

**1996 MALAYSIAN  
SCIENCE AND TECHNOLOGY  
INDICATORS REPORT**

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## **INTRODUCTION**

### **1.1 The Use of Science and Technology Indicators**

The use of Science and Technology Indicators (S&T Indicators) is now quite widespread. The primary purpose of these indicators, which are often used in conjunction with other economic indicators, is to guide the decision of S&T policy makers. Systematic and appropriate S&T Indicators would provide the policy makers with an indication of the status of the national S&T system and the relationship between scientific and technological efforts and the economic growth.

With the increased importance of S&T in a nation's economic system, S&T Indicators have been developed to describe and map the national system of innovation so that national competitive advantages could be identified and promoted. The OECD, North America, European Union, Nordic and Asian countries have constantly been using S&T Indicators as a measure of their scientific and technological development and simultaneously measure their competitiveness.

S&T Indicators measure both inputs and outputs. Among the inputs indicators that are normally evaluated are financial and human resources devoted to Research and Development (R&D) activities. These information are vital in assessing the R&D efforts and whether the level of R&D is keeping pace with the expansion of the economy and infrastructure in general. Human resources that are involved in S&T within a nation is also another important input component in the S&T Indicators. This indicator is aimed at measuring the distribution of trained and skilled personnel in various S&T related areas and sectors of a country. It also looks at the role of training institutions primarily institutes of higher learning (IHLs) in supplying the demand for the trained, educated and skilled people in all fields.

S&T outputs indicators on the other hand attempts to relates between investments in S&T and their possible benefit to the country. Even though there could be other outputs from investments in R&D and human resources, but by international standard, statistic on patents applications/granted and data on bibliometrics (number S&T publications produced and cited) are the two most recognised S&T indicators outputs. Patents would measure level of innovative and inventiveness while bibliometric indicators assess the level of S&T of a country as well as providing an indication of the quality and capability of local scientists.

As Malaysia propels into the next millennium with the nation's aspiration to be a developed nation by the year 2020, it is therefore of paramount importance for Malaysia to constantly assess its development and progress in S&T as to maintain its global competitiveness. With the appropriate use of S&T Indicators

perhaps in a more systematic manner and in accordance with acceptable standards, Malaysia would be able to evaluate its S&T status, progress and trends from time to time and if need be, new S&T policies may be formulated and implemented in ensuring the desired future is achieved.

## **1.2 Scope of the Report**

As discussed previously, S&T indicators are commonly considered in two main groups i.e. indicators of input and indicators of output. This report will make an attempt to answer some questions about Malaysia's scientific and technological achievement and progress in terms of inputs and outputs.

This report is structured to present indicators of input into R&D which is mainly based on the findings drawn from the national R&D Survey 1996 conducted by MASTIC. It will cover the trend that has occurred since the last survey carried out in 1992. Another important input indicator namely human resources for science and technology would also be addressed where the main source of information was obtained from related government agencies primarily from the Ministry of Education.

As for the output indicators, the report will highlight on the statistic of patent application and granted in 1996. It will analyse among others patents granted to residents relative to non-residents. Based on the recommendation of the 1994 R&D Survey which suggested that bibliometric output be included in this report and since some amount of data on the subject are available during the preparation of this report, bibliometric output indicator is also evaluated here and where possible international comparison is also made. In addition to the above, data on technology balance of payment and trade in intensive products are also discussed in this report. .

Apart from areas mentioned above, this report would also make recommendations and suggestions for improvement for the next S&T Indicators Report.

Although the data presented in this report is analysed to internationally accepted definition and format, not all data however is internationally comparable. The unavailability and the lack of up-dated data on certain subjects would make it rather difficult to do a meaningful comparison. Therefore, international comparison is only made whenever there is useful and reliable data available. Generally, the format of the report would follow the 1994 Science and Technology Indicators Report in order to ensure consistency in the analysis of

the important indicators with the hope that readers would find it easier if comparison of the trends were to be made.

### **1.3. Basic Socio-economic Data**

As shown in Table 1.0 in the appendix, Malaysia's population stood at an estimated figure of 21.2 million in 1996. The population rate increased by 7.7% from 1994 to 1996 as opposed to 4.8% from 1992 to 1994, due to higher standards of medical and health facilities available and extended to cover almost all populated areas of the country.

In real terms, GDP registered slight growth from 1992 to 1994 of 18.4% to 18.5% from 1994 to 1996 as opposed to GNP, which registered a slight percentage decline from 18.6% to 18.5% for the same review period. Malaysia's balance of trade is estimated to register a much lower deficit of RM619.0 million for 1996 as compared to RM9.4 billion in 1995; brought about by almost equal imports and exports for 1996. In terms of employment, Malaysia is estimated to achieve almost full employment rate for 1996 where total labour force stood at 8,398,000 while total employed labour is 8,181,000. Therefore, 1996 proves to be able to provide a very good economic environment for Malaysians as well as foreign investors, not only due to the favourable economic situation but also due to the very stable political climate.

## **NATIONAL OVERVIEW OF R&D**

### **2.1 Introduction**

The result of the research and development (R&D) surveys since 1992, allow a detailed trend analysis on Malaysian performance of research and development in three major sectors namely, Government Research Institutes (GRIs), private sector and Institutes of Higher Learning (IHLs). However, analysis on the trend of R&D in Non-profit Organisation (NPOs) sector could not be done due to the poor response received from the NPOs and therefore such data are not analysed.

Although the report generally covers similar areas of study, it must be cautioned that the parameters for each survey may differ from one another and affect the consistency of the data to a certain extent. Therefore, the analysis made on these data will also be affected. The results however, could provide some trend on the national R&D effort.

## **2.2 Growth in R&D efforts**

Generally, the growth in R&D efforts is closely linked to the R&D expenditure in the various sectors as well as the resources in terms of R&D workforce. The major indicators used to show the trend are derived from financial and human resources data. Data and analysis done on these two subjects will provide a clear picture and could be used as indicators to show the trend in R&D efforts.

Detailed analysis on human resources and financial resources spent on S&T and R&D will be done in the forthcoming paragraphs and chapter four will discuss in detail on human resources for S&T.

### **2.2.1 Trend In the R&D Workforce**

The R&D workforce is characterised by researchers, technicians and other support staff. The workforce is further divided into two categories i.e. full-time equivalent (FTE) and headcount.

"Headcount" refers to the number of individuals employed while "FTE" adjust for those individuals who devote only part of their time to R&D activities.

A general overview of the R&D workforce shows a much lower figure for 1996 as compared to 1994 although a significant increase was reported from 1992 to 1994. Total R&D personnel have dropped from 11,472 in 1994 to 9,233 in 1996. One reason for this decrease might be due to under-reporting of figure by some GRIs and IHLs. It is also a well-known fact that Malaysia is downsizing its public service personnel and many privatisation and corporatisation exercises have taken place. Therefore, once the public service sector is privatised, the number of public service personnel automatically will be reduced and probably not replaced again. Table 2.1 illustrates the figures clearly where the number of FTE Researchers dropped from a total of 2,287 in 1994 to 1,894 in 1996, representing a decrease of 17%. The number of headcount declined by 7%, which is a lower decrease as compared to the decline in FTE. As for total R&D Personnel, there is again a drop in FTE in 1996 i.e. 33% from 1994 as compared to a decline of 19% for headcount for the same year of assessment.

#### **2.2.1.1 Trend In the R&D Workforce Content**

The R&D workforce content comprises of private sector, GRIs, IHLs and NPOs. A further analysis of R&D workforce content in 1996, as in Table 2.1; IHLs showed a small increase of FTE Researchers i.e. 3% as opposed to a higher increase for headcount of 28% from 1994. This might be due to the teaching load

and other administrative works of Researchers from IHLs making their time limited for R&D work. However, GRIs registered a drop of 38% of FTE Researchers from 1994 to 1996 compared to a hike of 7% from 1992 to 1994. The declining trend persists from 1994 to 1996 where headcount registered a negative 25% growth. In this case, there might be movement from GRIs to IHLs as IHLs is moving more towards commercialisation of its R&D.

In the case of private sector, both FTE and headcount researchers also registered a decline of 8% and 5% respectively from 1994 to 1996. However, this is very much lower as compared to the decline in GRIs, as explained above.

Overall, R&D Personnel also registered a huge drop for both FTE and headcount i.e. 33% and 20% respectively. R&D Personnel comprises of support staff for the R&D workforce like Professionals and Technicians. They do not fall within "qualified researchers" category. Normally support staff are generalists meaning they could move into other areas than R&D. Since the nature of R&D is normally long-term, there might be possibilities of these people to choose jobs in other sectors. This will result in staff turnover.

The above information concludes that there has not been much improvement in attracting people to work in R&D related activities. It is also observed that a substantial portion of people involved in R&D comes from the public sector. Public sector's R&D are normally "applied" or "developmental" in nature. R&D personnel in the private sector should be increased, as private sector R&D activities are more market-oriented which is much needed by the economy.

### **2.2.1.2 Female Participation in the R&D Workforce**

Table 2.2, 2.2A and 2.2B show the extent of female participation in the R&D workforce in Malaysia.

Focusing on the female contribution towards R&D workforce, Table 2.2 and 2.2A show that GRIs and IHLs commanded higher number of female researchers as compared to female technicians and other personnel. Especially in IHLs, the percentage of researchers is an overwhelming 77%. This suggested that women R&D professionals are contributing remarkably towards the nation building of future R&D.

The private sector employs a higher percentage of female technicians and other categories of personnel compared to that of researchers. They accounted for 69% of the private sector's female R&D workforce (see table 2.2B). In total, private sector's contribution of female in R&D workforce is 35% of the nation's total female R&D workforce.

## 2.2.2 Trend in R&D Expenditure

R&D expenditure is divided into two types of expenditure i.e. current expenditure and capital expenditure. Current expenditure components are labour and operating costs whereas capital expenditure is made up of land, building and equipment.

One of the steps taken by the government in 7MP in promoting Malaysia's technological level and competitiveness is to intensify R&D activities. Therefore, in line with this, R&D expenditure is expected to also increase. However, this is not the case. At national level, there has been a fall in R&D investment over the period from 1994 to 1996 which recorded a decrease of 20% in total expenditure with the IHLs and GRIs experiencing a drop in expenditure by 76% and 41% respectively (see Table 2.3, 1978 prices).

Looking at individual type of expenditure from Table 2.3 (1978 prices), total current expenditure dropped by 17% from 1994 to 1996 and total capital expenditure experienced a decline of 22% for the same period. However, the total percentage drop is much contributed by the decline of current and capital expenditure in GRIs. IHLs also registered a large percentage drop in capital expenditure of 96%. Private sector R&D experienced a high surge in total expenditure registering a 74% increase.

Overall, from 1994 to 1996 Malaysia has registered a fall in the expenditure for R&D related activities where National Gross Expenditure on R&D (GERD) for 1996 stood at only RM549 million relative to expenditure of RM611 million in 1994 despite a significant increase in Gross Domestic Product (GDP) from RM184, 692 million in 1994 to RM246,825 in 1996. If comparison is made in terms of percentage ratio of GERD to GDP, in 1996, gross spending on R&D activities only about 0.22% of GDP and this figure was very much lower than that of 1994 which stood at 0.33%.

## 2.2.3 International Comparison GERD to GDP

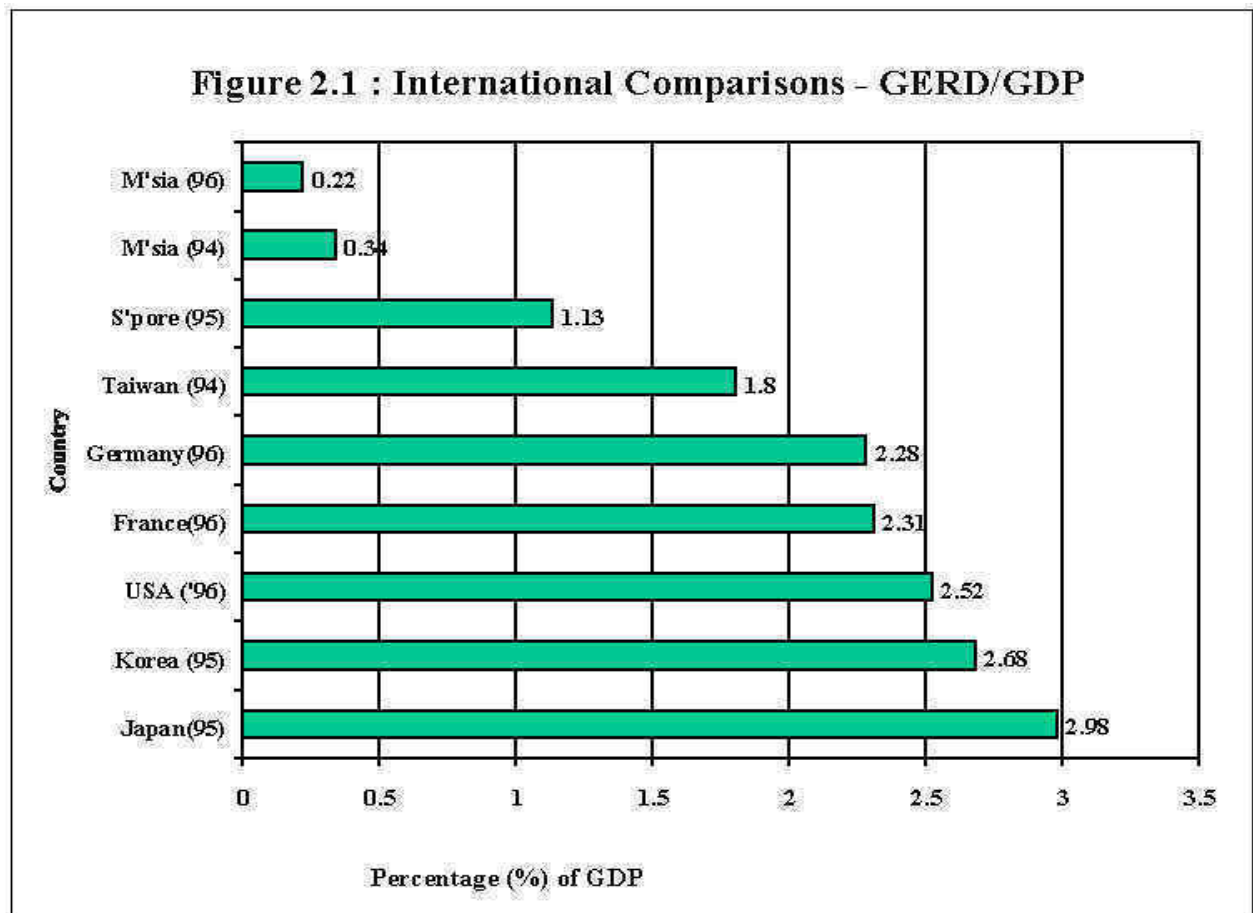
International comparison with other countries has to be read with caution, as the year of comparison is different especially among ASEAN countries. Updated information on ASEAN countries is not available at the time this report is written.

Although programmes are being made to step up and increase the R&D efforts, Malaysia's growth in R&D expenditure (GERD)/GDP ratio does not indicate so (Table 2.6). The GERD in Malaysia does not move in tandem with the economic growth. In fact, the GERD ratio has declined from 0.37% in 1992 to 0.33% in

1994 and the last survey showed that the ratio fell further to 0.22%, as illustrated in [Figure 2.1](#).

In order for Malaysia to achieve what it has set out to do in the 7MP, financial resources have to be committed to such plans. On average, the GERD of a developed nation is 2% of GDP. Therefore, looking at Malaysia's GERD to GDP ratio in 1996 of 0.22% suggested that Malaysia is very far behind in terms of expenditures for R&D activities as compared to the international figure and further more it has not grown in tandem with National GDP.

When compared with newly industrialised countries such as Taiwan and Singapore, Malaysia's GERD to GDP is very much lower too.



*Source: Table 2.6*

### 2.3 National Research Priorities

### **2.3.1 Balance Between Public and Private Sector R&D**

Based on the 1996 survey, the private sector spent 207.3 million, which is an increase of 37% from 1994 (see Table 2.3, 1978 prices). Capital expenditure, which increased by 93% from 1994 to 1996, is obviously the main contributor to the increase in GERD. This shows that the private sector is heavily investing in land and buildings to heighten their R&D activities in the future. This is a positive indication of the private sector taking advantage of incentives provided by the Malaysian government to enhance R&D.

Looking at overall changes in the public sector, there is decrease in expenditure on R&D of 34% for GRIs and 73% for IHLs for the same review period. However, for IHLs, this figure does not synchronise with the increase in FTE Researchers and headcount, which actually experienced an increase in figures.

Referring to the Table 2.3 1978 prices, it seems that the private sector is the largest contributor to national GERD. For current expenditure, private sector contributes 38% of the total national current expenditure. Private sector contributes 73% to total GERD, which is much higher than total for both GRIs and IHLs contribution. NPOs contribution is not available at the time of reporting.

### **2.3.2 International Comparison of GERD**

Table 2.6 shows international comparison of GERD among some ASEAN countries. However, it should be made with caution due to the different year of comparison.

Comparing Malaysia to some countries within the same region such as Indonesia, Singapore, Philippine and Thailand, in 1994, Table 2.6 shows that Indonesia's GERD is US\$292.1 million compared to Malaysia which is US\$233 million, that is, 25% higher. For the year 1992, Malaysia's GERD was US\$215.1 million compared to that of Thailand for 1991 which is US\$154 million, Malaysia exceeded by 40%. Malaysia compared to Philippines for 1992 showed Malaysia's GERD exceeded Philippines by 87%.

### **2.3.3 Socio-economic Objective of R&D**

As so far as the R&D personnel and expenditure are important bases to measure R&D of a certain country, the purpose into which they are employed is just as important to be analysed. The breakdown is available by sector making it possible to compare the various sectors' contribution for each area.

Table 2.8 shows the national and sector objectives of R&D based on number of researchers FTE. The most effort was put in economic development, a trend that has prevailed since 1992 to 1996. Manufacturing and plant production and primary products seem to be priority in economic development. Advancement of knowledge is least considered for in all sectors' distribution. There was an increase in priority towards society R&D effort in 1996 i.e.8% of FTE directed towards this area as compared to 3% in 1994. However, it is obvious that the private sector's R&D priority was directed very largely towards economic development while GRIs and IHLs in addition to economic development also directed their R&D efforts towards society, environment and advancement of knowledge R&D effort.

Comparing the public and private sector's R&D priority, some consistency of emphasis is observed in areas like manufacturing, energy resources and supply, information and communication services where all sectors provides quite some effort into them.

Looking at overall percentage change from 1994 to 1996, priorities that have been given a lot of emphasis i.e. registering more than one hundred percent increase by rank of order are as shown in Figure 2.2

Based on Figure 2.2 and Table 2.8, it is evidently true that in terms of socio-economic objectives (SEO) the nation's R&D priority areas are directed more towards society and economic development effort of the country where the public sector emphasised more towards society and the private sector more towards economic development.

**Figure 2.2: Nation's R&D Priority by Socio-economic Objectives - Source: Table 2.8**

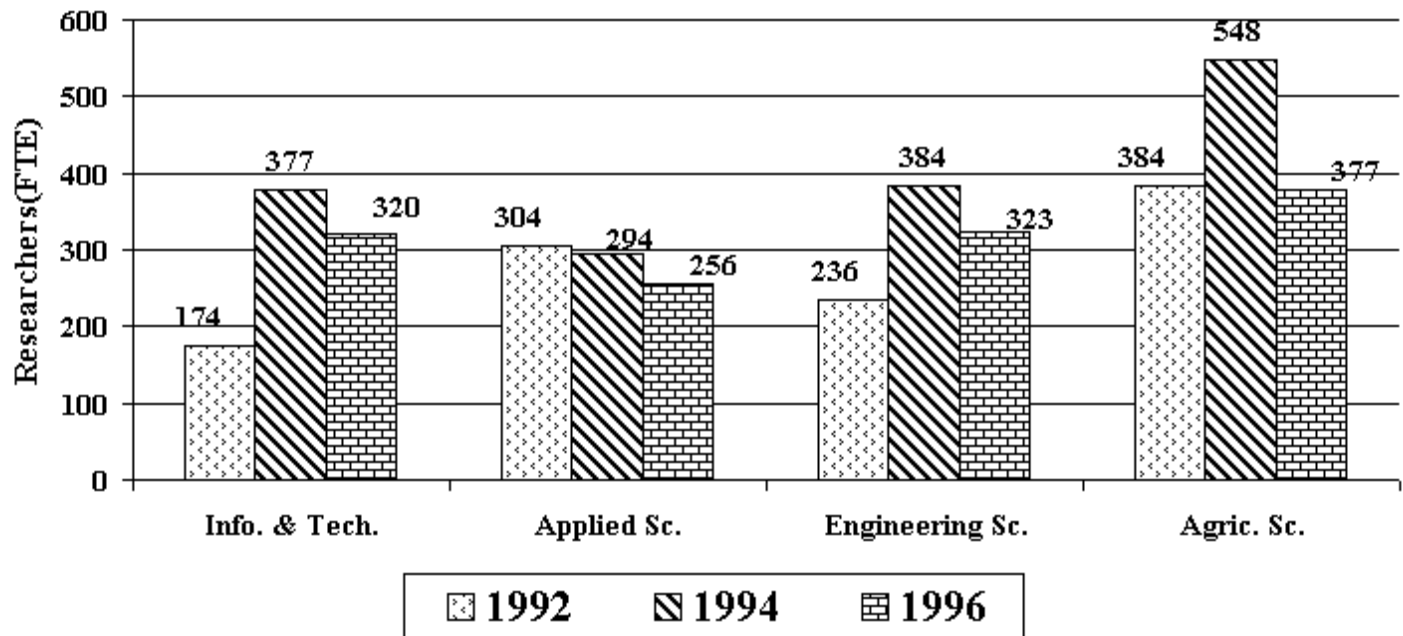
Rank	Category	Priority	% Increase '94 - '96
1	Society	Social Development and community service	268
2	Society	Education and Training	242
3	Society	Health	165
4	Economic Development	Construction	161

5	Economic Development	Energy Resources	85
6	Economic Development	Commercial Services	80
7	Advancement Knowledge	Sciences and Humanities	78
8	Economic Development	Energy Supply	49
9	Economic Development	Natural Resources	18
10	Economic Development.	Information and Communication Services	0.9

#### **2.3.4. The Research Skills Base**

Besides the financial and Socio-economic Objectives, another indicator that has been used as a quantitative measure of research priorities is the Field of Research. This indicator also shows the collaborative linkages between the public and the private sectors.

**Figure 2.3 : Researchers (FTE) by main Field of Research (TOP 4 Sciences)**



There has been an increase emphasis put in social sciences and humanities 1994 to 1996 (see *Table 2.9*). This shows the importance of humanities and training and effort are being focused to effect the increase. R&D in this area is as important as economic development as the society forms the base of future development, be it in technology or otherwise.

Figure 2.3 shows researchers FTE by main field of research on top 4 sciences. Agricultural Science seems to be the main priority, which is not surprising since Malaysia is still a highly agriculture-based economy. The trend is however, shifting towards information technology and engineering science. This indicates that the government is changing its priority towards a more information-based economy with high value added technology.

## SCIENCE & TECHNOLOGY FOR INDUSTRY

### 3.1 Introduction

During the 6MP, the achieved growth rate surpasses that of the targeted growth or at least the target set almost achieved. The following table summarises the average annual growth rate by industry achieved during the 6MP and the targeted 7MP:

**Figure 3.1: Gross Domestic Product by Industry, 1990 – 2000** - Source: 7MP 1996-2000, Table 2.5, pg.52

Sector	Average Annual Growth Rate (%)			Share of GDP (%)		
	Target 6MP	Achieved 6MP	Target 7MP	1990	1995	2000
Agriculture, Forestry, Livestock & Fishing	2.1	2.0	2.4	18.7	13.6	10.5
Mining & Quarrying	1.1	2.9	2.3	9.8	7.4	5.7
Manufacturing	12.2	13.3	10.7	26.9	33.1	37.5
Construction	12.8	13.3	10.2	3.6	4.4	4.8
Electricity, Gas & Water	12.3	13.1	10.7	1.9	2.3	2.7
Transport, Storage & Communications	10.0	9.9	10.7	6.9	7.3	8.3
Wholesale & Retail Trade, Hotels & Restaurants	11.4	10.6	9.0	11.1	12.1	12.7
Finance, Insurance, Real Estate & Business Service	11.0	10.7	10.2	9.8	10.7	11.9

Government Services	4.5	6.7	4.2	10.6	9.7	8.1
Other Services	8.1	7.7	9.0	2.1	2.0	2.1
(-) Imputed Bank Service Charges	14.8	15.6	9.5	5.1	7.0	7.5
(+) Import Duties	9.9	11.6	2.7	3.7	4.3	3.2
<b>GDP at Purchasers' Value</b>	<b>8.1</b>	<b>8.7</b>	<b>8.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>

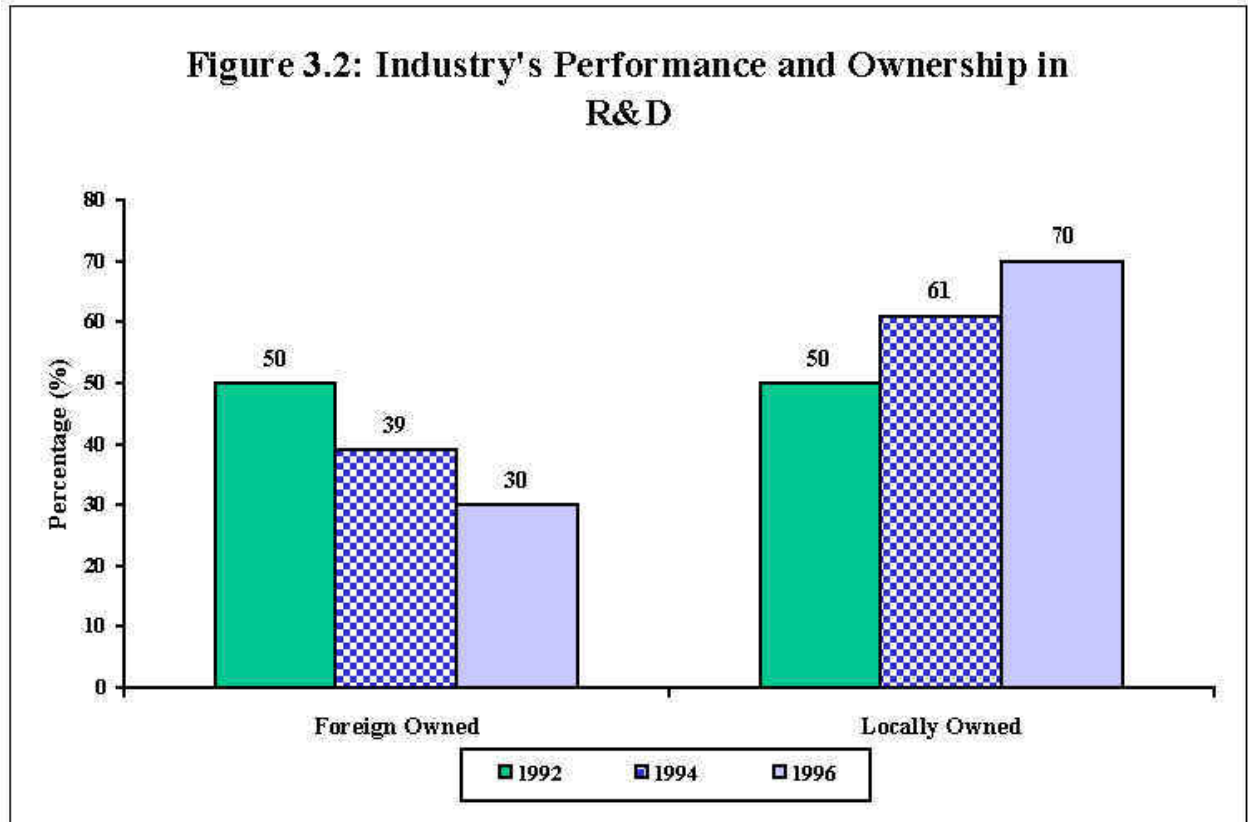
The manufacturing sector is expected to dominate the growth in the 7MP and will continue to be the main contributor to the growth of the economy. To ensure such growth, strengthening S&T and R&D capabilities are important prerequisites for continued improvement and to be in line with the strategy towards productivity driven growth. The manufacturing industries will still emphasise export-oriented strategy and manufacturers are encouraged to increase local content and to target quality products for international market.

To encourage the growth and development, the following incentives were instituted and will continue to be in force until year 2000.

- Investment incentive
- Industrial restructuring and rationalisation
- Tariff policy
- Developing industrial estates

### 3.2 Industry Performance and Ownership in R&D

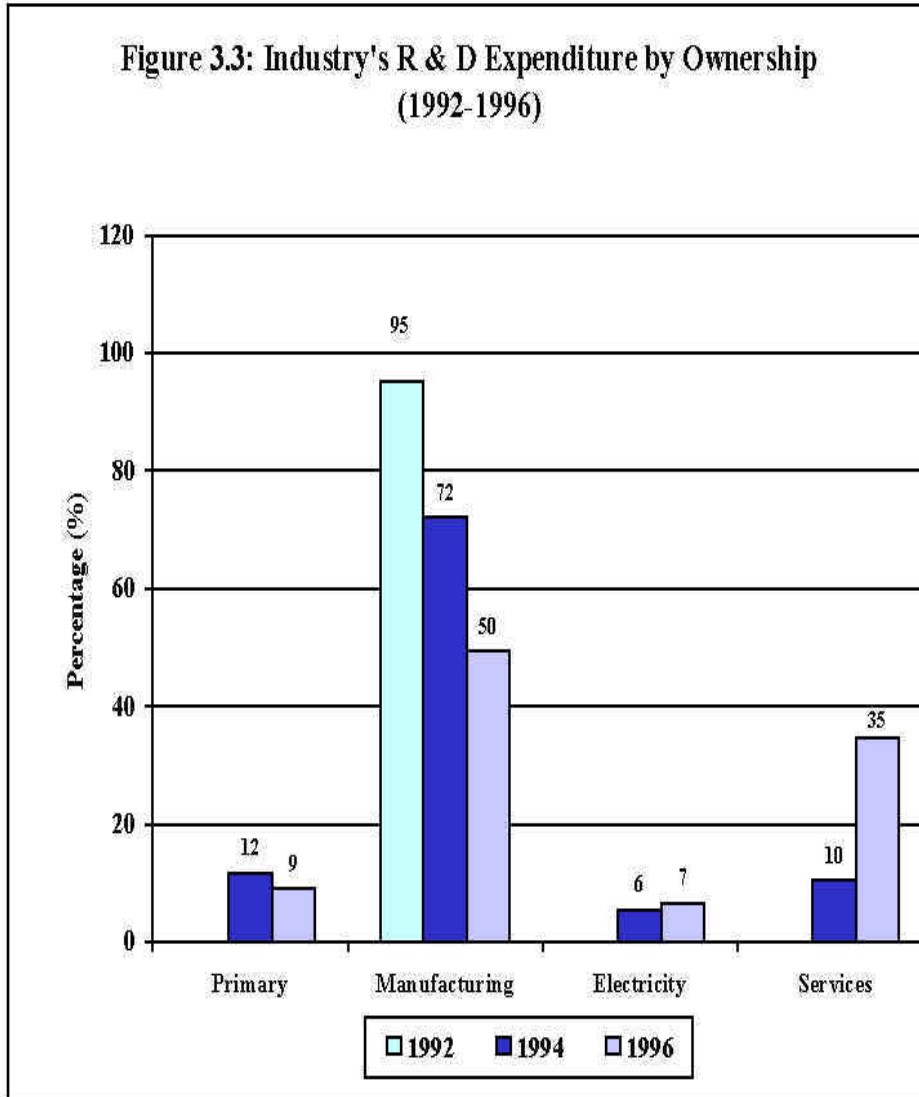
**Figure 3.2: Industry's Performance and Ownership in R&D**



Over the years, there have been marked changes in ownership in the industrial sectors. Figure 3.2 shows the steady decreasing trend in foreign ownership and simultaneously higher local ownership. This was highly attributed to the government's policy over the last ten years to improve the economic situation of the Malaysian entrepreneurs by encouraging projects to be undertaken on a joint-venture basis between Malaysians and foreigners.

With this policy, foreign companies are allowed to operate locally and thus reducing unemployment but on the other hand, with high foreign owned or controlled industries, the technology tends to be also foreign owned and controlled.

Within the industrial sub-sector, the continuation of Table 3.2 shows that foreign owned industries tend to concentrate on manufacturing with high emphasis on electronic equipment and components. Locally owned company on the other hand is quite well spread with 47% total expenditure are spent on services, followed by manufacturing 33% and primary industries 11%. On a national level, the trend by selected sub-sectors is given in Figure 3.3.



From the above graph, it shows a shift from manufacturing emphasis in 1992 (95% of total R&D expenditure) to a more "balanced economy" with R&D expenditure being spread across a few major sectors namely manufacturing, services, primary industries and electricity. The service sector that comprises telecommunication and computer related service shows a dramatic three fold increase in expenditure as compared manufacturing which has been declining about 31% over the last period of survey. This is also in line with the government's policy from a higher industrialisation nation to a high information-based nation.

### 3.3 Industry R & D Expenditure by Type

In 1996, the private sector spent 48% of the R&D on the capital expenditure (land, building & machinery), and 52% on current expenditure (labour and operating cost). The capital R&D expenditure is double than previous years or an increase of 93% (see *table 3.3*). This indicated the emphasis and priorities that the private sector is putting on R&D facilities. The amount spend on capital expenditure shows the commitment by the private sector in enhancing the development of science and technology by committing the funds for a more long term framework i.e. land, building and machinery.

### **3.4 R & D Expenditure by Company Size.**

In 1996, 64% of the total R&D expenditure are spent by companies with has less than 500 employees. This is contrary to the figures of 1994 which showed that 53% of total expenditure by private sectors was spent by companies with more than 500 employees.

### **3.5 Patent**

Another indicator that is used by OECD and other developed countries to measure their innovative and inventive level is the level of patent granted to its residents and non-residents.

Table 3.6 indicates that although on a national level the total number of patents applied for and granted is increasing gradually, the auto sufficiency ratio (ratio of resident/total) is extremely low and still dominated by foreigners. This reflects that although commitment in terms of financial and human resources has been put aside for the development of S&T technology, the results are not very encouraging. In 1996, out of 5,575 patents applied for, only 221 or (4%) were from residents and the same percentage was for patents granted (see *Figure 3.4*). Similarly, the dependency ratio (ratio non-resident/resident) also registered high figures, which shows that Malaysia is very dependent on foreign technology.

**Figure 3.4 : Patent Applied: Resident vs Non-Resident (1990-1996)**

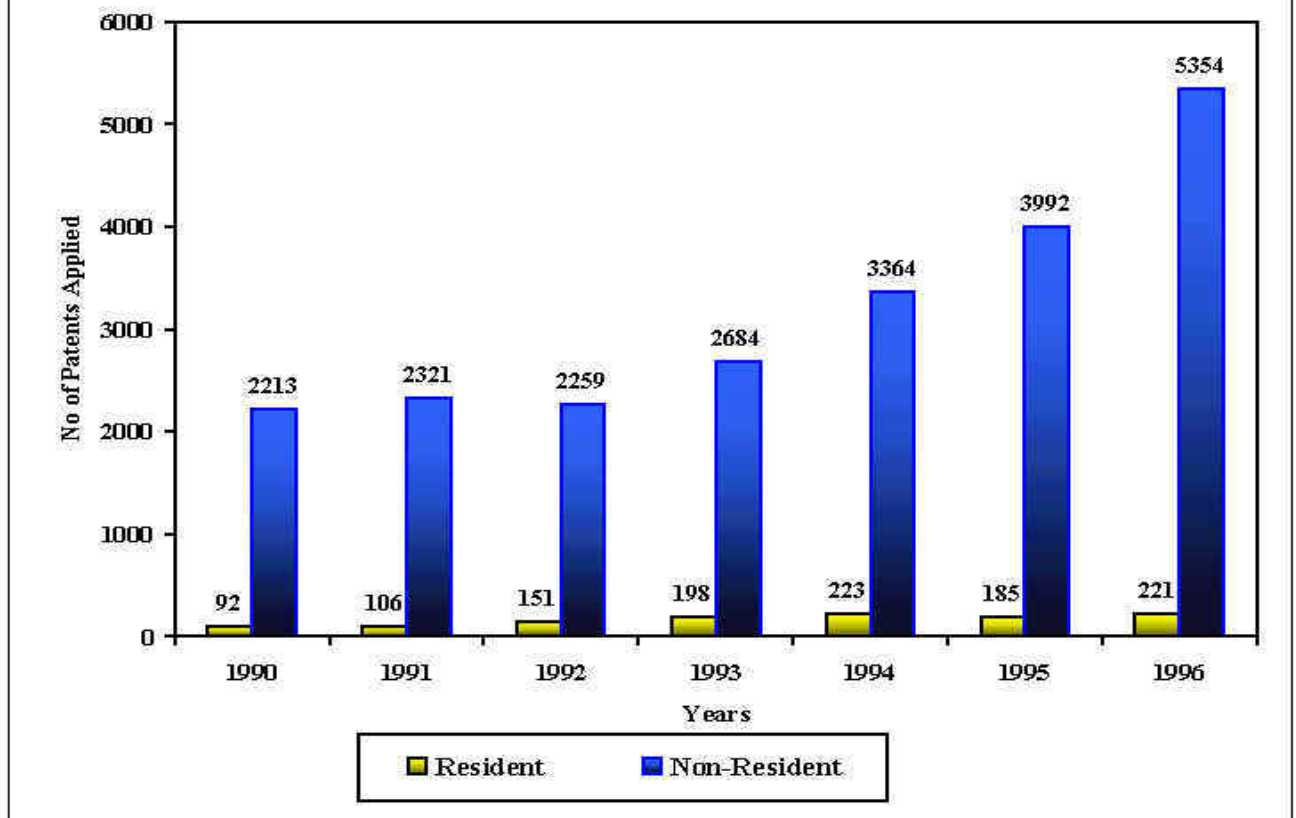
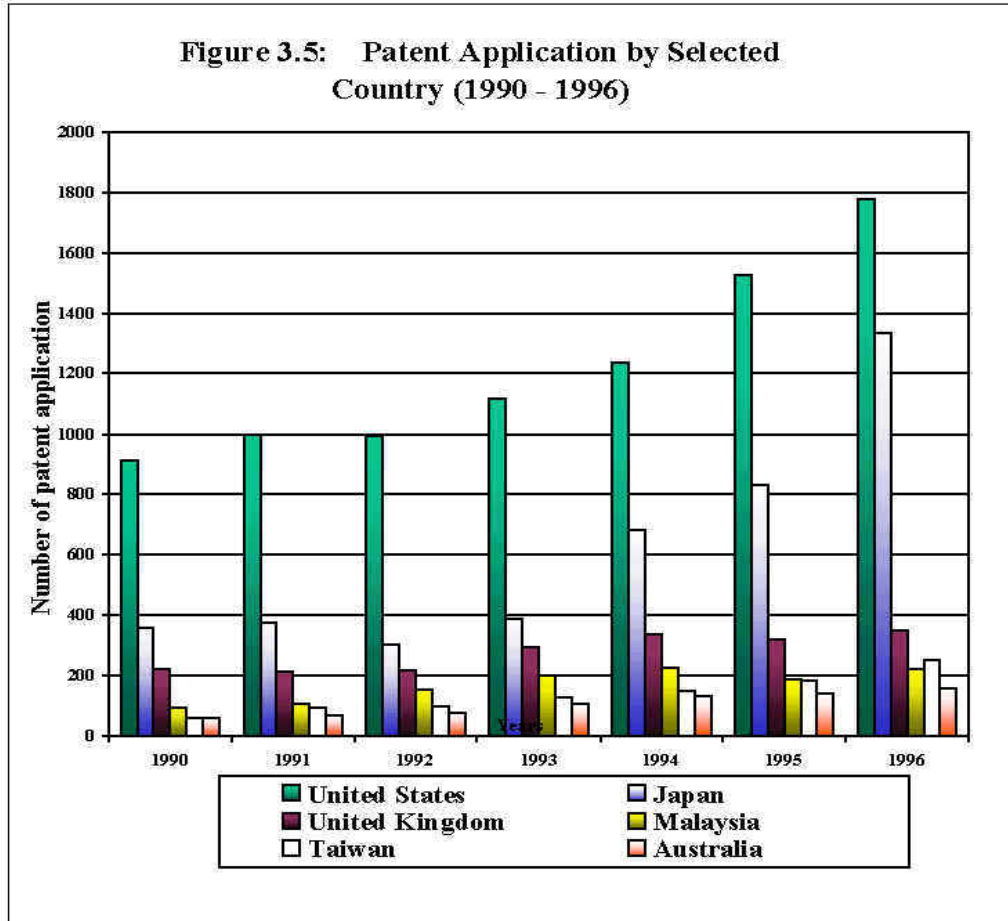


Table 3.6A shows the number of patent applications by residents and non-residents of selected OECD countries. Among the countries, Japan has the lowest number of non-resident applications with the dependency ratio of 0.1 which is very low. Similarly, Korea also has low dependency ratio as compared to other European countries and the North America. However, it is well known that Japan practices very stringent control on their trade policies and at the same time they are also very innovative people. Korea is taking the same stance that of Japan, having been an industrialised and export oriented country. Even advanced countries like United Kingdom, France, Canada and Germany and United States have relatively higher dependency ratio than their Asian counterparts like Japan and Korea.

The ASEAN nations data on patents applications by residents and non resident as illustrated in Table 3.6B shows that Malaysia's dependency ratio is the highest among the four countries. This suggested that inventive levels among

Malaysians are somewhat low or Malaysians generally do not apply to patent their product inventions.



There is a high increase in patent application from Japan from 1994 to 1996 as indicated by [Figure 3.5](#). This indicates increasing interest from the Japanese to be involved in the S&T development in this region especially Malaysia. Taiwan was also showing much interest in Malaysia, evidenced by the increasing trend in patent application since 1992. Three countries i.e. United States, Japan and Taiwan showed similar trend in patents granted to them i.e. an increase from 1993 to 1996. This could be attributed to the conducive economic situation prevailing in Malaysia during these years.

**Figure 3.6: Patent Granted : Resident vs Non- Resident (1990 -1996)**

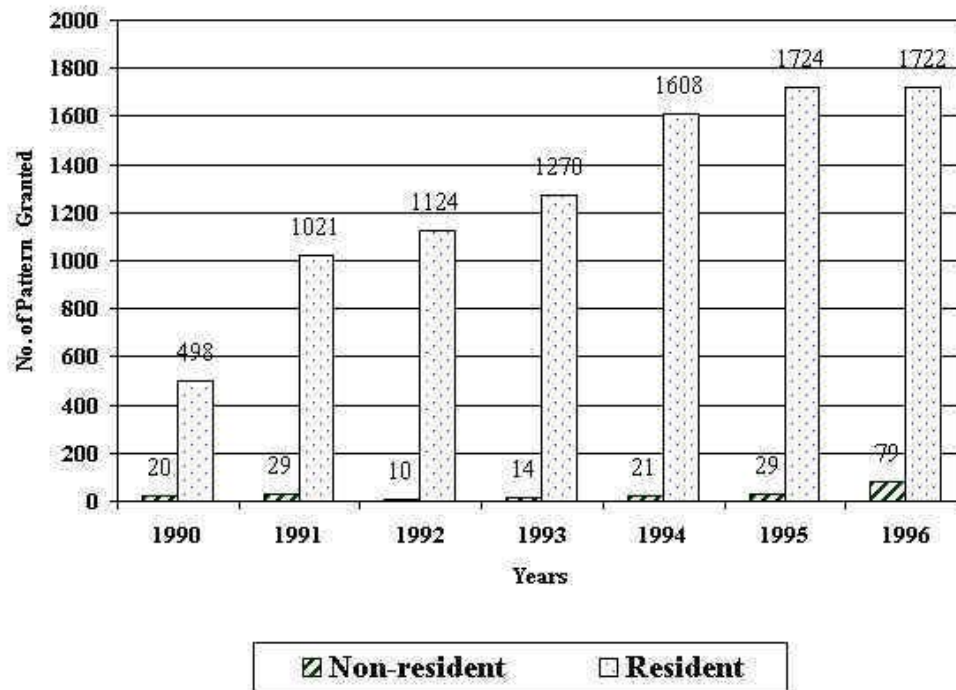


Figure 3.6 indicates the number of patents granted to residents and non-residents. Years 1990 to 1991 saw a very remarkable increase in percentage i.e. 105% for patents granted to non-residents. The percentage increase seems to be getting lower and lower from 1994 to 1995 i.e. registering 7.2% and finally decreased by 0.1% from 1995 to 1996, as illustrated in [Table 3.6](#).

The number of patents granted to residents is very low as compared to that of non-residents. However, since 1992, the percentage is on the increasing trend albeit a small increases.

### 3.6 Bibliometric

Malaysia has been producing quite a considerable number of publications on S&T which are internationally recognised. Malaysia’s publications on S&T are

ranked in 50 top leading countries publication output in the world. From 1984 – 1989 saw Malaysia ranked number 44 out of 48 leading countries with 0.05% share of publication output in the world. From 1990 – 1995, Malaysia's percentage publication output increased to 0.07% and ranked number 46 out of 50 leading countries in the world.

**Figure 3.7: Ranking & Percentage Share of Publication on S&T by ASEAN Countries**

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

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

In terms of average annual growth rate of the share in the world's publication output, Malaysia's average annual growth rate for publication output is 4%, 5% and 7% for 1980 – 1985, 1986 – 1989 and 1990 – 1995 respectively. The ranking is as follows:

**Figure 3.8: Average Annual Growth Rate of Publication Output in ASEAN Countries**

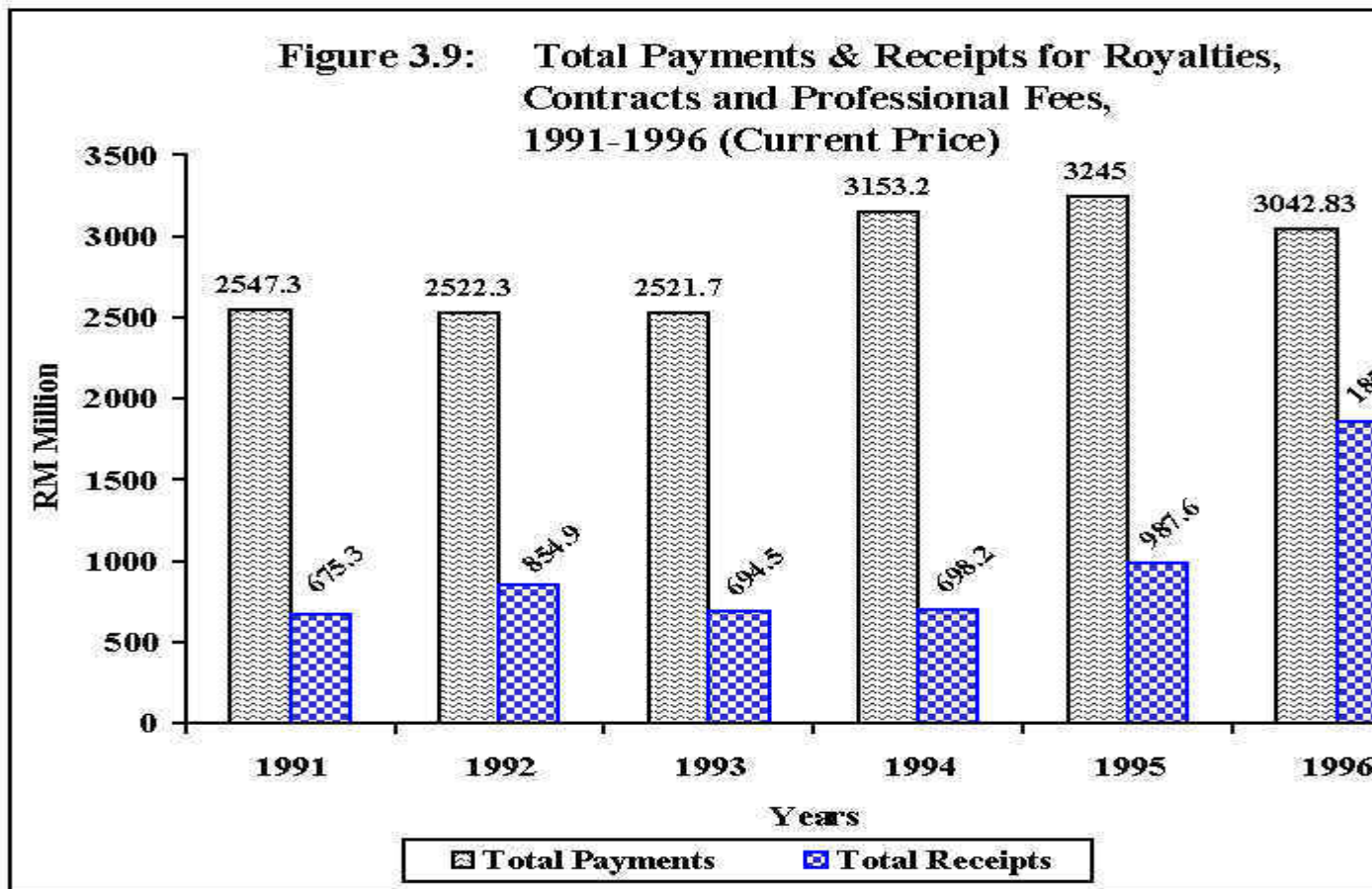
Country	1980 – 1985 (%)	1984 – 1989 (%)	1990 – 1995 (%)
Singapore	15.80	10.52	14.23
Indonesia	7.34	4.85	7.74
Malaysia	3.78	4.58	7.41

Thailand	3.88	5.38	3.88
Philippines	2.13	1.95	-1.37

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

Singapore is ahead of other ASEAN nations registering 16% in average annual growth rate of the share in the world's publication output. Asian countries posted quite remarkable growth against their European and North American counterparts in the annual average growth rate of the share in the world's publication; where South Korea was ranked first, Turkey third and Taiwan fourth.

Malaysia's scientific publications have also been cited 510 times in 1993, which was second to Thailand which recorded 1,368 times.



### 3.7 Trade in Technology

Technology balance of payments (TBP) measures international trade in intangible technology including trade in technique, transaction involving intellectual property such as money paid or received for the used of patent, licenses, trade - marks, designs and know-how, services with technical contract such as consultancy and payment for R & D carried out in foreign countries.

In an effort to make comparisons in TBP, payments and receipts for royalties, contract and professional fees are two components that will determine whether Malaysia has deficit or surplus in its TBP.

Malaysia has consistently suffered deficit in TBP and has to pay royalties and contract and professional charges acquired from other countries. Although deficit for royalties did not diminish drastically and amounted to RM969 million in 1996 and RM 742 million in 1994, deficit for contracts and professional services has dropped significantly from RM 1,712 million to RM 214 million (*see Table 3.8*). These figures reflected that Malaysian did also provide professional services to other foreign countries. The small deficit indicates that professional services might be one of the nation's strength. This is also one of the reason for the 35% commitment of the R& D expenditure is concentrated on services as stated in Table 3.2.

#### 3.7.1 Payments for Royalties, Contracts and Professional Fees

Table 3.9 shows payment made by Malaysian to respective foreign countries. It shows that Malaysia has been receiving knowledge from three major countries namely Japan (24%), United States (22%) and Singapore (12%). Payments made to these countries either by royalties or contracts and professional charges emphasis earlier findings that although efforts and commitment were made to improve the innovation standard of the country, Malaysia still relies heavily on knowledge and information from overseas especially its trading partners, Singapore, Japan and United States. This is something not so surprising as Malaysia is heading towards becoming an industrialised nation and the amount of technology and professional advice need to be transferred to Malaysians. However, Malaysia has to increase its level of expertise in S&T in order not to be too dependent on other countries and simultaneously is self - sufficient. Besides the private sector, IHLs must also be committed to train researchers in areas that have potential to be exported to other countries.

Figure 3.9 shows the trend in payment made for royalties, contracts and professional fees made by Malaysia to other countries. The trend line has not shown any increase from 1991 to 1993 but a sharp increase prevailed from 1993 to 1994, followed by only a small increase from 1994 to 1995 and finally

decreased from 1995 to 1996. The trend is showing some positive note since it is on the declining side and converging with that of receipts. This shows that TBP will achieve an equilibrium state once payments and receipts equalised, after which Malaysia should aim for surplus in TBP.

### **3.7.2 Receipts for Royalties, Contracts and Professional Fees**

Table 3.10 illustrates Malaysian receipts for contracts and professional services fee by country. Figure 3.9 on the other hand shows the trend in receipts for royalties, contracts and professional fees in 1996. Comparing total receipts and payments, there exists very large gap between the two.

Looking at receipts by country, receipts from Japan is the highest, where contracts and professional charges received from Japan made up 15% of total contracts and professional charges received and royalties receipts is 7% of total royalties. United States paid RM 11.4 million worth in royalty, which is 16% of total royalties, paid to Malaysia in 1996. In rank of order of total receipts, highest receipts came from Japan (15%), followed by Hong Kong (6%) and Australia (3%).

## **3.8 Import and Export of Technology-based products**

This section will uncover the balance of trade of technology-based products. It is important to look at the flow of technology-based products in and out of the country, to understand the strength and weaknesses in terms of the R&D products. High knowledge based economy will be placed competitively in a global and competitive scenario.

### **3.8.1 Export of Highly R&D Intensive Products**

Table 3.12 shows that highly R&D intensive products constitute 59.2% of manufacturing sector's total export in 1996 in comparison to 56% in 1994. There have not been any marked changes in trend since 1994. In real terms, the change is not as high as the change from 1992 to 1994. There was only 27% increase in real value since 1994 for highly R&D intensive products (Table 3.11b).

In real terms, two product categories within the highly R&D intensive products category i.e. aerospace and pharmaceutical both have registered a decrease of 28% in export figure from 1995 to 1996 as stated in Table 3.11b. Only one

product category i.e. office computing machinery registered increase of 25% in export. Export trend of highly R&D intensive product category is as illustrated in [Figure 3.11](#).

### **3.8.2 Imports of Highly R&D Intensive Products**

Imports of highly R&D intensive products category saw an increase of 84% from 1994 to 1996. [Table 3.11a](#) shows that there is an increase in imports of all products except for one category i.e. aerospace, which experienced a decrease of 41%. The total decrease is also due to the fact that in 1996, two new products category were added to the list of highly R&D intensive products list i.e. vehicles and automobile (excluding railway and tramway and parts and accessories) and railway and tramway locomotives, rolling stock and part thereof.

### **3.8.3 Balance of Trade of Highly Intensive Products**

Within the highly R&D intensive products category, office and computing machinery registered an up-trend in trade surplus since 1992. Radio, TV and communication equipment (including electronic components) also shows the same positive upward trend from 1992 to 1995, as stated in [Table 3.11b](#) (1978 prices) and [3.11a](#) (current prices). However, from 1995 to 1996, according to current prices, although there existed surplus in balance of trade, the percentage decreased markedly by 62.2% in real terms (*see Table 3.11b*). This could be the result of increased importation of electronic parts and components to produce finished products like radio, TV and communication equipment. The demand for these products depend largely on consumer affluence, the ever changing taste and higher expectations for sophisticated products which Malaysia is experiencing due to the robust economy growth experienced since 1992.

[Figure 3.10](#) shows exports and imports of selected highly R&D intensive products for 1996. Radio, TV and communication equipment, office and computing machinery clearly shows a surplus in TBP.

### **3.8.4 Imports of Medium-High R&D Intensive Products**

Imports in all product categories of medium-high R&D intensive products increased from 1994 to 1996 by 15%. Professional equipment registered 27% increase while electrical machinery (excluding radio, TV and communication equipment) registered a percentage increase of 11.6% as shown in [Table 3.11b](#).

### **3.8.5 Exports of Medium-High R&D Intensive Products**

Total export of medium-high R&D intensive products also registered an increase of 18% from 1994 to 1996, as illustrated in Table 3.11b. Similar to that of imports, all product categories listed under medium-high intensive products also registered increase in export level. As opposed to imports in electrical machinery (excluding radio, TV and communication equipment) which registered much higher percentage of increase, the export figure on the other hand registered lower percentage increase of only 10%.

Figure 3.12 shows the trend in exports of medium-high R&D intensive products. All product categories show an up-trend in exports. The difference between them is that electrical machinery's export increase shows a less steeper gradient than that of other product categories.

### **3.8.6 Balance of Trade in Medium-High R&D Intensive Products**

Medium-high R&D intensive products which includes professional equipment, chemicals and electrical machinery, had always suffer deficit in their balance of trade. The deficit figure increased from the RM2 billion level in 1992 to RM3 billion level in 1994 and 1995 and consequently increased to RM4 billion level in 1996; as stated in Table 3.11a.

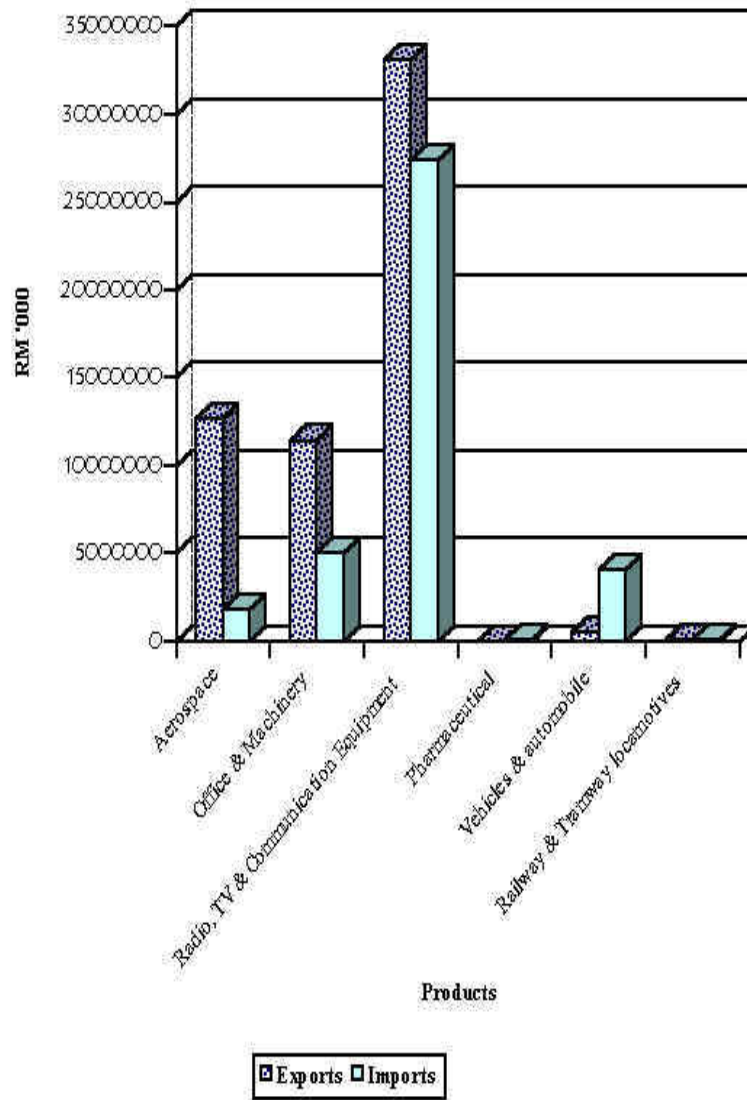
## **3.9 International Comparison of Exports and Imports of High-tech Products**

Table 3.14 shows total exports (in million ECU) of high-tech products data of selected countries within the world as comparison to Malaysia. Within the ASEAN nations, Malaysia ranked second after Singapore. However, Singapore is categorised in "developed Asian economies" list together with Japan, Korea and Taiwan in the Second European Report on S&T Indicators – 1997, and therefore not comparable to Malaysia. Therefore, within the Association of South-East Asian Nations (ASEAN – 4) nations, Malaysia emerged first in value of exports of high-tech products. Malaysia is however getting closer to Korea in terms of export of high-tech products. This is a good sign since Korea is also categorised under "developed Asian economies". If Malaysia continue to constantly upgrade its effort in acquiring technological knowledge and know-how, Malaysia will then be comparable to "developed Asian economies", at least in exports of high-tech products.

In terms of total imports, Malaysia imports quite a considerable amount of high-tech products i.e. second after Singapore within the ASEAN nations, and equivalent to Korea, as stated in Table 3.14a. Therefore, Malaysia's market readiness and acceptance of high – tech products is equivalent to that of Korea (as shown by the exports and imports), indicating Malaysia's degree of advancement in science and technology.

Balance of Trade in high-tech product is favourable for Malaysia since Malaysia has been registering surplus since 1992 to 1996 (see Table 3.15). Among the ASEAN – 4 nations, Malaysia is the only country that registers surplus in balance of trade if high-tech products; although the surplus decreased from 1994 to 1995. Even developed nation like USA is starting to experience deficit in balance of trade of high-tech products.

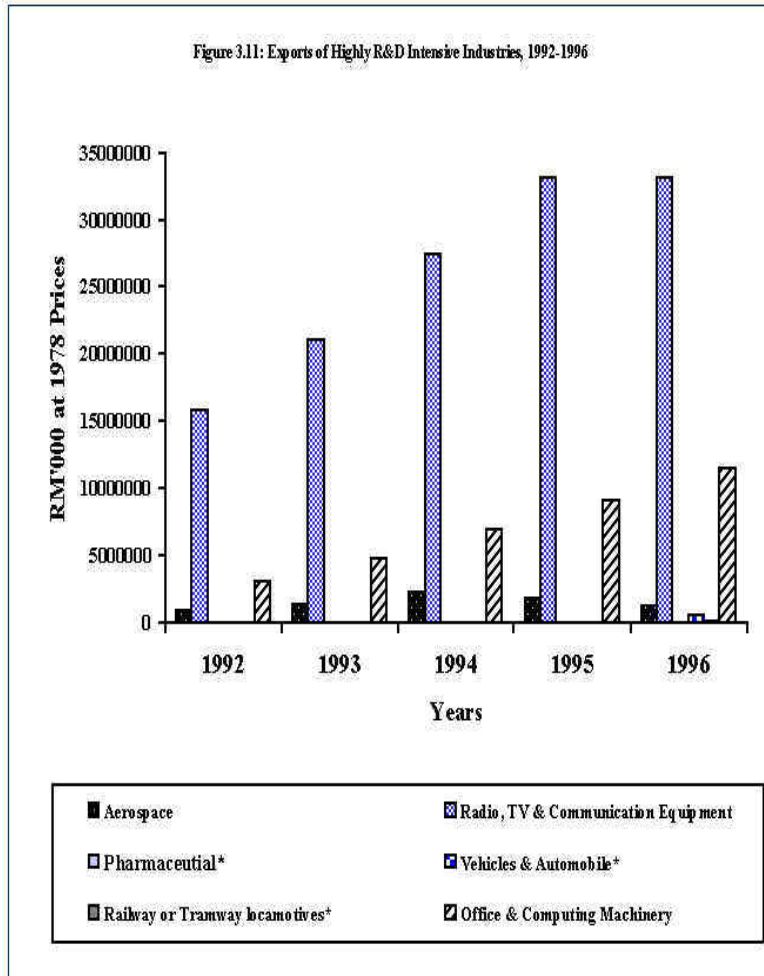
Figure 3.10: Exports & Imports of Selected Highly R&D Intensive Products, 1996



Source:

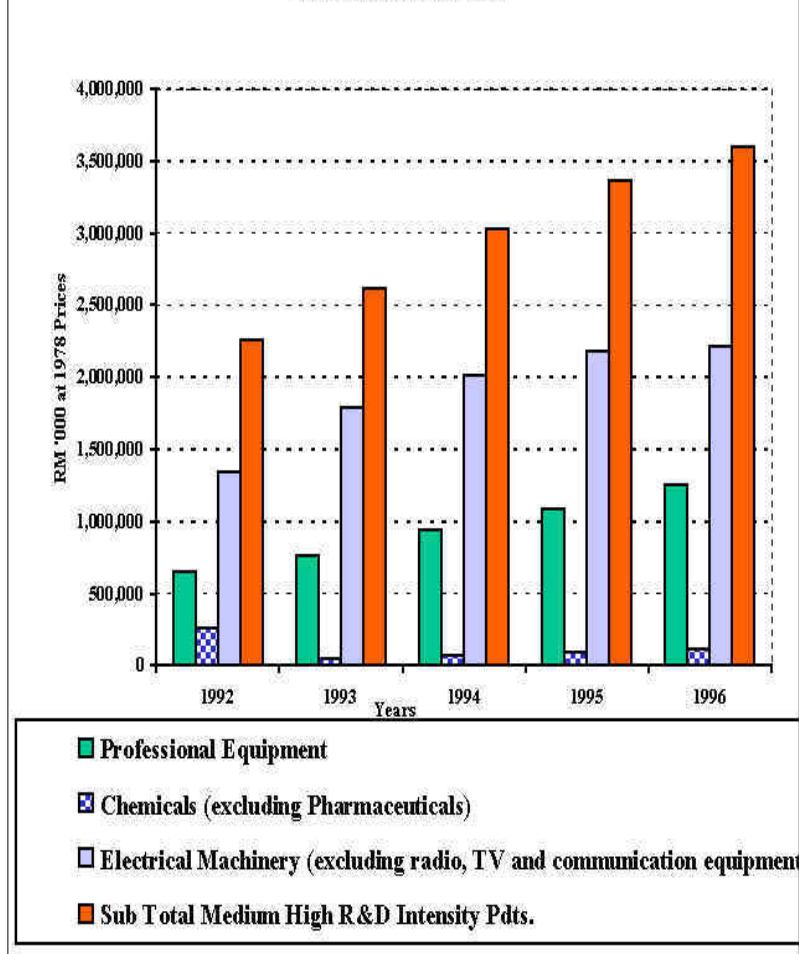
Table 3.11b

Figure 3.11: Exports of Highly R&D Intensive Industries, 1992-1996



**Note:** \*The figure is too small and data available is only for 1996

**Figure 3.12: Exports of Medium-High R&D Intensive Industries 1992 - 1996**



## HUMAN RESOURCES FOR SCIENCE & TECHNOLOGY

### 4.1 INTRODUCTION

The adequate supply of human resources is one of the critical factors in the development of S&T in Malaysia. With the rapid growth of the Malaysia's economy and coupled with Malaysia's ambition to be a developed nation by the year 2020, the demand for highly educated, trained and skilled human resources in S&T would always remain high. It is therefore of paramount importance for Malaysia not only to meet this demand, but it is equally important that those with S&T skills are effectively deployed and their skill efficiently utilised.

The usefulness of data that provides human resources indicators is to examine the stocks and the flows of highly skilled personnel particularly scientists,

engineers and technicians. It is now increasingly accepted that the definition of human resources indicators should also include post-secondary teachers, medical practitioners, consultants and R&D managers. They cover both categories namely qualified personnel who are not employed in S&T related activities and those without formal qualifications but involved actively in skilled works. This chapter however, will only analyse the two most important aspects i.e. the production of qualified and trained graduates by the tertiary educational institutions and the present distribution of S&T personnel involved in R&D activities.

Based on the 1994 S&T indicators report, since 1991 the demand for workers in professional, technical and related jobs grew at a very rapid rate, an average annual rate of 7% and it is anticipated the demand will grow to 12% of the employment by the turn of century. The report also noted that over the period 1991-1995, the education and training system were unable to respond adequately to the demand for skilled personnel and this has resulted in the shortage of skilled personnel particularly in new technology sectors.

Recognising the upward demand for the trained and skilled manpower in S&T related areas in the coming years and realising the shortcoming of 6MP in terms of responding to the requirements for trained and skilled personnel of the country, the government has formulated several strategies to meet the required mass that would be implemented throughout 7MP.

In terms of meeting the above requirement, the 7MP period will put into effect a number of changes with a view to strengthen and improve the education system. These efforts are expected to improve the quality and increase the quantity to meet the manpower needs of the nation, particularly in the fields of S&T.

The 7MP stipulates the following strategies to be implemented over the next five years:

- increasing capacity to meet the growing local demand for higher education as well as developing higher education as an export industry;
- improving quality and relevance of courses offered so as to match national manpower requirements;
- increasing the enrolment at the first degree level in local public institutions for those in the 19 – 24 age-group from 3.5 per cent in 1995 to 5.6 per cent in the year 2000;
- increasing the capacity of enrolment in the science, engineering and technical –related courses so as to intensify the production of manpower with science and technical knowledge;
- increasing the capacity for post-graduate courses from 11.5 per cent of total enrolment at the degree level in 1995 to at least 14 per cent in the year 2000;

- increasing the capacity and capability to undertake R&D, particularly those which are relevant to industrial and services sectors requirement; and
- Increasing private sector participation to supplement Government efforts in expanding tertiary education opportunities, while at the same time helping to reduce the growing public expenditure on education.

## **4.2. Tertiary Education – Commitment Towards R&D**

In parallel with the strong economic growth and the subsequent demand, the Malaysian tertiary education needs also to expand at a similar rate. The focus is to give more priority to science, technology and technical related courses as to provide enough supply of skilled manpower in these fields to meet the demand for the future of the country. To achieve this objective, the government is targeting that by the year 2000, all public universities would each have 20,000 full-time students with half of the enrolment in S&T related courses.

With regards to the objective of promoting local IHLs as centres of excellence in R&D and consultancy services, efforts will be undertaken to strengthen R&D activities in certain strategic fields such information technology, micro electronics, advanced materials technology, advanced manufacturing, biotechnology, aerospace, energy and environmental related technology and communication technology.

## **4.3 Enrolments of Degree-Level Students**

### **4.3.1. Doctoral Degree Enrolments**

There has been a significant increase in the total doctoral degree enrolment in 1995-1996 relative to 1993-1994. As indicated in [Figure 4.1A](#), during the year 1995-1996 session a total of 1,255 PhD students were enrolled and this represents an increase of more than 75% over the number three years previously which recorded 716 students. In terms of the division between SSH and NSE, the number of students enrolled in NSE represents nearly half of the total enrolments.

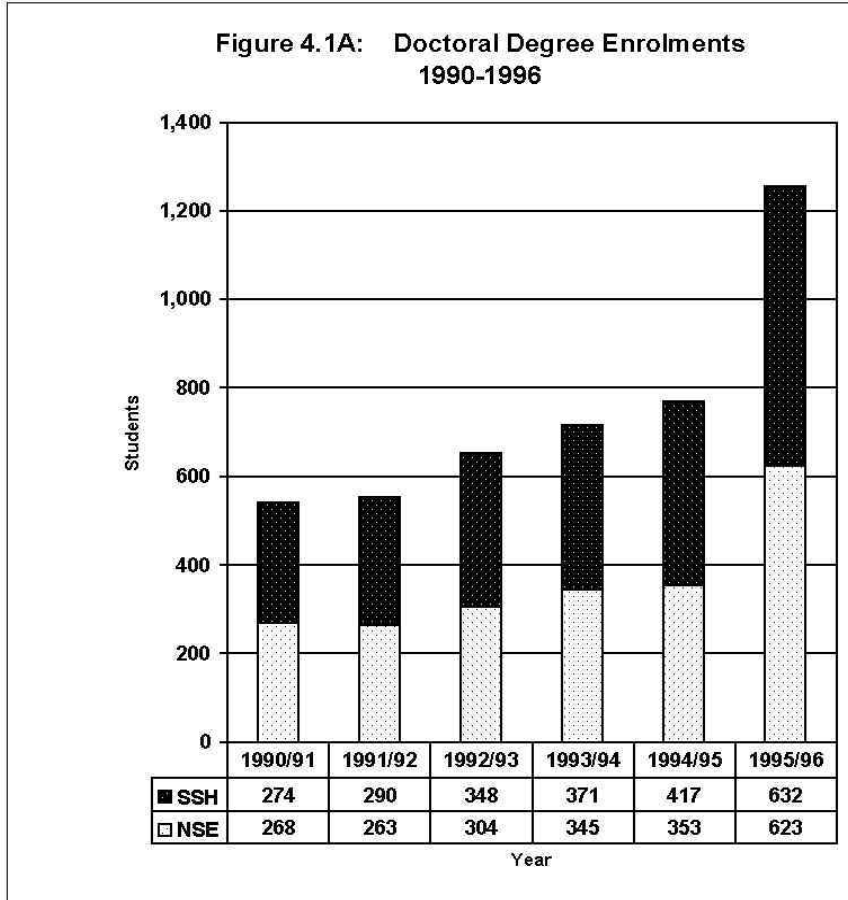


Figure 4.1B shows that out of four major fields of study in NSE, in 1995-1996, Natural Sciences seems to be the most preferred fields of study which represents about 27 % of the total PhD students and it is followed by Engineering Science & Applied S&T (10%), Medical

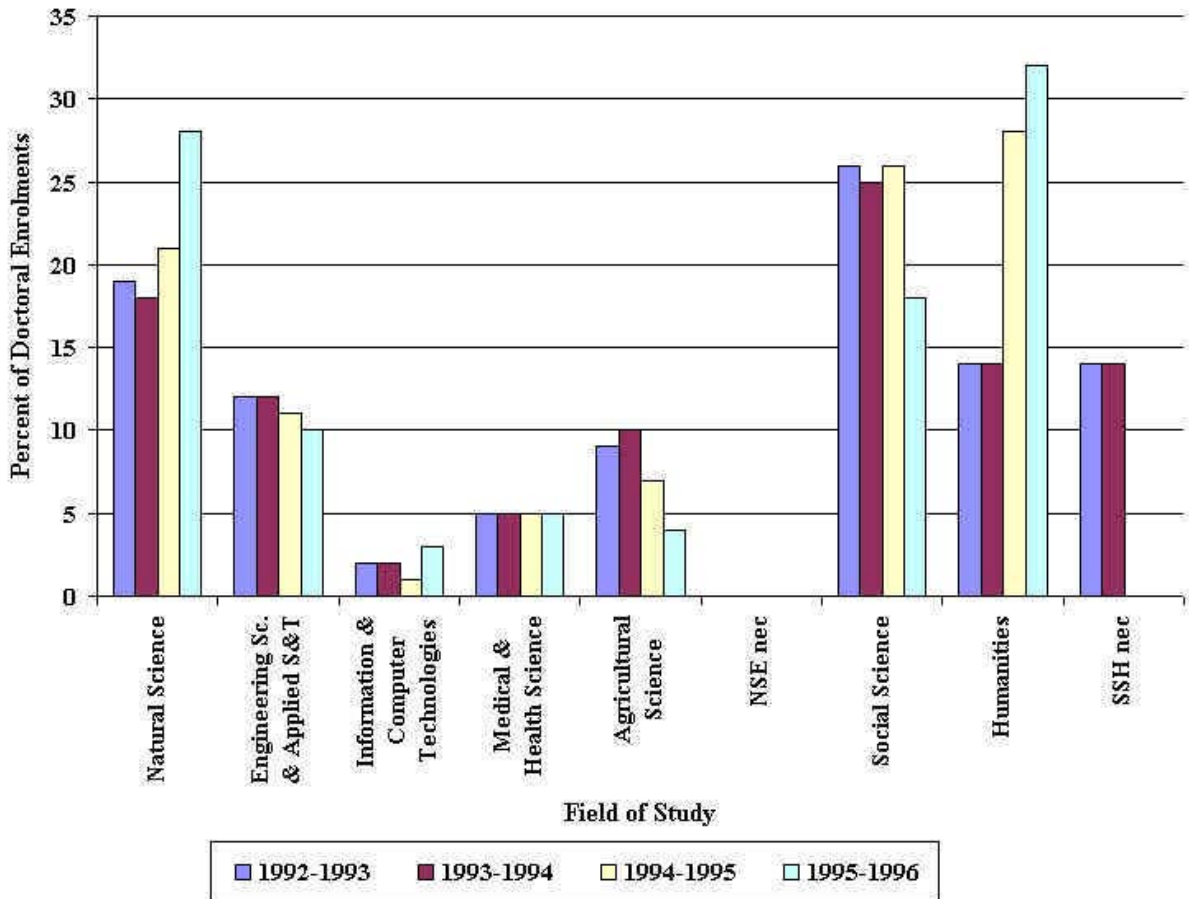
and Health Services (5%) and Agricultural Sciences about 4%, while Information and Computer Technologies is the least popular registering just about of 3% in 1995-1996 enrolment year.

It is interesting to note that over the period 1993-1994 to 1995-1996, there has been a significant increase in percentage contribution by Natural Sciences in doctoral enrolments from 18% to 28% and this represents an increase of nearly 53%. As has been expected the popularity of Agricultural Science among candidate has recorded a downward trend where the percentage contribution has dropped from 10% in 1993-1994 to only about 4 % of the total enrolment in 1995-1996.

The analysis on the trend of doctoral degree in SSH related field shows that they represent about 50% of the total enrolment in 1995-1996 and this trend has also

been noted in the past three years. The enrolment in SSH related field has shown that Humanities has recorded a big increase in the number of students majoring in this field from 97 students in 1993-1994 to 402 in 1995-1996 and this represents a jump of more than 300%.

**Figure 4.1B: Doctoral Degree (PhD) Enrolments by Fields, 1992-1996**



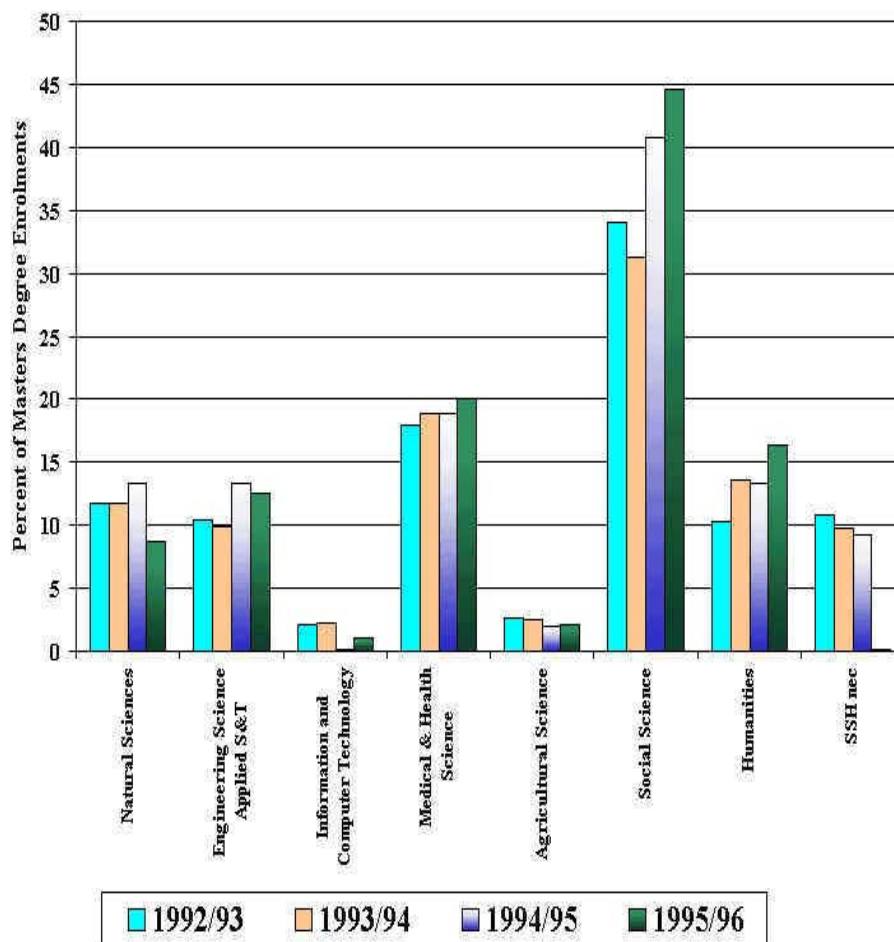
### 4.3.2 Masters Degree Enrolments

Figure 4.2A clearly indicates that there has been a progressive increase in the number of master students enrolments over the last 6 years period 1990 to 1996. The number of SSH students has always recorded slightly higher percentage compared to NSE during that period.

Over the period of 1993-1994 to 1995-1996 the numbers of masters students increased from 4,001 to 5,136 and this represents increase of 28%. Similar pattern of growth has also been seen in both SSH and NSE over the same period.

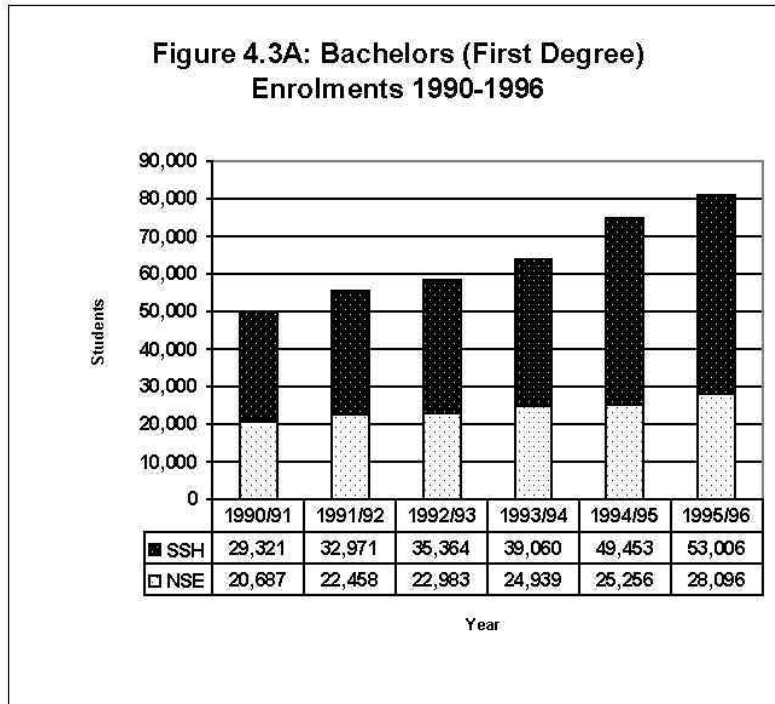
Despite an increase in numbers of NSE students from 1,814 students in 1993-1994 to 2,164 in 1995-1996, the percentage contribution to total Master Degree dropped slightly from 45% (in 1993-1994) to 42% (in 1995-1996). The drop in NSE enrolment was mainly contributed by the drop in Natural Science enrolments which fell 15% from 470 to 398 students. Further to that Information and Computer Technology also decreased by 70% even though total number contributed is not significantly big.

**Fig. 4.2B : Masters Degree Enrolments by Fields**  
1992 - 1996



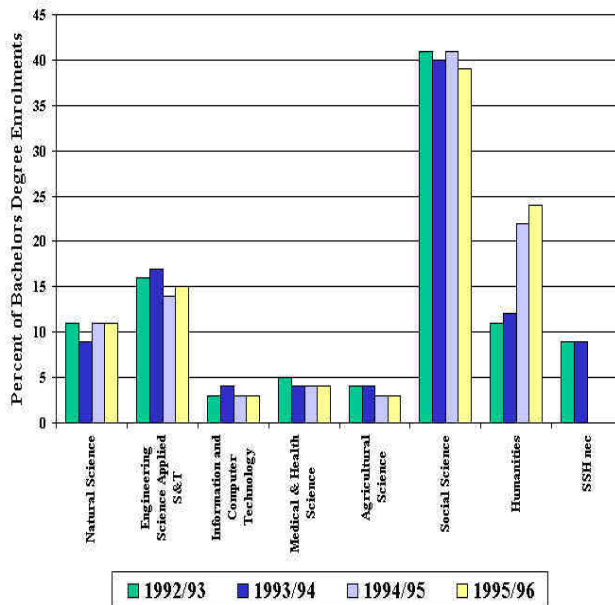
### 4.3.3 Bachelors Degree Enrolment

As demonstrated in [Figure 4.3A](#), there appears to be a steady increase in Bachelors Degree enrolments into public institute of higher learning over the last six years with an annual growth rate of 9.4%.



Since the last S&T Indicators Report in 1994, the enrolments of Bachelor Degree students have registered a steady increase from 63,999 in 1993-1994 to 81,102 in 1995-1996 and this represents an increase of nearly 27%. Even though there has been an increase in the number of NSE students throughout the period, but their share to total enrolment not registered similar growth but instead showed a declining trend from 39% (1993-1994) to 35% in 1995-1996 relative to SSH enrolments (see [Table 4.3b](#)).

Fig. 4.3B: Bachelors Degree Enrolments by Fields - 1990 - 1996



Analysing on the enrolment of Bachelor Degree students in NSE fields over the last three years from 1993, it shows that there has been an increase in the number enrolled from 24,939 in 1993-1994 to 28,096 in 1995-1996 and this represents a surge of 13%. The increase was mainly contributed by the higher intake in almost all fields except Agriculture Sciences. Enrolment in Natural Sciences has increased by 41% from 5,946 in 1993-1994 to 8,374 in 1995-1996 while Engineering Sciences & Applied S&T recorded 6% increase (from 11,128 to 11,798). The popularity of Agricultural Sciences related courses also followed the same downward trend as seen in PhD enrolments where the number dropped by 17% from 2,618 in 1993-1994 to 2,169 in 1995-1996.

Over the same period, similar upward growth is also seen in the first-degree enrolments for SSH related fields of studies. It is noted that students studying SSH have increased from 39,060 students in 1993-1994 to 53,006 students in 1995-1996 an increase of 36%. When compared between Social Sciences and Humanities, it is clear that there has been a big increase of nearly 150% in the number of students enrolled in Humanities from 7,466 in 1993-1994 to 18,584 in 1995-1996.

Figure 4.3B presents the share of first degree enrolment by field of studies. Over the last six years, there has been a downward trend in the total percentage of students in NSE related courses relative to the students enrolled in SSH field of studies. The share of total NSE students has dropped from 41% in 1991-1992 to 39% in 1993-1994 and decreased further to 35% in 1995-1996. In spite a fall

trend in share of overall NSE, students studying fields such as Natural Sciences as well as Engineering Sciences and Applied S&T have shown a slight increase in terms of overall share. Among field of studies in NSE, over the years it has been dominated by the Engineering Sciences & Applied S&T with contributed between 13% to 17%. In SSH field of studies, Social Sciences related courses received the most number of students throughout the period registering about 40% every year.

#### **4.4 Graduations of Degree Level Students**

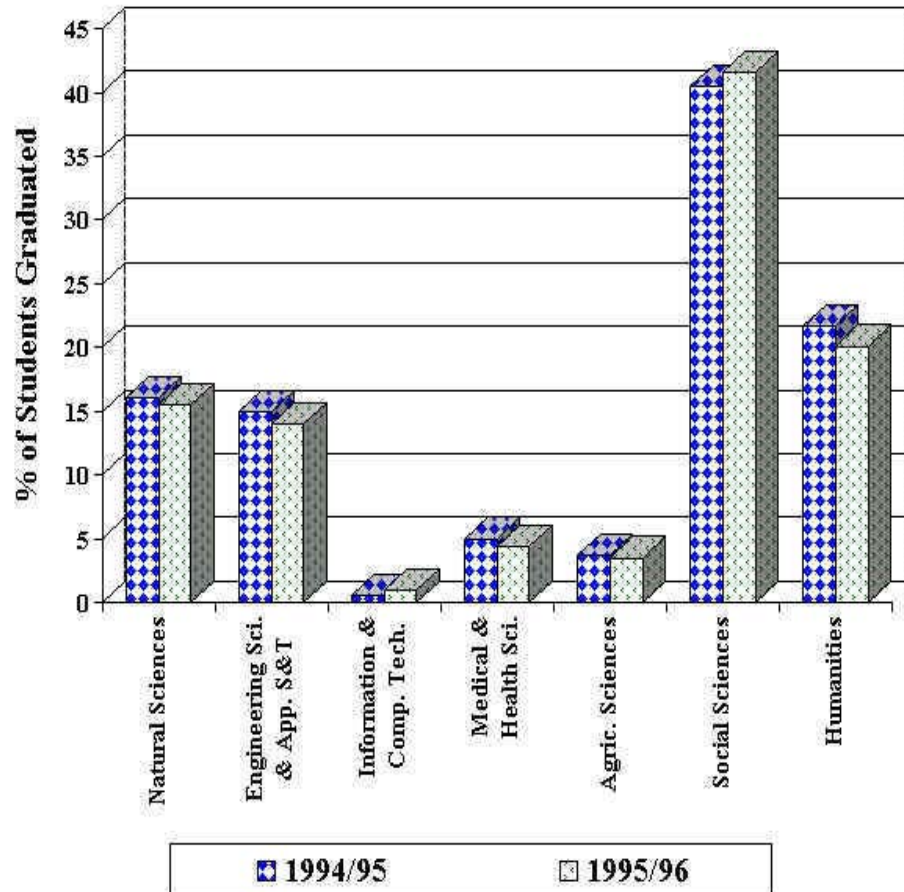
##### **4.4.1 Graduations at Doctoral, Masters and Degree Level Students**

As indicated in Table 4.4, there has been an increase in the number of First Degree, Masters and Doctoral awarded in Malaysia in both NSE and SSH related field of studies over the period from 14,708 graduates in 1994/95 to 17,135 at the end of 1995/1996 academic year. However, the total graduates in NSE remained a lower figure compared to SSH (see Figure 4.3C). This trend prevailed since 1990/91.

##### **4.4.2 Completion Rate For Graduates**

Successful graduation rate for students is not a straightforward figure that could be extracted direct from the number of student enrolments. Along the way, there are students who either dropped out or change courses or students who left the IHLs to pursue their studies overseas. There are also cases of students who refer or repeat their examinations, therefore lengthening the time for completion. However, comparing it on a straightforward basis, it is only natural that the graduation figure is much lesser than enrolment figure. To calculate the completion rate is not possible unless there is more information regarding drop out rate.

**Figure 4.3C: Graduation at Doctoral, Master and Bachelor Degree 1994-1996**



#### 4.5 Enrolments and Graduations of Private Institutes of Higher Learning

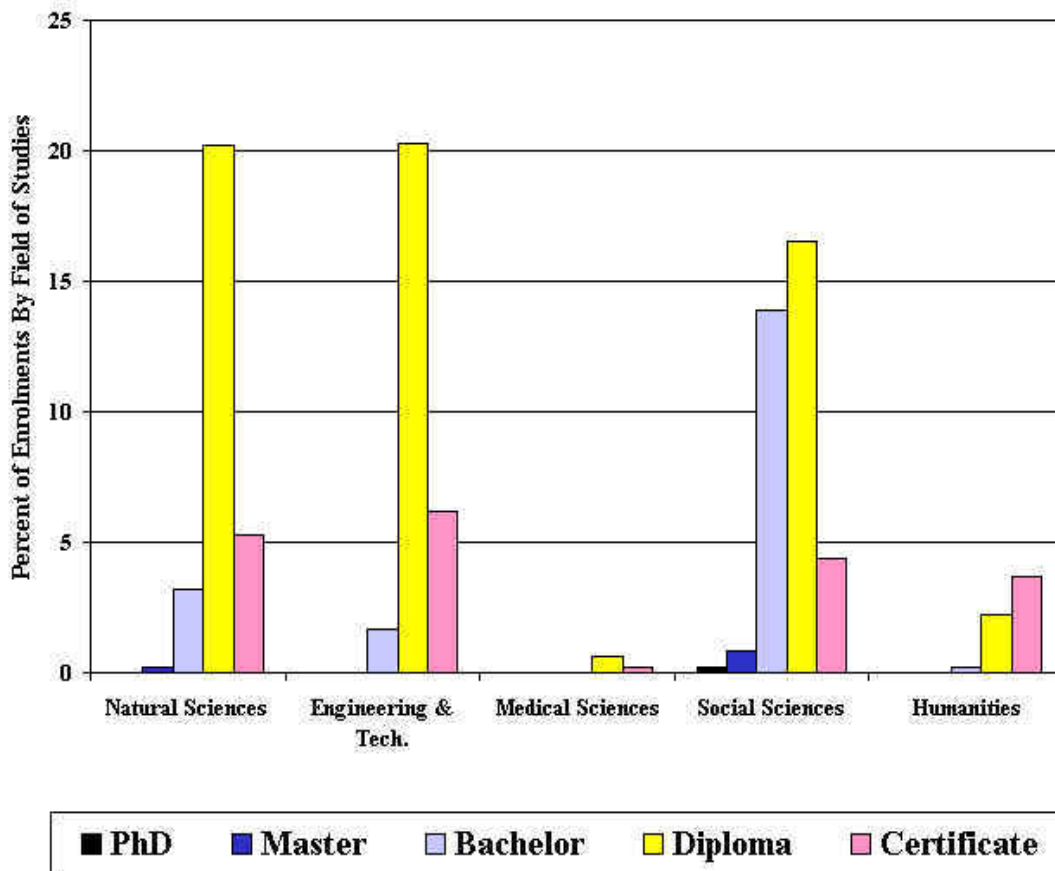
In addition to public institutes of higher learning, private colleges are also playing an important role in the local education arena. With the limited capacity provided by public universities and colleges, private colleges provide new avenues for students and parents in filling the gap for higher education in Malaysia.

Table 4.4A provides statistic on student enrolment in 88 private IHLs. Courses offered are similar as that of public IHLs. However, students intake are largely at diploma level which accounted for about 60% of total enrolments. Bachelor and certificate level made up close to 20% of the total enrolment respectively. Higher education levels at Masters and PhD made up less than 2% of the total

enrolments. Even then, private IHLs offer only Social Science courses at PhD level and Natural and Social Science courses at Masters level. Therefore, compared to public IHLs, private IHLs still need to acquire more capacity at accommodating students at higher graduate levels i.e. Masters and PhD in order to produce highly professional and skilled workers. Simultaneously, the government must ensure the quality of private IHLs so that it does not affect the standard of personnel produced by these institutions.

Enrolment year 1996/97 at 88 private IHLs, registered 38,690 students from Certificates to PhD level of which the highest percentage i.e. nearly 57.9% were enrolled in Natural Sciences, Engineering & Technical and Medical Sciences field of studies while the rest was in Social Sciences and Humanities (*see Figure 4.3D*). In terms of share between SSH and NSE, this shows an opposite trend with that of public IHLs where Natural Science and Engineering fields attract more students as compared to Social Sciences and Humanities.

**Fig. 4.3D: Enrolments Into Private IHLs 1996/97**



Both Natural Sciences and Engineering & Technical recorded similar percentage of share each about 28% of the total enrolments in 1996/1997. Medical sciences however registered the least number of students which accounted for only 0.8% and it only cater for students at diploma and certificate levels. Low percentage of intake by private IHLs in medical sciences might be due to lack of expertise and capacity in producing professionals at degree level in

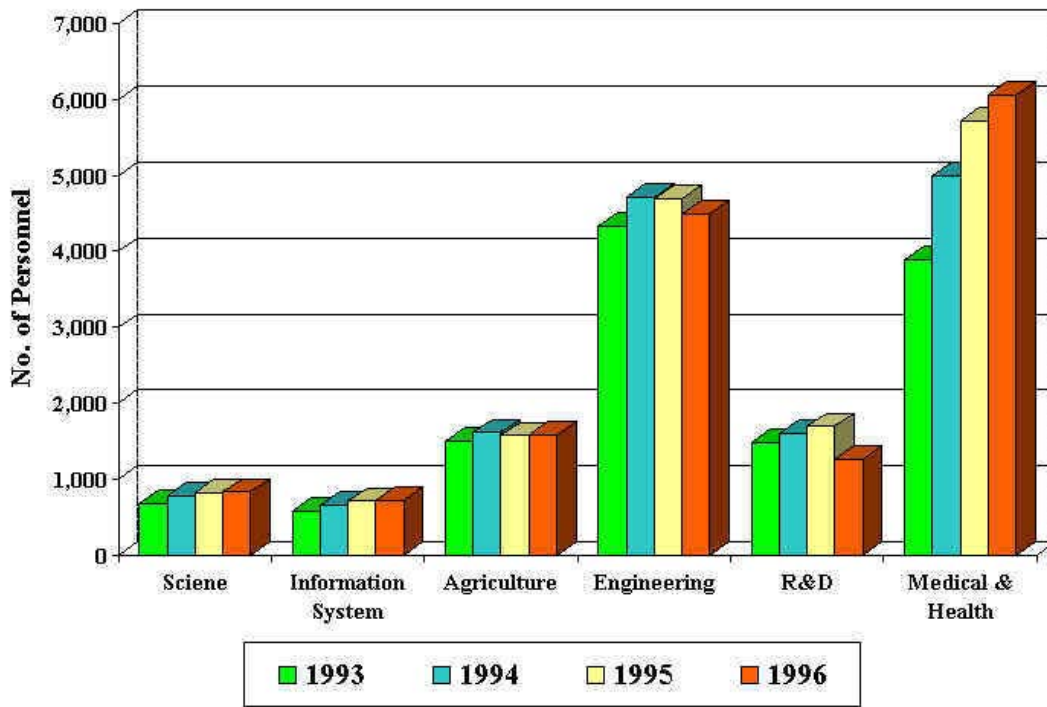
this field or professional medical courses are only recognised at public local IHLs or certain IHLs abroad. However it is not known whether medical science students who completed their certificate and diploma courses at the private IHLs would pursue their undergraduate levels in similar field at public IHLs or recognised IHLs abroad.

Table 4.4B illustrates the number of graduations from the 88 private IHLs for the past two years i.e. 1995 – 1997. The number of graduates produced was largely at the diploma and certificate levels i.e. in tandem with enrolment figures, accounting for 87% of total graduates. However, there were no graduates at the Masters and PhD levels

#### **4.6 Public Service Professional and Technical Staff in Science and Technology**

Over the years, the number of personnel in the public service (including foreigners) involved in S&T related occupations has increased from 127,956 in 1994 to 130,577 in 1996, representing an increase of 2%. (see Table 4.5). Over the same period, there has been an increase in the number of Professionals and Technical staff employed in S&T related occupation in Public Service from 14,372 in 1994 to 14,975 in 1996, an increase of 4.2%. Similar trend also occurred in Support staff which recorded almost 2% increase.

**Figure 4.4: Public Service Professional/Technicians in S & T - Related Classifications**



#### 4.6.1 Participation of Malaysians Vs Foreigners

Malaysia is a country that is moving towards becoming an industrialised nation. Technology and skills transfer, are among important pre-requisites in achieving the developed nation status. With that in mind, the government is encouraging as much skills and technology transfer to take place especially from foreign entities to local people.

Table 4.5 shows the public service personnel in S&T. They are made up of Malaysians as well as foreigners. The table shows that although there are foreigners engaged in the public sector as R&D personnel, the percentage is very insignificant. Malaysian personnel comprised almost 100% of the public service personnel in S&T related classifications. This shows that in public service science and technology R&D, Malaysians are highly involved and there is no dependency on foreigners in this area. Despite the very insignificant involvement of foreigners in the public service S&T related classification, the trend is at the same time declining. This is evidently true for all service categories from 1993 to 1996 where the involvement of foreigners in S&T of Public Service has dropped drastically (*see Table 4.5*).

#### 4.6.2 Division Between Professionals/Technicians and Support Level Groups

The public service personnel S&T related classification content comprises of professional/technical and support level groups. From the year 1993 to 1996, there was only slight increase registered for all of the professional/technical service categories except that of R&D (Q) category which experienced a decline from 43.5% in 1995 to 38.8% in 1996. This relates back to the decline in R&D personnel of GRIs and IHLs from 1994 to 1996 as stated in Table 2.1.

The support level R&D personnel in the public service has been on the increasing trend for all categories except for the R&D category which had 2,200 personnel in 1995 but decreased to 1,986 in 1996 (see Table 4.5). This is in line with the decrease in the professional/technical level for the same review period.

In terms of the ratio of support staff to each professional/technician, the agriculture and medical service categories seems to provide their professionals/technicians with the highest support level. This might conclude to the fact that in both these areas, professionals in the medical and agriculture fields spent much time on their daily job; R&D might be done on a part-time basis. That is the reason why they need a much higher support level compared to the other service categories.

The ratio of support staff to professional/technician for the different service categories are as follows:

<u>Category</u>	<u>Ratio</u>
Science	4: 1
Information System	5: 1
Agriculture	9: 1
Engineering	5: 1
R&D	3: 2
Medical & Health	9: 1

Overall, the ratio of support staff : professional/technician is 3 : 1. For similar year of assessment i.e. 1996, Singapore's ratio of support staff : professional/technician is 1: 5. This is a complete reverse to that of Malaysia's ratio. It shows the high emphasis put on R&D by the Singaporean government

where Researchers and Technicians outnumbered support staff. It may also suggest that in Singapore, R&D offer attractive grounds for people to opt it as their career.

#### **4.6.3 Male Vs Female Participation in Public Service Personnel in S&T Related Classification**

In general, the involvement of male personnel in S&T is much higher than that of female personnel in the public service R&D related classification, as illustrated in Table 4.5. A closer look at the different service categories suggested that male dominance is very high in areas such as Agriculture, Engineering and R&D; where male dominated more than three quarter of the total personnel in these service categories. One service category which female personnel recorded a significant involvement is the information system service category. In 1996, total female personnel for this service category is 3,750 as opposed to male participation of 1,071. This trend prevailed ever since 1993.

#### **4.7 S&T Professionals in Public Employment**

The public sector's professionals in S&T are very low; evidenced by the much lower number of professionals and technicians as opposed to that of support staff (see Table 4.5). Out of the total 130,560 personnel employed, 88.5% were support staff and only 11.5% were professionals/technician, as illustrated in Table 4.5.

Professionals in the medical field dominated the professional/technical classifications in 1996 recording 41% of the total professionals/technicians followed by engineers who dominated 30% of the total percentage (see Table 4.5). The area that lacks professionals/technicians in the public service sector is the information systems service category. This situation does not augur well with the government's vision in moving Malaysia towards an information-based society. Therefore, IHLs have to play a more important role to promote information systems as the choice subject in order to produce more professionals in this area for the nation's future needs.

It should be noted that the engineering service category figures should be read with caution. For the years 1993 to 1995, there was no breakdown for professional/technician and support groups. Figures given for the professional group is a combination of both professional and support level groups. Therefore, estimate figures are used from 1993 to 1995, derived from the 1996 percentage breakdown and applied to the total 1993 – 1995 professional/technician figures. This is done to avoid misrepresentation of facts.

## **AWARENESS, KNOWLEDGE AND ATTITUDE TOWARDS S&T**

### **5.1 INTRODUCTION**

The public attitude and awareness of Science and Technology is vital in drawing up of national policies and also plays an important role in indicating a nation's scientific and competitive level. Recognising the importance played by the level of awareness, Malaysia, through MASTIC, have started a quantitative measure to gauge and evaluate the public's understanding of Science and Technology.

The first study was conducted in 1994 in two separate studies i.e. " Public Awareness of S & T in Malaysia " and "S & T Awareness Among Secondary School Students". In 1996, however, the two studies were combined and only one national survey on public awareness of S & T in Malaysia was conducted. Due to a different questionnaire structure in both studies, comparison between the two years (1994 & 1996) sometimes may not be conclusive but inference could be made on the findings. In this section, the major findings of both studies will be analysed and comparisons will be made wherever possible.

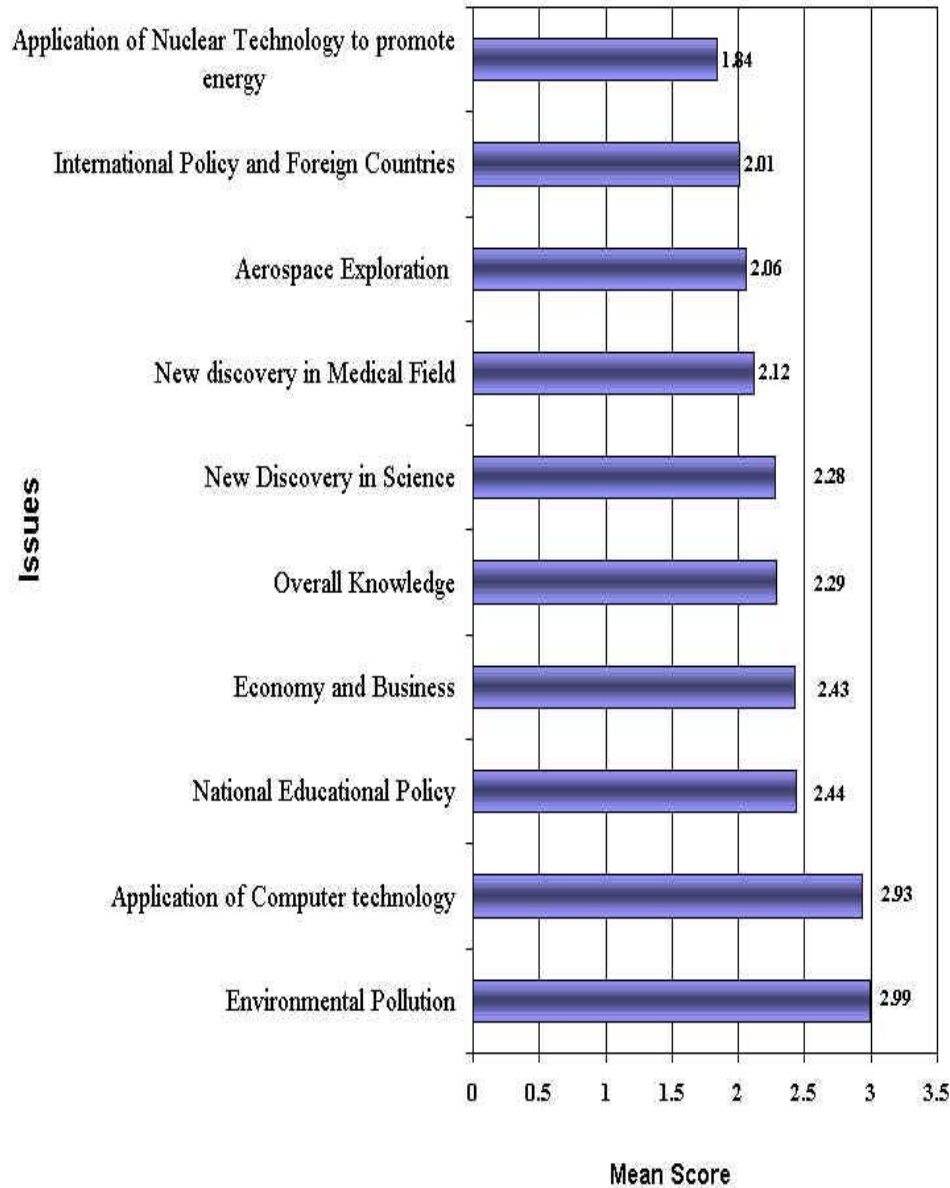
### **5.2 Public Awareness and Knowledge of S & T and General Issues**

From the 1996 survey, generally the Malaysian public perceived that their understanding of the S&T ranges from below average to poor with environmental pollution issues scored the highest with a mean score of 2.99, followed by application of computer technology with a mean score of 2.93 (Scores: 1 - No Knowledge and 4 - Very Knowledgeable). Figure 5.1 shows the extent of public knowledge on S & T and general issues.

Awareness of environmental pollution and computer technology scored comparatively higher mean score compared to other issues and this could be due to the publicity in the media on environmental issues and the government's campaign to promote the use of computers in Malaysia.

Science and Technology issues that appear to be quite distant from the Malaysian public are application of nuclear technology to promote energy; aerospace exploration and new discovery in medical field which obtained mean score of 1.84, 2.06 and 2.12 respectively. This is something not surprising since information and news about nuclear technology; aerospace exploration and new discovery in medical field do not receive much exposure in the local media. People who are exposed to these kind of information primarily those who are involved in them.

**Figure 5.1 : A Comparison on Public Knowledge of Various General and S&T Issues - Mean Score**



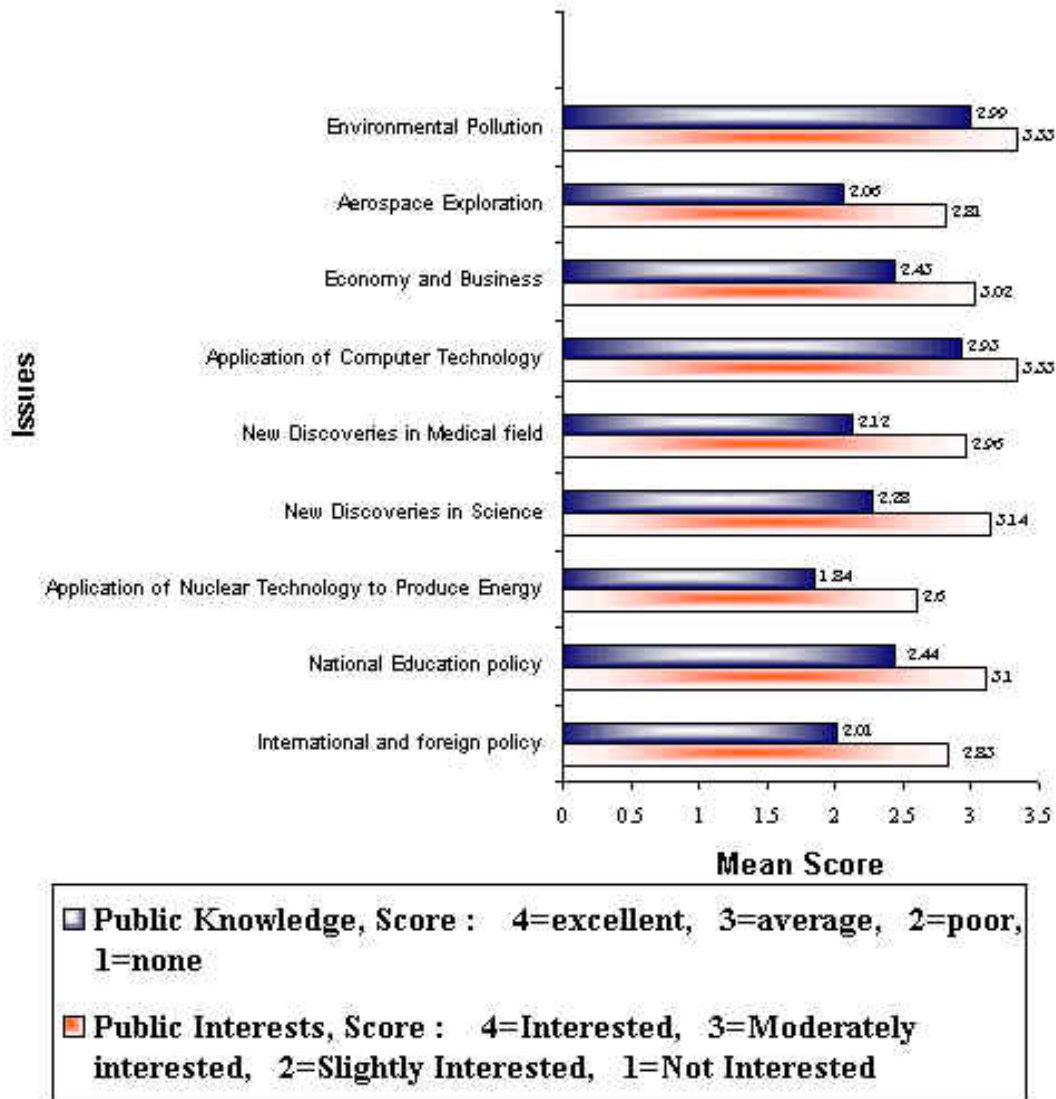
From the three categories of respondent surveyed, youth see themselves as more knowledgeable than the adults and children in all S&T issues. With regard to the level of knowledge of S&T among rural and urban people, it is interesting to note that their level of knowledge and interest in the issues asked are almost equal. The survey however discovered that Malaysian from different educational

backgrounds, gender, ethnic groups and states display different levels of interest in S&T issues.

### **5.3. Perceived Interest in S&T and General Issues**

The study shows a high correlation between perceived interest and knowledge in S&T. On a scale of 1 to 4, environmental pollution and application of computer technology received the highest mean score, each with 3.33, which is above average in terms of interest as indicated in Fig 5.2.

**Figure 5.2 : Public Knowledge and Interest on Various General and S&T Issues**



However, the public seems to have high interests on issues like new education policy, new discoveries in science, economy, and business. This indicates the higher and increasing emphasis put on education by the government and the public is paying much more attention to their children's education. This is evidenced by the higher demand for tertiary education, which resulted in the mushrooming of private colleges in the country.

#### **5.4 General Attitudes Toward S&T**

Generally Malaysian felt positively and is agreeable to the fact that science and technology play a role in enhancing and improving society's life. Only 25% agreed that " People depend too much on science". This gives an indication that generally 75% of Malaysian believed that science and technology is a necessity in modern life.

Science and Technology were not only viewed as an enhancement for quality of life but 83% also believe that it enhanced working conditions, 81% said it raised standard of living and 70% felt that it improved public health

As for the attitude of Malaysian on the environmental issues, many felt that the government has not done enough to address issues pertaining environmental pollution.

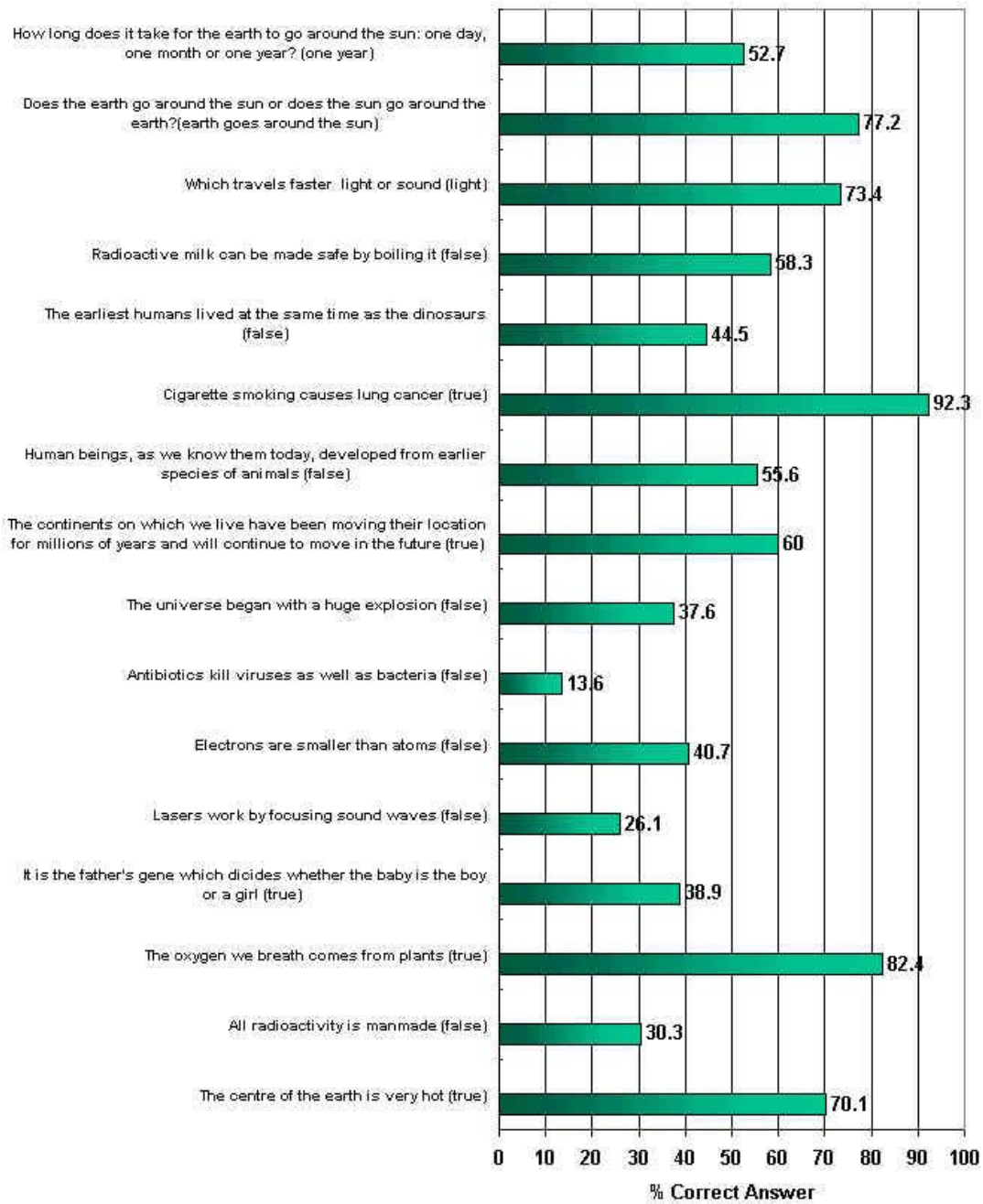
#### **5.5 Understanding of Scientific Environmental Terms and Concepts.**

A set of scientific environmental terms and concepts, which was tested in other countries, were also used to check the level of understanding of scientific environmental terms or concepts by Malaysians.

Figure 5.3 shows that generally concepts that received either high public exposure or ones that affects their life such as "*cigarette smoking*", "*oxygen comes from plant*" and "*earth goes around the sun*" is being more understood than concepts that they have little contact with.

For instance, concepts such as " *Antibiotics kill viruses as well as bacteria*", "*Lasers work by focusing sound waves*", and " *All radioactivity is manmade*" have low percentage of correct answer. This reflects that concepts, which the public could not relate to, have a low understanding among Malaysians. Laser and radioactivity are not a part of the daily life; therefore understanding the concepts is slightly distant to them.

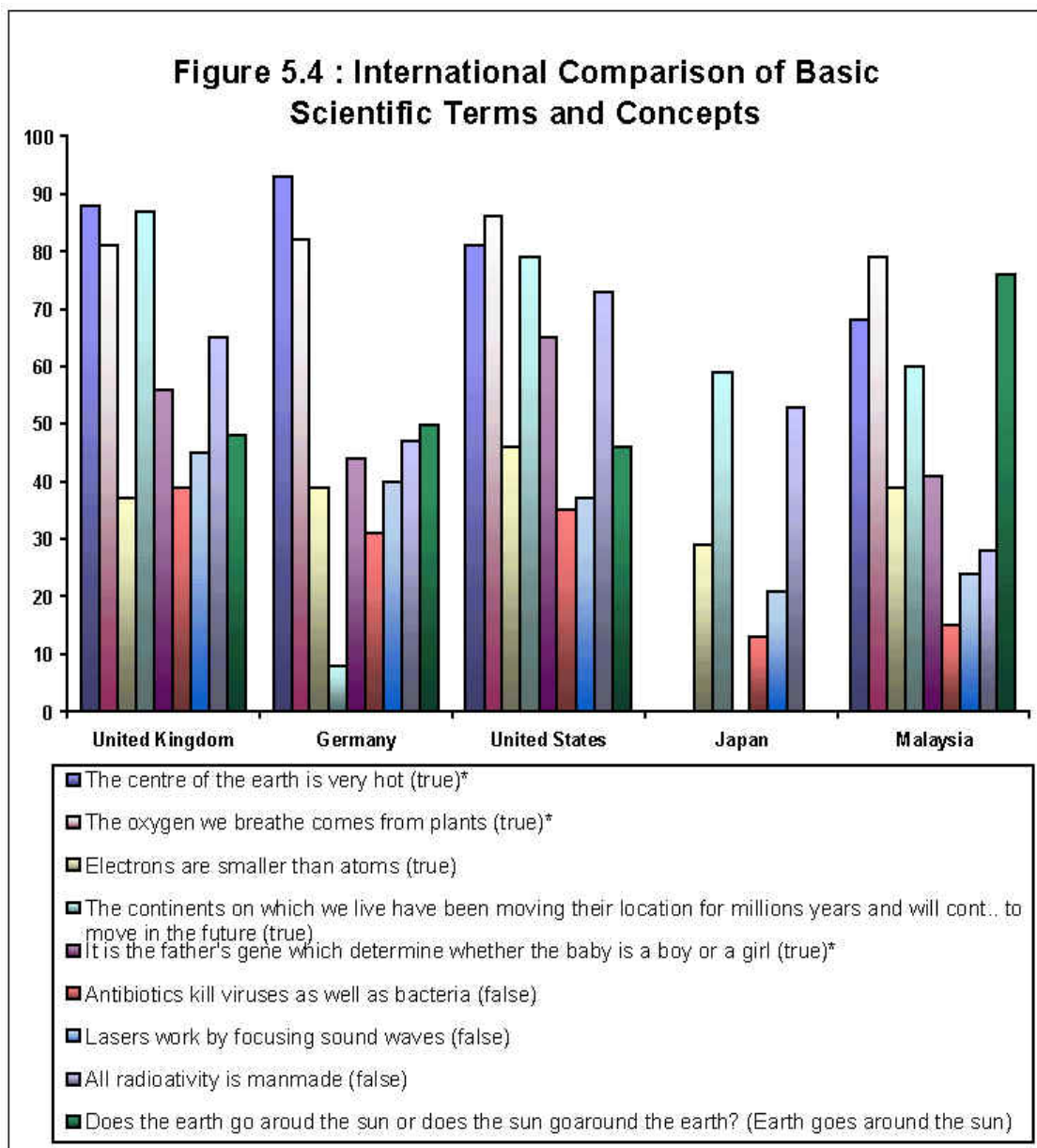
**Figure 5.3: Understanding of S&T By All Respondent**



## 5.6 International Comparison

Generally, Malaysians do not fare too badly on the understanding of scientific concepts against other countries. Malaysians scored highest in the concept *"Earth goes around the sun"*, as compared to other countries.

Overall from figure 5.4, it could be summarised that the public tend not to relate too well to concepts which are "alien" to them. For instance, understanding of a laser is more complex than what the average person could understand. Even in the U.S, only 37% answered the statement correctly, and Japan only scored 21%. For scientific concepts to be understood by the general public, the concepts has to be simple and easily related to their lifestyle or way of living.



Note: "\*" - The statement was not asked in Japan

## **POTENTIAL AND FURTHER DEVELOPMENT OF S&T INDICATORS FOR MALAYSIA**

### **6.1 R & D Surveys**

In order to ensure that the data collected are accurate and up-to date, it is recommended that a mechanism be established to obtain better co-operation from all parties particularly private sectors to report their R&D figures and data in their accounting system. Streamlining of the concepts is also important as this would ensure consistency and under-reporting or over-reporting do not occur.

The use of correct reporting system must also be imposed upon all organisations involved as lacking in the knowledge and awareness on the importance of R&D data may cause some misrepresentation of data. Organisations must be encouraged to be transparent in disclosing their R&D related information as this would provide a more accurate picture of the status and progress of R&D in Malaysia.

In addition to that, the government must continue to encourage and remind organisations especially industries to enhance their competitive edge especially in this era of globalisation. Knowledge and information is the key to future development and commitment to R&D development is one of the ways to achieve it.

On the regional co-operation, Malaysia should continue to work closely with its neighbouring countries through forum that have already been established at ASEAN level on the development of harmonised R&D indicators and survey methodologies. Areas such as agreed frequency of R&D surveys and exchange of information between member countries on the subject could be addressed.

### **6.2 S & T in Industry**

In this year's report, the data for S&T in industries was not fully covered. R&D Innovation survey was not carried out in 1996. As such, data are based on industry's expenditure and import-export data.

Areas covered in 1996 but not covered in 1992 and 1994 such as data on automotive industry would not permit an analysis on the trend of the particular industries. However, once it has been included in one survey, it is a starting point for some new areas of classification and every effort should be made in the future to collect the data and include them in every subsequent report.

Since industry data is extremely important in understanding the level of S&T within a country, it is suggested that special effort be made to collect these data on a more regular basis instead of every two-year period so that discrepancies in data could be ironed out.

Like in science subjects, the quantity of patent outputs should also be analysed in terms of 'subject areas' in order to see which categories of industry is of high interest and low interest in the country, and whether the trend matches the outline of the Industrial Master Plan.

### **6.3 Human Resources for Science and Technology**

A standard classification and definitions must always be used to ensure meaningful international comparison. The OECD recommends that human resource for S&T includes all post-secondary teachers, consultants and R&D managers, however in this report such data are not fully obtained and analysed. Therefore, efforts should be made to include this information in the next report so that comparison with OECD countries may be made. Even among the IHLs, the definitions used are not clear. Each IHLs seems to have their own definition of courses offered by them. Courses that have similar curriculum should be given a standard classification following international system since they produce professionals that are qualified in the same field.

To be able to achieve this, there must be full and close co-operation among ministries concerned particularly the Ministry of Education and IHLs as well as the other public sectors in determining the parameters used.

### **6.4 Public Awareness**

Although in general, awareness of Malaysians on S&T is comparable to that of other more advanced countries, the level is still quite low especially among school children. This is indicated by the low number of students enrolling in the science stream as opposed to the arts stream at tertiary education level. The science stream is always thought to be difficult and therefore students shy away from it. Appropriate strategies should be devised to change this attitude in bringing about the right perspective of S&T so those students would choose S&T as the platform for their career development.

The government must also step up their efforts in promoting the public to be interested in S&T. More campaign and promotion on S&T should be carried out to increase awareness and knowledge among public on S&T related subjects.

Based on the 1996 Public Awareness Survey, television and newspapers have been identified as the primary source from where Malaysian public obtained information on S&T. Therefore it is of important that television stations and newspapers companies too be aware of this findings and more importantly they should also play a more active role in promoting awareness and interest towards S&T among viewers and readers. With the co-operation of right agencies and the willingness on the part of electronic media and newspapers companies to participate, relevant TV programmes and articles on S&T may be produced.

## **6.5 Bibliometric Analysis**

An attempt is made to include in this report available bibliometric indicator aimed at assessing the status and position of scientific and technological publications produced by Malaysian scientists internationally. Findings of this report indicate that contribution made by Malaysian scientists as an output of S&T in terms of bibliometric has been very low. However it should be noted that data collected and analysed are only those papers published in English. It is suggested that publications produced in Malay should also be captured in the next report.

## **6.6 Technology Transfer Analysis**

Technology transfer is among the reasons why Malaysia encourages foreign investment and equity participation in local companies. The level of technology transfer, which is the main agenda in foreign investment in the country, however should be measured in a more structured manner to obtain information on the extent to which this has been so far achieved.

This information should be one good measure of the country's level of achievement in S&T and therefore should act as a good indicator to be included in the next S&T indicators report.