

THE SCIENCE AND TECHNOLOGY SYSTEM OF MALAYSIA¹



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Introduction²

Malaysia transformed from a country dependent on the production and export of primary commodities to an emerging multi-sector economy over the period from 1971 through the late 1990s. During the last decade, the country emerged as a leading exporter of high technology products. Its current growth was almost exclusively driven by exports - particularly of electronics, followed by palm oil and palm oil based products and other manufactured goods and articles. The services sector contributes 57% of the gross domestic product (GDP), manufacturing constitutes 30% of GDP, while a lesser amount is contributed by the traditional sectors of agriculture and forestry (8.4% of GDP) and, mining and quarrying (7.2% of GDP)³. Malaysians have a per capita income of RM 13,722 per capita Gross National Income (GNI).

In the last three years, the Malaysian economy recorded a creditable performance despite the unprecedented volatility in the global economy as well as uncertainties arising from international terrorism, wars in Afghanistan and Iraq, and the outbreak of the Severe Acute Respiratory Syndrome. Through fiscal stimulus and accommodative monetary policies, the government was able to sustain growth due to the expansion in domestic demand and promotion of domestic sources of growth. From a GDP growth rate of only 0.4% in 2001, the Malaysian economy recovered strongly to register growth rates of 4.2% and 5.2% in 2002 and 2003 respectively. With the outlook for the global economy becoming increasingly optimistic, the Malaysian economy is expected to strengthen further in 2004 and real GDP growth is expected to expand by 6% - 6.5 %). Today, its market-oriented economy, combined with an educated multilingual workforce and

¹ This report has drawn from Ahmad, F. and Krishna, V.V. (2006); Malaysian websites on S&T and other sources. The draft is the outcome of collaboration with Dr Fadzilah Ahmand of Ministry of Science, Technology and Innovation, Malaysia.

² Malaysia is considered by several international agencies of the UN as a middle-income country in 2005. The country covers a total area of 329,750 sq. km with a population of 25.5 million in 2004.

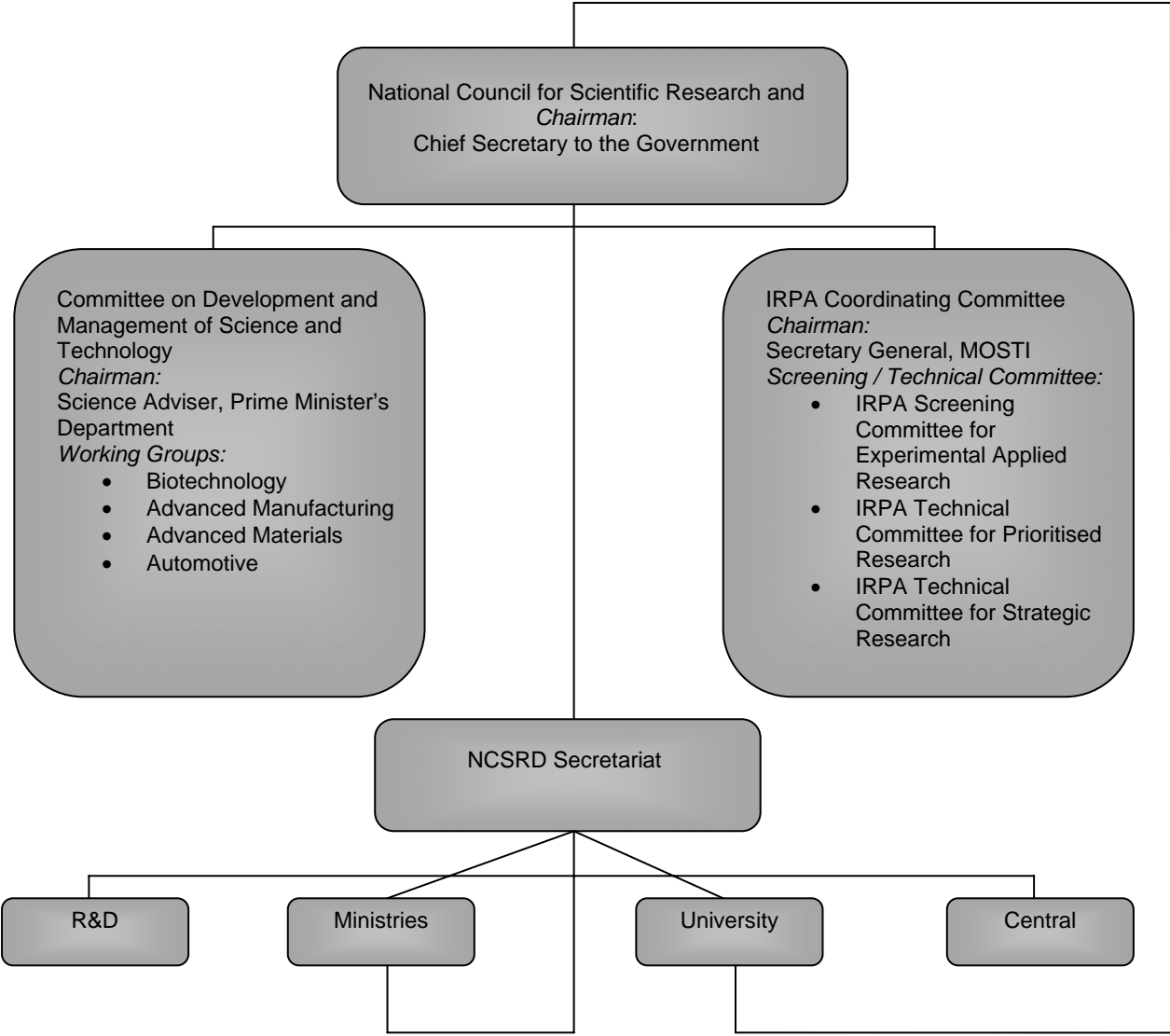
³ Central Bank (Malaysia) Report on the Economy, Statistical Yearbook 2003

a well-developed infrastructure, has made Malaysia one of the major recipients of FDI among developing countries. The Institute for Management Development (IMD) in its 2004 World Competitiveness Yearbook ranked Malaysia as the fifth most competitive country in the world (for countries with a population of greater than 20 million).

1. Science and Technology Policies

The Ministry of Science, Technology and Innovation (MOSTI) is the lead ministry that formulates policies in the area of science, technology and innovation. MOSTI also implements many programmes related to the promotion of S&T and national R&D activities. The National Council for Scientific Research and Development (NCSRD) is an advisory body comprising high-level representatives from the public and private sectors as shown in Figure 1. The main function of the NCSRD is to provide advice and directions on S&T policies and S&T priorities. The Ministry of Science, Technology and Innovation acts as the secretariat to the National Council of Scientific Research and Development (NCSRD). The Council is chaired by the Chief Secretary to the government. Representations include the universities and public research institute and key central government agencies, and the private sectors. This council meets three to four times a year to deliberate on matters related to research and scientific advancement.

Figure 1: Organisation of S&T in Malaysia



It has been well recognised, as noted earlier, that research and development as well as technological innovations are essential in the Malaysian government's strategy of sustainable development and knowledge-based economy. Recognising that biotechnology has the potential as a new area of economic growth, the government has recently launched the National Biotechnology Policy. The policy outlines the future orientation and framework for the biotechnology industry and introduces attractive incentives that will accelerate Malaysia's foray into biotechnology. Malaysia's S&T development has thus far been based on the S&T Policy of 1986. The tenets of this policy were implemented through the National Plan of Action for Industrial Technology Development (1990). The S&T policy went through a review process in the year 2000, and this resulted in the formulation of the Second National Science and Technology Policy (STP II), which was launched in the year 2003. The STP II seeks to set out the path for science and technology to be the engine for the country's future growth and ensure national competitiveness. The STP II attempts to address the gaps in the national innovation system and will focus on strengthening research and technological capacity and capability with emphasis on commercialisation of research outputs, strengthening institutional framework and management of S&T. Central to all these strategic thrusts is to bring government, industry, universities and public research institutions together in a synergistic partnership. The STP II therefore addresses seven key priority areas, which have a strong influence on the innovation system.

- Strengthening research and technological capacity and capability
- Promoting commercialisation of research outputs
- Developing human resource capacity and capability
- Promoting a culture for science, innovation and techno- entrepreneurship
- Strengthening institutional framework and management for S&T and monitoring of S&T policy implementation
- Ensure widespread diffusion and application of technology, leading to enhanced market-driven R&D to adapt and improve technologies
- Build competence for specialisation in key emerging technologies

2. Government Schemes and Policy Mechanisms for S&T Development

Since 1988, the government has implemented a centralised grant system of financing science and technology (S&T) research in public institutions and research agencies. The Ministry of Science, Technology and Innovation (MOSTI) is charged with the responsibility of managing the fund and the implementation of S&T and R&D programmes in the country. Various schemes of government are listed in the following paragraphs.

2.1 Intensification of Research in Priority Areas (IRPA)

This Fund was introduced in 1988 with the purpose of focusing research and development (R&D) activities on areas, which have the potential for enhancing the national socio-economic position. This is largest of the grants managed by MOSTI. This grant is mainly utilised by the public sector universities and research institutes, however of late a small proportion has also been given to the private sector. IRPA is considered as a key programme to catalyse the generation of new products, processes, services and solutions. A large portion of IRPA funding is allocated to activities that will lead to commercialisation. In allocating grants for R&D projects, the granting agency adheres to several principles such as to:

- fund projects that are of high national priority and can be commercialized;
- fund projects that address the needs of Malaysian Industry;
- encourage collaborative efforts among research institutions;
- Enhance R&D linkages between the public and private sectors.

2.2 The Industry R&D Grant Scheme (IGS)

This scheme is administered by the MOSTI since 1996 to mobilise Malaysian companies towards enhancing their technological capabilities and innovation. This scheme is restricted to mainly Malaysian companies. The other objective of this scheme is to also foster public-private partnerships including universities. Between 1998 and 2003, 102 projects were approved worth RM 243 million. Most of the projects funded under the IGS scheme relate to high technology and advance science sectors.

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

This scheme was launched in 1997 mainly to promote the development of R&D clusters. During the period 2002-2003, 29 projects worth RM 66.71 millions were approved. In all more than 52 projects worth RM 114 million were sanctioned from 1997. In 2003, some changes were made to make more companies eligible for seeking funding.

2.4 Technology Acquisition Fund (TAF)

This scheme was introduced in 1997. The TAF has been established by the Government to facilitate the acquisition of strategic and relevant technology by Malaysian companies to enhance their technology level and production processes and is operated by the Malaysian Technology Development Corporation. TAF provides partial funding to private sectors to acquire and enhance their technological capacity. Under the TAF, these included the purchase of high-tech equipment & machinery, technology licensing, acquisition of patent rights, prototypes & design placement of Malaysians in foreign technology based companies/Technology Institutes. Under this scheme, 112 projects totalling RM133.3 million had been approved since 1997. The TAF program is an important component in the technology development value chain as it provides the means for companies to undertake technology acquisition projects. In general, the TAF program has benefited many small and medium enterprises that have recognised the need to keep abreast of new technologies in order to compete globally.

2.5 Demonstrator Application Grant Scheme (DAGS)

This scheme is managed by the Malaysian Institute of Microelectronics (MIMOS). This is an ICT related R&D organisation that functions as an advisor to the Malaysian Government on technologies, policies and strategies relating to ICT development. MIMOS manages the Demonstrator Application Grant Scheme (DAGS), which funds focused and short term projects (not exceeding 12 months) for the benefit of the community and focuses on content and people development. This scheme requires a partnership of private sector with a public research organisation or institution. Priority is given to IT and multimedia technology-based proposals that have local content.

2.6 Commercialisation of R&D Fund (CRDF)

This scheme also came into operation in 1997 as other schemes which is managed by the Malaysian Technology Development Corporation to commercialise results of research and development. It provides three types of grants to market survey and research; product and process design including designs, prototypes, pilot plant, and standardisation measures including IPR. Industrial Training For Manufacturing And Services: In 1993, the Human Resource Development Fund (HRDF) was launched by the government to encourage training, retraining and skills upgrading in the private sector. Employers, in the manufacturing and service sectors who contribute to this fund are eligible to apply for grants to defray or subsidise the costs incurred in training and retraining their workforce. The National Vocational Training Council under the Ministry of Human Resources coordinates the planning and development of a comprehensive system of vocational and industrial training programmes for all public training agencies. It also develops the National Occupational Skills Standards (NOSS) on a continuous basis. To-date, there are more than 650 NOSS covering basic, intermediate and advanced training levels. Human Resource Development Fund Programme: The Human Resource Development Fund Programme in S&T is another effort by the Government to strengthen the human capacity and capability for the enhancement of S&T in Malaysia. Among the objectives of this programme is to increase the critical mass of scientists and researchers of the country. It also aims at further strengthening the R&D functions in institutions of higher learning and public research institutions; and

to enhance the country's competitiveness through the development of a trained, innovative and creative human resource. The HRDF provides scholarships for in-service training, as well as students wishing to take up further degrees of Masters and PhDs. To date this program has benefited 4,359 science-based professionals.

2.7 Tax Incentives

The involvement of private companies in Research and Development (R&D) activities is crucial to the nation's industrialisation drive. To further encourage the involvement of the private sector in carrying out R&D, the government of Malaysia has made available various types of incentives for R&D activities. Most of the R&D deductions and allowances are provided for under the Income Tax Act, 1967. The category of incentives by way of Pioneer Status and Investment Tax Allowance are provided under the Promotion of Investments Act 1986. These incentives allow for technology acquisition and double deduction for R&D.

Programmes such as the Technology Acquisition Fund (TAF) provide partial funding to private sectors to acquire and enhance their technological capacity. The TAF programme has enabled recipient companies to undertake various acquisition activities to shorten technology development time and providing them with a competitive edge.

2.8 Loans and Venture Capital

Over the years, the Malaysian government through various ministries and agencies have helped the Small and Medium Industries (SMI) succeed from start-up through the many stages of growth. Financial assistance is offered to help start or expand these businesses and achieve success through business loans to entrepreneurs and business owners of specialised industries. These loans are made available through various financial institutions to enable entrepreneurs to obtain up to 100% loan and credit facilities to support their business aspirations. Venture Capital is an alternative form of financing. The Government has proven itself in the past to be supportive of the VC industry and has continued to do so, providing adequate liquidity to meet the industry's needs.

3. Government Infrastructure and Incubation Related Schemes

The Malaysian Technology Development Corporation or MTDC is a venture capital based company established by the Government and the private sector. MTDC's objectives were established by taking into consideration the need to improve the level of technologies of Malaysian companies. Thus, MTDC's objective is to spearhead technology development in Malaysia through:

- Commercialisation of Research Results,
- Development of Technology-based Companies and
- Providing venture capital.

MTDC also collaborates with local institutions to set up incubation parks near the institutions to assist their start up ventures such as Serdang - UPM - MTDC Technology Incubation Centre, UTM – MTDC Technology Incubation Centre and UUM - MTDC - Advanced Electronic Centre.

The Multimedia Development Corporation (MDC) was set up to promote the development of the ICT sector, MDC, focusing on ensuring the success of the Multimedia Super Corridor (MSC) and the companies operating in it. This one stop centre was set up to ensure that the necessary infrastructure (hard and soft) is in place to create a vibrant ICT industry with the necessary linkages. The MDC also advises the Malaysian Government on legislation and policies, development of MSC-specific practises, and setting breakthrough standards for multimedia operations. MDC promotes the MSC locally and globally, as well as support companies, which are locating within the MSC.

The Technology Park, Malaysia was set up to provide infrastructure and services for technological innovation and R&D to enable knowledge based enterprises to grow and compete in the global marketplace and to facilitate government and private sector smart partnerships in technology development. The Park, located within the Multimedia Super Corridor, provides entrepreneurs with services on a one-stop basis, and enabling tenants to reduce their overhead costs by sharing facilities, these parks are able to significantly improve the survival and growth prospects of new start-ups. As part of the national agenda to promote biotechnology BioNexus Malaysia, essentially a network of centres of excellence throughout the country, comprising companies and institutions, which specialise in specific biotech sub-sectors has been established. Initially, three centres of excellence will be established as part of the BioNexus.

More universities are now aware of commercialisation issues and the need to develop relationships with the industry. Of late, there has been a shift towards applied research as more universities try to align their R&D towards the local and market needs. Many universities have set up technology transfer/commercialisation units to enable better liaison with the private sector and to facilitate business arrangements between the researchers and the private sector, at the same time providing advisory on intellectual property issues. Some also provide advisory services to the private sector through consultancies based on available expertise at the universities. In order to disseminate research findings to the industry and the public, science and technology expositions are held, to display the research findings and provide opportunities for business-research matching.

4. R&D Budget

The government through its development Plans from early 1990s accorded high priority to S&T and R&D. The gross expenditure on R&D as proportion GDP increased considerably during decade from 0.37% in 1992 to 0.69% in 2002 as shown in Figure -2. Over the decade, the private sector has come to play an important role as an important actor in the Malaysian innovation system. In 2002 while the private industrial sector contributed 58% of GERD of GDP, the government sector contributed the rest 42%. In this latter, the institutes of higher learning accounts for 17% and government research institutes accounts for 25%.

Figure 2: GERD/GDP (1992-2002)

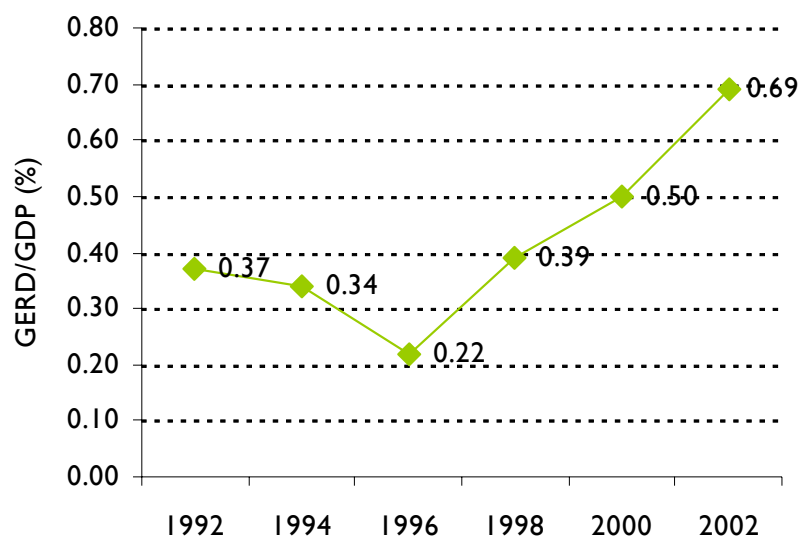


Table 1: Distribution of R&D Investments in Malaysia by Sector in RM million

Year	Private Industrial	Higher Education	GRI's	Total
1985	NA	NA	NA	NA
1992	246 (44.7)	50.7 (9.2)	253.7 (46.1)	550.7
1994	292.6 (47.9)	150.9 (24.7)	164.8 (27.0)	611.2
1996	400.1 (72.8)	40.4 (7.4)	108.7 (19.8)	549.3
1998	746.1 (66.2)	133.6 (11.9)	247.3 (21.9)	1127.0
2000	967.9 (57.9)	286.1 (17.1)	417.5 (25.0)	1671.5
2004	1633.1 (65.3)	360.4 (14.4)	507.1 (20.3)	2500.6

Overall, the GERD of 0.69% of GDP is low level compared to other countries such as South Korea, China and India in the Asian region and developed countries, which spent an average of 2.5-3.0% of their GDP on R&D during the last decade.

Even though the high technology component of Malaysian industry witnessed considerable progress over the last decade, the private industrial sector, particularly the local firms, confront a number of challenges and problems. In 2000 while the local companies accounted for RM 446 million of R&D expenditure (decrease of 27% compared to 1998), the foreign companies accounted for RM 637 million (an increase of 120% compared to 1998). For local companies, the most important sectors are manufacturing, transport equipment industry and the service sector. For foreign companies manufacturing is most important sub-sector. For local companies R&D expenditure for 2002 was RM929.9 million which represents an increase of 180.9% compared to 2000. Foreign companies, on the other hand experienced a marginal increase of 8.1%. In 2002, expenditure by local companies

made up 56.8% of total R&D, whereas it was 34.1% in 2000. For local companies, manufacturing industry was the sector with the largest R&D expenditures for 2002 (RM 742.8 million or 80.0% of total local companies R&D). The Science and Technology Policy II set a target for Malaysia to achieve an R&D Intensity of 1.5% by the year 2010. While according priority to R&D being one important feature of the Malaysian S&T policy, the challenges of globalisation and the increasing significance of knowledge based industries, particularly ICT and electronics has come into sharp focus in the S&T policy document of 2003.

5. Malaysian S&T System

The main drivers of Malaysia's scientific and technological efforts are the public sector research system comprising research institutions and universities; and the private industry sector. The bulk of the public sector R&D funding is managed by the Ministry of Science, Technology and Innovation, which funds research for the public sector, namely the Institutes of Higher Learning (IHL) and Government Research Institutes (GRIs).

5.1 Universities and S&T Human Resource Base

Malaysia has seventeen public and 20 private universities. The universities are the training ground for the S&T human resource base for the country. The older more established universities are University of Malaya, University Kebangsaan Malaysia, University Putra Malaysia and University Sains Malaysia. Private universities are growing in importance as these institutions are being established to cater to the growing needs of the industry and institutional sector. Among the more recent universities are the Multimedia University (MMU), which focuses on multimedia and ICT based courses, and the University Tenaga Nasional (UNITEN) a private university that focuses on engineering, information technology, business management and related courses. University Teknologi Petronas (UTP), which focuses on engineering, science and technology. Recently, the Malaysian University of Science and Technology (MUST) was established, focussing on science and technology courses. Various private colleges in Malaysia offer degree programmes on a twinning basis with overseas institutions of higher learning, while foreign universities have set up branch campuses in the country.

Table 2: Growth of FTEs in Malaysian Institutes of Higher Learning

Universities	1992	1994	1996	1998	2000	2002
UPM	498.6	208.27	73.96	124.46	1,372.93	916.5
USM	242.7	42.15	125.12	303.58	383.11	780.4
UM	193.2	96.05	83.89	128.34	619.07	323
UKM	101.3	105.87	79.75	167.2	466.02	456.2
UTM	94.6	18.68	102.4	83.46	446.73	707.2
ITM/UITM	16.9	10.16	27.21	20.3	54.51	175.2
UUM	7.5	4.73	3.83	10.7	131.34	47.8
UIA		2.5	8.67	38.89	69.03	25

Table 2 Continued

Universities	1992	1994	1996	1998	2000	2002
UNIMAS/Sarawak		3.6	15.46	33.14	57.88	19.5
UMS/Sabah				2.45	63.38	83.8
UTP				3.11		7.6
UTN//UNITEN				0.6	0.7	
UNITAR					4.2	0.2
UNITEL					62.4	
UPSI					6.7	37.7
KUITTHO						31
KUSTEM						93.3
KUTKM						7.6
MMU						100.2
TOTAL FTEs	1154.8	492.01	520.29	916.23	7,738.00	3812.20

With the advent of new industries and emerging technologies, the requirement for a critical mass of qualified human resources, has been recognized as a priority for the government's human resource development plans and as well as the science and technology policies over the last decade. Education and training are accorded high priority in national development with about 25% of total public development expenditure allocated for this purpose under Malaysia's five-year development plans as shown in Table 3 below. While allocation for tertiary sector increased by over 70%, the allocation for training increased almost by 90% in the Malaysian Plan period of 2001-2005.

Table 3: Development Allocation for Education and Training in Malaysian Plans

1996 – 2005 (RM Million)		
Program	7 th Plan Expenditure	8 th Plan
Total Education	17542.2	18660.0
Tertiary Education	5005.1	8900.0
Teacher Education	332.5	300.0
Other Educational Support	4147.8	1700.0
Training*	2181.9	4000.0

*Note: includes industrial, commercial and management training

Source: 8th Malaysian Plan

As the last decade witnessed considerable S&T policy focus laid on higher education and training, the country witnessed a corresponding increase in the access to higher education, particularly in most of the science and engineering fields as can be seen in the Table 4. Between 1995 and 2005, while the proportion of arts decreased from 59.3% to 42.5%, the engineering enrolments witnessed considerable increase from 16.7% to 28.1%. The science enrolments witnessed only marginal increase from 24% to 29.4%.

Table 4: Enrolment of First Degree Courses from Local Public Institutions 1995-2005

Course	1995 Enrolment	2000 Enrolment	2005 Enrolment
Arts*	44886 (59.3%)	81914(48.0%)	103846(42.5%)
Science**	18171(24.0%)	49575(29.0%)	71897(29.4%)
Technical**	12652(16.7%)	39305(23.0%)	68784(28.1%)

Note: *Arts includes humanities, economics, business and law;

**Science includes medicine and dentistry, agriculture and pure sciences;

***Technical includes engineering, architecture and town planning and survey and others.

Source: Awang Halimah (2004)

Table 5: Enrolment of First Degree Courses at Public Institutions, 1992-2002

Field of Study	Academic Year									
	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02
Natural Sciences	6,354	5,946	8,198	8,374	4,228	4,660	9,960	12,149	9,553	10,608
Eng. & Tech.	9,571	11,128	9,814	11,798	18,992	25,192	23,307	25,780	30,596	37,138
IT & Computer Sc.	1,901	2,382	2,35	2,530	5,069	6,857	8,391	10,504	11,501	17,276
Medical Sciences	2,713	2,824	2,859	3,225	3,962	4,701	5,915	6,340	9,191	7,682
Agricultural Sc.	2,444	2,618	2,032	2,169	2,373	3,124	1,341	1,030	8,382	4,589
Sub total NSE	22,983	24,898	25,256	28,096	34,624	44,534	48,914	55,803	69,223	77,293

Table 5 Continued

Field of Study	Academic Year									
	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02
Social Sciences	23,605	25,801	29,393	30,328	32,643	39,490	42,391	39,832	43,488	55,394
Humanities	6,388	7,466	16,272	18,584	19,902	23,038	15,196	24,260	27,746	32,008
Sub total SSH	29,993	33,267	45,665	48,912	52,545	62,528	57,587	64,092	71,234	87,402
Other Fields	-	-	-	-	-	-	19,972	21,375	16,292	17,874
Total All Fields	52,976	58,165	70,921	77,008	87,169	107,062	126,473	141,270	156,749	182,569

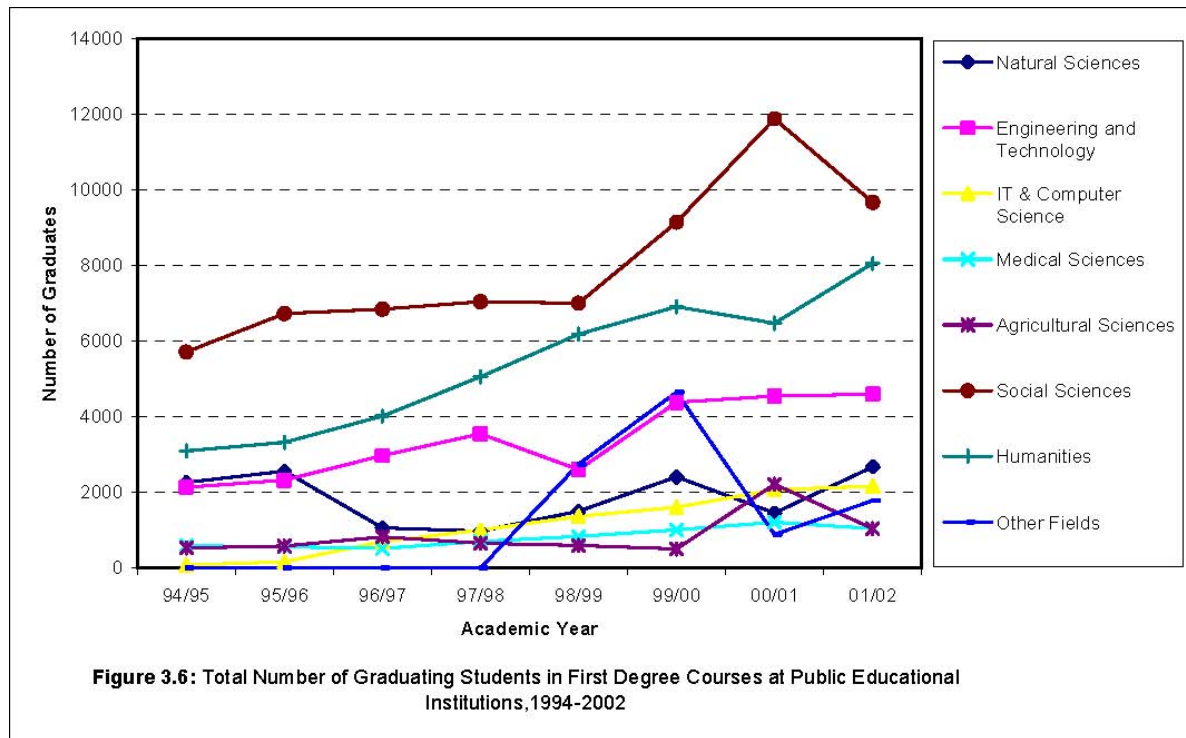
Table 6: Enrolment in Doctoral Degree Courses at Public Educational Institutions, 1992-2002

Field of Study	Academic Year									
	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02
Arts	260	274	417	632	246	897	665	1,154	1,637	1,898
Science	229	256	266	492	106	422	484	752	1,158	1,331
Technical	75	89	87	131	89	327	277	383	564	627
Other										
Fields	-	-	-	-	-	-	282	412	-	-
Total All Fields	564	619	770	1,255	441	1,646	1,708	2,701	3,359	3,856

Enrolment in Doctoral Degree Courses at Public Educational Institutions, 1992-2002 MASTIC/MOE - source

The Ministry of Education set a target of 60% enrolment in S&T related courses. However, this target has yet to be realised. Courses leading to certificate, diploma, degree and post-graduate degree qualifications are offered by 17 public and 20 private universities and colleges, as well as various polytechnics and industrial training institutes. Total enrolment in public institutions of higher learning alone is projected to reach over 325,600⁴ this year (2004), with more than half in the science and technical disciplines. The ten-year trend of graduations for courses in public universities is shown in Figure 2.

Figure 2: Graduation from Public Universities for First Degree Courses



The greater proportion of graduating students from public education institutions were from the Social Sciences and Humanities. The number of students from the public and private universities graduating in Natural Science and Engineering courses grew in numbers from just 5,588 in 1992⁵ to 12,911 in 2002. Despite this increasing trend, the numbers of science and engineering graduates in Malaysia is still inadequate. The number of researchers in Malaysia stands at 18 researchers per 10,000 workforce⁶ (2002). This figure seems low when compared with that of developed countries, which average 80 researchers per 10,000 labour force. During 4 MIDA website 5 Private universities only began producing graduates in the late 90's 6 MASTIC's National R&D Survey, based on the Frascati Manual 1994-96 there were 200 per million which increased to 730 per million in 2002. Malaysia fares better when compared with some of its Asian neighbours, Thailand, Philippines and Indonesia. Nonetheless, these are indications that Malaysia does face shortages of skills and capabilities in some areas. This is likely to be a constraint for Malaysia to develop a strong technology base. In cognisance of this shortfall, various initiatives have been made to continuously develop Malaysia's human resources, through provision of better access to training and re-training of human resources. On a similar note, the Government has also sought to improve programs to attract qualified personnel from abroad through its 'Brain Gain' programme. The Malaysian Government also introduced several initiatives to ensure that the workforce is given opportunity for training of the industrial workforce as well as the S&T workforce.

5.2 Government Research Institutes (GRIs)

Mission oriented research institutes have been established to focus on sectors of strategic importance to the country. Agriculture and related fields are the dominant sector. For the advancement of research in commodity crops well established institutes include the Rubber Research Institute of Malaysia, RRIM (established in 1925), Palm Oil Research Institute Malaysia, PORIM (Malaysian Palm Oil Board), Malaysian Cocoa Board and Malaysian Agricultural Research and Development Institution (MARDI). These agencies' main objective is to develop the particular industry in Malaysia to be well

⁵ Private universities only began producing graduates in the late 90's
⁶ MASTIC's National R&D Survey, based on the Frascati Manual

integrated and competitive in the global market with emphasis given to increasing productivity and efficiency in production and increasing downstream activities.

Both the public and private sectors carry out oil palm research and development (R&D). In Malaysia, the Palm Oil Research Institute of Malaysia (PORIM) was set up in 1974 and was merged in 2000 with the Palm Oil Licensing Authority (PORLA) to form the Malaysian Palm Oil Board (MPOB). MPOB now deals with all aspects of oil palm and palm oil development and provides regulatory, training and technical advisory services to all sectors of the industry. Other research organizations that conduct research on oil palm and palm oil include the Indonesian Oil Palm Research Institute (IOPRI), Nigerian Oil Palm Research Institute (NIFOR), CENIPALMA in Columbia, CIRAD in France and Bah Lias Research Station in Indonesia. In Malaysia, there are also many local plantation companies with R&D facilities such as FELDA, Golden Hope, United Plantations and Applied Agricultural Research.

As Malaysia moves on from the traditional commodity and agriculture base to a more industrial base, institutions to ensure the success of industrial development and growth have been established. SIRIM, the national organization of standardization and quality is an institute for industrial research and development. SIRIM undertakes the role (i) to promote and undertake scientific industrial research, (ii) to boost industrial efficiency and development, (iii) to provide technology transfer and consultancy services and (iv) to develop Malaysian standards and to promote standardization and quality assurance for greater competitiveness. SIRIM's clients comprising mostly small and medium enterprises are given technical assistance to upgrade their businesses and to stay competitive. The GRIs sector in Malaysia is dominated by agriculture and related research sector as it constituted for 52% of FTEs in 2002; followed by 15% biological sciences; and 7.3% applied science and technology fields. In terms of qualifications, while 65% of FTEs in JTSK and JPSK had PhD degrees, only 25% of FTEs in four institutions (MARDI, FRIM, MRB and MPOB) had PhD degrees in 2000. Growth of GRIs sector can be seen in Table 7.

Table 7: R&D Personnel (FTEs) in Malaysian GRIs

Institution	1992	1994	1996	1998	2000	2002
Agricultural Research Institute	357.8	317.61	156.9	336.27	207.04	167.4
Forest Research Institute Malaysia	295.2	168.15	45.53	99.55	106.93	294.5
Rubber Research Institute of Malaysia	220.4	319.85	185.9	121.16	212.08	44.6
Malaysian Agricultural Research & Development Institute	179.3	769.66	628.7	782.54	871.99	407.1
Malaysian R&D in ICT and Microelectronics (MIMOS)	144.2	67.3	33.8	109.5	64.5	100.1
Malaysian Institute for Nuclear Technology Research	136.2	77.18	41.1	53.45	89.14	111.2
Palm Oil Research Institute of Malaysia	128.2	107.2	24.29	15.63	204.91	357.8
Institute for Medical Research	110.4	52.06	58.03	66.63	114.6	41.3
Malaysian Coco Board		74.24	42.66	60.53	87.15	76.9
Standard and Industrial Research Institute of Malaysia	54.3	36.67	27.12	23.2	167.81	124

The National Biotechnology Directorate was set up to spearhead the development of biotechnology in Malaysia through research and related activities directed at the commercialization of biotechnology and establish Malaysia as the leading centre for biotechnology industry with a view to commercialise R&D outputs and to create spin-off commercial activities. In collaboration with universities and research agencies locally and internationally, the National Biotechnology Directorate also identifies focal points for specific areas of biotechnology for collaboration among institutes of higher learning to enhance national capabilities through training of scientists, technologists and other related personnel.

The Multimedia Super Corridor (MSC) is Malaysia's most exciting initiative for the global information and communication technology (ICT) industry. Conceptualized in 1996, the MSC has since grown into a thriving dynamic ICT hub, hosting more than 900 multinationals, foreign-owned and homegrown Malaysian companies focused on multimedia and communications products, solutions, services and; research and development.

The first phase of the MSC has been successful, with the following major achievements and milestones:

- More than 1,000 MSC-status companies
- 19,000 knowledge-based jobs have been created
- ICT sales amounted to RM5 billion, where export value was RM1.2 billion
- R&D expenditure was valued at RM419 million
- 70% of companies listed in MESDAQ were MSC-status companies

Among the 1000 MSC companies, software development is the biggest component with 213 companies (27%); followed by system integration 169 companies (22%); web design 133 companies (16%); internet 66 companies (8%); rest others. In terms of sectors, financial and insurance account for 22%; telecommunications 19%; manufacturing 13%; retail 8%; health 8%; software applications 8%; and rest others.

5.3 *S&T in the Private Sector*

The manufacturing sector is the main engine of economic growth that has evolved a certain degree of international competitiveness over the last few years. As noted in the previous sections, the private industry accounts for over 57% of GERD of GDP in 2000 occupying a significant position in the innovation system. The government S&T policy laid considerable emphasis on building technological capacities through promoting R&D in the private sector as it is seen to enhance Malaysia's position internationally. The private sector in Malaysia is composed of both local and foreign companies. The significant position of foreign companies is revealed when we look into the R&D expenditure of these two groups. Participation in the high technology based industries as an engine for future growth is one of the many strategies of the Malaysian Government. The Malaysian Industry Group for High Technology (MIGHT) was established as a government think-tank group, which was set up with the following main objectives:

- To participate or assist in transforming Malaysia into a truly industrialised economy, committed to wide application of research and technology in productive sectors; and
- To strengthen and widen the industrial base and to sustain and enhance the competitiveness of Malaysia's manufactured products in the global market through the combined effort of the public and private sectors.

Malaysia's main strength during the last decade has been its manufacturing sector, particularly dominated by high technology exports as proportion of the total as can be seen in table. During the

last two decades, the high technology exports have increased from 40% to over 55-60% of total exports in 2000-03.

6. Scientific output of Malaysian R&D

For Malaysia, the output of scientific papers or publications in international journals grew considerably since 1998. Prior to that period, Malaysia produced less than 100 papers per year. The number of papers as seen in the ISI database has risen steadily to about 1,000 papers per year for the 1998-2002 period as shown in Table 8 below. Although there has been a growth in the number of papers produced, Malaysia contributes only 0.08% of the world output of publications, giving it a rank of number 55 out of 178 countries. The top field of research is Physical Chemistry/Chemical Physics, followed by Agriculture/Agrotechnology and Medical Research.

Table 8: ISI based Science Publications for Malaysia, 1998-2004

%	Total 1998-2004	2004	2003	2002	2001	2000	1999	1998
.58	6,675	1,257	1,171	934	922	814	869	798

Over the 2001-2002 period 10,871 patents were filed, of which 10,278 were filed by non-residents. Since 1993, Malaysia has filed 268 patents with the United States Patent Office. Currently efforts are being made to increase the awareness of the importance of intellectual property protection through patent filing. Funding mechanisms are being reviewed to include funding for patent applications, in an effort to encourage researchers to file their IPs.

7. Concluding remarks

As a developing country, the Malaysian government's direct role in developing a robust science system is likely to be quite substantial for quite a while. In areas such as education, research and development, the government will still have to provide support, to ensure that the overriding development objectives are met. There is now a shift towards demand led R&D, with a concept of inviting the private sectors to participate in R&D at the early stages, rather than to offer technologies or research output which have been based on the perceived needs by the researcher. This mechanism is thought to offer better chances of success in commercialising outputs of research and development. The private sector in Malaysia on their part will need to increase their investment in R&D over time to sustain their competitiveness, for which market forces will determine the need and motivation for innovation. In the coming decade, an important policy component in Malaysia's development plans will be to enhance the knowledge content of the economy. There is a need for intensive research and technology development increasing the R&D as proportion of GDP from the current 0.6% level to at least 2% if the country has to join the ranks of South Korea, Singapore and Taiwan. The next 10 years will see a greater emphasis on human resource enhancement as availability of skilled and knowledge workers are a major pre-requisite to transform Malaysia from a production-based into a knowledge-based economy. Malaysia is likely to face shortages of highly skilled workers in the coming decade.

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