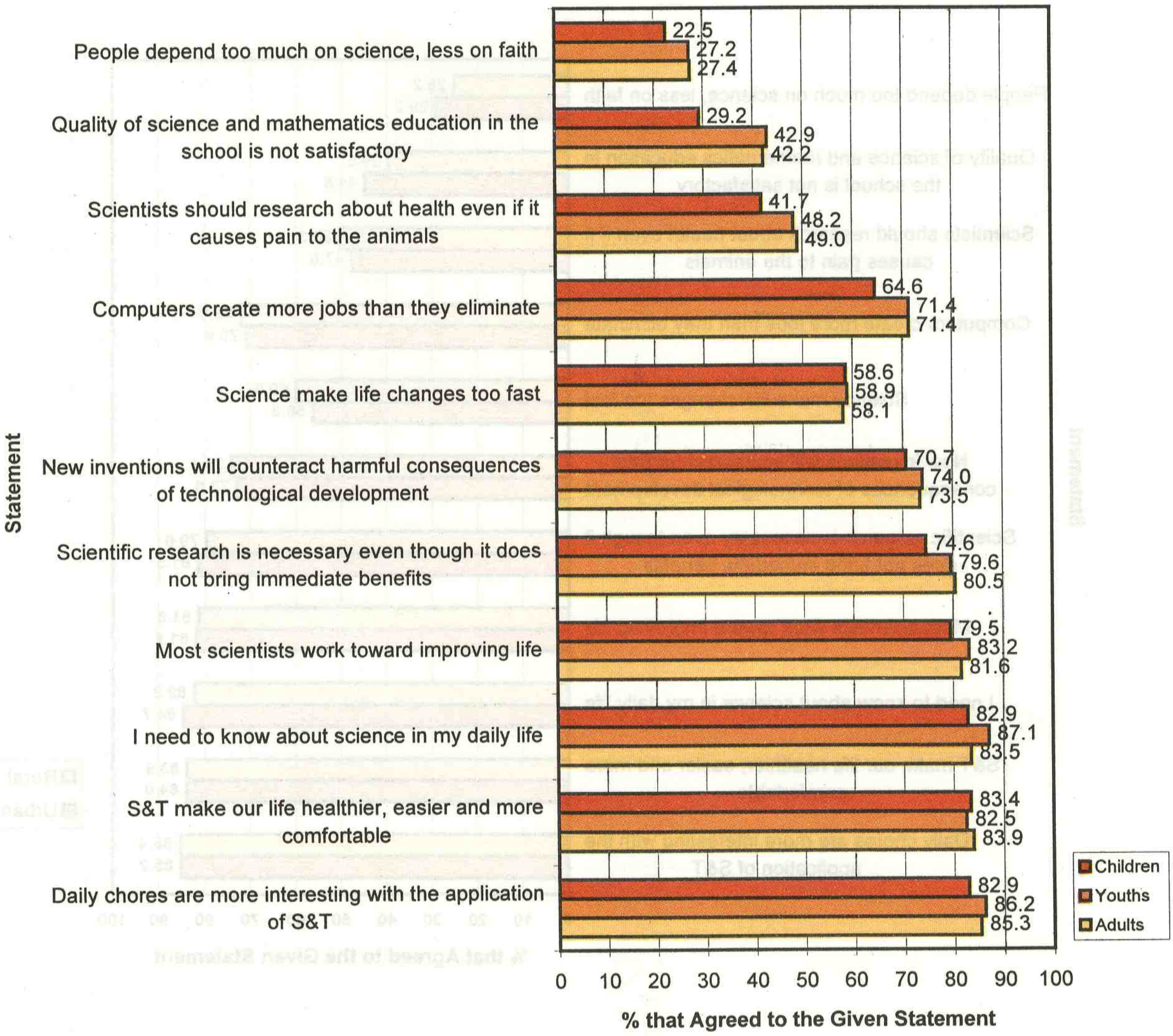


Source: Table 5.3

5.3.1 Age Group Comparison

Youths had the highest percentage of respondents who agreed to the statements relating to perception and attitude towards science and technology (Figure 5.8) reflecting their positive opinion. Although children were the group with the lowest percentage that was in agreement with the statements, the gap between children and youths, children and adults was small.

Figure 5.8: Perception and Attitude Towards Science and Technology by Age Group, 1998

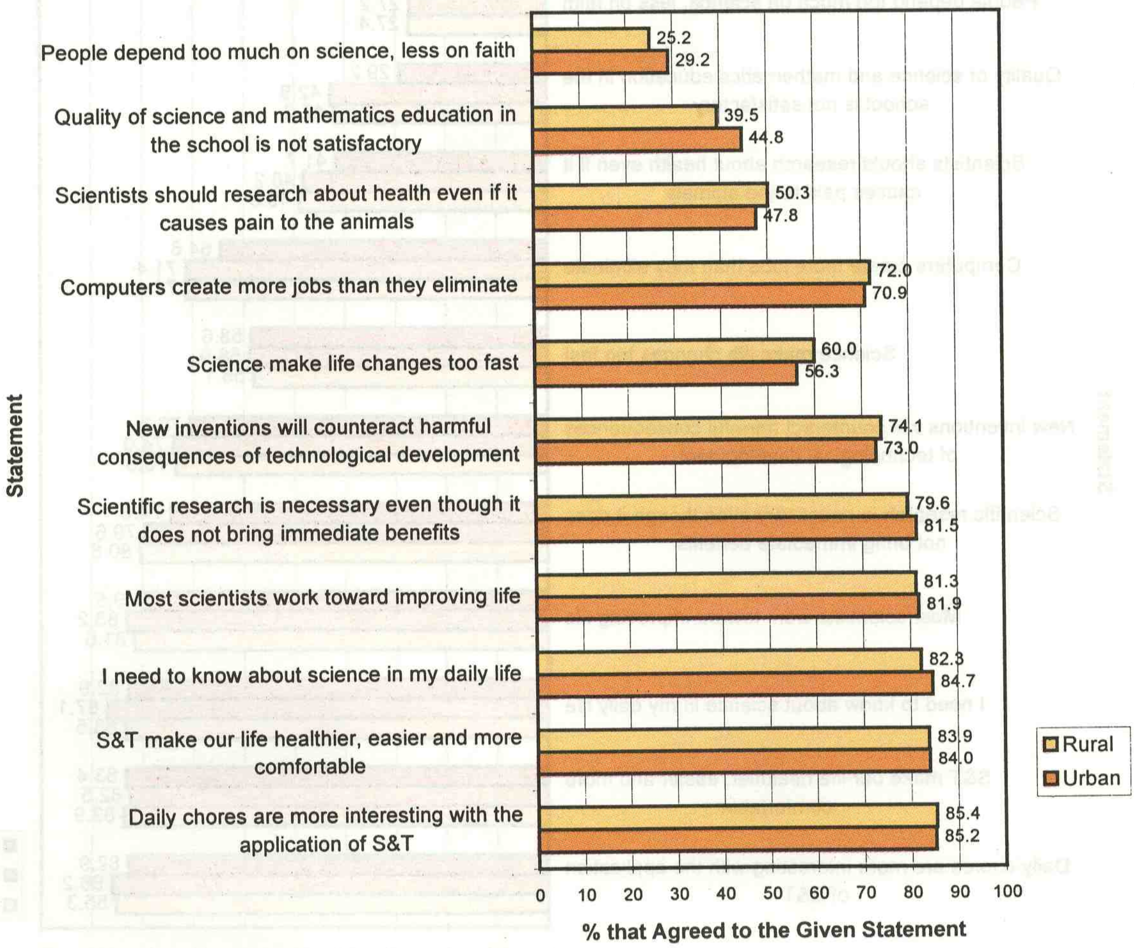


Source: Table 5.3

5.3.2 Rural Urban Comparison

Findings show that the percentage of rural and urban respondents who agreed to the statements with regards to science and technology were about the same (Figure 5.9). Results indicated that the Malaysian society is positive towards science and technology. This will pave the way for scientific applications for the betterment of society in the future.

Figure 5.9: Perception and Attitute Towards Science and Technology by Area, 1998



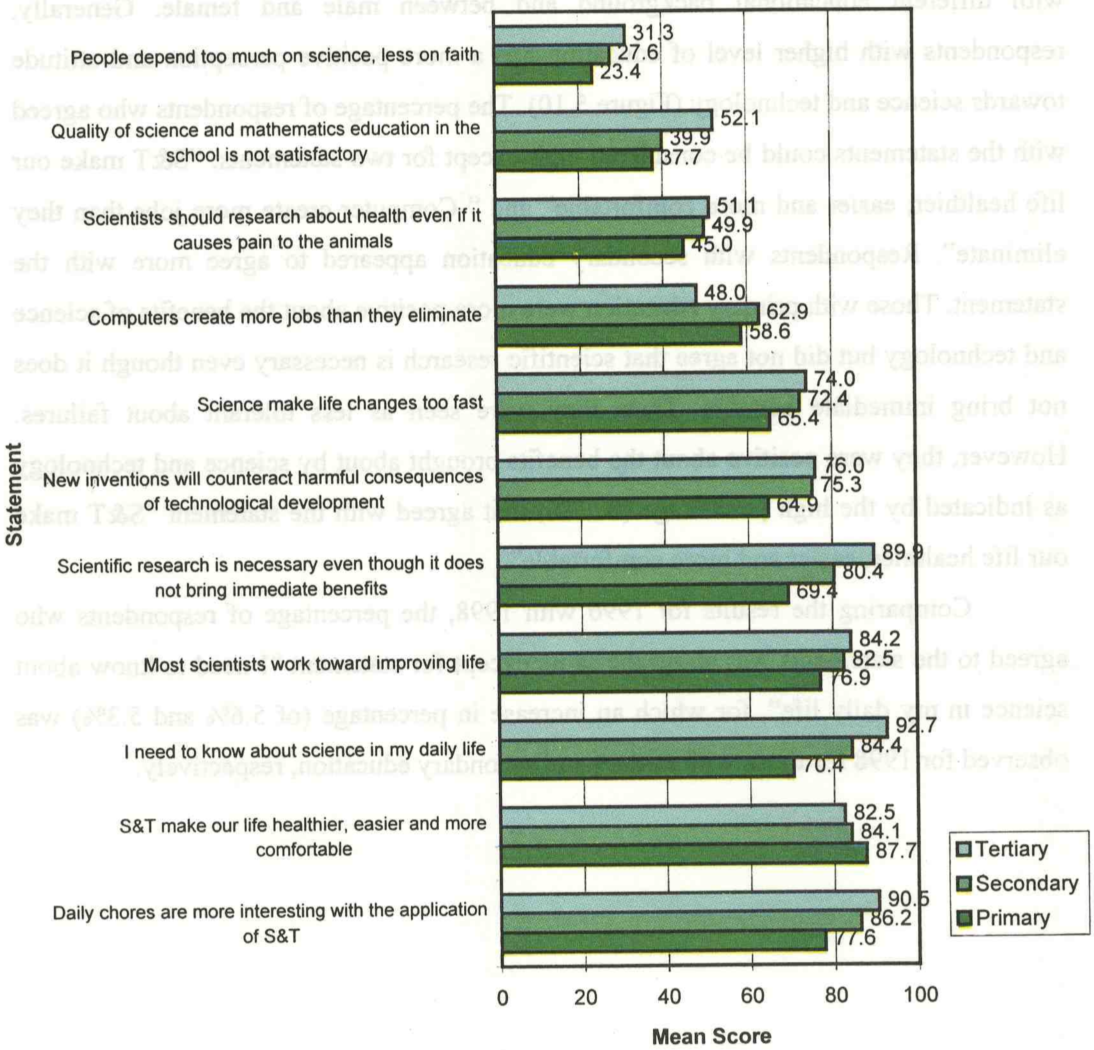
Source: Table 5.3

5.3.3 Educational Level

Table 5.4 compares the perception and attitude towards S&T among respondents with different educational background and between male and female. Generally, respondents with higher level of education had a more positive perception and attitude towards science and technology (Figure 5.10). The percentage of respondents who agreed with the statements could be considered high except for two statements: "S&T make our life healthier, easier and more comfortable" and " Computer create more jobs than they eliminate". Respondents with secondary education appeared to agree more with the statement. Those with primary education were more positive about the benefits of science and technology but did not agree that scientific research is necessary even though it does not bring immediate benefits. Thus, they were seen as less tolerant about failures. However, they were positive about the benefits brought about by science and technology as indicated by the high percentage (87.7%) that agreed with the statement "S&T make our life healthier, easier and more comfortable".

Comparing the results for 1996 with 1998, the percentage of respondents who agreed to the statements was about the same except for statement "I need to know about science in my daily life", for which an increase in percentage (of 5.6% and 5.3%) was observed for 1998 for those with tertiary and secondary education, respectively.

Figure 5.10: Perception and Attitude Towards Science and Technology by Educational Level, 1998

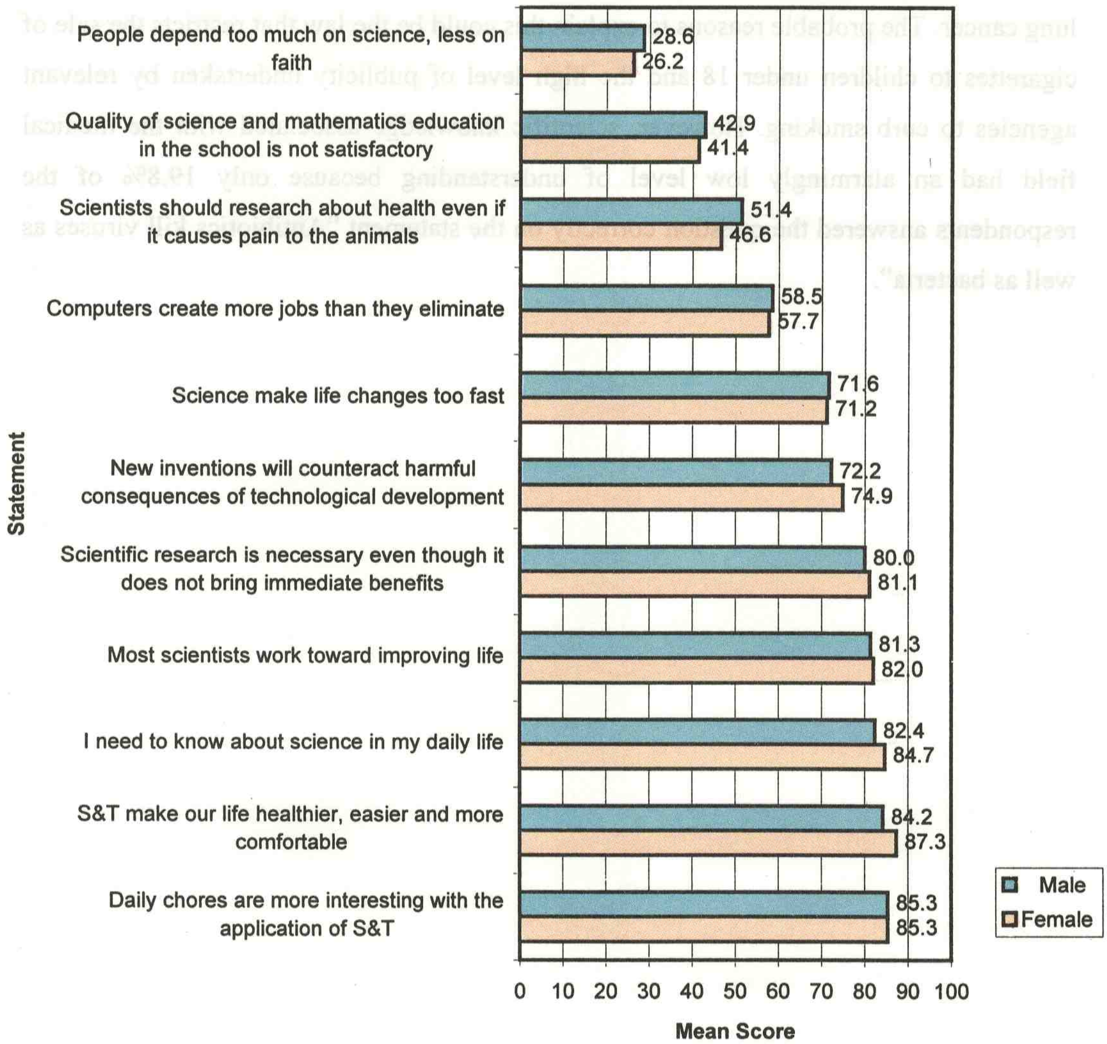


Source: Table 5.4

5.3.4 Gender

In terms of gender, females appeared to be more positive towards science and technology than males as evidenced by the higher percentage of females that agreed to the statements covered in the study compared to males (Figure 5.11). They were not agreeable to using animals in research about health. Comparison for 1996 was not possible because of the lack of data.

Figure 5.11: Perception and Attitude Towards Science and Technology by Gender, 1998

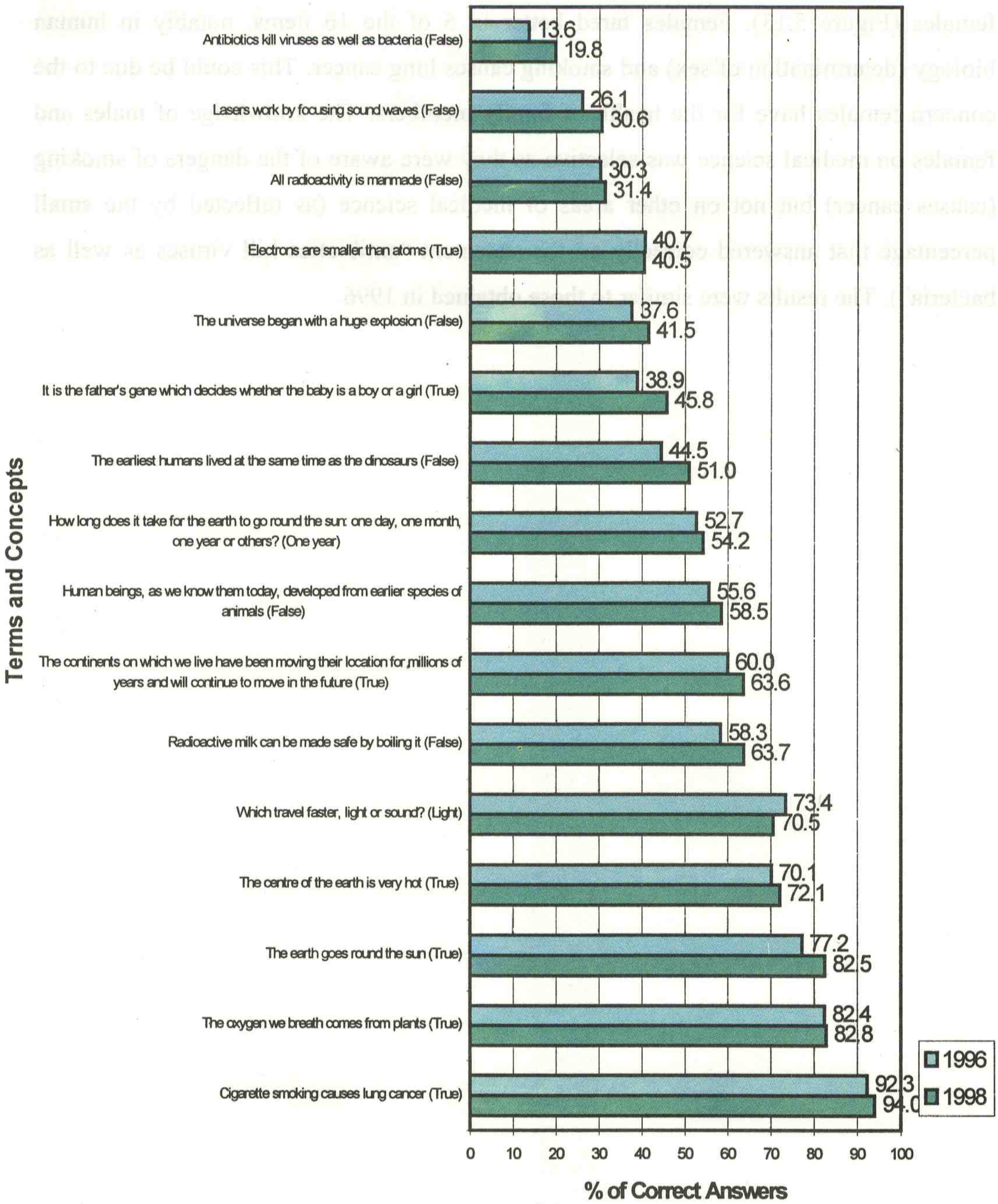


Source: Table 5.4

5.4 Understanding of Scientific Terms and Concepts

At a glance, the percentage with accurate understanding of science and technology had improved slightly in 1998 compared to 1996 except for the statement about the speed at which light and sound travel (Figure 5.12). This improvement over 1996 is a good sign as the nation strives towards achieving greater knowledge in S&T. However, the gap between the present level of understanding and a 100% understanding is still great. This can be seen from the results. The only statement with more than 90% of respondents answering it correctly is the one on the link between cigarette smoking and lung cancer. The probable reasons to explain this could be the law that restricts the sale of cigarettes to children under 18 and the high level of publicity undertaken by relevant agencies to curb smoking. However, scientific knowledge associated with the medical field had an alarmingly low level of understanding because only 19.8% of the respondents answered the question correctly on the statement "Antibiotics kill viruses as well as bacteria".

Figure 5.12: Understanding of Scientific Terms and Concepts, 1996-98

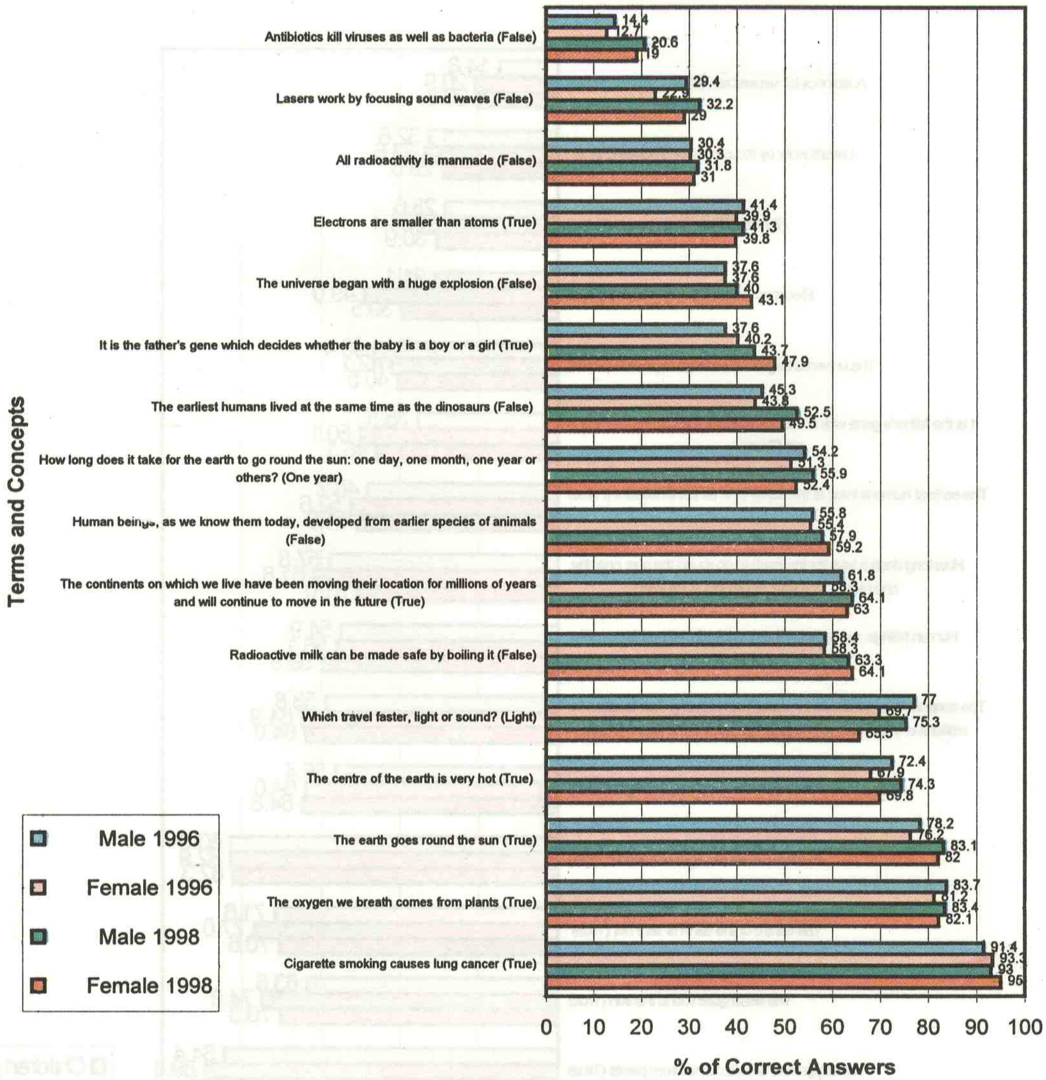


Source: Table 5.5

5.4.1 Gender

On the whole, a higher percentage of males had the correct answers compared to females (Figure 5.13). Females fared better in 5 of the 16 items, notably in human biology (determination of sex) and smoking causes lung cancer. This could be due to the concern females have for the health of family members. The knowledge of males and females on medical science was selective as they were aware of the dangers of smoking (causes cancer) but not on other areas of medical science (as reflected by the small percentage that answered correctly on the statement "antibiotics kill viruses as well as bacteria"). The results were similar to those obtained in 1996.

Figure 5.13: Understanding of Scientific Terms and Concepts by Gender, 1996-98

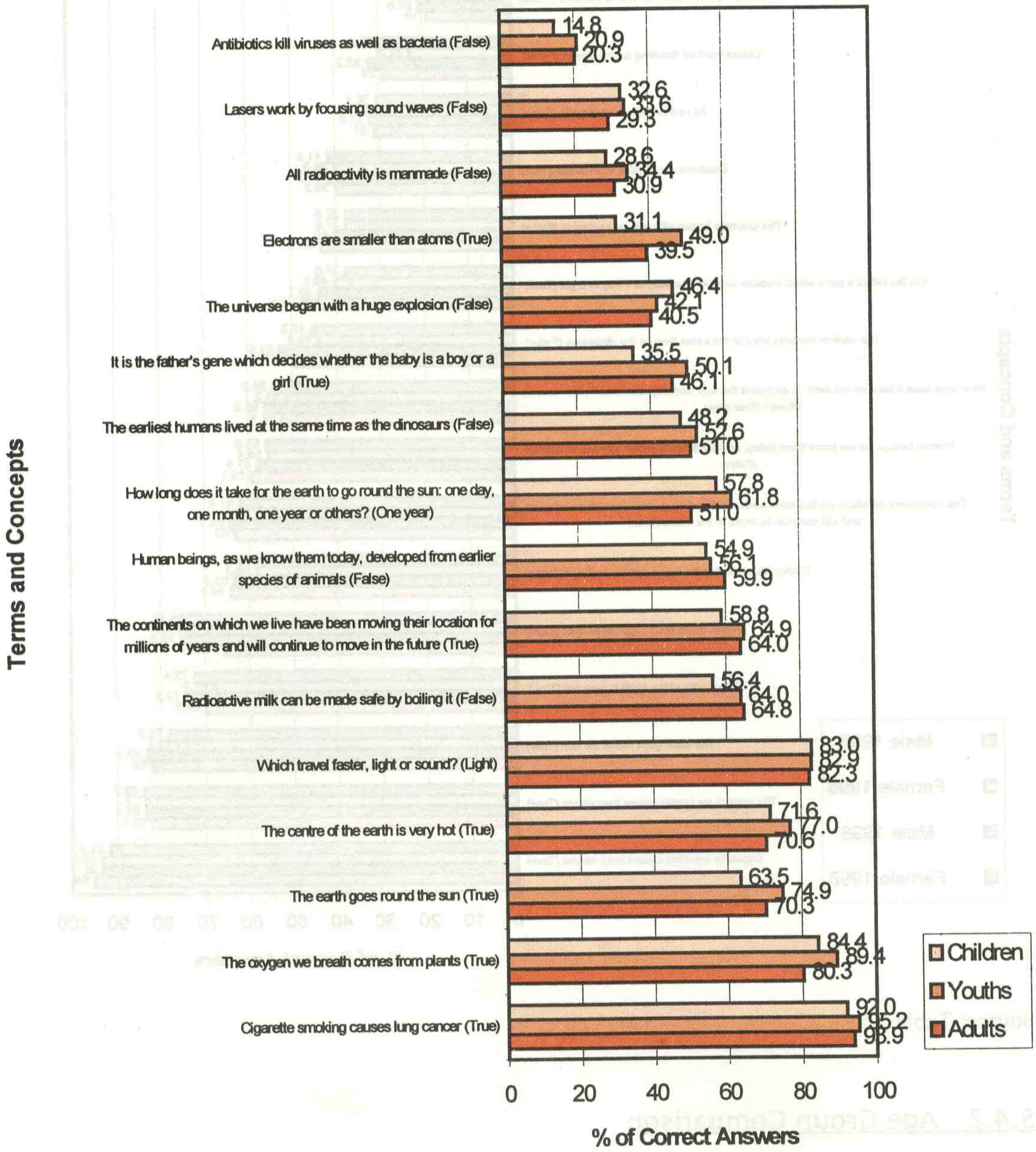


Source: Table 5.5

5.4.2 Age Group Comparison

Comparing the three age groups, it is clear that youths had the highest percentage with correct answers in 12 of the 16 statements. The adults and children had the highest percentage for only two statements (Figure 5.14). Youths who were still pursuing education were more knowledgeable than the other two age groups. Children who were still young had not learned the necessary knowledge whereas the adults who were busy with their career advancement might have forgotten some of the knowledge obtained previously.

Figure 5.14: Understanding of Scientific Terms and Concepts by Age Group, 1998



Source: Table 5.5

5.4.3 Educational Level and Stream

Knowledge of science and technology is positively correlated with educational level, i.e., the higher the educational level, the better the knowledge as indicated by the higher percentage of correct answers. Hence, respondents with tertiary education had the highest percentage of correct answers in 14 of the 16 statements. Those with secondary school education fared better in two statements: "the universe begins with a huge explosion" and " cigarette smoking causes lung cancer" (Table 5.6). Respondents with primary education fared badly with less than fifty percent of them giving the correct answers for most of the statements except two. Almost 90% of them knew that smoking causes cancer and light travels faster than sound (72.8%). Compared with results obtained in 1996, those with tertiary education did not do well for 12 out of the 16 statements in 1998. For those with secondary and primary education, their performance was about the same for 1996 and 1998.

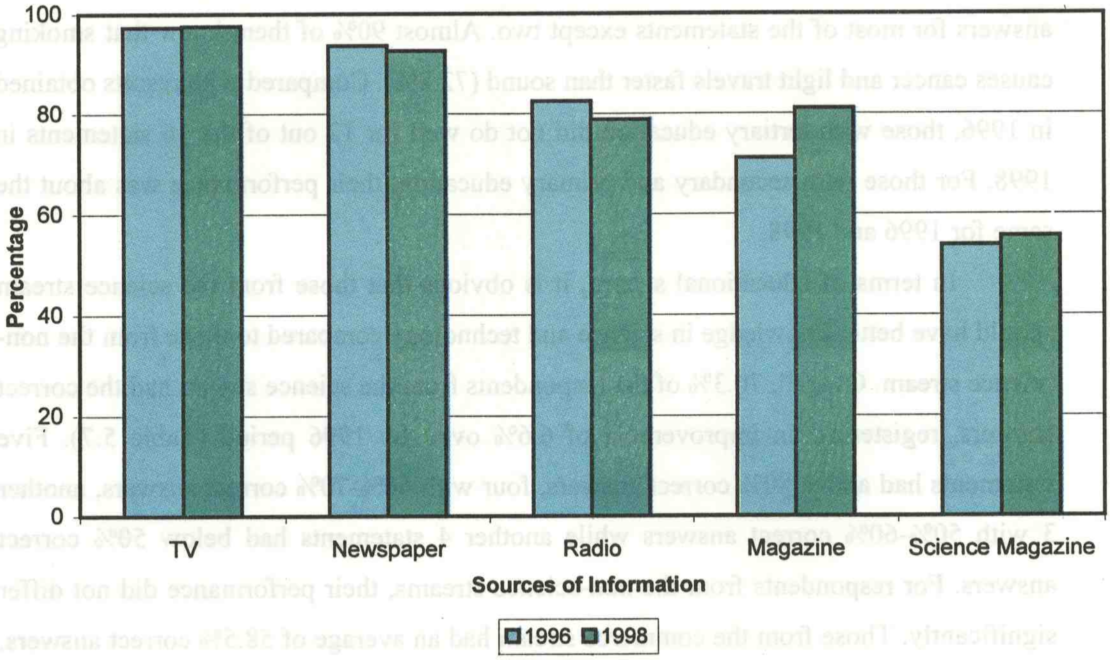
In terms of educational stream, it is obvious that those from the science stream should have better knowledge in science and technology compared to those from the non-science stream. Overall, 70.3% of the respondents from the science stream had the correct answers, registering an improvement of 6.6% over the 1996 period (Table 5.7). Five statements had above 80% correct answers, four with 60%-70% correct answers, another 3 with 50%-60% correct answers while another 4 statements had below 50% correct answers. For respondents from the non-science streams, their performance did not differ significantly. Those from the commerce stream had an average of 58.5% correct answers, Arts with 57.4% and religious study, 55.6% (Table 5.7).

5.5 Sources of Information and Media Habits

Table 5.8 shows the media habits among Malaysians. Television remained the most popular source of information (97.6%) followed by newspapers (92.6%), magazine (81.0%), radio (78.8%), and science magazine (55.6%) (Figure 5.15). Compared to the 1996 survey results, television, and science magazine enjoyed a slight improvement as a source of information whereas newspapers and radio declined in popularity. However, the percentage increase or decrease was not significant. It is worthy to note that the percentage that used science magazine as a source of information could be considered to be high. This not withstanding, it is then surprising that the actual knowledge of respondents in science and technology was not impressive (refer Tables 5.5 –5.7).

The Internet as a source of information is a trend that policy makers cannot afford to ignore. As Malaysia pushes for e-commerce and e-economy, the development on the usage pattern that includes "what", "when", "why" consumers use the Internet should be documented. However, as data is not available, discussion on the use of the Internet as a source of information is not possible.

Figure 5.15: Media Habits, 1996-98

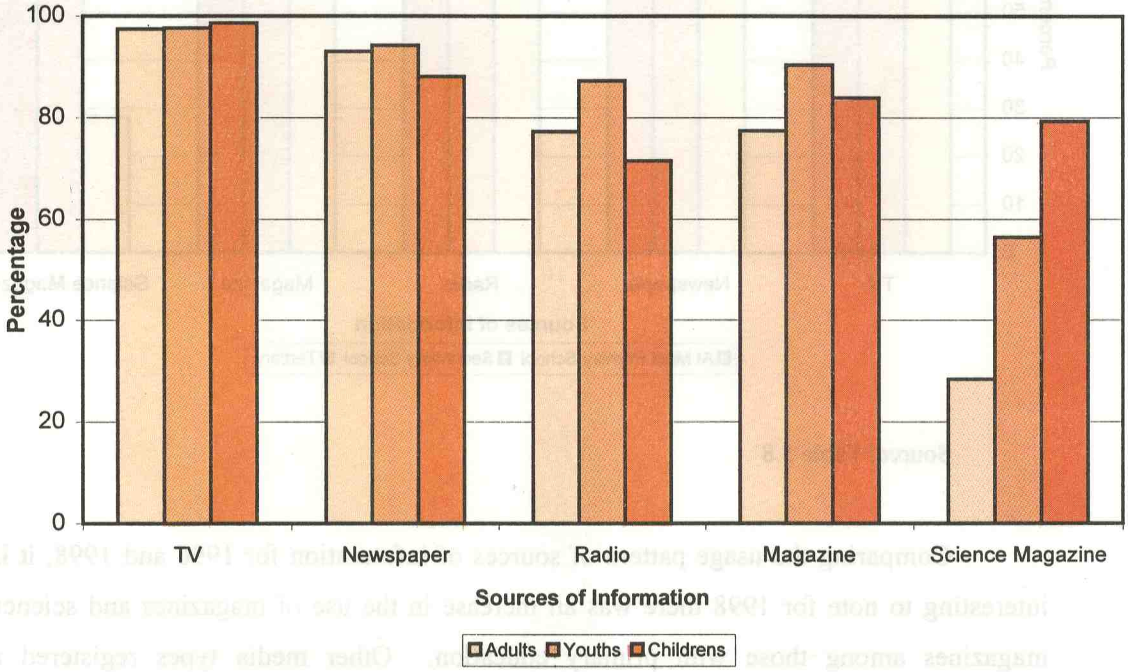


Source: Table 5.8

5.5.1 Age Groups, Locality, and Educational Level

Examining the use of media by age groups, it is clear that children watched television the most, followed by youths and adults (Figure 5.16). Less of the youths and children watched television while more adults did so compared to 1996. For newspapers, 94.2% of the youths read newspapers, 93.0% of adults and 88.1% of children did so similarly. Comparing this with the 1996 results, all the three groups appeared to be reading less of newspapers. Magazines and science magazines enjoyed a substantial increase in readership with slightly more than 10% and at least 30% increase respectively for magazine and science magazine for the three age groups compared to the 1996 results. The increase could be due to the economic downturn that forced people to switch to less expensive hobbies such as reading. However, the substantial increase in reading habit did not yield a corresponding increase in the knowledge of respondents in science and technology. The results of 1998 did not differ much from the 1996 findings. This needs further investigation.

Figure 5.16: Media Habits by Age Group, 1998

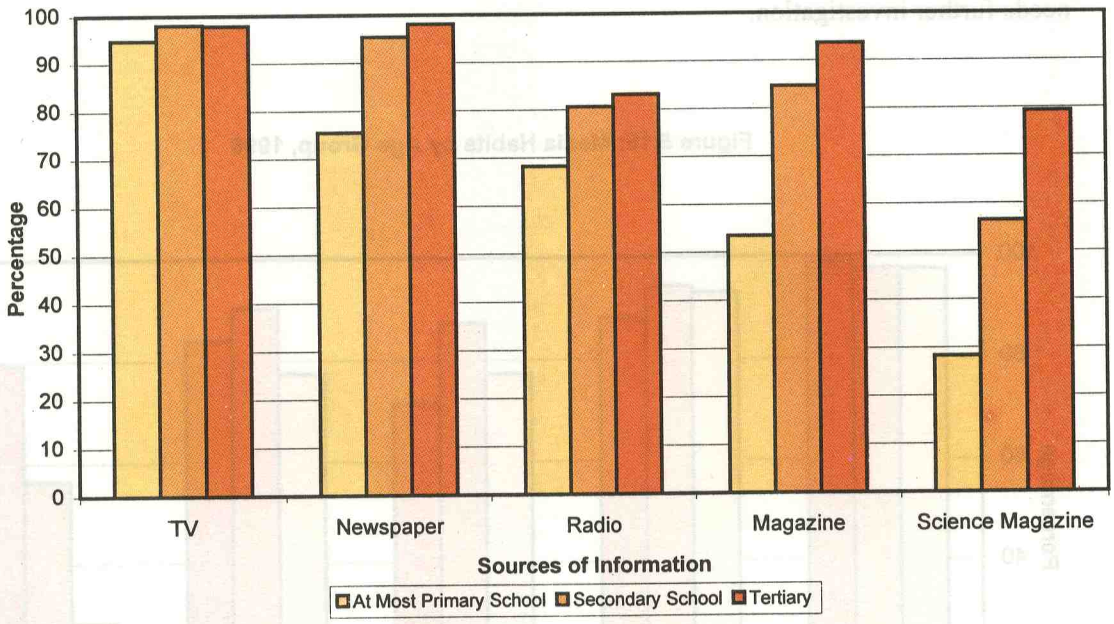


Source: Table 5.8

Comparing the use of media as an information source by locality, the urban and rural respondents did not differ in terms of their use of the different media types except for science magazines which were more widely read by urban than rural respondents (Table 5.8).

In terms of educational level, those with tertiary education read newspapers, magazines and science magazines and listened to the radio substantially more than those with primary education (Figure 5.17). For those with secondary and primary school education, television remained the most widely used source of information.

Figure 5.17: Media Habits by Educational Level, 1998



Source: Table 5.8

Comparing the usage pattern of sources of information for 1996 and 1998, it is interesting to note for 1998 there was an increase in the use of magazines and science magazines among those with primary education. Other media types registered a decrease. A similar trend was observed for those with secondary school education in the use of magazines and science magazines as a source of information. The use of radio and newspapers showed a decrease for all educational groups.

Overall, the decrease in the use of the different media as sources of information in 1998 compared to the 1996 period needs further investigation because the "Survey on Public Awareness" did not address causes of movements in trends. Due to the lack of data on the rate of readership of magazines and science magazines, any intelligent guess on the increase in readership will not serve the purpose of this report.

CHAPTER 6

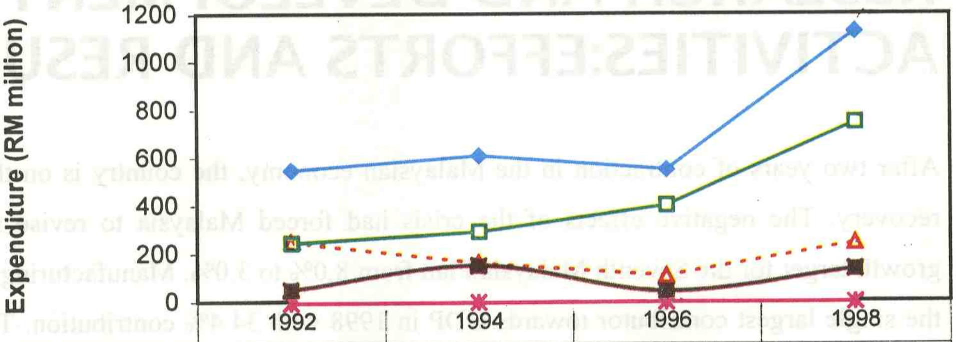
RESEARCH AND DEVELOPMENT ACTIVITIES:EFFORTS AND RESULTS

After two years of contraction in the Malaysian economy, the country is on the path to recovery. The negative effects of the crisis had forced Malaysia to revise its annual growth target for the Seventh Malaysia Plan from 8.0% to 3.0%. Manufacturing remained the single largest contributor towards GDP in 1998 with 34.4% contribution. This sector is expected to continue to lead and to sustain the pace of economic recovery. In order to do so, it has to be resilient, innovative and competitive. To further strengthen the sector, R&D has to be intensified. This involves the broadening and deepening of R&D activities.

6.1 R&D Expenditure: An Overview

Overall, R&D expenditure has increased steadily from RM549.1 million for the 1994-1996 period to RM1,127 million (an increase of 105.2%) for the 1996-1998 period. This indicates the resilience of R&D (Figure 6.1) in the face of economic downturn (See Appendix D for an analysis of private sector R&D). The majority of the R&D expenditure (66.2%) was from the private sector, 21.9% from government agencies and research institutes (GRIs) while the remaining 11.9% came from institutes of higher learning (IHLs). Although R&D expenditure increased in real terms for the private sector, in terms of percentage contribution towards total R&D for the whole economy, it registered a decrease, from 72.8% in 1996 to 66% in 1998. This is due to the overwhelming increase in spending by GRIs (127.5%) and IHLs (230.7%) for the 1996-1998 period. Therefore, the percentage contribution was not an indication of the diminishing role of the private sector in R&D, but a reduction in percentage contribution due to the tremendous increase in expenditure by other sectors.

Figure 6.1: Total Expenditure on R&D by Sector, 1992-98



	1992	1994	1996	1998
Overall	550.7	611.2	549.1	1,127
Private Sector	246.3	292.6	400.1	746.1
GRI's	253.7	164.9	108.7	247.3
IHL's	50.7	150.9	40.4	133.6
NPO	0	2.9	0	0

Year

Source: Table 6.1

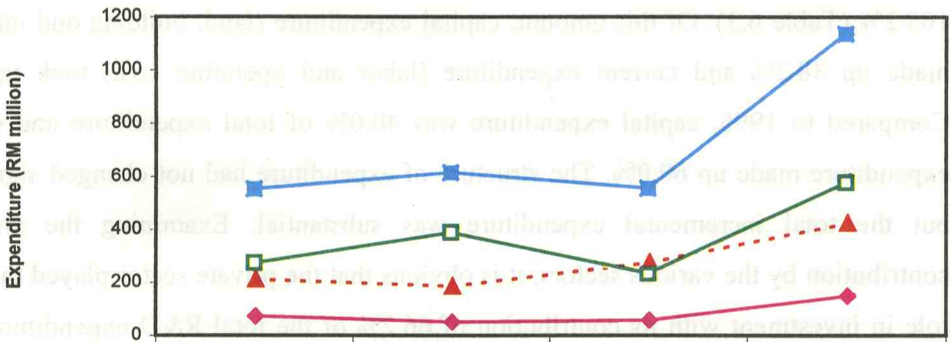
Corresponding to the overall increase in R&D expenditure, all sectors within the economy had simultaneously increased their R&D expenditure. For the private sector, the amount of expenditure increased by RM346 million or 86.5%, while GRIs and IHLs also increased spending on R&D amounting to RM138.6 million (an increase of 127.5%) and RM93.2 million (an increase of 230.7%), respectively.

In terms of the GERD/GDP ratio, the increase was from 0.22 in 1996 to 0.39 in 1998. Expenditure per research personnel had also increased from RM19,513 in 1996 to RM22,946 in 1998, representing an increase of 17.6%.

6.1.1 R&D by Type, Field of Research (FOR) and Socio-economic Objectives (SEO)

Examining the profile of R&D expenditure in terms of types of research, it can be seen that all the three types of research, i.e., basic, applied and experimental work, received substantial increase in R&D spending (Figure 6.2). It is obvious that a large portion of the expenditure was for applied research, followed by experimental work and basic research. In 1996, applied and experimental work made up 41.6% and 49.4% of total R&D expenditure. But in 1998, applied research made up 50.5% of the total expenditure and experimental work made up 37.2% (i.e., representing a decline of 12.2% from 1996). Expenditure on basic research increased marginally by 3.3%. In terms of percentage increase from 1996 to 1998, applied research had an increase of 8.9%. The shift towards more applied research and less on experimental work was probably due to the prudential attitude taken by the private sector in order to minimize risks. However, there must be a balance between the different types of research. Although greater importance is given to applied research, basic research must be stepped up in order to develop cutting edge technology that will generate products that are "new to the world".

Figure 6.2: R&D Expenditure by Type of Research, 1992-98



	1992	1994	1996	1998
Basic	68.8	44.2	49.2	138.8
Applied	271.7	383.5	228.5	568.6
Experimental Work	210.2	183.5	271.4	419.6
Total:	550.7	611.2	549.1	1127

Year

Source: Table 6.2

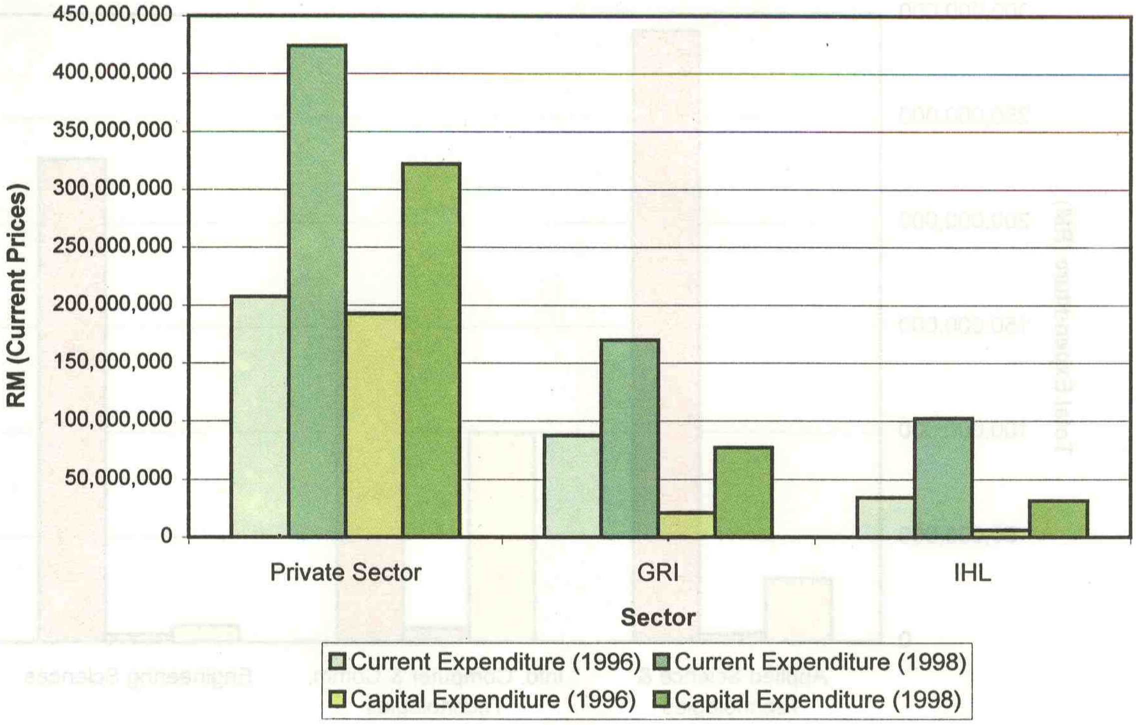
In terms of the priority area of research, applied science and technology was the focus for the private sector whereas GRIs emphasized research in information, computer and communication sciences. IHLs focused their research mainly on chemical sciences (Table 6.2). All these areas were different from those stated in 1996. Engineering sciences, agricultural sciences and biological sciences were the focus for the private sector, GRIs and IHLs respectively for 1996. The shift away from agricultural sciences to information, computer and communication technologies indicated the strategic shift by GRIs in response to the government's effort in promoting the development of the IT industry. For the private sector and IHLs the change could be a response to the economic crisis that started in mid-1997.

For socio-economic objectives, manufacturing had remained the objective for the private sector whereas GRIs had changed from plant production and plant primary products to information and communication services. The IHLs had continued to set manufacturing as the socio-economic objective for 1998 after the change that took place in 1996.

6.2 Industry R&D Expenditure

In 1998, total R&D expenditure was RM1.1 billion, an increase of RM0.6 billion or 105.2% (Table 6.3). Of this amount, capital expenditure (land, building and machinery) made up 38.2% and current expenditure (labor and operating cost) took up 61.8%. Compared to 1996, capital expenditure was 40.0% of total expenditure and operating expenditure made up 60.0%. The structure of expenditure had not changed significantly but the total incremental expenditure was substantial. Examining the amount of contribution by the various sectors, it is obvious that the private sector played the leading role in investment with its contribution of 66.2% of the total R&D expenditure (Figure 6.3). Compared to 1996, the percentage had dropped by 6.7% despite the increase in real terms. This is because the government and the institutes of higher learning had spent more in 1998 compared to 1996. GRI contributed 21.9% (19.8% in 1996) while the balance 11.9% came from IHL (7.3% in 1996).

Figure 6.3: R&D Expenditure by Sector, 1996-98

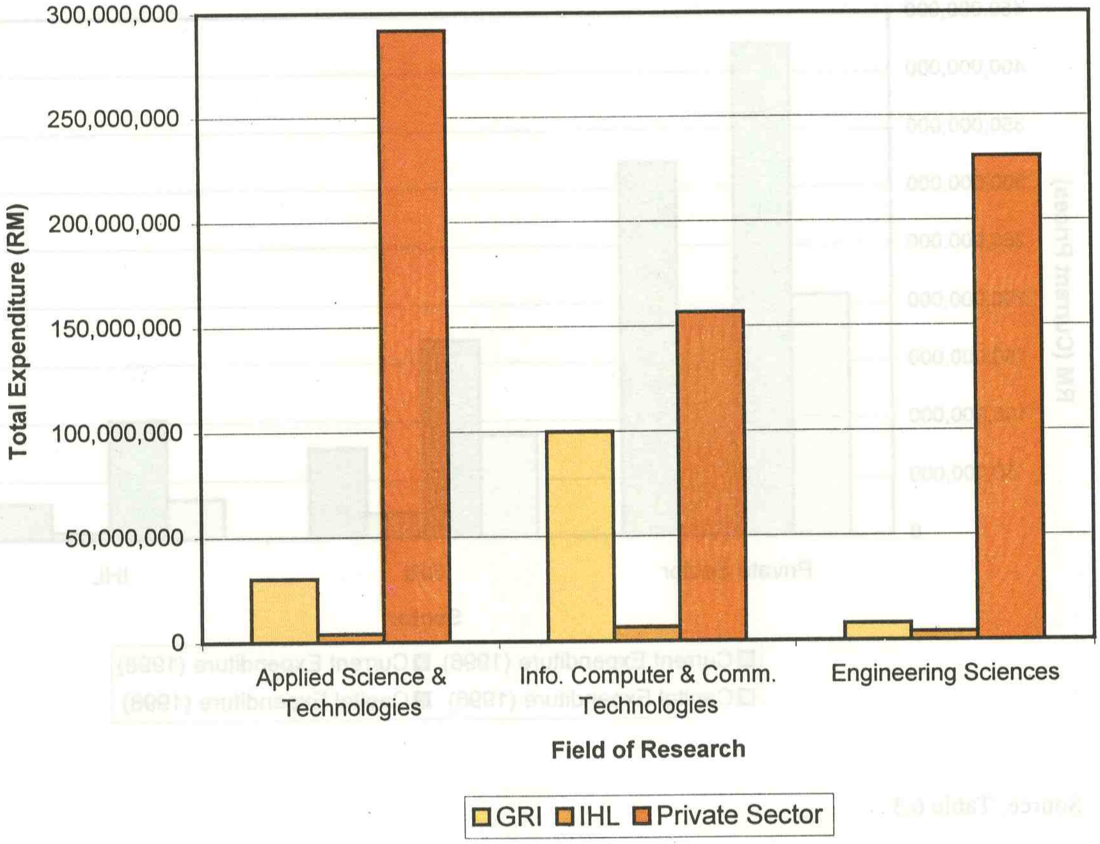


Source: Table 6.3

6.2.1 R&D Expenditure by Sector and Field of Research (FOR)

Figure 6.4 presents R&D expenditure for the various sectors and the allocation of resources for the various fields of research. The three areas that received the bulk of R&D expenditure were: applied science and technologies (28.92%), information, computer and communication technology (23.33%) and engineering science (21.52%). Comparing the three sectors, the private sector spent heavily on applied science technologies, followed by engineering science, and information, computer and communication technology. GRIs spent heavily on information, computer and communication technology followed by agriculture and applied science and technologies. The IHLs concentrated on chemical science followed by medical and health science. This information is useful for identifying opportunities for collaborative linkages among the various sectors and research groups. As not one institution can develop all the technologies that it requires, strategic alliances or smart partnership among institutions/organizations should be explored further.

Figure 6.4: R&D Expenditure by Sector and Selected Field of Research, 1998



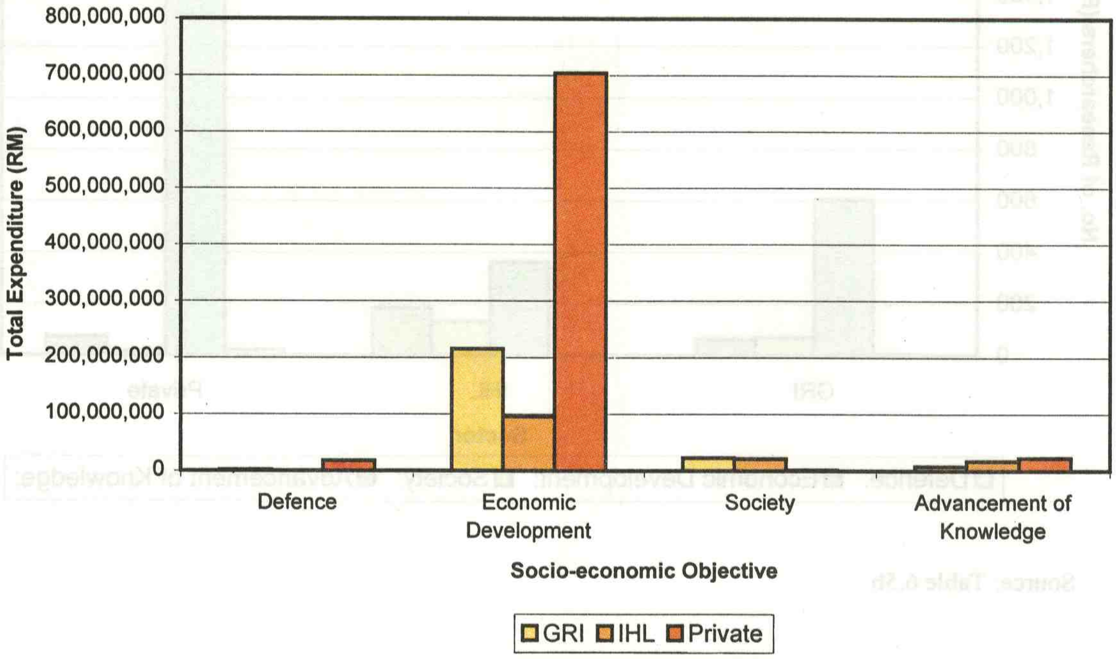
Source: Table 6.4

6.2.2 Socio-economic Objectives (SEO) of R&D by Sector (Expenditure and FTE)

In 1998 economic development remained the main objective with 90% of total R&D expenditure spent for the purpose. The sub-sector that showed the largest amount of spending was manufacturing followed by information and communication technology and plant production and plant primary products. This is consistent with the national economic structure where manufacturing is the major contributor towards GDP. Compared to 1996, although manufacturing was the main socio-economic objective, the other sub-sectors that received substantial R&D expenditure were energy resources and energy supply. The obvious shift in focus was mainly due to the economic crisis that needed a re-alignment in national economic strategy. As the world moves very quickly into the age of information technology, substantial investment had been allocated towards

R&D in information, computer and communication technology as indicated in the R&D expenditure for the 1998 period. Knowledge in this cutting edge technology will improve Malaysia's competitiveness.

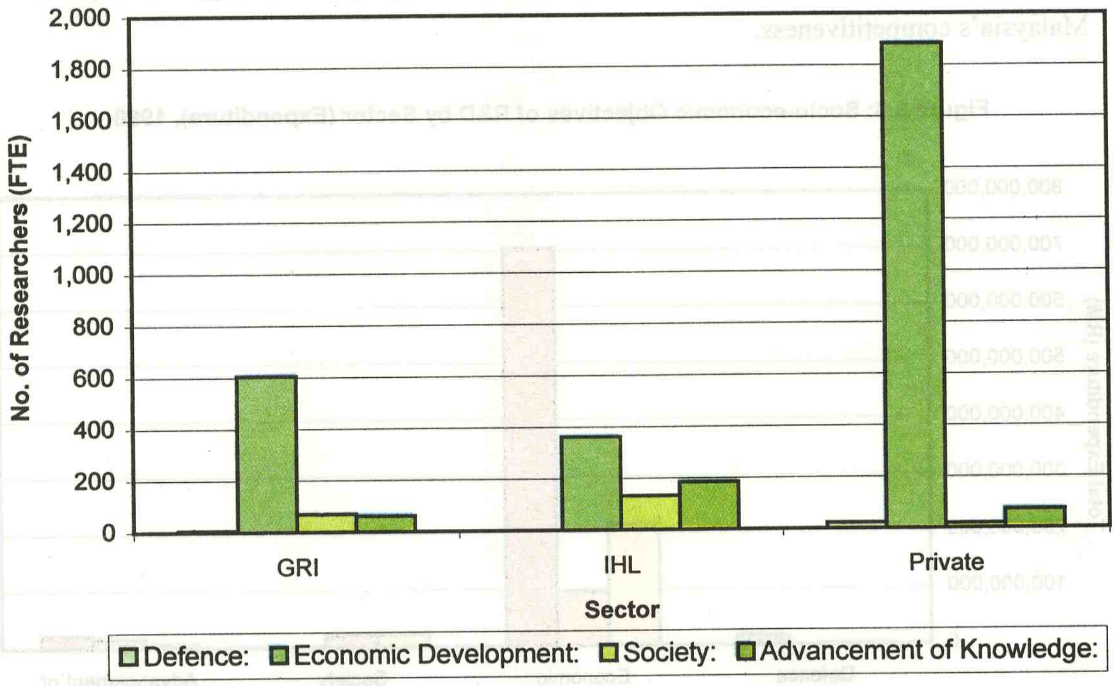
Figure 6.5: Socio-economic Objectives of R&D by Sector (Expenditure), 1998



Source: Table 6.5a

In terms of FTE, economic development was the top priority of R&D for 1996 (79.8%) and 1998 (83.4%). This category experienced an increase of 3.6% over 1996 (Figure 6.6). For the private sector, although economic development remained the most important objective for R&D, it declined slightly from 95.7% to 94.3% while advancement of knowledge received increased attention, from 2.7% in 1996 to 3.6% in 1998. For GRIs and IHLs, economic development received the most attention in terms of FTE. Apart from economic development, the next objective for IHLs was the advancement of knowledge, a departure from the emphasis on 'society' for 1996. This again indicated the shift that was necessary in response to the economic situation facing Malaysia during the difficult period of the crisis. For GRIs, the next important objective of R&D after economic development was "society" that comprises "health, education and training, and social development and community services" sub-sectors. The emphasis remained the same for 1996 and 1998.

Figure 6.6: Socio-economic Objective of R&D by Sector (FTE), 1998



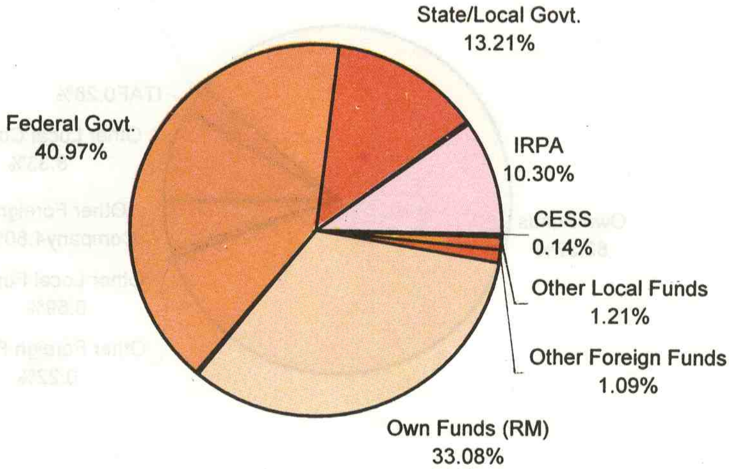
Source: Table 6.5b

6.2.3 Sources of Funds and Extramural R&D Expenditure

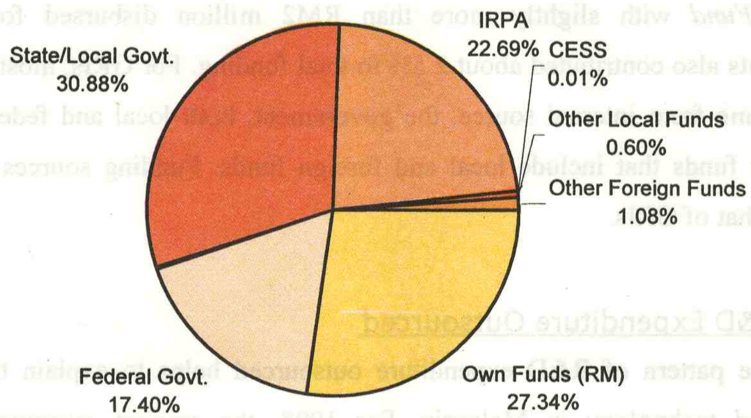
Figure 6.7 shows the sources of funds for R&D expenditure for the three sectors, namely private sector, GRIs and IHLs. Sources of funds point to the financial strength of local R&D capacity as well as the role played by the financial community in promoting R&D. Table 6.6 shows the sources of funds for the three sectors as well as the amount outsourced. Overall, internal source of funds was the major source of funding for R&D. Funds totaling RM740,323,639 (65.69%) was sourced internally. Compared with 1996, own funds made up 76.03% of total funding. Federal government provided 11.05% (2.9% in 1996), while state and local government contributed another 8.16% (1.86% in 1996). The majority of the funds for R&D concentrated in the private sector (66.2%). This is lower than the contribution by private sector in 1996 (72.85%). GRIs contributed 21.9% (19.79% in 1996) in funds. Compared with 1996, similar pattern could be observed for IHLs.

Figure 6.7: Sources of Funds for R&D Expenditure, 1998

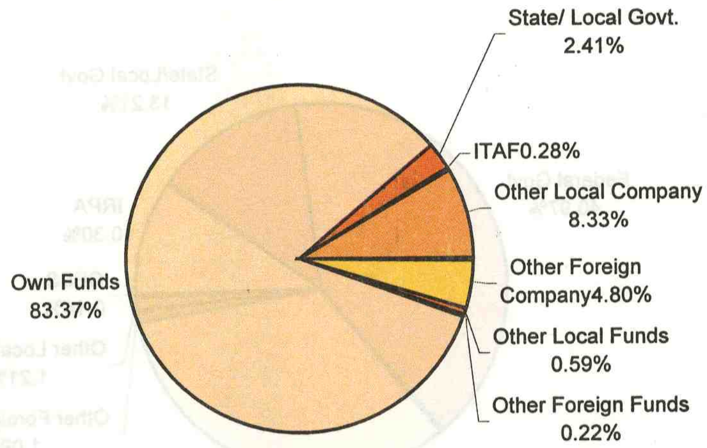
(a) GRI



(b) IHL



(c) **Private Sector**



Source: Table 6.6

For the private sector, it is clear that most of the funds (83.4%) came from internal sources. Funding from the federal government was from *Industrial Technical Assistant Fund* with slightly more than RM2 million disbursed for 1998. State governments also contributed about 2.5% to total funding. For GRIs, most of the sources of fund came from internal source, the government, both local and federal, as well as from other funds that include local and foreign funds. Funding sources for IHLs was similar to that of GRIs.

6.2.4 R&D Expenditure Outsourced

The pattern of R&D expenditure outsourced helps to explain the strength of science and technology in Malaysia. For 1998, the amount outsourced to foreign countries remained very substantial at RM58.6 million, representing 77.98% of the total amount outsourced (with the majority from the private sector) compared to the amount outsourced locally, i.e., RM16.6 million or 22.02% (Table 6.7). The total amount of expenditure outsourced abroad increased by about 8% in 1998. The country that received the largest amount of R&D expenditure was Italy followed by Japan and UK. In 1996 USA was the top recipient of expenditure.

For the private sector, the amount outsourced represented 81.8% whereas GRIs and IHLs outsourced less than 40%. This indicated that the private sector is very dependent on foreign capacity and skills for R&D. In addition, private sector R&D could be concentrated in a few large multinationals that operate in Malaysia that have strong resources for R&D (derived from their operations around the world, mainly the advanced countries). The type of R&D conducted in Malaysia by MNCs are mainly restricted to applied R&D on products to suit local taste and/or on process to achieve greater economies of scale and scope. Very little basic research was conducted in Malaysia.

The pattern of amount outsourced indicated that there was a high level of cooperation between GRIs and IHLs. For example, the percentage of amount outsourced from GRIs to IHLs was 97.3% of the total amount outsourced locally whereas the percentage of R&D expenditure outsourced by IHLs to IHLs was 95.2%. However, for the private sector, the percentage outsourced to the public sector was 73.6%, though high in terms of percentage but the absolute value was low since the amount outsourced abroad was more than 80%. Comparison with 1996 is not possible due to insufficient data for 1996.

The introduction of the *Industrial R&D Grant Scheme* (IGS) is set to improve the flow of outsource payment from the private to the public sector. One of the main objectives of this scheme is to encourage private sector companies to foster closer cooperation with public sector universities and research institutes through joint ventures and institutional linkages (for details see Chapter 9). As at December 31, 1998, a total of 39 companies have successfully received funding under this scheme.

6.3 Private Sector R&D

The manufacturing sector is the engine of growth for Malaysia. Building capacity for R&D in the private sector will enhance the competitiveness of the sector in terms of new product development and process innovation. In order to achieve growth, Malaysia in general, and private sector companies, in particular, must increase its own internal capabilities for R&D and at the same time reduce its dependence on foreign countries for materials and parts, technology and management expertise.

6.3.1 R&D Expenditure by Size

Table 6.8 presents R&D expenditure by size (revenue and employee). In terms of size measured by revenue, 38.6% of the respondent companies had revenue of between RM10 million to RM100 million whereas those with revenue of more than RM100 million made up 29.4% of the companies surveyed. Another 32% had revenue of RMl0 million or less. As indicated, the large companies were the ones that had the capacity to spend on R&D. About 53% of total R&D spending came from companies that received revenue of more than RM100 million. Although companies with revenue of less than RM10 million made up 32% of the respondent companies, the amount of R&D spent made up only 17.7% of total private sector R&D expenditure, indicating the limited resources of small companies for R&D.

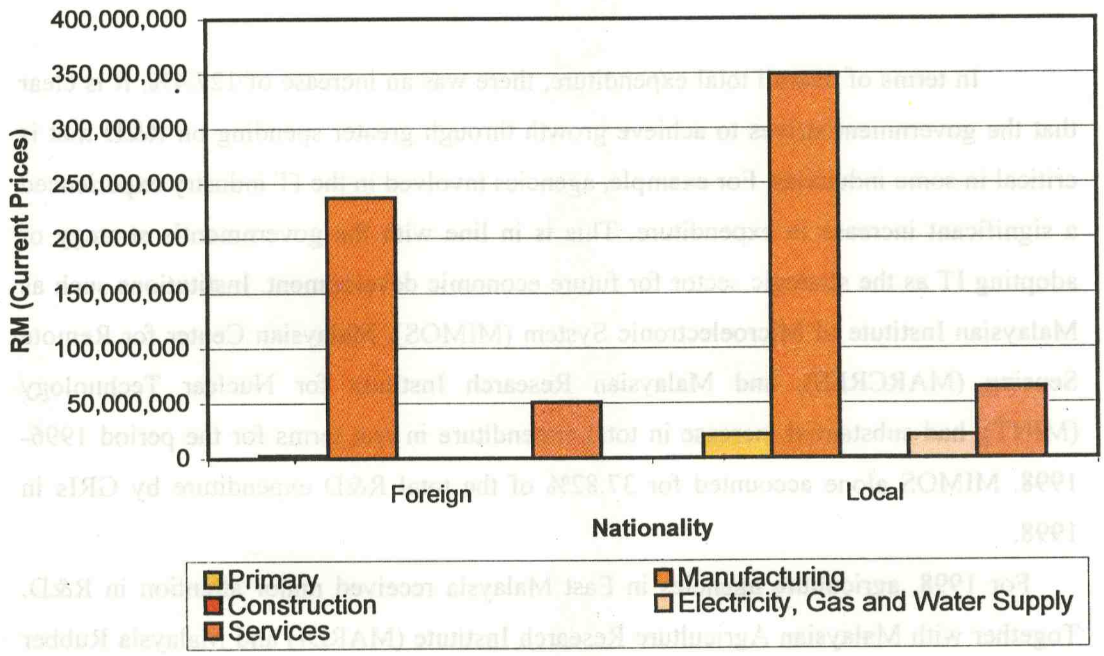
In terms of employee size, 73 (32%) of the companies had less than 75 employees, 86 (37.7%) had 75-500 employees, 49 (21.5%) had 501-2000 employees and 20 (8.8%) had more than 2000 employees. A large proportion of the companies surveyed could be classified as small and medium enterprises while a small number were large companies. Examining R&D expenditure by size, large companies (with employee size of more than 2,000) spent about 34.8% of the total R&D expenditure. A total of 73 companies with employee size of less than 75 spent only 10.8% of total R&D expenditure. This clearly shows the resource constraints of small companies for R&D.

6.3.2 R&D Expenditure by Ownership

Figure 6.8 shows private sector R&D expenditure by industry and ownership. Companies that were owned or controlled were grouped together for easy comparisons. For local companies, R&D expenditure for 1998 was RM456 million representing an increase of 54.2% compared to 1996 whereas foreign companies with expenditure of RM290 million enjoyed an increase of 177.5%. In 1998, expenditure by local companies made up 61.1% of total R&D whereas it was 73.9% in 1996. This is an indication that local companies were not spending enough for R&D although there had been an increase over the 1994-1996 period. For local companies, manufacturing industry was the sector with the largest R&D expenditure for 1998 (RM349 million or 76.6% of total expenditure). Transport equipment industry had the second largest expenditure in R&D, RM99 million, which is 21.7% of total expenditure. This is followed by the services sector with expenditure of RM64 million (14.1% of total expenditure). R&D expenditure for 1998 by manufacturing and transport equipment sectors enjoyed phenomenal increases compared to spending in 1996. Although expenditure by the services sector was the third largest, the amount spent was smaller compared to 1994-1996 period. This is due to the large contraction (from RM119 million in 1996 to RM8 million in 1998) in expenditure by the wholesale and retail, financial and business sub-sectors that were adversely affected by the economic crisis. The other sub-sectors of telecommunication services, and computer and related services enjoyed a significant increase in expenditure.

For foreign companies, the pattern was similar with 81.7% of total expenditure coming from manufacturing. Expenditure by the services sector made up 28.2% of total R&D expenditure. Compared with 1996, the increase in total R&D expenditure was substantial, resulting from increases in all sectors except the primary industry.

Figure 6.8:Private Sector R&D Expenditure by Industry and Ownership, 1998



Source: Table 6.9

6.3.3 Type of R&D Expenditure

Table 6.10 presents the types of R&D expenditure. Current expenditure comprising labor and operating cost made up 56.8% while the balance was capital expenditure, made up of land and building and machinery and equipment. The structure of expenditure did not differ much from the 1996 period. Analyzing expenditure of sub-sectors, it can be seen that the electronic equipment and component sector spent substantially on machinery and equipment indicating that additional capacity were added for R&D purposes. In line with this, it also incurred a large sum in current expenditure for R&D during this period. Compared to 1996, capital expenditure for 1998 more than doubled the spending in 1996. The sub-sector classified as "other manufacturing industries" had the second highest spending in R&D for 1998.

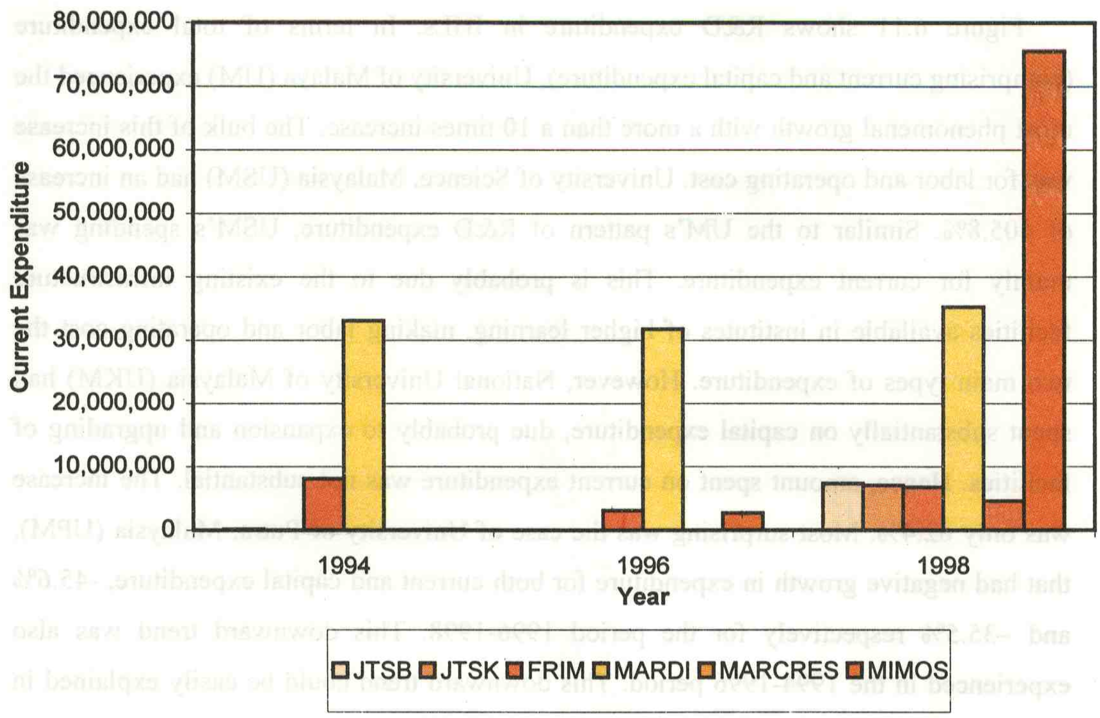
6.4 R&D Expenditure in Government Agencies and Research Institutes (GRIs)

In terms of overall total expenditure, there was an increase of 127.4%. It is clear that the government strives to achieve growth through greater spending on R&D that is critical in some industries. For example, agencies involved in the IT industry experienced a significant increase in expenditure. This is in line with the government's strategy of adopting IT as the strategic sector for future economic development. Institutions such as Malaysian Institute of Microelectronic System (MIMOS), Malaysian Center for Remote Sensing (MARCRES), and Malaysian Research Institute for Nuclear Technology (MINT), had substantial increase in total expenditure in real terms for the period 1996-1998. MIMOS alone accounted for 37.82% of the total R&D expenditure by GRIs in 1998.

For 1998, agriculture agencies in East Malaysia received major attention in R&D. Together with Malaysian Agriculture Research Institute (MARDI) and Malaysia Rubber Board (MRB) the percentage of total expenditure stood at 32.11% of all GRI's R&D spending.

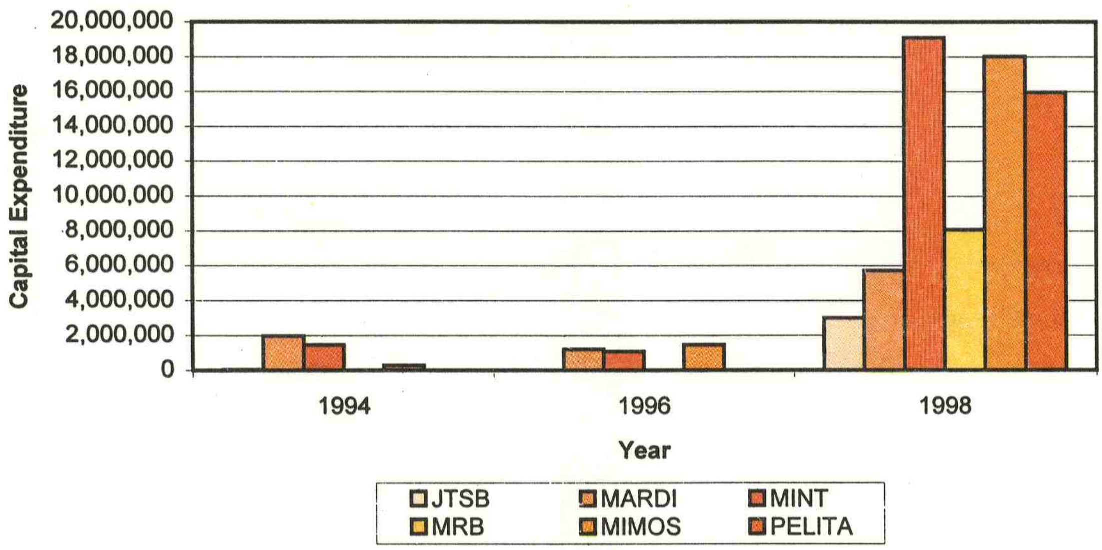
Figures 6.9 and 6.10 present current and capital expenditure incurred by selected GRIs. Substantial increases in both current and capital expenditure can be observed for the period 1996-1998 compared to 1994-1996 period. Total expenditure increased by 127% whereas capital expenditure increased by 268% and current expenditure, 93.7%.

Figure 6.9: R&D Expenditure in Selected GRIs by Current Expenditure, 1994-98



Source: Table 6.11

Figure 6.10: R&D Expenditure in Selected GRIs by Capital Expenditure, 1994-98

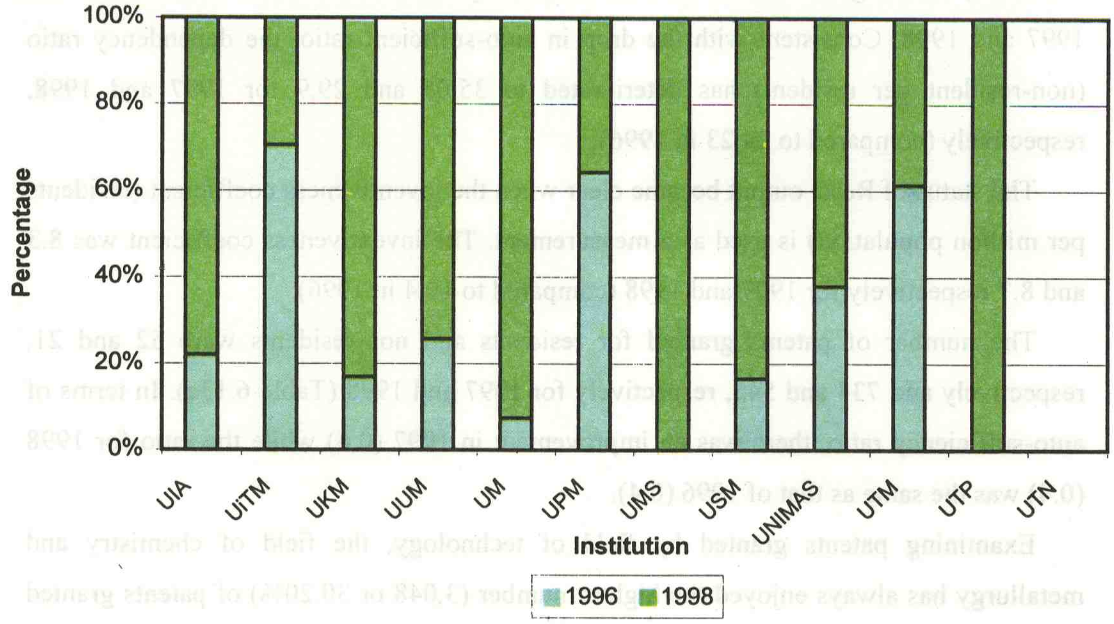


Source: Table 6.11

6.5 R&D Expenditure in Institutes of Higher Learning (IHLs)

Figure 6.11 shows R&D expenditure in IHLs. In terms of total expenditure (comprising current and capital expenditure), University of Malaya (UM) experienced the most phenomenal growth with a more than a 10 times increase. The bulk of this increase was for labor and operating cost. University of Science, Malaysia (USM) had an increase of 405.8%. Similar to the UM's pattern of R&D expenditure, USM's spending was mainly for current expenditure. This is probably due to the existing infrastructure facilities available in institutes of higher learning, making labor and operating cost the two main types of expenditure. However, National University of Malaysia (UKM) had spent substantially on capital expenditure, due probably to expansion and upgrading of facilities. Hence, amount spent on current expenditure was not substantial. The increase was only 62.4%. Most surprising was the case of University of Putra, Malaysia (UPM), that had negative growth in expenditure for both current and capital expenditure, -45.6% and –35.5% respectively for the period 1996-1998. This downward trend was also experienced in the 1994-1996 period. This downward trend could be easily explained in the case of capital expenditure because huge amounts were spent in 1994 (hence, no major additional facilities are required). But for the case of current expenditure, more information is needed to provide further understanding.

Figure 6.11: R&D Expenditure in Institutes of Higher Learning (IHLs) by Type of Expenditure, 1996-98



Source: Table 6.12

The other two universities that experienced decline in the percentage of current R&D expenditure were MARA University of Technology (UiTM) and University of Technology, Malaysia (UTM). For University of Sarawak, Malaysia (UNIMAS), a newly established university in East Malaysia, capital expenditure decreased over the period of 1996-1998 (-38.2%). Current expenditure increased by 119.5%.

6.6 R&D Output

For the purpose of this report, patents, bibliometric and awards won by Malaysian inventors at the International Inventors' Exhibitions (Geneva), will be used as measurements of R&D output.

Patent is one of the indicators used by OECD countries to measure innovation achievements. Table 6.13a presents the number of patents applied for and granted to residents and non-residents. The total number of patents applied in 1997 and 1998 declined slightly compared to the applications made in 1996. Patents applied by residents declined from 221 in 1996 to 179 in 1997 and 193 in 1998 (Table 6.13a). For non-residents, the number of applications increased by 920 (or 17%) and 416 (or 8%). The number of applications by residents declined. In contrast, applications by non-residents increased, resulting in a fall in the auto-sufficiency ratio from 0.04 in 1996 to 0.03 for 1997 and 1998. Consistent with the drop in auto-sufficient ratio, the dependency ratio (non-resident per resident) has deteriorated to 35.05 and 29.9 for 1997 and 1998, respectively (compared to 24.23 in 1996).

The status of R&D output became clear when the inventiveness coefficient (residents per million population) is used as a measurement. The inventiveness coefficient was 8.3 and 8.7 respectively for 1997 and 1998 (compared to 10.4 in 1996).

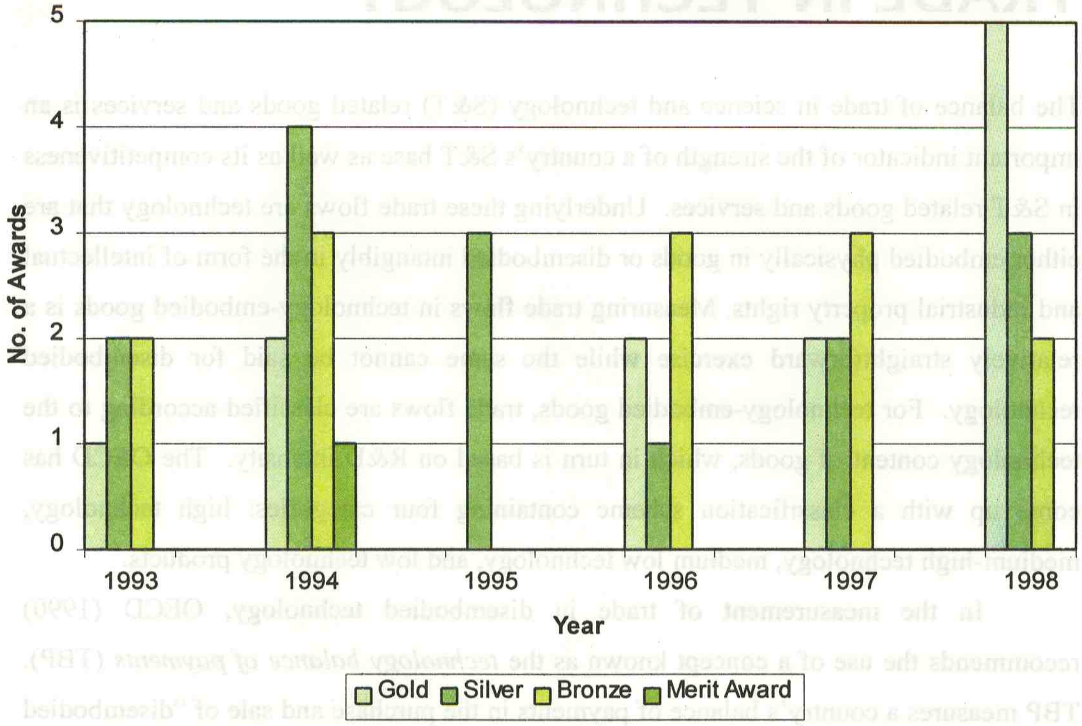
The number of patents granted for residents and non-residents were 52 and 21, respectively and 734 and 545, respectively for 1997 and 1998 (Table 6.13a). In terms of auto-sufficiency ratio, there was an improvement in 1997 (0.6) while the ratio for 1998 (0.4) was the same as that of 1996 (0.4).

Examining patents granted by field of technology, the field of chemistry and metallurgy has always enjoyed the highest number (3,048 or 30.20%) of patents granted since 1988 (Table 6.13b). 'Human necessities had the second highest number (1971 or 19.53%) of patents granted followed by performing operations and transporting (1,717 or 17.01%). The field with the least patents granted was textiles and paper.

In terms of Bibliometric, Malaysia registered 510 citations in 1993 (Table 6.14). More current information was not available. For scientific publications, the number of publications has increased steadily from 375 in 1993 to 429 IN 1994 and 493 in 1995.

During 1993-1998, Malaysian inventors have won numerous awards at the international level, i.e., International Inventors' Exhibition, Geneva (Figure 6.12). Caution should be exercised when using this as an indicator of R&D output as we do not have details of competition (in terms of scale, scope and intensity).

Figure 6.12: Awards Received by Malaysian Inventors at the International Inventors' Exhibition, Geneva, 1993-1998



Source: Table 6.15

TRADE IN TECHNOLOGY

The balance of trade in science and technology (S&T) related goods and services is an important indicator of the strength of a country's S&T base as well as its competitiveness in S&T related goods and services. Underlying these trade flows are technology that are either embodied physically in goods or disembodied intangibly in the form of intellectual and industrial property rights. Measuring trade flows in technology-embodied goods is a relatively straightforward exercise while the same cannot be said for disembodied technology. For technology-embodied goods, trade flows are classified according to the technology content of goods, which in turn is based on R&D intensity. The OECD has come up with a classification scheme containing four categories: high technology, medium-high technology, medium low technology, and low technology products.

In the measurement of trade in disembodied technology, OECD (1990) recommends the use of a concept known as the *technology balance of payments* (TBP). TBP measures a country's balance of payments in the purchase and sale of "disembodied technology" in the form of intellectual and industrial property rights including patents, licenses, know-how and technical assistance.[1] The difficulties involved in interpreting TBP data are well known and have been acknowledged by OECD. They include: (a) the inclusion of non-technology related transactions, (b) different data collection procedures, and (c) "disembodied" technology exchange not accompanied by financial transfers.[2]

The pattern of trade in technology of a country depends on its level of economic development. Malaysia is a middle-income country with about a third of its GDP devoted to manufacturing activities in 1998. As a country that is not quite a developed nation, it incurs persistent deficits in trade in technology particularly in goods and services that require high technology to produce. However, as the country improves upon its technology base, both in terms of physical and human capital, the more technologically sophisticated component of its balance of payments is set to become more favorable over time. There are some indications that this trend is already taking place.

[1] OECD (1997), p.M-29.

7.1 Technology Balance of Payments

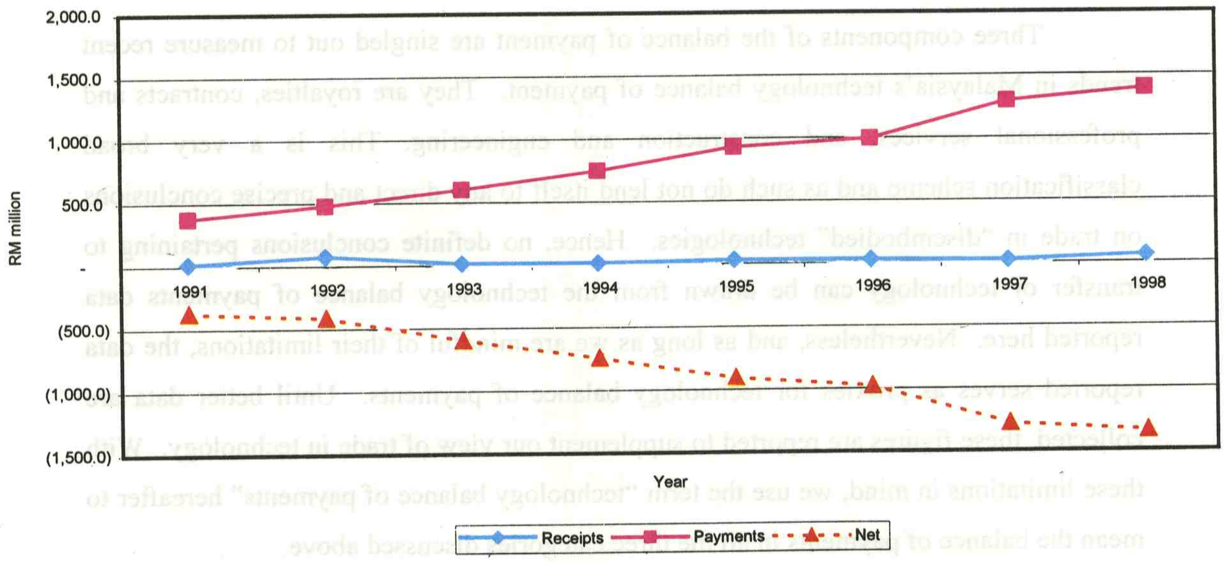
Three components of the balance of payment are singled out to measure recent trends in Malaysia's technology balance of payment. They are royalties, contracts and professional services, and construction and engineering. This is a very broad classification scheme and as such do not lend itself to any direct and precise conclusions on trade in "disembodied" technologies. Hence, no definite conclusions pertaining to transfer of technology can be drawn from the technology balance of payments data reported here. Nevertheless, and as long as we are mindful of their limitations, the data reported serves as proxies for technology balance of payments. Until better data are collected, these figures are reported to supplement our view of trade in technology. With these limitations in mind, we use the term "technology balance of payments" hereafter to mean the balance of payments in all the three categories discussed above.

7.1.1 Recent Trends in Technology Balance of Payments

The gap between royalties payment and receipt continues to widen, culminating in a deficit of RM1.3 billion in 1998. The long-term deterioration in this component of the country's technology balance of payment (TBP) is evident from Figure 7.1. In contrast, the balance of payments for contracts and professional fees has been improving steadily since 1996 (Figure 7.2). In 1997, this category recorded a surplus of RM469.7 million for the first time since 1991. This increased further to RM775 million in the following year.

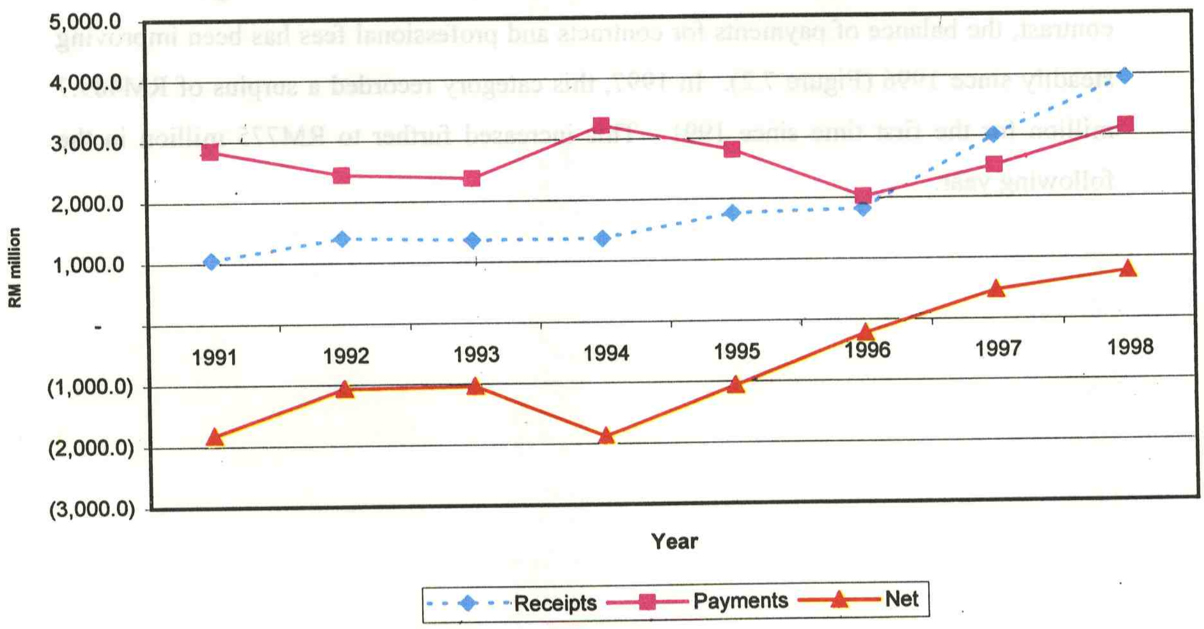
[2] Ibid, p.M-29.

Figure 7.1: Payments and Receipts for Royalties, 1991-98



Source: Table 7.1

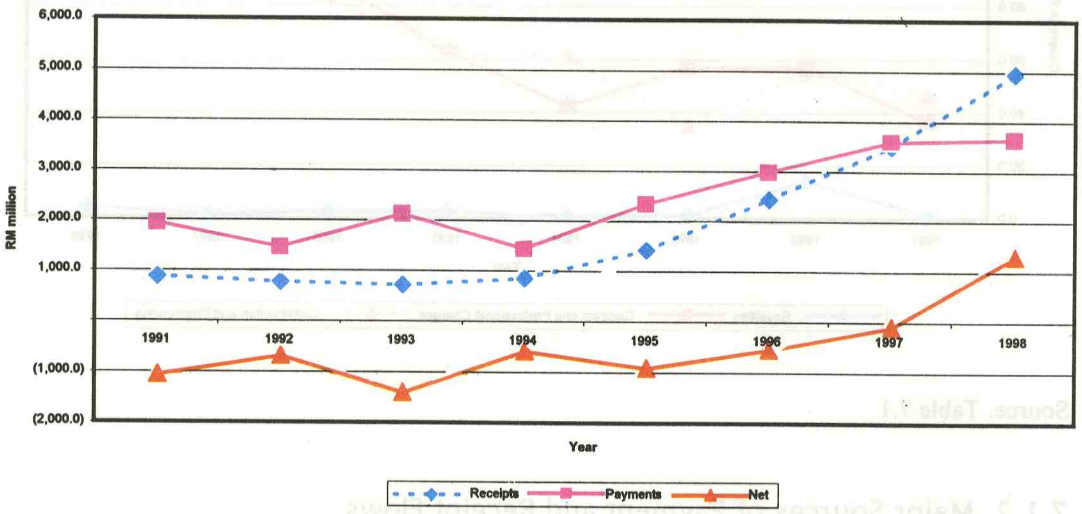
Figure 7.2: Payments and Receipts for Contracts and Professional Charges, 1991-98



Source: Table 7.1

Receipts for trade in construction and engineering services have been increasing significantly since 1995. As a result, this category turned around to register a surplus of RM1.3 billion in 1998, after incurring deficits between 1991 and 1997 (Figure 7.3).

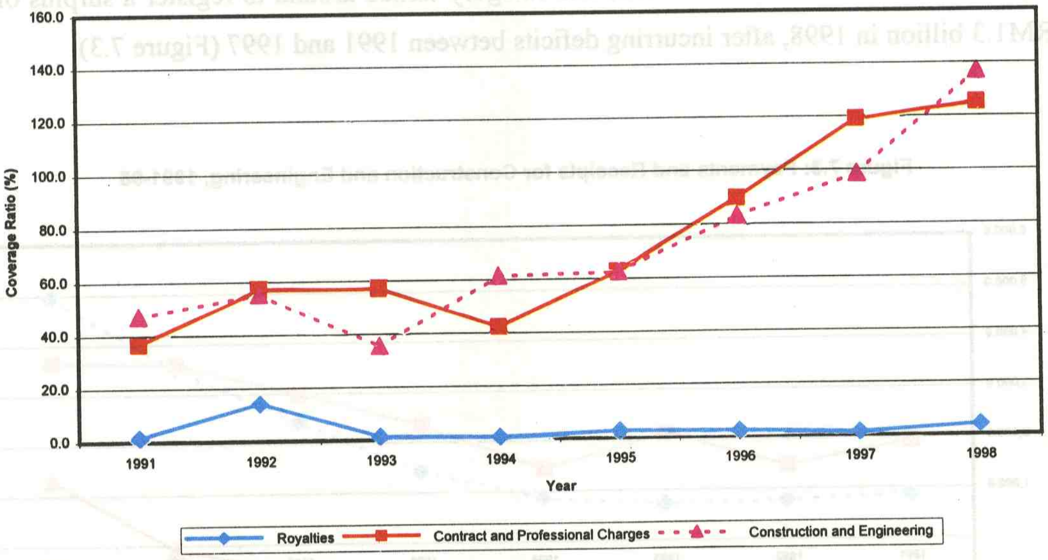
Figure 7.3: Payments and Receipts for Construction and Engineering, 1991-98



Source: Table 7.1

The different trends in the various categories of trade in technology balance of payment are reflected in the coverage ratio. The coverage ratio, defined as receipts/payments, is a measure of the extent to which receipts are financing (covering) payments. A balanced trade would imply a coverage ratio of 100% (i.e. receipts = payments). As we can see from Figure 7.4, the coverage ratio for royalties has been languishing below 20%. In contrast, the coverage ratios for contracts and professional fees and construction and engineering exceeded 100% in 1998.

Figure 7.4: Coverage Ratio for Trade in Technology-Related Services, 1991-98



Source: Table 7.1

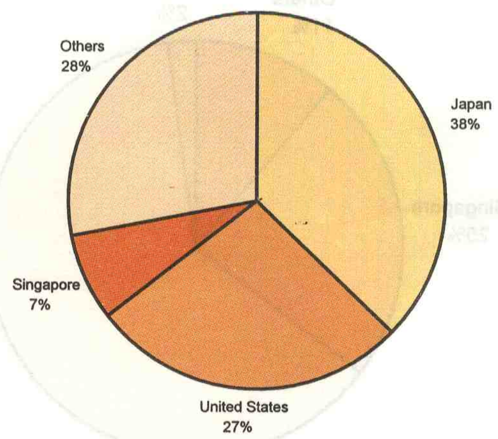
7.1.2 Major Sources of Payment and Receipt Flows

A more detailed analysis of payment and receipt flows for all the above three components of technology balance of payment reveals the major sources deficits/surpluses.

(a) Royalties

In the case of royalties, the largest source of deficit comes from royalty flows between Japan and Malaysia. Japan accounts for 38% of total royalty outflows from Malaysia in 1998 (Figure 7.5). The United States' share of total royalty payments from Malaysia at 27% is quite substantial. Royalty payment outflows to the US grew rapidly from RM215.7 million in 1996 to RM379 million in 1997 before declining slightly to RM370.9 million in 1998 (see Table 7.2 in Appendix).

Figure 7.5: Royalty Payments, 1998

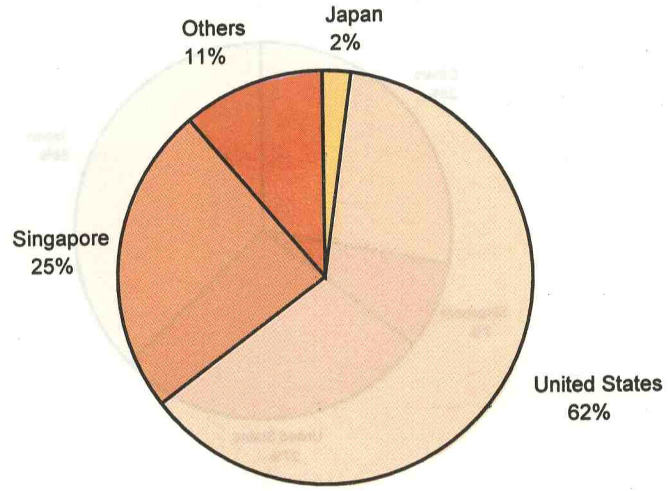


Source: Table 7.2

The United States is by far the largest source of royalty receipts from abroad for Malaysia. It accounts for as much as 62% of all royalties received by Malaysia in 1998 (see Figure 7.6). Japan's share of royalty receipts at 2% is very small in comparison with the United States. The second largest source of royalty receipts for Malaysia is Singapore. In 1998, about a quarter of total royalties received from abroad came from Singapore.

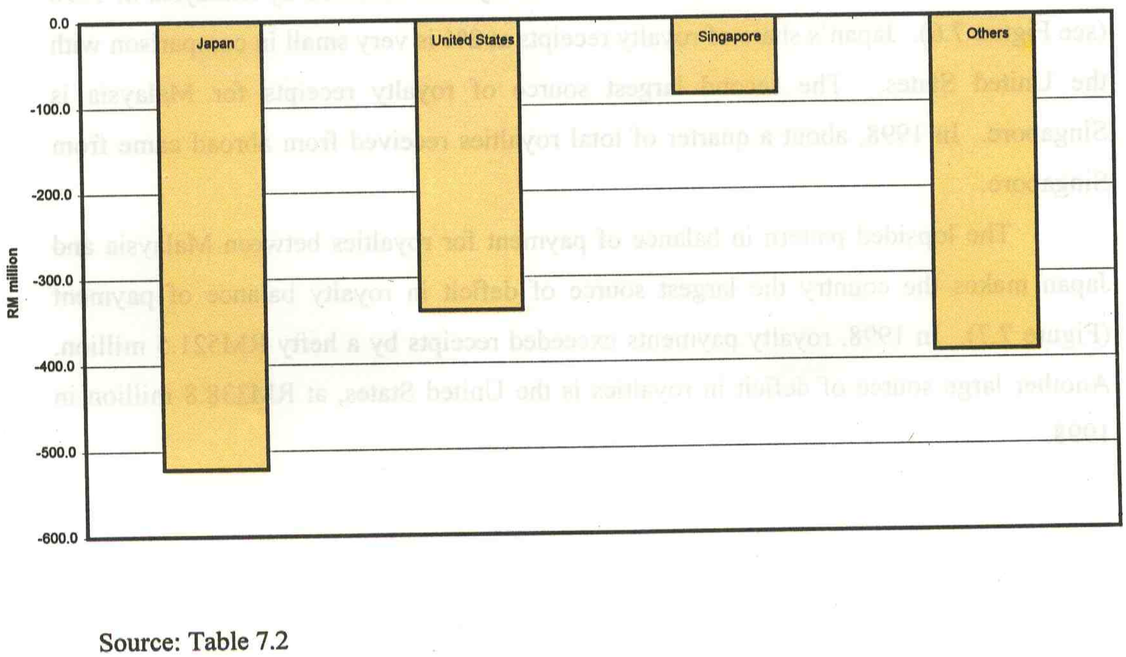
The lopsided pattern in balance of payment for royalties between Malaysia and Japan makes the country the largest source of deficit in royalty balance of payment (Figure 7.7). In 1998, royalty payments exceeded receipts by a hefty RM521.5 million. Another large source of deficit in royalties is the United States, at RM338.8 million in 1998.

Figure 7.6: Royalty Receipts, 1998



Source: Table 7.2

Figure 7.7: Sources of Royalty Deficits, 1998

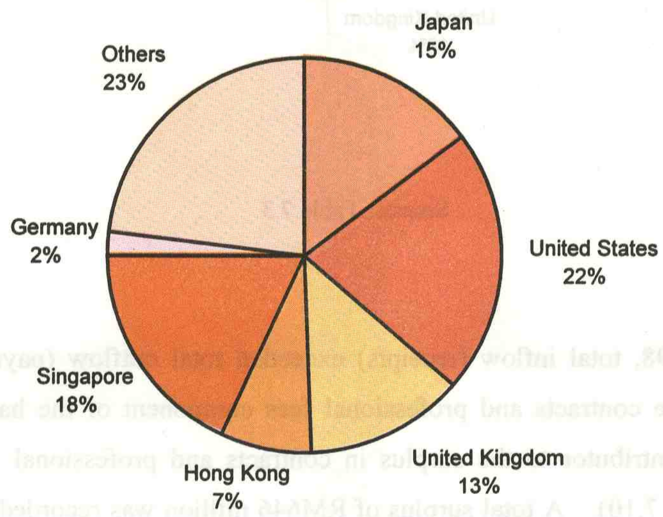


Source: Table 7.2

(b) Contracts and Professional Fees

Four countries account for two-thirds of the total payments outflow for contracts and professional fees. They are the United States, Japan, United Kingdom and Singapore (Figure 7.8). With a 22% share of total payments for contracts and professional fees, the US is by far the most important source of payment outflows in this category. Between 1997 and 1998, in particular, the payments outflow for contracts and professional fees from Malaysia to the US grew at a rate of 81.2% (Table 7.3 in Appendix). During the same period, the payments outflow for contracts and professional fees increased by 25%.

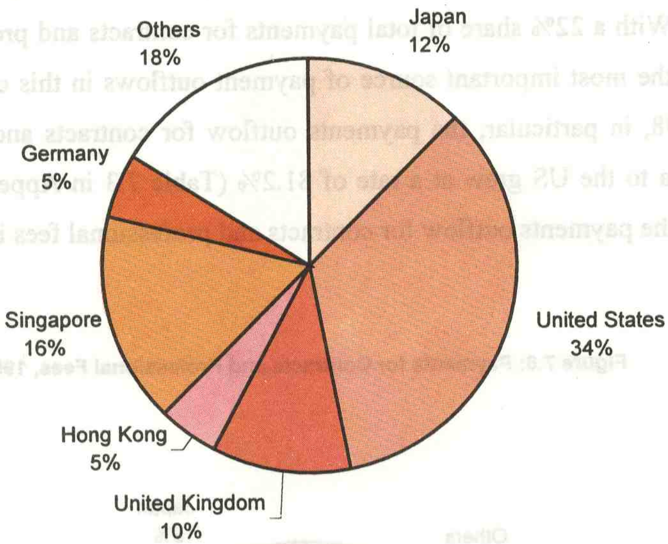
Figure 7.8: Payments for Contracts and Professional Fees, 1998



Source: Table 7.3

In the case of the receipts for contracts and professional fees, the combined share of the United States, Japan, United Kingdom, and Singapore in 1998 is 72% (Figure 7.9). The US alone accounted for 34% of total receipts for contracts and professional fees in 1998. Receipts from both the US and UK experience rapid growth between 1997 and 1998. Contract and professional fees received from the UK increased by 173% from RM143 million in 1997 to RM391 million in 1998.

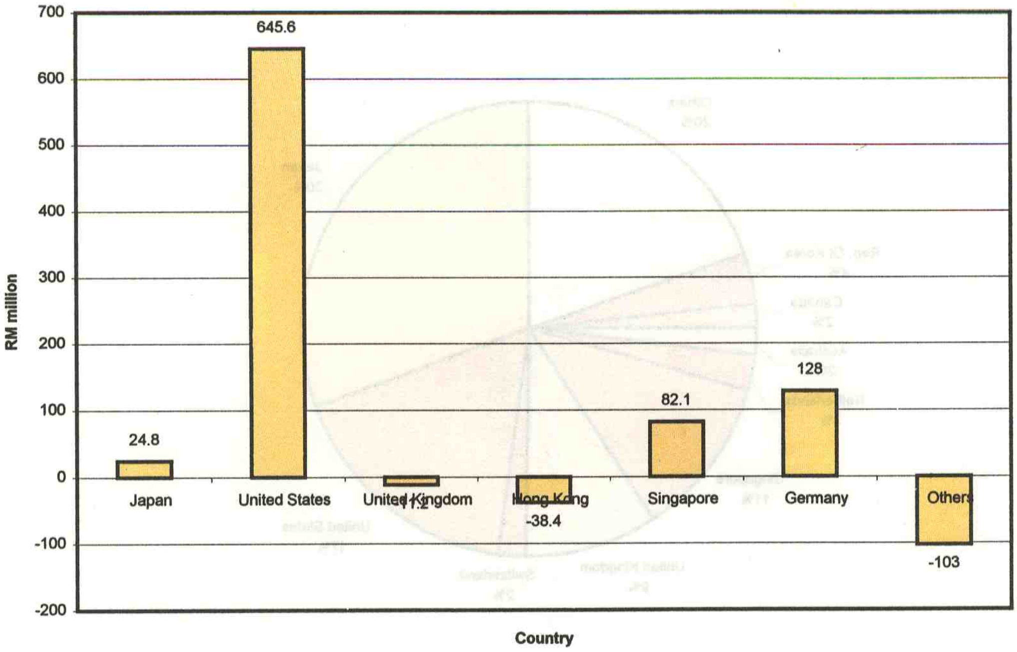
Figure 7.9: Receipts for Contracts and Professional Fees, 1998



Source: Table 7.3

In 1998, total inflow (receipts) exceeded total outflow (payments) by RM775 million for the contracts and professional fees component of the balance of payment. The major contributor to the surplus in contracts and professional fees is the United States (Figure 7.10). A total surplus of RM646 million was recorded for the balance of payment between Malaysia and the US for this category. Another country that made significant contributions to the surplus in contracts and professional services in 1998 was Germany (RM128 million). The largest deficit in this category was recorded in the trade between Malaysia and Hong Kong – payments exceeded receipts by RM38 million.

Figure 7.10: Balance of Payments for Contracts and Professional Fees, 1998

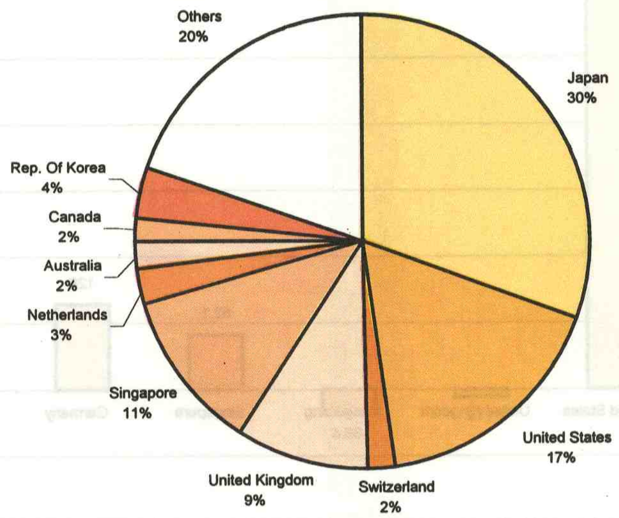


Source: Table 7.3

(c) Construction and Engineering

The five major sources of payments for construction and engineering in 1998 are Japan (RM1.1 billion), United States (RM631.4 million), Singapore (RM414 million), United Kingdom (RM328.8 million), and Republic of Korea (RM136 million) (see Figure 7.11). Outflows to the US in this category experienced a sharp increase of 94.6% between 1997 and 1998 (Table 7.4 in Appendix). The outflows to other countries in this category declined during this period – Japan by 12%, UK by 10.8%, and Republic of Korea by 4.6%.

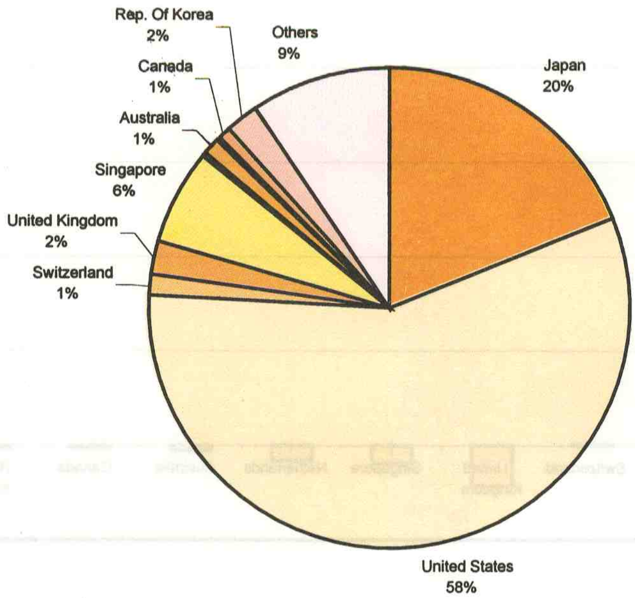
Figure 7.11: Payments for Construction and Engineering, 1998



Source: Table 7.4

In 1996 Japan was the largest source of receipt for construction and engineering. In the following year, the United States (RM1.4 billion) overtook Japan (RM1.2 billion) as the largest source of receipt for construction and engineering (see Table 7.4 in Appendix). This trend continued in 1998, when receipts in this category from Japan declined by 18% while that from the US increased by 95.8%. These drastic changes were probably due to the 2.8% contraction experienced by the Japanese economy in 1998. In the same year, the US economy grew at a healthy rate of 3.9%.

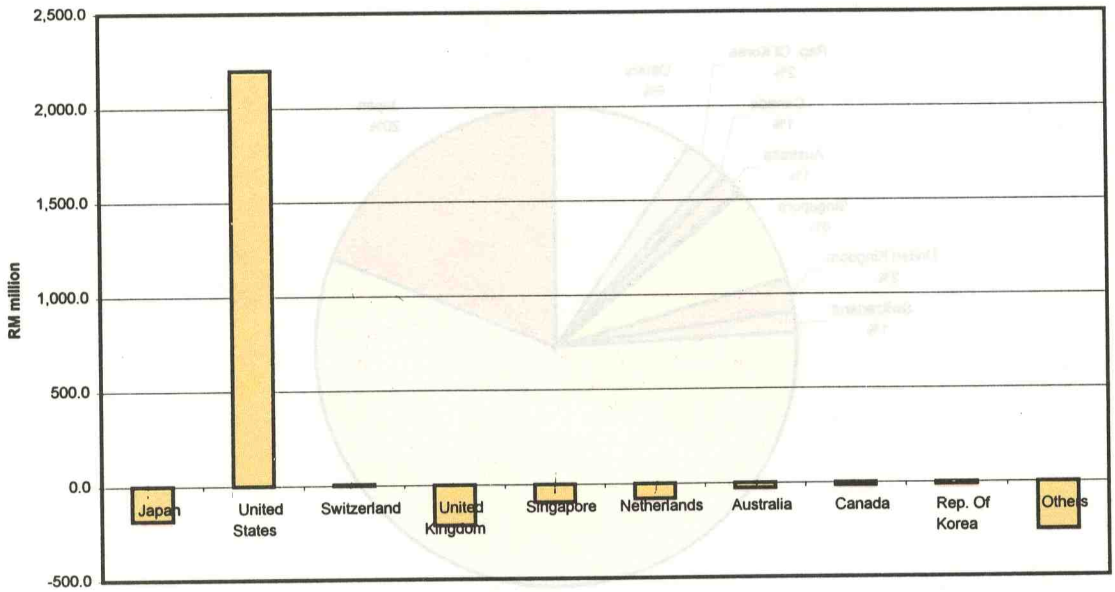
Figure 7.12: Receipts for Construction and Engineering, 1998



Source: Table 7.4

The surplus in the balance of payment in construction and engineering in 1998 was substantially driven by the net inflow for this category from the United States. For this trade category, Malaysia registered deficits with four other major countries namely, Japan, United Kingdom, Singapore and Republic of Korea (see Figure 7.13). In contrast, Malaysia's bilateral balance of payment with the US in this category registered a RM2.2 billion surplus.

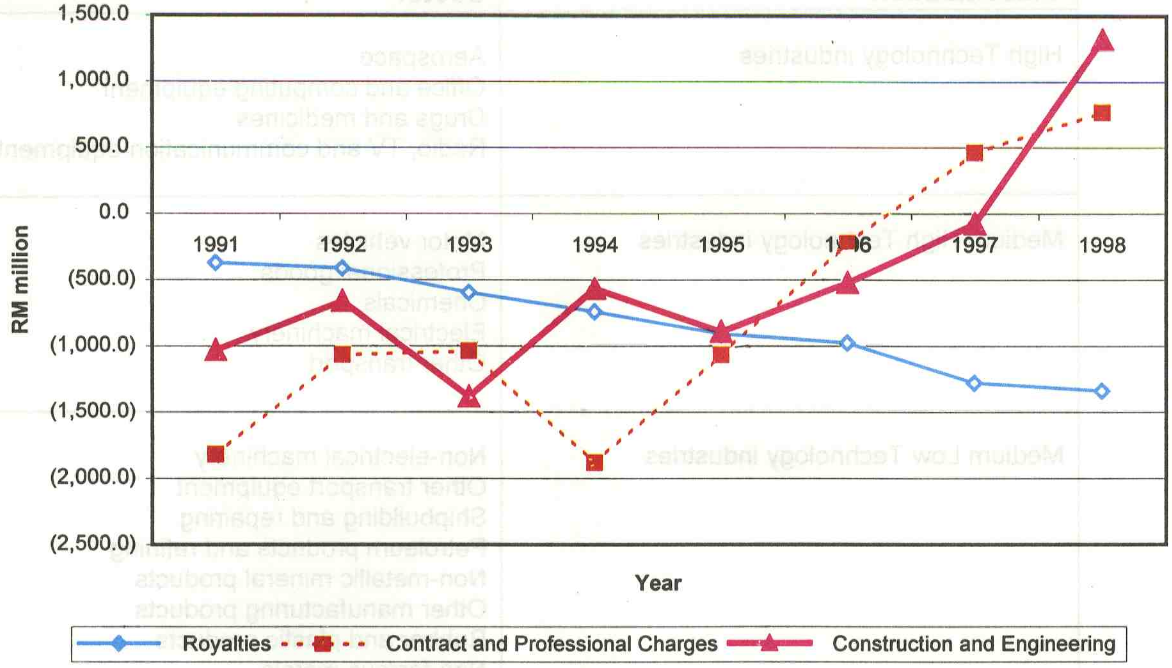
Figure 7.13: Balance of Payments for Construction and Engineering, 1998



Source: Table 7.4

Recent trends in Malaysia's technology balance of payment reflect, to some extent, the country's state of technology (Figure 7.14). The persistent deficits in the balance of payment for royalties may be an indication of structural weaknesses in Malaysia's technology base particularly in her ability to develop intangible technology such as patents and licenses that have export potential. In the other two categories – contract and professional fees, and construction and engineering – cyclical factors have a great impact on their balance of payments. The fluctuations observed in payment and receipts in these categories seem to depend greatly on the state of Malaysia's economy as well as that of its major trading partners. A handful of countries, notably the United States, Japan, and Singapore, dominate the inflows and outflows of trade in intangible "disembodied" technology. This seems to have exacerbated the cyclical fluctuations in the balance of payment for trade in technology-related services.

Figure 7.14: Balance of Payments for Technology-Related Services, 1991-98



Source: Table 7.1

7.2 External Trade in High-Technology Goods

Malaysia produces a variety of products with different technological requirements. An indirect measure of the country's technological status is the pattern of its trade flow in different categories of goods classified in terms of technology intensity. OECD's classification scheme, which is based on R&D intensity, comprise of four categories: high technology, medium-high technology, medium-low technology, and low technology products. Briefly, the table below summarizes this classification scheme. (For more details see the Methodology Appendix.)

Classification of Products by Technology Intensity

Classification	Sector
High Technology industries	Aerospace Office and computing equipment Drugs and medicines Radio, TV and communication equipment
Medium High Technology industries	Motor vehicles Professional goods Chemicals Electrical machinery Other transport
Medium Low Technology industries	Non-electrical machinery Other transport equipment Shipbuilding and repairing Petroleum products and refining Non-metallic mineral products Other manufacturing products Rubber and plastic products Non-ferrous metals
Low Technology industries	Iron and steel Metal products Food products, beverages and tobacco Paper and printing Textiles, wearing apparel, fur and leather Wood products and furniture

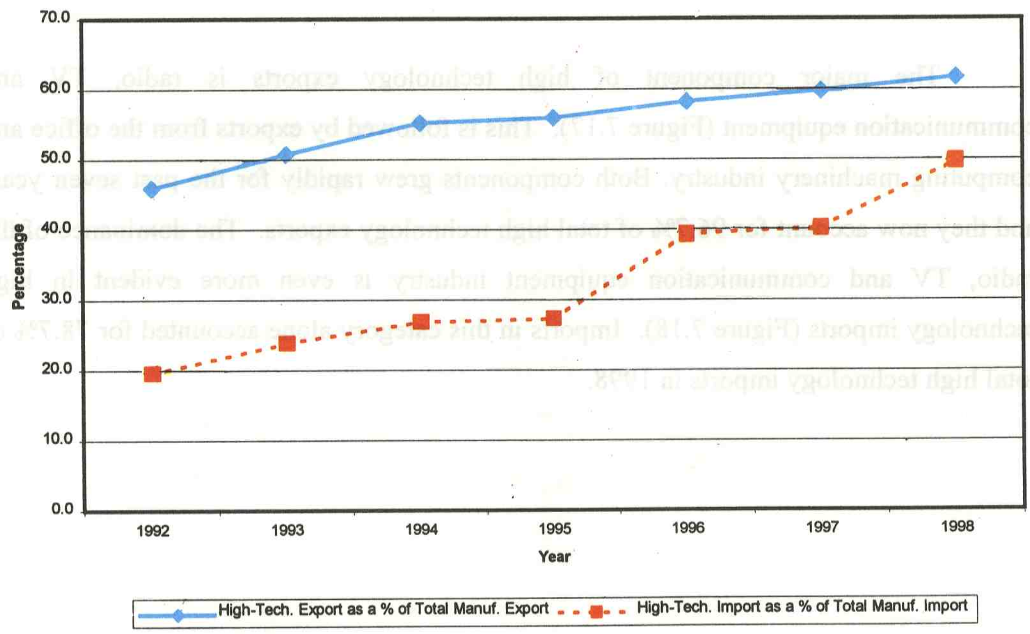
Source: OECD

A detailed list of goods under the various product groups is provided in the Methodology Appendix. Ideally, for a developing country such as Malaysia with a technology diverse industry structure we should analyze trade flows in all the above four categories. Due to data limitations, this report focuses on trade in high technology and medium-high technology industries.

7.2.1 Recent Trends in Trade in High Technology Goods

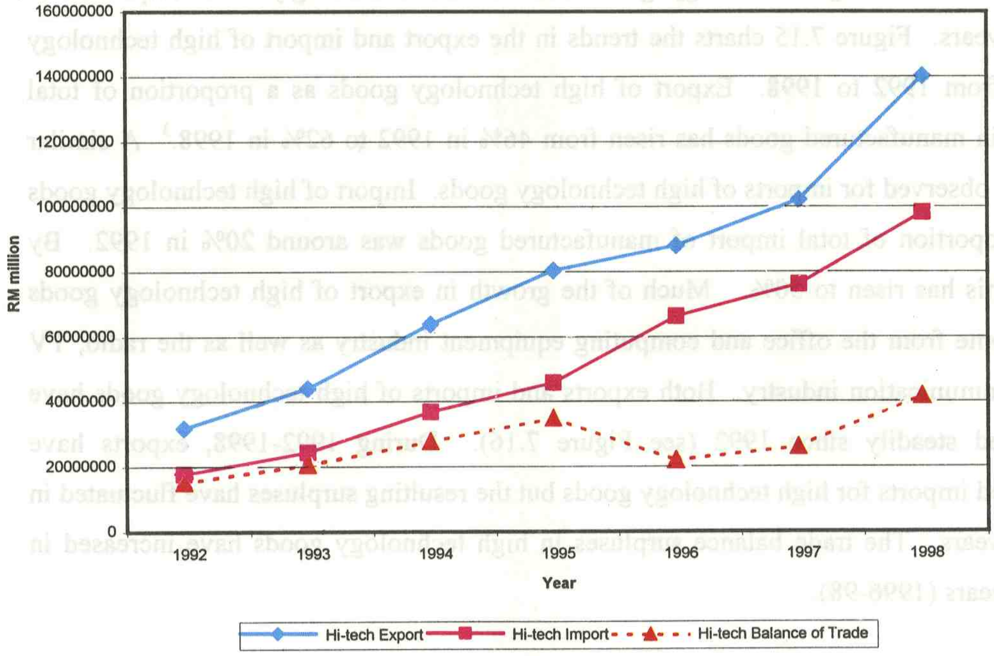
Trade in high technology goods has become increasingly more important in recent years. Figure 7.15 charts the trends in the export and import of high technology goods from 1992 to 1998. Export of high technology goods as a proportion of total export in manufactured goods has risen from 46% in 1992 to 62% in 1998.[3] A similar trend is observed for imports of high technology goods. Import of high technology goods as a proportion of total import of manufactured goods was around 20% in 1992. By 1998, this has risen to 50%. Much of the growth in export of high technology goods have come from the office and computing equipment industry as well as the radio, TV and communication industry. Both exports and imports of high technology goods have increased steadily since 1992 (see Figure 7.16). During 1992-1998, exports have exceeded imports for high technology goods but the resulting surpluses have fluctuated in recent years. The trade balance surpluses in high technology goods have increased in recent years (1996-98).

Figure 7.15: Trends in Trade in High-Technology Goods, 1992-98



Source: Table 7.5

Figure 7.16: High Technology Balance of Trade, 1992-98

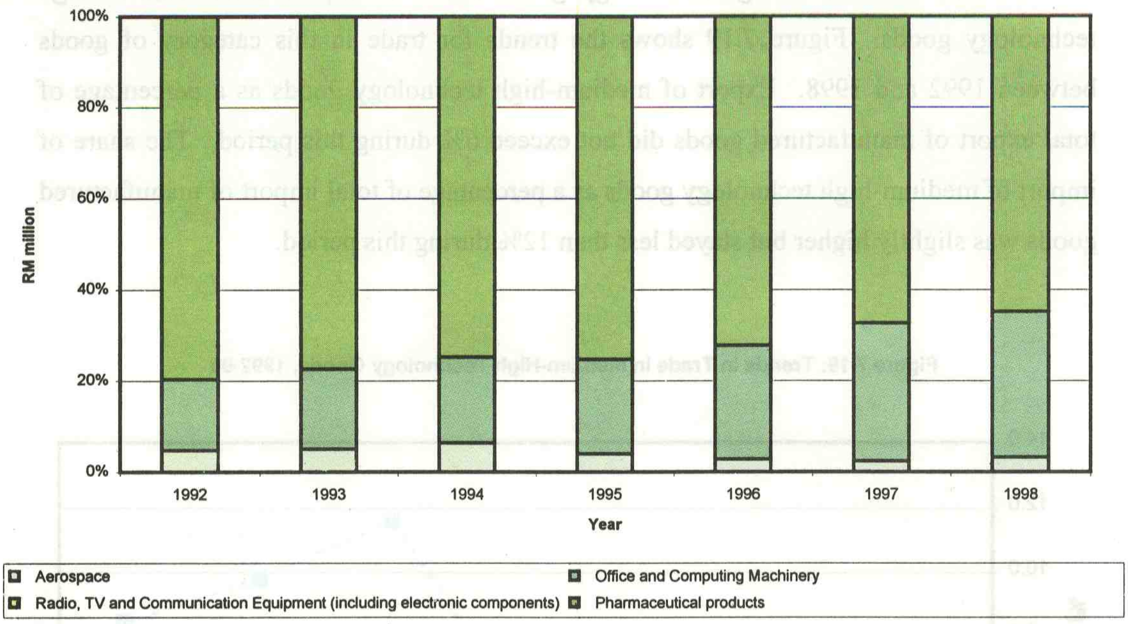


Source: Table 7.5

The major component of high technology exports is radio, TV and communication equipment (Figure 7.17). This is followed by exports from the office and computing machinery industry. Both components grew rapidly for the past seven years and they now account for 96.7% of total high technology exports. The dominance of the radio, TV and communication equipment industry is even more evident in high technology imports (Figure 7.18). Imports in this category alone accounted for 78.7% of total high technology imports in 1998.

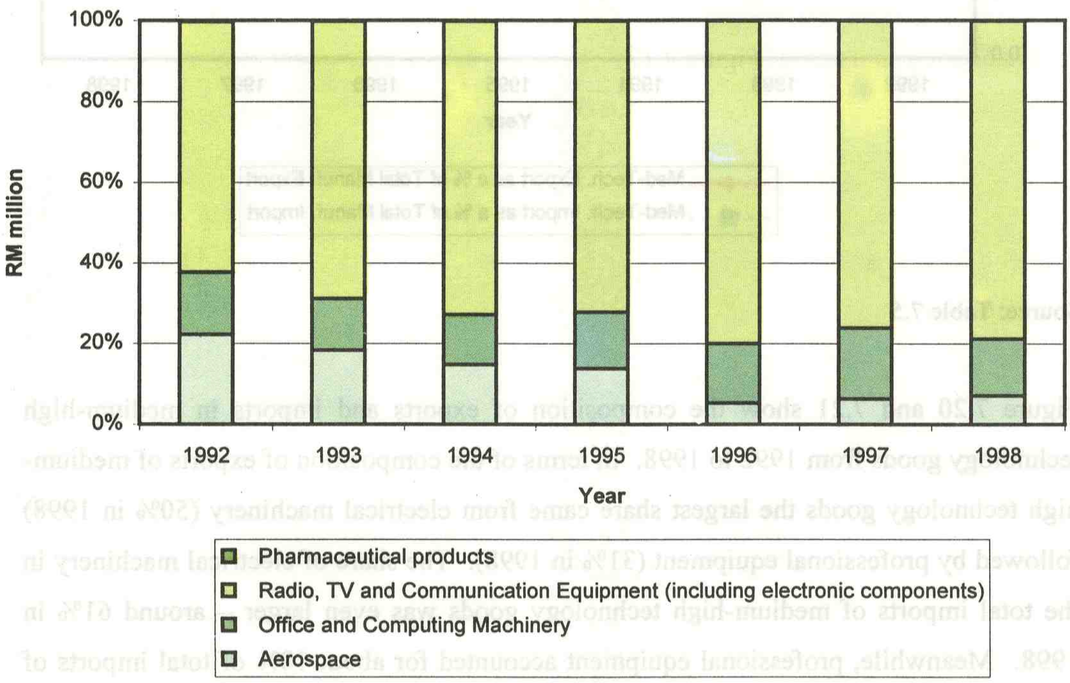
[3] Based on a more disaggregated approach, Malaysia's share of high tech exports to total manufactured exports is estimated to be lower at 49% in 1997. (See Mani, 2000)

Figure 7.17: Composition of High Technology Exports, 1992-98



Source: Table 7.5

Figure 7.18: Composition of High Technology Imports, 1992-98

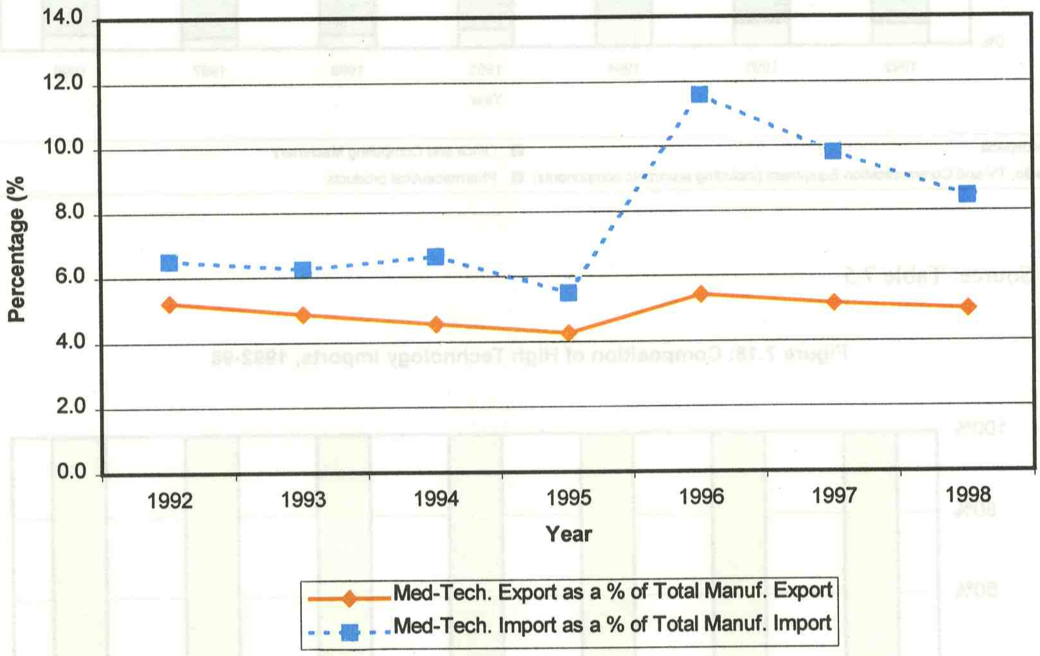


Source: Table 7.5

7.2.2 Recent Trends in Trade in Medium-High Technology Goods

Trade in medium-high technology goods is not as important as trade in high technology goods. Figure 7.19 shows the trends for trade in this category of goods between 1992 and 1998. Export of medium-high technology goods as a percentage of total export of manufactured goods did not exceed 6% during this period. The share of import of medium-high technology goods as a percentage of total import of manufactured goods was slightly higher but stayed less than 12% during this period.

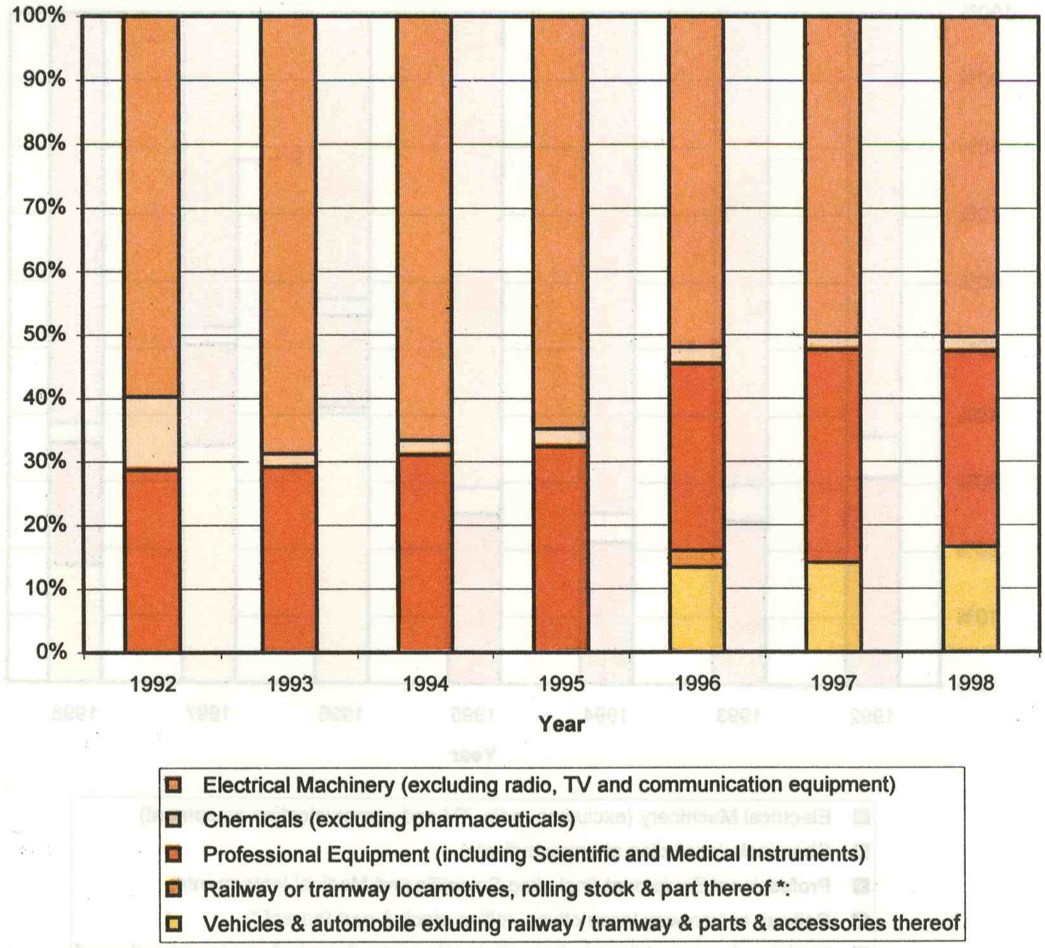
Figure 7.19: Trends in Trade in Medium-High Technology Goods, 1992-98



Source: Table 7.5

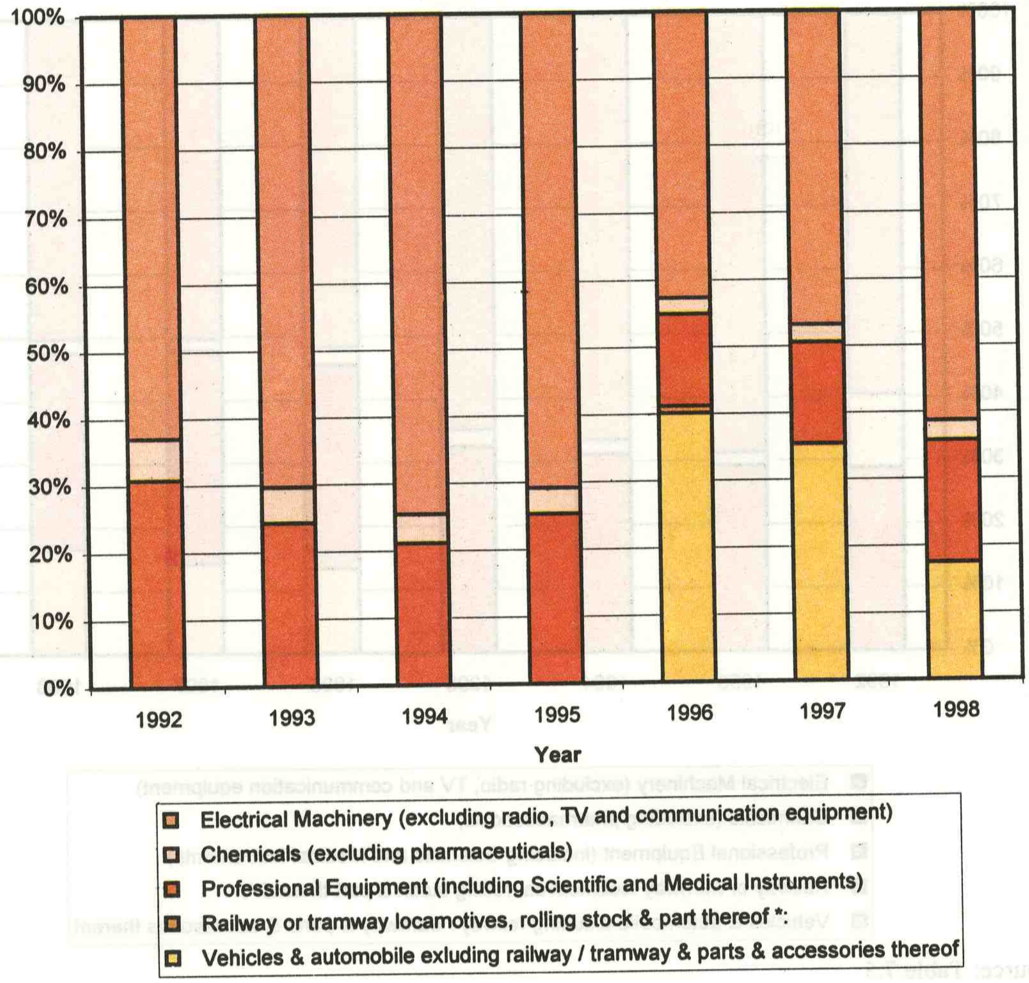
Figure 7.20 and 7.21 show the composition of exports and imports in medium-high technology goods from 1992 to 1998. In terms of the composition of exports of medium-high technology goods the largest share came from electrical machinery (50% in 1998) followed by professional equipment (31% in 1998). The share of electrical machinery in the total imports of medium-high technology goods was even larger – around 61% in 1998. Meanwhile, professional equipment accounted for about 18% of total imports of medium-high technology goods in 1998.

Figure 7.20: Composition of High-Medium Technology Export, 1992-98



Source: Table 7.5

Figure 7.21: Composition of High-Medium Technology Imports, 1992-98



Source: Table 7.5

CHAPTER 8

INTERNATIONAL COMPARISONS

A country's achievement in science and technology (S&T) is related to the level of its economic development. Science and technology play an important role in the structural transformations that nations undergo in the process of economic development. In general, these structural transformations involve the change from an agricultural and labor-intensive economy to an industrial, and capital and technology intensive one. Thus, a useful starting point in any analysis of a country's S&T achievements is the level of its economic development as measured by two indicators - GNP per capita and the output structure.

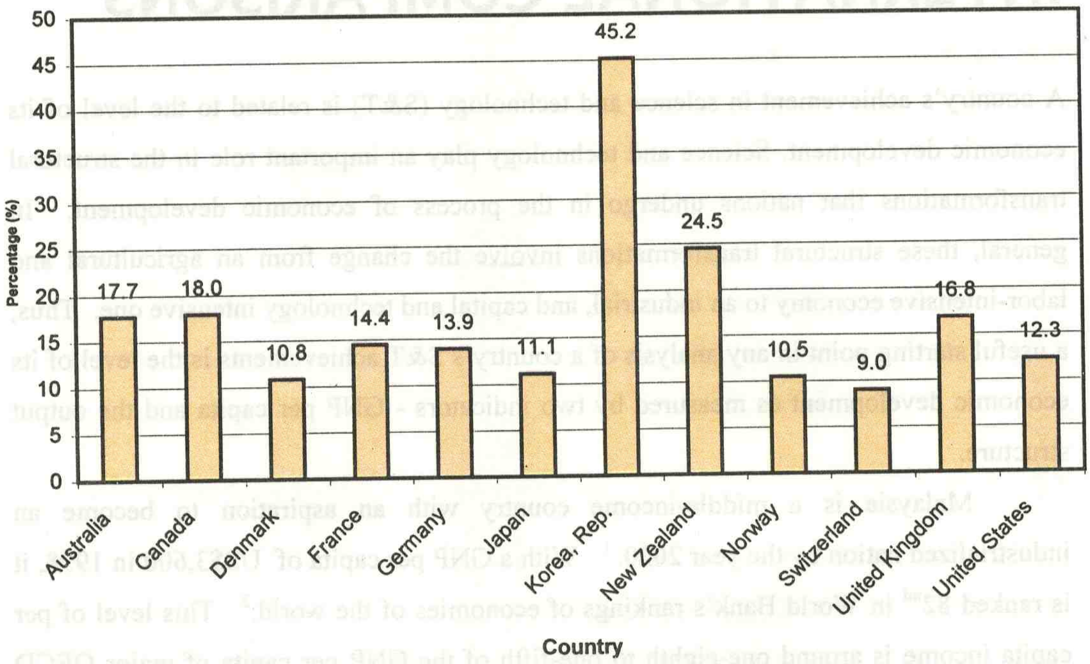
Malaysia is a middle-income country with an aspiration to become an industrialized nation by the year 2020.[1] With a GNP per capita of US$3,600 in 1998, it is ranked 82nd in World Bank's rankings of economies of the world.[2] This level of per capita income is around one-eighth to one-fifth of the GNP per capita of major OECD nations such as the United States and Canada (Figure 8.1). Malaysia's GNP per capita is somewhat larger than the GNP per capita in other ASEAN countries with the exception of Singapore (Figure 8.2).

In terms of output structure, the major OECD Countries are predominantly countries with relatively high GDP share of the manufacturing sector (Figure 8.3). They range from 11% (Norway) to 26% (Rep. Korea). The agriculture sector's share of total GDP for these countries is typically less than 5%. In the case of the selected ASEAN countries, the manufacturing sector's share of total GDP is quite high (Figure 8.4). These are comparable or even higher than for OECD countries. The only significant difference is the substantial GDP share of the services sector in OECD countries. Thus, in light of the above comparisons Malaysia can be characterized as an industrializing country with a very high GDP share of the manufacturing sector (34%).

[1] World Bank's classification of economies are as follows:
Low-income: GNP per capita ≤ US$760
Middle income: US$761 ≤ GNP per capita ≤ US$9,360
High-Income: GNP per capita ≥ US$9,361

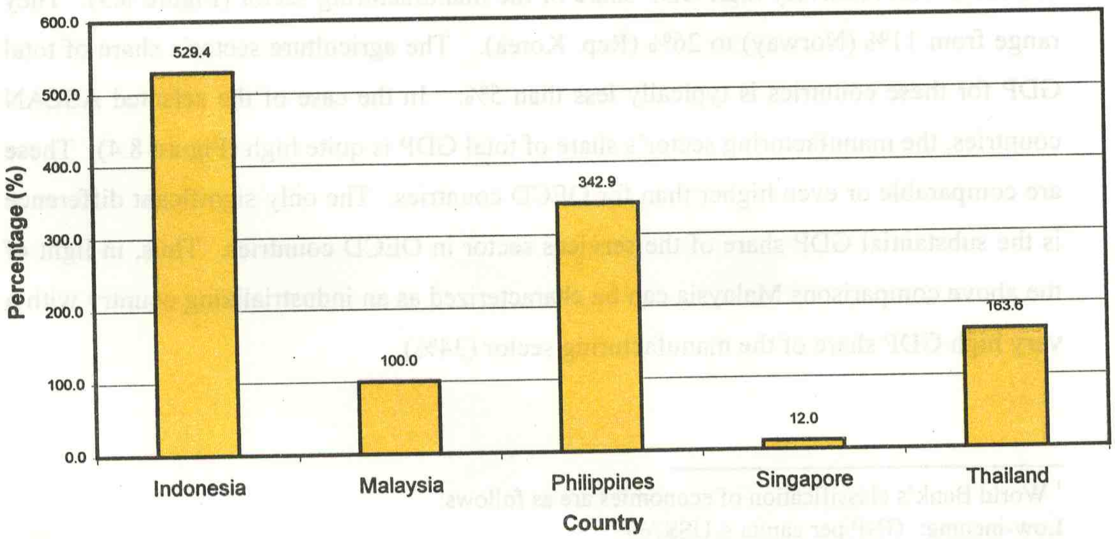
[2] World Bank figure. Using an exchange rate of RM3.8 = US$1, Malaysia GNP per capita is around US$3,093.

Figure 8.1: Malaysia GNP Per Capita as a Percentage of Major OECD Countries' GNP Per Capita



Source: Table 8.1

Figure 8.2: Malaysia GNP Per Capita as a % of GNP Per Capita of Selected ASEAN Countries, 1998



Source: Table 8.1

Figure 8.3: Output Structure of Selected OECD Countries, 1998

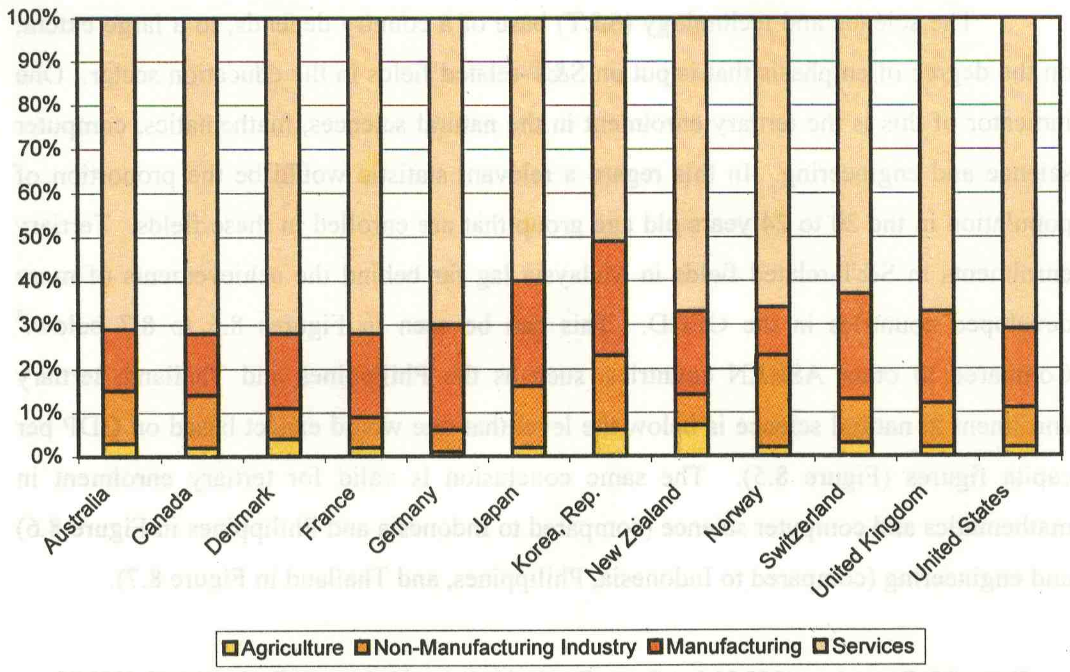
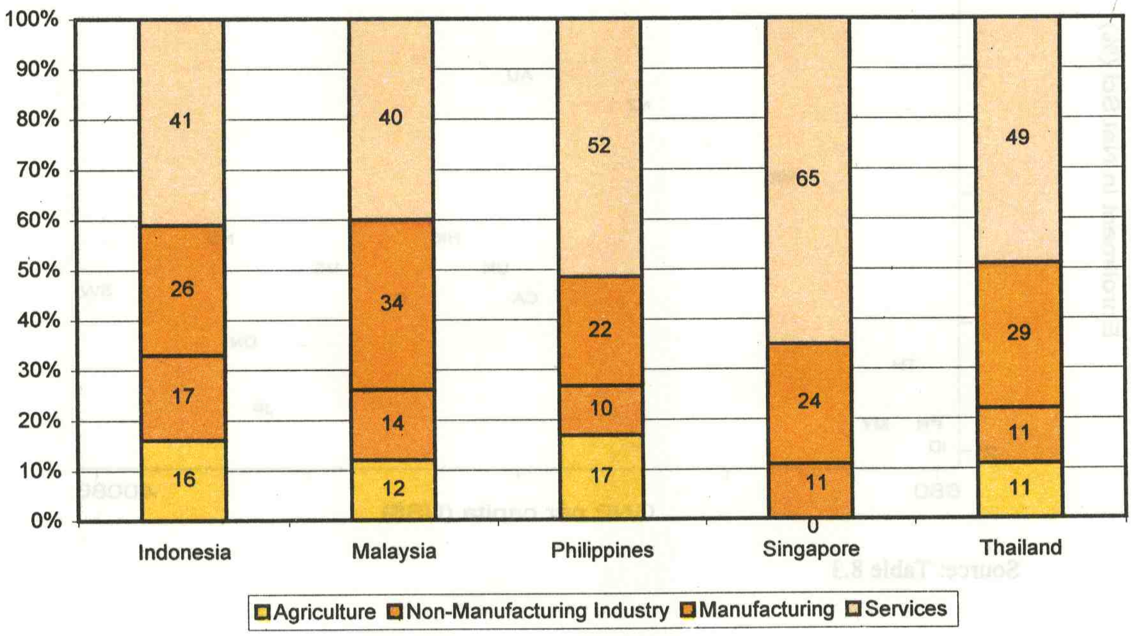


Figure 8.4: Output Structure of Selected ASEAN Countries, 1998

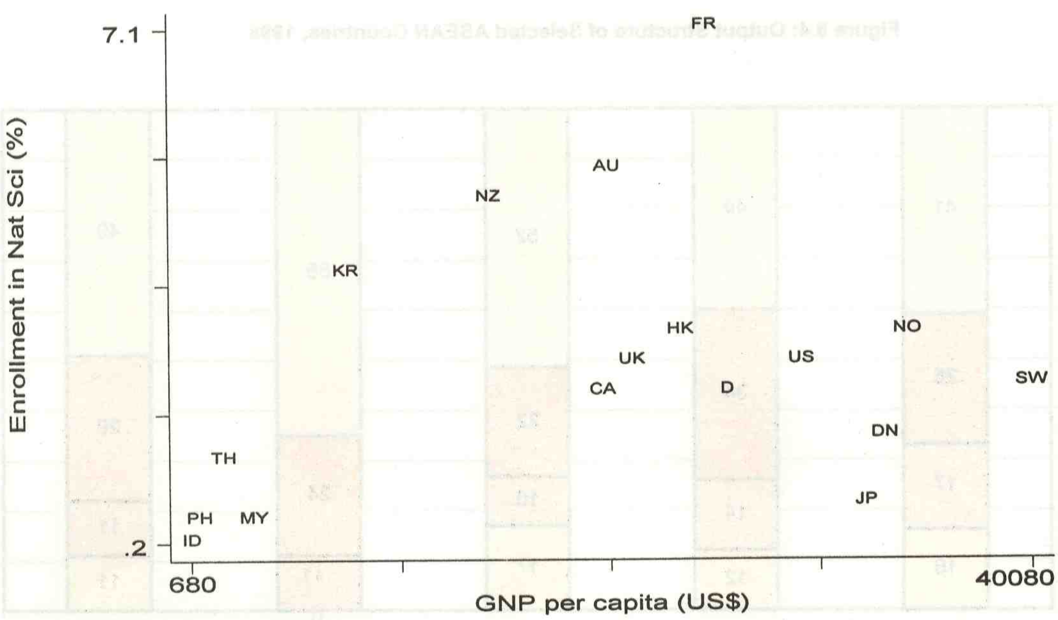


Source: Table 8.2

8.1 Education

The science and technology (S&T) base of a country depends, to a large extent, on the degree of emphasis that is put on S&T-related fields in the education sector. One indicator of this is the tertiary enrolment in the natural sciences, mathematics, computer science and engineering. In this regard a relevant statistic would be the proportion of population in the 20 to 24 years old age group that are enrolled in these fields. Tertiary enrolments in S&T-related fields in Malaysia lag far behind the achievements of more developed countries in the OECD. This can be seen in Figures 8.5 to 8.7 below.[3] Compared to other ASEAN countries, such as the Philippines and Thailand, tertiary enrolment in natural science is below the level that one would expect based on GDP per capita figures (Figure 8.5). The same conclusion is valid for tertiary enrolment in mathematics and computer science (compared to Indonesia and Philippines in Figure 8.6) and engineering (compared to Indonesia, Philippines, and Thailand in Figure 8.7).

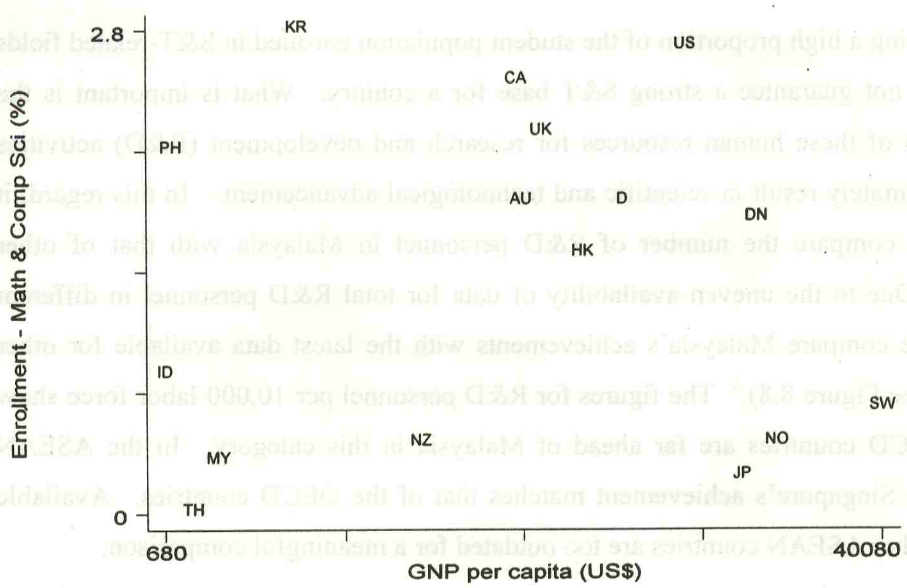
Figure 8.5: Percentage of 20-24 Age Group Enrolled in Natural Science at Tertiary Level, 1990-95



Source: Table 8.3

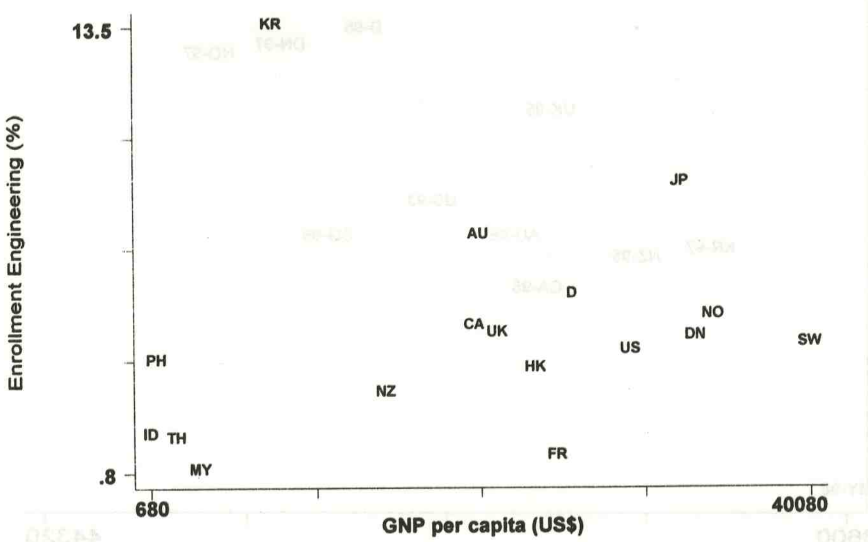
[3] The country abbreviations are as follows: Australia (AU), Canada (CA), Denmark (DN), France (FR), Germany (D), Japan (JP), Hong Kong (HK), Indonesia (ID), Malaysia (MY), New Zealand (NZ), Norway (NO), Philippines (PH), Rep. of Korea (KR), Switzerland (SW), Thailand (TH), United Kingdom (UK), United States (US).

Figure 8.6: Percentage of 20-24 Age Group Enrolled in Mathematics and Computer Science at Tertiary Level



Source: Table 8.3

Figure 8.7: Percentage of 20-24 Age Group Enrolled in Engineering at Tertiary Level

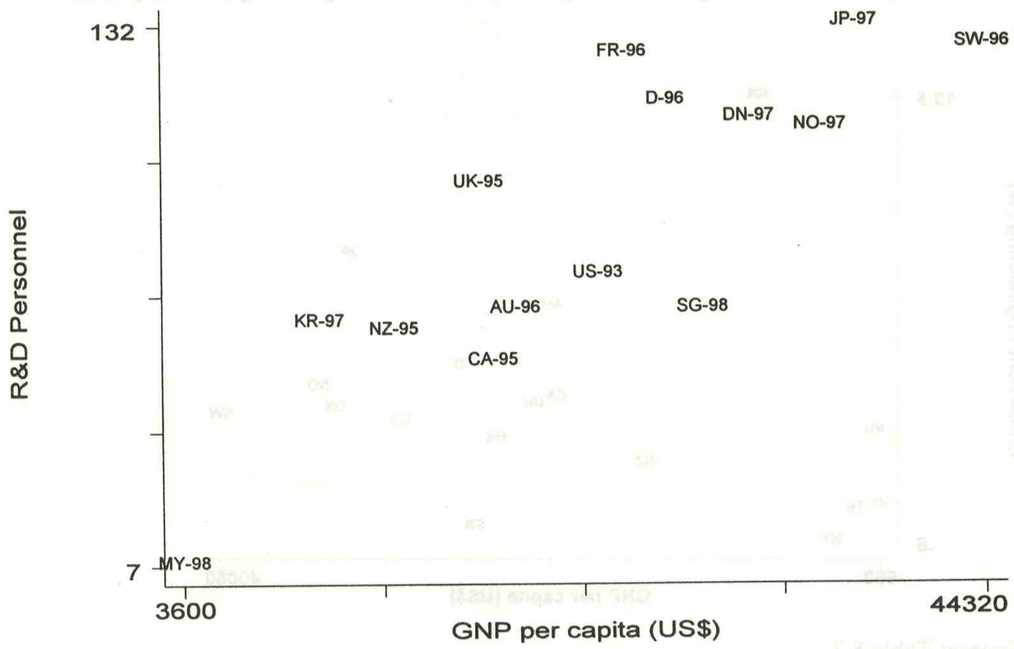


Source: Table 8.3

8.2 Human Resource Development for R&D

Having a high proportion of the student population enrolled in S&T-related fields *per-se* does not guarantee a strong S&T base for a country. What is important is the mobilization of these human resources for research and development (R&D) activities that will ultimately result in scientific and technological advancement. In this regard, it is useful to compare the number of R&D personnel in Malaysia with that of other countries. Due to the uneven availability of data for total R&D personnel in different countries we compare Malaysia's achievements with the latest data available for other countries (see Figure 8.8).[4] The figures for R&D personnel per 10,000 labor force show that the OECD countries are far ahead of Malaysia in this category. In the ASEAN region, only Singapore's achievement matches that of the OECD countries. Available data from other ASEAN countries are too outdated for a meaningful comparison.

Figure 8.8: Total R&D Personnel per 10,000 Labor Force for Selected Countries

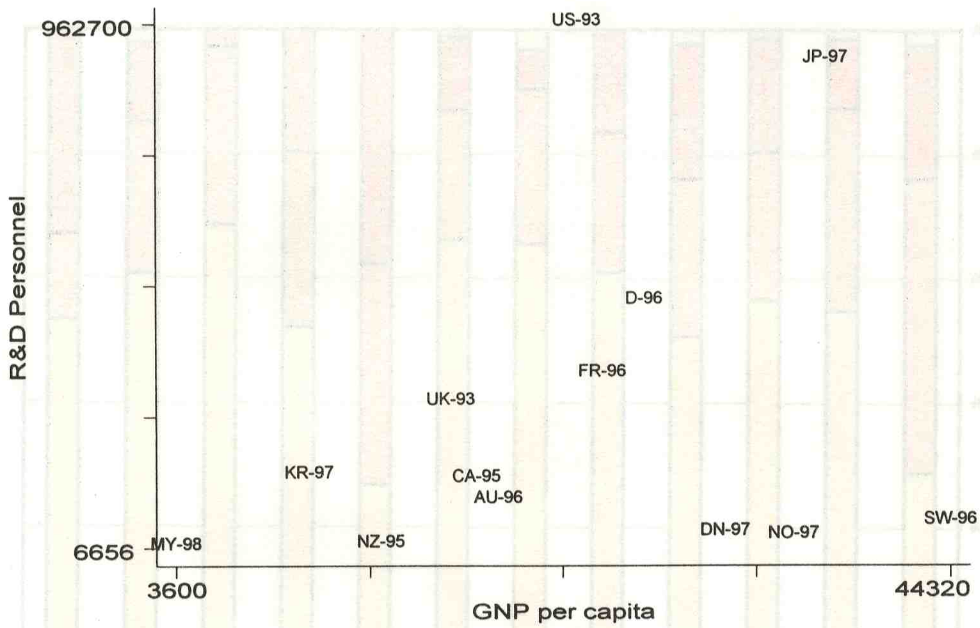


Source: Table 8.5

[4] The two digits that follow country abbreviations denotes year. For example, CA-95 denotes Canada in 1995.

When full time equivalent (FTE) data are used for comparisons, differences between countries become even larger. From Figure 8.9, we can see that the amount of human resources devoted to R&D in both Japan (JP) and USA (US) are significantly higher compared to other countries including Malaysia. In terms of FTE, the total R&D personnel in Malaysia is comparable to those found in developed countries with smaller populations such as New Zealand (NZ, population: 4 million), Denmark (DN, 5 million), Norway (NO, 4 million) and Switzerland (SW, 9 million).[5]

Figure 8.9: Total R&D Personnel for Selected Countries (FTE)



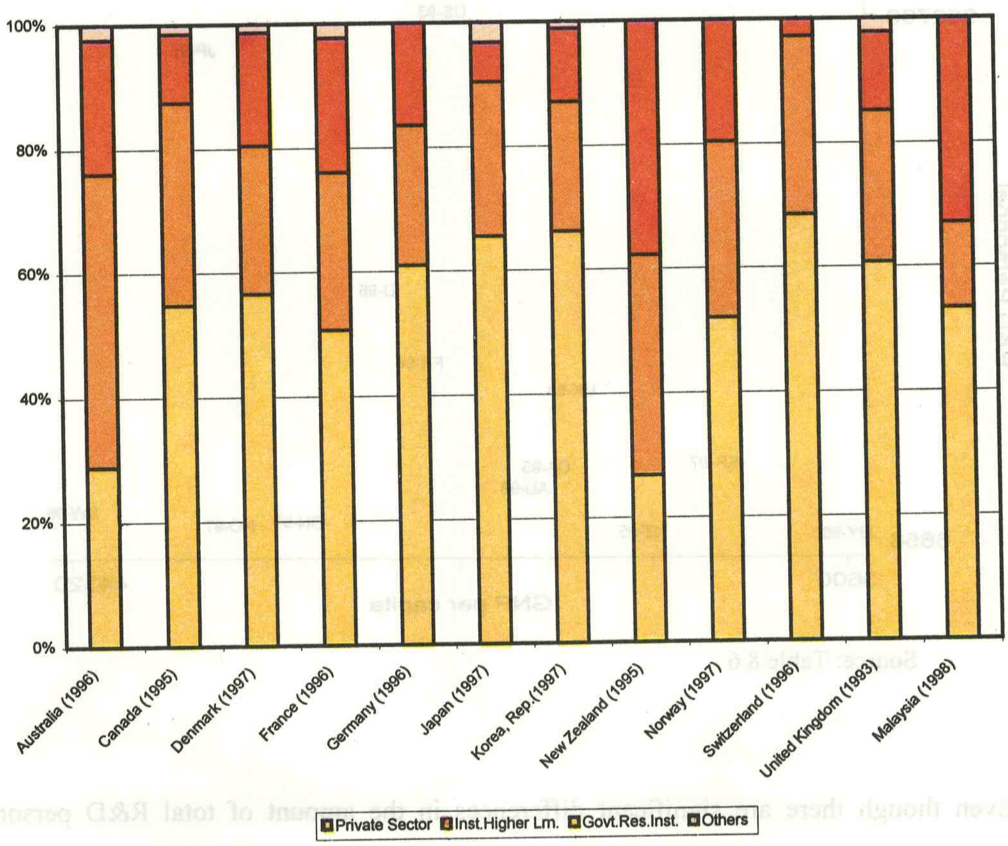
Source: Table 8.6

Even though there are significant differences in the amount of total R&D personnel between major OECD countries and Malaysia, the composition of R&D personnel shows some degree of similarity. The private sector's share of total R&D personnel is about 50% in Malaysia (Figure 8.10). In major OECD countries, the private sector plays a similar role in terms of composition of total R&D personnel. There are, however, some differences in terms of the shares of other components in total R&D personnel. In

[5] Total population figures are for 1998. Obtained from World Bank (2000).

Malaysia, the government's role is larger than that observed in OECD countries. Among the countries listed in Figure 8.10, a higher share of R&D personnel in government research institutes is observed only in New Zealand. Furthermore, the proportion of total R&D personnel coming from institutes of higher learning is smaller in Malaysia compared to other OECD countries. No data (in FTE) is available to compare Malaysia's experience in this area with other ASEAN countries.

Figure 8.10: Composition of R&D Personnel

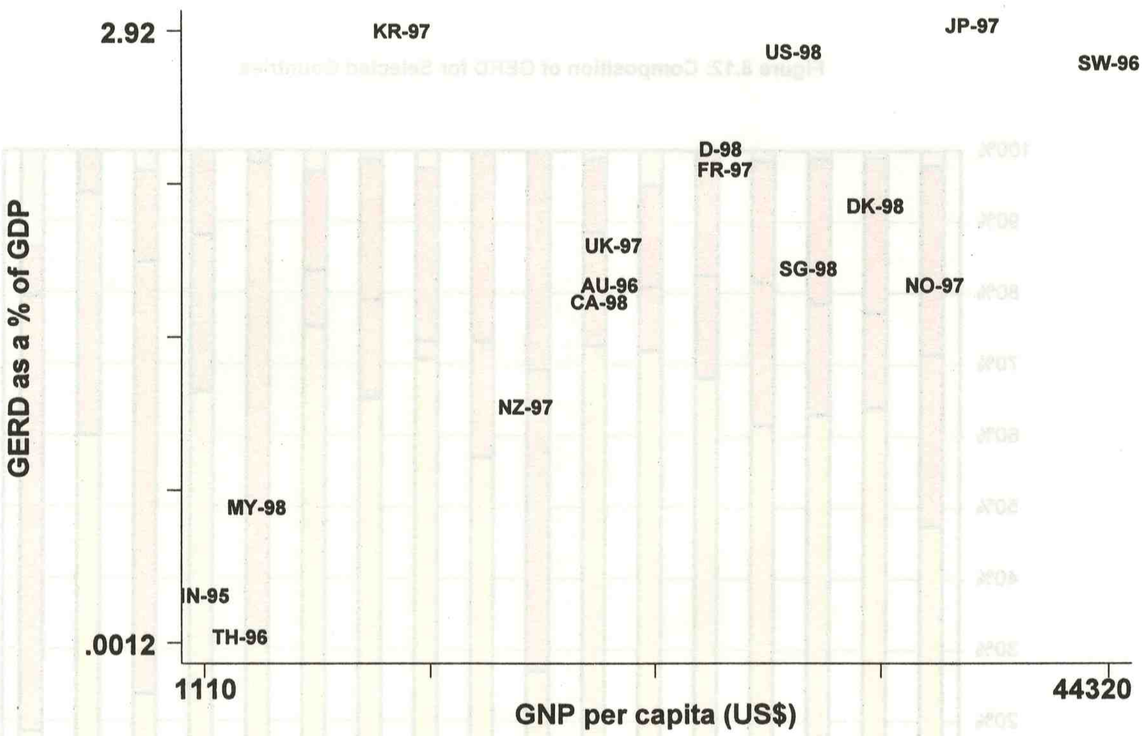


Source: Table 8.7

8.3 R&D Expenditure

Another measure of the level of resources devoted to R&D is the *gross domestic expenditure on R&D* (GERD) as a percentage of GDP. The amount that Malaysia spends on R&D in terms of GERD as a percentage of GDP is relatively high compared to ASEAN countries such as Indonesia, Philippines and Thailand (Figure 8.11). However, this figure is very much below that of major OECD countries.

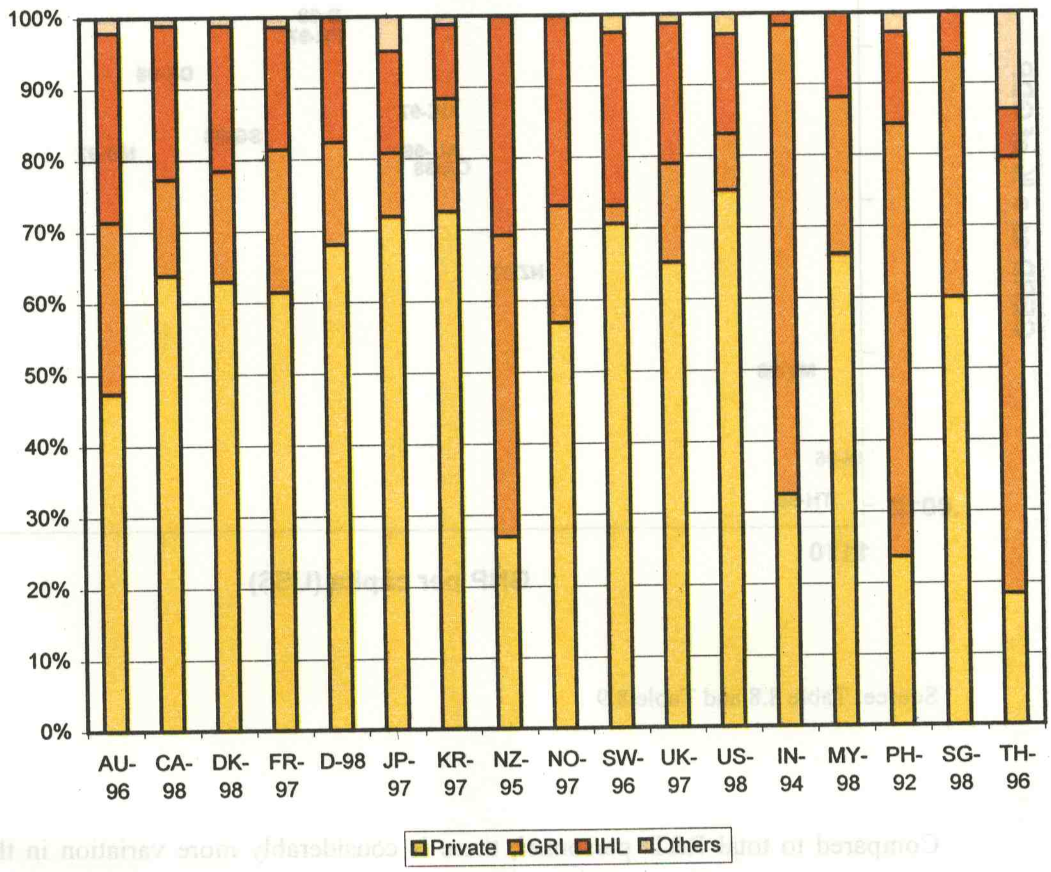
Figure 8.11: GERD as a percentage of GDP



Source: Table 8.8 and Table 8.9

Compared to total R&D personnel, there is considerably more variation in the composition of gross domestic expenditure on R&D (GERD) amongst the major OECD and ASEAN countries (see Figure 8.12). Generally, the private sector plays an important role in R&D expenditure in the OECD countries. With the exception of New Zealand, the private sector's share of GERD exceeds 50% in most of the OECD countries. In these countries, the government's share of GERD is usually less than 30%. In contrast, the government plays a much more important role in R&D expenditure in some of the ASEAN countries such as Indonesia, Philippines and Thailand. Malaysia's GERD composition is similar to that of major OECD countries where the private sector plays a more substantial role. Since the private sector's share of GERD (around 65%) is higher than its share of total R&D personnel (around 50%) it is also possible that R&D activities in the private sector are more capital intensive compared to those carried out in the public sector.

Figure 8.12: Composition of GERD for Selected Countries

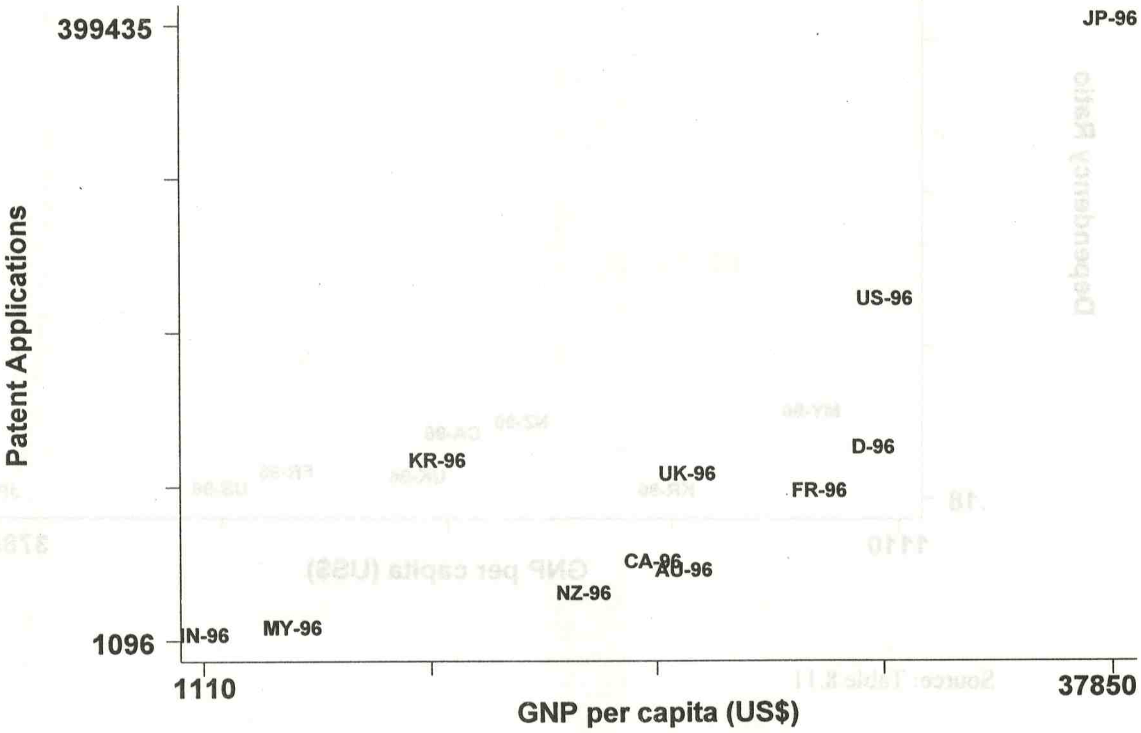


Source: Table 8.10

8.4 Patents

A high level of R&D expenditure in itself does not guarantee advancement in a country's science and technology base. An important issue is the effectiveness of R&D and other policies in enhancing the science and technology base of a country. Part of this effectiveness is captured by science and technology output variables such as the number of patent applications in the country. Figure 8.13 plots the number of patent applications against GNP per capita in 1996 for selected countries including Malaysia.[6] The number of patent applications in Malaysia lags behind most of the major OECD countries. Its achievement in this area appears to commensurate with the level of GNP per capita in Malaysia.

Figure 8.13: Patent Applications in Selected Countries, 1996

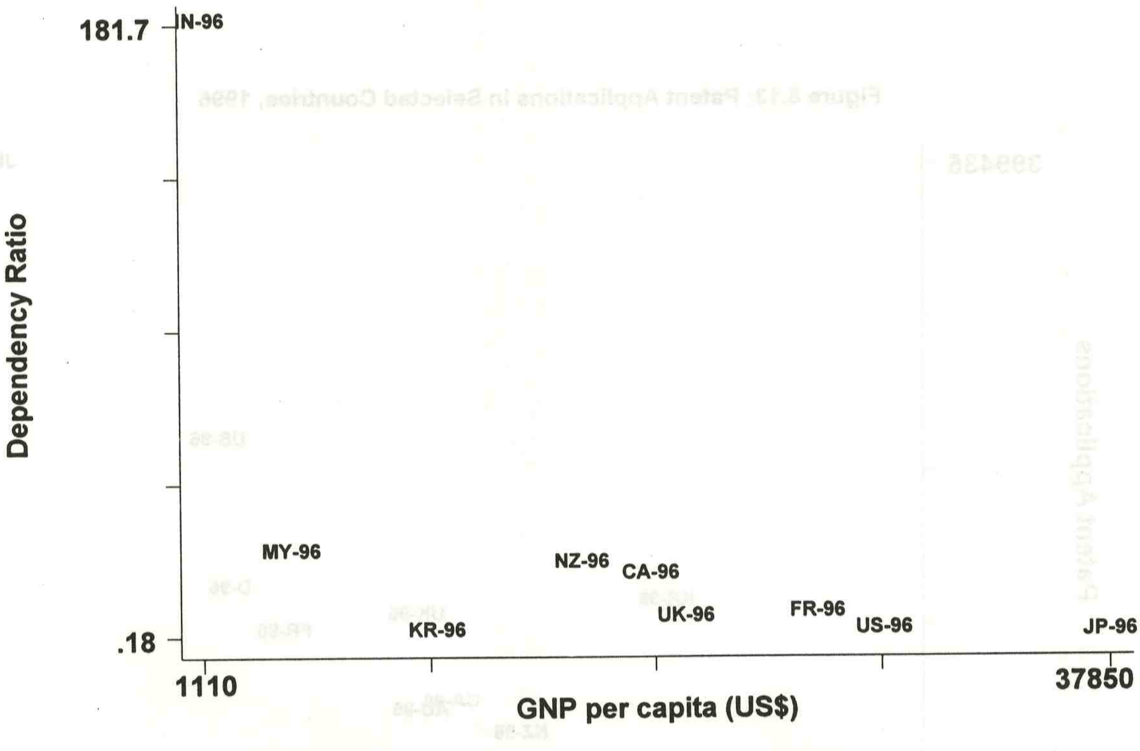


Source: Table 8.11

[6] Data after 1996 for international comparisons were not available.

Another patent-related measure of technological progress is the dependency ratio. The dependency ratio is defined as the ratio of non-resident to resident patent applications. This ratio measures the extent to which patents generated in a country are heavily dependent on resident versus non-resident population in the country. The larger the dependency ratio, the greater a country is dependent on foreign or non-resident population to generate patent applications. The dependency ratio for Malaysia (24.2 in 1996) is comparable to countries such as New Zealand (20.82 in 1996) and Canada (17.52 in 1996) – see Figure 8.14.

Figure 8.14: Dependency Ratio in Selected Countries, 1996



Source: Table 8.11

Aside total patent applications and dependency ratio, it is also useful to know whether patenting activities are taking place in high technology sectors. A comparison of the patenting activities of Malaysian inventors in the U.S. with those form Singapore and Korea reveals that Malaysian inventors put relatively less emphasis on high technology patents (see Table 8A).

Table 8A: Top 15 Most Emphasized U.S. Patent Classes for Inventors from Korea, Singapore and Malaysia

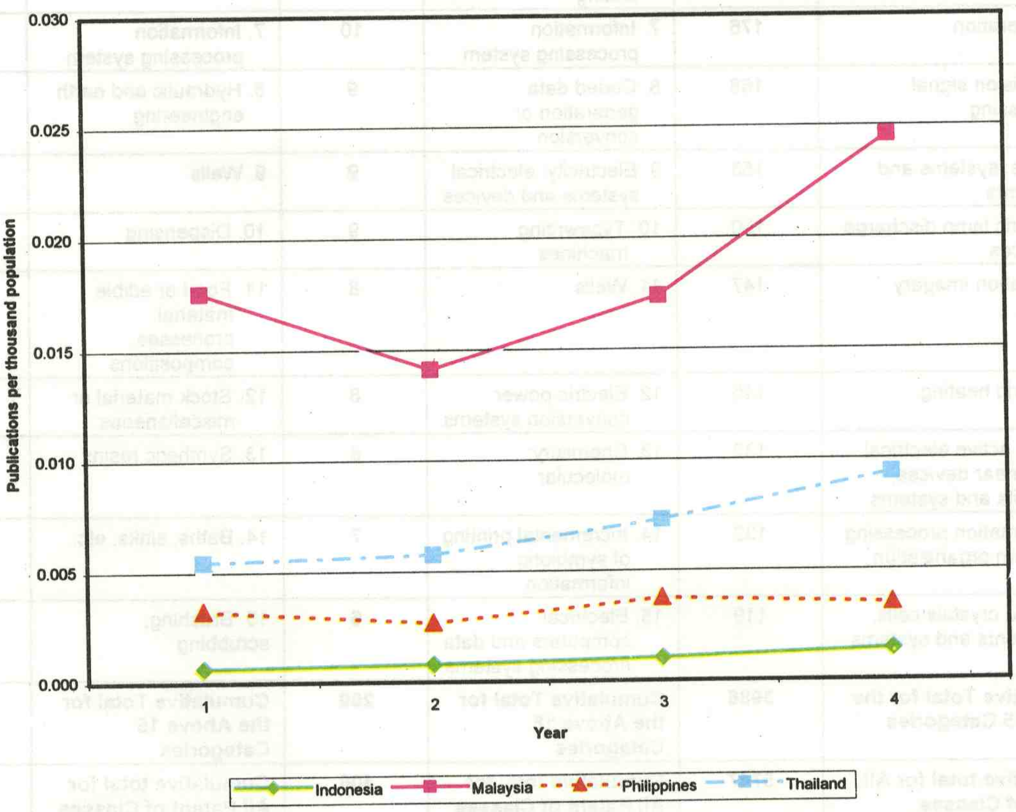
Korea	Cumulative Number of Patents 1994-1998	Singapore	Cumulative Number of Patents 1994-1998	Malaysia	Cumulative Number of Patents 1994-1998
1. Semiconductor device manufacturing process	741	1. Semiconductor device manufacturing process	58	1. Communications: electrical	5
2. Television	584	2. Active solid state devices	23	2. Horizontally supported planar surfaces	4
3. Static information storage and retrieval	468	3. Electrical connecters	19	3. Optical wave guides	4
4.Active solid state devices	328	4. Television	14	4. Games using tangible projectiles	4
5. Dynamic information storage or retrieval	272	5. Electric lamp and discharge devices	11	5. Printing	3
6. Dynamic magnetic information storage or retrieval	271	6. Electricity: measuring and testing	10	6. Conveyors: power-driven	3
7.Refrigeration	176	7. Information processing system	10	7. Information processing system	3
8. Television signal processing	168	8. Coded data generation or conversion	9	8. Hydraulic and earth engineering	3
9. Optics: systems and elements	153	9. Electricity: electrical systems and devices	9	9. Wells	2
10.Electric lamp discharge devices	150	10. Typewriting machines	9	10. Dispensing	2
11.Radiation imagery	147	11. Wells	8	11. Food or edible material: processes, compositions	2
12.Electric heating	145	12. Electric power conversion systems	8	12. Stock material or miscellaneous	2
13.Misc. active electrical nonlinear devices, circuits and systems	132	13. Chemistry: molecular	8	13. Synthetic resins	2
14. Information processing system organization	132	14. Incremental printing of symbiotic information	7	14. Baths, sinks, etc.	1
15. Liquid crystals cells, elements and systems	119	15. Electrical computers and data processing systems	6	15. Brushing, scrubbing	1
Cumulative Total for the Above 15 Categories	**3986**	**Cumulative Total for the Above 15 Categories**	**209**	**Cumulative Total for the Above 15 Categories**	**41**
Cumulative total for All Patent of Classes	**8747**	**Cumulative total for All Patent of Classes**	**406**	**Cumulative total for All Patent of Classes**	**69**

Source: Mani (2000)

8.5 Bibliometric

Yet another approach to the measurement of the science and technology output is bibliometric. In bibliometric, the number of scientific publications and their citations are analyzed. In the ASEAN region, Malaysia's scientific publications per capita is second only to Singapore (Figure 8.15). Since the mid-1980s scientific publications per capita has been on the rise in Malaysia. Despite this, the level of scientific publications per capita in Malaysia is still very low compared to that of developed nations such as Singapore (see Figure 8.16).

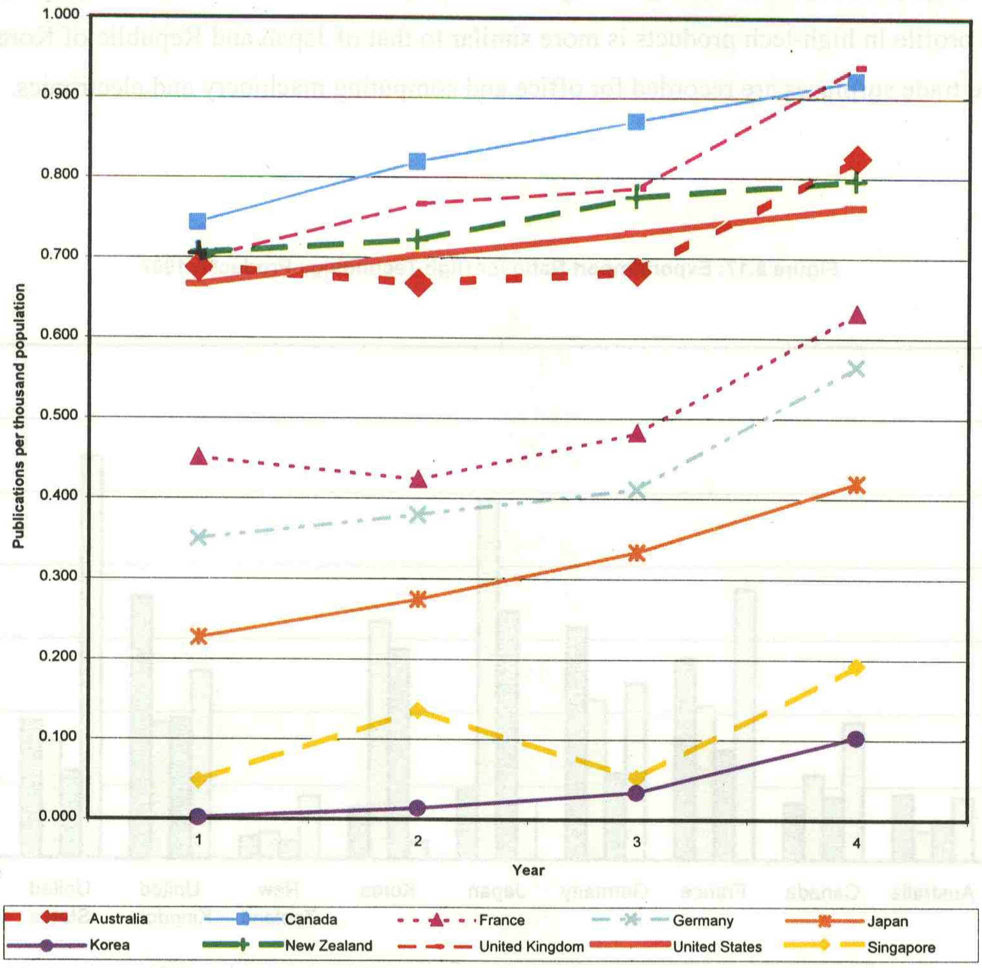
Figure 8.15: Scientific Publications Per Capita in Selected ASEAN Countries, 1980-95



Year 1 = 1980, Year 2 = 1985, Year 3 = 1990, Year 4 = 1995

Source: Table 8.12

Figure 8.16: Scientific Publications Per Capita in Selected Countries, 1980-95



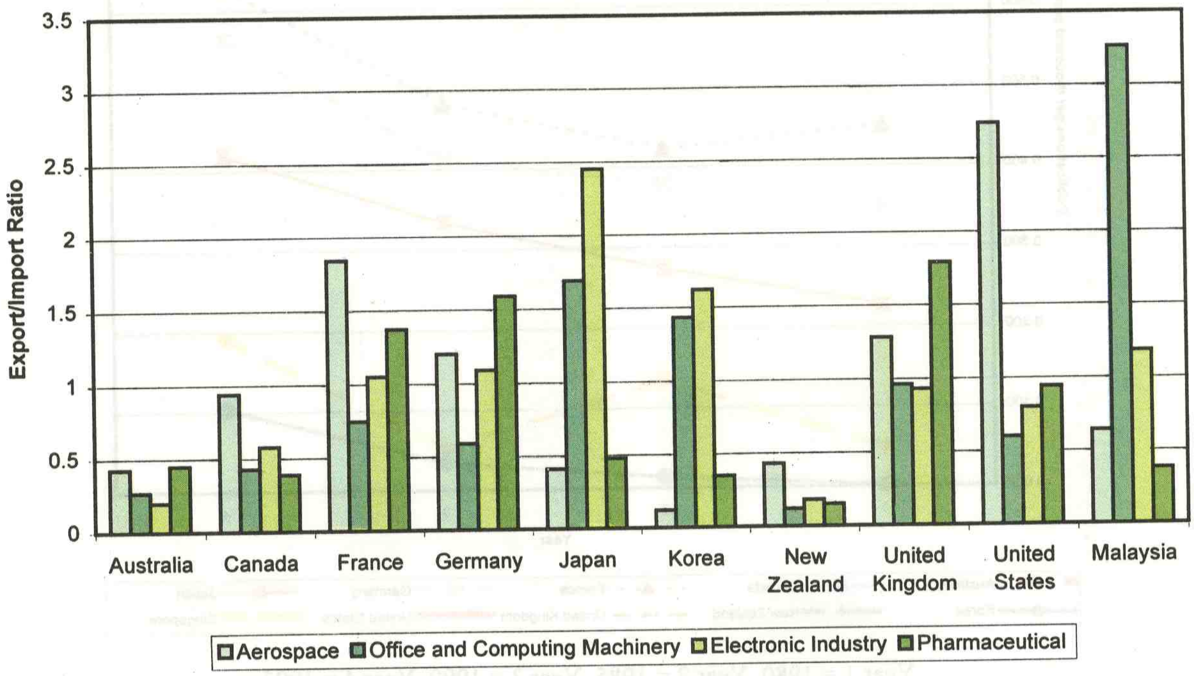
Year 1 = 1980, Year 2 = 1985, Year 3 = 1990, Year 4 = 1995

Source: Table 8.12

8.6 External Trade in HighTechnology Products

The role of technology in enhancing a country's economic competitiveness is partly reflected in its total trade flows in high technology products. These are products that are considered to be highly R&D intensive. They include products from industries such as aerospace, office and computing machinery, pharmaceutical, radio, TV and communication equipment. Figure 8.17 shows the export/import ratio for Malaysia and selected OECD countries. An export/import ratio exceeding one indicates that trade for that product category is in surplus. There are significant differences in the high technology trade flows among OECD countries. For the European OECD countries, trade surplus is recorded for the aerospace and pharmaceutical industries. Malaysia's trade profile in high-tech products is more similar to that of Japan and Republic of Korea where trade surpluses are recorded for office and computing machinery and electronics.

Figure 8.17: Export/Import Ratio for High Technology Products, 1997



Source: Table 8.13

Note: Data for Malaysia is for 1998 and data for UK is for 1996.

8.7. Overall Indicators of High Technology Competitiveness

Attempts have been at measuring the competitiveness of countries in high technology sectors. A recent study by the National Science Foundation (1995) lists four indicators of technological competitiveness:

- **National Orientation** – This indicator attempts to identify those nations whose business, government, and cultural orientation encourage high-technology development.
- **Socioeconomic Infrastructure** – This indicator assess the underlying physical, financial, and human resources needed to support modern technology-based economies.
- **Technological Infrastructure** – This indicator evaluates the institutions and resources that contribute to a nation's capacity to develop, produce, and market new technology.
- **Productive capacity** – This indicator evaluates the strength of a nation's current, in-place manufacturing infrastructure as a baseline for assessing its capacity for future growth.

Malaysia's competitiveness as measured in terms of the above indicators is uneven. It scores high for "national orientation", medium for "socioeconomic infrastructure", and low for both "technological infrastructure" and "productive capacity"(See Table 8B below).

Table 8B: Indicators of Technological Competitiveness

Country	National Orientation	Socioeconomic Infrastructure	Technological Infrastructure	Productive Capacity
Hong Kong	74.4	69.6	23.0	43.0
Singapore	92.7	73.3	40.5	54.6
South Korea	81.9	69.6	42.6	46.4
Taiwan	81.1	74.5	37.4	43.1
China	62.3	46.4	38.6	33.2
India	52.4	46.4	33.0	38.6
Indonesia	62.5	49.5	25.3	24.8
Malaysia	81.1	63.7	34.3	47.5
Japan	86.3	72.7	83.7	92.7
USA	69.9	84.0	87.5	89.8

Source : National Science Foundation (1995), Mani (2000)

CHAPTER 9

PUBLIC SUPPORT FOR SCIENCE AND TECHNOLOGY

The important role of science and technology in the economic development of Malaysia can be traced back to the establishment of the Ministry of Science in 1973. Since then progress has been made especially in the mid-1980s culminating in the formation of the first National Science and Technology Policy in 1986. From this point onwards, the government has been strategizing, formulating and fine-tuning, as well as implementing programs that are directed towards building a strong science and technology base for the nation.

The effectiveness of the various incentives and linkages that can be forged between the public and the private sectors will depend, in part, on the understanding of the business community, public institutions and universities about the programs and policies that are in place. In addition, the business community must be aware of the different types of incentives that are made available to them. For policy makers, a need for a reconsideration of new delivery mechanisms for improved efficiency and effectiveness at the different stages of implementation may be desirable.

This chapter attempts to outline some of the major government incentives and assistance that are directed towards strengthening the science and technology base of Malaysia. Institutions that are established to play a specific role in the development of S&T will also be included in this chapter. The objective of this chapter is to provide information on some of the incentives and types of support programs that the government has implemented.

9.1 Tax Incentives

Various tax incentives are available to companies resident in Malaysia. In this section, we will focus only on incentives pertaining to R&D.

In general, the following types of companies (only those related to R&D are listed) and activities are eligible for various tax incentives:

- High technology company;
- Projects of national and strategic importance;

- Contract R&D company (provides R&D services in Malaysia to companies other than its related companies);
- R&D company (provides R&D services in Malaysia to its related companies or any other companies);
- In-house R&D (R&D carried out in Malaysia within a company for the purposes of its own business);
- Integrated agricultural projects;
- Technical or vocational training company; and
- Vendors including small and medium industries (SMIs) that are able to achieve world-class standards.

The types of incentives available include:

- Pioneer status;
- Investment Tax Allowance (ITA);
- Infrastructure allowance;
- Industrial adjustment allowance;
- Abatement of adjusted income in respect of exports;
- Tax exemption for the promotion of exports of goods and services with value-added element; and
- Double deduction for expenses.

The set of incentives applicable to companies vary from one company to another. For example, a contract R&D company which provides R&D services in Malaysia to companies other than its related companies is eligible for pioneer status. However, a R&D company which performs R&D for its related companies, is not. This is to encourage more contract R&D companies to invest in Malaysia.

9.2 Specific S&T-Related institutions, Incentives and Support Programs

9.2.1 Malaysian Institute of Microelectronic Systems (MIMOS)

Established in 1985 when Malaysia was aggressively developing its electronic-based industry, MIMOS *Berhad* remains a premier mission-oriented R&D corporate organization. MIMOS strives to regularly develop indigenous technology and competencies in order to generate new products and services. The main areas for R&D activities include IT policies or strategies, multimedia technology and applications, computing, networking and data communications, and microelectronics. Facilities in MIMOS include several laboratories such as the Computing Laboratory, Microelectronics Laboratory, Networking Laboratory, Real-Time Systems Laboratory, Software Laboratory, Web Laboratory and Security Laboratory. MIMOS, which acts as the secretariat to the National Information Technology Council (NITC), assists the Government in the implementation of its strategy to transform Malaysia into a knowledge society via a tri-sector partnership – public, private, and community interest groups.

9.2.2 Multimedia Super Corridor (MSC)

MSC companies that operate in Cyberjaya will be able to enjoy the full range of incentives and benefits of the Multimedia Super Corridor, backed by the Malaysian Government's Bill of Guarantees. The institution responsible for the administration of incentives under the MSC is the Multimedia Development Corporation. A whole range of incentives and benefits are aimed at encouraging the growth of the IT industry in Malaysia.

Bill of Guarantees

The Malaysian Government commits the following under the Bill of Guarantees to MSC companies:

1. Provide a world-class physical and information infrastructure;
2. Allow unrestricted employment of local and foreign knowledge workers;
3. Ensure freedom of ownership by exempting companies with MSC status from local ownership requirements;
4. Give the freedom to source capital globally for MSC infrastructure and the right to borrow funds globally;
5. Provide competitive financial incentives, including no income tax for up to ten years or an Investment Tax Allowance, and no duties on the importation of multimedia equipment;
6. Become a regional leader in intellectual property protection and cyberlaws;
7. No censorship of the Internet;
8. Provide globally competitive telecommunication tariffs;
9. Tender key MSC infrastructure contracts to leading companies willing to use the MSC as their regional hub; and
10. Provide a high-powered agency to act as an effective one stop super shop.

Financial Incentives

MSC-status companies may enjoy the following financial incentives:

- Five-year exemption from Malaysia income tax, renewable to 10 years or a 100% Investment Tax Allowance (ITA) on new investments made in MSC Cybercities;
- Duty-free importation of multimedia equipment; and
- R&D grants for local small and medium-size enterprises (SMEs).

Non-Financial Incentives

MSC-status companies will enjoy the following non-financial incentives:

- Unrestricted employment of foreign knowledge workers;
- Freedom of ownership;
- Freedom to source capital globally for MSC infrastructure and the right to borrow funds globally; and
- Other MSC benefits such as intellectual property protection and a comprehensive framework of cyberlaws, green environment protected by strict zoning.

9.2.3 Malaysian Technology Development Corporation (MTDC)

MTDC is a joint-venture company between the private sector and the Government. The objectives of MTDC can be summarized as "Research for Innovation for Applications". The main functions of MTDC are the promotion of commercialization of local research results, introduction of strategic technologies and the manufacture of products widely used as industrial inputs. Services performed by MTDC can be classified as financial and non-financial. The financial services include:

- Seed financing;
- Start-up financing; and
- Expansion financing.

Non-financial services include:

- Technical consultancy services – "packaging" of research findings with feasibility studies and business planning, assistance to companies to absorb new technologies through technology transfer; and
- Technical support services – evaluation of equipment, implement productivity improvements, registration of patents and industrial design.

Various grants are administered by MTDC. The Technology Acquisition Fund (TAF) and Commercialization of R&D Fund are highlighted below.

Technology Acquisition Fund (TAF)

Established under the Ministry of International Trade and Industry, TAF's role is to facilitate the acquisition of strategic and relevant technologies by the industrial sector. The fund provides partial funding to further promote efforts by the private sector to enhance their technology level and production processes. On the whole, TAF strives to enhance the competitiveness of Malaysian firms.

Provision of funding covers the following areas:

- *Purchase of High-Tech Equipment and Machinery*

  Approved activities include the purchase of machinery and equipment for high-technology industries as listed in the list of promoted activities and products for high-technology companies under the Promotion of Investment Act 1986, and multimedia and other strategic industries as approved by the government. A maximum of 50% of the total cost of machinery or equipment can be granted.

- *Technology Licensing*

  TAF provides funding to enable the acquisition of technology through licensing to enhance the design and production of new and existing products and processes. The fund provides a partial grant of up to 70% of the total cost involved in the initial payment of the licensing fees.

- *Acquisition of Patent Rights, Prototypes and Design*

  This is to facilitate the transfer of technology to local companies so as to enable them to develop new processes and products. The activities that are eligible for funding include the procurement of patents/manufacturing rights and registered design and procurement of prototypes and its related technology transfer to facilitate the physical development of new products. The fund provides a partial grant of up to a maximum of 70% of the total cost involved in the acquisition of patent rights, prototypes and design.

- *Placement of Malaysians in Foreign Technology Companies and Foreign Technology Institutes*

  The objective of this program is to expose Malaysians to new technologies and to upgrade their knowledge on technology development in foreign technology companies. Activities include job attachment or on-the-job training. The funding for this program is partial restricted to not more than 3 persons for the duration not exceeding three months. The grant that can be dispersed is up to a maximum of 50% of total cost or RM30,000, which ever is lower for each person.

- *Expert Sourcing Program*

  This is to assist firms in engaging foreign technical experts and consultants to upgrade their products and processes. The grant is partial, up to a maximum of 50% of the total cost or RM30,000, whichever is lower.

- *Information Dissemination Seminars/Workshops*

  The aim is to assist industry associations and chambers of commerce to engage foreign expert advice in upgrading the current technological capability of its member companies. The amount of grants has a limit of a maximum of RM50,000 and are disbursed to industry associations or chambers of commerce to help organize technical workshops/seminars.

<u>*Commercialization of R&D Fund*</u>

The objectives of the fund are as follows:

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

In order to obtain assistance from this fund, companies must be local-controlled companies, i.e., more than 50% equity are owned by Malaysians. In addition, collaboration with local research institutions and universities are encouraged.

Eligible commercialization activities include any stage in a series of activities that are geared towards commercialization. The amount of funding varies with each stage. The stages are as follows:

- *Phase I: Market Survey and Research*

  The objective here is to assist in the evaluation of the market potential of the proposed product/process for commercialization. The fund provides a partial grant to a maximum of 50% of the total cost involved in market survey and research.

- *Phase II: Product/Process Design and Development*

  The fund provides a partial grant to a maximum of 50% of the total cost involved in product/process design and development. Funding does not include capital expenditure.

- *Phase III: Standards and Regulation Compliance and Intellectual Property Protection*

  The fund provides a partial grant to a maximum of 70% of the total cost involved in the process of meeting established standards and regulations and in intellectual property protection.

9.2.4 Intensification of Research in Priority Areas Program (IRPA)

The IRPA is a core program of the Ministry of Science, Technology and the Environment. The IRPA system was first established in 1987 during the implementation of the nation's Fifth Malaysia Plan with the objective of selecting and coordinating R&D activities in the public sector. Industrial sub-sectors and research areas in high technology such as microelectronics, laser technology and electro-optics, biotechnology, material technology, manufacturing technology and software technology were identified as growth areas for the country's economic development and progress.

Under the Seventh Malaysia Plan, RM935 million was allocated for R&D. This program is extended to the private sector through the Industry R&D Grant Scheme (IGS), Multimedia Super Corridor R&D Grant Scheme (MGS), and the Demonstrator Application Grant Scheme (DAGS).

Industrial R&D Grant Scheme (IGS)

This scheme was launched in 1997 and is opened to the private sector for funding of R&D projects. The objectives of the scheme are:

- To encourage Malaysian companies to be more innovative in using and adapting existing technologies and creating new technologies, products and processes which will benefit the economy;
- To strengthen national competitiveness in the global markets;
- To promote closer cooperation through joint-ventures and institutional linkages between the private sector and public sector universities and research institutes; and
- To encourage strategic global and regional linkages in R&D to enhance indigenous technology development.

Priority is given to proposals relating to advanced manufacturing, advanced materials, microelectronics, information technology, multimedia technology, biotechnology, aerospace as well as the 22 industrial clusters identified in the Second Industrial Master Plan (IMP2), and targeted technologies under the Seventh Malaysia Plan.

Demonstrator Application Grant Scheme (DAGS)

This scheme is set up with the objective of encouraging Malaysians to adapt and customize existing IT and multimedia technologies in applications so as to make them compatible with local culture. It also seeks to promote the development of software and content industries for greater competitiveness of Malaysian industries in the global market. The three schemes – IGS, MSC R&D Grant Scheme and DAGS, are aimed at enhancing the competencies of Malaysian firms in the rapidly evolving information and communication technology (ICT) industry.

Demonstrator Applications (DAGS) are small, focused and short-term projects aimed at creating, developing and promoting new applications. Funding of up to 70% of project cost will be provided. Priority is given to projects in areas of e-learning, e-economy, e-community, e-public services and e-sovereignty.

9.2.5 Industrial Technical Assistant Fund (ITAF)

This fund was established in 1990 with the aim of providing financial assistance to small and medium scale industries (SMIs) in the form of matching grants for consultancy studies, product design and development, quality and productivity improvements and market development.

This scheme provides matching grants to SMIs for:

- Quality improvement;
- Development of product;
- Quality based on customer's requirements;
- Factory auditing;
- Documentation of Quality System Certification;
- Total quality management scheme (TQM); and
- Other quality development systems.

Process and Product Development Upgrading Scheme

This is an assistance scheme in the form of a matching grant to SMIs to improve and upgrade indigenous technology through the development of new products, designs and processes. The maximum grant allocated per company is RM250,000. Assistance is in the form of a matching grant where 50% of the project cost is borne by the Government and the applicant is responsible for the remainder of the project cost.

The types of expenses that are eligible for funding are as follows:

- Consultancy costs;
- Costs of acquiring technology and skills through training;
- Service cost for related schemes, testing and calibration;
- Cost of testing materials and developmental equipment used in designing and prototypes; and
- Other cost as per contract.

Productivity and Quality improvement and Certification Scheme

This is an assistance scheme in the form of a matching grant to SMIs to upgrade productivity and quality, and to achieve international standards and certification. The scheme provides matching grants to SMIs for quality improvement, development of product, factory auditing, and total quality management scheme.

The types of expenses that qualify for assistance include consultancy costs, cost of acquiring technology and skills through training, service costs for related schemes, testing and calibration, and cost of testing materials and development equipment.

9.2.6 S&T Human Resource Development Programs

Concerted efforts have been made to develop the critical mass of skilled and technical S&T manpower required to support the development strategies of the Second Industrial Master Plan. The key S&T human resource development programs implemented are as follows:

- Science and Technology Human Resource Development Fund (S&T HRD Fund);
- Post-graduate and Post-doctoral Training Program;
- Teaching Company Scheme (TCS); and
- Recruitment of Malaysian Scientist Abroad and Foreign Scientist Scheme.

Science and Technology Human Resource Development Fund (S&T HRD Fund)

Introduced in 1997 with an allocation of RM300 million under the Seventh Malaysia Plan, this fund seeks to create a pool of skilled and trained manpower among professionals as well as among supporting staff of government departments, public research institutions, universities and Government corporatized institutions. Priority is given to critical technologies such as industrial design, IT and others mentioned above. The Fund supports training programs that include formal courses, short courses/attachments, appointment of local/foreign consultants for training purposes as well as Science Awareness Programs for science teachers.

9.2.7 Malaysian Industry-Government Group for High Technology (MiGHT)

Launched in 1993, MiGHT is a non-profit company limited by guarantee. Its role is to carry out the process of prospecting and identifying business and investment opportunities for industry, to identify research priorities for public and private research initiatives, to mobilize and manage technology efforts (which are considered to be beyond the resources of individual organization), and to provide strategic direction in the development of human resource capability. MiGHT brings together private sector companies and relevant government agencies in the form of smart partnership for "co-prosperity". It also serves as a platform for interaction between both the private sector and their public sector counterpart.

9.2.8 Malaysian Institute for Nuclear Technology Research (MINT)

The main objectives of MINT are to expand market and diversity applications of nuclear and related technologies, to achieve excellence in research, application and management of nuclear and related technologies, and to achieve self-financing targets. The focus of MINT is on the commercialization of technology.

MINT-Tech Park

The establishment of the MINT-Tech Park has enabled MINT to provide infrastructure and facilities to enhance commercialization of R&D. It provides clients with access to its laboratories and centers of excellence. The Park aims:

- To focus on technologies that possess high commercial potential by building appropriate pilot plants;
- To enhance MINT's competitive advantages and capability in developing new technologies from conception of idea to the design and construction of pilot plants; and
- To facilitate the establishment of a clearly defined physical area where appropriate tax incentives can be extended to entrepreneurs.

9.2.9 Technology Park Malaysia (TPM)

Established in 1988 under the Ministry of Science, Technology and the Environment and corporatized in 1996, Technology Park Malaysia is one of the World's most advanced and comprehensive centers for research and development for knowledge-based industries. It is designed to propel Malaysia into the Information Age. The first phase of its development consists of 12 state-of-the-art buildings with specific functions while the second phase will include a Multimedia Centre which is a cluster of intelligent buildings to service the physical needs of multimedia companies so as to enable them to be service providers to the Multimedia Super Corridor, the rest of Malaysia and the world. The planned Phase 3 involves leasing of R&D lots to individual companies to establish custom-designed head offices, research facilities, test sites and planned future expansions.

The objectives of TPM are as follows:

- To facilitate private sector R&D and innovation;
- To participate in the commercialization of research results and innovation;
- To facilitate government and private sector smart partnership in technology development;
- To provide support in marketing, management and technical fields to tenant companies;
- To create a conducive environment in order to stimulate a knowledge-based community; and
- To participate in wealth creation through technology.

Technologies that promise future potentials are the priorities of TPM. They include: information technology, advanced materials, aerospace advance system, biotechnology, biomedical technology, environment and pollution, multimedia, software development, telecommunication, and others. As information technology is the technology that drives the Information Age, the majority of the companies located in TPM are in IT-related businesses. At the same time, opportunities exist for companies that provide support services to these companies. They include banking service, medical service and other types of services.

In terms of infrastructure, facilities and services, a comprehensive range of facilities can be found. They include resource centers, buildings and land that include innovation house, incubator center, incubator house and R&D lots. In addition, a center known as the Master Centre is created to provide services and consultancy in areas such as design, prototyping and manufacturing, engineering, technical consultancy, robotics and flexible manufacturing system. Since IT is the strategic focus of Malaysia, an IT and Multimedia Centre is established that houses R&D lab, multimedia lab, multimedia studios, data warehousing, and training and consultancy.

In summary, there are a variety of incentives and assistance in place in Malaysia, ranging from general to specific types of incentives designed to encourage R&D. For fields of research that the Government has identified as strategic, an abundance of incentives, financial and non-financial, are made available so as to direct resources to these areas. This is necessary in order to enable the nation to "leap frog" in technological development in these areas, thus enhancing the competitiveness of the country.

Although the Government offers various financial incentives and assistance such as in the form of seed money and grants as well as the indirect incentives in the form of tax rebates and pioneer status, the adequacy of these incentives needs to be assessed. At the moment, the involvement of the financial community with regards to the funding of R&D can be to be considered low. Due to the nature of high-technology ventures (capital and manpower intensive in highly-skilled areas), a greater involvement of the financial institutions is expected. Hence, the future development of R&D incentives should take into account a bigger role for the financial community, in addition to the present set of fiscal and monetary incentives.

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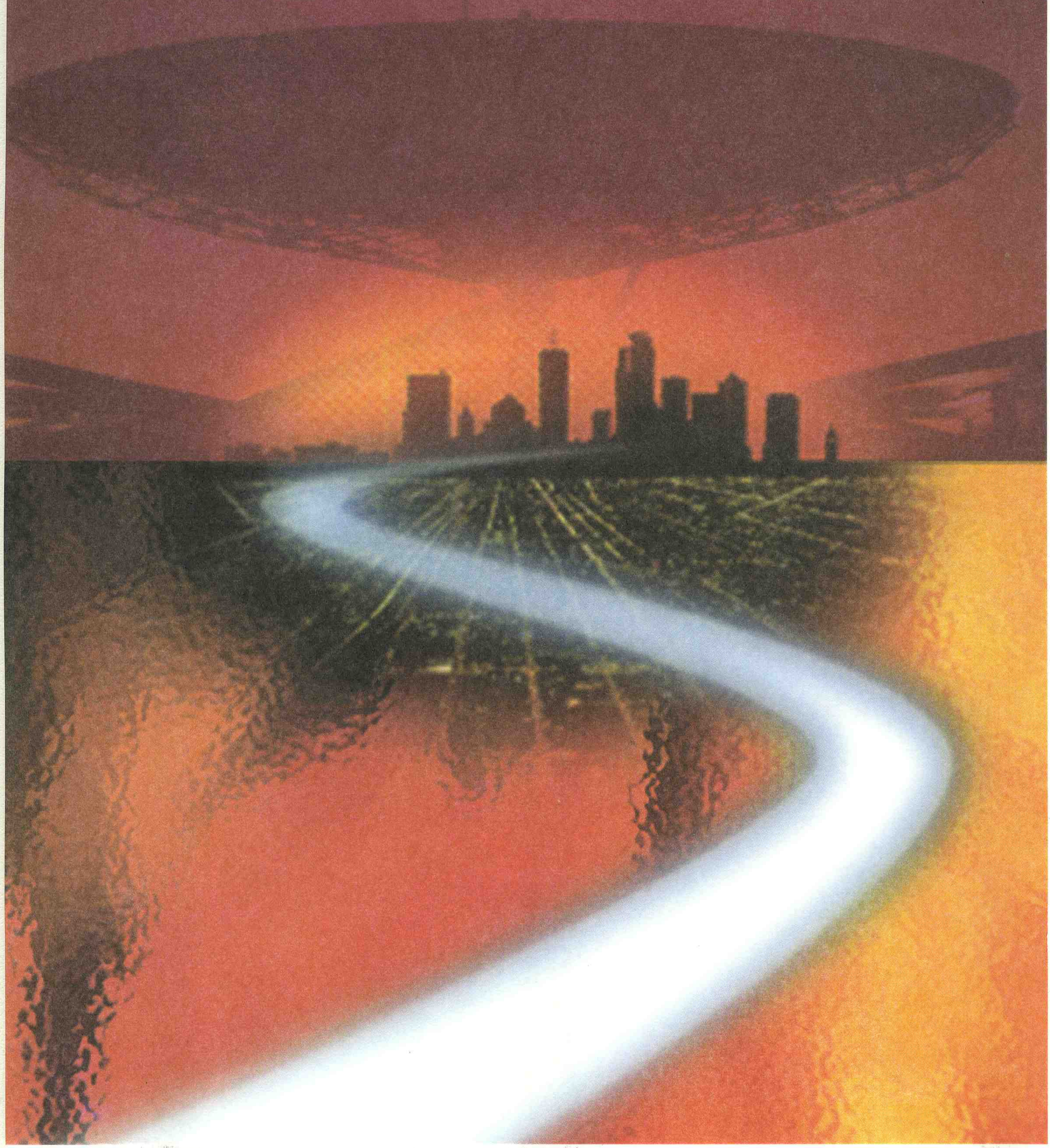

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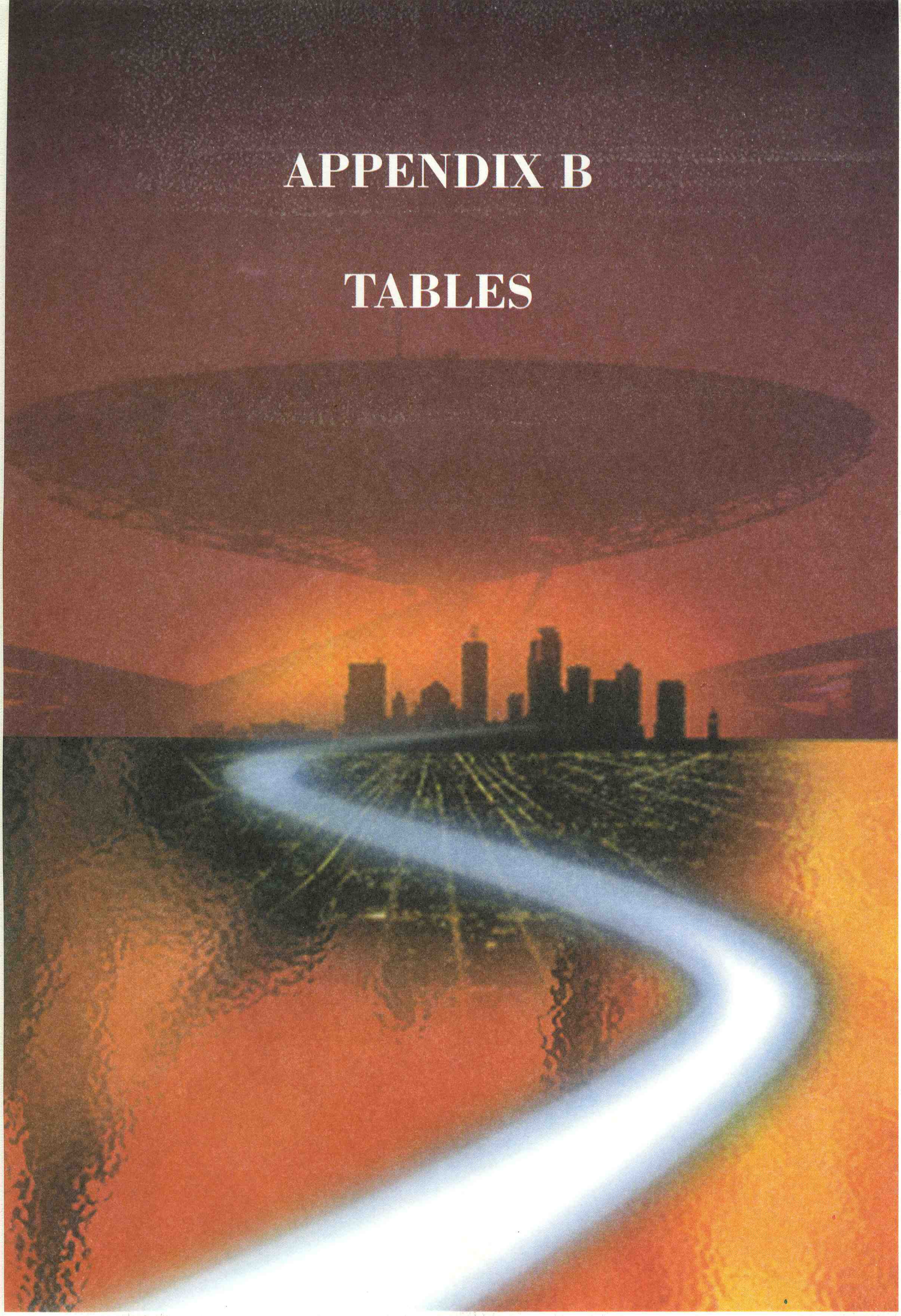

Table 3.1: OECD's Classification Scheme for Field of Study in Education

Aggregated Field of Study	ISCED no.	Field of Study
Natural Sciences	42	Natural science
	46	Mathematics and computer science
Engineering and Technology	54	Engineering
	58	Architecture and town planning
	52	Trade, craft and industrial programs
	70	Transport and communications
Medical Sciences	50	Medical science and health related
Agricultural Sciences	62	Agriculture, forestry and fishery
Social Sciences	38	Law
	30	Social and behavioral science
	34	Commercial and business administration
	84	Mass communication and documentation
	66	Home economics (domestic science)
Humanities	22	Humanities
	26	Religion and Theology
	18	Fine and Applied Arts
Other Fields	1	General programs
	14	Education science and teacher training
	78	Service trades
	89	Other programs

Source : OECD

Table 3.2: Student Registration for the SPM and STPM Examinations, 1999.

SPM Level - Subject	No of Students
Mathematics	291,471
Science	210,994
Additional Maths	86,975
Physics	79,554
Chemistry	81,618
Biology	62,191
Additional Science	3,614
Total Number of students	**293,476**

STPM Level - Subject	No. of Students
Advanced Mathematics	2,275
Physics	7,806
Chemistry	7,870
Biology	5,693
Computer Science	655
Total Number of Students	**43,331**

Note: NSE nec - Natural Sciences and Engineering, not elsewhere classified
SSH nec - Social Sciences and Humanities, not elsewhere classified
Source: Ministry of Education and Board of Examination Malaysia.

Table 3.3: First Degree Enrolment in Public Educational Institutions, 1992-98

Field of Study	Academic Year					
	1992/1993	**1993/1994**	**1994/1995**	**1995/1996**	**1996/97**	**1997/98**
Natural Sciences	6,354	5,946	8,198	8,374	4,228	4,660
Engineering & Technology	9,571	11,128	9,814	11,798	18,992	25,192
IT & Computer Science	1,901	2,382	2,353	2,530	5,069	6,857
Medical Sciences	2,713	2,824	2,859	3,225	3,962	4,701
Agricultural Sciences	2,444	2,618	2,032	2,169	2,373	3,124
NSE nec	-	41	-	-		
Sub total NSE	**22,983**	**24,939**	**25,256**	**28,096**	**34,624**	**44,534**
Social Sciences	23,605	25,801	29,393	30,328	32,643	39,490
Humanities	6,388	7,466	16,272	18,584	19,902	23,038
SSH nec	5,371	5,793	3,788	4,094	-	
Sub Total SSH	**35,364**	**39,060**	**49,453**	**53,006**	**52,545**	**62,528**
Total All Fields	**58,347**	**63,999**	**74,709**	**81,102**	**87,169**	**107,062**

Source : Ministry of Education, complied and reclassified by MASTIC.

Table 3.4: Graduation for First Degree Courses at Public Educational Institutions, 1994-98

Field of Study	Academic Year			
	1994/1995	**1995/1996**	**1996/1997**	**1997/98**
Natural Sciences	2,264	2,560	1,065	971
Engineering and Technology	2,137	2,322	2,972	3,547
IT & Computer Science	71	163	698	1,002
Medical Sciences	587	562	519	698
Agricultural Sciences	529	580	821	654
Social Sciences	5,713	6,733	6,848	7,042
Humanities	3,095	3,324	4,017	5,058
Total All Fields	**14,396**	**16,244**	**16,940**	**18,972**

Sources : Ministry of Education, Complied and reclassified by MASTIC.

Table 3.5: Enrolment in Master Degree Courses at Public Educational Institutions, 1992-98

Field of Study	No. of Students					
	Academic Year					
	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98
Natural Sciences	401	470	549	425	300	526
Engineering & Technology	354	397	548	608	486	1,252
IT & Computer Sciences	73	90	6	53	69	404
Medical Sciences	615	756	780	974	344	1,020
Agricultural Sciences	88	101	101	104	248	448
NSE nec						
Sub total NSE	**1,531**	**1,814**	**1,984**	**2,164**	**1,447**	**3,650**
Social Sciences	1,159	1,252	1,687	2,168	1,770	4,575
Humanities	350	545	551	797	889	1,560
SSH nec	368	390	382	7	-	-
Sub Total SSH	**1,877**	**2,187**	**2,620**	**2,972**	**2,659**	**6,135**
Total All Fields	**3,408**	**4,001**	**4,604**	**5,136**	**4,106**	**9,785**

Note: NSE nec - Natural Sciences and Engineering, not elsewhere classified
SSH nec - Social Sciences and Humanities, not elsewhere classified

Source : Ministry of Education, compiled and reclassified by MASTIC.

Table 3.6: Doctoral Degree Enrolment at Public Educational Institutions, 1992-98

Field of Study	No. of Students					
	Academic Year					
	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98
Natural Sciences	125	129	165	345	38	160
Engineering & Technology	75	89	87	131	89	327
IT & Computer Science	11	15	6	36	7	46
Medical Sciences	35	38	39	56	14	66
Agricultural Sciences	58	74	56	55	47	150
Sub total NSE	**304**	**345**	**353**	**623**	**195**	**749**
Social Sciences	166	177	202	230	149	610
Humanities	94	97	215	402	97	287
SSH nec	88	97	-	-	-	-
Sub Total SSH	**348**	**371**	**417**	**632**	**246**	**897**
Total All Fields	**652**	**716**	**770**	**1,255**	**441**	**1,646**

Note: NSE nec - Natural Sciences and Engineering, not elsewhere classified
SSH nec - Social Sciences and Humanities, not elsewhere classified

Table 3.7: Graduation for Master Level Degree Courses at Public Educational Institutions, 1994-98

Field of Study	Academic Year			
	1994/1995	1995/1996	1996/1997	1997/98
Natural Sciences	82	85	300	230
Engineering and Technology	45	62	486	652
IT & Computer Science	0	9	69	284
Medical Sciences	148	179	344	516
Agricultural Sciences	16	18	248	302
Social Sciences	231	369	1,770	1,925
Humanities	77	98	889	1,022
Total All Fields	**599**	**820**	**4,106**	**4,931**

Sources : Ministry of Education, Complied and reclassified by MASTIC.

Table 3.8: Graduating Students in Doctoral Courses at Public Educational Institutions, 1994-98

Field of Study	Academic Year			
	1994/1995	1995/1996	1996/1997	1997/98
Natural Sciences	15	17	38	63
Engineering and Technology	10	9	89	72
IT & Computer Science	0	1	7	12
Medical Sciences	3	6	14	9
Agricultural Sciences	1	5	47	41
Social Sciences	15	18	149	181
Humanities	18	15	97	134
Total All Fields	**62**	**71**	**441**	**512**

Sources : Ministry of Education, Complied and reclassified by MASTIC.

Table 3.9: Enrolment in First Degree Courses at Private Educational Institutions, 1999

Field of Study	No. of Students	Percentage
Engineering & Technology	4,093	14.7
IT & Computer Science	7,001	25.1
Social Sciences	11,939	42.4
Others	4,851	17.4
Total	**27,883**	**100.0**

Note:

1. Enrolment for first degree courses comprise of students undertaking 3+0 programs and other twinning programs (2+1,2+2,1+2)
2. Data collected from 290 private institutes of higher learning as at 31 December 1999.

Source: Ministry of Education, compiled and reclassified by MASTIC

Table 4.1a: Human Resource in R&D, 1992-1998

	1992	1994	1996	1998
Researchers per 10,000 labour force	2.1	5.8	5.1	7.0
Researchers per 10,000 population	-	2.3	2.0	2.8
Headcount (Researchers, Technicians & Others)	-	11,472	9,233	12,127
Full Time Equivalent (FTE)	**4,562.90**	**6,675.60**	**4,436.90**	**6,656.33**

Source: 1998 National Survey of Research and Development, MASTIC

Table 4.1b: R&D Personnel by Sector, 1992-1998

Sector	Researchers		R&D Personnel*		Researchers		R&D Personnel*	
	FTE	Headcount	FTE	Headcount	FTE	Headcount	FTE	Headcount
	1992				1994			
Private Sector	393.5	-	1,077.9	-	1,116.7	1,416	2,500.1	3,164
GRIs	720.4	-	2,330.4	-	768.0	2,020	3,660.5	6,850
IHLs	519.2	-	1,154.6	-	383.2	1,075	492.0	1,417
NPOs	-	-	-	-	18.8	34	23.0	41
Total	1,633.1	-	4,562.9		2,286.7	4,545	6,675.6	11,472
	1996				1998			
Private Sector	1,026.4	1,342	2,349.5	3245	1,996.9	2,287	3,546.9	4,158
GRIs	471.9	1,524	1,567.1	4231	741.0	1,987	2,193.2	5,234
IHLs	395.4	1,377	520.3	1757	677.9	1,975	916.2	2,735
NPOs	-	-	-	-	-	-	-	-
Total	1,893.7	4,243	4,436.9	9233	3,415.8	6,249	6,656.3	12,127
	Percentage Change 1992-1994				Percentage Change 1994-1996			
Private Sector	183.8	-	131.9	-	-8.1	-5.2	-6	2.6
GRIs	6.6	-	57.1	-	-38.6	-24.6	-57.2	-38.2
IHLs	-26.2	-	-57.4	-	3.2	28.1	5.7	24
NPOs	-	-	-	-	-	-	-	-
Total	40.0	-	46.3	-	-17.2	-6.6	-33.5	-19.5
	Percentage Change 1996-1998							
Private Sector	94.6	70.4	51.0	28.1				
GRIs	57.0	30.4	40.0	23.7				
IHLs	71.4	43.4	76.1	55.7				
NPOs	-	-	-	-				
Total	80.4	47.3	50.0	31.3				

Notes : * R&D Personnel comprised of researchers, technicians and other R&D support staff
Source: 1996 Malaysian Science and Technology Indicators Report

...continue

Sector	Researchers		R&D Personnel*	
	FTE	Headcount	FTE	Headcount
	Percent of Total 1994			
Private Sector	48.8	31.2	37.5	27.6
GRIs	33.6	44.4	54.8	59.7
IHLs	16.8	23.7	7.4	12.4
NPOs	0.8	0.7	0.3	0.4
Total	100.0	100.0	100.0	100.0
	Percent of Total 1996			
Private Sector	54.2	31.6	53.0	35.1
GRIs	24.9	35.9	35.3	45.8
IHLs	20.9	32.5	11.7	19.0
NPOs	-	-	-	-
Total	100.0	100.0	100.0	100.0
	Percent of Total 1998			
Private Sector	58.5	36.6	53.3	34.3
GRIs	21.7	31.8	32.9	43.2
IHLs	19.8	31.6	13.8	22.6
NPOs	-	-	-	-
Total	100.0	100.0	100.0	100.0

Ratio of Researchers/R&D Personnel, FTE and Headcount 1994, 1996 and 1998

	FTE			Headcount		
	1994	1996	1998	1994	1996	1998
Private Sector	0.4	0.4	0.6	0.4	0.4	0.6
GRIs	0.2	0.3	0.3	0.1	0.4	0.4
IHLs	0.8	0.8	0.7	0.8	0.8	0.7
NPOs	0.8	-	-	0.8	-	-
Total	0.3	0.4	0.5	0.4	0.5	0.5

Ratio of FTE/Headcount for Researchers and R&D Personnel 1994, 1996 and 1998

	Researchers			R&D Personnel*		
	1994	1996	1998	1994	1996	1998
Private Sector	0.8	0.8	0.9	0.8	0.7	0.6
GRIs	0.4	0.3	0.4	0.5	0.4	0.4
IHLs	0.4	0.3	0.3	0.4	0.3	0.7
NPOs	0.6	-	-	0.6	-	-
Total	0.5	0.4	0.5	0.6	0.5	0.5

Notes : * R&D Personnel comprised of researchers, technicians and other R&D support staff
Source: 1996 Malaysian Science and Technology Indicators Report, MASTIC

Table 4.2a: R&D Personnel (Headcount and FTE) by Sector by Category and Gender, 1998

R&D Personnel (Headcount)																
Sector	Researcher					Technician					Others					Total
	Male	%	Female	%	Total	Male	%	Female	%	Total	Male	%	Female	%	Total	
GRI	1,384	69.65	603	30.35	1,987	581	70.00	249	30.00	830	2,035	84	382	16	2,417	5,234
IHL	1,213	61.42	762	38.58	1,975	205	86.50	32	13.50	237	308	59	215	41	523	2,735
Private	1,799	78.66	488	21.34	2,287	514	81.59	116	18.41	630	697	56	544	44	1,241	4,158
Total	**4,396**	**70.35**	**1,853**	**29.65**	**6,249**	**1,300**	**76.61**	**397**	**23.39**	**1,697**	**3,040**	**73**	**1,141**	**27**	**4,181**	**12,127**
R&D Personnel (FTE)																
Sector	Researcher					Technician					Others					Total
	Male	%	Female	%	Total	Male	%	Female	%	Total	Male	%	Female	%	Total	
GRI	496.07	66.95	244.92	33.05	740.99	268.32	73.54	96.53	26.56	364.85	912.77	83.94	174.57	16.06	1,087.34	2,193.18
IHL	412.71	60.89	265.14	39.11	677.85	59.24	16.08	11.35	16.08	70.59	94.22	56.15	73.57	43.85	167.79	916.23
Private	1,571.25	78.68	425.68	21.32	1,996.93	427.89	19.40	102.97	19.40	530.86	575.63	56.48	443.50	43.52	1,019.13	3,546.92
Total	**2,480.03**	**72.61**	**935.74**	**27.39**	**3,415.77**	**755.45**	**78.18**	**210.85**	**21.82**	**966.30**	**1,582.62**	**69.59**	**691.64**	**30.41**	**2,274.26**	**6,656.33**

Source: 1998 National Survey of Research and Development, MASTIC

Table 4.2b: Researchers (Headcount) by Sector, Qualification and Gender, 1998

Sector	Qualification												Total
	Ph.D			Masters			Bachelor			Non-Degree			
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
Private Sector	114 (87.7)	16 (12.3)	130 (100.0)	232 (82.0)	51 (18.0)	283 (100.0)	1196 (76.5)	367 (23.5)	1563 (100.0)	257 (82.7)	54 (17.3)	311 (100.0)	2287
GRI	422 (79.3)	110 (20.7)	532 (100.0)	529 (69.7)	230 (30.3)	759 (100.0)	360 (63.6)	206 (36.4)	566 (100.0)	73 (56.2)	57 (43.8)	130 (100.0)	1987
IHL	612 (75.3)	212 (24.7)	824 (100.0)	254 (56.3)	197 (43.7)	451 (100.0)	256 (52.8)	229 (47.2)	485 (100.0)	91 (42.3)	124 (57.7)	215 (100.0)	1975
Total	**1148** **(77.3)**	**338** **(22.7)**	**1486** **(100.0)**	**1015** **(68.0)**	**478** **(32.0)**	**1493** **(100.0)**	**1812** **(69.3)**	**802** **(30.7)**	**2614** **(100.0)**	**421** **(64.2)**	**235** **(35.8)**	**656** **(100.0)**	**6249**

Note: Grand Total Female Researchers (Headcount) = 1853 (29.7%)
Grand Total Male Researchers (Headcount) = 4396 (70.3%)

Source: 1998 National Survey of Research and Development, MASTIC

Table 4.2c: Researchers (FTE) by Sector, Qualification and Gender, 1998

Sector	Qualification												Total
	Ph.D			Masters			Bachelor			Non-Degree			
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
Private Sector	85.34 (85.9)	14.00 (14.1)	99.34 (100.0)	197.52 (81.7)	44.12 (18.3)	241.64 (100.0)	1060.12 (76.8)	319.96 (23.2)	1380.08 (100.0)	228.27 (82.7)	47.60 (17.3)	275.87 (100.0)	1996.93
GRI	134.13 (73.7)	47.97 (26.3)	182.10 (100.0)	184.45 (69.6)	80.61 (30.4)	265.06 (100.0)	145.04 (62.6)	86.80 (37.4)	231.84 (100.0)	32.45 (52.4)	29.54 (47.6)	61.99 (100.0)	740.99
IHL	159.68 (75.0)	53.19 (25.0)	212.87 (100.0)	102.90 (65.8)	53.55 (34.2)	156.45 (100.0)	126.48 (49.2)	130.46 (50.8)	256.94 (100.0)	23.65 (45.8)	27.94 (54.2)	51.59 (100.0)	677.85
Total	**379.15 (76.7)**	**115.16 (23.3)**	**494.31 (100.0)**	**484.87 (73.1)**	**178.28 (26.9)**	**663.15 (100.0)**	**1331.64 (71.3)**	**537.22 (28.7)**	**1868.86 (100.0)**	**284.37 (73.0)**	**104.99 (27.0)**	**389.36 (100.0)**	**3415.77**

Note: Grand Total Female Researchers (FTE) = 935.65 (27.4%)
Grand Total Male Researchers (FTE) = 2480.03 (72.6%)

Source: 1998 National Survey of Research and Development, MASTIC

Table 4.3: Number of Researchers (Headcount) by Type of Research and Nationality, 1998

Type of Research	R&D Researchers									Total
	GRI			IHL			Private Sector			
	Malaysian	Foreign	Total	Malaysian	Foreign	Total	Malaysian	Foreign	Total	
Basic Research	271	18	289	444	40	484	54	14	68	849
Applied Research	981	14	995	485	42	527	816	135	951	2,473
Experimental Development	139	5	144	98	14	112	515	48	563	819
Basic & Applied Res.	178	-	178	230	24	254	4	-	4	436
Basic Res. & Experimental Dev.	15	-	15	65	2	67	31	3	34	116
Applied Res. & Experimental Dev.	196	-	196	35	3	38	350	33	383	617
All types	159	11	170	441	52	493	248	36	284	947
Total	**1,939**	**48**	**1,987**	**1,798**	**177**	**1,975**	**2,018**	**269**	**2,287**	**6,249**

Note: Data on FTE are not available

Source: 1998 National Survey of Research and Development, MASTIC

Table 4.4: Number of Researchers (Headcount) by Field of Research (FOR) and Qualification, 1998

FOR Code	Field of Research	GRI					IHL					Private					Grand Total
		Ph.D	Masters	Bachelor	Non degree	Total	Ph.D	Masters	Bachelor	Non degree	Total	Ph.D	Masters	Bachelor	Non degree	Total	
F10100	Mathematical Sciences	-	-	-	-	-	9	1	6	-	16	-	-	-	-	-	16
F10200	Physical Sciences	2	1	1	-	4	29	13	16	2	60	-	3	11	-	14	78
F10300	Chemical Sciences	8	5	6	-	19	81	15	38	42	176	3	7	29	4	43	238
F10400	Earth Sciences	7	4	10	-	21	30	4	11	-	45	-	-	-	-	-	66
F10500	Information Comp. & Comm. Tech	35	61	147	88	331	57	56	51	8	172	26	73	404	65	568	1,071
F10600	Appi.Sci & Technologies	31	42	33	6	112	42	3	22	13	80	38	76	399	82	595	787
F10700	Engineering Sciences	52	66	49	13	180	47	31	59	19	156	26	72	556	119	773	1,109
F10800	Biological Sciences	107	55	44	4	210	64	38	51	16	169	5	6	13	2	26	405
F10900	Agricultural	185	412	213	17	827	99	71	60	43	273	9	22	55	20	106	1,206
F11000	Medical & Health Sciences	53	35	29	-	117	189	87	99	42	417	15	4	27	1	47	581
F11100	Environmental Sciences	17	23	9	-	49	49	25	32	7	113	4	7	13	3	27	189
F11200	Material Sciences	15	14	10	1	40	27	5	7	17	56	3	11	40	12	66	162
F11300	Marine Sciences	-	1	-		1	-			-	-	-	-	3	-	3	4
F20100	Social Sciences	20	40	15	1	76	91	83	28	6	208	1	2	13	3	19	303
F20200	Humanities	-	-	-	-	-	10	19	5		34	-	-	-	-	-	34
Total		532	759	566	130	1,987	824	451	485	215	1,975	130	283	1,563	311	2,287	6,249
% of Total		26.8	38.2	28.5	6.5	100.0	41.7	22.8	24.6	10.9	100.0	5.7	12.4	68.3	13.6	100.0	100.0

Source: 1998 National Survey of Research and Development, MASTIC

Table 4.5: Number of Researchers (Headcount) by Socio-economic Objectives (SEO) and Qualification, 1998

SEO Code	Socio-economic Objective	GRI					IHL					Private				
		Ph.D	Masters	Bachelor	Non degree	Total	Ph.D	Masters	Bachelor	Non degree	Total	Ph.D	Masters	Bachelor	Non degree	Total
S10100	Defence	2	3	18	5	28	3	-	-	-	3	5	3	10	7	25
S20100	Plant Prod. & Prim. Prod.	194	367	177	18	756	33	11	12	10	66	11	25	64	20	120
S20200	Animal Prod. & Prim. Prod.	35	50	31	-	116	9	-	4	-	13	-	-	-	-	-
S20300	Mineral Resources	-	1	6	-	17	107	33	72	25	237	-	-	-	1	1
S20400	Energy Resources	2	-	2	-	4	5	2	2	3	12	28	65	139	6	238
S20500	Energy Supply	-	-	-	-	-	-	-	-	-	-	1	-	3	6	10
S20600	Manufacturing	88	123	78	12	301	119	46	70	47	282	52	129	968	222	1,371
S20700	Construction	15	5	2	-	22	13	17	19	2	51	6	-	2	-	8
S20800	Transport	3	7	34	-	44	6	1	5	5	17	-	1	4	-	5
S20900	Info. & Comm. Services	8	18	70	82	178	35	32	32	-	99	19	46	223	32	320
S21000	Commercial Services	-	-	-	-	-	11	10	9	-	30	-	-	-	-	-
S21100	Economic Framework	4	12	15	1	32	42	33	11	6	92	2	2	49	4	57
S21200	Natural Resource	41	50	54	2	147	42	50	28	39	159	-	-	-	1	1
S30100	Health	64	43	40	3	150	164	79	89	19	351	-	-	-	-	-
S30200	Education & Training	1	-	-	-	1	10	21	4	-	35	-	-	-	-	-
S30300	Social Dev. & Com. Services	11	12	-	-	23	3	7	5	2	17	-	1	33	6	40
S40100	Environ. Knowledge	7	6	5	-	18	64	25	26	5	120	-	-	-	-	-
S40200	Environ. Aspects of Dev.	12	7	4	-	23	5	8	7	7	27	-	-	1	-	1
S40300	Environ. Mgt. & Other Aspect	25	30	5	-	60	34	26	24	2	86	4	7	13	3	27
S50100	Natural Sci.Tech. & Engin.	20	25	25	7	77	103	39	58	43	243	2	4	54	3	63
S50200	Social Sci. & Humanities	-	-	-	-	2	16	11	8	-	35	-	-	-	-	-
Total		532	759	566	130	1,987	824	451	485	215	1,975	130	283	1,563	311	2,287

Source: 1998 National Survey of Research and Development, MASTIC

Table 4.6: Private Sector R&D Personnel (Headcount and FTE) by Nationality, 1996-98

	Headcount				Total		Ratio of Local/Foreign		FTE				Total		Ratio of Local/Foreign	
	Local		Foreign						Local		Foreign					
	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998
Researchers	1,252	2,018	90	269	1,342	2,287	13.91	7.50	969.90	1,759.48	56.55	237.45	1,026.45	1,996.93	17.15	7.41
Technicians	482	619	2	11	484	630	241.00	56.27	340.90	523.71	0.45	7.15	341.35	530.86	757.56	73.25
Others	1,419	1,232	-	9	1,419	1,241	-	136.89	982.14	1,012.90	-	6.23	982.14	1,019.13	-	162.58
Total	**3,153**	**3,869**	**92**	**289**	**3,245**	**4,158**	**34.27**	**13.39**	**2,292.94**	**3,296.09**	**57.00**	**250.83**	**2,349.90**	**3,546.92**	**40.23**	**13.14**

Source: 1996 & 1998 National Survey of Research and Development, MASTIC

Table 4.7: Private Sector R&D Personnel (Headcount) by Nationality, Gender and Industry, 1996-98

Industry	Malaysians												Foreigners												Total Headcount	
	Researchers				Technicians				Others				Researchers				Technicians				Others					
	Male		Female		Male		Female		Male		Female		Male		Female		Male		Female		Male		Female			
	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998
Primary:																										
Agriculture, Livestock & Fishery	111	77	15	27	21	14	18	6	542	204	333	142	3	4	-	1	-	-	-	-	-	-	-	-	1043	475
Mining	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manufacturing:																										
Food Products, Beverages & Tobacco	21	27	14	16	2	25	4	7	23	94	8	63	3	1	-	-	-	-	-	-	-	-	-	-	75	233
Rubber, Plastic Products	57	98	27	42	33	29	6	7	65	40	17	22	5	8	-	-	1	2	-	-	-	4	-	-	211	252
Wood, Paper, Printing and Furniture	15	6	3	3	2	7	-	4	3	43	2	2	-	-	-	1	-	-	-	-	-	-	-	-	25	66
Textiles, Wearing, Apparel, Fur & Leather	10	16	4	4	9	5	3	6	9	41	10	68	5	2	4	3	-	1	-	-	-	-	-	-	54	146
Chemicals & Chemical Products	36	39	30	28	22	22	2	2	26	42	7	30	1	26	1	-	-	1	-	-	-	-	-	-	125	190
Pharmaceutical	3	10	4	19	-	-	-	-	-	8	-	3	-	-	-	-	-	-	-	-	-	-	-	-	7	40
Petroleum Products & Refining	1	97	-	47	1	76	-	8	-	24	-	18	-	4	-	-	-	-	-	-	-	-	-	-	2	274
Non-metallic Mineral Products	26	27	9	8	7	6	2	1	33	31	41	23	4	2	-	-	-	1	-	-	-	-	-	-	122	99
Electrical Machinery & Appliances	44	128	-	59	38	23	2	3	12	5	3	40	1	83	-	1	-	-	-	-	-	-	-	-	100	342
Electronic Equipment & Components	279	386	43	71	106	149	20	39	43	24	53	47	38	35	1	-	1	1	-	-	-	-	-	-	584	752
Transport Equipment	16	94	2	7	16	25	3	1	4	8	3	13	2	9	-	-	-	1	-	-	-	-	-	-	46	158
Basic/Fabricated Metal Products	10	5	-	1	5	7	-	1	30	6	-	-	1	1	-	-	-	-	-	-	-	-	-	-	46	21
Non-Electrical Machinery	4	-	-	-	4	3	-	-	5	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	9
Other Manufacturing Industries	44	117	13	25	8	46	3	8	12	42	12	23	10	24	1	-	-	4	-	-	-	3	-	1	103	293
Construction:																										
Construction	3	11	1	1	1	3	-	-	2	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	7	18
Electricity, Gas & Water Supply:																										
Electricity, Gas & Water Supply	57	72	2	21	33	14	-	4	5	12	16	13	-	-	-	-	-	-	-	-	-	-	-	-	113	136
Services:																										
Telecommunication Services	116	113	33	20	53	15	14	7	12	47	8	20	2	11	2	3	-	-	-	-	-	-	-	-	240	236
Computer and Related Services	37	174	9	65	11	28	-	10	1	6	-	7	1	21	3	2	-	-	-	-	-	1	-	-	62	314
Other Services (e.g. transport, wholesale and retails, financial, business services)	103	44	50	13	26	6	7	2	70	4	9	9	2	26	-	-	-	-	-	-	-	-	-	-	267	104
Total	993	1,541	259	477	398	503	84	116	897	689	522	543	78	258	12	11	2	11	-	-	-	8	-	1	3,245	4,158

Source: 1996 & 1998 National Survey of Research and Development, MASTIC

Table 4.8: Private Sector Researchers (FTE) by Nationality, Qualification, Gender and Industry, 1998

Industry	Malaysians								Foreigners								Total FTE	
	Ph.D		Masters		Bachelors		Non-degree		Ph.D		Masters		Bachelor		Non-degree			
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	1996	1998
Primary:																		
Agriculture, Livestock & Fishery	7.00	1.00	11.17	8.54	32.00	12.95	11.60	1.10	2.00	1.00	-	-	1.10	-	-	-	100.59	89.46
Mining	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manufacturing:																		
Food Products, Beverages &	3.10	-	2.70	1.18	8.60	9.10	3.00	1.00	-	-	0.50	-	-	-	-	-	18.85	29.18
Tobacco	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	54.34	-
Rubber, Plastic Products	7.80	0.50	7.15	0.80	36.09	23.70	15.12	5.80	2.00	-	0.80	-	1.70	-	-	-	9.20	101.46
Wood, Paper, Printing and Furniture	-	-	1.50	-	2.50	1.00	1.00	1.00	-	0.20	-	-	-	-	-	-	14.03	7.20
Textiles, Wearing, Apparel, Fur & Leather	-	-	1.50	-	3.10	1.00	10.00	2.00	0.20	-	-	-	0.80	2.00	-	0.50	12.24	21.10
Chemicals & Chemical Products	2.25	-	2.00	1.90	15.90	20.60	11.00	-	1.00	-	2.80	-	21.00	-	-	-	42.24	78.45
Pharmaceutical	4.25	3.00	1.00	1.00	1.00	15.00	-	-	-	-	-	-	-	-	-	-	2.10	25.25
Petroleum Products & Refining	11.00	6.00	25.00	10.00	57.00	29.00	4.00	2.00		-	3.00		1.00				0.40	148.00
Non-metallic Mineral Products	2.04	-	2.00	-	13.96	7.00	1.00	-	1.00	-		-	-	-	0.70	-	34.17	27.70
Electrical Machinery & Appliances	-	-	4.40	1.00	109.85	54.80	4.95	1.00	-	-	4.00	-	58.85	1.00	19.00	-	43.60	258.85
Electronic Equipment & Components	0.90	-	24.80	3.20	262.70	45.80	64.80	15.00	0.60	-	2.25	-	25.25	-	5.00	-	298.30	450.30
Transport Equipment	1.00	-	5.40	-	76.00	7.00	9.00	-	-	-	-	-	9.00	-	-	-	9.85	107.40
Basic/Fabricated Metal Products	0.10	-	1.00	-	3.00	1.00	-	-	-	-	-	-	0.10	-	-	-	6.00	5.20
Non-Electrical Machinery	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.00	-
Other Manufacturing Industries	2.30	0.30	10.15	1.50	47.40	14.75	22.60	1.00	1.50	-	1.90	-	6.95	-	3.20	-	41.24	113.55
Construction:																		
Construction	1.00	-	-	-	4.10	-	5.00	1.00	-	-	-	-	0.10	-	-	-	1.16	11.20
Electricity, Gas & Water Supply:																		
Electricity, Gas & Water Supply	12.20	-	18.40	8.00	35.40	13.00	-	-	-	-	-	-	-	-	-	-	59.00	87.00
Services:																		
Telecommunication Services	11.00	1.00	22.70	1.00	74.30	17.00	4.00	1.00	2.00	-	6.80	2.00	2.00	1.00	-	-	134.00	145.80
Computer and Related Services	1.40	1.00	8.50	1.50	109.77	31.76	31.30	15.20	3.00	-	5.80	-	11.40	2.00	-	-	34.43	222.63
Other Services (e.g. transport, wholesale and retails, financial, business services)	3.75	-	3.00	2.50	27.00	9.50	2.00	-	0.95		17.30	-	1.20	-	-		119.95	67.20
Total	71.09	12.80	152.37	42.12	919.67	313.96	200.37	47.10	14.25	1.20	45.15	2.00	140.45	6.00	27.90	0.50	1,026.45	1,996.93

Nate: For 1996, only Total FTE data are available, the breakdown by gender and qualification is not available

Source: 1996 & 1998 National Survey of Research and Development, MASTIC

Table 4.9: Private Sector R&D Personnel (FTE) and Expenditure by Field of Research (FOR), 1996-98

FOR Code	Field of Research	Personnel (FTE)											
		Malaysians						Foreigners					
		Researchers		Technicians		Others		Researchers		Technicians		Others	
		1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998
F10200	Physical Sciences	25.48	14.00	12.02	13.00	6.74	7.00	1.50	-	-	1.00	-	-
F10300	Chemical Sciences	57.87	27.10	21.77	6.85	26.22	23.60	2.14	0.50	0.20	-	-	-
F10500	Info. Comp. & Comm. Technologies	245.67	464.08	39.48	90.26	35.63	81.84	8.38	44.80	-	-	-	0.23
F10600	Applied Sc. & Technologies	166.34	456.43	74.51	166.00	116.08	224.26	10.60	52.40	-	3.80	-	1.00
F10700	Engineering Sciences	228.68	586.70	115.74	176.85	118.56	150.46	27.21	132.25	-	1.60	-	-
F10800	Biological Sciences	11.35	24.00	5.40	1.00	67.56	15.00	0.07	2.00	-	-	-	-
F10900	Agricultural Sciences	97.99	76.24	28.10	57.30	527.28	472.14	1.75	1.80	-	-	-	3.00
F11000	Medical & Health Sciences	7.07	43.25	1.28	1.00	3.20	19.00	0.05	-	-	-	-	
F11100	Environmental Sciences	13.41	13.00	6.73	1.00	5.74	-	0.004	2.00	-	-	-	-
F11200	Material Sciences	95.97	34.68	31.85	6.45	66.69	12.10	4.85	1.70	0.25	0.75	-	2.00
F11300	Marine Sciences	N.A	1.00	N.A	1.00	N.A	1.50	N.A	-	N.A	-	N.A	-
F20100	Social Sciences	N.A	19.00	N.A	3.00	N.A	6.00	N.A	-	N.A	-	N.A	-
	Total	**949.83**	**1,759.48**	**336.88**	**523.71**	**973.70**	**1,012.90**	**56.55**	**237.45**	**0.45**	**7.15**	**-**	**6.23**

N.A : Not Available

Source: 1996 & 1998 National Survey of Research and Development, MASTIC

Table 4.10b: R&D Personnel (FTE) in GRIs by Institution, 1996-98

Government Agencies and Research Institutes	Local								Foreign								Total of Research Personnel	
	Researcher		Technician		Other Staff		Total		Researcher		Technician		Other Staff		Total			
	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998
Department of Forestry Sarawak / Forest Research Center	9.00	10.94	6.00	3.09	38.00	112.94	53.00	126.97	-	2.76	-	0.75	-	-	-	3.51	53.00	130.48
Department of Agriculture Sabah	-	18.90	-	31.40	-	72.00	-	122.30	-	-	-	-	-	-	-	-	-	122.30
Department of Agriculture Sarawak / Semonggok	13.26	19.17	29.69	31.61	113.70	285.49	156.65	336.27	0.20	-	-	-	-	-	0.20	-	156.85	336.27
Department of Environment	-	10.50	-	-	-	6.20	-	16.70	-	1.75	-	-	-	-	-	1.75	-	18.45
Department of Irrigation and Drainage of Malaysia	-	0.10	-	-	-	0.10	-	0.20	-	-	-	-	-	-	-	-	-	0.20
Department of Museum and Antiquity	7.00	-	-	5.00	2.00	30.00	9.00	35.00	-	-	-	-	-	-	-	-	9.00	35.00
Department of Veterinary Services & Live Stock Sabah	-	0.35	-	-	-	0.50	-	0.85	-	-	-	-	-	-	-	-	-	0.85
Department of Wildlife and National Parks	5.31	2.40	0.88	-	4.22	2.30	10.41	4.70	1.20	-	-	-	-	-	1.20	-	11.61	4.70
Fisheries Research Institute, Sarawak Branch	1.90	3.31	-	0.65	6.50	2.44	8.40	6.40	-	-	-	-	-	-	-	-	8.40	6.40
Forest Research Institute of Malaysia	21.95	41.19	3.55	16.66	17.43	40.70	42.93	98.55	2.60	1.00	-	-	-	-	2.60	1.00	45.53	99.55
Forestry Department of the Malaysian Peninsular	-	15.95	-	1.95	-	42.05	-	59.95	-	7.60	-	-	-	-	-	7.60	-	67.55
Geological Survey Department of Malaysia	0.70	2.80	0.10	-	0.15	3.50	0.95	6.30	-	-	-	-	-	-	-	-	0.95	6.30
Institute for Development Studies, Sabah	-	2.55	-	-	-	1.30	-	3.85	-	-	-	-	-	-	-	-	-	3.85
Institute for Medical Research	36.78	41.42	17.01	23.11	3.74	1.60	57.53	66.13	0.50	0.50	-	-	-	-	0.50	0.50	58.03	66.63
Malaysian Agricultural Research Institute	163.18	235.45	140.31	200.37	324.53	341.42	628.02	777.24	0.70	5.30	-	-	-	-	0.70	5.30	628.72	782.54
Malaysian Centre for Remote Sensing	0.33	20.93	-	0.40	-	-	0.33	21.33	-	1.04	-	-	-	-	-	1.04	0.33	22.37
Malaysian Cocoa Board	11.46	18.31	7.99	12.56	23.01	26.61	42.46	57.48	0.20	3.05	-	-	-	-	0.20	3.05	42.66	60.53
Malaysian Department of Geological Research, Sarawak	-	0.40	-	0.60	-	1.20	-	2.20	-	-	-	-	-	-	-	-	-	2.20
Malaysian Industry - Gov. Group For High Technology	-	30.00	-	-	-	-	-	30.00	-	-	-	-	-	-	-	-	-	30.00
Malaysian Meteorological Services	2.00	0.02	-	-	5.00	0.17	7.00	0.19	-	-	-	-	-	-	-	-	7.00	0.19
Malaysian Ministry of Defence	4.30	5.80	0.80	1.60	2.00	2.10	7.10	9.50	-	-	-	-	-	-	-	-	7.10	9.50
Malaysian Research Institute for Nuclear Technology	18.82	31.85	3.20	8.20	19.01	13.40	41.03	53.45	0.07	-	-	-	-	-	0.07	-	41.10	53.45
Malaysian Rubber Board	-	41.27	-	10.87	-	68.92	-	121.06	-	0.10	-	-	-	-	-	0.10	-	121.16
MIMOS Berhad	30.80	106.00	2.00	3.00	0.50	0.50	33.30	109.50	0.50	-	-	-	-	-	0.50	-	33.80	109.50
Mines Research Institute	1.23	0.58	0.01	0.01	1.10	0.37	2.34	0.96	-	-	-	-	-	-	-	-	2.34	0.96
National Institute of Public Administration	-	10.50	-	-	-	-	-	10.50	-	-	-	-	-	-	-	-	-	10.50
National Prawn Fry Production and Research Centre, Kedah	-	1.70	-	-	-	0.90	-	2.60	-	-	-	-	-	-	-	-	-	2.60
Palm Oil Research Institute of Malaysia	12.88	7.98	2.76	4.40	8.65	3.25	24.29	15.63	-	-	-	-	-	-	-	-	24.29	15.63
PELITA	-	7.30	-	-	-	23.00	-	30.30	-	-	-	-	-	-	-	-	-	30.30
Pusat Pengeluaran & Penyelidikan Ikan Laut	-	4.66	-	0.25	-	2.75	-	7.66	-	0.10	-	-	-	-	-	0.10	-	7.76
Sarawak Development Institute	-	0.47	-	-	-	0.04	-	0.51	-	-	-	-	-	-	-	-	-	0.51
SIRIM Bhd.	16.72	17.85	6.79	4.87	3.30	0.31	26.81	23.03	0.31	-	-	0.17	-	-	0.31	0.17	27.12	23.20
Veterinary Research Institute	6.58	7.14	4.25	3.33	0.78	1.28	11.61	11.75	-	-	-	-	-	-	-	-	11.61	11.75
Total	364.20	717.79	225.34	363.93	573.62	1,087.34	1,163.16	2,169.06	6.28	23.2	-	0.92	-	-	6.28	24.12	1,169.44	2,193.18

Source: 1996 & 1998 National Survey of Research and Development, MASTIC

Table 4.11: Research Personnel (Headcount) by Nationality and Qualification, 1998

Government Agencies and Research Institutes	Local							Foreign							Grand Total
	PhD	MSc	BSc	NDG	Tech	Others	Total	PhD	MSc	BSc	NDG	Tech	Others	Total	
Department of Forestry Sarawak / Forest Research Center (JPSK)	-	7	27	-	12	178	224	5	-	1	-	1	-	7	231
Department of Agriculture Sabah (JTSB)	1	8	18	-	35	80	142	-	-	-	-	-	-	-	142
Department of Agriculture Sarawak / Semonggok(JTSK)	2	17	55	-	84	880	1,038	-	-	-	-	-	-	-	1,038
Department of Environment (DOE)	13	2	3	-	-	7	25	2	1	-	-	-	-	3	28
Department of Irrigation and Drainage of Malaysia (DID)	-	1		-	-	1	2	-	-	-	-	-	-	-	2
Department of Museum and Antiquity (DMA)	-	-		-	5	30	35	-	-	-	-	-	-	-	35
Department of Veterinary Services & Live Stock Sabah(JHSB)	-	-	1	-	-	3	4	-	-	-	-	-	-	-	4
Department of Wildlife and National Parks (PERHILITAN)	-	-	3	-	-	8	11	-	-	-	-	-	-	-	11
Fisheries Research Institute, Sarawak Branch	-	3	4	-	3	11	21	-	-	-	-	-	-	-	21
Forest Research Institute of Malaysia (FRIM)	55	38	29	-	41	118	281	-	1	1	-	-	-	2	283
Forestry Department of the Malaysian Peninsular (Headquarters)	6	6	21	7	11	80	131	1	4	5	-	-	-	10	141
Geological Survey Department of Malaysia (Headquarters)	-	1	6	-	-	9	16	-	-	-	-	-	-	-	16
Institute for Development Studies,Sabah (IDS)	2	1	7	1	-	3	14	-	-	-	-	-	-	-	14
Institute for Medical Research (IMR)	45	31	25	1	74	7	183	-	-	1	-	-	-	1	184
Malaysian Agricultural Research Institute (MARDI)	186	423	64	22	417	672	1,784	5	4	-	-	-	-	9	1,793
Malaysian Centre for Remote Sensing (MACRES)	11	21	38	1	2	-	73	5	-	-	-	-	-	5	78
Malaysian Cocoa Board (MCB)	11	23	24	-	26	45	129	5	-	-	-	-	-	5	134
Malaysian Department of Geological Research, Sarawak	-	-	2	-	3	11	16	-	-	-	-	-	-	-	16
Malaysian Industry - Gov. Group For High Technology (MIGHT)	8	12	5	5	-	-	30	-	-	-	-	-	-	-	30
Malaysian Meteorological Services	1	-	1	-	-	4	6	-	-	-	-	-	-	-	6
Malaysian Ministry of Defence	2	3	18	5	8	11	47	-	-	-	-	-	-	-	47
Malaysian Research Institute for Nuclear Technology (MINT)	32	18	29	3	25	31	138		-	-	-	-	-	-	138
Malaysian Rubber Board (MRB)	80	32	20	-	33	158	323	1	-	-	-	-	-	1	324
MIMOS Berhad	7	19	102	81	6	1	216		-	-	-	-	-	-	216
Mines Research Institute (PEGAMA)	-	6	3	-	1	8	18	-	5	-	-	-	-	5	23
National Institute of Public Administration (INTAN)	11	12		-	-	-	23	-	-	-	-	-	-	-	23
National Prawn Fry Production and Research Centre, Kedah (PPPBUK)	-	-	4	-	-	7	11	-	-	-	-	-	-	-	11
Palm Oil Research Institute of Malaysia (PORIM)	17	8	9	1	10	10	55	-	-	-	-	-	-	-	55
PELITA	4	-	4	-	-	24	32	-	-	-	-	-	-	-	32
Pusat Pengeluaran & Penyelidikan Ikan Laut (PPPIL)	1	5	8	-	1	9	24	-	-	1	-	-	-	1	25
Sarawak Development Institute (SDI)	3	-	3	-	-	2	8	-	-	-	-	-	-	-	8
SIRIM Bhd.	8	39	20	3	19	4	93	-	-	-	-	1	-	1	94
Veterinary Research Institute (IPH)	2	8	4	-	12	5	31	-	-	-	-	-	-	-	31
Total	**508**	**744**	**557**	**130**	**828**	**2,417**	**5,184**	**24**	**15**	**9**	**-**	**2**	**-**	**50**	**5,234**

Source: 1998 National Survey of Research and Development, MASTIC

Table 4.12: R&D Personnel (FTE) in GRIs by Field of Research (FOR), 1996-98

Field of Research	FTE		% Change
	1996	1998	
Mathematical Sciences	0.04	-	-100
Physical Sciences	0.22	1.00	354.55
Chemical Sciences	20.12	8.83	-56.11
Earth Sciences	12.62	15.99	26.7
Information, Computer & Communication Technologies	40.51	173.63	328.61
Applied Sciences and Technologies	79.40	73.48	-7.46
Engineering Sciences	49.33	107.18	117.27
Biological Sciences	158.76	222.54	40.17
Agricultural Sciences	1017.37	1397.67	37.38
Medical and Health Sciences	79.09	69.22	-12.48
Environmental Sciences	13.31	24.81	86.4
Material Sciences	12.34	22.04	78.61
Marine sciences	1.97	0.40	-79.7
Social Sciences	81.75	76.39	-6.56
Humanities	0.27	-	-100
Total	**1567.10**	**2193.18**	**39.95**

Source: 1996 & 1998 National Survey of Research and Development, MASTIC

Table 4.13a: R&D Personnel (FTE and Headcount) in Institutes of Higher Learning (IHLs) 1996-98

Institutions	FTE						Headcount					
	Researchers			Total Personnel			Researchers			Total Personnel		
			% Change			% Change			% Change			% Change
	1996	1998	96-'98	1996	1998	96-'98	1996	1998	96-'98	1996	1998	96-'98
International Islamic University (UIAM)	8.2	12.7	54.5	8.7	38.9	347.0	27	46	70.4	29	167	475.9
MARA University of Technology (UiTM)	24.2	15.3	-36.8	27.2	20.3	-25.4	126	63	-50.0	137	90	-34.3
National University of Malaysia (UKM)	61.6	137.8	123.6	79.8	167.2	109.5	179	436	143.6	247	543	119.8
Northern University of Malaysia (UUM)	3.8	9.7	155.3	3.8	10.7	181.6	98	84	-14.3	98	90	-8.2
University of Malaya (UM)	72.2	99.2	37.4	83.9	128.3	53.0	199	264	32.7	223	368	65.0
University of Putra, Malaysia (UPM)	50.0	96.7	93.5	74.0	124.5	68.2	160	220	37.5	223	283	26.9
University of Sabah, Malaysia (UMS)	-	1.7	-	-	2.5	-	-	6	-	-	7	-
University of Sains, Malaysia (USM)	77.5	225.9	191.5	125.1	303.6	142.7	291	674	131.6	411	916	122.9
University of Sarawak, Malaysia (UNIMAS)	10.7	24.2	126.2	15.5	33.1	113.8	51	78	52.9	75	113	50.7
University of Technology, Malaysia (UTM)	87.3	51.3	-41.2	102.4	83.5	-18.5	246	92	-62.6	314	141	-55.1
University of Technology, Petronas (UTP)	-	2.8	-	-	3.1	-	-	5	-	-	15	-
University of Tenaga Nasional (UTN)	-	0.6	-	-	0.6	-	-	2	-	-	2	-
Total	395.5	677.8	71.4	520.4	916.2	76.1	1377	1970	43.1	1757	2735	55.7

Source: 1996 Malaysian Science and Technology Indicators Report
1998 National Survey of Research and Development

Table 4.13b: R&D Personnel (Headcount and FTE) in Institutes of Higher Learning (IHLs) by Institution and Nationality, 1996-98

Research Personnel (Headcount)

Institution of Higher Learning	Local								Foreign								Total Headcount	
	Researcher		Technician		Other Staff		Total		Researcher		Technician		Other Staff		Total			
	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998
International Islamic University of Malaysia (UIAM)	14	37	-	7	2	114	16	158	13	9	-	-	-	-	13	9	29	167
National University of Malaysia (UKM)	170	413	31	51	37	56	238	520	9	23	-	-	-	-	9	23	247	543
University of Malaya (UM)	188	230	9	30	15	68	212	328	11	34	-	-	-	6	11	40	223	368
University of Sabah, Malaysia (UMS)	N.A	6	N.A	-	N.A	1	N.A	7	N.A	-	N.A	-	N.A	-	N.A	-	N.A	7
University of Sarawak, Malaysia (UNIMAS)	41	67	13	10	11	23	65	100	10	11	-	1	-	1	10	13	75	113
University of Putra, Malaysia (UPM)	144	182	9	28	53	35	206	245	16	38	-	-	1	-	17	38	223	283
University of Sains, Malaysia (USM)	266	626	30	70	90	170	386	866	25	48	-	-	-	2	25	50	411	916
University of Technology, Malaysia (UTM)	230	87	46	26	22	23	298	136	16	5	-	-	-	-	16	5	314	141
MARA University of Technology (UiTM)	122	62	5	9	6	18	133	89	4	1	-	-	-	-	4	1	137	90
University of Technology, Petronas (UTP)	N.A	5	N.A	1	N.A	-	N.A	6	N.A	5	N.A	4	N.A	-	N.A	9	N.A	15
University of Tenaga Nasional (UTN)	N.A	2	N.A	-	N.A	-	N.A	2	N.A	-	N.A	-	N.A	-	N.A	-	N.A	2
Northern University of Malaysia (UUM)	95	81	-	-	-	6	95	87	3	3	-	-	-	-	3	3	98	90
Total	1,270	1,798	143	232	236	514	1,649	2,544	107	177	-	5	1	9	108	191	1,757	2,735

IHL Research Effort (FTE)

Institution of Higher Learning	Local								Foreign								Total FTE	
	Researcher		Technician		Other Staff		Total		Researcher		Technician		Other Staff		Total			
	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998
International Islamic University of Malaysia (UIAM)	5.95	9.85	-	2.41	0.51	23.81	6.46	36.07	2.21	2.82	-	-	-	-	2.21	2.82	8.67	38.89
National University of Malaysia (UKM)	58.17	124.78	12.21	8.70	5.94	20.75	76.32	154.23	3.43	12.97	-	-	-	-	3.43	12.97	79.75	167.20
University of Malaya (UM)	65.74	79.87	4.71	7.43	7.01	18.64	77.46	105.94	6.43	19.35	-	-	-	3.05	6.43	22.40	83.89	128.34
University of Sabah, Malaysia (UMS)	N.A	1.65	N.A	-	N.A	0.80	N.A	2.45	N.A	-	N.A	-	N.A	-	N.A	-	N.A	2.45
University of Sarawak, Malaysia (UNIMAS)	8.28	19.77	1.32	1.62	3.46	7.10	13.06	28.49	2.40	4.45	-	0.10	-	0.10	2.40	4.65	15.46	33.14
University of Putra, Malaysia (UPM)	40.70	70.49	2.28	10.21	21.52	17.52	64.50	98.22	9.31	26.24	-	-	0.15	-	9.46	26.24	73.96	124.46
University of Sains, Malaysia (USM)	69.94	200.05	10.63	20.96	37.00	56.32	117.57	277.33	7.55	25.85	-	-	-	0.40	7.55	26.25	125.12	303.58
University of Technology, Malaysia (UTM)	78.60	47.21	11.13	15.35	4.00	16.80	93.73	79.36	8.67	4.10	-	-	-	-	8.67	4.10	102.40	83.46
MARA University of Technology (UiTM)	22.99	15.10	2.43	3.50	0.59	1.50	26.01	20.10	1.20	0.20	-	-	-	-	1.20	0.20	27.21	20.30
University of Technology, Petronas (UTP)	N.A	1.80	N.A	0.01	N.A	-	N.A	1.81	N.A	1.00	N.A	0.30	N.A	-	N.A	1.30	N.A	3.11
University of Tenaga Nasional (UTN)	N.A	0.60	N.A	-	N.A	-	N.A	0.60	N.A	-	N.A	-	N.A	-	N.A	-	N.A	0.60
Northern University of Malaysia (UUM)	3.69	9.20	-	-	-	1.00	3.69	10.20	0.14	0.50	-	-	-	-	0.14	0.50	3.83	10.70
Total	354.06	580.37	44.71	70.19	80.03	164.24	478.80	814.80	41.34	97.48	-	0.40	0.15	3.55	41.49	101.43	520.29	916.23

N.A : Not Available
Source: 1996 & 1998 National Survey of Research and Development, MASTIC

Table 4.14: IHL Reseachers (FTE and Headcount) by Nationality, Qualification and Gender, 1998

IHL Researchers (FTE)																	
IHL	Malaysians								Foreigners								Total
	Ph.D		Masters		Bachelors		Non-degree		Ph.D		Masters		Bachelors		Non-degree		
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	
UIAM	2.50	1.15	4.35	3.30	1.25	1.80	0.50	0.25	0.20	-	-	-	-	-	-	-	15.30
UKM	5.84	0.73	0.09	-	2.88	0.31	-	-	2.30	-	0.52	-	-	-	-	-	12.67
UM	23.41	11.20	12.97	11.04	21.91	33.25	5.60	5.40	1.45	-	5.50	1.42	1.50	1.10	-	2.00	137.75
UMS	17.53	9.67	4.00	6.20	16.03	21.91	2.16	2.30	6.15	2.10	4.10	-	6.00	-	1.00	-	99.22
UNIMAS	0.15	-	0.40	0.10	1.00	16.03	-	-	-	-	-	-	-	-	-	-	1.65
UPM	3.42	0.60	5.05	3.60	4.90	1.80	0.40	-	2.55	-	0.50	-	1.40	-	-	-	24.22
USM	13.38	6.67	11.51	6.65	13.48	18.40	0.20	-	3.31	0.30	15.90	1.50	1.33	3.90	-	-	96.73
UTM	50.61	16.17	16.41	14.41	39.05	35.92	13.39	14.09	7.05	0.20	11.50	-	2.10	5.00	-	-	225.90
UiTM	13.13	2.60	7.20	2.63	11.55	6.00	0.40	3.70	1.10	-	-	-	2.00	1.00	-	-	51.31
UTP	1.80	-	-	-	-	-	-	-	1.00	-	-	-	-	-	-	-	2.80
UTN	0.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.60
UUM	2.20	2.90	2.90	2.70	0.10	-	-	-	-	0.50	-	-	-	-	-	-	9.70
Total	134.57	50.09	64.88	50.63	112.15	119.46	22.65	25.94	25.11	3.10	38.02	2.92	14.33	11.00	1.00	2.00	677.85

IHL Researchers (Headcount)																	
IHL	Malaysians								Foreigners								Total
	Ph.D		Masters		Bachelors		Non-degree		Ph.D		Masters		Bachelors		Non-degree		
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	
UIAM	21	4	4	-	6	2	-	-	7	-	2	-	-	-	-	-	46
UKM	95	55	37	71	42	49	19	45	4	-	8	4	2	2	-	3	436
UM	70	38	13	15	33	45	6	10	10	4	6	-	9	-	5	-	264
UMS	1	-	3	1	1	-	-	-	-	-	-	-	-	-	-	-	6
UNIMAS	16	2	17	15	13	3	1	-	7	-	1	-	3	-	-	-	78
UPM	47	23	25	11	42	31	2	1	10	1	17	2	4	4	-	-	220
USM	230	64	53	31	73	64	54	57	23	1	16	-	3	5	-	-	674
UTM	23	8	9	7	15	15	3	7	2	-	-	-	2	1	-	-	92
UiTM	13	4	14	14	7	8	1	1	1	-	-	-	-	-	-	-	63
UTP	5	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	10
UTN	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
UUM	20	5	29	26	1	-	-	-	-	3	-	-	-	-	-	-	84
Total	543	203	204	191	233	217	86	121	69	9	50	6	23	12	5	3	1,975

Source: 1998 National Survey of Research and Development, MASTIC

Table 4.15a: R&D Personnel (Headcount) in IHLs by Field of Research (FOR), 1996-98

Field of Research	Institutions of Higher Learning																								Total	
	UiTM		UIA		UKM		UM		UMS		UNIMAS		UPM		USM		UTM		UTP		UNITEN		UUM			
	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998
Mathematical Sciences	1	-	7	-	2	-	-	-	-	-	-	-	-	-	1	16	20	3	-	-	-	-	-	-	31	19
Physical Sciences	-	3	-	2	-	30	8	3	-	-	1	-	3	10	17	22	8	-	-	-	-	-	-	-	37	70
Chemical Sciences	1	4	-	-	20	67	46	47	-	-	-	-	1	3	23	83	6	18	-	-	-	-	-	-	97	222
Earth Sciences	2	2	-	-	5	21	-	-	-	6	-	-	13	8	10	6	10	-	-	11	-	-	-	-	40	54
Information, Comp. & Comm. Tech	7	6	-	-	-	-	-	33	-	-	36	26	-	10	50	95	42	26	-	-	-	-	37	13	172	209
Appi.Sci & Technologies	11	1	-	-	-	-	13	13	-	-	-	-	26	10	17	73	104	10	-	-	-	-	-	-	171	107
Engineering Sciences	50	16	-	-	9	-	10	37	-	-	-	6	11	48	14	41	63	63	-	-	-	2	-	-	157	213
Biological Sciences	16	16	-	-	32	46	25	21	-	-	15	25	39	21	27	69	11	6	-	-	-	-	-	-	165	204
Agricultural	-	6	-	-	-	105	17	17	-	-	-	11	63	143	29	56	-	-	-	-	-	-	-	-	109	338
Medical & Health Sciences	-	-	-	54	100	152	55	179	-	1	14	20	-	5	143	251	-	-	-	-	-	-	-	-	312	662
Environmental Sciences	8	3	-	-	-	68	3	-	-	-	9	8	-	-	6	61	-	2	-	-	-	-	-	-	26	142
Material Sciences	9	-	-	-	28	9	-	17	-	-	-	-	-	5	7	37	47	-	-	4	-	-	-	-	91	72
Marine Sciences	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Social Sciences	28	30	20	111	45	8	46	1	-	-	-	10	59	20	54	90	-	13	-	-	-	-	49	77	301	360
Humanities	4	3	2	-	6	37	-	-	-	-	-	7	8	-	13	16	3	-	-	-	-	-	12	-	48	63
Total	137	90	29	167	247	543	223	368	-	7	75	113	223	283	411	916	314	141	-	15	-	2	98	90	1,757	2,735

Source: 1996 & 1998 National Survey of Research and Development, MASTIC

Table 4.15b: R&D Personnel (FTE) in IHLs by Field of Research (FOR), 1996-98

Field of Research	Institutions of Higher Learning																						Total	
	UiTM		UIA		UKM		UM		UMS		UNIMAS		UPM		USM		UTM		UTP		UNITEN		UUM			
	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998
Mathematical Sciences	0.30	0.00	-	-	0.60	-	0.06	-	-	-	-	-	-	-	0.21	7.75	4.48	1.80	-	-	-	-	-	-	5.65	9.55
Physical Sciences	0.00	0.60	-	1.00	-	8.10	2.47	1.40	-	-	0.20	-	0.30	8.00	1.11	4.60	6.69	-	-	-	-	-	-	-	10.77	23.70
Chemical Sciences	0.28	0.50	-	-	4.83	21.65	12.22	16.86	-	-	-	-	0.05	1.00	7.19	22.14	0.68	13.01	-	-	-	-	-	-	25.25	75.16
Earth Sciences	0.71	0.60	-	-	1.92	10.60	0.16	-	-	2.35	-	-	0.46	4.10	2.60	3.20	3.52	-	-	1.11	-	-	-	-	9.37	21.96
Information, Comp. & Comm. Tech	1.32	1.10	-	-	-	-	-	12.40	-	-	6.38	5.65	0.23	3.05	8.50	31.06	14.77	8.70	-	-	-	-	1.08	1.30	32.28	63.26
Appi.Sci & Technologies	2.75	1.00	-	-	0.49	-	3.75	6.80	-	-	-	-	7.64	3.18	1.92	22.58	26.91	2.80	-	-	-	-	-	-	43.46	36.36
Engineering Sciences	9.82	3.60	2.70	-	2.20	-	2.17	16.30	-	-	-	1.80	1.95	23.70	4.27	15.95	21.06	48.35	-	-	-	0.60	-	-	44.17	110.30
Biological Sciences	1.98	5.00	-	-	13.98	18.81	14.93	12.40	-	-	2.47	10.70	12.81	9.75	14.74	28.20	4.91	3.00	-	-	-	-	-	-	65.82	87.86
Agricultural	0.34	1.00	-	-	1.87	12.07	4.53	4.32	-	-	0.16	1.90	26.05	63.69	14.50	28.73	1.30	-	-	-	-	-	-	-	48.75	111.71
Medical & Health Sciences	0.24	0.00	-	5.40	30.50	50.71	36.79	52.06	-	0.10	4.45	5.54	-	3.26	58.56	77.40	0.38	-	-	-	-	-	-	-	130.92	194.71
Environmental Sciences	1.10	1.50	-	-	-	26.45	0.95	-	-	-	0.94	2.60	0.80	-	0.37	22.60	0.89	0.40	-	-	-	-	-	-	5.05	53.55
Material Sciences	1.18	0.00	-	-	5.04	2.37	0.17	5.60	-	-	-	-	0.79	1.40	1.57	10.37	5.43	-	-	2.00	-	-	-	-	14.18	21.74
Marine Sciences	0.00	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Social Sciences	5.79	4.40	5.37	32.25	14.52	1.10	5.27	0.20	-	-	0.86	4.45	21.99	3.33	9.46	27.40	10.38	5.40	-	-	-	-	2.09	9.40	75.73	87.93
Humanities	1.40	1.00	0.60	-	3.80	15.34	0.42	-	-	-	-	0.50	0.89	-	0.12	1.60	1.00	-	-	-	-	-	-	0.66	8.89	18.44
Total	27.21	20.30	8.67	38.89	79.75	167.20	83.89	128.34	-	2.45	15.46	33.14	73.96	124.46	125.12	303.58	102.40	83.46	-	3.11	-	0.60	3.83	10.70	520.29	916.23

Source: 1996 & 1998 National Survey of Research and Development, MASTIC

Table 4.16a: Public Service Personnel (Number of Personnel) in S&T Related Classification, 1993-98

	Malaysians						Foreigners					
	1993	1994	1995	1996	1997	1998	1993	1994	1995	1996	1997	1998
Science (C)	4,642	5,117	5,220	5,287	5,369	5,568	50	49	48	11	155	153
Information System (F)	4,271	4,668	4,830	4,812	5,125	5,185	48	49	49	9	100	101
Agriculture (G)	16,860	18,801	18,768	18,964	17,389	17,233	273	276	277	19	1,046	1,031
Engineering (J)	25,312	27,498	27,430	27,077	25,836	25,517	221	227	209	28	1,004	1,010
R & D (Q)	3,490	3,756	3,872	3,249	3,242	3,052	26	26	25	9	83	81
Medical & Health (U)	62,019	66,825	68,841	70,857	70,876	72,286	588	664	776	255	2,857	2,868
Sub total S & T Related	116,594	126,665	128,961	130,246	127,837	128,841	1,206	1,291	1,384	331	5,245	5,244

	Male						Female					
	1993	1994	1995	1996	1997	1998	1993	1994	1995	1996	1997	1998
Science (C)	3,389	3,611	3,661	3,643	3,713	3,738	1,303	1,555	1,607	1,655	1,811	1,983
Information System (F)	977	1,077	1,100	1,071	1,208	1,226	3,342	3,640	3,779	3,750	4,017	4,060
Agriculture (G)	15,992	17,738	17,681	17,594	17,076	16,840	1,141	1,339	1,364	1,389	1,359	1,424
Engineering (J)	22,124	23,901	23,660	23,089	22,508	22,153	3,409	3,824	3,979	4,016	4,332	4,374
R & D (Q)	2,683	2,881	2,958	2,517	2,543	2,384	833	901	939	741	782	749
Medical & Health (U)	22,237	23,784	24,513	24,942	25,819	26,132	40,370	43,705	45,104	46,170	47,914	49,022
Sub total S & T Related	67,402	72,992	73,573	72,856	72,867	72,473	50,398	54,964	56,772	57,721	60,215	61,612

	Prof./Tech.						Support						Total					
	1993	1994	1995	1996	1997	1998	1993	1994	1995	1996	1997	1998	1993	1994	1995	1996	1997	1998
Science (C)	679	789	829	836	880	911	4,013	4,377	4,439	4,462	4,644	4,810	4,692	5,166	5,268	5,298	5,524	5,721
Information System (F)	579	659	712	724	858	884	3,740	4,058	4,167	4,097	4,367	4,402	4,319	4,717	4,879	4,821	5,225	5,286
Agriculture (G)	1,502	1,614	1,575	1,587	1,552	1,504	15,631	17,463	17,470	17,396	16,883	16,760	17,133	19,077	19,045	18,983	18,435	18,264
Engineering (J)	4,340	4,713	4,697	4,486	4,031	4,038	21,193	23,012	22,942	22,619	22,809	22,489	25,533	27,725	27,639	27,105	26,840	26,527
R & D (Q)	1,479	1,601	1,697	1,272	1,324	1,301	2,037	2,181	2,200	1,986	2,001	1,832	3,516	3,782	3,897	3,258	3,325	3,133
Medical & Health (U)	3,885	4,996	5,717	6,070	7,386	7,919	58,722	62,493	63,900	65,042	66,347	67,235	62,607	67,489	69,617	71,112	73,733	75,154
Sub total S & T Related	12,464	14,372	15,227	14,975	16,031	16,557	105,336	113,584	115,118	115,602	117,051	117,528	117,800	127,956	130,345	130,577	133,082	134,085

Source : Public Service Department

Notes : Prof./Tech indicates staff in the salary groups 'Management and Professional and Top Management [and Technical Services' (used exclusively for engineers)]

* Estimate based on 1996 percentage breakdown

Table 4.16b: Public Service Personnel in S&T Related Classification 1993-98 (Percentage of Total for Each Service Category)

	Malaysians						Foreigners					
	%						%					
	1993	1994	1995	1996	1997	1998	1993	1994	1995	1996	1997	1998
Science (C)	98.9	99.1	99.1	99.8	97.2	97.3	1.1	0.9	0.9	0.2	2.8	2.7
Information System (F)	98.9	99.0	99.0	99.8	98.1	98.1	1.1	1.0	1.0	0.2	1.9	1.9
Agriculture (G)	98.4	98.6	98.5	99.9	94.3	94.4	1.6	1.4	1.5	0.1	5.7	5.6
Engineering (J)	99.1	99.2	99.2	99.8	96.3	96.2	0.9	0.8	0.8	0.1	3.7	3.8
R & D (Q)	99.3	99.3	99.4	99.7	97.5	97.4	0.7	0.7	0.6	0.3	2.5	2.6
Medical & Health (U)	99.1	99.0	98.9	99.6	96.1	96.2	0.9	1.0	1.1	0.4	3.9	3.8
Sub total S & T Related	99.0	99.0	98.9	99.7	96.1	96.1	1.0	1.0	1.1	0.3	3.9	3.9

	Male						Female					
	%						%					
	1993	1994	1995	1996	1997	1998	1993	1994	1995	1996	1997	1998
Science (C)	72.2	69.9	69.5	68.8	67.2	65.3	27.8	30.1	30.5	31.2	32.8	34.7
Information System (F)	22.6	22.8	22.5	22.2	23.1	23.2	77.4	77.2	77.5	77.8	76.9	76.8
Agriculture (G)	93.3	93.0	92.8	92.7	92.6	92.2	6.7	7.0	7.2	7.3	7.4	7.8
Engineering (J)	86.6	86.2	85.6	85.2	83.9	83.5	13.4	13.8	14.4	14.8	16.1	16.5
R & D (Q)	76.3	76.2	75.9	77.3	76.5	76.1	23.7	23.8	24.1	22.7	23.5	23.9
Medical & Health (U)	35.5	35.2	35.2	35.1	35.0	34.8	64.5	64.8	64.8	64.9	65.0	65.2
Sub total S & T Related	57.2	57.0	56.4	55.8	54.8	54.1	42.8	43.0	43.6	44.2	45.2	45.9

	Prof./Tech.						Support						Total					
	%						%						%					
	1993	1994	1995	1996	1997	1998	1993	1994	1995	1996	1997	1998	1993	1994	1995	1996	1997	1998
Science (C)	14.5	15.3	15.7	15.8	16.0	15.9	85.5	84.7	84.3	84.2	84.0	84.1	4.0	4.0	4.0	4.1	4.1	4.3
Information System (F)	13.4	14.0	14.6	15.0	16.4	16.7	86.6	86.0	85.4	85.0	83.6	83.3	3.7	3.7	3.7	3.7	3.9	4.0
Agriculture (G)	8.8	8.5	8.3	8.4	8.4	8.2	91.2	91.5	91.7	91.6	91.6	91.8	14.5	14.9	14.6	14.5	13.9	13.6
Engineering (J)	100.0	100.0	100.0	16.6	15.0	15.2	83.0	83.0	83.0	83.4	85.0	84.8	21.7	21.7	20.8	20.8	20.2	19.8
R & D (Q)	42.1	42.3	43.5	39.0	39.8	41.5	57.9	57.7	56.5	61.0	60.2	58.5	3.0	3.0	2.5	2.5	2.5	2.3
Medical & Health (U)	6.2	7.4	8.2	8.5	10.0	10.5	93.8	92.6	91.8	91.5	90.0	89.5	53.1	52.7	54.4	54.4	55.4	56.0
Sub total S & T Related	10.6	11.2	11.7	11.5	12.0	12.3	89.4	88.8	83.3	88.5	88.0	87.7	100.0	100.0	100.0	100.0	100.0	100.0

Source : Public Service Department

Notes : Prof./Tech indicates staff in the salary groups 'Management and Professional and Top Management [and Technical Services' (used exclusively for engineers)]

Table 5.1: Perceived Knowledge and Interest about Various General and S&T Related Issues by Gender, 1996-98

Issues	Knowledge						Interest					
	Total		Male		Female		Total		Male		Female	
	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998
Environmental pollution	2.99	3.06	3.01	3.04	2.97	3.09	3.33	2.96	3.29	2.93	3.36	3.00
Economy and business	2.43	2.62	2.51	2.68	2.35	2.55	3.02	2.77	3.11	2.81	2.94	2.72
New invention from Malaysia	-	2.32	-	2.36	-	2.28	-	2.60	-	2.64	-	2.56
Application of computer technology	2.43	2.30	2.47	2.28	2.40	2.32	3.33	2.70	3.35	2.66	3.30	2.73
New technology and innovation	-	2.26	-	2.32	-	2.21	-	2.59	-	2.65	-	2.53
National education policy	2.44	2.15	2.45	2.18	2.42	2.11	3.10	2.37	3.11	2.37	3.09	2.37
New discovery in medical fields	2.12	2.10	2.11	2.11	2.14	2.09	2.96	2.42	2.89	2.40	3.01	2.44
New discovery in science	2.28	2.08	2.34	2.12	2.22	2.03	3.14	2.39	3.16	2.43	3.13	2.35
Aerospace exploration	2.06	1.97	2.13	2.04	1.97	1.91	2.89	2.28	2.53	2.34	2.84	2.21
Application of nuclear technology to promote energy	1.84	1.93	1.92	2.00	1.76	1.86	2.60	2.10	2.66	2.16	2.53	2.04
International and foreign policies	2.01	1.82	2.06	1.88	1.96	1.75	2.83	2.06	2.89	2.12	2.78	2.01
Overall knowledge/interest	**2.29**	**2.23**	**2.34**	**2.27**	**2.24**	**2.20**	**3.02**	**2.47**	**3.04**	**2.50**	**3.00**	**2.45**

Knowledge Score: 4="excellent", 3="average", 2="poor" and 1="none"

Interest Score: 4="interested", 3="moderately interested", 2="slightly interested" and 1="not interested"

Source: Public Awareness of Science and Technology Malaysia 1998, MASTIC

Table 5.2: Perceived Knowledge and Interest about Various General and S&T Related Issues by Age Group, 1996-98

Issues	Knowledge						Interest					
	Children		Youths		Adults		Children		Youths		Adults	
	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998
Environmental pollution	2.80	2.89	3.14	3.14	2.94	3.07	3.14	2.68	3.36	3.02	3.35	2.99
Economy and business	1.94	2.10	2.47	2.53	2.60	2.74	2.74	2.21	2.93	2.67	3.15	2.89
New invention from Malaysia	-	2.15	-	2.42	-	2.32	-	2.46	-	2.75	-	2.57
Application of computer technology	2.33	2.22	2.58	2.43	2.39	2.26	3.19	2.67	3.43	2.93	3.29	2.62
New technology and innovation	-	2.15	-	2.39	-	2.24	-	2.52	-	2.78	-	2.54
National education policy	2.10	1.79	2.56	2.16	2.50	2.20	3.02	2.07	2.05	2.40	3.16	2.41
New discovery in medical fields	1.84	1.84	2.20	2.12	2.18	2.14	2.84	2.21	2.99	2.51	2.96	2.42
New discovery in science	2.13	1.89	2.46	2.27	2.22	2.05	3.15	2.29	3.19	2.62	3.12	2.33
Aerospace exploration	2.02	2.00	2.56	2.13	1.95	1.92	2.94	2.46	3.08	2.53	2.76	2.16
Application of nuclear technology to promote energy	1.61	1.78	2.00	2.02	1.83	1.92	2.45	1.92	2.65	2.23	2.60	2.09
International and foreign policies	1.65	1.43	2.07	1.80	2.12	1.99	2.63	1.78	2.76	2.05	2.94	2.13
Overall knowledge/interest	**2.05**	**2.02**	**2.41**	**2.30**	**2.31**	**2.25**	**2.90**	**2.29**	**3.05**	**2.59**	**3.04**	**2.47**

Knowledge Score: 4="excellent", 3="average", 2="poor" and 1="none"

Interest Score: 4="interested", 3="moderately interested", 2="slightly interested" and 1="not interested"

Source: Public Awareness of Science and Technology Malaysia 1998, MASTIC

Table 5.3: Perception and Attitude Towards Science and Technology by Age and Locality, 1996-98

Statement	Percentage that Agreed to the Given Statement											
	Total		Children		Youths		Adults		Urban		Rural	
	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998
1. Daily chores are more interesting with the application of S&T	84.3	85.3	79.6	82.9	86.6	86.2	84.1	85.3	84.2	85.2	83.8	85.4
2. S&T make our life healthier, easier and more comfortable	82.8	83.9	81.5	83.4	84.2	82.5	82.2	83.9	82.4	84.0	83.1	83.9
3. I need to know about science in my daily life	78.0	83.5	76.0	82.9	82.6	87.1	75.9	83.5	79.5	84.7	76.1	82.3
4. Most scientists work toward improving life	82.1	81.6	80.2	79.5	84.2	83.2	80.6	81.6	83.3	81.9	79.6	81.3
5. Scientific research is necessary even though it does not bring immediate benefits	78.8	80.5	68.7	74.6	81.8	79.6	80.6	80.5	79.1	81.5	78.1	79.6
6. New inventions will counteract harmful consequences of technological development	75.1	73.5	68.6	70.7	77.6	74.0	75.1	73.5	75.0	73.0	77.4	74.1
7. Science make life changes too fast	69.2	71.4	60.8	64.6	70.4	71.4	71.5	71.4	69.1	70.9	69.0	72.0
8. Computers create more jobs than they eliminate	58.6	58.1	59.3	58.6	61.3	58.9	56.3	58.1	55.9	56.3	61.4	60.0
9. Scientists should research about health even if it causes pain to the animals	NA	49.0	NA	41.7	NA	48.2	NA	49.0	NA	47.8	NA	50.3
10. Quality of science and mathematics education in the school is not satisfactory	NA	42.2	NA	29.2	NA	42.9	NA	42.2	NA	44.8	NA	39.5
11. People depend too much on science, less on faith	25.0	27.4	21.5	22.5	26.6	27.2	25.1	27.4	24.9	29.2	24.8	25.2

Key: NA = Not Available

Note: Statement 10 and 11 are new statement added in 1998

Source: Public Awareness of Science and Technology Malaysia 1998, MASTIC

Table 5.4 : Perception and Attitude Towards Science and Technology by Educational Level and Gender, 1996-98

Statement	Tertiary		Secondary		Primary		Male	Female
	1996	1998	1996	1998	1996	1998	1998*	1998*
1. Daily chores are more interesting with the application of S&T	89.1	90.5	85.6	86.2	76.0	77.6	85.3	85.3
2. S&T make our life healthier, easier and more comfortable	82.3	82.5	83.5	84.1	79.7	87.7	84.2	87.3
3. I need to know about science in my daily life	87.1	92.7	79.1	84.4	68.7	70.4	82.4	84.7
4. Most scientists work toward improving life	83.3	84.2	83.0	82.5	76.8	76.9	81.3	82.0
5. Scientific research is necessary even though it does not bring immediate benefits	88.9	89.9	79.5	80.4	69.2	69.4	80.0	81.1
6. New inventions will counteract harmful consequences of technological development	79.0	76.0	75.5	75.3	69.4	64.9	72.2	74.9
7. Science make life changes too fast	74.4	74.0	70.2	72.4	61.8	65.4	71.6	71.2
8. Computers create more jobs than they eliminate	47.5	48.0	60.1	62.9	59.5	58.6	58.5	57.7
9. Scientists should research about health even if it causes pain to the animals	NA	51.1	NA	49.9	NA	45.0	51.4	46.6
10. Quality of science and mathematics education in the school is not satisfactory	NA	52.1	NA	39.9	NA	37.7	42.9	41.4
11. People depend too much on science, less on faith	26.3	31.3	25.4	27.6	22.8	23.4	28.6	26.2

Key: NA = Not Available

Note: Statement 10 and 11 are new statement added in 1998

* Data for 1996 are not available

Source: Public Awareness of Science and Technology Malaysia 1998, MASTIC

Table 5.5: Understanding of Scientific Terms and Concepts by Gender and Age, 1996-98

Terms and Concepts	Percentage of Correct Answers											
	Total		Male		Female		Children		Youths		Adults	
	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998
A. Cigarette smoking causes lung cancer (True)	92.3	94.0	91.4	93.0	93.3	95.0	91.9	92.0	93.3	95.2	92.0	93.9
B. The oxygen we breath comes from plants (True)	82.4	82.8	83.7	83.4	81.2	82.1	82.0	84.4	89.2	89.4	78.6	80.3
C. The earth goes round the sun (True)	77.2	82.5	78.2	83.1	76.2	82.0	68.7	63.5	75.3	74.9	74.0	70.3
D. The centre of the earth is very hot (True)	70.1	72.1	72.4	74.3	67.9	69.8	64.2	71.6	77.2	77.0	68.0	70.6
E. Which travel faster, light or sound? (Light)	73.4	70.5	77.0	75.3	69.7	65.5	74.0	83.0	82.2	82.9	75.5	82.3
F. Radioactive milk can be made safe by boiling it (False)	58.3	63.7	58.4	63.3	58.3	64.1	50.4	56.4	61.2	64.0	59.6	64.8
G. The continents on which we live have been moving their location for millions of years and will continue to move in the future (True)	60.0	63.6	61.8	64.1	58.3	63.0	55.6	58.8	63.1	64.9	60.0	64.0
H. Human beings, as we know them today, developed from earlier species of animals (False)	55.6	58.5	55.8	57.9	55.4	59.2	52.0	54.9	53.4	56.1	58.4	59.9
I. How long does it take for the earth to go round the sun: one day, one month, one year or others? (One year)	52.7	54.2	54.2	55.9	51.3	52.4	47.0	57.8	59.8	61.8	50.7	51.0
J. The earliest humans lived at the same time as the dinosaurs (False)	44.5	51.0	45.3	52.5	43.8	49.5	44.2	48.2	44.2	52.6	44.7	51.0
K. It is the father's gene which decides whether the baby is a boy or a girl (True)	38.9	45.8	37.6	43.7	40.2	47.9	24.8	35.5	45.7	50.1	40.4	46.1
L. The universe began with a huge explosion (False)	37.6	41.5	37.6	40.0	37.6	43.1	41.9	46.4	38.3	42.1	35.6	40.5
M. Electrons are smaller than atoms (True)	40.7	40.5	41.4	41.3	39.9	39.8	32.3	31.1	49.0	49.0	38.8	39.5
N. All radioactivity is manmade (False)	30.3	31.4	30.4	31.8	30.3	31.0	30.4	28.6	34.3	34.4	27.8	30.9
O. Lasers work by focusing sound waves (False)	26.1	30.6	29.4	32.2	22.9	29.0	30.5	32.6	27.5	33.6	23.7	29.3
P. Antibiotics kill viruses as well as bacteria (False)	13.6	19.8	14.4	20.6	12.7	19.0	11.8	14.8	14.7	20.9	15.5	20.3
Mean Percentage Correct	**53.4**	**56.4**	**54.3**	**57.0**	**52.4**	**55.8**	**50.1**	**53.7**	**56.8**	**59.3**	**52.6**	**55.9**

Source: Public Awareness of Science and Technology Malaysia 1998, MASTIC

Table 5.6: Understanding of Scientific Terms and Concepts by Educational Level, 1996-98

Terms and Concepts	Percentage of Correct Answers					
	Tertiary		Secondary		Primary	
	1996	1998	1996	1998	1996	1998
A. Cigarette smoking causes lung cancer (True)	96.7	94.6	94.8	95.0	88.8	88.9
B. The oxygen we breath comes from plants (True)	93.8	90.9	84.2	84.5	75.1	65.0
C. The earth goes round the sun (True)	86.4	83.5	82.8	70.8	62.0	54.0
D. The centre of the earth is very hot (True)	82.2	81.9	72.3	73.0	61.2	56.4
E. Which travel faster, light or sound? (Light)	85.7	85.8	70.0	84.0	63.3	72.8
F. Radioactive milk can be made safe by boiling it (False)	76.2	76.8	63.1	63.4	48.4	49.7
G. The continents on which we live have been moving their location for millions of years and will continue to move in the future (True)	70.7	70.8	64.5	65.3	52.4	47.8
H. Human beings, as we know them today, developed from earlier species of animals (False)	66.4	60.9	59.0	57.6	50.0	59.5
I. How long does it take for the earth to go round the sun: one day, one month, one year or others? (One year)	75.7	72.4	52.4	54.2	34.7	32.4
J. The earliest humans lived at the same time as the dinosaurs (False)	57.9	57.4	52.5	51.2	36.7	43.0
K. It is the father's gene which decides whether the baby is a boy or a girl (True)	57.2	54.7	46.5	46.3	29.4	33.2
L. The universe began with a huge explosion (False)	42.0	40.4	44.1	42.2	34.3	40.3
M. Electrons are smaller than atoms (True)	60.3	55.4	41.1	40.7	29.8	23.4
N. All radioactivity is manmade (False)	50.8	46.5	27.5	30.1	24.3	20.1
O. Lasers work by focusing sound waves (False)	28.3	35.9	31.2	30.1	25.3	26.1
P. Antibiotics kill viruses as well as bacteria (False)	29.0	29.3	17.4	18.4	9.4	15.0
Mean Percentage Correct	66.2	64.8	56.5	56.7	45.3	45.5

Source: Public Awareness of Science and Technology Malaysia 1998, MASTIC

Table 5.7: Understanding of Scientific Terms and Concepts by Educational Streams, 1996-98

Terms and Concepts	Percentage of Correct Answers							
	Science		Commerce		Arts		Religious Studies	
	1996	1998	1996	1998	1996	1998	1996	1998
A. Cigarette smoking causes lung cancer (True)	94.4	96.0	93.7	95.6	93.1	95.3	93.8	93.4
B. The oxygen we breath comes from plants (True)	90.6	91.1	84.7	87.6	83.7	85.7	79.8	83.4
C. The earth goes round the sun (True)	89.1	84.8	78.4	72.2	73.3	74.2	69.4	71.2
D. The centre of the earth is very hot (True)	83.7	85.9	74.8	76.5	68.3	71.6	61.7	65.5
E. Which travel faster, light or sound? (Light)	91.1	88.2	84.3	83.7	77.7	84.8	81.3	75.7
F. Radioactive milk can be made safe by boiling it (False)	69.7	74.5	60.1	67.4	58.8	66.0	51.8	62.7
G. The continents on which we live have been moving their location for millions of years and will continue to move in the future (True)	71.8	72.5	60.8	64.1	60.6	67.9	56.5	59.8
H. Human beings, as we know them today, developed from earlier species of animals (False)	54.5	57.8	54.8	53.9	58.8	60.4	73.1	74.7
I. How long does it take for the earth to go round the sun: one day, one month, one year or others? (One year)	74.0	74.2	61.7	59.8	51.7	55.7	45.0	48.7
J. The earliest humans lived at the same time as the dinosaurs (False)	49.1	58.0	46.3	52.3	44.6	50.7	46.6	56.8
K. It is the father's gene which decides whether the baby is a boy or a girl (True)	52.1	53.1	45.2	50.2	41.3	49.8	35.2	46.5
L. The universe began with a huge explosion (False)	35.0	41.7	39.3	40.0	38.7	41.6	36.8	45.6
M. Electrons are smaller than atoms (True)	64.1	62.7	41.9	43.4	39.1	40.2	32.6	35.2
N. All radioactivity is manmade (False)	47.4	49.5	28.8	33.3	26.0	28.5	26.9	25.0
O. Lasers work by focusing sound waves (False)	30.7	33.5	24.9	32.8	23.7	29.2	16.1	30.7
P. Antibiotics kill viruses as well as bacteria (False)	21.5	27.8	13.7	23.3	12.1	17.4	9.8	14.8
Mean Percentage Correct	**63.7**	**70.3**	**55.8**	**58.5**	**53.2**	**57.4**	**51.0**	**55.6**

Source: Public Awareness of Science and Technology Malaysia 1998, MASTIC

Table 5.8: Sources of Information by Age Group, Locality and Educational Level, 1996-98

National, Age, Locality and Educational Level	Sources									
	TV		Newspaper		Radio		Magazine		Science Magazine	
	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998
National	97.3	97.6	93.6	92.6	82.5	78.8	71.1	81.0	53.8	55.6
Adult	96.3	97.4	93.9	93.0	80.2	77.3	65.5	77.4	17.1	51.4
Youth	98.1	97.6	95.7	94.2	88.5	87.3	79:9	90.4	24.5	66.3
Children	99.1	98.6	89.9	88.1	79.0	71.5	72.0	83.9	17.3	59.8
Urban	97.6	97.8	94.5	94.0	81.5	78.4	72.5	82.2	18.1	58.2
Rural	97.2	97.6	88.1	91.2	83.9	79.3	69.5	79.6	20.5	53.0
At Most Primary School	97.3	94.8	83.5	75.5	76.4	68.2	52.7	53.4	10.7	28.3
Secondary School	97.5	98.1	96.1	95.4	83.8	80.6	73.9	84.7	18.7	56.4
Tertiary	97.0	97.9	98.8	98.1	85.1	83.1	85.1	93.6	36.5	79.3

Source: Public Awareness of Science and Technology Malaysia 1998, MASTIC

Table 6.1: Overview of National R&D Expenditure, 1992-98

	1992	1994	1996	1998
Expenditure				
Overall (RM million)	550.7 (100.0%)	611.2 (100.0%)	549.1(100.0%)	1127(100.0%)
Private Sector (RM million)	246.3 (44.8%)	292.6 (47.8%)	400.1(72.8%)	746.1(66.0%)
GRI's (RM million)	253.7 (46.0%)	164.9 (27.2%)	108.7(19.8%)	247.3(22.0%)
IHL's (RM million)	50.7 (9.2%)	150.9 (24.6%)	40.4(7.4%)	133.6 (12.0%)
NPO (RM million)	-	2.9 (0.4%)	-	-
Expenditure Per Research Personnel	-	RM18,500	RM19,513	RM22,946
Ratio GERD/GDP%	0.3	0.34	0.22	0.39

Source: 1998 National Survey of Research and Development, MASTIC

Table 6.2: Type of Research and Priority Areas, 1992-98

	Expenditure (RM million)			
Type of Research	**1992**	**1994**	**1996**	**1998**
Basic	68.8	44.2	49.2	138.8
Applied	271.7	383.5	228.5	568.6
Experimental Work	210.2	183.5	271.4	419.6
Total	**550.7**	**611.2**	**549.1**	**1127**
	Priority Areas			
Sector	**Field of Research (FOR)**			
	1992	**1994**	**1996**	**1998**
Private Sector	Engineering Sciences	Applied Science & Technology	Engineering Sciences	Applied Science & Technology
GRI	Agricultural Sciences	Agricultural Sciences	Agricultural Sciences	Information, Computer & Communications Technologies
IHL	Agricultural Sciences	Biological Sciences	Biological Sciences	Chemical Sciences
Sector	**Sosio-economic Objectives (SEO)**			
	1992	**1994**	**1996**	**1998**
Private Sector	Manufacturing	Manufacturing	Manufacturing	Manufacturing
GRI	Plant Production & Primary Products	Plant Production & Primary Products	Plant Production & Primary Products	Plant Production & Primary Products
IHL	Manufacturing	Energy Resources	Manufacturing	Manufacturing

Source: 1998 National Survey of Research and Development, MASTIC

Table 6.3: R&D Expenditure by Sector and Type of Cost, 1992-98

Sector	RM (Current Prices)											
	Current Expenditure				Capital Expenditure				Total Expenditure			
	1992	1994	1996	1998	1992	1994	1996	1998	1992	1994	1996	1998
Private Sector	125,409,000	192,462,715	207,284,574	423,976,880	120,929,000	100,120,666	192,852,221	322,101,907	246,335,000	292,583,381	400,136,795	746,078,787
GRI	181,628,103	133,643,883	87,745,906	169,978,178	72,050,980	31,209,129	21,003,909	77,337,423	253,679,083	164,853,011	108,749,815	247,315,601
IHL	31,141,767	27,486,381	34,282,588	102,305,045	19,543,387	123,393,123	6,057,185	31,333,156	50,685,154	150,879,504	40,339,773	133,638,201
NPO	-	-	-	-	-	172,350	-	-	-	2,910,568	-	-
Total	338,178,870	353,592,979	329,313,068	696,260,104	212,523,367	254,895,268	219,913,315	430,772,486	550,699,237	611,226,464	549,226,383	1,127,032,589

Sector	Per Cent of Total											
	Current Expenditure				Capital Expenditure				Total Expenditure			
	1992	1994	1996	1998	1992	1994	1996	1998	1992	1994	1996	1998
Private Sector	37.1	54.4	62.9	60.9	56.9	39.3	87.7	74.8	44.7	47.9	72.9	66.2
GRI	53.7	37.8	26.6	24.4	33.9	12.2	9.6	18.0	46.1	27.0	19.8	21.9
IHL	9.2	7.8	10.4	14.7	9.2	48.4	2.8	7.3	9.2	24.7	7.3	11.9
NPO	-	-	-	-	-	0.1	-	-	-	0.5	-	-
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: 1998 National Survey of Research and Development, MASTIC

Table 6.4: R&D Expenditure by Sector and Field of Research (FOR), 1998

FOR Code	Field of Research	Total Expenditure (RM)			Total	% of Total
		GRI	IHL	Private		
F10100	Mathematical Sciences	-	2,581,195.00	-	2,581,195.00	0.23
F10200	Physical Sciences	100,600.00	1,805,560.27	1,703,426.43	3,609,586.70	0.32
F10300	Chemical Sciences	1,138,377.34	68,691,713.39	5,485,485.69	75,315,576.42	6.68
F10400	Earth Sciences	781,617.71	1,273,022.18	-	2,054,639,89	0.18
F10500	Information, Computer & Communication Technologies	99,864,779.90	6,691,298.45	156,426,885.16	262,982,963.51	23.33
F10600	Applied Science & Technologies	30,148,019.77	4,027,345.67	291,731,839.71	325,907,205.15	28.92
F10700	Engineering Sciences	8,024,561.23	4,001,824.46	230,474,630.91	242,501,016.60	21.52
F10800	Biological Sciences	24,400,266.27	6,495,262.21	3,019,029.00	33,914,557.48	3.01
F10900	Agricultural	61,520,062.02	8,086,372.67	28,868,979.56	98,475,414.25	8.74
F11000	Medical & Health Sciences	4,599,843.44	20,820,428.77	7,931,195.50	33,351,467.71	2.96
F11100	Environmental Sciences	1,082,496.18	3,833,791.12	2,525,000.00	7,441,287.30	0.66
F11200	Material Sciences	13,596,030.88	1,141,893.56	8,036,170.10	22,774,094.54	2.02
F11300	Marine Sciences	101,000.00	-	20,520.00	121,520.00	0.01
F20100	Sosial Sciences	1,957,945.95	3,495,623.53	9,855,625.42	15,309,194.90	1.36
F20200	Humanities	-	692,869.90	-	692,869.90	0.06
	Total	247,315,600.69	133,638,201.18	746,078,787.48	1,127,032,589.35	100.00
	% of Total	21.94	11.86	66.20	100.00	

Source: 1998 National Survey of Research and Development, MASTIC

Table 6.5a: Socio-economic Objectives (SEO) of R&D by Sector (Expenditure), 1996-98

SEO Code	Socio-economic Objective	Total Expenditure (RM)								% of Total	
		GRI		IHL		Private Sector		Total			
		1996	1998	1996	1998	1996	1998	1996	1998	1996	1998
	Defence:	**1,786,951.27**	**1,423,788.10**	**109,062**	**20,000.00**	**655,208.20**	**17,740,520.00**	**2,551,221.47**	**19,184,308.10**	**0.46**	**1.71**
S10100	Defence	1,786,951.27	1,423,788.10	109,062	20,000.00	655,208.20	17,740,520.00	2,551,221.47	19,184,308.10	0.46	1.71
	Economic Development:	**88,282,444.90**	**215,236,095.29**	**23,564,541**	**95,580,184.25**	**385,192,400.95**	**703,908,002.99**	**497,039,386.85**	**1,014,724,282.53**	**90.49**	**90.02**
S20100	Plant Prod. & Prim. Prod.	50,759,753.23	75,156,448.55	1,487,661	29,900,045.78	29,699,635.40	30,946,506.45	81,947,049.63	136,003,000.78	14.92	12.07
S20200	Animal Prod. & Prim. Prod.	10,435,091.10	6,396,879.50	1,969,402	2,546,802.29	-	-	12,404,493.10	8,943,681.79	2.26	0.79
S20300	Mineral Resources	163,030.39	303,984.07	101,891	368,251.32	-	50,000.00	264,921.39	722,235.39	0.05	0.06
S20400	Energy Resources	378,924.40	421,000.00	3,022,696	1,147,884.12	55,619,854.00	76,018,699.85	59,021,474.40	77,587,583.97	10.74	6.88
S20500	Energy Supply	-	-	1,505,321	3,253,255.27	45,256,708.00	299,000.00	46,762,029.00	3,552,255.27	8.51	0.32
S20600	Manufacturing	16,773,174.73	28,843,356.46	10,840,002	48,806,522.81	227,480,336.70	506,064,702.12	255,093,513.43	583,714,581.39	46.44	51.79
S20700	Construction	77,419.20	1,085,614.95	872,470	757,108.31	992,523.45	1,099,130.50	1,942,412.65	2,941,853.76	0.35	0.26
S20800	Transport	421,752.00	2,081,532.23	144,981	175,498.69	519,800.00	316,000.00	1,086,533.00	2,573,030.92	0.20	0.23
S20900	Information & Comm. Services	516,342.29	92,003,855.19	1,310,553	4,487,440.70	14,480,629.60	83,051,464.48	16,307,524.89	179,542,760.37	2.97	15.93
S21000	Commercial Services	2,616,386.75	-	300,502	385,116.53	5,974,505.90	-	8,891,394.65	385,116.53	1.62	0.03
S21100	Economic Framework	2,917,213.12	1,624,991.42	859,103	1,943,588.85	3,874,960.40	6,017,589.59	7,651,276.52	9,586,169.86	1.40	0.85
S21200	Natural Resource	3,223,357.69	7,318,432.92	1,149,959	1,808,669.58	1,293,447.50	44,910.00	5,666,764.19	9,172,012.50	1.03	0.81
	Society:	**9,062,549.26**	**22,539,748.04**	**8,035,487**	**20,937,523.77**	**3,102,570.20**	**1,808,128.00**	**20,200,606.46**	**45,285,399.81**	**3.68**	**4.02**
S30100	Health	7,786,670.46	22,346,365.64	6,089,141	19,901,057.81	765,305.00	-	14,641,116.46	42,247,423.45	2.67	3.75
S30200	Education & Training	150,033.60	93,382.40	1,482,884	730,648.06	2,337,265.20	-	3,970,182.80	824,030.46	0.72	0.07
S30300	Social Dev. & Com. Services	1,125,845.20	100,000.00	463,462	305,817.90	-	1,808,128.00	1,589,307.20	2,213,945.90	0.29	0.20
	Advancement of Knowledge:	**9,611,149.96**	**8,115,969.26**	**8,700,384**	**17,100,493.16**	**3,102,570.20**	**22,622,136.49**	**29,498,149.66**	**47,838,598.91**	**5.37**	**4.25**
S40100	Environ. Knowledge	3,017,385.41	883,789.89	1,257,063	4,827,917.76	379,898.65	-	4,654,347.06	5,711,707.65	0.85	0.51
S40200	Environ. Aspects of Dev.	4,034,142.90	1,679,081.20	2,209,288	313,246.68	6,114,745.60	300,000.00	12,358,176.50	2,292,327.88	2.25	0.21
S40300	Environ. Mgt. & Other Aspect	1,418,041.10	570,833.80	1,550,879	3,087,284.24	3,800,250.75	2,525,000.00	6,769,170.85	6,183,118.04	1.23	0.55
S50100	Natural Sciences Techno & Engin	1,021,851.55	4,982,264.37	3,275,765	8,597,791.75	891,720.70	19,797,136.49	5,189,337.25	33,377,192.61	0.94	2.96
S50200	Social Sciences & Humanities	119,729.00	-	407,389	274,252.73	-	22,622,136.49	527,118.00	274,252.73	0.10	0.02
	Total	108,743,095.39*	247,315,600.69	40,409,473*	133,638,201.18	400,136,795.05	746,078,787.48	549,289,364.44	1,127,032,589.35	100.00	100.00
	% of Total	19.80	21.94	7.36	11.86	72.84	66.20	100.00	100.00		

Note: * Taken from table 5.6 and 7.6 1996 National Survey of Research and Developtment, MASTIC

Source: 1996 & 1998 National Survey of Research and Development, MASTIC

Table 6.5b: Socio-economic Objectives of R&D by Sector (FTE), 1996-98

SEO Code	Socio-economic Objective	FTE												Total		% of Total	
		GRI				IHL				Private							
		1996	%	1998	%	1996	%	1998	%	1996	%	1998	%	1996	1998	1996	1998
	Defence:	**4.87**	**1.03**	**5.80**	**0.78**	**1.76**	**0.34**	**0.20**	**0.03**	**6.59**	**0.64**	**22.00**	**1.10**	**13.22**	**28.00**	**0.66**	**0.82**
S10100	Defence	4.87	1.03	5.80	0.78	1.76	0.34	0.20	0.03	6.59	0.64	22.00	1.10	13.22	28.00	0.66	0.82
	Economic Development:	**368.22**	**78.24**	**604.75**	**81.62**	**260.07**	**49.99**	**361.21**	**53.29**	**982.62**	**95.73**	**1,883.86**	**94.34**	**1,610.91**	**2,849.82**	**79.84**	**83.43**
S20100	Plant Prod. & Prim. Prod.	199.22	42.33	269.80	36.41	24.42	4.69	84.75	12.50	89.16	8.69	93.01	4.66	312.80	447.56	15.50	13.10
S20200	Animal Prod. & Prim. Prod.	42.37	9.00	43.78	5.91	25.62	4.92	26.01	3.84	-	-	-	-	67.99	69.79	3.37	2.04
S20300	Mineral Resources	1.91	0.41	2.80	0.38	2.28	0.44	6.17	0.91	-	-	1.00	0.05	4.19	9.97	0.21	0.29
S20400	Energy Resources	4.48	0.95	1.10	0.15	29.63	5.69	24.18	3.57	51.24	4.99	235.50	11.79	85.35	260.78	4.23	7.63
S20500	Energy Supply	-	-	-	-	16.06	3.09	4.10	0.60	59.10	5.76	10.00	0.50	75.16	14.10	3.73	0.41
S20600	Manufacturing	75.19	15.98	110.24	14.88	69.46	13.35	94.93	14.00	607.08	59.14	1,199.99	60.09	751.73	1,405.16	37.26	41.14
S20700	Construction	3.34	0.71	11.55	1.56	5.72	1.10	25.40	3.75	9.18	0.89	1.40	0.07	18.24	38.35	0.90	1.12
S20800	Transport	6.30	1.34	20.50	2.77	5.18	1.00	7.20	1.06	4.62	0.45	2.95	0.15	16.10	30.65	0.80	0.90
S20900	Info. & Comm. Services	11.50	2.44	87.31	11.78	22.38	4.30	32.75	4.83	132.20	12.88	299.01	14.97	166.08	419.07	8.23	12.27
S21000	Commercial Services	1.68	0.36	-	-	5.99	1.15	5.68	0.84	17.56	1.71	-	-	25.23	5.68	1.25	0.17
S21100	Economic Framework	9.27	1.97	11.54	1.56	29.30	5.63	19.57	2.89	6.91	0.67	40.00	2.00	45.48	71.11	2.25	2.08
S21200	Natural Resource	12.96	2.75	46.13	6.22	24.03	4.63	30.47	4.50	5.57	0.54	1.00	0.05	42.56	77.60	2.12	2.28
	Society:	**51.00**	**10.84**	**69.91**	**9.43**	**168.37**	**32.36**	**132.19**	**19.50**	**9.40**	**0.91**	**18.57**	**0.93**	**228.77**	**220.67**	**11.34**	**6.46**
S30100	Health	47.16	10.03	59.31	8.00	123.70	23.78	114.04	16.82	1.68	0.16	-	-	172.54	173.35	8.55	5.07
S30200	Education & Training	0.67	0.14	0.10	0.01	30.91	5.94	11.70	1.73	7.72	0.75	-	-	39.30	11.80	1.95	0.35
S30300	Social Dev. & Com. Services	3.17	0.67	10.50	1.42	13.76	2.64	6.45	0.95	-	-	18.57	0.93	16.93	35.52	0.84	1.04
	Advancement of Knowledge:	**46.57**	**9.89**	**60.60**	**8.17**	**90.09**	**17.31**	**184.25**	**27.18**	**27.87**	**2.72**	**72.50**	**3.63**	**164.53**	**317.35**	**8.16**	**9.29**
S40100	Environ. Knowledge	14.66	3.12	7.32	0.99	14.49	2.78	34.03	5.02	1.76	0.18	-	-	30.91	41.35	1.53	1.21
S40200	Environ. Aspects of Dev.	10.60	2.25	9.51	1.28	9.87	1.90	7.50	1.11	14.27	1.39	1.00	0.05	34.74	18.01	1.72	0.53
S40300	Environ. Mgt. & Other Aspect	6.51	1.38	9.72	1.31	12.05	2.31	40.81	6.02	4.94	0.48	15.00	0.75	23.50	65.53	1.17	1.92
S50100	Natural Sciences Techno & Engin	7.67	1.63	34.05	4.59	40.73	7.83	86.86	12.81	6.90	0.67	56.50	2.83	55.30	177.41	2.74	5.19
S50200	Social Sciences & Humanities	7.13	1.51	-	-	12.95	2.49	15.05	2.22	-	-	-	-	20.08	15.05	1.00	0.44
	Total	**470.66**	**100.00**	**741.06**	**100.00**	**520.29**	**100.00**	**677.85**	**100.00**	**1,026.48**	**100.00**	**1,996.93**	**100.00**	**2,017.43**	**3,415.84**	**100.00**	**100.00**

Source: 1998 National Survey of Research and Development, MASTIC

Table 6.6: Source of Funds for R&D Expenditure by Sector, 1996-98

1998												
Sector	Own Funds (RM)	External Funds (RM)									Total	% of Total
		Federal Govt.	State/Local Govt.	IRPA	CESS	ITAF	Other Company		Other Funds			
							Local Based	Foreign Based	Local	Foreign		
GRI	81,807,072.24	101,319,873.49	32,674,040.22	25,475,696.45	335,800.00	-	-	-	2,998,649.91	2,704,468.38	247,315,600.69	21.94
IHL	36,536,617	23,259,028.42	41,267,270.00	30,316,609.34	20,000.00	-		-	797,152.12	1,441,524.25	133,638,201.18	11.86
Private	621,979,950.11	-	18,016,554.00	-	-	2,065,993.86	62,161,384.11	35,836,167.17	4,374,138.23	1,644,600.00	746,078,787.48	66.20
Total	740,323,639.35	124,578,901.91	91,957,864.22	55,792,305.79	355,800.00	2,065,993.86	62,161,384.11	35,836,167.17	8,169,940.26	5,790,592.63	1,127,032,589.35	100.00
% of Total	65.69	11.05	8.16	4.95	0.03	0.18	5.52	3.18	0.72	0.51	100.00	

1996												
Sector	Own Funds (RM)	External Funds (RM)									Total	% of Total
		Federal Govt.	State/Local Govt.	IRPA	CESS	ITAF	Other Company		Other Funds			
							Local Based	Foreign Based	Local	Foreign		
GRI	53,805,103.43	15,116,272.27	9,969,927.92	21,400,849.15	2,963,851.00	-		-	2,449,250.43	3,044,560.64	108,749,814.84	19.79
IHL	18,405,932	986,635.00	198,838.00	20,147,923.00	-	-	-	-	347,322.00	322,823.00	40,409,473.00*	7.36
Private	345,407,598.00	-	18,383.00	-	-	-	45,535,617.00	1,450,000.00	7,724,550.00	-	400,136,148.00*	72.85
Total	417,618,633.43	16,102,907.27	10,187,148.92	41,548,772.15	2,963,851.00	-	45,535,617.00	1,450,000.00	10,521,122.43	3,367,383.64	108,749,814.84	100.00
% of Total	76.03	2.93	1.86	7.56	0.54	-	8.29	0.26	1.92	0.61	100.00	

Note: *Taken from Tabie 6.16 and 7.2 1996 National Survey of Research and Development, MASTiC

Source: 1996 & 1998 National Survey of Research and Development, MASTIC

Table 6.7: Extramural R&D Expenditure and R&D Expenditure Outsourced Overseas, 1996-98

Sector	Extramural R&D Expenditure 1998*							
	Total (RM) Outsourced Locally to					Total (RM) Outsourced Oversea	Total	% of Total
	IHL	GRI	Private	Others	Total			
Private	4,577,212.00	4,734,479.32	3,282,043.00	53,190.00	12,646,924.32	56,995,626.57	69,642,550.89	92.60
GRI	3,366,444.41	33,106.00	40,000.00	20,000.00	3,459,550.41	1,391,063.30	4,850,613.71	6.45
IHL	432,200.00	22,000.00	-	-	454,200.00	257,300.00	711,500.00	0.95
Total	**8,375,856.41**	**4,789,585.32**	**3,322,043.00**	**73,190.00**	**16,560,674.73**	**58,643,989.87**	**75,204,664.60**	**100.00**
% of Total	**11.14**	**6.37**	**4.42**	**0.1**	**22.02**	**77.98**	**100.00**	

Country	Expenditure Outsourced Overseas					
	Number of Companies		Total Expenditures (RM)		% of Total Expenditures	
	1996	1998	1996	1998	1996	1998
Australia	3	5	225,000	1,301,992	0.4	2.3
China	2	-	804,348	-	1.5	-
Crotia	1	-	35,550	-	0.1	-
England	-	1	-	919,000	0.0	1.6
Germany	1	-	15,000,000	-	28.4	-
India	1	-	1,384,360	-	2.6	-
Italy	-	1	-	30,000,000	0.0	52.6
Japan	2	3	8,832,345	12,519,242	16.7	22.0
Netherland	-	1	-	200,000	0.0	0.4
Singapore	1	3	315,000	1,336,000	0.6	2.3
U.K	4	6	1,084,915	9,522,000	2.1	16.7
U.S.A	4	1	25,198,500	1,197,393	47.7	2.1
Total	**19**	**21**	**52,880,018**	**56,995,627**	**100.0**	**100.0**

*1996 data not available

Source: 1996 & 1998 National Survey of Research and Development, MASTIC

Table 6.8: Private Sector R&D Expenditure by Sales Revenue and Employment Size, 1998

Sales Revenue (RM million)	No. of Companies	Expenditure* (RM)	% of Total
Below 10	73	144,551,467.66	17.7
11 to 50	52	123,011,664.37	15.1
51 to 100	36	112,304,764.56	13.8
Above 100	67	435,853,441.78	53.4
Total	**228**	**815,721,338.37**	**100.0**
Employment Size			
Less than 75	73	83,812,666.14	10.3
75 to 200	42	154,549,177.22	18.9
201 to 500	44	114,620,744.16	14.1
501 to 1000	25	20,443,738.51	2.5
1001 to 2000	24	139,536,731.19	17.1
Above 2000	20	302,758,281.15	37.1
Total	**228**	**815,721,338.37**	**100.0**

* Including Outsourced Expenditure

Source: 1998 National Survey of Research and Development

Table 6.9: Private Sector R&D Expenditure by Industry and Ownership, 1992-98

Industry	RM (Current Prices)											
	1992			1994			1996			1998		
	Foreign	Local	Total Expenditure	Foreign	Local	Total Expenditure	Foreign	Local	Total Expenditure	Foreign	Local	Total Expenditure
Primary:	-	-	-	**367,441**	**34,102,378**	**34,469,819**	**3,668,623**	**32,724,521**	**36,393,144**	**2,735,048**	**20,877,003**	**23,612,051**
Agriculture, Livestock and Fishery	-	-	-	367,441	34,102,378	34,469,819	3,668,623	32,724,521	36,393,144	2,735,048	20,877,003	23,612,051
Mining	-	-	-	-	-	-	-	-	-	-	-	-
Manufacturing:	**119,721,000**	**115,184,000**	**234,905,000**	**112,580,081**	**98,693,986**	**211,274,067**	**100,014,399**	**98,015,812**	**198,030,211**	**237,177,317**	**349,216,933**	**586,394,249**
Food Products, Beverage and Tobacco	1,279,000	14,826,000	16,105,000	4,796,036	16,313,254	21,109,290	1,907,696	8,118,809	10,026,505	3,853,829	5,955,055	9,808,884
Rubber & Plastic Products	1,737,000	3,670,000	5,407,000	8,915,009	3,143,799	12,058,808	6,702,002	15,807,677	22,509,679	16,968,096	15,471,672	32,439,768
Wood, Paper, Printing and Furniture	-	750,000	750,000	-	378,944	378,944	-	3,402,957	3,402,957	-	1,260,470	1,260,470
Textiles, Wearing, Apparel Fur and Leather	446,000	449,000	895,000	415,853	1,623,580	2,039,433	1,464,348	3,629,023	5,093,371	2,487,771	1,753,100	4,240,871
Chemicals and Chemical Products	11,686,000	1,860,000	13,546,000	6,534,487	2,054,007	8,588,494	9,373,911	3,912,888	13,286,798	4,460,005	6,717,532	11,177,537
Pharmaceuticals		-		300,000	10,000	310,000	416,205	176,000	592,205	115,000	3,881,349	3,996,349
Petroleum Products and Refining	1,205,000	24,000	1,229,000	-	30,449,000	30,449,000	-	47,975	47,975	-	54,068,974	54,068,974
Non-Metallic Mineral Products	-	-	-	700,000	495,671	1,195,671	1,350,261	6,173,086	7,523,347	519,658	5,109,554	5,629,212
Electrical Machinery and Appliances	-	-	-	26,852,301	4,923,268	31,775,569	76,000	5,186,164	5,262,164	32,677,086	3,780,353	36,457,440
Electronic Equipment and Components	-	-	-	63,009,473	18,607,765	81,617,238	73,132,425	33,405,294	106,537,719	157,706,540	59,559,273	217,265,813
Sub total Electrical and Electronic	**102,698,000**	**9,673,000**	**112,371,000**	**89,861,774**	**23,531,033**	**113,392,807**	**73,208,425**	**38,591,458**	**111,799,883**	**190,383,627**	**63,339,626**	**253,723,253**
Transport Equipment	-	82,040,000	82,040,000		15,699,753	15,699,753	83,000	4,107,540	4,190,540	500,000	98,910,520	99,410,520
Basic/Fabricated Metal Products	670,000	926,000	1,596,000	936,922	3,108,885	4,045,807	1,420,000	804,009	2,224,009		797,905	797,905
Non-Electrical Machinery	-	570,000	570,000	120,000	99,250	219,250	100,000	488,000	588,000	102,000	175,000	277,000
Instrumentation and Scientific Equipment	-	396,000	396,000	-	-	-		-	-	-	-	-
Other Manufacturing	-	-	-	-	1,786,810	1,786,810	3,988,551	12,756,390	16,744,941	17,787,330	91,776,177	109,563,507
Construction:	-	-	-	-	-	-	-	**353,508**	**353,508**	-	**559,000**	**559,000**
Construction	-	-	-	-	-	-		353,508	353,508	-	559,000	559,000
Electricity, Gas and Water Supply:	-	-	-	-	**16,367,192**	**16,367,192**	-	**26,765,065**	**26,765,065**	-	**20,753,859**	**20,753,859**
Electricity	-	-	-	-	16,367,192	16,367,192	-	26,765,065	26,765,065	-	20,753,859	20,753,859
Services:	-	-	-	-	**30,472,303**	**30,472,303**	**951,090**	**137,643,777**	**138,594,867**	**50,498,257**	**64,261,371**	**114,759,628**
Telecommunication Services	-	-	-	-	7,754,580	7,754,580	448,180	14,748,004	15,196,184	4,278,173	38,233,707	42,511,880
Computer and Related Services	-	-	-	-	20,309,723	20,309,723	-	4,766,435	4,766,435	44,060,084	18,370,672	62,430,756
Other Services (eg. Transport, Wholesale & Retail, Financial, Business Services	-	-	-	-	2,408,000	2,408,000	502,910	118,129,338	118,632,248	2,160,000	7,656,992	9,816,992
Total non Manufacturing	**2,893,000**	**8,573,000**	**11,430,000**	**367,441**	**80,941,873**	**81,309,314**	**4,619,713**	**197,486,871**	**202,106,584**	-	-	-
Total	**122,614,000**	**123,757,000**	**246,335,000**	**112,947,522**	**179,635,859**	**292,583,381**	**104,634,112**	**295,502,684**	**400,136,795**	**290,410,621**	**455,668,166**	**746,078,787**

Source:

1996 Malaysian Science and Technology Indicators Report, MASTIC
1998 National Survey of Research and Development, MASTIC

Table 6.10: Private Sector R&D by Type of Expenditure, 1992-98

Industry	RM (Current Prices)											
	1992			1994			1996			1998		
	Current Expenditure	Capital Expenditure	Total Expenditure	Current Expenditure	Capital Expenditure	Total Expenditure	Current Expenditure	Capital Expenditure	Total Expenditure	Current Expenditure	Capital Expenditure	Total Expenditure
Primary:	-	-	-	**30,902,465**	**3,567,354**	**34,469,819**	**31,903,544**	**4,489,600**	**36,393,144**	**20,562,404**	**3,049,647**	**23,612,051**
Agriculture, Livestock and Fishery	-	-	-	30,902,465	3,567,354	34,469,819	31,903,544	4,489,600	36,393,144	20,562,404	3,049,647	3,049,647
Mining	-	-	-	-	-	-	-	-	-	-	-	-
Manufacturing:	**116,022,000**	**118,883,000**	**234,905,000**	**125,057,675**	**86,216,392**	**211,274,067**	**107,084,842**	**90,945,369**	**198,030,211**	**222,660,497**	**153,684,821**	**376,345,318**
Food Products, Beverage and Tobacco	14,749,000	1,356,000	16,105,000	12,547,663	8,561,627	21,109,290	2,922,754	7,103,751	10,026,505	8,120,060	1,688,824	9,808,884
Rubber & Plastic Products	2,021,000	3,386,000	5,407,000	7,443,066	4,615,742	12,058,808	7,137,982	15,371,697	22,509,679	19,649,138	12,790,630	32,439,768
Wood, Paper, Printing and Furniture	743,000	7,000	750,000	301,775	77,169	378,944	831,457	2,571,500	3,402,957	1,260,470	-	1,260,470
Textiles, Wearing, Apparel Fur and Leather	777,000	118,000	895,000	1,417,873	621,560	2,039,433	3,490,525	1,602,846	5,093,371	2,875,899	1,364,972	4,240,871
Chemicals and Chemical Products	5,777,000	7,769,000	13,546,000	8,076,450	512,044	8,588,494	7,736,322	5,550,477	13,286,798	7,135,375	4,042,163	11,177,537
Pharmaceuticals	-	-	-	310,000	-	310,000	434,205	158,000	592,205	3,240,444	755,905	3,996,349
Petroleum Products and Refining	1,099,000	130,000	1,229,000	23,276,000	7,173,000	30,449,000	47,975	-	47,975	42,180,600	11,888,374	54,068,974
Non-Metallic Mineral Products	-	-	-	962,071	233,600	1,195,671	4,758,215	2,765,132	7,523,347	3,405,766	2,223,447	5,629,212
Electrical Machinery and Appliances	-	-	-	21,839,505	9,936,064	31,775,569	5,016,084	246,080	5,262,164	31,149,239	5,308,201	36,457,440
Electronic Equipment and Components	-	-	-	41,715,065	39,902,173	81,617,238	61,478,464	45,059,255	106,537,719	103,643,507	113,622,306	217,265,813
Sub total Electrical and Electronic	**82,756,000**	**29,615,000**	**112,371,000**	**63,554,570**	**49,838,237**	**113,392,807**	**66,494,548**	**45,305,335**	**111,799,883**	**134,792,746**	**118,930,507**	**253,723,253**
Transport Equipment	6,779,000	75,261,000	82,040,000	4,953,742	10,746,011	15,699,753	2,259,025	1,931,515	4,190,540	47,934,020	51,476,500	99,410,520
Basic/Fabricated Metal Products	991,000	605,000	1,596,000	1,452,405	2,593,402	4,045,807	714,009	1,510,000	2,224,009	702,905	95,000	797,905
Non-Electrical Machinery	170,000	400,000	570,000	209,250	10,000	219,250	536,000	52,000	588,000	238,000	39,000	277,000
Instrumentation and Scientific Equipment	160,000	236,000	396,000	-	-	-	-	-				
Other Manufacturing	-	-	-	552,810	1,234,000	1,786,810	9,721,825	7,023,116	16,744,941	71,058,438	38,505,069	109,563,507
Construction:	-	-	-	-	-	-	**353,508**	-	**353,508**	**369,000**	**190,000**	**559,000**
Construction	-	-	-	-	-	-	353,508	-	353,508	369,000	190,000	190,000
Electricity, Gas and Water Supply:	-	-	-	**10,331,173**	**6,036,019**	**16,367,192**	**26,765,065**	-	**26,765,065**	**9,197,860**	**11,555,999**	**20,753,859**
Electricity	-	-	-	10,331,173	6,036,019	16,367,192	26,765,065	-	26,765,065	9,197,860	11,555,999	20,753,859
Services:	-	-	-	**26,171,402**	**4,300,901**	**30,472,303**	**41,177,615**	**97,417,252**	**138,594,867**	**51,253,757**	**63,505,871**	**114,759,628**
Telecommunication Services	-	-	-	5,101,341	2,653,239	7,754,580	8,265,730	6,930,454	15,196,184	17,311,579	25,200,301	42,511,880
Computer and Related Services	-	-	-	20,198,061	111,662	20,309,723	3,984,088	782,347	4,766,435	26,175,607	36,255,149	62,430,756
Other Services, (eg. Transport, Wholesale & Retail Financial, Business Services	-	-	-	872,000	1,536,000	2,408,000	28,927,797	89,704,451	118,632,248	7,766,571	2,050,421	9,816,992
Total non Manufacturing	**9,387,000**	**2,043,000**	**11,430,000**	**67,405,040**	**13,904,274**	**81,309,314**	**100,199,732**	**101,906,852**	**202,106,584**	-	-	-
Total	**125,409,000**	**120,926,000**	**246,335,000**	**192,462,715**	**100,120,666**	**292,583,381**	**207,284,574**	**192,852,221**	**400,136,795**	**423,976,880**	**322,101,907**	**746,078,787**

Source:
1996 Malaysian Science and Technology Indicators Report, MASTIC
1998 National Survey of Research and Development, MASTIC

Table 6.11: R&D Expenditure in Government Research Institutes (GRIs), 1994-98

GRI	Current Expenditure					
	1994	%	1996	%	1998	%
Agriculture Research Centre of Semonggok	8,517,000	6.37	4,238,408	4.83	1,171,160	0.69
Angkatan Zaman Mansang Sarawak	62,000	0.05	-	-	-	-
Atomic Energy Licencing Board	-	-	41,464	0.05	-	-
Department of Agriculture of Sabah (JTSB)	136989	0.10	-	-	7,345,300	4.32
Department of Agriculture of Sarawak (JTSK)	-	-	-	-	7,041,848	4.14
Department of Environment (DOE)	-	-	-	-	908,267	0.53
Department of Irrigation & Drainage of Malaysia (DID)	611,483	0.46	-	-	72,000	0.04
Department of Museum & Antiquity (DMA)	-	-	80,600	0.09	900,000	0.53
Department of Veterinary Services & Live Stock Sabah (JHSB)	89,261	0.07	-	-	16,000	0.01
Department of Wildlife & National Parks (PERHILITAN)	872,940	0.65	763,012	0.87	105,832	0.06
Fisheries Research Institute, Terengganu Branch	965,604	0.72	-	-	-	-
Fisheries Research Institute, Penang Branch	9,806,491	7.34	3,689,707	4.20	-	-
Fisheries Research Institute, Sarawak Branch	1,057,380	0.79	334,999	0.38	269,389	0.16
Forest Research Institute of Malaysia (FRIM)	8,106,319	6.07	3,076,749	3.51	6,752,845	3.97
Foresty Department of the Malaysian Peninsular (Headquarters)	1,095,720	0.82	-	-	2,821,790	1.66
Geological Survey Department of Malaysian (Headquarters)	57,600	0.04	28,000	0.03	80,504	0.05
Institute for Development Studies, Sabah (IDS)	-	-	-	-	111,202	0.07
Institute for Medical Research (IMR)	2,508,678	1.88	5,968,375	6.80	4,125,062	2.43
Malaysian Agricultural Research Institute (MARDI)	33,033,118	24.72	31,737,226	36.17	35,241,036	20.73
Malaysian Archaelogical Project	87,400	0.07	-	-	-	-
Malaysian Centre for Remote Sensing (MARCRES)	54,663	0.04	23,971	0.03	4,594,305	2.70
Malaysian Cocoa Board (MCB)	3,447,551	2.58	1,437,773	1.64	1,800,625	1.06
Malaysian Department of Geological Research, Sarawak	478,994	0.36	-	-	22,000	0.01
Malaysian Department of Statistic	7,219,849	5.40	331,548	0.38	-	-
Malaysian Industry - Gov. Group For High Technology (MIGHT)	-	-	-	-	136,701	0.08
Malaysian Meteorogical Services	11,171,330	8.36	26,600	0.03	5,252	0.00
Malaysian Ministry of Defence	246,000	0.18	398,000	0.45	687,196	0.40
Malaysian Ministry of Information	240,000	0.18	759,639	0.87		
Malaysian Research Institute for Nuclear Technology (MINT)	2,826,564	2.11	1,562,601	1.78	2,719,188	1.60
Malaysian Rubber Board (MRB)	-	-	-	-	11,066,525	6.51
MIMOS Berhad	81,200	0.06	2,645,288	3.01	75,540,739	44.44
Mines Research Institute (PEGAMA)	831,000	0.62	65,703	0.07	95,240	0.06
National Institute of Public Administration (INTAN)	-	-	-	-	100,000	0.06
National Prawn Fry Production & Research Centre	935,121	0.70	-	-		
National Prawn Fry Production & Research Centre, Kedah (PPPB	-	-	-	-	168,195	0.10
Palm Oil Research Institute of Malaysia (PORIM)	320,767	0.24	1,593,564	1.82	897,454	0.53
Public Work Institute of Malaysia	661,395	0.49	-	-		
PELITA	-	-	-	-	534,435	0.31
Pusat Pengeluaran & Penyelidikan Ikan Laut (PPPIL)	-	-	-	-	361,691	0.21
Rubber Research Institute of Malaysia	3,295,394	2.47	18,000,579	20.51		
Sarawak Development Institute (SDI)	-	-	-	-	172,103	0.10
Sabah Fisheries Department	22,387,630	16.75	-	-		
Sabah Forest Industries	7,907,836	5.92	1,237,023	1.41		
Sabah Forestry Department	1,412,218	1.06	4,979,400	5.67		
Sarawak Forestry Department	-	-	2,130,900	2.43		
SIRIM Bhd.	2,269,693	1.70	1,321,484	1.51	3,415,574	2.01
Veterinary Research Institute (IPH)	848,695	0.64	1,273,293	1.45	698,721	0.41
Total	133,643,883	100.00	87,745,906	100.00	169,978,178	100.00

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GRI	Capital Expenditure					
	1994	%	1996	%	1998	%
Agriculture Research Centre of Semonggok	2,469,995	7.91	1,097,742	5.23	454,404	0.59
Angkatan Zaman Mansang Sarawak	-	-	-	-	-	-
Atomic Energy Licencing Board	-	-	-	-	-	-
Department of Agriculture of Sabah (JTSB)	41,315	0.13	-	-	2,983,600	3.86
Department of Agriculture of Sarawak (JTSK)	-	-	-	-	1,939,651	2.51
Department of Environment (DOE)	-	-	-	-	113,828	0.15
Department of Irrigation & Drainage of Malaysia (DID)	262,246	0.84	-	-	-	-
Department of Museum & Antiquity (DMA)	-	-	-	-	-	-
Department of Veterinary Services & Live Stock Sabah (JHSB)	14,814	0.05	-	-	-	-
Department of Wildlife & National Parks (PERHILITAN)	192,800	0.62	753,000	3.59	212,000	0.27
Fisheries Research Institute, Terengganu Branch	204,000	0.65	-	-	-	-
Fisheries Research Institute, Penang Branch	1,954,190	6.26	1,353,313	6.44	-	-
Fisheries Research Institute, Sarawak Branch	319,754	1.02	31,318	0.15	47,041	0.06
Forest Research Institute of Malaysia (FRIM)	2,315,638	7.42	387,760	1.85	961,384	1.24
Foresty Department of the Malaysian Peninsular (Headquarters)	95,280	0.31	-	-	700,531	0.91
Geological Survey Department of Malaysian (Headquarters)	-	-	30,000	0.14	-	-
Institute for Development Studies, Sabah (IDS)	-	-	-	-	-	-
Institute for Medical Research (IMR)	334,230	1.07	418,770	1.99	534,181	0.69
Malaysian Agricultural Research Institute (MARDI)	1,978,540	6.34	1,198,104	5.70	5,707,207	7.38
Malaysian Archaelogical Project	-	-	-	-	-	-
Malaysian Centre for Remote Sensing (MARCRES)	-	-	10,000	0.05	9,100	0.01
Malaysian Cocoa Board (MCB)	2,594,322	8.31	238,634	1.14	139,182	0.18
Malaysian Department of Geological Research, Sarawak	-		-	-	-	-
Malaysian Department of Statistic	8,478,710	27.17	-	-	-	-
Malaysian Industry - Gov. Group For High Technology (MIGHT)	-	-	-	-	23,050	0.03
Malaysian Meteorogical Services	928,530	2.98	-	-	-	-
Malaysian Ministry of Defence	130,000	0.42	1,309,000	6.23	736,592	0.95
Malaysian Ministry of Information	-	-	174,589	0.83	-	-
Malaysian Research Institute for Nuclear Technology (MINT)	1,466,888	4.70	1,069,494	5.09	19,096,452	24.69
Malaysian Rubber Board (MRB)	-	-	-	-	8,073,839	10.44
MIMOS Berhad	269,400	0.86	1,452,447	6.92	18,003,967	23.28
Mines Research Institute (PEGAMA)	270,000	0.87	77,965	0.37	39,253	0.05
National Institute of Public Administration (INTAN)	-	-	-	-	-	-
National Prawn Fry Production & Research Centre	-	-	-	-	-	-
National Prawn Fry Production & Research Centre, Kedah (PPPB	-	-	-	-	66,000	0.09
Palm Oil Research Institute of Malaysia (PORIM)	277,104	0.89	345,269	1.64	598,000	0.77
Public Work Institute of Malaysia	87,500	0.28	-	-	-	-
PELITA	-	-	-	-	15,949,763	20.62
Pusat Pengeluaran & Penyelidikan Ikan Laut (PPPIL)	-	-	-	-	53,000	0.07
Rubber Research Institute of Malaysia	471,000	1.51	3,072,980	14.63	-	-
Sarawak Development Institute (SDI)	-	0.00	-	-	2,775	0.004
Sabah Fisheries Department	3,594,170	11.52	-	-	-	-
Sabah Forest Industries	607,862	1.95	134,585	0.64	-	-
Sabah Forestry Department	147,248	0.47	130,000	0.62	-	-
Sarawak Forestry Department	-	0.00	7,130,000	33.95	-	-
SIRIM Bhd.	1,467,292	4.70	449,574	2.14	891,514	1.15
Veterinary Research Institute (IPH)	236,300	0.76	139,367	0.66	1,110	0.001
Total	31,209,128	100.00	21,003,911	100.00	77,337,423	100.00

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GRI	Total Expenditure					
	1994	%	1996	%	1998	%
Agriculture Research Centre of Semonggok	10,986,995	6.66	5,336,150	4.91	1,625,564	0.66
Angkatan Zaman Mansang Sarawak	62,000	0.04	-	-	-	-
Atomic Energy Licencing Board	-	-	41,464	0.04	-	-
Department of Agriculture of Sabah (JTSB)	178,303	0.11	-	-	10,328,900	4.18
Department of Agriculture of Sarawak (JTSK)	-	-	-	-	8,981,500	3.63
Department of Environment (DOE)	-	-	-	-	1,022,095	0.41
Department of Irrigation & Drainage of Malaysia (DID)	873,729	0.53	-	-	72,000	0.03
Department of Museum & Antiquity (DMA)	-	-	80,600	0.07	900,000	0.36
Department of Veterinary Services & Live Stock Sabah (JHSB)	104,074	0.06	-	-	16,000	0.01
Department of Wildlife & National Parks (PERHILITAN)	1,065,740	0.65	1,516,012	1.39	317,832	0.13
Fisheries Research Institute, Terengganu Branch	1,169,604	0.71	-	-	-	-
Fisheries Research Institute, Penang Branch	11,760,681	7.13	5,043,020	4.64	-	-
Fisheries Research Institute, Sarawak Branch	1,377,134	0.84	366,317	0.34	316,430	0.13
Forest Research Institute of Malaysia (FRIM)	10,421,957	6.32	3,464,509	3.19	7,714,229	3.12
Foresty Department of the Malaysian Peninsular (Headquarters)	1,191,000	0.72	-	-	3,522,321	1.42
Geological Survey Department of Malaysian (Headquarters)	57,600	0.03	58,000	0.05	80,504	0.03
Institute for Development Studies, Sabah (IDS)	-	-	-	-	111,202	0.04
Institute for Medical Research (IMR)	2,842,908	1.72	6,387,145	5.87	4,659,243	1.88
Malaysian Agricultural Research Institute (MARDI)	35,011,658	21.24	32,935,330	30.29	40,948,242	16.56
Malaysian Archaelogical Project	87,400	0.05	-	-	-	-
Malaysian Centre for Remote Sensing (MARCRES)	54,663	0.03	33,971	0.03	4,603,405	1.86
Malaysian Cocoa Board (MCB)	6,041,873	3.67	1,676,407	1.54	1,939,807	0.78
Malaysian Department of Geological Research, Sarawak	478,994	0.29	-	-	22,000	0.01
Malaysian Department of Statistic	15,698,559	9.52	331,548	0.30	-	-
Malaysian Industry - Gov. Group For High Technology (MIGHT)	-	-	-	-	159,751	0.06
Malaysian Meteorogical Services	12,099,860	7.34	26,600	0.02	5,252	0.002
Malaysian Ministry of Defence	376,000	0.23	1,707,000	1.57	1,423,788	0.58
Malaysian Ministry of Information	240,000	0.15	934,228	0.86	-	-
Malaysian Research Institute for Nuclear Technology (MINT)	4,293,452	2.60	2,632,095	2.42	21,815,640	8.82
Malaysian Rubber Board (MRB)	-	-	-	-	19,140,364	7.74
MIMOS Berhad	350,600	0.21	4,097,735	3.77	93,544,706	37.82
Mines Research Institute (PEGAMA)	1,101,000	0.67	143,668	0.13	134,493	0.05
National Institute of Public Administration (INTAN)	-	-	-	-	100,000	0.04
National Prawn Fry Production & Research Centre	935,121	0.57	-	-	-	-
National Prawn Fry Production & Research Centre, Kedah (PPPB	-	-	-	-	234,195	0.09
Palm Oil Research Institute of Malaysia (PORIM)	597,871	0.36	1,938,833	1.78	1,495,454	0.60
Public Work Institute of Malaysia	748,895	0.45	-	-	-	-
PELITA	-	-	-	-	16,484,198	6.67
Pusat Pengeluaran & Penyelidikan Ikan Laut (PPPIL)	-	-	-	-	414,691	0.17
Rubber Research Institute of Malaysia	3,766,394	2.28	21,073,559	19.38	-	-
Sarawak Development Institute (SDI)	-	-	-	-	174,877	0.07
Sabah Fisheries Department	25,981,800	15.76	-	-	-	-
Sabah Forest Industries	8,515,699	5.17	1,371,608	1.26	-	-
Sabah Forestry Department	1,559,466	0.95	5,109,400	4.70	-	-
Sarawak Forestry Department	-	-	9,260,900	8.52	-	-
SIRIM Bhd.	3,736,986	2.27	1,771,058	1.63	4,307,088	1.74
Veterinary Research Institute (IPH)	1,084,995	0.66	1,412,660	1.30	699,831	0.28
Total	164,853,011	100.00	108,749,817	100.00	247,315,601	100.00

....continue

GRI	% Change '94-'96			% Change '98-'96		
	Current Expenditure	Capital Expenditure	Total Expenditure	Current Expenditure	Capital Expenditure	Total Expenditure
Agriculture Research Centre of Semonggok	(50.2)	(55.6)	(51.4)	(72.4)	(58.6)	(69.5)
Angkatan Zaman Mansang Sarawak	0.0	0.0	0.0	0.0	0.0	0.0
Atomic Energy Licencing Board	0.0	0.0	0.0	0.0	0.0	0.0
Department of Agriculture of Sabah (JTSB)	0.0	0.0	0.0	0.0	0.0	0.0
Department of Agriculture of Sarawak (JTSK)	0.0	0.0	0.0	0.0	0.0	0.0
Department of Environment (DOE)	0.0	0.0	0.0	0.0	0.0	0.0
Department of Irrigation & Drainage of Malaysia (DID)	0.0	0.0	0.0	0.0	0.0	0.0
Department of Museum & Antiquity (DMA)	0.0	0.0	0.0	1016.6	0.0	1016.6
Department of Veterinary Services & Live Stock Sabah (JHSB)	0.0	0.0	0.0	0.0	0.0	0.0
Department of Wildlife & National Parks (PERHILITAN)	(12.6)	290.6	42.2	(86.1)	(71.8)	(79.0)
Fisheries Research Institute, Terengganu Branch	0.0	0.0	0.0	0.0	0.0	0.0
Fisheries Research Institute, Penang Branch	(62.4)	(30.7)	(57.1)	0.0	0.0	0.0
Fisheries Research Institute, Sarawak Branch	(68.3)	(90.2)	(73.4)	(19.6)	50.2	(13.6)
Forest Research Institute of Malaysia (FRIM)	(62.0)	(83.3)	(66.8)	119.5	147.9	122.7
Foresty Department of the Malaysian Peninsular (Headquarters)	0.0	0.0	0.0	0.0	0.0	0.0
Geological Survey Department of Malaysian (Headquarters)	(51.4)	0.0	0.7	187.5	0.0	38.8
Institute for Development Studies, Sabah (IDS)	0.0	0.0	0.0	0.0	0.0	0.0
Institute for Medical Research (IMR)	137.9	25.3	124.7	(30.9)	27.6	(27.1)
Malaysian Agricultural Research Institute (MARDI)	(3.9)	(39.4)	(5.9)	11.0	376.4	24.3
Malaysian Archaelogical Project	0.0	0.0	0.0	0.0	0.0	0.0
Malaysian Centre for Remote Sensing (MARCRES)	(56.1)	0.0	(37.9)	19066.1	(9.0)	13451.0
Malaysian Cocoa Board (MCB)	(58.3)	(90.8)	(72.3)	25.2	(41.7)	15.7
Malaysian Department of Geological Research, Sarawak	0.0	0.0	0.0	0.0	0.0	0.0
Malaysian Department of Statistic	(95.4)	0.0	(97.9)	0.0	0.0	0.0
Malaysian Industry - Gov. Group For High Technology (MIGHT)	0.0	0.0	0.0	0.0	0.0	0.0
Malaysian Meteorogical Services	(99.8)	0.0	(99.8)	(80.3)	0.0	(80.3)
Malaysian Ministry of Defence	61.8	906.9	354.0	72.7	(43.7)	(16.6)
Malaysian Ministry of Information	216.5	0.0	289.3	0.0	0.0	0.0
Malaysian Research Institute for Nuclear Technology (MINT)	(44.7)	(27.1)	(38.7)	74.0	1685.6	728.8
Malaysian Rubber Board (MRB)	0.0	0.0	0.0	0.0	0.0	0.0
MIMOS Berhad	3157.7	439.1	1068.8	2755.7	1139.6	2182.8
Mines Research Institute (PEGAMA)	(92.1)	(71.1)	(87.0)	45.0	(49.7)	(6.4)
National Institute of Public Administration (INTAN)	0.0	0.0	0.0	0.0	0.0	0.0
National Prawn Fry Production & Research Centre	0.0	0.0	0.0	0.0	0.0	0.0
National Prawn Fry Production & Research Centre, Kedah (PPPB	0.0	0.0	0.0	0.0	0.0	0.0
Palm Oil Research Institute of Malaysia (PORIM)	396.8	24.6	224.3	(43.7)	73.2	(22.9)
Public Work Institute of Malaysia	0.0	0.0	0.0	0.0	0.0	0.0
PELITA	0.0	0.0	0.0	0.0	0.0	0.0
Pusat Pengeluaran & Penyelidikan Ikan Laut (PPPIL)	0.0	0.0	0.0	0.0	0.0	0.0
Rubber Research Institute of Malaysia	446.2	552.4	459.5	0.0	0.0	0.0
Sarawak Development Institute (SDI)	0.0	0.0	0.0	0.0	0.0	0.0
Sabah Fisheries Department	0.0	0.0	0.0	0.0	0.0	0.0
Sabah Forest Industries	(84.4)	(77.9)	(83.9)	0.0	0.0	0.0
Sabah Forestry Department	252.6	(11.7)	227.6	0.0	0.0	0.0
Sarawak Forestry Department	0.0	0.0	0.0	0.0	0.0	0.0
SIRIM Bhd.	(41.8)	(69.4)	(52.6)	158.5	98.3	143.2
Veterinary Research Institute (IPH)	50.0	(41.0)	30.2	(45.1)	(99.2)	(50.5)
Total	(34.3)	(32.7)	(34.0)	93.7	268.2	127.4

Source: 1998 National Survey of Research and Development, MASTIC

Table 6.12: R&D Expenditure in Institutes of Higher Learning (IHLs) by Type of Expenditure, 1994-98

Institutions	Current Expenditure			% Change		Capital Expenditure			% Change	
	1994	1996	1998	94-'96	96-'98	1994	1996	1998	94-'96	96-'98
International Islamic University (UIAM)	34,100.00	342,273.00	1,267,899.80	903.7	270.4	40,700.00	25,968.00	31,000.00	-36.2	19.4
MARA University of Technology (UITM)	1,061,946.40	2,606,106.00	792,542.00	145.4	-69.6	247,817.20	240,732.00	395,668.30	-2.9	64.4
National University of Malaysia (UKM)	7,372,019.90	7,210,264.00	11,707,281.70	-2.2	62.4	792,032.80	178,883.00	24,642,271.90	-77.4	13,675.60
Northern University of Malaysia (UUM)	198,367.50	182,716.00	520,953.90	-7.9	185.1	-	-	7,442.00	-	-
University of Malaya (UM)	4,624,879.90	3,656,957.00	50,183,061.10	-20.9	1,272.30	683,941.00	489,335.00	1,057,672.80	-28.5	116.1
University of Putra, Malaysia (UPM)	11,672,519.50	10,143,946.00	5,516,585.00	-13.1	-45.6	121,388,230.50	1,314,832.00	848,086.60	-98.9	-35.5
University of Sabah, Malaysia (UMS)	-	-	36,184.20	-	-	-	-	6,850.00	-	-
University of Sains, Malaysia (USM)	1,585,572.50	4,269,518.00	28,034,826.00	169.3	556.6	166,221.30	1,708,742.00	2,200,854.20	928	28.8
University of Sarawak, Malaysia (UNIMAS)	188,180.00	715,989.00	1,571,914.60	280.5	119.5	-	387,165.00	239,258.60	-	-38.2
University of Technology, Malaysia (UTM)	748,795.30	5,154,819.00	2,416,699.20	588.4	-53.1	74,180.00	1,711,528.00	1,904,051.40	2,207.30	11.2
University of Technology, Petronas (UTP)	-	-	217,300.00	-	-	-	-		-	-
University of Tenaga Nasional (UTN)	-	-	39,798.00	-	-	-			-	-
Total	**27,486,381.00**	**34,282,588.00**	**102,305,045.50**	**24.7**	**198.3**	**123,393,122.80**	**6,057,185.00**	**31,333,155.70**	**-95.1**	**417.3**

Institutions	Total Expenditure			% Change	
	1994	1996	1998	94-'96	96-'98
International Islamic University (UIAM)	74,800.00	368,241.00	1,298,899.80	392.3	252.7
MARA University of Technology (UITM)	1,309,763.60	2,846,838.00	1,188,210.30	117.4	-58.3
National University of Malaysia (UKM)	8,164,052.70	7,389,147.00	36,349,553.60	-9.5	391.9
Northern University of Malaysia (UUM)	198,367.50	182,716.00	528,395.90	-7.9	189.2
University of Malaya (UM)	5,308,820.90	4,146,292.00	51,240,733.90	-21.9	1,135.80
University of Putra, Malaysia (UPM)	133,060,750.00	11,458,778.00	6,364,671.60	-91.4	-44.5
University of Sabah, Malaysia (UMS)	-	-	43,034.20	-	-
University of Sains, Malaysia (USM)	1,751,793.80	5,978,260.00	30,235,680.20	241.3	405.8
University of Sarawak, Malaysia (UNIMAS)	188,180.00	1,103,154.00	1,811,173.20	486.2	64.2
University of Technology, Malaysia (UTM)	822,975.30	6,866,347.00	4,320,750.60	734.3	-37.1
University of Technology, Petronas (UTP)	-	-	217,300.00	-	-
University of Tenaga Nasional (UTN)	-	-	39,798.00	-	-
Total	**150,879,503.80**	**40,339,773.00**	**133,638,201.30**	**-73.3**	**231.3**

Source: 1998 National Survey of Research and Development, MASTIC

Table 6.13a: Patents and Utility Innovation Applications and Grants, 1990-98

Year	Patents Applied For						Patents Granted			
	Resident	Non-Resident	Total	Auto-sufficiency Ratio (Resident/ Total)	Inventiveness Coefficient (Resident applications per million population)	Dependency Ratio (Non Resident per resident)	Resident	Non-resident	Total	Auto-sufficiency Ratio
1990	92	2,213	2,305	0.04	5.2	24.05	20	498	518	0.04
1991	106	2,321	2,427	0.04	5.7	21.90	29	1,021	1,050	0.03
1992	151	2,259	2,410	0.06	8.0	14.96	10	1,124	1,134	0.01
1993	198	2,684	2,882	0.07	10.3	13.56	14	1,270	1,284	0.01
1994	223	3,364	3,587	0.06	11.3	15.09	21	1,608	1,629	0.01
1995	185	3,992	4,177	0.04	8.9	21.58	29	1,724	1,753	0.02
1996	221	5,354	5,575	0.04	10.4	24.23	79	1,722	1,801	0.04
1997	179	6,274	6,453	0.03	8.3	35.05	52	734	786	0.06
1998	193	5,770	5,963	0.03	8.7	29.90	21	545	566	0.04
Total 1990-98	**1,548**	**34,231**	**35,779**	-	-	-	**275**	**10,246**	**10,521**	-

Source : Intellectual Property Division, Ministry of Domestic Trade and Consumer Affairs.

Table 6.13b: Patents Granted by Field of Technology, 1988-97

Section	1988-1992	1993	1994	1995	1996	1997	Total	%
Human Necessities	727	215	260	336	285	148	1,971	19.53
Performing Operations; Transporting	553	169	267	268	323	137	1,717	17.01
Chemistry; Metallurgy	818	503	505	542	483	197	3,048	30.20
Textiles; Paper	42	15	12	27	31	13	140	1.39
Fixed Constructions	154	37	71	48	76	32	418	4.14
Mechanical Engineering; Lighting; Heating; Weapons; Blasting	174	52	79	61	103	45	514	5.09
Physics	186	155	192	194	178	82	987	9.78
Electricity	186	138	243	277	322	132	1,298	12.86
Total	**2,840**	**1,284**	**1,629**	**1,753**	**1,801**	**786**	**10,093**	**100.00**

Source: Intelellectual Property Division, Ministry of Domestic Trade and Consumer Affairs

Table 6.14: Bibliometric Data for Malaysia, 1980-95

	1980	1985	1990	1991	1992	1993	1994	1995
Number of scientific publications	241	220	309	321	315	375	429	493
Number of citations	305	247	501	471	484	510	-	-

Source: Second European Report on S&T Indicators 1997, European Commission

Table 6.15: Inventor Awards Received by Malaysian Inventors in Geneva International Invention Exhibition/Competition, 1993-98

Year	Medal				Total
	Gold	Silver	Bronze	Merit Award	
1993	1	2	2	0	5
1994	2*	4	3	1	10
1995	0	3	0	0	3
1996	2	1	3	0	6
1997	2	2	3	0	7
1998	5	3	2	0	10

*Multiple awards won by same inventor

Source: MINDS

Table 7.1: Balance of Payments for Royalties, Contract and Professional Fees, Construction and Engineering, 1991-98

	Current Prices (RM Million)							
	1991	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*
Receipts								
Royalties	4.9	66.8	6.2	4.6	22.3	19.2	13.7	51.6
Contract and Professional Charges	1,032.9	1,386.0	1,345.9	1,354.3	1,750.3	1,803.9	2,992.5	3,931.1
Construction and Engineering	914.6	805.6	748.7	882.4	1,457.1	2,474.3	3,527.8	4,981.8
Total	**1,952.4**	**2,258.4**	**2,100.8**	**2,241.3**	**3,229.7**	**4,297.4**	**6,534.0**	**8,964.5**
Payments								
Royalties	377.5	480.0	603.6	747.9	932.1	995.1	1,292.7	1,390.6
Contract and Professional Charges	2,850.3	2,448.0	2,379.3	3,230.9	2,811.7	2,019.5	2,522.8	3,156.1
Construction and Engineering	1,942.7	1,462.7	2,125.4	1,445.6	2,344.7	2,993.3	3,596.9	3,653.0
Total	**5,170.5**	**4,390.7**	**5,108.3**	**5,424.4**	**6,088.5**	**6,007.9**	**7,412.4**	**8,199.7**
Net								
Royalties	(372.6)	(413.2)	(597.4)	(743.3)	(909.8)	(975.9)	(1,279.0)	(1,339.0)
Contract and Professional Charges	(1,817.4)	(1,062.0)	(1,033.4)	(1,876.6)	(1,061.4)	(215.6)	469.7	775.0
Construction and Engineering	(1,028.1)	(657.1)	(1,376.7)	(563.2)	(887.6)	(519.0)	(69.1)	1,328.8
Total	**(3,218.1)**	**(2,132.3)**	**(3,007.5)**	**(3,183.1)**	**(2,858.8)**	**(1,710.5)**	**(878.4)**	**764.8**
	Coverage Ratio (Receipts/Payments)							
	1991	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*
Royalties	1.3	13.9	1.0	0.6	2.4	1.9	1.1	3.7
Contract and Professional Charges	36.2	56.6	56.6	41.9	62.3	89.3	118.6	124.6
Construction and Engineering	47.1	55.1	35.2	61.0	62.1	82.7	98.1	136.4
Total	**37.8**	**51.4**	**41.1**	**41.3**	**53.0**	**71.5**	**88.1**	**109.3**

Source : Cash Balance of Payments Reporting System, Bank Negara Malaysia

Table 7.2 : Malaysian Receipts and Payments for Royalties by Country, 1996-98

Country	Receipts (RM)			Payments (RM)			Net Receipts = Receipts - Payments (RM)		
	1996	1997	1998	1996	1997	1998	1996	1997	1998
Japan	4,898,413	1,000,000	1,000,000	437,269,973	482,000,000	428,000,000	(432,371,560)	(481,000,000)	(427,000,000)
United States	11,429,460	6,000,000	32,000,000	215,699,300	379,000,000	356,000,000	(204,269,840)	(373,000,000)	(324,000,000)
Singapore	704,587	3,000,000	12,000,000	49,014,261	69,000,000	107,000,000	(48,309,674)	(66,000,000)	(95,000,000)
Others	54,452,448	4,000,000	3,000,000	339,783,661	360,000,000	361,000,000	(285,331,213)	(356,000,000)	(358,000,000)
Total	72,156,060	14,000,000	48,000,000	1,041,767,195	1,290,000,000	1,252,000,000	(969,611,135)	(1,276,000,000)	(1,204,000,000)

Source: Bank Negara Malaysia

Table 7.3 : Malaysian Receipts and Payments for Contract and Professional Fees by Country, 1997-98 (RM million)

Country	Receipts		Payments		Net	
	1997	*1998*	*1997*	*1998*	*1997*	*1998*
Japan	375	480	535	455	-160	25
United States	1,018	1,331	378	685	640	646
United Kingdom	143	391	250	403	-107	-12
Hong Kong	146	182	146	220	0	-38
Singapore	546	634	398	552	148	82
Germany	93	201	36	73	57	128
Others	671	712	780	768	-109	-56
Total	**2,992**	**3,931**	**2,523**	**3,156**	**469**	**775**

Source: Cash Balance of Payments Reporting System, Bank Negara Malaysia

Table 7.4 : Malaysian Receipts and Payments for Construction and Engineering by Country, 1996-98

Country	Receipts (RM)			Payments (RM)			Net Receipts = Receipts - Payments (RM)		
	1996	1997	1998	1996	1997	1998	1996	1997	1998
Japan	903,984,515	1,154,000,000	627,000,000	1,192,915,516	1,269,000,000	986,000,000	-288,931,001	-115,000,000	-359,000,000
United States	756,827,458	1,441,000,000	3,317,000,000	256,760,601	322,000,000	569,000,000	500,066,857	1,119,000,000	2,748,000,000
Switzerland	26,814,981	71,000,000	61,000,000	12,735,086	59,000,000	55,000,000	14,079,895	12,000,000	6,000,000
United Kingdom	80,233,162	53,000,000	97,000,000	197,551,160	357,000,000	287,000,000	117,317,998	-304,000,000	-190,000,000
Singapore	216,954,925	283,000,000	270,000,000	266,594,657	328,000,000	374,000,000	-49,639,732	-45,000,000	-104,000,000
Netherlands	11,243,874	14,000,000	15,000,000	51,725,027	102,000,000	82,000,000	-40,481,153	-88,000,000	-67,000,000
Australia	47,152,800	105,000,000	47,000,000	41,493,510	59,000,000	73,000,000	5,659,290	46,000,000	26,000,000
Canada	9,326,107	1,000,000	46,000,000	230,922,755	189,000,000	55,000,000	-221,596,648	-188,000,000	-9,000,000
Rep. Of Korea	43,515,476	65,000,000	120,000,000	74,796,406	143,000,000	122,000,000	-31,280,930	-78,000,000	-2,000,000
Others	264,019,817	335,000,000	373,000,000	648,615,835	740,000,000	655,000,000	-399,138,164	-290,000,000	-123,000,000
Total	**2,360,073,115**	**3,522,000,000**	**4,973,000,000**	**2,974,110,553**	**3,568,000,000**	**3,258,000,000**	**-614,037,438**	**-46,000,000**	**1,715,000,000**

Source: Bank Negara Malaysia

Table 7.5 : Trade in High Technology and Medium-High Technology Products, 1992-98 (Current Prices)

	1992	1993	1994	1995	1996	1997	1998
EXPORT (RM'000)							
High Technology							
Aerospace	1500585	2223175	4076454	3225385	2461439	2445255	4548600
Office and Computing Machinery	4882994	7710750	12079652	16731620	22144637	31229682	45208219
Radio, TV and Communication Equipment (including electronic components)	24987038	33902671	47790371	60639714	63881755	69185168	91447483
Pharmaceutical products	4417	2935	7870	20437	15582	26874	48480
High Technology Export	**31375034**	**43839531**	**63954347**	**80617156**	**88503413**	**102886979**	**141252782**
Medium High Technology							
Vehicles & automobile exluding railway / tramway & parts & accessories thereof	-	-	-	-	1104615	1251696	1891212
Railway or tramway locamotives, rolling stock & part thereof *:	-	-	-	-	213624	-	-
Professional Equipment (including Scientific and Medical Instruments)	1024947	1228414	1643201	1995238	2431755	2964679	3519046
Chemicals (excluding pharmaceuticals)	411135	88414	120965	172925	220782	182761	259679
Electrical Machinery (excluding radio, TV and communication equipment)	2131282	2889830	3513296	3990655	4282827	4454092	5735804
Medium High Technology Export	**3567364**	**4206658**	**5277462**	**6158818**	**8253604**	**8853228**	**11405741**
Total of High & Medium Technology Export	34942398	48046190	69231809	86775974	96757016	111740207	152658523
Total Manufacturing Export	67796400	85744500	115008600	143288000	151190000	171059000	227673000
IMPORT (RM'000)							
High Technology							
Aerospace	3751850	4366677	5393611	6322666	3517673	4824444	7063673
Office and Computing Machinery	2607836	3039615	4491949	6377390	9793357	13452639	13860555
Radio, TV and Communication Equipment (including electronic components)	10475511	16313101	26486585	32945146	52950487	57978582	77665140
Pharmaceutical products	56011	57383	80842	81497	102740	111919	127703
High Technology Import	**16891208**	**23776776**	**36452987**	**45726699**	**66364257**	**76367583**	**98717071**
Medium High Technology							
Vehicles & automobile exluding railway / tramway & parts & accessories thereof	-	-	-	-	7834836	6586914	2925396
Railway or tramway locamotives, rolling stock & part thereof *:	-	-	-	-	205497	-	-
Professional Equipment (including Scientific and Medical Instruments)	1725906	1517518	1901089	2334936	2684128	2826275	3060907
Chemicals (excluding pharmaceuticals)	347977	334959	390252	361044	473921	495955	498826
Electrical Machinery (excluding radio, TV and communication equipment)	3529766	4398745	6735801	6549586	8342315	8718494	10284073
Medium High Technology Import	**5603649**	**6251222**	**9027142**	**9245566**	**19540697**	**18627638**	**16769201**
Total of High & Medium Technology Import	22494857	30027997	45480129	54972265	85904954	94995221	115486272
Total Manufacturing Import	85294100	98904000	134820900	166451000	167716000	188654000	197188000
BALANCE OF TRADE (RM'000)							
High Technology							
Aerospace	-2251265	-2143502	-1317157	-3097281	-1056233	-2379189	-2515073
Office and Computing Machinery	2275158	4671135	7587703	10354230	12351279	17777043	31347664
Radio, TV and Communication Equipment (including electronic components)	14511527	17589569	21303786	27694568	10931267	11206586	13782343
Pharmaceutical products	-51594	-54448	-72972	-61060	-87158	-85045	-79223
High Technology Balance of Trade	**14483826**	**20062755**	**27501360**	**34890457**	**22139156**	**26519396**	**42535711**
Medium High Technology							
Vehicles & automobile exluding railway / tramway & parts & accessories thereof	-	-	-	-	-6730221	-5335218	-1034184
Railway or tramway locamotives, rolling stock & part thereof *:	-	-	-	-	8126	-	-
Professional Equipment (including Scientific and Medical Instruments)	-700959	-289104	-257888	-339698	-252373	138404	458139
Chemicals (excluding pharmaceuticals)	63157	-246545	-269287	-188119	-253138	-	-
Electrical Machinery (excluding radio, TV and communication equipment)	-1398484	-1508915	-3222505	-2558931	-4059488	-4264402	-4548268
Medium High Technology Balance of Trade	**-2036285**	**-2044564**	**-3749680**	**-3086748**	**-11287094**	**-9774409**	**-5363460**
Total of High & Medium Technology Balance of Trade	-19052459	18018193	23751680	31803709	10852063	16744987	37172251
Total Manufacturing Balance of Trade	17497700	-13159500	-19812300	-23163000	-16526000	-17595000	30485000

Notes : * Railway or tramway locomotives, rolling stock and part thereof: railway or tramway track fixtures and fitting and part, thereof, mechanical (including electromechanical) traffic signally equipment of all kinds

Source :
1. Department of Statistic, Malaysia
2. The Malaysian Trade Classification and Custom Duties Order, Revised Edition 1996

Table 8.1: Size of Economy for Selected Countries, 1998

Economy	Population Millions 1998	Gross National Product (GNP) Billions of US dollars 1998	Rank 1998	GNP per capita US Dollars 1998	Rank 1998
Australia	19	380.6	14	20,300	24
Canada	31	612.2	9	20,020	26
Hong Kong, China	7	158.3	24	23,670	21
Denmark	5	176.4	23	33,260	6
France	59	1,466.20	4	24,940	17
Germany	82	2,122.70	3	25,850	13
Japan	126	4,089.90	2	32,380	7
Korea, Rep.	46	369.9	15	7,970	59
New Zealand	4	55.8	46	14,700	36
Norway	4	152.1	25	34,330	4
Switzerland	7	284.8	18	40,080	3
United Kingdom	59	1,263.80	5	21,400	22
United States	270	7,921.30	1	29,340	10
Indonesia	204	138.5	28	680	154
Malaysia	22	79.8	39	3,600	82
Philippines	75	78.9	41	1,050	135
Singapore	3	95.1	37	30,060	9
Thailand	61	134.4	29	2,200	102

Source: World Bank

Table 8.2: Structure of Output for Selected Countries, 1998

Economy	Gross Domestic Product (mil., USD)	Value added as a % of GDP			
		Agriculture	Industry	Manufacturing	Services
Australia	364,247	3	26	14	71
Canada	598,847	2	26	14	72
Denmark	174,272	4	24	17	72
France	1,432,902	2	26	19	72
Germany	2,142,018	1	29	24	70
Japan	3,783,140	2	38	24	60
Korea, Rep.	297,900	6	43	26	51
New Zealand	54,093	7	26	19	67
Norway	145,896	2	32	11	66
Switzerland	264,352	3	34	24	63
United Kingdom	1,357,429	2	31	21	67
United States	8,210,600	2	27	18	71
Indonesia	96,265	16	43	26	41
Malaysia	71,302	12	48	34	40
Philippines	65,096	17	32	22	52
Singapore	85,425	0	35	24	65
Thailand	153,909	11	40	29	49

Source: World Bank, OECD

Table 8.3: Tertiary Enrolment by Field of Study for Selected Countries. 1990-95

Economy	Natural Science		Mathematics and Computer Science		Engineering		Transport and Communications	
	% of 20-24 age group	% female	% of 20-24 age group	% female	% of 20-24 age group	% female	% of 20-24 age group	% female
Australia	5.2	45.4	1.8	25.6	7.5	10	..	..
Canada	2.2	46.4	2.5	30	4.9	14.3	0.2	6.7
Hong Kong, China	3	28.9	1.5	25.1	3.7	6.2	0	32.3
Denmark	1.6	40.3	1.7	26.1	4.6	20.2	0.1	7.5
France	7.1	36.4	..	..	1.2	21.2	..	..
Germany	2.2	33.3	1.8	24.1	5.8	9.7	0	2.9
Japan	0.7	17.6	0.2	20.2	9	10.8	0	6.2
Korea, Rep.	3.8	33.7	2.8	25.9	13.5	9.9	0	35
New Zealand	4.8	42.3	0.4	30.3	3	13.3	0.2	11.6
Norway	3	40	0.4	27.6	5.2	18.6	0.3	8.1
Switzerland	2.3	29.8	0.6	14.4	4.4	4.7	0	3.5
United Kingdom	2.6	44.4	2.2	25.2	4.7	12.3	..	..
United States	2.6	..	2.7	..	4.2	..	0.6	..
Indonesia	0.2	34	0.8	34.3	1.8	14.2	0.1	20.5
Malaysia	0.5	46.1	0.3	51	0.8	14.4	..	..
Philippines	0.5	67.9	2.1	54.4	3.9	18.3	0.9	0.8
Singapore	..	..	..	..	..	..	..	..
Thailand	1.3	41.7	0	50.5	1.7	5.9	0	..

Source: World Bank

Table 8.4: R&D Researchers in Selected Countries

No. of researchers per 10,000 labour force

Country	1991	1992	1993	1994	1995	1996	1997	1998
Australia	..	60	..	64	..	66	..	..
Canada	46	48	50	52	54	..	..	..
Denmark	88	91	95	..	108	109	110	..
France	120	124	125	124	126	125	..	..
Germany	130	123	..	..	116	114	..	..
Japan	140	143	143	142	142	133	132	..
Korea, Rep.	..	..	..	..	73	64	63	..
New Zealand	53	60	63	..	61	..	..	..
Norway	95	..	104	..	110	..	108	..
Switzerland	..	121	..	..	..	127	..	..
Taiwan	..	..	..	..	..	..	..	..
United Kingdom	91	92	95	..	..	..	..	..
United States	76	..	74	..	..	..	..	..
Indonesia	3	..	..	..	..	..	..	..
Malaysia	..	2	..	6	..	5	..	7
Philippines	3	..	..	..	..	..	..	..
Singapore	..	..	..	..	48	56	60	66
Thailand	5	..	..	..	..	..	..	..

Source: ASEAN, OECD, MASTIC, and US Science and Engineering Indicators 1998

Table 8.5: R&D Personnel in Selected Countries

No. of researchers per 10,000 labor force

Country	Year	R&D Personnel	GNP per capita (USD)
Australia	1996	66	20,540
Canada	1995	54	19,380
Denmark	1997	110	32,500
France	1996	125	26,050
Germany	1996	114	28,260
Japan	1997	132	37,850
Korea, Rep.	1997	63	10,550
New Zealand	1995	61	14,340
Norway	1997	108	36,090
Switzerland	1996	127	44,320
United Kingdom	1995	95	18,700
United States	1993	74	24,740
Indonesia	1991	3	570
Malaysia	1998	7	3,600
Philippines	1991	3	730
Singapore	1998	66	30,060
Thailand	1991	5	1,420

Source: ASEAN, MASTIC, World Bank, US Technology and Engineering Indicators 1998, and Singapore S&T Indicators

Table 8.6: Total R&D Personnel in Selected Countries
FTE

Country	Year	R&D Personnel	GNP per capita (USD)
Australia	1996	90,519	20,540 in 1997
Canada	1995	129,750	19,380 in 1995
Denmark	1997	31,467	32,500 in 1997
France	1996	320,805	26,050 in 1997
Germany	1996	453,679	28,260 in 1997
Japan	1997	894,003	37,850 in 1997
Korea, Rep.	1997	136,559	10,550 in 1997
New Zealand	1995	10,547	14,340 in 1995
Norway	1997	24,877	36,090 in 1997
Switzerland	1996	50,265	44,320 in 1997
United Kingdom	1993	270,000	18,060 in 1997
United States	1993	962,700	24,740 in 1993
Malaysia	1998	6,656	3,600 in 1998

Source: OECD, MASTIC

Table 8.7: Total R&D Personnel in Selected Countries
FTE

Country	Year	Private Sector	IHL	GRI	Others	Total
Australia	1996	26,138	42,739	19,518	2,124	90,519
Canada	1995	71,160	42,360	14,310	1,920	129,750
Denmark	1997	17,797	7,533	5,715	422	31,467
France	1996	162,590	81,538	69,184	7,493	320,805
Germany	1996	276,794	102,160	74,725	0	453,679
Japan	1997	586,156	222,285	56,554	29,008	894,003
Korea, Rep.	1997	90,425	28,546	16,014	1,574	136,559
New Zealand	1995	2,828	3,735	3,984	0	10,547
Norway	1997	12,942	7,062	4,873	0	24,877
SwitzerlanD	1996	34,450	14,430	1,385	0	50,265
United Kingdom	1993	164,000	66,000	34,000	6,000	270,000
Malaysia	1998	3,547	916	2,193	0	6,656

Note: IHL - Institutes of Higher Learning
GRI - Government Research Institutes
Source: OECD, MASTIC

Table 8.8: Expenditures on R&D by Selected Countries, 1992-98

GERD as a % of GDP

Country	1992	1993	1994	1995	1996	1997	1998
Australia	1.59	..	1.62	..	1.68	..	..
Canada	1.54	1.60	1.60	1.58	1.60	1.64	1.60
Denmark	1.74	1.80	..	1.91	2.01	2.03	2.06
France	2.42	2.45	2.38	2.34	2.32	2.23	..
Germany	2.48	2.42	2.32	2.31	2.29	2.31	2.33
Japan	2.95	2.88	2.84	2.98	2.83	2.92	..
Korea, Rep.	2.08	2.30	2.58	2.68	2.79	2.89	..
New Zealand	1.01	1.02	..	0.97	..	1.1	..
Norway	..	1.73	..	1.71	..	1.68	..
Switzerland	2.66	..	..	..	2.74	..	..
United Kingdom	2.13	2.15	2.11	2.02	1.94	1.87	..
United States	2.74	2.62	2.52	2.61	2.52	2.71	2.79
Indonesia	..	..	0.16	0.2	..	..	..
Malaysia	0.37	..	0.33	..	0.22	..	0.62
Philippines	..	..	..	..	..	0.22	..
Singapore	..	..	..	..	..	1.47	1.76
Thailand	..	..	..	..	0.0012	..	..

Source: OECD, PECC, MASTIC

Table 8.9: Expenditures on R&D and GDP Per Capita of Selected Countries

GERD as a % of GDP

Country	GERD as a % of GDP	Year	GNP per capita (USD)
Australia	1.68	1996	20,540
Canada	1.6	1998	20,020
Denmark	2.06	1998	33,260
France	2.23	1997	26,050
Germany	2.33	1998	25,850
Japan	2.92	1997	37,850
Korea, Rep.	2.89	1997	10,550
New Zealand	1.1	1997	16,480
Norway	1.68	1997	36,090
Switzerland	2.74	1996	44,320
United Kingdom	1.87	1997	20,710
United States	2.79	1998	29,340
Indonesia	0.2	1995	1,110
Malaysia	0.62	1998	3,600
Philippines	0.22	1997	1,220
Singapore	1.76	1998	30,060
Thailand	0.0012	1996	2,800

Source: OECD, MASTIC, PECC

Table 8.10: Composition of R&D Expenditures in Selected Countries

% of GERD by Sector

	Year	Private	GRI	IHL	Others	Total
Australia	1996	47.4	24.0	26.5	2.1	100.0
Canada	1998	63.9	13.4	21.6	1.1	100.0
Denmark	1998	63.0	15.5	20.3	1.2	100.0
France	1997	61.5	19.9	17.2	1.4	100.0
Germany	1998	68.1	14.3	17.6	0.0	100.0
Japan	1997	72.0	8.8	14.3	4.9	100.0
Korea, Rep.	1997	72.6	15.8	10.4	1.2	100.0
New Zealand	1995	27.0	42.2	30.7	0.1	100.0
Norway	1997	56.9	16.4	26.6	0.1	100.0
Switzerland	1996	70.7	2.5	24.3	2.5	100.0
United Kingdom	1997	65.2	13.8	19.7	1.3	100.0
United States	1998	75.2	7.9	14.0	2.9	100.0
Indonesia	1994	32.5	65.8	1.7	0	100.0
Malaysia	1998	66.2	21.9	11.9	0	100.0
Philippines	1992	23.7	60.6	12.9	2.8	100.0
Singapore	1998	60	34	6	0	100.0
Thailand	1996	18.4	61.1	6.8	13.7	100.0

Source: OECD, MASTIC, PECC

Table 8.11: International Comparison of Resident and Non resident Patent Application in 1993 -1996

	1993			1994			1995			1996		
	Resident	Non Resident	Dependency ratio	Resident	Non Resident	Dependency ratio	Resident	Non resident	Dependency ratio	Resident	Non resident	Dependency ratio
Australia	8,103	22,004	2.7	8,325	25,624	3.1	8,606	28,156	3.3	8,484	34,125	4.0
Canada	3,669	43,685	11.9	2,527	38,419	15.2	2,467	40,565	16.4	2,622	45,938	17.5
France	12,807	66,099	5.2	12,666	70,155	5.5	12,605	73,626	5.8	13,110	81,418	6.2
Germany	35,291	63,895	1.8	37,199	67,571	1.8	38,675	70,946	1.8	42,957	79,594	1.9
Japan	331,840	47,575	0.1	319,344	50,477	0.2	333,770	53,896	0.2	339,045	60,390	0.2
Korea	21,450	25,869	1.2	28,557	32,018	1.1	59,230	37,308	0.6	68,410	45,548	0.7
New Zealand	1,243	11,232	9.0	1,261	15,879	12.6	1,303	19,230	14.8	1,294	26,947	20.8
United Kingdom	18,806	70,809	3.8	18,465	74,534	4.0	18,705	78,335	4.2	18,257	87,209	4.8
United States	100,216	89,155	0.9	107,545	99,710	0.9	124,210	107,964	0.9	107,106	111,536	1.0
Malaysia	198	2,684	13.6	223	3,364	11.3	185	3,992	8.9	221	5,354	10.4

Source : OECD, PECC

Table 8.12: Number of Scientific Publications per capita in Selected Countries, 1980-95

	Scientific Publications				Population				Scientific Publications per capita			
	1980	1985	1990	1995	1980	1985	1990	1995	1980	1985	1990	1995
Australia	10,053	10,477	11,552	14,820	14,569	15,641	16,888	17,946	0.69	0.67	0.68	0.83
Canada	18,316	21,268	24,164	27,229	24,593	25,942	27,791	29,617	0.74	0.82	0.87	0.92
France	24,389	23,434	27,359	36,607	53,880	55,170	56,718	58,020	0.45	0.42	0.48	0.63
Germany	27,546	29,526	32,585	45,903	78,304	77,668	79,365	81,661	0.35	0.38	0.41	0.56
Japan	26,773	33,335	41,275	52,599	116,807	120,837	123,537	125,472	0.23	0.28	0.33	0.42
Korea	145	579	1,395	4,514	38,124	40,806	42,869	44,949	0.00	0.01	0.03	0.10
New Zealand	2,202	2,346	2,603	2,915	3,113	3,247	3,360	3,671	0.71	0.72	0.77	0.79
United Kingdom	39,419	43,509	45,355	54,781	56,330	56,618	57,561	58,308	0.70	0.77	0.79	0.94
United States	154,037	170,128	185,599	203,164	230,406	241,855	254,076	267,020	0.67	0.70	0.73	0.76
Indonesia	81	116	170	262	150,958	167,332	182,812	197,464	0.00	0.00	0.00	0.00
Malaysia	241	220	309	493	13,763	15,677	17,845	20,108	0.02	0.01	0.02	0.02
Philippines	152	142	223	233	48,317	54,668	60,687	68,354	0.00	0.00	0.00	0.00
Singapore	121	374	160	640	2,415	2,709	3,016	3,321	0.05	0.14	0.05	0.19
Thailand	248	288	398	543	46,718	51,146	55,595	58,610	0.01	0.01	0.01	0.01

Source: OECD, World Bank

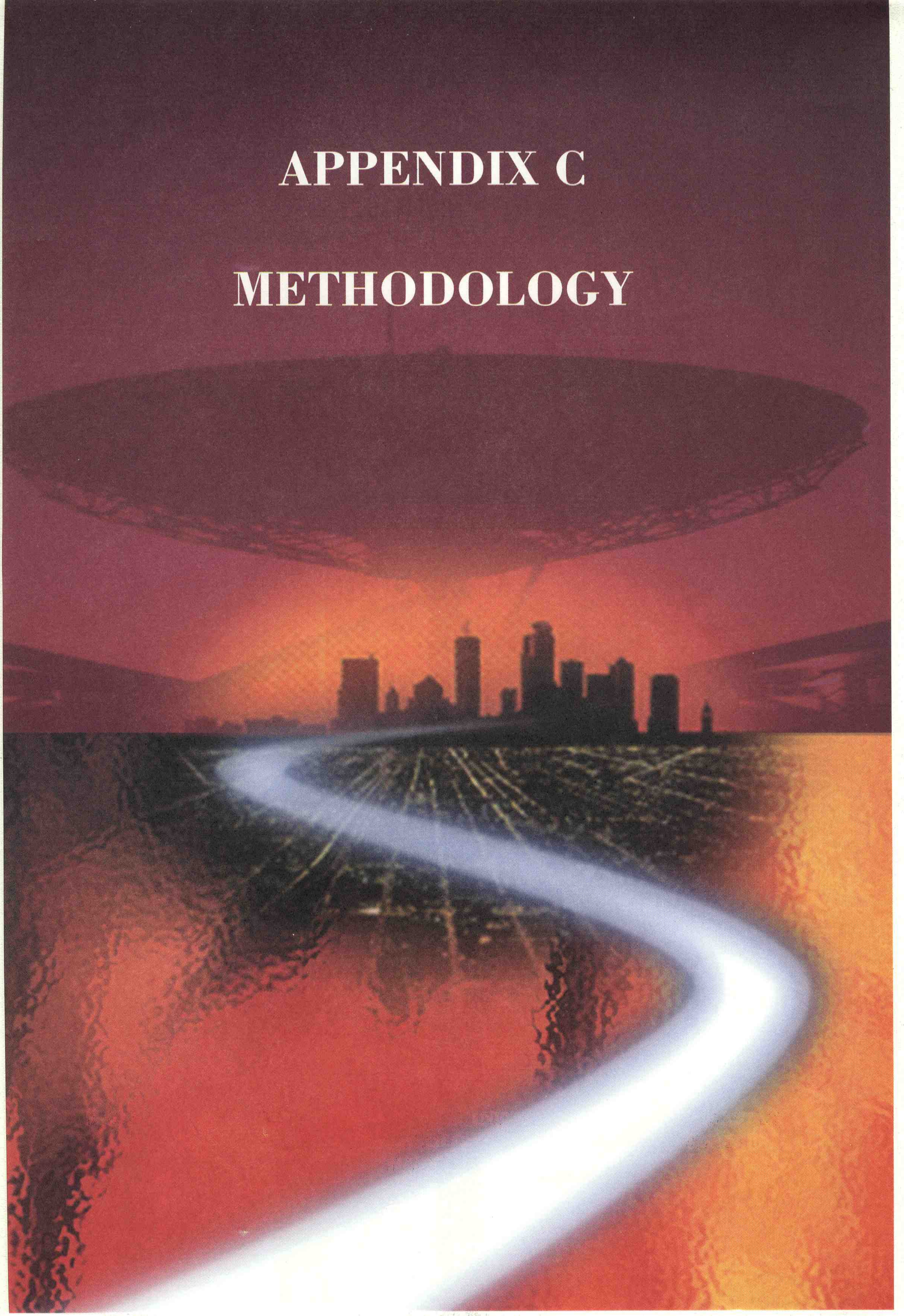
Table 8.13: Export-Import Ratio for High Technology Industries, 1997

	Aerospace	Office and Computing Machinery	Electronic	Pharmaceutical
Australia	0.43	0.27	0.2	0.45
Canada	0.94	0.43	0.58	0.39
France	1.84	0.75	1.05	1.37
Germany	1.2	0.59	1.09	1.59
Japan	0.41	1.69	2.45	0.48
Korea	0.12	1.43	1.62	0.35
New Zealand	0.43	0.12	0.18	0.15
United Kingdom	1.28	0.96	0.93	1.79
United States	2.74	0.6	0.8	0.94
Malaysia	0.64	3.26	1.18	0.38

Source: OECD

APPENDIX C

METHODOLOGY



APPENDIX C

METHODOLOGY

This appendix provides methodological details about the type of indicators that are used in the report. It will help clarify not only definitions and sources of data but their limitations as well.

A. Education in Science and Technology

Data Sources

Data on enrolment and graduation at public and private educational institutions are obtained from the Ministry of Education, Malaysia.

Definition / Classification

In general, this report follows OECD's classification / aggregation scheme for the field of studies. See Table A1 for more details. Due to the importance of information technology and computer science, this field of study is not included in the "natural sciences" and is reported separately. In the previous 1994 S&T indicators report, information technology and computer science was classified under "information and computer technologies". "Engineering sciences & applied S&T" is now classified under the heading "engineering and technology". Two problematic categories in the previous reports are NSE nec (Natural Sciences and Engineering not elsewhere classified) and SSH nec (Social Sciences and Humanities not elsewhere classified). These two categories are not very informative. Therefore, steps have been taken to minimize their use.

It is not always possible to maintain a strict adherence to OECD's classification due to the format in which data are collected. For example, the Ministry of Education (MOE), Malaysia has its own classification scheme. The re-grouping of MOE's data to fit the OECD classification scheme is presented in Table A2. There are a few problems when attempts are made to re-classify data from MOE in accordance to the OECD classification scheme. The category "Art-others" includes education arts and communication – two fields that come under the social sciences (see mass communication) and humanities (art). Similarly, the category "technical-others" includes property management that can be classified under social sciences rather than engineering and technology.

Table A1: OECD's Classification Scheme for Field of Study in Education

Aggregated Field of Study	Field of Study
Natural Sciences	Natural science Mathematics and computer science
Engineering and Technology	Engineering Architecture and town planning Trade, craft and industrial programs Transport and communications
Medical Sciences	Medical science and health related
Agricultural Sciences	Agriculture, forestry and fishery
Social Sciences	Law Social and behavioral science Commercial and business administration Mass communication and documentation Home economics (domestic science)
Humanities	Humanities Religion and Theology Fine and Applied Arts
Other Fields	General programs Education science and teacher training Service trades Other programs

Table A2: Comparison Between OECD and MOE Classification Scheme for Education

OECD SCHEME		MOE'S SCHEME
Natural Sciences	Natural science Mathematics **IT and Computer Science**	Pure Science Computer Science
Engineering and Technology	Engineering Architecture and town planning Trade, craft and industrial programs Transport and communications	Engineering Architecture and town planning Science – others Survey
Medical Sciences	Medical science and health related	Medical & Dentistry
Agricultural Sciences	Agriculture, forestry and fishery	Agriculture & Related Sciences
Social Sciences	Law Social and behavioral science Commercial and business administration Mass communication and documentation Home economics (domestic science)	Law Economics and Business Arts – others Technical-others
Humanities	Humanities Religion and Theology Fine and Applied Arts	Arts and Humanities
Other Fields	General programs Education science and teacher training Service trades Other programs	

B. Human Resources for Science and Technology

Data Sources

Data on R&D personnel are obtained from the *1998 National Survey of Research and Development* conducted by MASTIC.

Definitions / Classifications

Research and Development (R&D)

This report adopts OECD's definition of R&D that is stated in the *Frascati Manual* (1994, p.29):

" ... research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications."

The three types of R&D activities are defined as follows.

Basic research – as experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.

Applied research – as also original investigation undertaken in order to acquire new knowledge, however, directed primarily towards a specific practical aim or objective.

Experimental development – in the sense of systematic work, drawing on existing knowledge gained from research and/or practical experience, that is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed.

Researchers are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems, and in the management of the projects concerned. (OECD, 1997)

Full Time Equivalent (FTE) is a measure of the proportion of time a researcher, technician or other support staff spend on R&D work during the surveyed year. (MASTIC, 1998). FTE in year *x* can be calculated based on the following formula:

$$\frac{\text{Hours or days spent on R\&D in year } x}{\text{Total working hours or days in year } x} \times \frac{\text{No.of months in year } x \text{ doing R\&D}}{12 \text{ months}}$$

C. Awareness, Knowledge, and Attitude Towards Science and Technology

Data Sources

Data for public awareness, knowledge and attitude towards S&T issues are obtained from the *1998 Public Awareness of Science and Technology Malaysia Survey* conducted by MASTIC.

A Brief Tour of the Survey Methodology

A sample size of 5,000 respondents was used for the survey. Proportional sampling was employed in terms of characteristics such as race, rural/urban, age group, and gender. In the survey, knowledge and interest in S&T issues are surveyed in 11 categories: (1) space exploration; (2) application of computer technology; (3) application of nuclear technology for electricity generation; (4) business and economy; (5) environmental pollution; (6) foreign affairs; (7) national education policy; (8) new discoveries in medicine; (9) new discoveries in the sciences; (10) new inventions in Malaysia; and (11) new technology and innovation. A scale of one to four is used in the survey.

A set of ten questions was posed to the survey respondents' to gauge their perceived S&T knowledge. These were questions requiring yes/no responses. To assess the public's perception and attitude, a set of 11 questions were asked. Respondents were required to state whether they agree, disagree or are not sure about each of these statements.

D. Research and Development Activities

Data Sources

Data on R&D personnel are obtained from the *1998 National Survey of Research and Development* conducted by MASTIC.

Definitions

Gross Domestic Expenditure on R&D (GERD) comprise of current expenditures as well as gross capital expenditures that incurred in R&D activities in a given year. Current expenditures consist of labor costs and other current costs, while capital expenditures consist of land and buildings, and instruments and equipments.

E. Trade in Technology

Data Sources

Data on royalties, contracts and professional fees, construction and engineering are obtained from Bank Negara Malaysia (BNM). These data refer to cash transactions between residents of Malaysia and the rest of the world, as reported for the *Cash Balance of Payments Reporting System*. Trade figures for high-technology goods and medium-high technology goods are obtained from Department of Statistics.

Definitions:

Technology Balance of Payments

The basis for the technology balance of payments and the methodology used are laid out in the OECD document titled *Proposed Standard Method of Compiling and Interpreting Technology Balance of Payments Data – TBP Manual* (1990).

The OECD defines the technology balance of payments (TBP) in the following manner: "The technological balance of payments measures the flows of funds for transactions concerning industrial property rights. It covers invisible transaction in a country's balance of payments concerning the purchase and sale of "disembodied" technology in the form of intellectual and industrial property rights including patents, licenses, know-

High Technology Goods

The technology level of industries is determined in this report based on OECD's classification scheme. This scheme is based on R&D intensity in each industry. There are four broad categories in this scheme:

(i) High technology industries;

(ii) Medium-high technology industries;

(iii) Medium-low technology industries; and

(iv) Low technology industries.

The various sectors that come under each of these industries is summarized in Table E1 below. The products that come under some of the high technology and medium-high technology industries and their SITC codes are listed in Table E2.

Table E1: Classification of Products by Technology Intensity

Classification	Sector
High Technology industries	Aerospace Office and computing equipment Drugs and medicines Radio, TV and communication equipment
Medium High Technology industries	Motor vehicles Professional goods Chemicals Electrical machinery Other transport
Medium Low Technology industries	Non-electrical machinery Other transport equipment Shipbuilding and repairing Petroleum products and refining Non-metallic mineral products Other manufacturing products Rubber and plastic products Non-ferrous metals
Low Technology industries	Iron and steel Metal products Food products, beverages and tobacco Paper and printing Textiles, wearing apparel, fur and leather Wood products and furniture

how and technical assistance. It is therefore an indicator of technology transfer across countries."

In Malaysia, there are no efforts as yet to collect technology transfer data in accordance to the guidelines such as the TBP Manual. The closest proxy to TBP is the compilation of cash balance of payments data for the following three categories:

(i) royalties and license fees;

(ii) contracts and professional fees; and

(iii) construction and engineering.

These data are used as proxies for TBP in the report. Items included in each of the above categories are as follows:

(i) Royalties and license fees – comprise of fees for authorized use of patents, copyrights, trademarks, industrial processes, franchises etc. and the use through licensing agreements, of produced originals or prototypes (such as manuscripts and films).

(ii) Contracts and Professional Fees – comprise of: (a) payments to/receipts from non-resident head-offices and branches arising from sharing of administrative and operating expenses, and (b) fees for services provided in the form of legal, accounting, management consulting, public relations, advertising, market research and all commissions, brokerage fees levied by non-financial intermediaries.

(iii) Construction and Engineering – comprise of: (a) construction (e.g. ports, dams, bridges, roads, airports, refineries and plants) and installation of electrical and mechanical systems. It also includes activities undertaken in connection with the prospecting and exploration of all types of minerals (exclude imports and exports of goods), (b) fees for provision of expertise in engineering, architectural and other technical services, including planning, project design and supervision of turnkey projects; research and development; product testing and certification.

Table E.2: Detailed List of Products under industry groupings

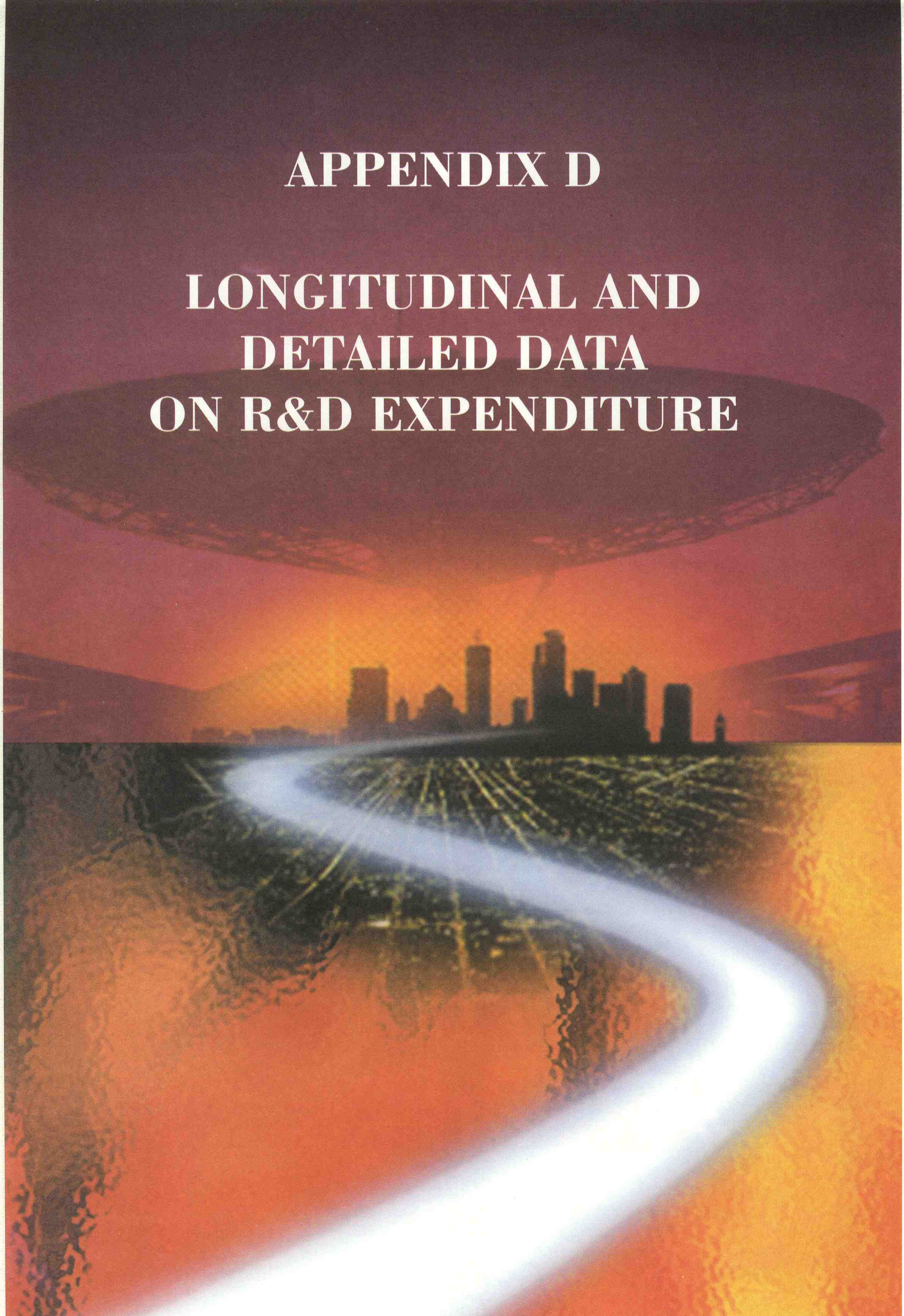
SITC Code	Products
	Aerospace
8802	Other aircraft (for example, helicopters, aeroplanes); spacecraft(including satellites) and spacecraft vehicle
8803	Parts of goods of heading No 8802
8804	Parachutes (including dirigible parachutes) and rotochutes; parts there of and accessories thereto:
8805	Aircraft launching gear, desk-arrestor or similar gear, ground flying trainer, parts of the foregoing articles
	Office and Computing Machinery
8471	Automatic data processing machines and units thereof, magnetic or optical reader, machines for transcribing data onto data media in coded from and machines for processing such data, not elsewhere specified or included.
8473	Parts & accessories (other than covers, carrying cases and the like) suitable for use solely or principally with machines of Heading No. 8469 (typewriters and word-processing machines) to 8472 (other office machines)
9009	Photo-copying apparatus incorporating an optical system or of the contact type and thermo-copying apparatus
	Radio TV and Communications Equipment (including electronic components)
8518	Microphone and stands therefore; loud-speaker, headphone, audio-frequency electric amplifiers
8519	Turntable (record-decks), record-player, cassette-player and other sound
8520	Magnetic tape recorders and other sound recording apparatus
8521	Video recording or reproduced apparatus whether or not incorporating a video tuner
8522	Parts and accessories of apparatus of heading No.8519 to 8521
8523	Prepared unrecorded media for sound recording or similar recording of other phenomena, other than products of chapter 37
8524	Records, tapes and other recorded media for sound or other similarly recorded phenomena, including matrices and master for the production of record, but excluding products of chapter 37
8525	Transmission apparatus for radio-telephony, radio-telegraphy radio-broadcasting or television camera
8526	Radar apparatus, radio navigational aid apparatus and radio remote control apparatus
8527	Reception apparatus for radio-telephony or radio-broadcasting
8528	Television receiver (including video monitors and video projectors), whether or not incorporating radio-broadcast receivers or sound or video recording or reproducing apparatus.
8530	Electrical signaling, safety or traffic control equipment for railways, tramway, road, inland waterway, parking facilities, port installation or airfields (other than those of heading No. 8608)
8532	Electrical capacitors, fixed, variable or adjustable (pre-set)
8533	Electrical resistor (including rheostats and potentiometers), other than heating resistors
8534	Printed circuits
8540	Thermionic, cold cathode or photo-cathode valves and tubes (example vacuum or vapour gas filled valves and tubes, mercury are rectifying valves and tubes, cathode-ray tubes, television camera tubes)
8541	Diodes, transistor and similar semiconductor devices; photosensitive semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light emitting diodes;
8542	Electronic integrated circuits and micro-assemblies
9013	Liquid crystal devices not constituting articles provided for more specifically in other heading, lasers, other than lase diodes; other optical appliances and instrument, not specified or included elsewhere in this chapter.
	Pharmaceutical products
2936	Pro-vitamins & vitamins, natural or reproduced by synthesis (including natural concentrates), derivatives thereof used primarily as vitamins, and intermixtures of the foregoing, whether or not in any solvent.
2937	Hormones, natural or reproduced by synthesis; derivatives thereof, used primarily as hormones; other steroids used primarily as hormones
2938	Glycosides, natural or reproduced by synthesis, and their salts, ethers, esters & other derivatives
2941	Antibiotics.

	Professional Equipment (including Scientific and Medical Instruments)
9005	Binocular, monoculars, other optical telescopes, and mountings therefore, other astronomical instruments and mountings therefore, but not including instrument for radio-astronomy
9006	Photographic (other than cinematographic) camera, photographic flashlight apparatus and flashbulbs other than discharge lamps of heading No.8539
9007	Cinematographic camera and projectors, whether or not incorporating sound recording or reproducing apparatus
9010	Apparatus and equipment for photographic (including cinematographic) laboratories (including apparatus for the projection of circuit patterns on semi-conductor materials), not specified or included elsewhere; negatoscopes; projection screen
9011	Compound optical microscopes, including those for photomicrography, cine-photomicrography or micro-projection
9012	Microscopes other than optical microscopes, diffraction apparatus
9015	Surveying (including photogrammetrical surveying), hydrographic, hydrological, meteorological or geophysical instrument and appliances, excluding compasses; rangefinders
9018	Instruments and appliances used in medical, surgical, dental or veterinary science, including other electro-medical apparatus and sight-testing instruments.
9022	Apparatus based on the use of x-rays or of alpha, beta or gamma radiations, whether or not for medical, surgical, dental or veterinary uses, including radiography or radiotherapy.
9030	Oscilloscopes, spectrum analysers & other instrument & apparatus for measuring or checking electrical quantities, excluding meters of heading No.9028. Instrument & apparatus for measuring or detecting alpha, beta, gamma, x-ray, cosmic
9032	Automatic regulating or controlling instrument and apparatus
9101	Wrist-watches, pocket-watches and other watches, including stop-watches, with case of precious metal or of metal clad with precious metal
9102	Wrist-watches, pocket-watches and other watches, including stop-watches, other than those of heading No.9101
9103	Clock with watch movement, excluding clocks of heading No.9104
9104	Instrument panel clocks and clocks of a similar type for vehicles, aircraft, spacecraft or vessels
9105	Others clocks
9106	Time of day recording apparatus and apparatus for measuring, recording or otherwise indicating intervals of time, with clock or watch movement or with synchronous motor (for example, time-registers, time-recorders)
9107	Time switches with clock or watch movement or with synchronous motor
9108	Watch movements, complete and assembled
9109	Clocks movements, complete and assembled
9110	Complete watch or clock movements, unassembled or partly assembled (movement sets); incomplete watch or clock movements, assembled; rough watch or clock movement
9111	Watch cases and parts thereof
9112	Clock cases and cases of a similar type for other goods of this chapter, and parts thereof
9113	Watch straps, watch bands and watch bracelets, and parts thereof
9114	Other clock or watch parts.
	Chemicals (excluding pharmaceuticals)
2844	Radioactive chemical element & radioactive isotopes (including the fissile or fertile chemical elements and isotopes) and their compounds; mixtures and residues containing these products.
2845	Isotopes other than those of heading No. 2844; compounds, inorganic or organic, of such isotopes, whether or not chemically defined
2939	Vegetable alkaloids, natural or reproduced by synthesis, and their salts, ether, esters and other derivatives
2942	Other organic compounds
3203	Colouring matter of vegetable or animal origin (including dyeing extracts but excluding animal black), whether or not chemically defined; preparation as specified in note 3 to this chapter based on colouring matter vegetable or animal origin
3204	Synthetic organic colouring matter, whether or not chemically defined; preparation as specified in note 3 to this chapter based on synthetic organic colouring synthetic organic product of a kind used as fluorescent brightening agent or as luminophore.
3808	Insecticides, rodenticides, fungicides, herbicides, anti-sprouting product & plan-growth regulator, disinfectants & similar product, put up in forms or packing for retail sale or as preparation or articles (Example, sulphur-treated bands, wick)

	Electrical Machinery (excluding radio, TV and communication equipment)
8501	Electric motor and generators (excluding generating sets)
8502	Electric generating sets and rotary converter
8503	Parts suitable for use solely or principally with the machines of heading No 8501 or 8502
8504	Electric transformer, static converter (for example, rectifiers) and inductors
8505	Electric-magnet, permanent and articles intended to become permanent magnets after magnetization
8531	Electrical sound or visual signaling apparatus (for example, bells, sirens, indicators panel, burglar or fire alarm), other than those of heading No 8512 (Electrical lighting or signaling equipment) or 8530 (Electrical signaling safety equipment)
8535	Electrical apparatus for switching or protecting electrical circuit, or for making connection to or in electrical circuit (example, switcher, fuses, voltage limiter, junction boxes, lightning arrester) for a voltage exceeding 1,000 volts
8536	Electrical apparatus for switching or protecting electrical circuit, or for making connection to or in electrical circuit (example, switcher, fuses, voltage limiter, junction boxes, lightning arrester) for a voltage exceeding 1,000 volts
8537	Boards, panel (including numerical control panel), consoles, desk, cabinet & other bases, equipped with 2 or more apparatus of heading No 8535 and 8536 for electric control
8538	Parts suitable for use solely or principally with the apparatus of heading No 8535, 8536 or 8537
8543	Electrical machines and apparatus, having individual function, not specified or included elsewhere

APPENDIX D

LONGITUDINAL AND DETAILED DATA ON R&D EXPENDITURE



APPENDIX D

Longitudinal and Detailed Data on R&D Expenditure

This appendix provides additional information that readers might find useful for a better understanding of R&D expenditures discussed in Chapter 6 of this report.

1. The R&D surveys conducted over the years utilized the survey method. A total of 228 companies from the private sector responded in the 1998 survey. The corresponding figure for the 1996 survey was 148. Out of this number, 68 companies that responded in 1996 also responded in 1998.
2. Data from these 68 companies indicated a reduction in R&D expenditure. Obviously, this does not imply that the R&D expenditures for all the 68 companies declined during the 1996-98 period. The table below summarizes the R&D expenditure pattern of the 68 companies.

Year	1996 (RM)	1998 (RM)
R&D Expenditure (RM)	256,192,276	161,432,646
% Change		(37)
Total R&D Expenditure (RM)	400,136,795	746,432,646
% of expenditure to total R&D	64.3%	21.6%

The R&D expenditure of these 68 companies accounted for 64.3% of the total R&D expenditure in 1996. This figure declined substantially to 21.6% in 1998. However, more detailed information is needed to understand the reasons for the reduction in R&D expenditure by these companies.

3. It is a common belief that the private sector is not spending enough on R&D. But the percentage contribution of private sector R&D (slightly more than two thirds) to total R&D expenditure seemed to suggest that R&D is private sector-led. One possible explanation is that the substantial presence of the private sector in R&D activities in the country can be attributed to large companies that were previously government-owned, such as *Tenaga Nasional Berhad* (TNB), *Telekom Malaysia Bhd, and Petronas*. The table below provides some insight.

Company	**1996 (RM)**	**1998 (RM)**	**Change 1996-98**	**% Change**
TNB R&D	26,765,065	20,253,859	(6,511,206)	(24.3%)
Telekom R&D	12,594,470	19,024,707	6,430,237	51%
Petronas R&D	113,836,338	54,068,974	(59,767,364)	(52.5%)
Total	**153,195,873**	**93,347,540**	**(59,848,333)**	**(39.1)**

Except for *Telekom Malaysia Berhad,* the other two companies experienced a reduction in R&D expenditure. Aggregating R&D expenditure of these three companies, there was a substantial reduction in R&D expenditure amounting to RM59,848,333. This indicates that the increase in R&D expenditure may not be due to the R&D expenditures by large corporatized companies.