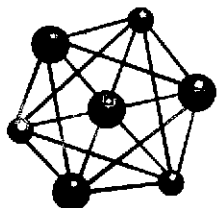


# **NATIONAL SURVEY OF RESEARCH & DEVELOPMENT**

## **2006 REPORT**



**MOSTI**



# MASTIC

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The 2006 Report on the National Survey of Research & Development was based on the financial year 2004, which was the seventh survey of Research & Development (R&D) activities conducted in Malaysia.

The National Survey of R&D is done once every two years and the analysis of the survey results provides an insight into the developments of R&D activities undertaken by the public and private sectors in Malaysia. Hence, this 2006 Report is the main source currently available to provide comprehensive information on the status of R&D activities in the country. In order to enhance its usefulness and to effectively measure R&D growth in Malaysia, the report also includes data spanning 10 years.

The survey received good cooperation from all sectors involved, and we hope it will be even better in future. We certainly will not spare any efforts to enhance the usefulness of the survey, as it has always been our objective to make it an informative tool for policy makers to develop strategies and directions for R&D in Malaysia.

MASTIC wishes to express our sincere appreciation to all individuals and organizations whose involvement and commitment have contributed towards the successful completion of the 2006 Report on the National Survey Research & Development. We would also like to thank all the individuals and corporations that were actively involved in the planning and conducting this survey.

We are particularly indebted to and would like to thank the Secretary-General of the Ministry of Science, Technology and Innovation for unparalleled guidance and support, as well as the heads of various public and private sector organizations, including their researchers, project coordinators and officials for their relentless efforts in ensuring that the full potential of the survey was realised.

We also wish to thank the Technical Committee for their contribution. Their assistance, advice and suggestions were invaluable in carrying out the survey and completing the report. Our appreciation, too, goes to all researchers for their comments and suggestions on improving the R&D online for the next R&D survey.

Last but not the least, we would like to express our deepest gratitude to IIUM Consultancies Sdn Bhd and the team of consultants, led by Assoc. Prof. Dr. Ratnawati Mohd Asraf, for carrying out this Survey and for compiling and analyzing the data as well as writing this survey in collaboration with MASTIC.

With everyone's co-operation, MASTIC will endeavor to further improve the R&D Survey and take it to even greater heights.

|                                                   |                                                                                                 |
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The importance of research and development (R&D) for the development of a country's economy and as being critical determinants of a country's competitiveness is almost universally recognized. This is especially so for Malaysia, which has seen increased foreign competition in light of a decrease in foreign direct investments (FDI) worldwide. This had led our government, in the past decade, to undertake a strategic initiative to establish a knowledge-based economy (henceforth, K-based economy) as a means to ensure that our economy "remains one of the most dynamic, productive, and fastest growing economies in the world" (Knowledge-Based Economy Master Plan, pg.1).

The concern about establishing a knowledge-based economy is not ours alone. Indeed, according to the UNESCO Science Report 2005, what is foremost in the minds of governments, enterprises, research bodies, and universities, is how to develop a knowledge-based economy; an economy based on the production, utilization and distribution of knowledge, which are the primary factors in the growth and wealth creation of the economy. For Malaysia, it was proposed in the Knowledge-Based Economy Master Plan that a knowledge-based economy be defined as "an economy in which knowledge, creativity, and innovation play an ever-increasing and important role in generating and sustaining growth" (pg. 1).

Why does Malaysia stress on a K-based economy? Firstly, the government believes that the services produced by the society—if they are to result in highly valued benefits—should be heavily transfused with knowledge. In a K-based economy, knowledge is the most critical production factor. "It generates more wealth than the other traditional factors of production, land, labor, and capital" (Knowledge-Based Economy Master Plan, pg. 1). This differs quite substantially from a production-based economy, where knowledge plays a less important role. We also see human capital as our most valuable assets, as the production of these goods and services requires highly skilled and educated individuals. At a time when we are facing increased foreign competition and a decline in our competitiveness, especially with regard to manufacturing, there is the need for diversification into other areas such as services. Hence, it is crucial that we develop our human resources and focus on knowledge, creativity, and innovation—though not forgetting our strength in the production-based economy—as these are the factors that would ensure that we regain our competitiveness in the world economy.

The creation, utilization, and diffusion of knowledge, and consequently, the realization of a knowledge-based economy, however, will require a strong foundation in S&T and high commitment to R&D. R&D allows us to increase the stock of knowledge, including knowledge of man, culture, and society, and to use this stock of knowledge to devise new applications (Frascati Manual, pg. 18). R&D is also crucial in improving production processes, in raising the quality of products and services, and in cutting costs through the introduction of new methods. It is through R&D that we are able to promote and support the production of high-quality, up-to-date, and relevant output, products, and services to allow us to be and remain competitive. Because of the importance of R&D in the development of a country's economy, many countries have set up initiatives to formulate policies to develop and further strengthen R&D activities within their own countries.

Hence, it is important to assess the overall R&D trends in our country. Accurate and timely data on various R&D activities in the country must be gathered and comprehensively analyzed to provide crucial input for policy makers. It is for this reason that MASTIC has been conducting surveys of R&D activities in Malaysia since 1992, the first year in which the survey was conducted.

## Overview of R&D in Malaysia

Malaysia's GERD has been steadily on the rise since 1996. From RM549.2 million in 1996, it grew to RM2.50 billion in 2002. In 2004, the GERD stands at RM2.84 billion, an increase of RM0.34 billion over 2002.

- The GERD/GDP ratio, however, decreased from 0.69 in 2002 to 0.63 in 2004.
- Current expenditure has also been on an upward trend. From a low of RM329.1 million in 1996, current expenditure increased to RM1,375.2 million in 2002 and subsequently, to RM2,196.6 million in 2004
- In 2004, there was a marked decline in capital expenditure, a decrease of RM478.2 million (or 42.5%) when compared to 2002.
- Since 1998, the emphasis has been on Applied Research, followed by Experimental Research and Basic Research. This trend continued in 2004:

|                         |       |
|-------------------------|-------|
| ▶ Applied Research      | 55.4% |
| ▶ Experimental Research | 28.5% |
| ▶ Basic Research        | 16.1% |

- The three main FOR for 2004 were the same as that of 2000. They were:
  - ▶ Engineering Sciences,
  - ▶ Information, Computer & Communication Technology (ICT), and
  - ▶ Applied Sciences and Technologies.
- In terms of SEO categories, the top 5 in 2004 were Manufacturing, Information and Communication Services (ICS), Natural Sciences, Technologies & Engineering, Plant Production and Plant Primary Products and Energy Resources.
- The trend in R&D headcount continues to be on the rise. Since 1998, there has been a steady increase in the number of personnel involved in R&D, from 12,127 in 1998, to 23,262 in 2000, to 24,937 in 2002, and 30,983 in 2004. This represents an overall increase of 6,046 (or 24.2%) over 2002.
- The total number of women R&D personnel increased from 8,009 in 2002 to 10,544 in 2004. Women made up 34% of total R&D personnel, an increase of 1.9% from 2002.
- In terms of FTE, there has also been a steady increase over the years. Indeed, there is a 66.7% increase in FTE, from 10,731 in 2002, to 17,886.5 in 2004. Researcher FTE increased by 77%, from 7,157.5 in 2002 to 12,669.5 in 2004. In terms of proportion, researchers accounted for 70% of the FTE.
- The bulk of the research in 2004 was conducted in Malaysia. Of the total national R&D expenditure, only RM32.9 million was outsourced, a remarkable decline (by 89.2%) from the RM306.0 million outsourced in 2002.

**R&D in the Institutions of Higher Learning (IHL)**

There has been a steady increase in R&D expenditure since 1996. Total R&D expenditure was RM513.3 million in 2004, an increase of 42.4% from 2002.

- There was a 91.2% increase in current expenditure from 2002, amounting to RM191.4 million, while capital expenditure decreased by 25.6% from 2002, amounting to RM38.5 million in 2004.
- The main research conducted, according to expenditure, was:

|                            |         |
|----------------------------|---------|
| ▶ Applied research         | RM237.2 |
| ▶ Basic research           | RM162.6 |
| ▶ Experimental development | RM113.5 |
- In 2004, the headcount of research personnel increased by 18.1% from 2002 to 14,809 in 2004. Total FTE also showed a 2-fold increase, from 3,811.9 in 2002 to 7,738 in 2004 due to a marked increase in the FTE for researchers.
- The top FOR was Engineering Sciences while the top SEO was Natural Sciences, Technologies & Engineering.
- The main limiting factors (internal & external) cited were limited funds and lack of R&D expert personnel. Additional factors include limited time due to administrative work, increasing capital costs, and lack of collaboration with the private sector.

**R&D in the Government Research Institutes (GRI)**

From 1996 to 2002, there was a steady increase in R&D expenditure in the GRIs. However this total expenditure declined markedly, from RM507.1 million (2002) to RM296.9 million in 2004, a 41.5% decrease.

- There was a 15.6% decrease of RM36.4 million in current expenditure from 2002. Similarly, there was a marked decrease of 63.3% in capital expenditure from 2002, amounting to RM173.8 million in 2004.
- The main research conducted, according to expenditure, was applied research followed by experimental development research.
- Total personnel headcount and total FTE both showed an increase, with researcher headcount and women researcher headcount having the highest increase in numbers.
- The top FOR was Agricultural Sciences, while the top SEO was Plant Production & Plant Primary Products.
- There was a decline in the amount of R&D outsourced by the GRIs, from RM11.6 million in 2002 to RM8.2 million in 2004.
- The main limiting factors (internal & external) were lack of funds and lack of R&D expert personnel. Other factors include limited time due to administrative work and increasing capital costs.

## R&D in the Private Sector

The total R&D expenditure for the private sector has shown a steady and consistent rise since 1992. In 2002, private sector expenditure passed the RM1 billion mark (RM1.63 billion), while in 2004 it surpassed the RM2 billion mark, with a recorded total of RM2.03 billion.

- The private sector remains the major contributor to the increase in GERD during the years from 1996 through 2004. Its contribution to the nation's GERD increased by RM400.5 million, from RM1.63 billion in 2002 to RM2.03 billion in 2004. This reflects an increase of 24.5%.
- Expenditure on the manufacture of motor vehicles, trailers & semi-trailers stood at RM646.28 million, constituting 31.8% of the total private sector expenditure. R&D expenditure by the private sector accounts for 71.5% of the national GERD.
- The main research type conducted by the private sector were:
  - ▶ Applied Research RM1.14 billion
  - ▶ Experimental Development Research RM644.0 million
  - ▶ Basic Research RM246.2 million

## International Comparison

- The United States, the EU15, and Japan are the key players in R&D, as measured by R&D spending. The United States spent RM1.1 trillion on R&D, the EU15 RM649.9 billion, and Japan about RM459.2 billion. China, with R&D spending of RM68.8 billion, is emerging as one of the major contributors to R&D.
- Malaysia's R&D expenditure in 2004 of RM2.84 billion represents an increase of RM343.2 million over the previous 2002 expenditure of RM2.50 billion. However, although it is higher than that of Thailand (RM1.4 billion in 2003), Indonesia (RM200 million in 2003), and Jordan (RM100 million in 2003), it is far less than that of our closest neighbour, Singapore (RM7.3 billion in 2003).
- Japan, Korea, the United States, Taiwan and Singapore are some of the leading countries with regard to research intensity versus GDP per capita. Malaysia's research intensity of 0.63% places her with Turkey and Chile, and above that of Mexico, Jordan, Thailand, and Indonesia. However, we are still a long way off from countries such as Singapore, whose research intensity is 2.13%.
- Malaysia is among the countries that has the highest proportion of women researchers. In Malaysia, the proportion of female researchers to men is 35.8%, almost the same as that of Spain, Turkey, and Iceland. In fact, the proportion of female researchers in Malaysia and in these countries is higher than that of Japan (13%), Korea (13%), Austria (21%), and Switzerland (21%).

## Key Indicators of R&D Activities in Malaysia

| ORGANIZATIONS SURVEYED WITH R&D                            | 2004                      | 2002                      |
|------------------------------------------------------------|---------------------------|---------------------------|
| Government Agencies and Research Institutions ( GRI )      | 43 agencies or institutes | 39 agencies or institutes |
| Institutions of Higher Learning ( IHL )                    | 24 institutes             | 17 institutes             |
| Private sector                                             | 230 companies             | 198 companies             |
| Total                                                      | 297 organizations         | 254 organizations         |
| <b>R&amp;D Projects Surveyed</b>                           |                           |                           |
| Government Agencies and Research Institutions ( GRI )      | 1,318 Projects            | 1,119 Projects            |
| Institutions of Higher Learning ( IHL )                    | 4,870 Projects            | 3,537 Projects            |
| Private sector                                             | 3,723 Projects            | 1,716 Projects            |
| Total                                                      | 9,911 Projects            | 6,372 Projects            |
| <b>Total R&amp;D Expenditure</b>                           |                           |                           |
| Gross Expenditure on R&D ( GERD )                          | RM 2,843.8 million        | RM 2,500.6 million        |
| GERD/GDP Ratio                                             | 0.63%                     | 0.69%                     |
| Current Expenditure                                        | RM 2,196.6 million        | RM 1,375.2 million        |
| • Labour Cost                                              | RM 947.2 million          | RM 532.7 million          |
| • Operating Cost                                           | RM 1,249.4 million        | RM 842.5 million          |
| Capital Expenditure                                        | RM 647.2 million          | RM 1,125.4 million        |
| <b>Three Main FOR</b>                                      |                           |                           |
| 1. Engineering Sciences                                    | RM 1,006.5 million        | RM 977.9 million          |
| 2. Information, Computer & Communication Technology (ICT)  | RM 764.6 million          | RM 610.1 million          |
| 3. Applied Science & Technologies                          | RM 260.9 million          | RM 313.9 million          |
| <b>Three Main SEO</b>                                      |                           |                           |
| 1. Manufacturing                                           | RM 1,441.2 million        | RM 1,063.0 million        |
| 2. Information & Communication Services                    | RM 297.4 million          | RM 644.7 million          |
| 3. Natural Science Technology & Engineering                | RM 241.1 million          | RM 205.2 million          |
| <b>Headcount and FTE</b>                                   |                           |                           |
| <b>Total Human Resources in R&amp;D</b>                    | <b>2004</b>               | <b>2002</b>               |
| Total Headcount of R&D Personnel                           | 30,983                    | 24,937                    |
| Total Headcount of Researchers                             | 23,092                    | 17,790                    |
| Total FTE of R&D Personnel                                 | 17,886.55                 | 10,730.95                 |
| Total FTE of Researchers                                   | 12,669.49                 | 7,157.54                  |
| FTE per R&D Personnel                                      | 0.58                      | 0.43                      |
| FTE per Researcher                                         | 0.55                      | 0.40                      |
| Total Number of Degree Holders (PhDs, Masters, Bachelors ) | 20,967                    | 16,553                    |
| Number of Researchers per 10,000 Labor Force               | 21.3                      | 18.0                      |
| R&D Expenditure per R&D Personnel                          | RM 91,782.6               | RM 100,277.7              |

| Other Indicators                                         |                                                                                                                                                        |                                  |
|----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| Largest R&D Activity by Field of Research (FOR)          | 1. <i>Engineering Sciences</i><br>2. <i>Applied Sciences &amp; Technologies</i><br>3. <i>Biological Sciences</i>                                       | 1. <i>Environmental Sciences</i> |
| Largest R&D Activity by Socio-Economic Objective ( SEO ) | 1. <i>Natural Sciences, Technology &amp; Engineering</i><br>2. <i>Manufacturing</i><br>3. <i>Plant Production &amp; Plant Primary Products</i>         | 1. <i>Manufacturing</i>          |
| R&D IN THE PRIVATE SECTOR                                |                                                                                                                                                        |                                  |
| R&D Expenditure                                          | 2004                                                                                                                                                   | 2002                             |
| Total Expenditure                                        | RM 2,033.6 million                                                                                                                                     | RM 1,633.1 million               |
| Current Expenditure                                      | RM 1,599.1 million                                                                                                                                     | RM 932.7 million                 |
| • Labour Cost                                            | RM 578.5 million                                                                                                                                       | RM 248.9 million                 |
| • Operating Cost                                         | RM 1,020.6 million                                                                                                                                     | RM 683.8 million                 |
| Capital Expenditure                                      | RM 434.5 million                                                                                                                                       | RM 700.3 million                 |
| Human Resources in R&D                                   |                                                                                                                                                        |                                  |
| Headcount of R&D Personnel                               | 8,737                                                                                                                                                  | 5,177                            |
| Headcount of Researchers                                 | 5,940                                                                                                                                                  | 3,349                            |
| Headcount of Technicians & Support Staff                 | 2,797                                                                                                                                                  | 1,828                            |
| FTE of R&D Personnel                                     | 6,127.20                                                                                                                                               | 4,266.70                         |
| FTE of Researchers                                       | 4,104.30                                                                                                                                               | 2,767.10                         |
| FTE per R&D Personnel                                    | 0.70                                                                                                                                                   | 0.82                             |
| FTE per Researcher                                       | 0.69                                                                                                                                                   | 0.83                             |
| Other Indicators                                         |                                                                                                                                                        |                                  |
| Largest R&D Activity by Field of Research (FOR)          | 1. <i>Engineering Sciences</i><br>2. <i>Information, Computer &amp; Communication Technology (ICT)</i><br>3. <i>Applied Science &amp; Technologies</i> | 1. <i>Engineering Sciences</i>   |
| Largest R&D Activity by Socio-Economic Objectives (SEO)  | 1. <i>Manufacturing</i><br>2. <i>Information &amp; Communication Services.</i><br>3. <i>Energy Resources</i>                                           | 1. <i>Manufacturing</i>          |

Notes :

Total labor force **2004** (RM mill) = 10.856

Total population **2004** (RM mill ) = 25.62

GDP **2004** (RM mill) = 449,609 (Based on current price)

Total labor force **2002** (RM mill) = 9.886

Total population **2002** (RM mill) = 24.53

GDP **2002** (RM mill) = 361,624



# **Objectives and Research Methodology of the Survey**

## Objectives of the 2004 National R&D the Survey

This report is the 7th Report on the National Survey of R&D in Malaysia. It presents the results of a very comprehensive survey on R&D in Malaysia for the year 2004 carried out in both the public and the private sectors. The main objectives of the 2004 National Survey of Research and Development were to:

- assess the trends and developments in R&D in Malaysia, specifically in the public sector (comprising institutions of higher learning, and government research institutes) and the private sector.
- assess the challenges faced by the above institutions in conducting R&D activities
- compare where Malaysia stands internationally with regard to R&D
- propose recommendations for the continued development of R&D in Malaysia
- guide the government in making policy decisions with regard to R&D

## Research Methodology

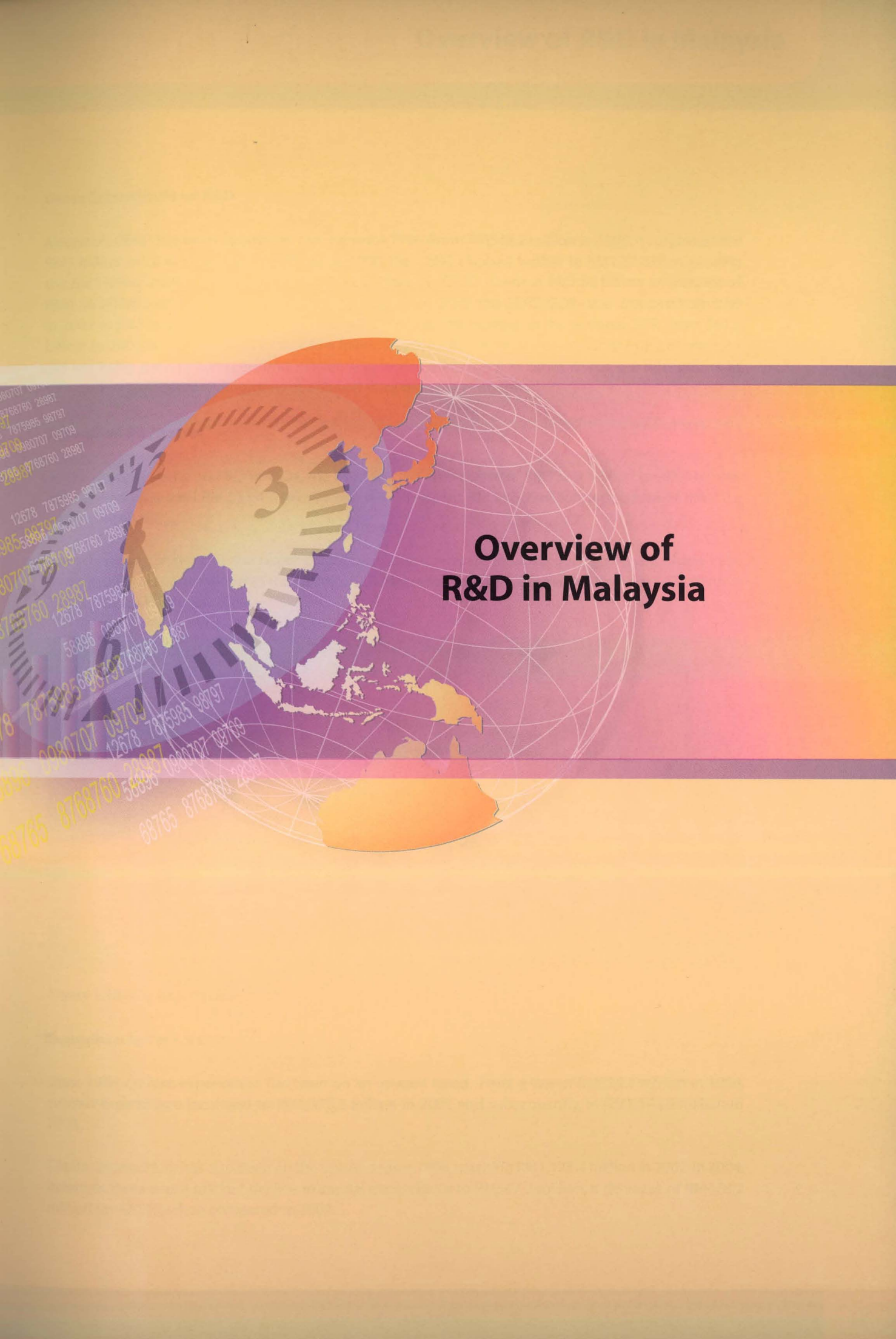
The data were obtained via questionnaires prepared by MASTIC, based on the Frascati Manual recommendations. Two sets of questionnaires were developed for the survey, one for the public sector, and the other for the private sector.

For the public sector, the survey was conducted online to provide a more efficient means of getting back the survey forms from the respondents. Letters were sent to each researcher or project leader known to have conducted R&D requesting them to submit the surveys through the R&D Online published in MASTIC's website.

In an attempt to achieve the highest response rate possible for the public sector, letters were sent to all research project leaders or researchers from all the IHLs and GRIs impressing upon them the importance of their participation in the survey, and the contribution that they would be making by doing so. Several follow-up measures, including visits, were also made to various institutions to assist researchers in filling in the survey forms online. For the researchers who were not able to attend these help sessions, help was provided through telephone. This strategy resulted in our obtaining a response rate of 91.5% for the government research institutes, and 89.6% for institutes of higher learning. The following table summarizes the number of projects surveyed and the response rate for the public sector:

| Sector | No. of Projects Surveyed |       | No. Of Projects Response |       | Response Rate |       |
|--------|--------------------------|-------|--------------------------|-------|---------------|-------|
|        | 2002                     | 2004  | 2002                     | 2004  | 2002          | 2004  |
| GRI    | 1,435                    | 1,440 | 1,119                    | 1,318 | 78.0%         | 91.5% |
| IHL    | 4,790                    | 5,437 | 3,537                    | 4,870 | 73.8%         | 89.6% |

For the private sector, survey forms were mailed to companies that are known to conduct, or that are very likely to have conducted, R&D activities. Several follow-up measures, including visits, were also made to various institutions to assist researchers in filling in online the survey forms. A total of 230 companies participated in the survey.



## Overview of R&D in Malaysia

## Gross Expenditure on R&D

Malaysia's GERD has been steadily on the rise since 1996. From RM549.2 million in 1996, it surpassed the RM1 billion mark in 1998 (RM1.13 billion). In 2000, the GERD climbed further to RM1.67 billion, passing the RM2 billion mark in 2002, at RM2.50 billion. In 2004, the GERD stands at RM2.84 billion, an increase of RM0.34 billion over 2002. However, despite the increase in GERD, the GERD/GDP ratio dropped from 0.69 in 2002 to 0.63 in 2004. This can be attributed primarily to the increase in the national GDP. From 361.6 billion in 2002, our GDP increased to 449.6 billion in 2004. This increase in economic growth, however, did not bring about a commensurate increase in research intensity. In other words, our R&D efforts, as reflected in our R&D spending, grew at a slower pace than our economy.

## Expenditure by Sector

Of the amount spent on R&D in 2004, the IHLs charted an increase of RM152.9 million (or 42.4%) over 2002, spending a total RM 513.4 million, while the GRIs spent RM 296.9 million, a decrease of RM210.2 million, (or 41.5%).

The private sector remains the major contributor to the increase in GERD during the years from 1996 through 2004. Its contribution to the nation's GERD increased by RM400.5 million, from RM1.63 billion in 2002 to RM2.03 billion in 2004.

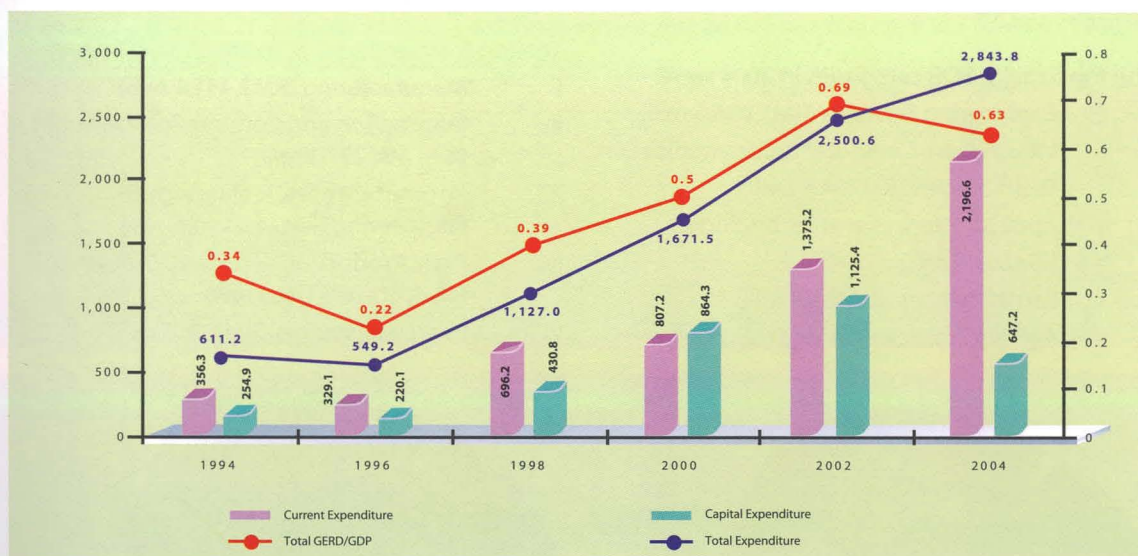


Figure 1: R&D by Expenditure

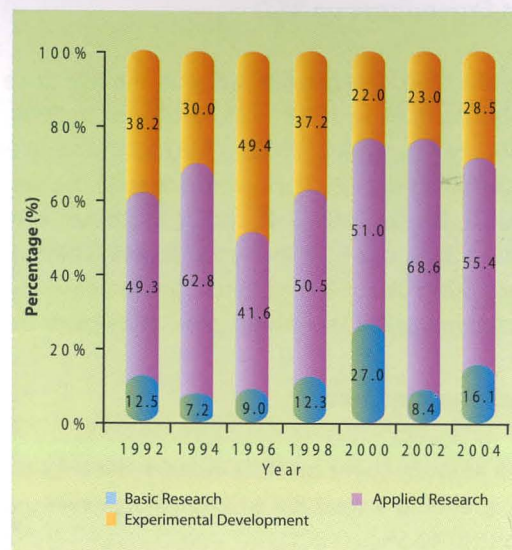
## Expenditure by Type of Cost

Since 1996, current expenditure has been on an upward trend. From a low of RM329.1 million in 1996, current expenditure increased to RM1,375.2 million in 2002 and subsequently, to RM2,196.6 million in 2004.

Capital expenditure has also been on the uptrend since 1996, reaching RM1,125.4 million in 2002. In 2004, however, there was a marked decline in capital expenditure to RM647.2 million, a decrease of RM478.2 million (or 42.5%) when compared to 2002.

### Expenditure by Type of Research

Since 1998, R&D has focused on applied research, followed by experimental research and basic research. This trend continued in 2004, with applied research contributing 55.4% of the nation's GERD, followed by experimental research (28.5%) and basic research (16.1%). The Private sector spends the most on applied research, and the least on basic research, as their R&D is conducted primarily for commercial purposes. The focus of the GRIs is similar to that of the private sector. Thus applied research and experimental development research were their top priorities. The IHLs emphasized on applied research, followed by basic research. This is in consonance with the role of the universities, which have always stressed on basic research as a means to develop the foundation of knowledge.

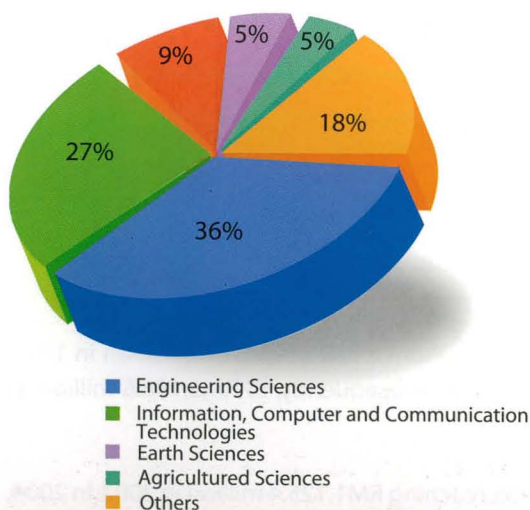


**Figure 2: Proportion of Expenditure by Type of Research**

### Expenditure by FOR

The top 5 major FOR categories in 2004 were:

- Engineering Sciences (RM1,006.5 mill)
- Information, Computer & Communication Technologies (RM764.6 mill)
- Applied Sciences and Technologies (RM260.9 mill)
- Earth Sciences (RM149.4 mill)
- Agricultural Sciences (RM138.5 mill)

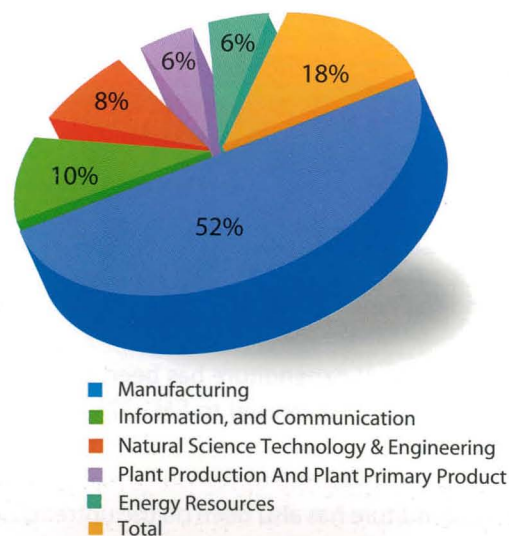


**Figure 3: Proportion of Expenditure by 5 Major FOR (2004)**

### Expenditure by SEO

The top 5 expenditure, according to SEO, were:

- Manufacturing (RM1,441.1 mill)
- Information and Communication Services (ICS) (RM297.3 mill)
- Natural Sciences, Technology & Engineering (RM241.1 mill)
- Plant Production and Plant Primary Products (RM179.4 mill)
- Energy Resources (RM158.6 mill)



**Figure 4: Proportion of Expenditure by SEO in 2004**

SOURCES OF FUNDS IN 2004

The majority of funds come from the institutions' or companies own funds. This accounts for 82.1% of the total R&D expenditure. The private sector relies most on its own funds for R&D, accounting for 98.7% of its expenditure. The GRIs spent 44.2% on R&D using its own funds, and 44.9% from federal sources. In contrast, the IHLs relied more on IRPA funds, amounting to 55.4% of its total expenditure. Only 38.2% were from the IHLs' own funds.

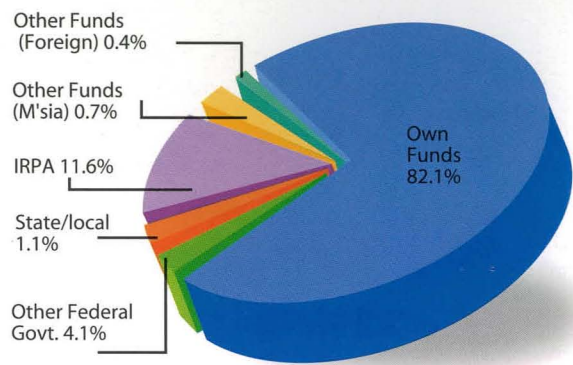


Figure 5: Sources of Funds in 2004

HUMAN RESOURCE DEVELOPMENT IN 2004

By Headcount

Since 1998, there has been a steady increase in the personnel involved in research, from 12,127 in 1998, to 23,262 in 2000, to 24,937 in 2002. In 2004, research personnel headcount increased to 30,983, an increase of 24.2% over 2002. This upward trend is also evident for researcher headcount, from 6,249 in 1998, to 15,022 in 2000, to 17,790 in 2002 and 23,092 in 2004.

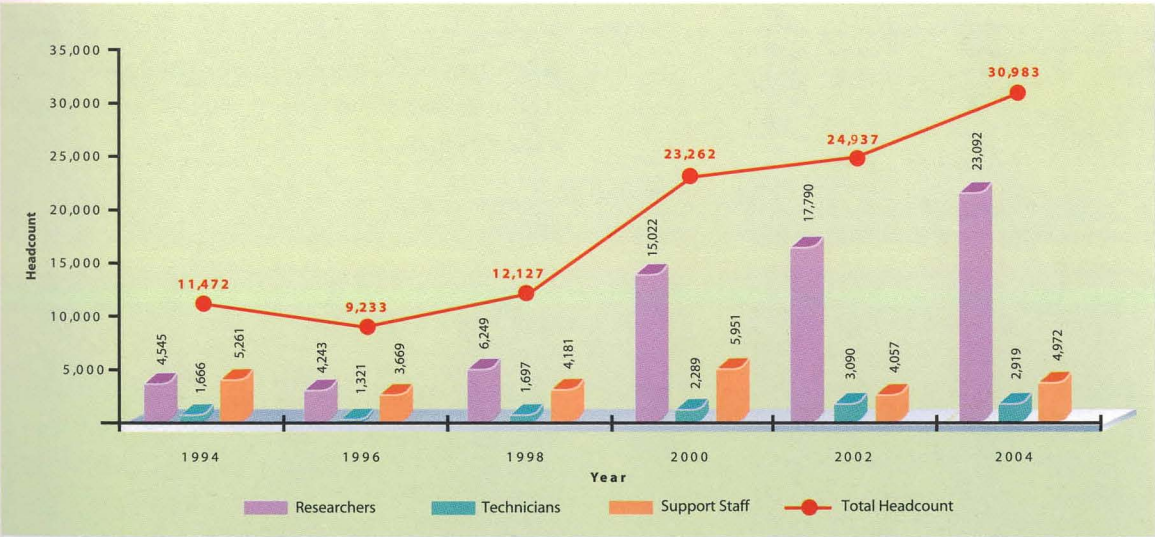


Figure 6: National Headcount

By FTE

In terms of FTE, there has also been a steady increase over the years (See Figure 7). Indeed, there is a 66.7% increase in the FTE of research personnel, from 10,731 in 2002, to 17,886.6 in 2004. Researcher FTE increased by 77%, from 7,157.5 in 2002 to 12,669.5 in 2004. In terms of proportion, researchers accounted for 70.8% of the total FTE.

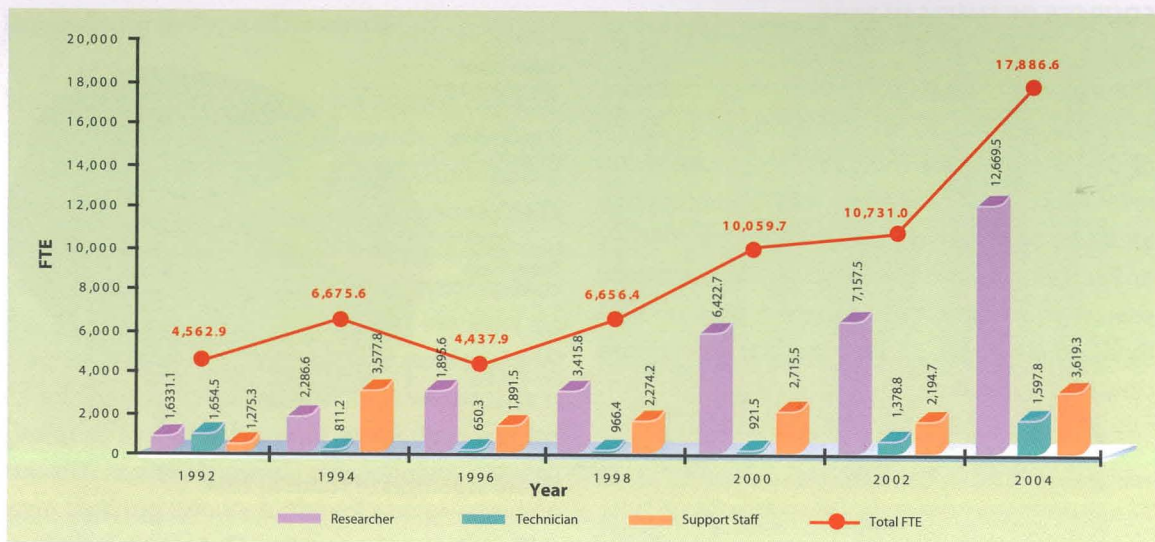


Figure 7: National FTE

### Participation of Women In R&D

The total number of women R&D personnel increased from 8,009 in 2002 to 10,544 in 2004. Of this total, 8,275 were researchers. Women made up 34.0% of total R&D personnel, an increase of 1.9% from 2002.

### OUTSOURCED R&D

Of the total national R&D expenditure, only RM32.9 million was outsourced, an 89.2% decline from the RM305.9 million outsourced in 2002. 39.4% of this amount was outsourced inside Malaysia, while 60.6% was outsourced outside of Malaysia. This is a positive trend, and reflects the utilization of local expertise in R&D.

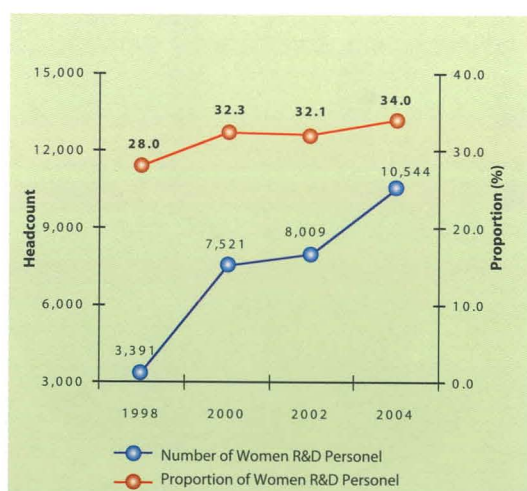


Figure 8: Women R&D Personnel

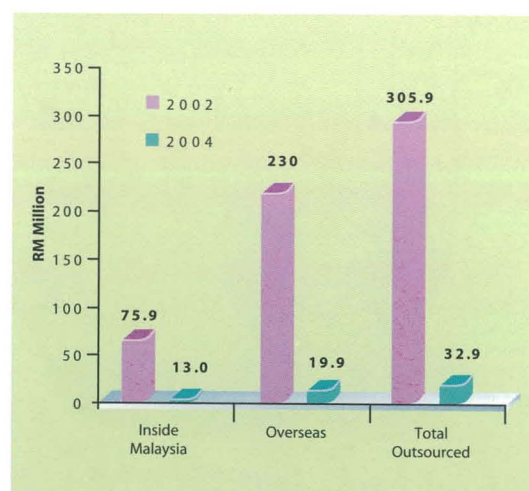


Figure 9: Total Outsourced R&D 2002 - 2004



**Comparison  
Between the  
Public and Private  
Sector**

## Gross Expenditure on R&D

From 1996 to 2002, the national GERD shows a continued, steady increase for both sectors, amounting to a total of RM2.84 billion, an increase of RM343.2 million (13.7%) compared to 2002, and an increase of about 417.8% from 1996. The main contributing factor for this upward trend was the GERD in the private sector, which occupied the lion's share of R&D expenditure.

The same pattern of continued growth can be seen in the GERD for the public sector, which increased from RM149.1 million in 1996 to RM867.5 million in 2002. However, in 2004, the GERD for the public sector dropped to RM810.2 million.

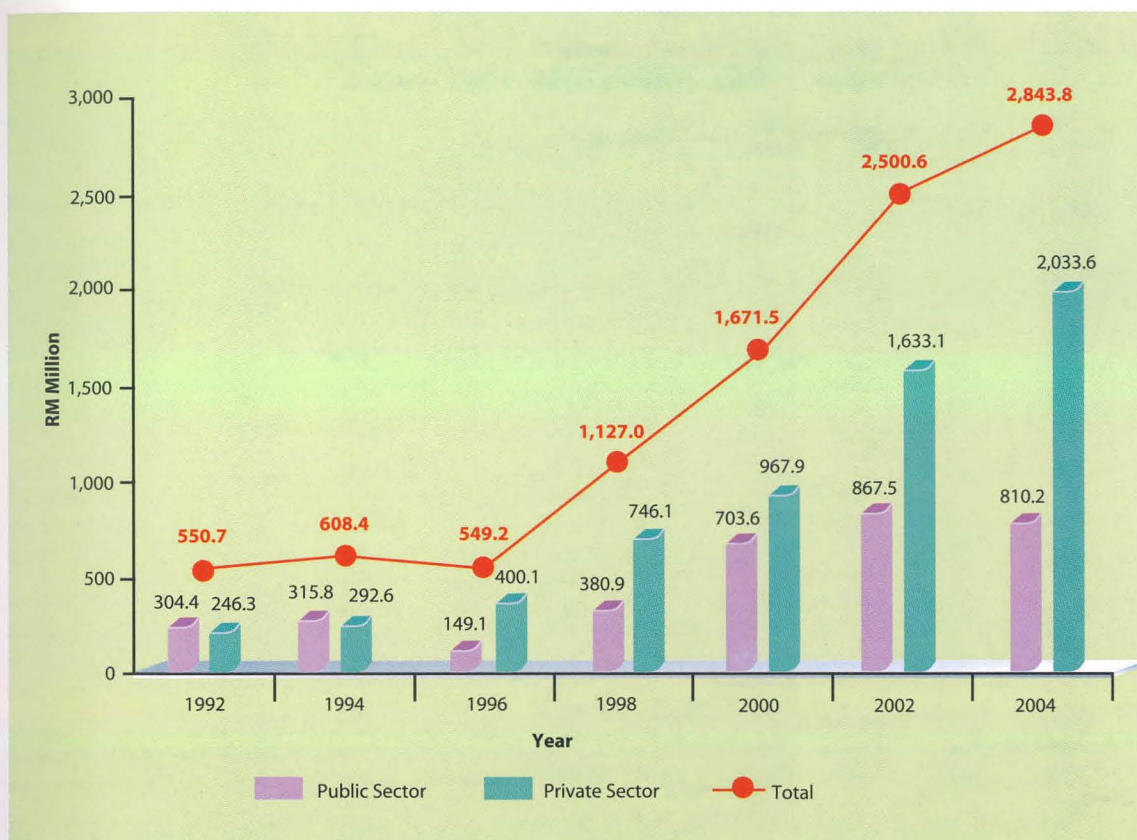
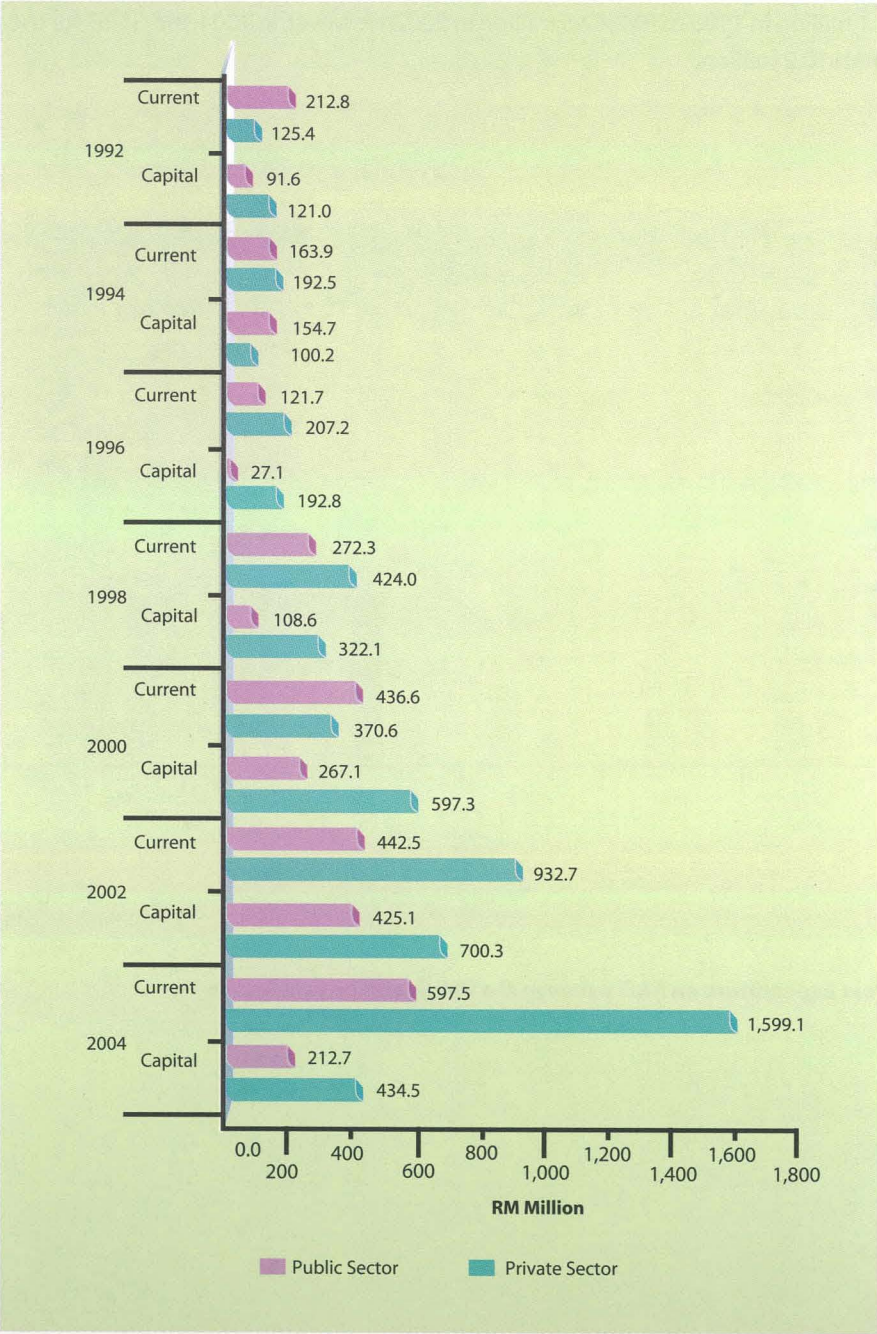


Figure 10: Gross Expenditure on R&D between the Public and Private Sector

**Expenditure by Type of Cost**

Since 1996, there has been an increase in current expenditure in both the public and private sectors, with the private sector generally taking a greater share. The same trend is also observed with regard to capital expenditure. However, in 2004, there is a sharp drop in capital expenditure by the private sector (from RM700.3 million in 2002 to RM434.5 million in 2004) and in the public sector, (from RM425.1 million in 2002 to RM212.7 in 2004).



**Figure 11: Expenditure by Type of Cost between the Public and Private Sector**

Expenditure by Type of Research

Applied research in the private sector has shown a steady growth from 1992 to 2002. However, expenditure on applied research dropped from RM1,313.5 million in 2002, to RM1,143.4 million in 2004. In 2004, there was a sharp increase in basic research by the private sector, from RM57.3 million in 2002 to RM246.1 million (a 329.7% increase), as well as in experimental research, from RM262.3 million in 2002 to RM644 million in 2004.

Basic research by the public sector also increased by RM63.6 million in 2004, while applied research increased by RM26.2 million. However, there was a sharp drop in experimental research by the public sector, from RM314.0 million in 2002 to RM166.9 million.

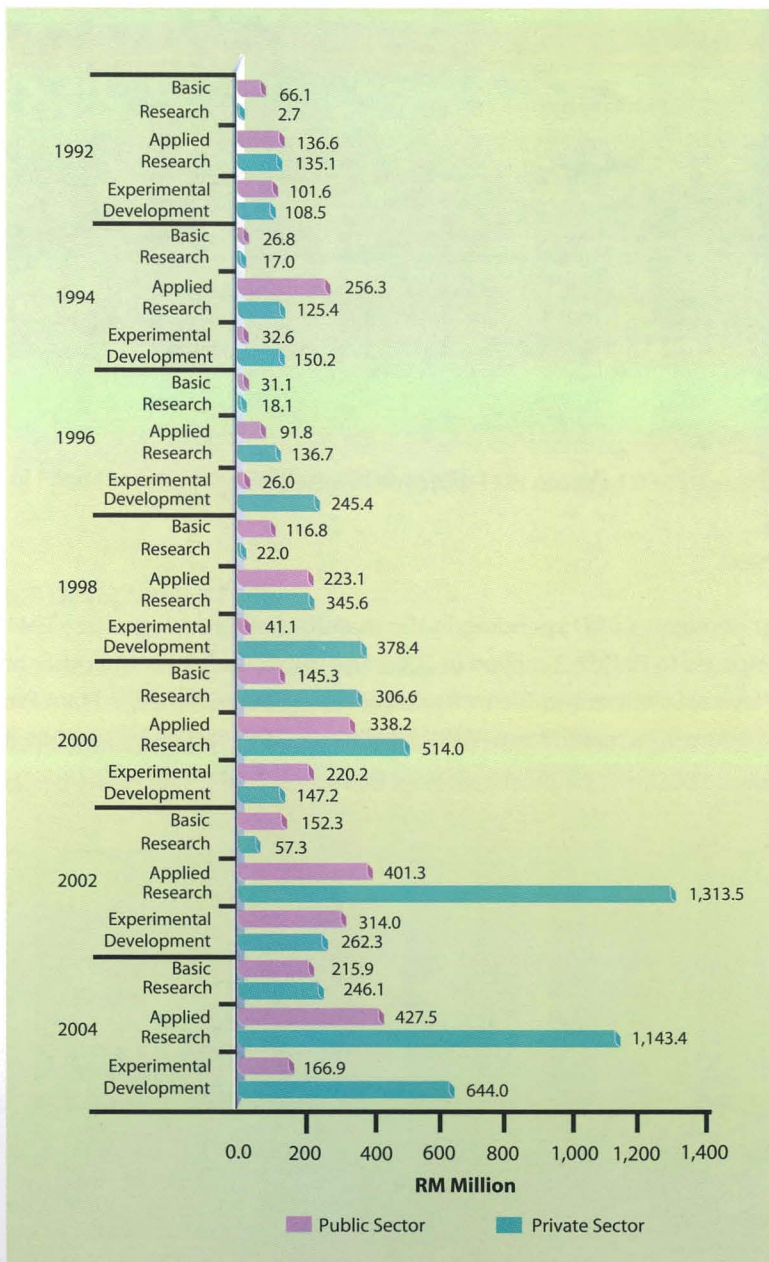


Figure 12: Expenditure by Type of Research between the Public and Private Sector

Expenditure by FOR

R&D expenditure by the private sector, according to FOR, far outweigh that of the public sector in three major areas: Engineering Sciences, ICT and Applied Sciences and Technologies. The Public sector, on the other hand, dominates the FOR categories in the Agricultural Sciences and the Biological Sciences in both 2002 and 2004.

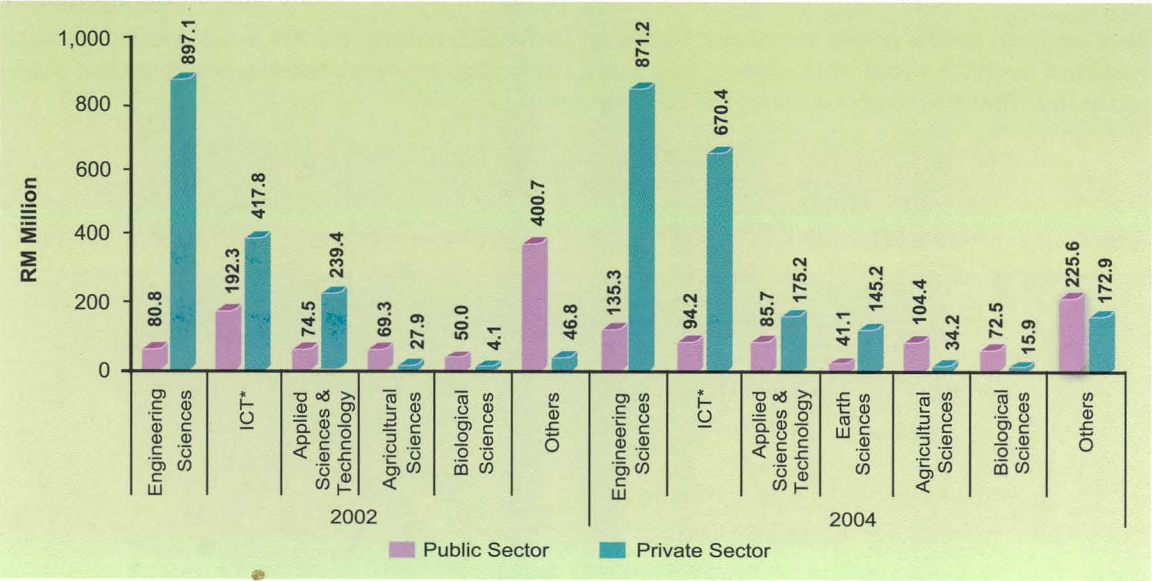


Figure 13: Expenditure by SEO between the Public and Private Sector

Expenditure by SEO

The private sector dominates R&D spending in the manufacturing sector, where RM1,317.2 million was spent in 2004 compared to RM956.3 million in 2002. The public sector, on the other hand, surpassed the private sector in Natural Sciences and Technologies, and, as to be expected, in Plant Production and Plant Primary Products, where it increased from RM85.3 million in 2002 to RM126.2 million in 2004.

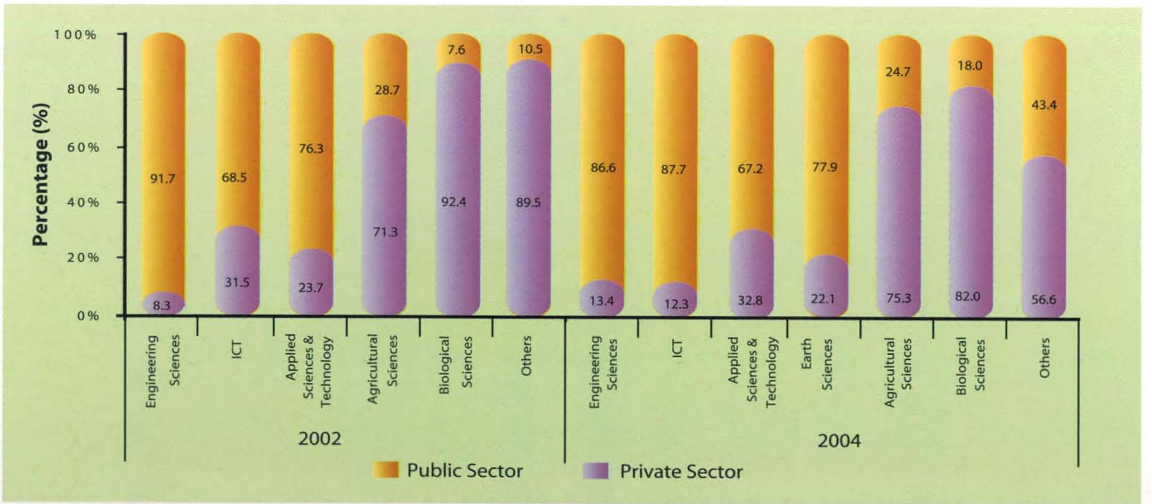


Figure 14: Expenditure by SEO between the Public and Private Sector

SOURCES OF FUNDS

The private sector relied primarily on “own funds”. In fact, in 2004 the private sector’s own funds amounted to about RM2 billion. They also received RM11.7 million from the federal government, RM1.6 million from the state and local government, and RM10.5 million from other agencies in Malaysia. The bulk of the R&D activities in the public sector in 2004 were also funded by “own funds” (RM327.5 million), IRPA (RM330.6 million), and federal government (RM105.9 million).

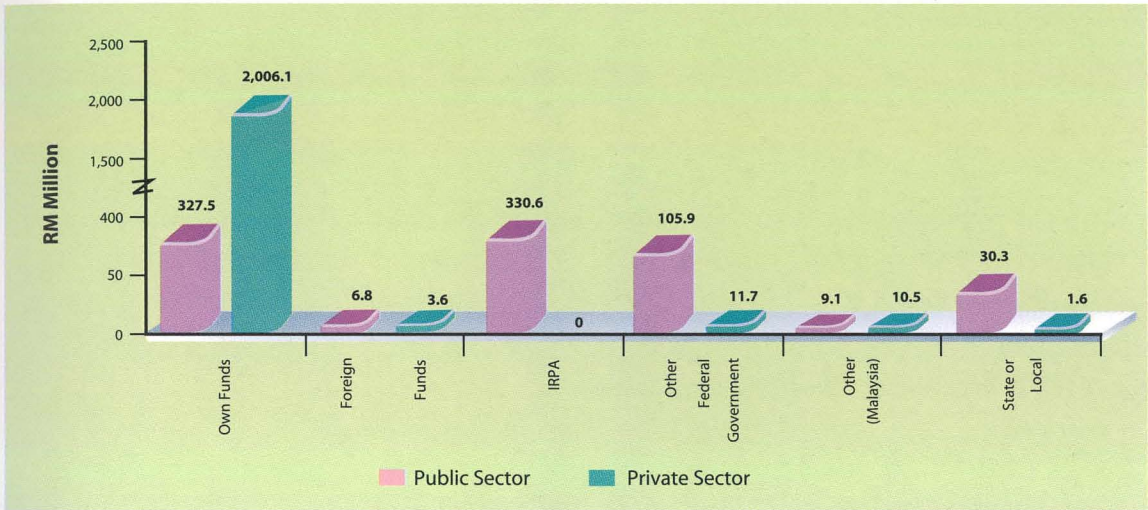


Figure 15: Sources of Funds between the Public and Private Sector

HUMAN RESOURCE DEVELOPMENT

By Headcount

The number of R&D personnel in the public sector increased from 19,760 in 2002 to 22,246 in 2004, while for the private sector, the number of R&D personnel increased from 5,177 in 2002 to 8,737 in 2004.

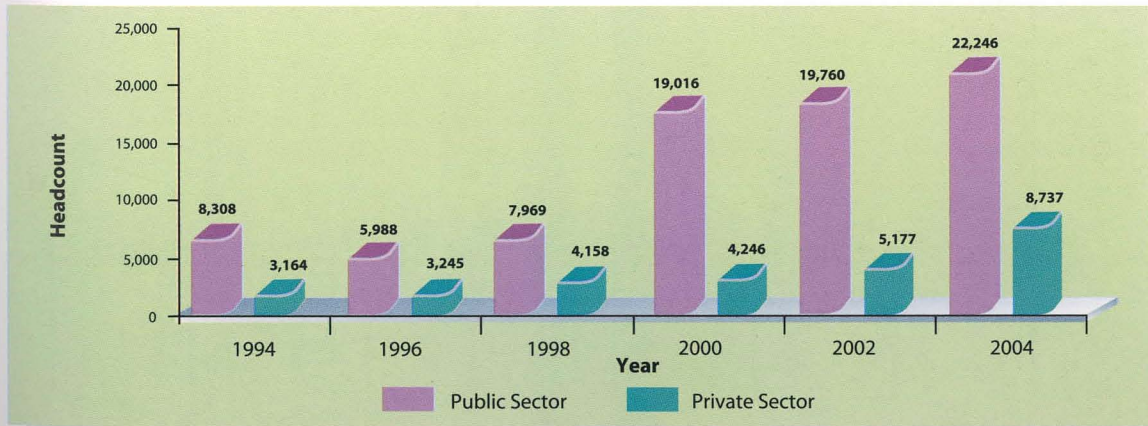
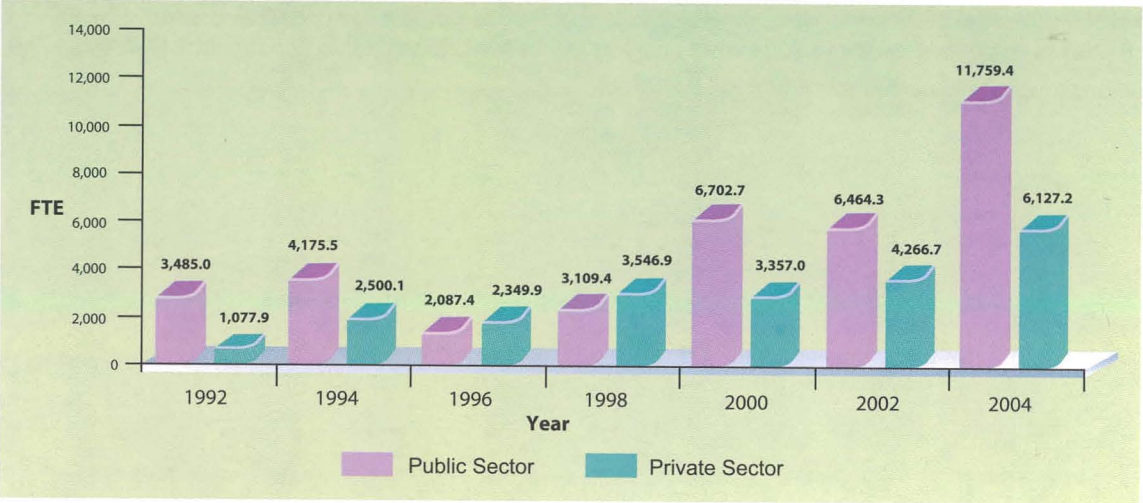


Figure 16: Headcount between the Public and Private Sector

**By FTE**

Since 1996, the FTE in both the public and private sectors has continued to grow, with the public sector FTE generally surpassing that of the private sector. In 2004, the FTE in the public sector increased by 81.9%, from 6,464.3 in 2002 to 11,759.4 in 2004.

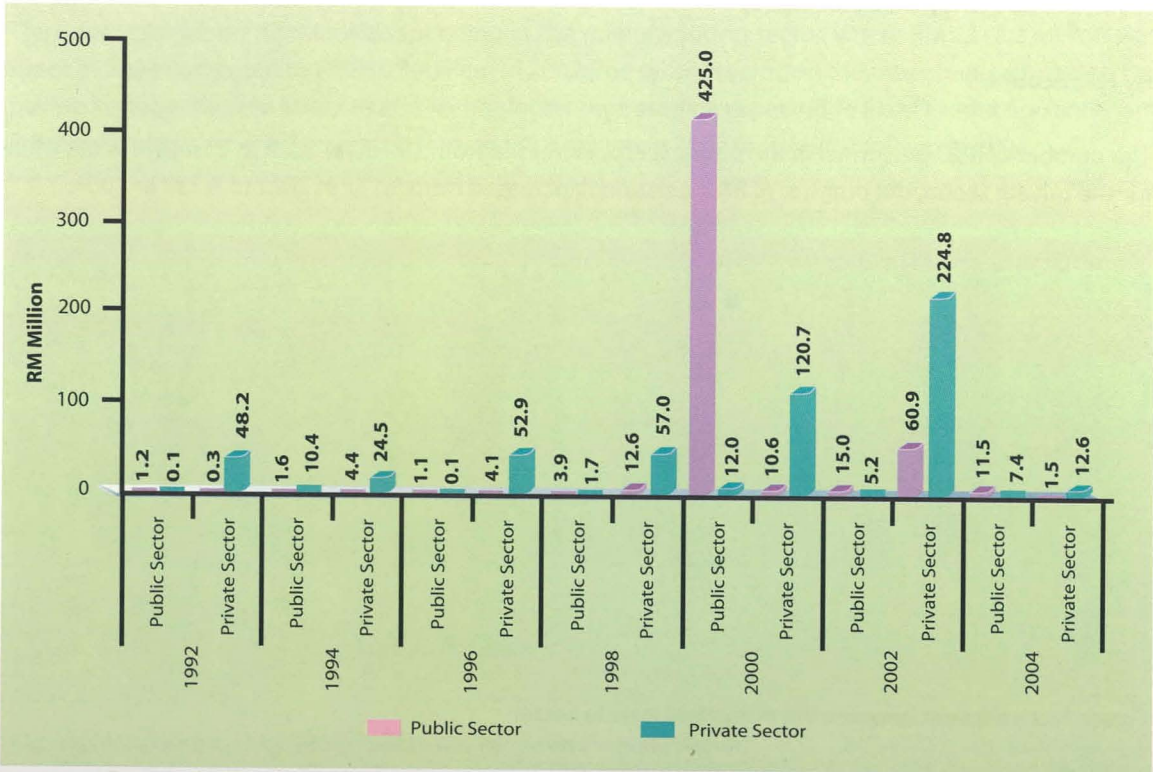


**Figure 17: FTE between the Public and Private Sector**

**OUTSOURCED R&D**

Outsourced R&D in Malaysia by the public sector fell sharply in 2002, from RM425.0 million in 2000 to RM15.0 million, and decreased further to RM11.5 million in 2004. Of this figure, RM7.4 million was spent on the outsourcing of R&D outside Malaysia.

The private sector also shows a tremendous drop in outsourced R&D. For instance, the outsourcing of R&D to foreign agencies declined (by 94.4%), from RM224.8 million in 2002 to RM12.6 million in 2004.



**Figure 18: Outsourced between the Public and Private Sector**



**R&D in Government  
Agencies  
and Research  
Institutions (GRI)**

R&D EXPENDITURE

There are a total of 43 government research institutions (GRIs) that participated in the 2004 R&D survey. The total expenditure for the GRIs showed a significant decline, from RM507.1 million in 2002 to RM296.9 million in 2004, marking a 41.5% decrease.

Expenditure by Type of Cost

Expenditure on labour dropped from RM174.6 million in 2002 to RM101.1 million in 2004, a decrease of 42.1%. Operating expenditure, on the other hand, increased by 63.9%, from RM58.1 million in 2002 to RM95.2 million in 2004.

Land and building expenditure showed an increase, from RM27.2 million in 2002 to RM29.2 million in 2004, while expenditure on machinery and equipment dropped from RM247.2 million in 2002 to RM71.4 million in 2004, a decrease of 71.1%.

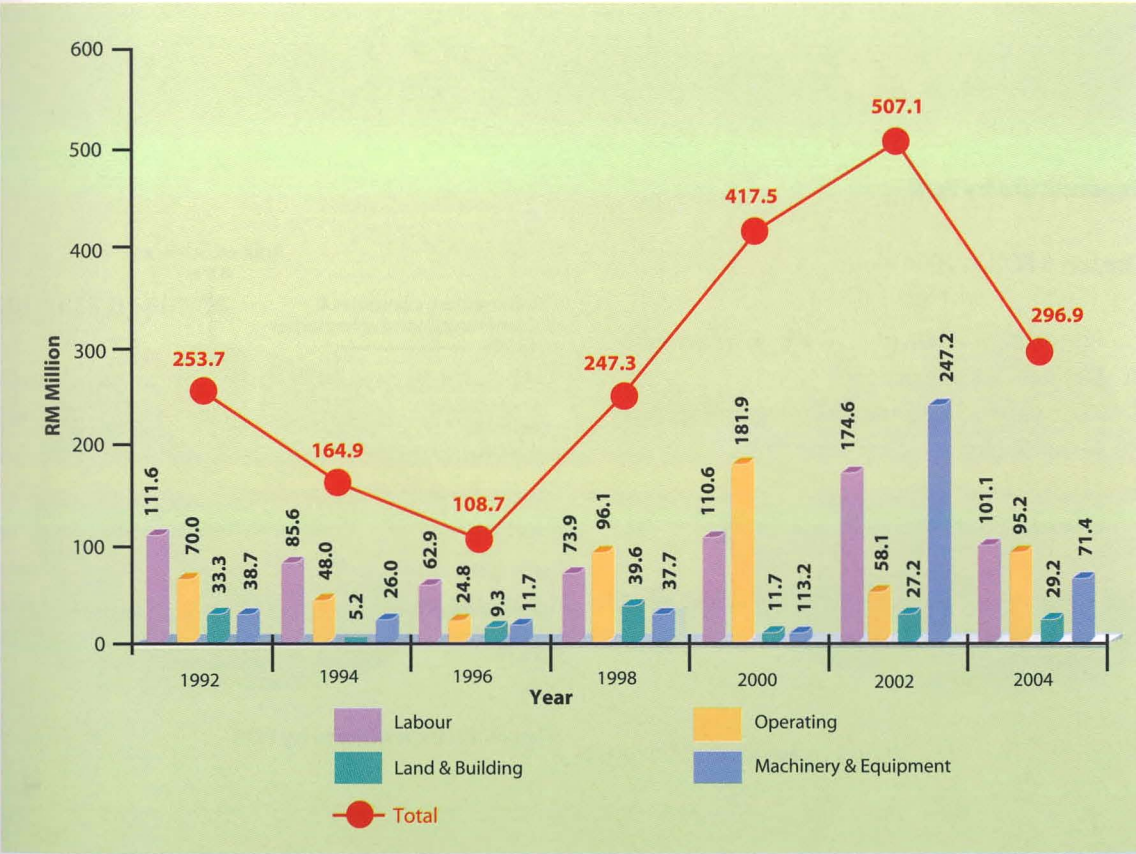
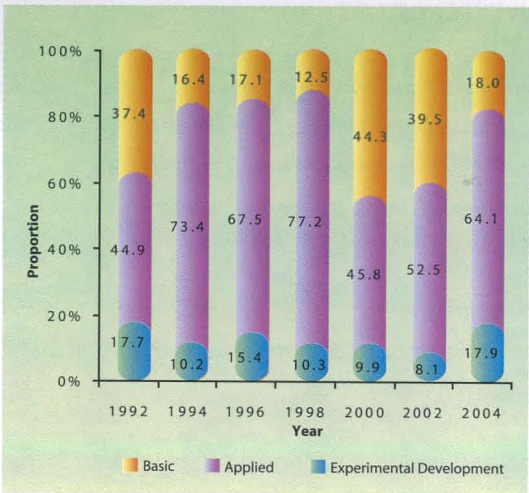


Figure 19: Expenditure by Type of Cost

**Expenditure by Type of Research**

Basic research increased from RM41.0 million in 2002 to RM53.3 million in 2004, an increase of 30%. Applied research, on the other hand, decreased from RM266.1 million to RM190.3 million, while Experimental Development research decreased from RM200.1 million to RM53.3 million. The trend from 1992 also shows that Applied research occupies the highest proportion of R&D expenditure.



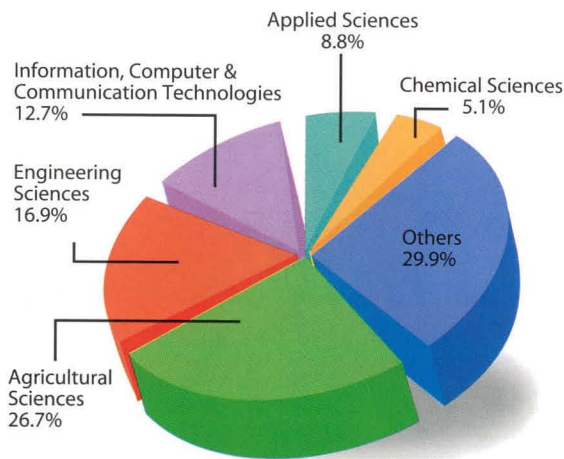
**Figure 20: Expenditure by Type of Research**

**Expenditure by FOR**

The top 5 FOR in 2004 were:

1. Agricultural Sciences
2. Engineering Sciences
3. Information, Computer & Communication Technologies
4. Applied Sciences
5. Chemical Sciences

Together, they accounted for 70.2% of the expenditure by the GRIs.



**Figure 21: Expenditure by FOR**

Expenditure by SEO

The top 5 SEO for GRI were:

- 1. Plant Production and Plant Primary Products
- 2. Natural Sciences, Technologies & Engineering
- 3. Environmental Management & Other Aspects
- 4. Manufacturing
- 5. Information & Communication Services

Together, they accounted for 73.7% of the expenditure by the GRIs.

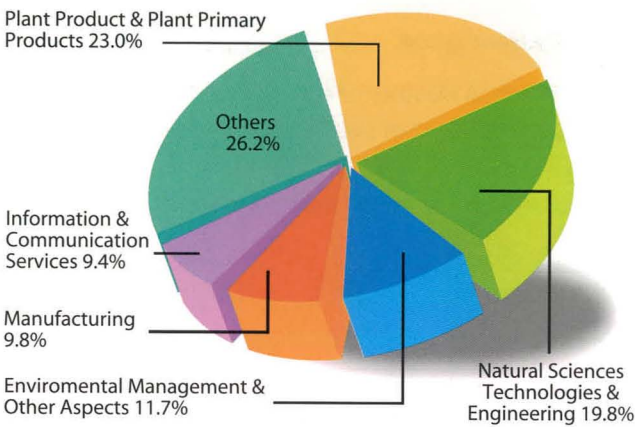


Figure 22: Expenditure by SEO

SOURCES OF FUNDS

"Own funds" were the main sources of funds for the GRIs in 2004. This represents a total of RM131.2 million, 44.2% of the total GRI expenditure of RM296.9 million. External funds by IRPA accounted for 15.5% of the total funds (RM46.0 million), other federal government funds 29.4% (RM87.3 million), and state/local government funds 8.5% (RM25.2 million).

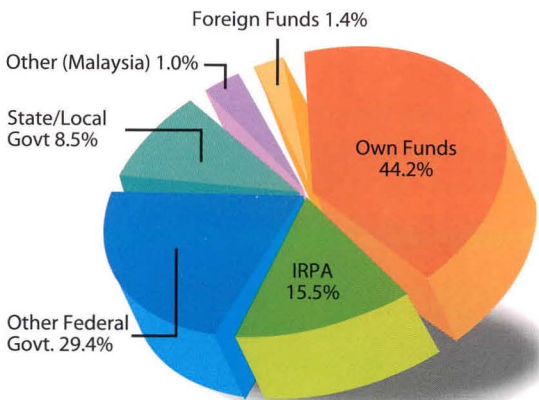


Figure 23: Sources of Funds

HUMAN RESOURCE DEVELOPMENT

By Headcount

The total number of research personnel working in the GRIs showed an increase, from a total of 7,222 in 2002 to 7,437 in 2004. Researchers represented 58.5% of the total number of research personnel. There was a 3.5% drop in the number of technicians, from 1,413 in 2002 to 1,363 in 2004. The number of support staff also decreased from 1,895 in 2002 to 1,727 in 2004.

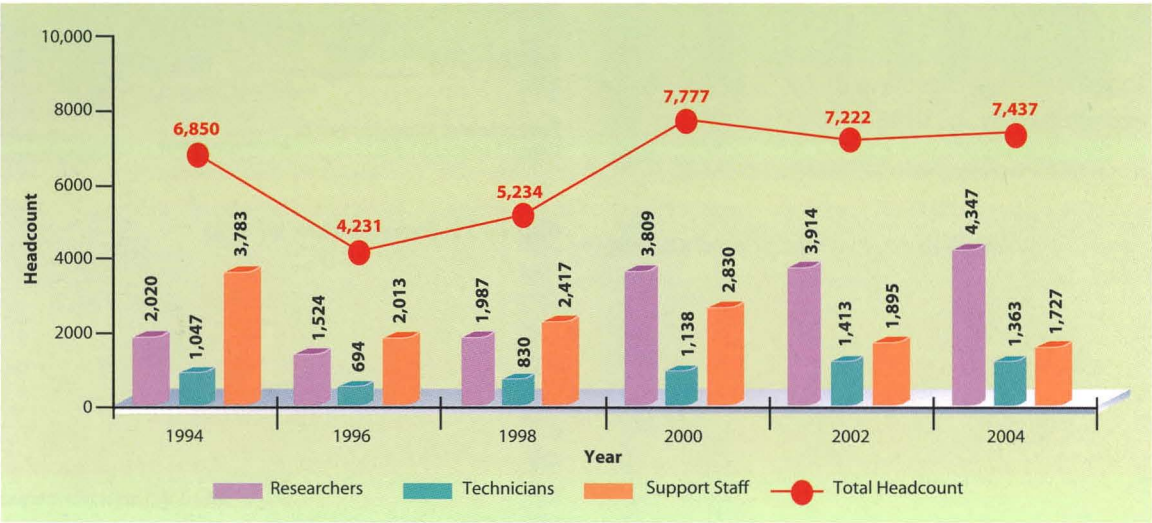


Figure 24: Headcount of R&D Personnel in GRI

By FTE

Since 1996, there has also been a steady upward trend in the FTE of research personnel, although there was a drop in 2002. In 2004, the FTE significantly increased by 51.6% to 4,021.3. The FTE for researchers increased by 77.1%, from 1,203.5 in 2002 to 2,130.8 in 2004. The FTE for technicians increased from 508.1 in 2002 to 682.2 in 2004. The FTE for support staff of increased by 28.4% to 1,208.3.

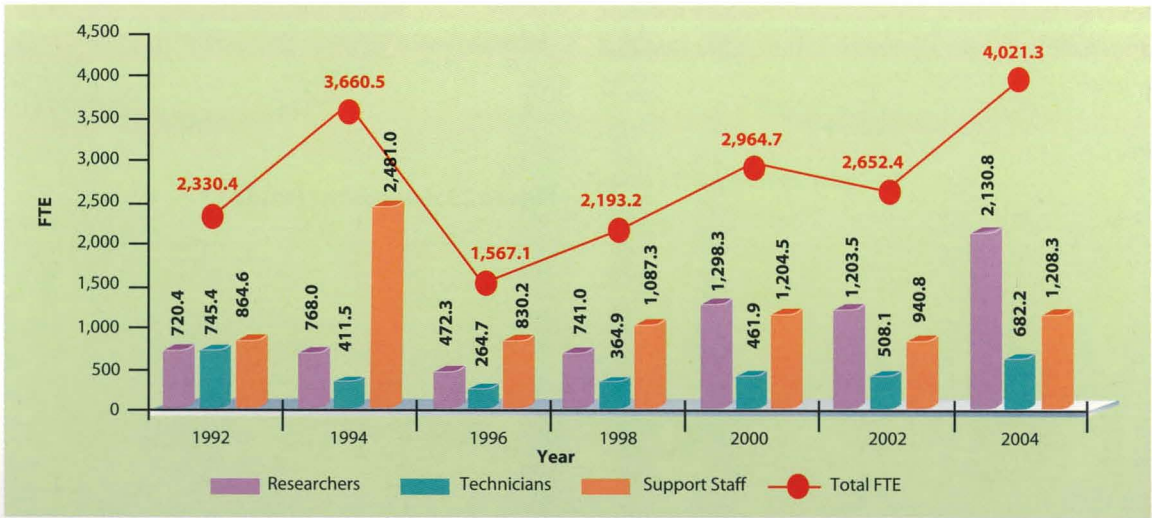


Figure 25: FTE of R&D Personnel in GRI

Participation of Women in R&D

Since 1998, there has been a consistent upward trend in the number of women personnel. Starting from 1,234 in 1998, it went up to 2,029 in 2000, 2,128 in 2002, and finally to 2,429 in 2004.

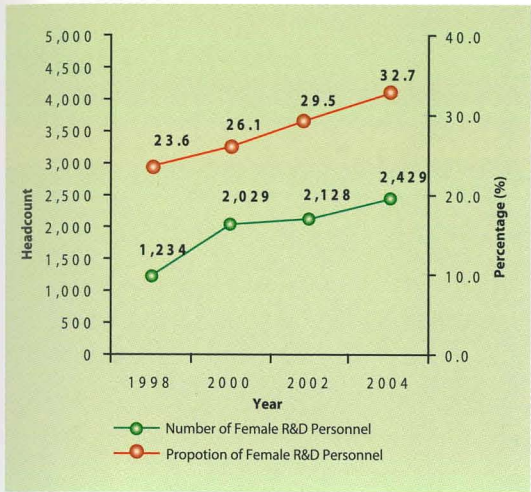


Figure 26: Women R&D Personnel

OUTSOURCED R&D

A total of RM6.3 million (77.2%) was outsourced inside Malaysia and RM1.9 million outside Malaysia. This represents a decrease of RM6.6 million from the total amount outsourced in 2002.

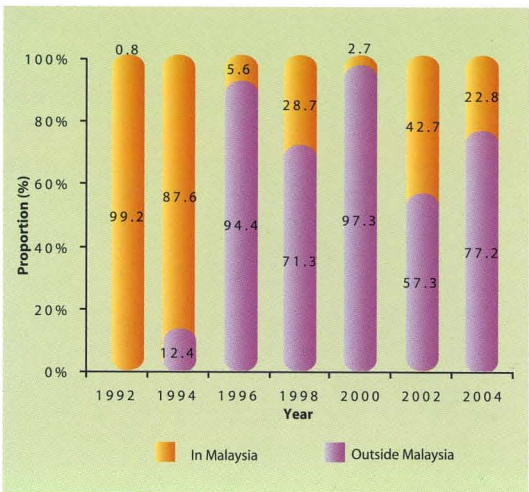


Figure 27: Outsourced R&D

Factors Limiting R&D Activities

Internal Factors limiting R&D

The main 5 factors limiting R&D activities for the GRIs in 2004 were:

- 1. Limited time due to class/ administrative work
- 2. Lack of skilled personnel
- 3. Limited financial resources
- 4. Poor reward system
- 5. Lack of infrastructure

External Factors limiting R&D

The following 5 main external factors limiting R&D in 2004 were:

- 1. Lack of R&D expertise
- 2. Increased capital cost
- 3. Lack of ancillary service to support R&D
- 4. Insufficient government funds
- 5. Difficulty in collaboration with private sector



**R&D in  
Institutions of  
Higher Learning  
(IHL)**

## R&D EXPENDITURE

Figure 28 shows a continuous growth in the total R&D expenditure by the IHLs since 1996. From RM40.3 million in 1996, R&D expenditure steadily increased, reaching RM513.3 million in 2004, up from RM360.4 million in 2002, representing an increase of 42.4%.

## Expenditure by Type of Cost

In 2004, R&D expenditure on labour increased by 145.1% to RM267.6 million, the highest increase seen since the surveys were conducted. This expenditure on labour represents two-thirds (66.7 %) of the total current expenditure in 2004.

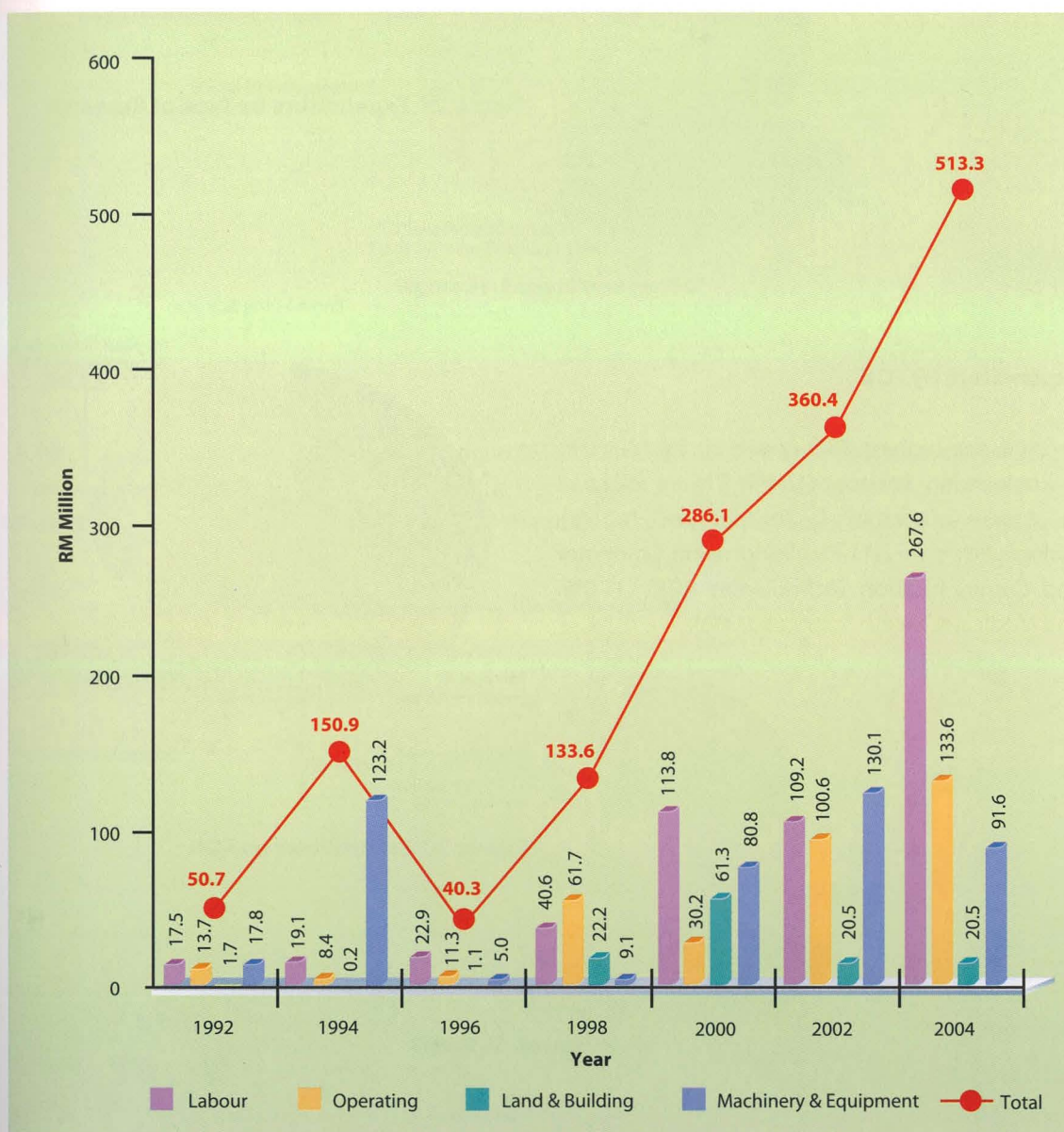
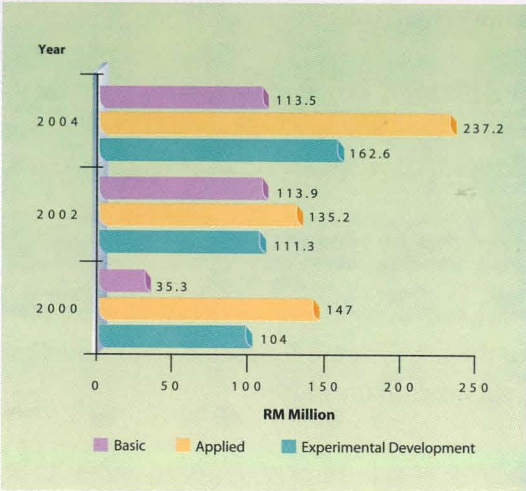


Figure 28: Expenditure by Type of Cost

**Expenditure by Type of Research**

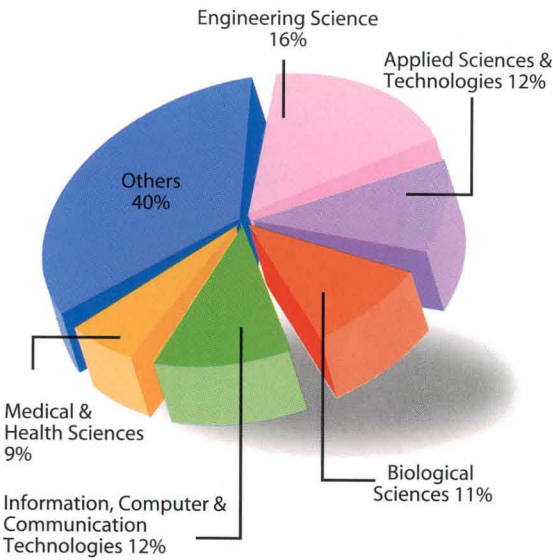
Expenditure on basic research increased from RM104.0 million in 2000 to RM111.3 million in 2002, and then further increased to RM162.6 million in 2004. Expenditure on applied research dropped from RM147.0 million in 2000 to RM135.2 million in 2002, and then increased two-fold to RM237.2 million in 2004. However, the expenditure on experimental research remained at an average of RM113 million for 2002 and 2004.



**Figure 29: Expenditure by Type of Research**

**Expenditure by FOR**

In 2004, the highest R&D spending by FOR was in Engineering Sciences (16.6%). This is followed by Applied Sciences & Technologies (11.6%), Biological Sciences (11.6%), Information, Computer and Communication Technologies (ICT) (11.0%) and Medical & Health Sciences (9.4%).



**Figure 30: Expenditure by FOR**

Expenditure by SEO

R&D expenditure, according to SEO, was highest in the Natural Sciences, Technologies & Engineering (NSTE), followed by Manufacturing (18.0%), Plant Production and Plant Primary Products (11.0%), Social Development & Community Services (10.0%), and Information & Communication Services (ICS) (7.0%).

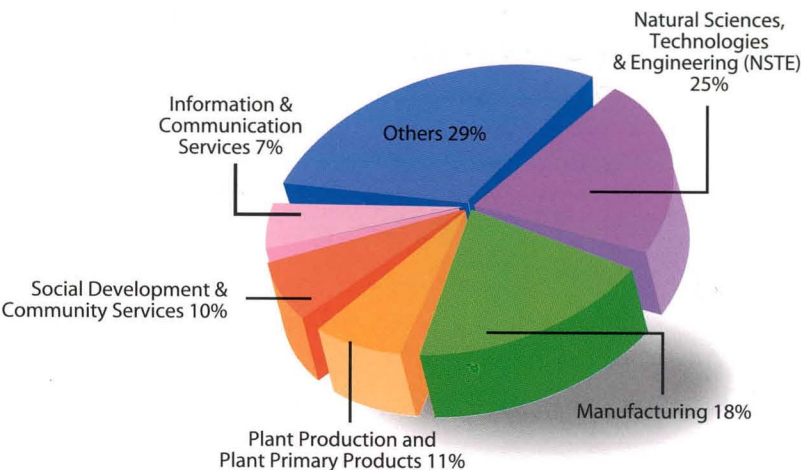


Figure 31: Expenditure by SEO

SOURCES OF FUNDS

55.4% of the funds came from IRPA, amounting to RM 284.7 million in 2004, while RM196.2 million (38.2%) came from the IHL's "Own Funds". Other Federal Government funds contributed RM18.5 million (3.6%), followed by State/Local Government Funds which amounted to RM5.1 million, or 1.0% of the funding.

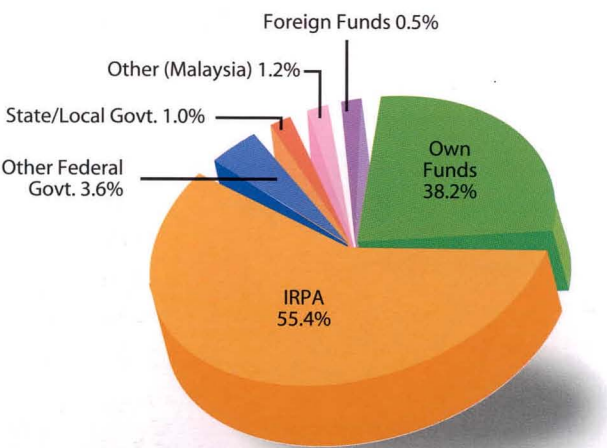


Figure 32: Sources of Funds

HUMAN RESOURCES DEVELOPMENT

By Headcount

From 1,417 in 1994 researcher headcount increased to 12,538 in 2002, and 14,809 in 2004. Since 1994, researchers accounted for the major proportion of the headcount in the IHLs, while technicians accounted for less than 10% of the total number of personnel involved in R&D.

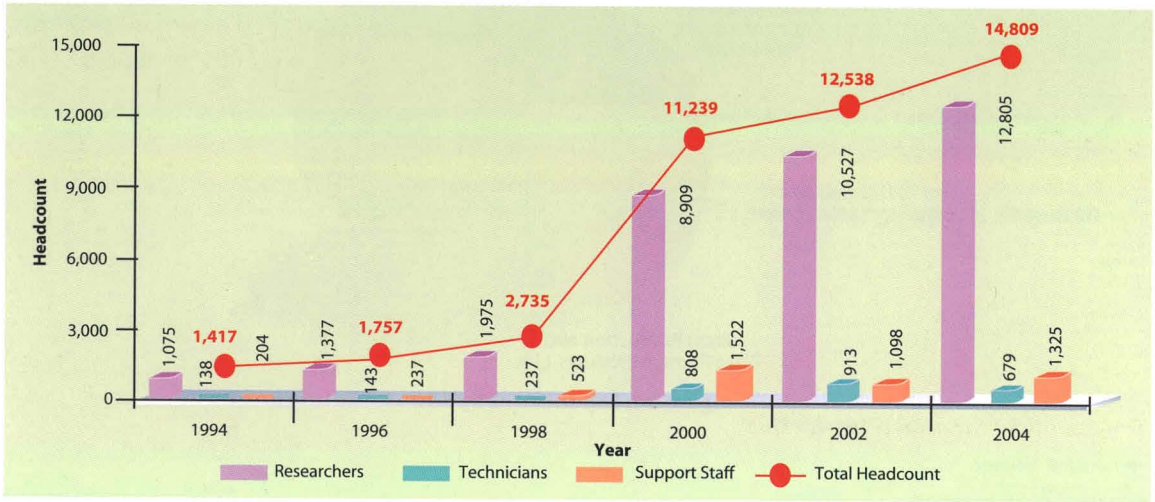


Figure 33: Headcount of R&D Personnel in IHL

By FTE

The total FTE in the IHL has shown a marked, 4-fold increase from 1998 to 2000. In 2004, there was a further, 2-fold increase, from 3,811.9 in 2002 to 7,738.0 in 2004 due to a marked increase in the FTE for researchers.

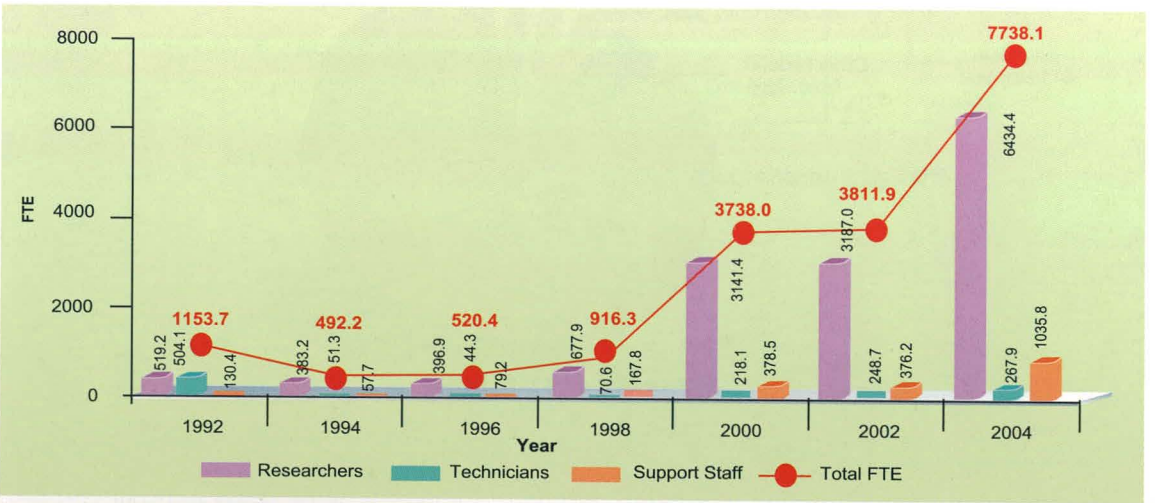


Figure 34: FTE of R&D Personnel in IHL

Participation of Women in IHL

The number of female R&D personnel increased 5-fold from 1,009 in 1998 to 5,785 in 2004. The number of women researchers in the IHLs also increased, from 3,772 in 2002 to 5,092. So did the proportion of women researchers to male researchers, from 35.8% in 2002 to 39.8% in 2004.

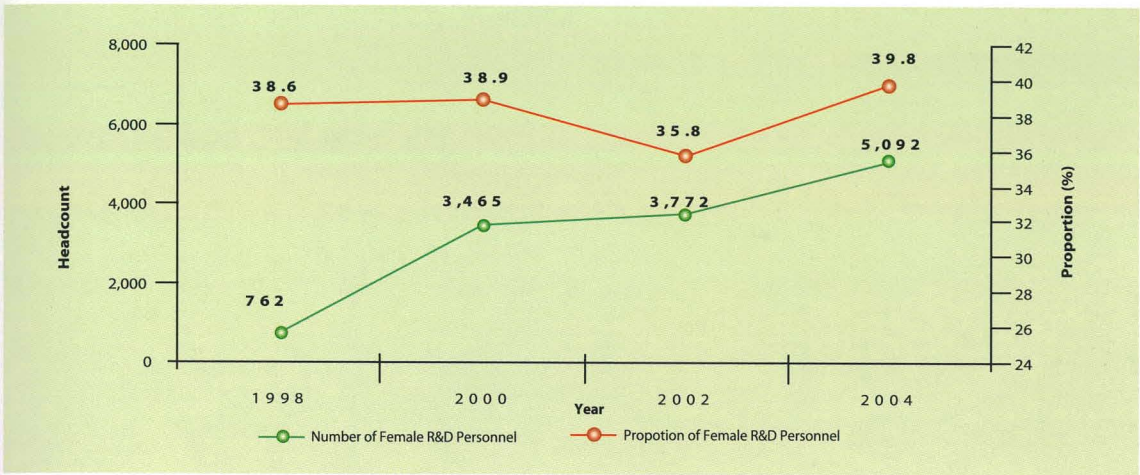


Figure 35: Participation of Women in IHL

OUTSOURCED R&D

There was a slight increase in the amount of outsourced R&D, from RM8.9 million in 2002 to RM10.7 million in 2004. Of this amount, the proportion of outsourced out of Malaysia in 2004 was 51.3%, a substantial increase when compared to the 3.5% that was outsourced in 2002.

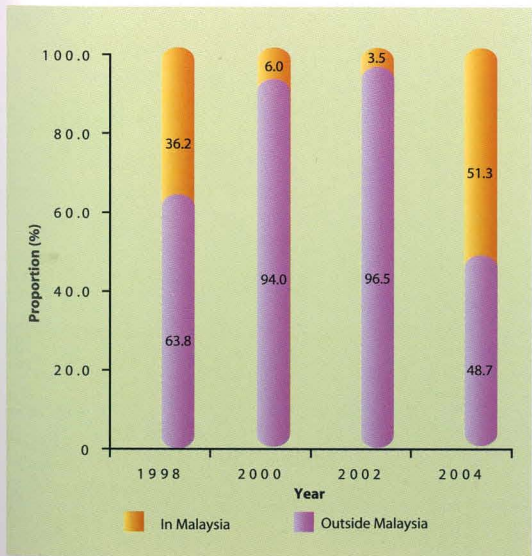


Figure 36: Outsourced R&D

FACTORS LIMITING R&D ACTIVITIES

Internal Factors Limiting R&D

The 5 major internal factors limiting R&D cited by those surveyed were:

- Limited time due to classes or administrative work (64.6%)
- Limited financial resources. (54.1%)
- Lack of infrastructure (44.2%).
- Delay in fund management (36.6%)
- Lack of skilled personnel (36.3%)

External Factors Limiting R&D

The 5 major external factors limiting R&D cited by those surveyed were:

- Increasing capital costs (51.7%).
- Insufficient government funds (45.5%)
- Difficulty in finding private sector collaboration (43.8%)
- Lack of R&D personnel with the requisite expertise (39.1%)
- Lack of ancillary services to support R&D (38.1%)



## **R&D in the Private Sector**

## R&D EXPENDITURE

The total R&D expenditure for the private sector has shown a steady and consistent rise since 1992. In 2002, the expenditure passed the RM1 billion mark (RM1.63 billion). In 2004, private R&D expenditure surpassed the RM2 billion mark, with a recorded total of RM2.03 billion.

### Expenditure by Type of Cost

Expenditure on labour has shown a similar increase over past surveys, with a total expenditure of RM248.9 million in 2002, and RM578.5 million in 2004, representing a 132.4% increase. Operating expenditure grew from RM683.8 million in 2002 to RM1,020.6 million in 2004, an increase of 49.3%. Expenditure on land and building, on the other hand, recorded a 24.8% decrease, from RM120.5 million in 2002 to RM90.6 million in 2004. Expenditure on machinery and equipment in 2004 declined by about RM235.9 million (or 40.7%), from 2002.

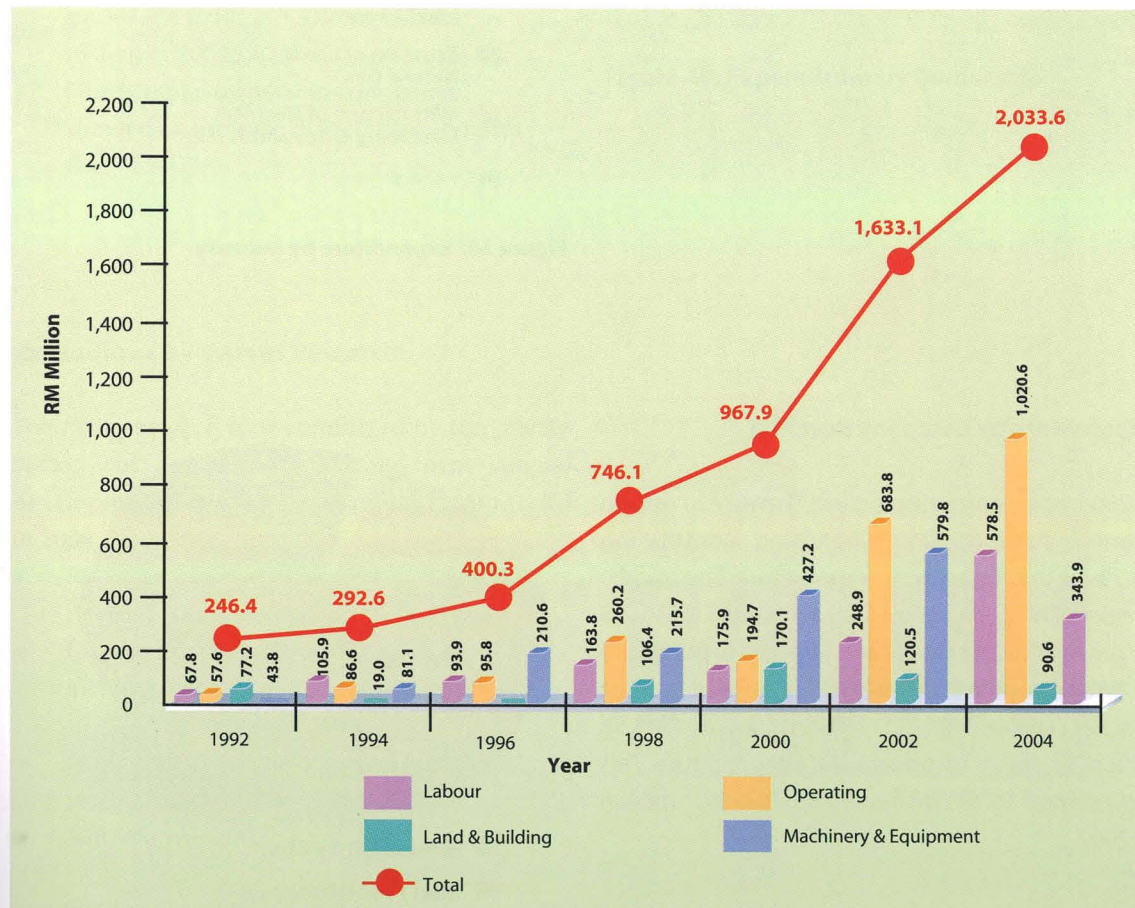
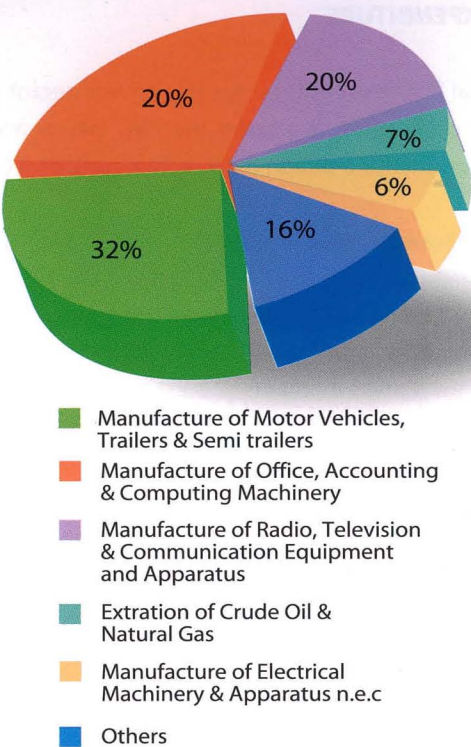


Figure 37: Expenditure by Type of Cost

**Expenditure by Industry**

In 2004, the top 3 industries in terms of R&D expenditure were:

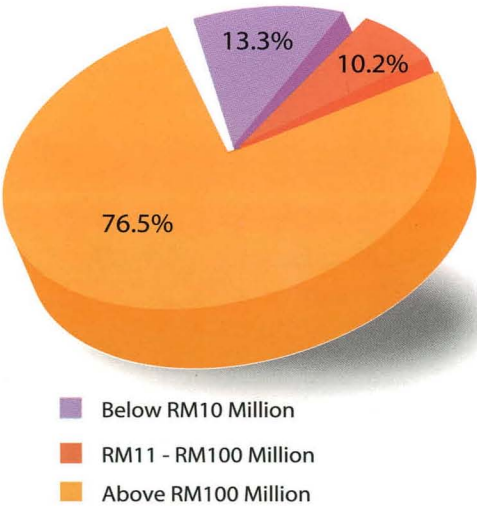
- 1. Manufacture of motor vehicles, trailers & semi-trailers
- 2. Manufacture of office, accounting & computing machinery
- 3. Manufacture of radio, television, & communication equipment and apparatus



**Figure 38: Expenditure by Industry**

**Expenditure by Company Revenue**

In 2004, companies earning less than RM10 million spent a total of RM269.5 million, constituting 13.3% of the R&D private expenditure. The middle bracket (RM11-RM100 million) accounted for 10.2% of private R&D expenditure, with an expenditure of RM207.6 million. Finally, those in the highest bracket (above RM100 million) spent RM1.56 billion, or 76.5% of private R&D expenditure. This represents a 97.6% increase from RM787.7 million in 2002.



**Figure 39: Expenditure by Company Revenue**

Expenditure by Ownership

Of the 5 different types of ownership, only Malaysian-controlled companies showed a decline, from 2002 (RM713.4 million) to RM541.1 million in 2004. The following types of ownership demonstrated a marked increase compared to 2002:

- Malaysian-owned companies showed an increase of 40.7%, from RM280.2 million in 2002 to RM394.2 million in 2004.
- Foreign-owned companies showed an increase from RM866.4 million in 2002 to RM888.4 million in 2004.
- Foreign-controlled companies increased by 257.7% to RM208.9, from RM58.4 million in 2002.
- Finally, equal ownership companies showed an increase of RM0.7 million over that of 2002.

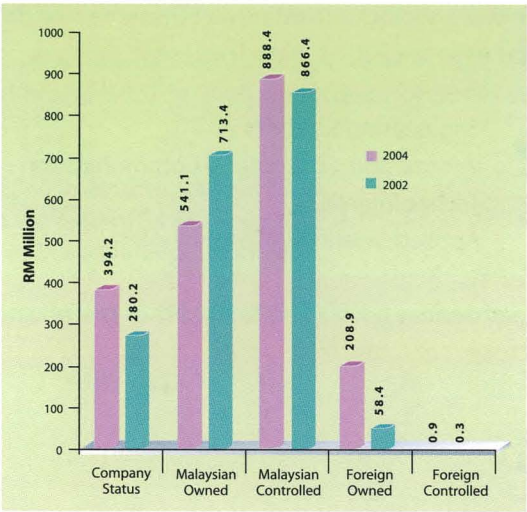


Figure 40: Expenditure by Ownership

Expenditure by Type of Research

The main research type conducted by the private sector was applied research and experimental developmental research. Basic research came third in 2004.

- RM1,143.4 million was spent for applied research, a decrease of 12.9% from 2002
- Experimental development research increased from RM262.3 million in 2002 to RM644.0 million in 2004
- RM246.2 million was spent on basic research, an increase of RM188.9, or 329.6%, over 2002

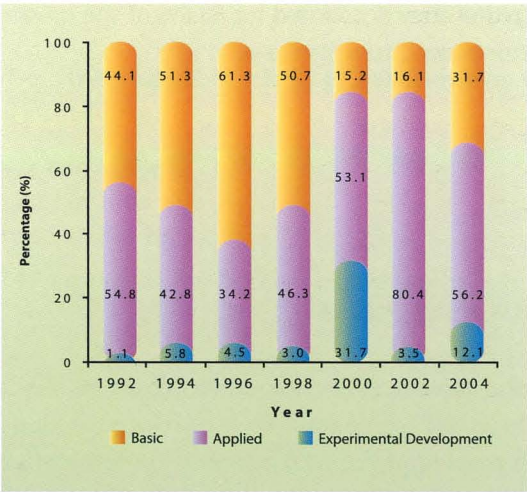


Figure 41: Expenditure by Type of Research

Expenditure by FOR

The top 3 sectors, according to FOR, remained the same as in the 2002 survey. They were:

- 1. Engineering Sciences
- 2. Information, Computer & Communication Technology (ICT)
- 3. Applied Sciences & Technologies

Together they accounted for 84.0% of the private sector expenditure for the year.

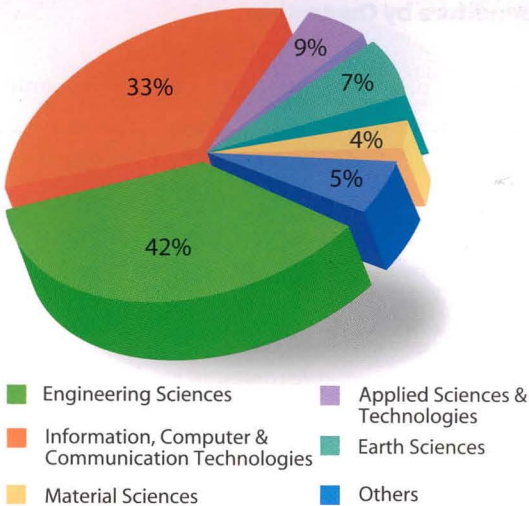


Figure 42: Expenditure by FOR

Expenditure by SEO

In 2004, the top 3 sectors for SEO were:

- 1. Manufacturing
- 2. Information & Communication Services (ICS)
- 3. Energy resources

Together they accounted for 83.5% of the private sector expenditure for the year.

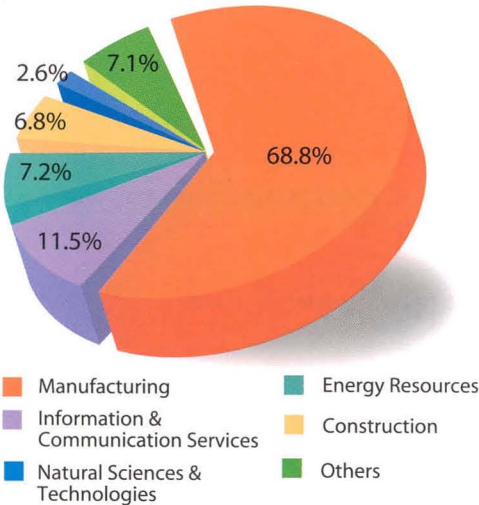


Figure 43: Expenditure by SEO

SOURCES OF FUNDS

In the private sector, about 98.7% of the funds used in R&D come from their own internal funds. This amounted to RM2.0 million in 2004. The other contributing sources of funds include other federal government sources (RM11.7 million), followed by other sources within Malaysia (RM10.5 million), foreign funds (RM3.6 million) and state/local government funds (RM1.6 million).

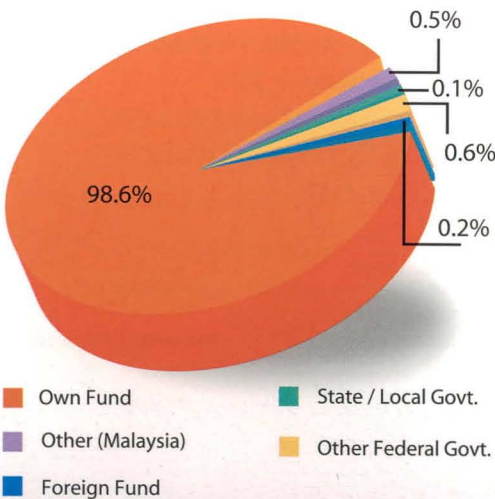


Figure 44: Sources of Funds

HUMAN RESOURCE DEVELOPMENT

By Headcount

From 1994 to 2002, there has been a steady increase in the total headcount of personnel in R&D. From 3,164 in 1994, the number grew to 5,177 in 2002, and finally, 8,737 in 2004, an increase of 68.8% over 2002

- The headcount for researchers increased from 3,349 in 2002 to 5,940 in 2004
- There were a total of 877 technicians in 2004, an increase of 14.8% from 2002
- There was a total number of 1,920 support staff in the private sector in 2004.

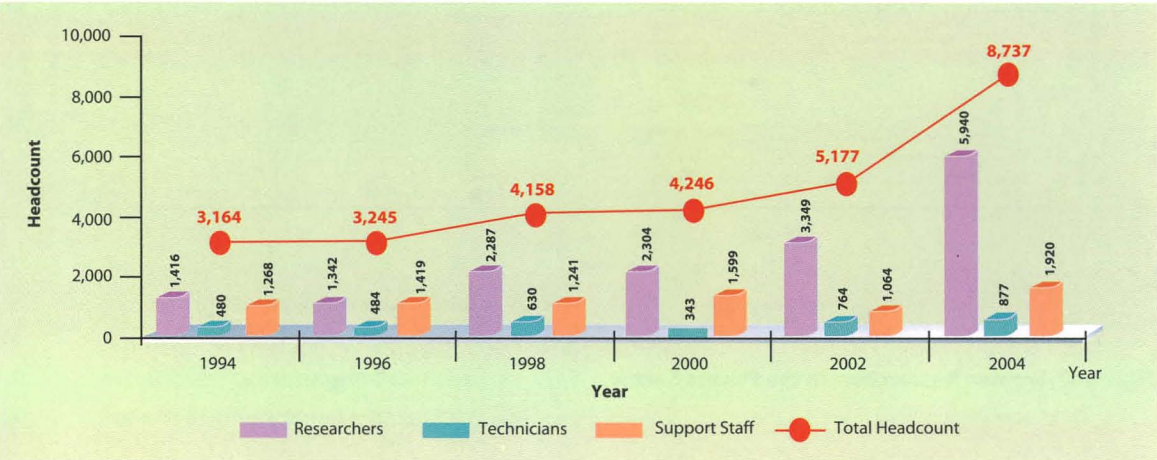


Figure 45: Headcount of R&D Personnel in the Private Sector

By FTE

In 2004, the total FTE was 6,127.2, an increase of 43.6% from the total FTE of 4,266.7 in 2002. However, the average FTE per person dropped from 0.82 in 2002 to 0.70 in 2004.

- Researcher FTE increased from 2,767.1 in 2002 to 4,104.3 in 2004.
- Technician FTE increased from 621.9 in 2002 to 647.7 in 2004.
- Support staff FTE increased from 877.7 in 2002 to 1,375.2 in 2004.

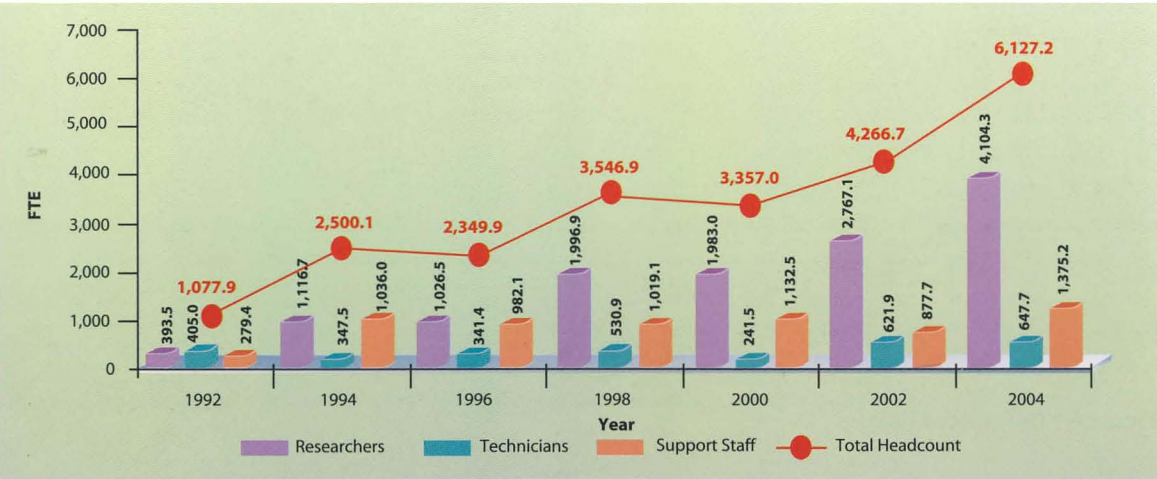


Figure 46: FTE of R&D Personnel in the Private Sector

### Women Participation in the Private Sector

While the number of female R&D personnel increased from 1,504 in 2002 to 2,330 in 2004, its proportion, relative to the number male personnel, decreased from 29.1% in 2002 to 26.7%. Similarly, the number of female researchers in the private sector increased from 821 in 2002 to 1,515 in 2004.

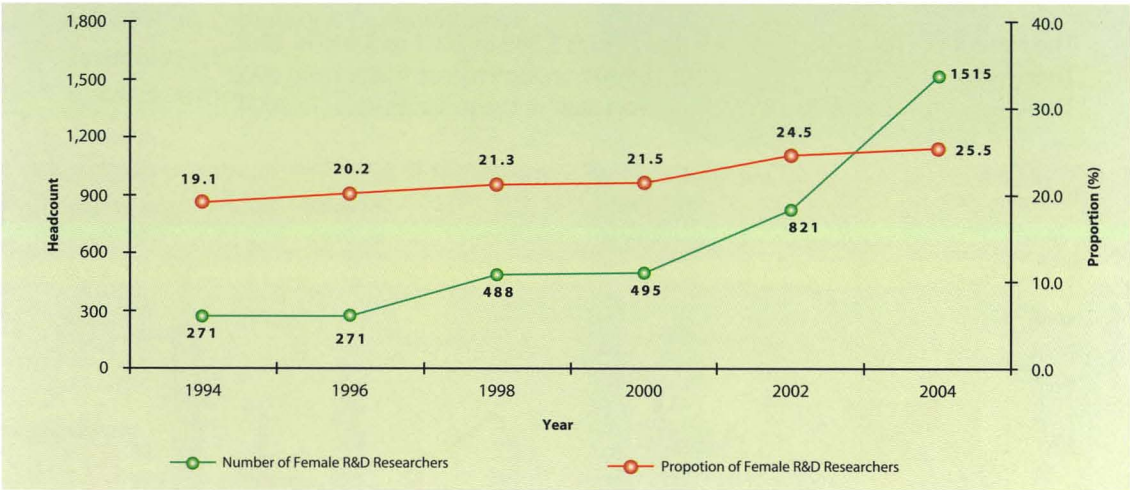


Figure 47: Women Researchers in the Private Sector

### OUTSOURCED R&D

The amount of R&D outsourced by the private sector dropped significantly from RM285.6 million in 2002 to RM14.1 million in 2004. Out of the amount outsourced, RM1.5 million (10.6%) was outsourced inside Malaysia while RM12.6 million (89.4%) outside Malaysia. A possible reason for this may be fact that the capabilities to conduct the R&D that pertained to specific and sophisticated technologies were not available in Malaysia. Another possibility is that the companies found it more cost-effective to outsource the R&D work to others or to collaborate with overseas partners.

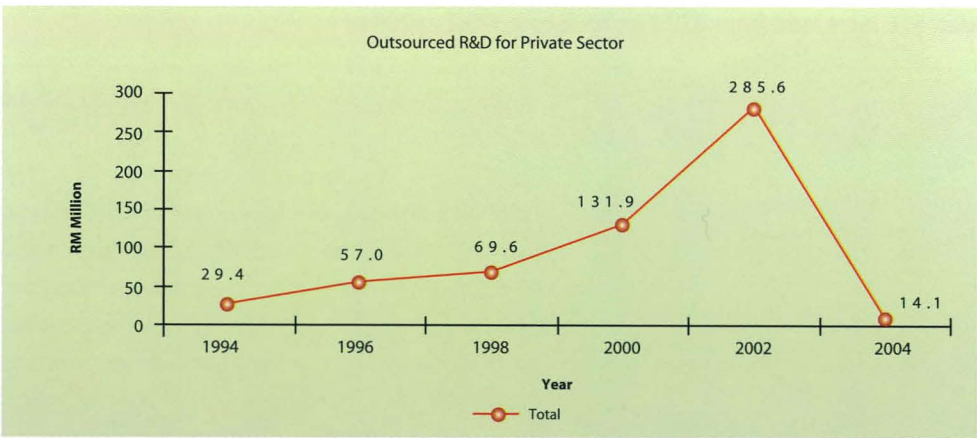


Figure 48: Outsourced R&D

## **FACTORS LIMITING R&D ACTIVITIES**

### **Internal Factors Limiting R&D**

The companies that participated in the survey ranked the following as the five major internal factors limiting R&D:

1. Limited financial resources
2. Lack of skilled R&D personnel
3. Inadequate market research
4. Lack of infrastructure for R&D
5. Lack of R&D policy/strategies tied with lack of proven analytical techniques

### **External Factors Limiting R&D**

The following were cited as the five major external factors limiting R&D:

1. Increasing capital costs
2. Increasing labour costs
3. Shortage of R&D personnel with requisite expertise
4. Insufficient government incentives
5. Lack of ancillary service to support R&D



# **National Survey of R&D**

## Gross Expenditure on R&D (GERD)

Viewing R&D expenditure from an international perspective shows Malaysia's position in light of her neighbouring countries. Malaysia's R&D expenditure in 2004, of RM2.84 billion, represents an increase of RM343.2 million over the previous expenditure, in 2002, of RM2.50 billion. Although this is a positive development, it is still behind Singapore (RM7.3 billion in 2003), but higher than Thailand (RM1.4 billion in 2003), Indonesia (RM200 million in 2003), the Philippines (RM400 million), and Jordan (RM100 million).

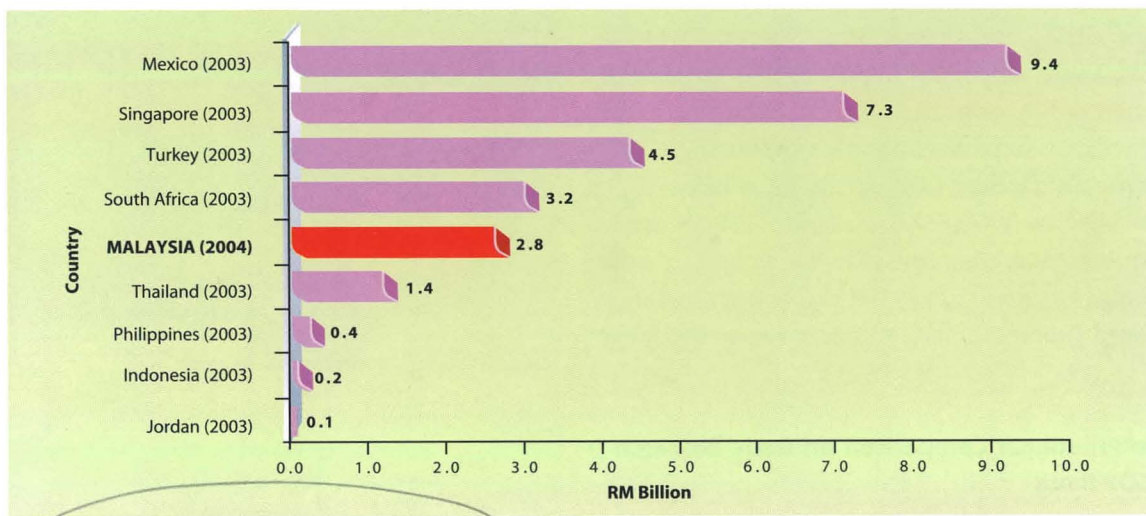


Figure 49: R&D Expenditure by Country

## Research Intensity

Japan, Korea, the United States, Taiwan and Singapore are the some of the leading countries with regard to research intensity versus GDP per capita. Malaysia's research intensity of 0.63% places her with Turkey and Chile. Our research intensity surpassed that of Mexico, Argentina, Jordan, Thailand, and Indonesia, but we are a long way off from countries such as Japan, which ranks highest in terms of research intensity, the United States, and even our closest neighbour, Singapore, whose research intensity is 2.13%.

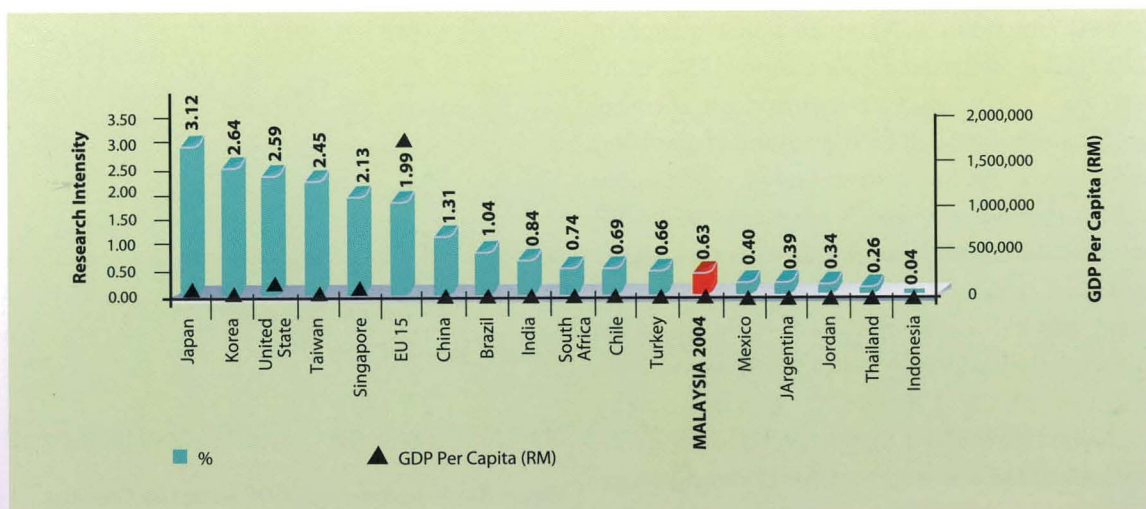


Figure 50: Research Intensity

### R&D Expenditure per Capita

A country's R&D expenditure per capita is a measurement of a country's GERD over its total population. There is also a generalized relationship between a country's R&D expenditure per capita and its GDP per capita. The general trend is that the higher a country's R&D expenditure per capita, the higher its GDP per capita. Table 1 shows that the EU15, the United States, Japan, Australia, Singapore, Korea, and Taiwan surpass many other countries in terms of GDP per capita. Chile's GDP per capita surpasses Malaysia by about RM4,266.1, while Singapore's GDP per capita is higher than Malaysia by RM75,657.6. Malaysia's GDP per capita, at RM17,549.1, is somewhat the same as that of South Africa and Turkey, but higher than Argentina, Brazil, Thailand, China, Indonesia, Jordan and India.

Table 1: International Comparison on GDP per Capita and R&D Expenditure per Capita

| Country                | GDP per Capita (RM) | Expenditure per Capita (RM) |
|------------------------|---------------------|-----------------------------|
| EU 15                  | 1,951,994.2         | 29,414.3                    |
| United States          | 146,031.6           | 3,617.9                     |
| Japan                  | 135,268.3           | 3,604.5                     |
| Australia              | 113,512.3           | 1,154.0                     |
| Singapore              | 93,206.7            | 1,737.9                     |
| Korea                  | 52,188.5            | 1,235.8                     |
| Taiwan                 | 49,798.3            | 1,145.2                     |
| Mexico                 | 23,735.5            | 90.3                        |
| Chile                  | 21,815.2            | 118.4                       |
| <b>MALAYSIA (2004)</b> | <b>17,549.1</b>     | <b>111.1</b>                |
| South Africa           | 16,923.8            | 72.5                        |
| Turkey                 | 15,503.0            | 65.1                        |
| Argentina              | 14,182.1            | 38.9                        |
| Brazil                 | 12,321.0            | 135.1                       |
| Thailand               | 9,283.3             | 21.5                        |
| Jordan                 | 7,744.1             | 23.7                        |
| China                  | 4,695.3             | 53.3                        |
| Indonesia              | 4,406.7             | 1.1                         |
| India                  | 2,138.6             | 13.3                        |

Source: IMD World Competitiveness Yearbook

### International Comparison on Basic Research / GDP Ratio

A high basic research per GDP ratio reflects high investment in academic research and or high tech industries. In general, basic research has low short-term returns, but it builds intellectual capital and lays the groundwork for future advances in S&T (Science and Engineering Indicators 2006).

Switzerland's basic research/GDP of 0.72 % is the highest among OECD member countries. It is significantly higher than that of the United States (0.49%) and Japan (0.39). Albeit a small nation, in 2000 alone Switzerland spent almost 75% of its R&D on basic research, prioritizing on chemical and pharmaceutical R&D (Science and Engineering Indicators 2006). The United States, a world leader in R&D expenditure, reports a basic research/GDP ratio of 0.49%, slightly below that of France (0.53%) and New Zealand (0.52%). Malaysia, on the other hand, has a basic research/GDP ratio of 0.10%, placing us below Singapore (0.33%), Taiwan (0.25%), Spain (0.16%), and Mexico (0.12%), but putting us higher than China (0.07%), which focuses on applied research for short-term economic growth.



Figure 51: Basic Research/GDP Ratios by Country

SOURCES OF FUNDS

Figure 52 shows that the industrial or business sector funds more than 50% of the R&D in countries such as France (52.1%), the United States (63.1%), Germany (66.1%), Japan (73.9%), and South Korea (74.0%). Malaysia's research funding is also dominated by the business or private sector, which accounts for 71.2% of the total R&D funding.

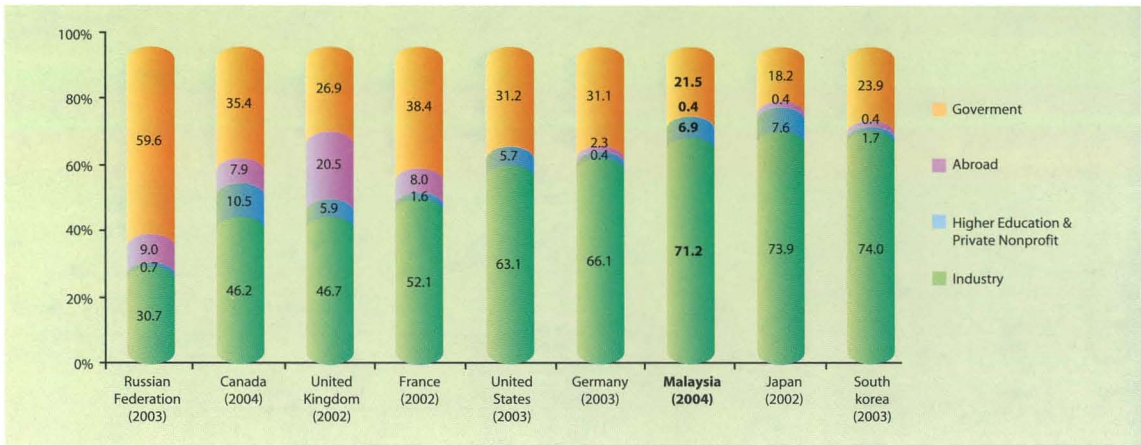


Figure 52: Sources of Funds by Country

HUMAN RESOURCE DEVELOPMENT

Headcount of Researchers

Figure 53 shows that in 2004, Malaysia's researcher headcount per 10,000 labour force was 21.3. That is, for every 10,000 Malaysians employed, there exists, on average, 21.3 researchers. This places us close to South Africa (24.8 per 10,000 labour force), and ahead of Chile (15.3 per 10,000 labour force), Thailand (8.6 per 10,000 labour force), and the Philippines (2.2 per 10,000 labour force). However, this also means that we are behind Romania (28.2 per 10,000 labour force), Turkey (33.4 per 10,000 labour force), Argentina (50.9 per 10,000 labour force), and Singapore (111.3 per 10,000 labour force).

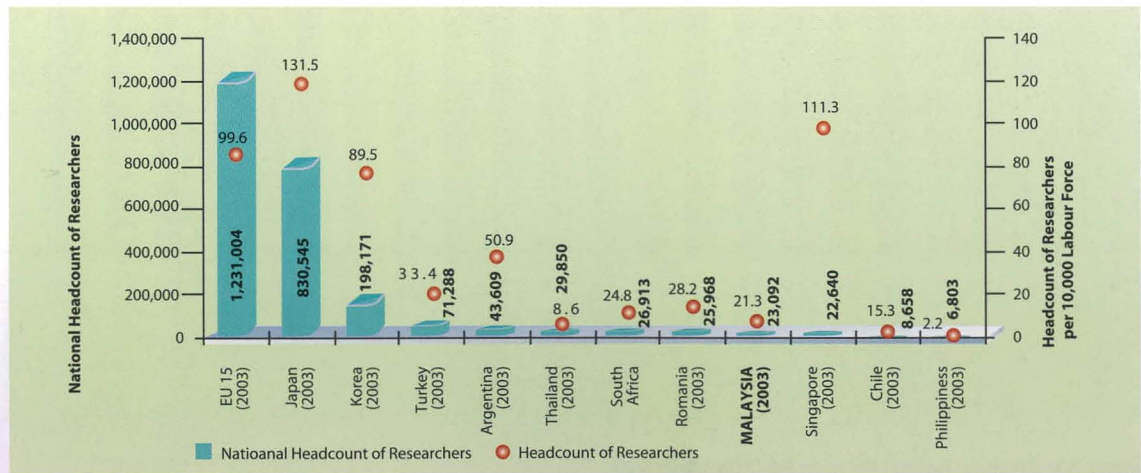


Figure 53: Headcount of

FTE of Researchers

The FTE of researchers (Figure 54) follows the same pattern as the FTE of personnel per capita. The United States, EU 15, China, Japan, and Korea, have among the highest researcher FTE per labour force. Malaysia, on the other hand, has a much lower researcher FTE per labour force. Our researcher FTE per labour force is less than that of our closest neighbours, Singapore and Thailand, but higher than South Africa or Chile. This suggests that a lower proportion of Malaysia's working population are involved in R&D, compared to many countries.

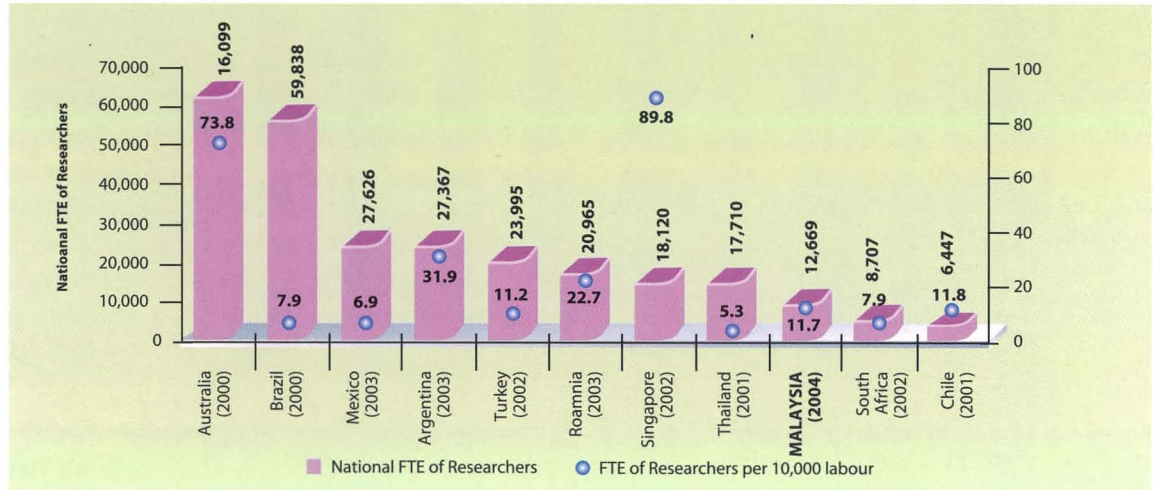


Figure 54: FTE of Researchers by Country

Women Researchers in R&D

Figure 55 shows that Malaysia, Spain, Poland, New Zealand, Slovak Republic and Portugal have among the highest proportion of women researchers. In fact, the proportion of female researchers in Malaysia and in these countries is higher than that of Japan (13%) and Korea (13%), Austria (21%), and Switzerland (21%).

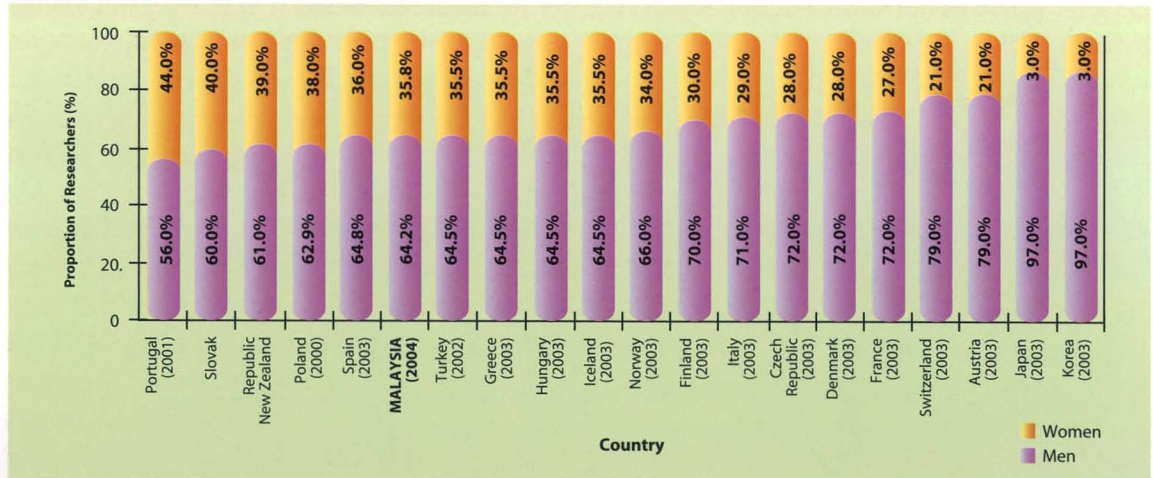


Figure 55: Women Researchers in R&D by Country

PRIVATE SECTOR IN NATIONAL R&D

Private Sector Expenditure on R&D

Table 2 summarizes the private sector expenditure on R&D. Malaysia's private sector expenditure (RM2.03 billion) is far less than Korea (RM45.1 billion), China (RM42.9 billion), Taiwan (RM16.2 billion) and Singapore (RM4.4 billion). Malaysia's private R&D expenditure per capita (RM79.4) is higher than South Africa, Turkey, Jordan, Romania and Philippines, but less than that of Singapore (RM1,056.1), Korea (RM940.5) and Taiwan (RM715.7). Still, due to the difference in the number of inhabitants, Malaysia's expenditure per capita is higher than that of China (RM33.2).

Table 2: Private GERD by Country

| Country       | Expenditure (RM billion) | R&D Expenditure private sector per capita (RM) |
|---------------|--------------------------|------------------------------------------------|
| United States | 725.60                   | 2493.1                                         |
| EU 15         | 451.90                   | 19307.2                                        |
| Japan         | 341.90                   | 2683.3                                         |
| Korea         | 45.10                    | 940.5                                          |
| China         | 42.90                    | 33.2                                           |
| Taiwan        | 16.20                    | 715.7                                          |
| Brazil        | 9.20                     | 53.8                                           |
| Singapore     | 4.40                     | 1056.1                                         |
| India         | 3.10                     | 3.0                                            |
| Mexico        | 2.70                     | 27.0                                           |
| *MALAYSIA     | 2.03                     | 79.4                                           |
| South Africa  | 1.80                     | 39.6                                           |
| Turkey        | 1.30                     | 18.6                                           |
| Romania       | 0.40                     | 17.8                                           |
| Philippines   | 0.30                     | 3.3                                            |
| Jordan        | 0.03                     | 6.5                                            |

Source: IMD World Competitiveness Yearbook 2005

\* Source: MASTIC R&D Survey Data (2004)

Note: The above figures were based on findings in 2003 with the exception of Malaysia which is based on the present 2004 findings

FTE in the Private Sector Per Capita

Table 3 shows that the private sector's contribution to the total FTE in China, Japan, Korea, Taiwan, Iceland, Singapore and Romania is between 53% to 69% of the countries' total FTE. On the other hand, Malaysia's private sector contribution to the FTE is 34.3%. With regard to FTE per 1000 population, Malaysia is far behind Japan, Korea, Singapore and Taiwan. It is also lags behind Romania, China, and Brazil. Clearly, efforts need to be taken to improve the situation

Table 3: Private FTE per Capita by Country

| Country      | Proportion of Private Sector of FTE (%) | FTE per 1000 population |
|--------------|-----------------------------------------|-------------------------|
| Korea        | 69.0                                    | 2.68                    |
| EU 15        | 66.8                                    | 46.98                   |
| Taiwan       | 66.1                                    | 3.50                    |
| Japan        | 64.8                                    | 4.36                    |
| China        | 59.9                                    | 0.51                    |
| Romania      | 56.1                                    | 0.84                    |
| Singapore    | 53.2                                    | 2.99                    |
| Brazil       | 39.3                                    | 0.38                    |
| *MALAYSIA    | 34.3                                    | 0.24                    |
| Mexico       | 27.8                                    | 0.12                    |
| Turkey       | 20.3                                    | 0.09                    |
| Philippines  | 18.2                                    | 0.01                    |
| South Africa | 17.4                                    | 0.14                    |
| Chile        | 6.9                                     | 0.03                    |

Source: IMD World Competitiveness Yearbook 2005

\*Source: MASTIC R&D Survey Data (2004)

Note: The above figures were based on findings for 2003 with the exception of Malaysia, which is based on the present findings (2004).

## Malaysia's Trend in R&D

Malaysia's GERD has been steadily on the rise since 1996. From RM549.2 million in 1996, it grew to RM1.13 billion in 1998, RM1.67 billion in 2000, and RM2.50 billion in 2002. In 2004, the GERD stands at RM2.84 billion, an increase of RM343.2 million over 2002. However, Malaysia's research intensity, or the GERD/GDP ratio decreased, from 0.69 in 2002 to 0.63 in 2004.

## Involvement of Personnel in R&D

The trend in R&D personnel headcount continues to be on the rise. Since 1998, there has been a steady increase in the number of personnel involved in R&D, from 12,127 in 1998, to 23,262 in 2000, to 24,937 in 2002, and 30,983 in 2004. This represents an overall increase of 6,046 (or 24.2%) over 2002.

This upward trend is also evident for researcher headcount, which grew from 6,249 in 1998, to 15,022 in 2000, to 17,790 in 2002, and 23,092 in 2004. In both the public and private sectors, researchers constitute the highest total headcount.

The total number of women R&D personnel increased from 8,009 in 2002 to 10,544 in 2004. Women made up 34.0% of the total R&D personnel. The number of women researchers, on the other hand, increased from 5,996 in 2002 to 8,275 in 2004.

In terms of FTE, there has also been a steady increase over the years. Indeed, there is a 66.7% increase in FTE, from 10,731.0 in 2002, to 17,886.6 in 2004. Researcher FTE increased by 77.0%, from 7,157.5 in 2002 to 12,669.5 in 2004, Technician FTE increased from 1,378.8 in 2002 to 1,597.8 in 2004, and Support Staff FTE increased by 64.9%, from 2,194.7 in 2002 to 3,619.3 in 2004. In terms of proportion, researchers accounted for 70.8% of the FTE.

## Major Research

Since 1998, the emphasis has been on Applied Research, followed by Experimental Research and Basic Research. This trend continued in 2004, with Applied Research contributing 55.4% of the nation's GERD, followed by Experimental Research (28.5%) and Basic Research (16.1%). The three main FOR for 2004 were Engineering Sciences, Information, Computer & Communication Technology, and Applied Sciences and Technologies.

The bulk of the research in 2004 was conducted in Malaysia. Of the total national R&D expenditure, only RM33.0 million was outsourced, a remarkable decline (by 89.2%) from the RM306.0 million outsourced in 2002. The private sector had the biggest drop in outsourcing, from RM285.6 million in 2002 to RM14.1 million in 2004. Of the R&D that was outsourced, 60.6% was outsourced outside Malaysia, while 39.4% inside Malaysia.

## Public Sector Involvement in R&D

In 2004, the GERD for the public sector dropped by RM57.3 million, from 867.5 million in 2002 to 810.2 million. This is primarily due to a sharp decrease in R&D expenditure among the GRIs, from 507.1 million in 2002 to 296.9 million in 2004. Public sector expenditure on R&D accounted for only 28.5% of the national R&D expenditure.

The major research, according to expenditure, was applied research (RM427.5 million), basic research (RM215.9 million), followed by experimental research (RM166.9 million). Overall, the three main areas of research, according to FOR, were engineering sciences, agricultural sciences, and ICT.

## Private Sector Involvement in R&D

The total R&D expenditure for the private sector has shown a steady and consistent rise since 1992. In 2002, private sector expenditure passed the RM1 billion mark (RM1.63 billion), while in 2004, it

surpassed the RM2 billion mark, with a recorded total of RM2.03 billion. Expenditure on the manufacture of motor vehicles, trailers & semi-trailers stood at RM646.3 million, constituting 31.8% of the total private sector expenditure. R&D expenditure by the private sector accounts for 71.5% of the national GERD.

The main research type conducted by the private sector was applied research, followed by experimental developmental research and basic research. RM1.14 billion was spent on applied research, an increase of 12.9% from 2002. Experimental development research increased from RM262.3 million in 2002 to RM644.0 million in 2004, a 145.5% increase, while the total for basic research in 2004 was RM246.2 million, an increase of 329.7% over 2002.

### **Malaysia's Performance in R&D**

Malaysia's GERD has been steadily on the rise since 1996. This upward trend is also evident for researcher headcount, researcher FTE, and FTE per researcher. All these developments point to the fact that Malaysia is making steady progress in R&D.

In terms of research intensity, or the GERD/GDP ratio, however, there is a decrease, from 0.69% in 2002 to 0.63% in 2004. Despite the increase in R&D expenditure over that of 2002, the GERD/GDP ratio decreased by 0.06%. This can be attributed primarily to the increase in the national GDP. From 361.6 billion in 2002, our GDP increased to 449.6 billion in 2004, indicating stronger economic growth in 2004 than in 2002. Indeed, this is reflective of our strong rate of economic growth from 1991-2005, in which our economy grew at an average rate of 6.2% per annum (refer 9th Malaysia Plan).

This increase in economic growth, however, did not bring about a commensurate increase in research intensity. In other words, our R&D efforts, as reflected in our R&D spending, grew at a slower pace than did our economy. Hence, a concerted effort must be made by all parties to increase our research intensity so that it is in line with the objectives of our nation.

### **The Challenges Ahead**

The key players in R&D, or in knowledge production, have traditionally been the USA, Europe, and Japan. However, the GERD of USA and Europe is gradually declining, and instead, China is coming up as an emerging economy, along with, to a lesser extent, India. Among the Asian countries, the Republic of Korea, the Republic of Taiwan, and Singapore, have all broken the 2% barrier in terms of percentage of GDP spent on research and development, while China is on its way to achieving its target of 1.5%.

The challenge, for us, lies in not only ensuring that we achieve our national targets for research intensity and R&D personnel, but that we move beyond the quantifiable aspects of R&D involvement such as research spending and headcount of personnel to the act of generating knowledge in the form of research as well as published papers. Our challenge lies in making our public realize and appreciate the importance of R&D for the development of the nation's economy. Our challenge also lies in effectively implementing our various plans of action such that they would allow us to achieve our objectives. It is only when we are able to meet these challenges that we will be able to achieve our objectives of becoming a knowledge-based economy.

# List of Acronyms and Abbreviations

|      |                                                          |
|------|----------------------------------------------------------|
| FOR  | : Field of Research                                      |
| FTE  | : Full-time Equivalence                                  |
| GDP  | : Gross Domestic Product                                 |
| GERD | : Gross Expenditure on R&D                               |
| GRI  | : Government Agencies and Research Institutions          |
| ICS  | : Information and Communication Services                 |
| ICT  | : Information, Computer and Communication Technology     |
| IHL  | : Institutions of Higher Learning                        |
| NSTE | : Natural Sciences, Technologies and Engineering         |
| OECD | : Organization for Economic Co-operation and Development |
| R&D  | : Research and Development                               |
| RM-9 | : 9 <sup>th</sup> Malaysian Plan                         |
| S&T  | : Science and Technology                                 |
| SEO  | : Socio-economic Objective                               |