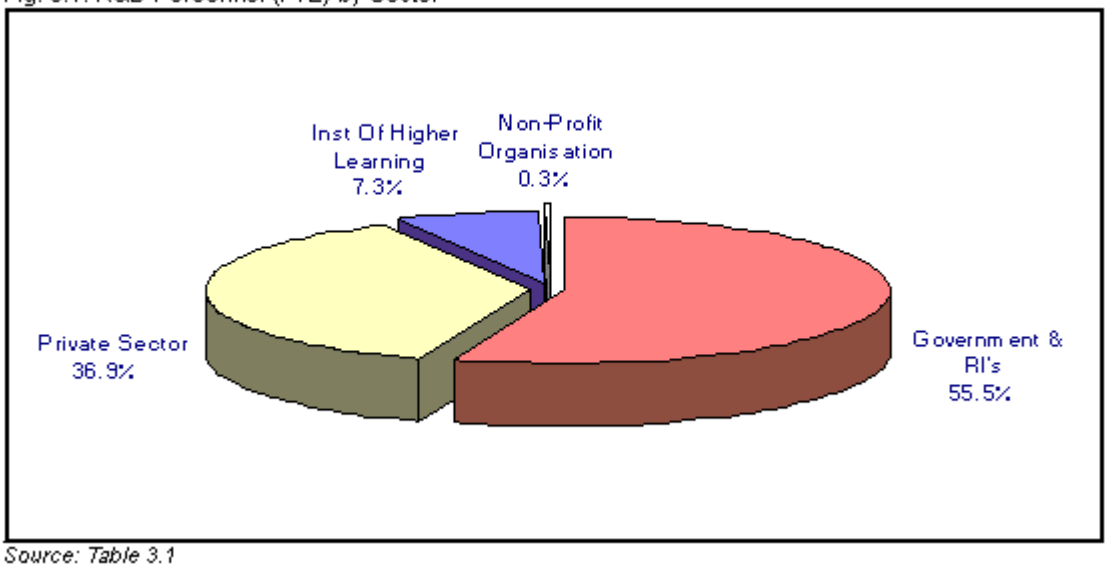
CHAPTER 3 - NATIONAL OVERVIEW FOR R&D RESOURCES

3.1 Human Resources for R&D

The equivalent of 6,675.6 person years of effort (full-time equivalent or FTE) on R&D took place in Malaysia in 1994. Of this, 3,660.5 person years (54.9%) was performed in government agencies and public research institutions, 492.0 (7.4%) in institutes of higher learning and 2,500 (37.4%) in the private sector. Less than one percent was performed in non-profit organisations (See Fig.3.1).
Fig. 3.1: R&D Personnel (FTE) by Sector
Source : Table 3.1

Fig. 3.1: R&D Personnel (FTE) by Sector



Source: Table 3.1

Table 3.1 R&D Personnel (FTE) by Category and Nationality

Sector	Researchers		Technicians		Others		Total		Grand Total	% of Total
	Malaysians	Foreigners	Malaysians	Foreigners	Malaysians	Foreigners	Malaysians	Foreigners		
Government & RI's	754.7	13.3	411.4	0.1	2,481.0	-	3,647.2	13.4	3,660.5	54.9
Private Sector	1,058.1	58.6	345.2	2.2	1,031.8	4.1	2,435.2	64.9	2,500.1	37.4
Inst. Of Higher Learning	355.0	28.1	51.3	-	57.6	-	463.9	28.1	492.0	7.4
Non-Profit Organisation	15.7	3.1	1.0	-	3.3	-	19.9	3.1	23.0	0.3
Total	**2,183.5**	**103.1**	**808.9**	**2.3**	**3,573.7**	**4.1**	**6,566.1**	**109.5**	**6,675.6**	**100.0**

Since in 1992 total R&D human resource efforts (FTE) was 4,563, there has therefore been an increase by 46% since 1992. This represents an average annual growth of 23%.

There were 2,286.6 person years of effort by researchers, the most highly qualified research personnel in 1994 (see Fig. 3.2). Of this 48.8% took place in the private sector, 33.6% in government research institutions and 16.8% in institutes of higher learning. Foreign researchers contributed only 4.5% of the total with the majority engaged in the private sector. The ratio of technicians and other support staff to researchers was highest in government agencies and public research institutes and lowest in non-profit organisations.
Fig. 3.2: Percentage of Researchers (FTE) by Sector
Source : Table 3.1

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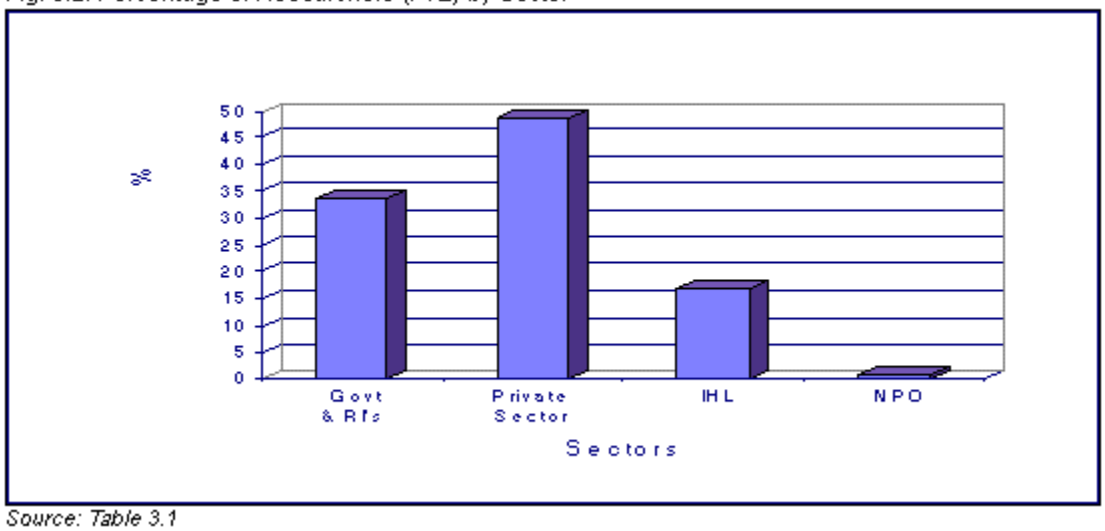

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In terms of headcount, a total of 11,472 individuals were involved in R&D activities. Comparing the FTE figure of 6,675.6 against the headcount figure of 11,472, it shows that individuals involved in R&D activities spent only about 58% of their time doing R&D and the balance on other tasks such as administration, teaching, etc. (see Fig. 3.3)
Fig 3.3 R&D Personnel (FTE and Headcount) by Sector and Category
Source : Table 3.1 and Table 3.2

Fig 3.3 R&D Personnel (FTE and Headcount) by Sector and Category

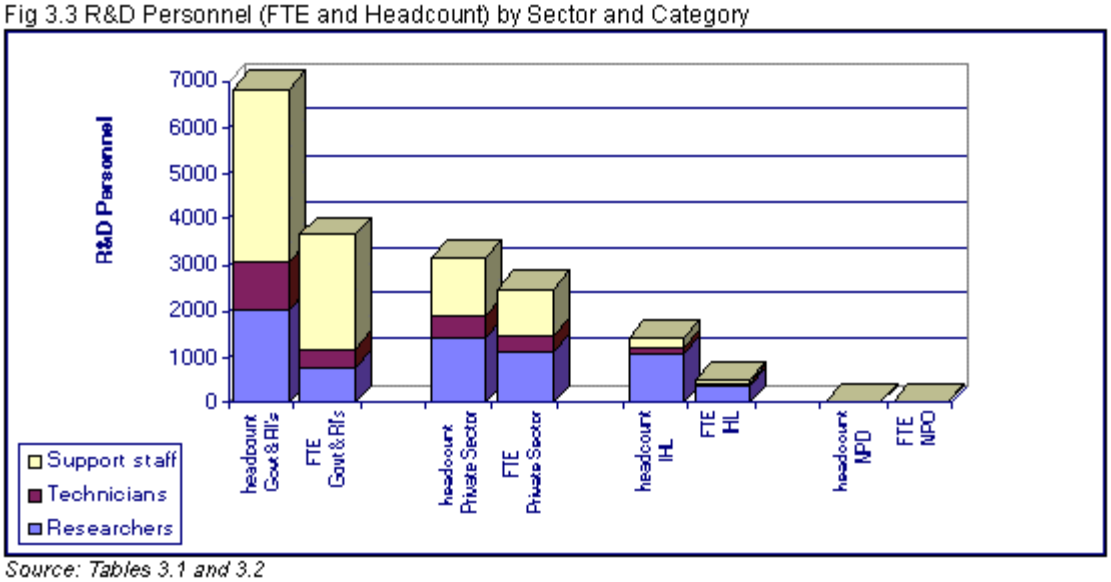

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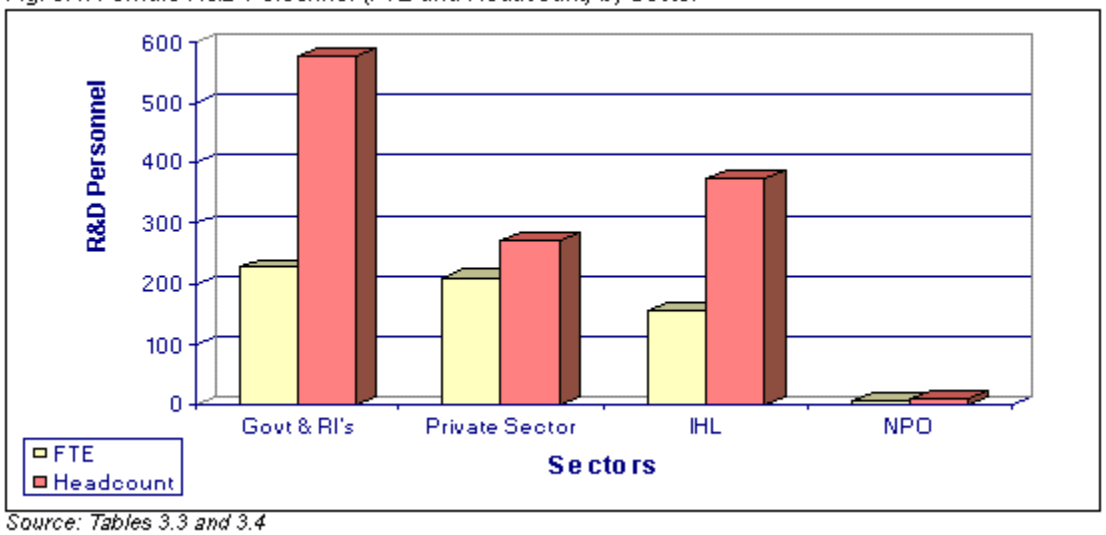
Table 3.2 R & D Personnel (Headcount) by Category and Nationality

Sector	Researchers		Technicians		Others		Total		Grand Total	% of Total
	Malaysians	Foreigners	Malaysians	Foreigners	Malaysians	Foreigners	Malaysians	Foreigners		
Government & RI's	1,985	35	1,046	1	3,783	-	6,814	36	6,850	59.7
Private Sector	1,339	77	477	3	1,262	6	3,078	86	3,164	27.6
Inst. Of Higher Learning	1,024	51	138	-	204	-	1,366	51	1,417	12.4
Non-Profit Organisation	31	3	1	-	6	-	38	3	41	0.4
Total	**4,379**	**166**	**1,662**	**4**	**5,255**	**6**	**11,296**	**176**	**11,472**	**100.0**

Discrepancies between FTE and headcount figures varied between sectors. The higher education sector for example demonstrated a very wide difference compared to others. This may reflect the fact that academicians has to perform other tasks (such as teaching) in addition to R&D activities.

Female personnel contributed 25% of total R&D effort (FTE), compared from 30% in 1992. However, as in 1992, there were significant differences between sectors with the government research institutes employing the highest proportion of females in 'researcher' category and the non-profit organisations employing the least (see Fig. 3.4).
Fig. 3.4. Female R&D Personnel (FTE and Headcount) by Sector
Source : Table 3.3 and Table 3.4

Fig. 3.4. Female R&D Personnel (FTE and Headcount) by Sector



Source: Tables 3.3 and 3.4

Table 3.3 R&D Personnel (FTE) by Category and Gender

Sector	Researchers		Technicians		Others		Total	
	Male	Female	Male	Female	Male	Female	Male	Female
Government & RI's	541.1	226.9	296.8	114.7	1,979.6	501.4	2,817.5	843.0
Private Sector	906.9	209.8	279.0	68.5	669.9	366.1	1,855.7	644.3
Inst. Of Higher Learning	228.8	154.4	36.9	14.4	33.8	23.9	299.4	192.6
Non-Profit Organisation	12.4	6.4	-	1.0	0.3	3.0	12.7	10.4
Total	**1,689.1**	**597.5**	**612.7**	**198.5**	**2,683.6**	**894.3**	**4,985.3**	**1,690.3**

Table 3.4 R&D Personnel (Headcount) by Category and Gender

Sector	Researchers		Technicians		Others		Total	
	Male	Female	Male	Female	Male	Female	Male	Female
Government & RI's	1,443	577	720	327	2,998	785	5,161	1,689
Private Sector	1,145	271	396	84	817	451	2,358	806
Inst. Of Higher Learning	700	375	108	30	130	74	938	479
Non-Profit Organisation	24	10	-	1	1	5	25	16
Total	**3,312**	**1,233**	**1,224**	**442**	**3,946**	**1,315**	**8,482**	**2,990**

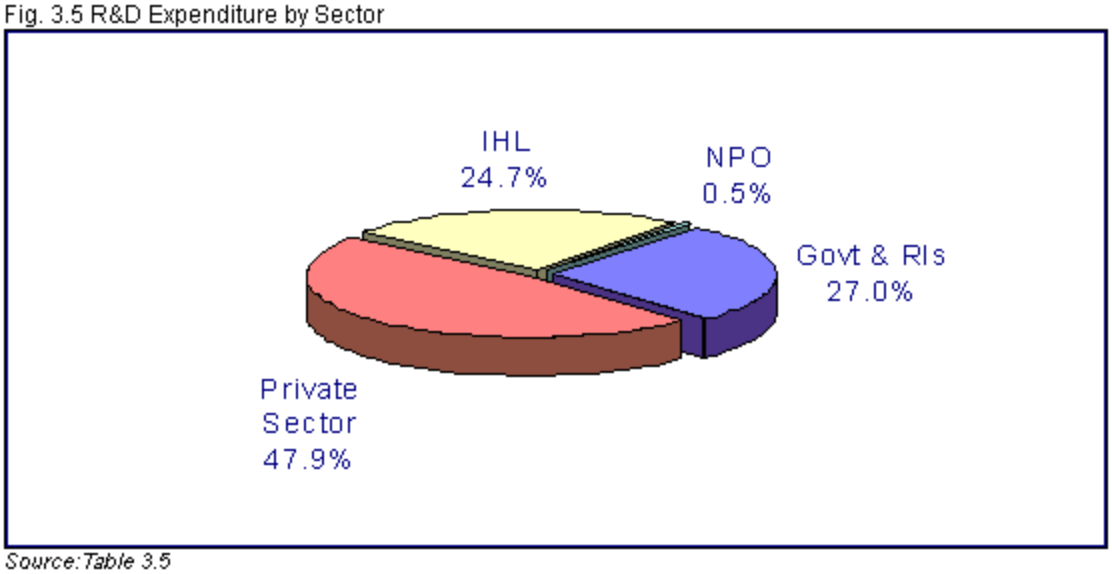
Figure 3.4 also show a similar scenario for female individuals (headcount). The efforts contributed by female personnel (FTE) as a percentage of headcount is only about 56.5%.

3.2 Financial Resources for R&D

The total reported expenditure on R&D in Malaysia increased from RM550, 699,237 in 1992 to RM611,226,464 in 1994. This represents an average annual growth of 5.5%. The to tal figure is a minimum for national R&D expenditure. As in 1992, there are reasons to believe that the expenditure for higher education institutions in particular was understated due to the imperfect research reporting systems practised by some universities plus there were no response from some large companies in the private sector.

The private sector accounted for 47.9% of total reported expenditure, followed by government research institutions (27.0%) and institutes of higher learning (24.7%). Non-profit organisations accounted for less than 1% of the total expenditure (see Fig. 3.5).
Fig. 3.5 R&D Expenditure by Sector
Source : Table 3.5

Fig. 3.5 R&D Expenditure by Sector



Source: Table 3.5

Table 3.5 R&D Expenditure (RM) by Type of Cost

Sector	Current Expenditure (RM)			Capital Expenditure (RM)			Total (RM)	% of Total
	Labour cost	Operating cost	Total	Land & Building	Machinery & Equipment	Total		
Government & RI's	85,646,370	47,997,513	133,643,883	5,173,974	26,035,154	31,209,129	164,853,011	27.0
Private Sector	105,905,590	86,557,125	192,462,715	19,053,327	81,067,339	100,120,666	292,583,381	47.9
Inst. Of Higher Learning	19,123,698	8,362,683	27,486,381	174,360	123,218,763	123,393,123	150,879,504	24.7
Non-Profit Organisation	1,599,139	1,139,079	2,738,218	-	172,350	172,350	2,910,568	0.5
Total	**212,274,797**	**144,056,400**	**356,331,197**	**24,401,661**	**230,493,606**	**254,895,267**	**611,226,464**	**100.0**

Capital items - 'land and buildings' and 'machinery and equipment' accounted for 40% of the national expenditure on R&D. The balance of 58.3% was for 'labour cost' and 'operating cost' (see Fig 3.6).
Fig. 3.6 R&D Expenditure by Type of Costs
Source : Table 3.5

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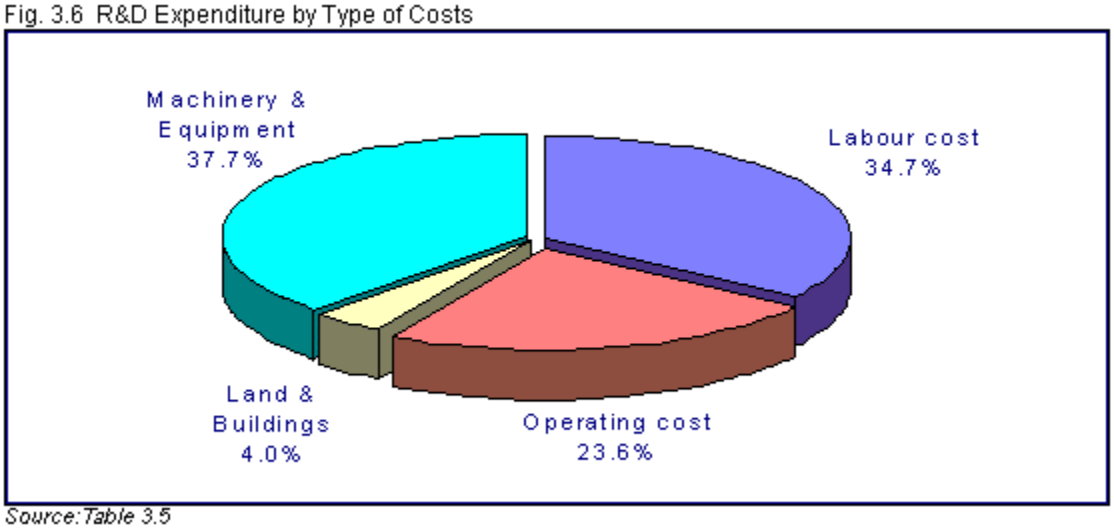

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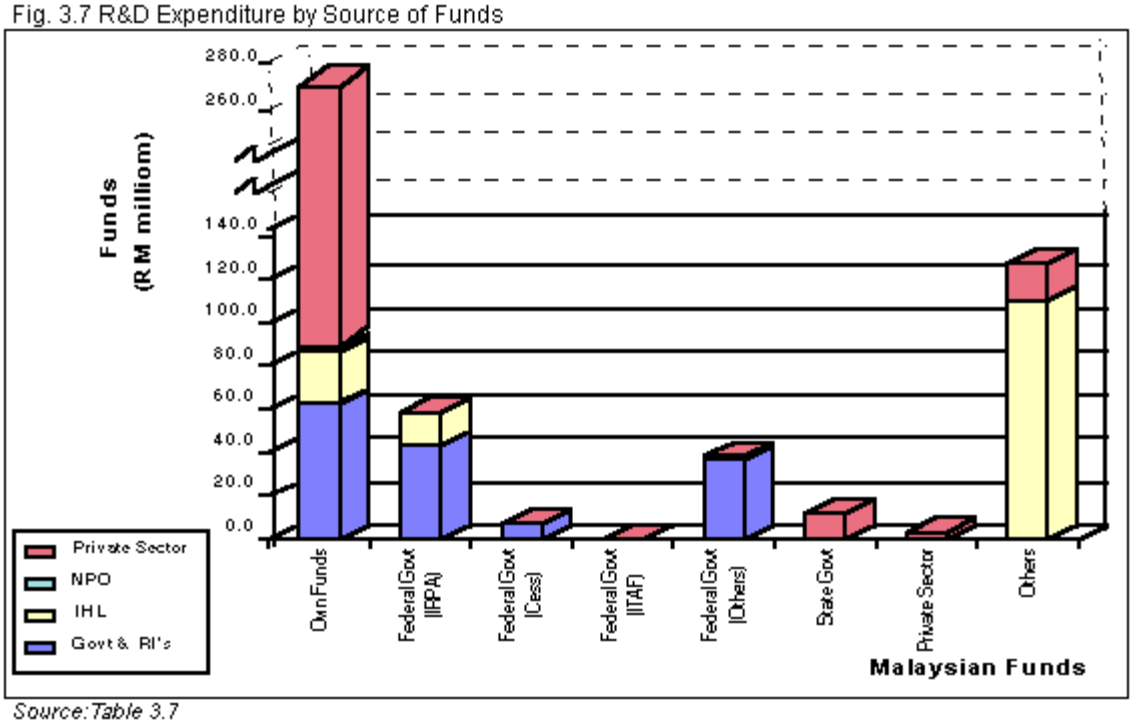
In terms of sources of funds, all the sectors, especially the private sector, were mainly using their own funds for R&D activities. This accounted for nearly 60% of the total funds used in 1994. (see Fig 3.7). 'Other Malaysian sources of fund' was another significant category. The Federal Government contributed only 17% of the total R&D funds. Foreign funds constitute less than 1% of the total amount. Fig. 3.7 R&D Expenditure by Source of Funds Source : Table 3.7

Fig. 3.7 R&D Expenditure by Source of Funds



Source: Table 3.7

Table 3.7 R&D Expenditure (RM) by Source of Funds

Sector	Malaysian Funds								Foreign Funds	Total
	Own Funds	Federal Government				State Government	Private Sector	Others		
		IRPA	Cess	ITAF	Other Federal Gov					
Government & RI's	62,911,025	43,131,522	7,631,118	-	37,434,454	12,085,250	-	194,080	1,465,562	164,853,011
Private Sector	268,779,533	-	-	135,000	-	120,000	3,435,650	16,857,658	3,255,540	292,583,381
Inst. Of Higher Learning	23,680,564	15,682,540	-	-	825,869	206,980	-	110,339,936	143,615	150,879,504
Non-Profit Organisation	2,081,696	-	-	-	100,000	-	-	-	728,872	2,910,568
Total	**357,452,818**	**58,814,062**	**7,631,118**	**135,000**	**38,360,323**	**12,412,230**	**3,435,650**	**127,391,674**	**5,593,589**	**611,226,464**

More than RM41 million worth of R&D activities were contracted out in 1994 (see table 3.8). The private sector contracted out 83% of their extramural R&D expenditures to overseas organisations.

Table 3.8 Extramural R&D Expenditure (RM)

Contracted from	Extramural R&D (RM) Contracted to :					Total
	Govt & RI's	Private Sector	Institute of Higher Learning	Other Malaysian Institutes	Foreign Institute overseas	
Government & RI's	34,500	517,732	919,479	-	10,394,400	11,866,111
Private Sector	300,731	2,222,887	1,949,276	369,300	24,544,000	29,386,194
Inst. Of Higher Learning	-	106,000	110,000	5,000	-	221,000
Non-Profit Organisation	38,000	106,000	200,000	9,400	-	353,400
Total	**373,231**	**2,952,619**	**3,178,755**	**383,700**	**34,938,400**	**41,826,705**

3.3 National R&D Focus and Priorities

The proportion of national R&D expenditure allocated to applied research increased significantly from 49% in 1992 to 63% in 1994. The shares of both experimental development and basic research were reduced from 38% and 13% respectively in 1992 to 30% and 7% in 1994. Different sectors emphasised different type of activities as shown by Fig. 3.8
Fig. 3.8: R&D Expenditure by Type of Activity
Source : Table 3.8

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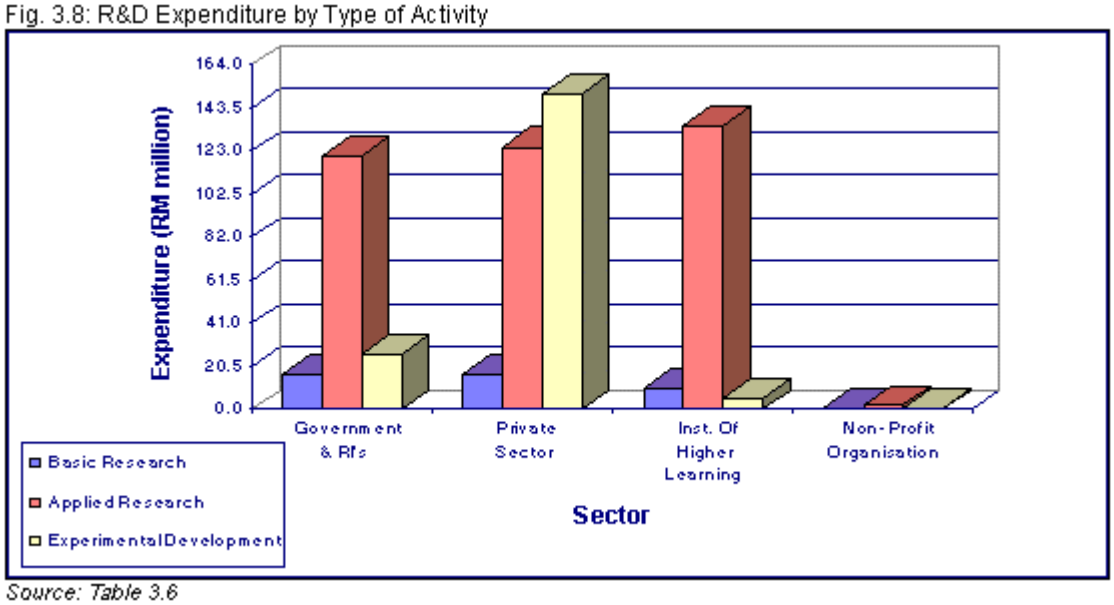

Source: Table 3.6

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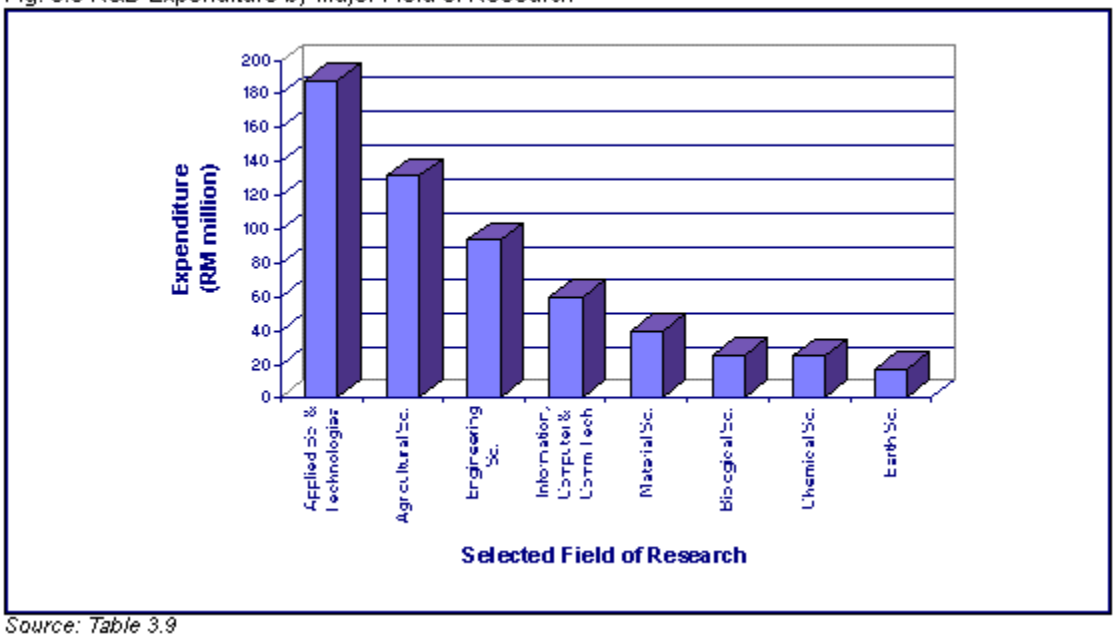
Total	**373,231**	**2,952,619**	**3,178,755**	**383,700**	**34,938,400**	**41,826,705**

In terms of fields of research (FOR), applied sciences and technologies emerged by far as the most important, contributing approximately 31% of total national R&D expenditure (see Fig. 3.9). Agricultural sciences and engineering sciences were the second and third most important fields accounting for 22% and 15% respectively. Social science and humanities together contributed approximately only 1% of the total.
Fig. 3.9 R&D Expenditure by Major Field of Research
Source : Table 3.9

Fig. 3.9 R&D Expenditure by Major Field of Research



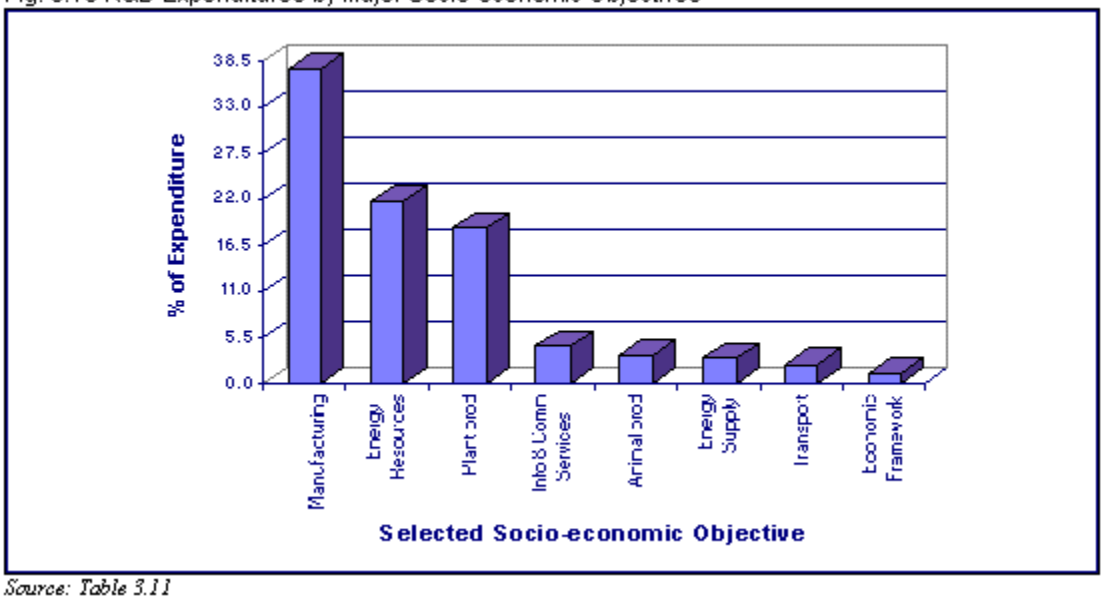
Source: Table 3.9

Table 3.9 Researchers (FTE) and R & D Expenditure by Field of Research (FOR)

FOR Code	Field of Research	Researchers(FTE)									Expenditure(RM)					
		Govt & RIs		Private Sector		IHL		NPO		Total	Labour Cost	Operating Cost	Land & Building	Machine & Equipment	Total	% of Total
		M'sians	Foreigners	M'sians	Foreigners	M'sians	Foreigners	M'sians	Foreigners							
F10100	Mathematical Sciences	2.8	-	-	-	0.2	0.1	-	-	3.1	170,613	31,374	1,400	23,910	227,896	0.0
F10200	Physical Sciences	4.3	0.4	10.0	0.8	24.6	0.2	-	-	40.2	1,467,462	1,616,553	30,750	1,196,148	4,370,913	0.7
F10300	Chemical Sciences	12.9	0.1	40.9	2.3	17.1	1.0	-	-	74.3	5,335,301	3,477,484	2,817,675	6,730,867	24,361,327	4.1
F10400	Earth Sciences	25.7	0.5	37.4	2.3	17.8	0.2	-	-	83.9	7,872,616	5,344,086	453,165	3,343,290	17,013,157	2.8
F10500	Information, Computer & Comm Tech	30.7	-	323.6	11.9	8.7	2.3	-	-	377.2	31,014,313	3,762,587	964,472	18,147,063	53,888,035	9.0
F10600	Applied Sciences & Technologies	64.8	0.6	176.0	13.1	28.0	7.1	2.1	2.5	294.3	26,477,906	15,747,232	5,832,445	140,430,783	188,548,367	30.8
F10700	Engineering Sciences	61.3	1.4	263.8	21.3	26.2	4.5	-	-	384.5	31,622,744	23,935,376	5,703,446	27,021,166	34,282,732	15.4
F10800	Biological Sciences	75.9	-	10.7	-	83.6	3.6	-	-	173.8	14,534,627	7,630,081	576,385	2,303,626	25,104,321	4.1
F10900	Agricultural Sciences	333.1	3.6	77.6	1.1	60.9	3.1	3.0	-	548.3	70,568,343	43,322,250	4,331,122	13,416,537	132,236,317	21.6
F11000	Medical & Health Sciences	36.1	0.6	5.5	0.3	23.0	0.5	-	-	72.0	4,393,007	3,045,540	167,177	2,570,377	10,776,101	1.8
F11100	Environmental Sciences	5.5	-	11.0	0.5	10.1	0.5	0.5	0.6	28.8	1,394,396	2,378,039	1,107,569	1,694,377	7,175,641	1.2
F11200	Material Sciences	18.3	0.1	34.7	4.6	20.6	4.8	-	-	143.0	11,842,401	12,685,764	2,220,858	13,390,077	40,139,100	6.6
F11300	Marine Sciences	-	-	-	-	0.8	-	-	-	0.8	55,278	33,460	1,000	5,600	95,339	0.0
F20100	Social Sciences	23.1	-	1.0	0.4	16.4	0.2	10.0	-	51.1	3,630,130	2,353,396	8,200	209,602	6,201,328	1.0
F20200	Humanities	0.1	-	-	-	5.0	-	-	-	5.1	93,055	31,316	-	9,520	134,491	0.0
	Total	754.7	13.3	1,058.1	58.6	365.0	28.2	15.7	3.1	2,286.6	212,274,737	144,056,339	24,401,662	230,433,607	611,226,465	100.0

In terms of overall socio-economic objectives, national expenditure figures indicated manufacturing to be the most important. However its overall share of total expenditure dropped from 53% in 1992 to 40% in 1994. The second most important objective was 'Energy Resources' (22.3%) followed by 'Plant Production and Primary Products'(18.8%) (See Fig. 3.10).
Fig. 3.10 R&D Expenditures by Major Socio-economic Objectives
Source : Table 3.11

Fig. 3.10 R&D Expenditures by Major Socio-economic Objectives



Source: Table 3.11

Table 3.11 R & D Expenditure (RM) by Socio-economic Objective (SEO)

SEO Code	Socio-economic Objective	Expenditure (RM)					% of Total
		Labour Cost	Operating Cost	Land & Building	Machinery & Equipment	Total	
	Defence:						
S10100	Defence	1,049,225	676,926	400,000	883,469	3,009,620	0.49
	Economic Development:						
S20100	Plant production & Primary products	62,991,805	38,639,143	2,835,452	10,634,795	115,101,196	18.83
S20200	Animal production & Primary products	8,360,129	10,065,144	1,270,481	1,834,707	21,530,461	3.52
S20300	Mineral Resources (excluding energy)	315,509	100,331	-	85,617	501,457	0.08
S20400	Energy Resources	8,324,885	5,054,480	1,400	122,806,880	136,187,645	22.28
S20500	Energy Supply	5,262,948	7,561,104	2,510,379	2,828,459	18,162,890	2.97
S20600	Manufacturing	75,457,557	63,422,323	12,925,893	72,525,602	224,331,374	36.70
S20700	Construction	590,980	159,359	-	108,609	858,948	0.14
S20800	Transport	1,653,457	2,595,050	1,061,679	8,826,543	14,136,730	2.31
S20900	Information & Communication Services	21,341,551	2,014,039	222,500	3,521,823	27,099,913	4.43
S21000	Commercial Service	1,246,142	1,789,916	1,037,480	590,369	4,663,906	0.76
S21100	Economic Framework	2,435,972	2,186,984	526,296	1,376,426	6,525,678	1.07
S21200	Natural Resources	3,671,644	883,282	226,606	536,616	5,318,148	0.87
	Society:						
S30100	Health	4,481,953	2,808,706	77,300	661,069	8,029,028	1.31
S30200	Education & Training	560,644	219,526	7,000	37,338	824,508	0.13
S30300	Social Development & Community Services	282,213	197,901	-	5,340	485,453	0.08
	Environment:						
S40100	Environmental Knowledge	2,575,722	419,966	109,553	304,479	3,409,720	0.56
S40200	Environmental Aspects of Development	5,511,852	1,925,979	1,039,224	667,812	9,144,867	1.50
S40300	Environmental Management & Other Aspects	2,202,951	1,136,381	112,846	1,315,129	4,767,308	0.78
	Advancement of Knowledge:						
S50100	Natural Sciences, Technologies & Engineering	3,087,687	1,783,472	35,893	874,657	5,781,709	0.95
S50200	Social Sciences and Humanities	869,970	416,389	1,680	67,867	1,355,905	0.22
	Total	**212,274,797**	**144,056,400**	**24,401,661**	**230,493,606**	**611,226,464**	**100.00**

The different sectors exhibited differing priorities as far as objectives were concerned. For example the government research institutions' researchers channelled more of their efforts to the objectives of Plant production and primary products (see Table 3.12). On the other hand, researchers from the private sector overwhelmingly focused more of their efforts on manufacturing. Manufacturing and plant production were the top two socio-economic objectives for the institutes of higher learning.

The fields of research (i.e. expertise) utilised by researchers in enhancing these objectives differed between sectors. Government investment in human resources were strongest in the fields of agricultural sciences with other contributions coming from the areas of biological sciences and applied sciences (see Table 3.9).

Table 3.9 Researchers (FTE) and R & D Expenditure by Field of Research (FOR)

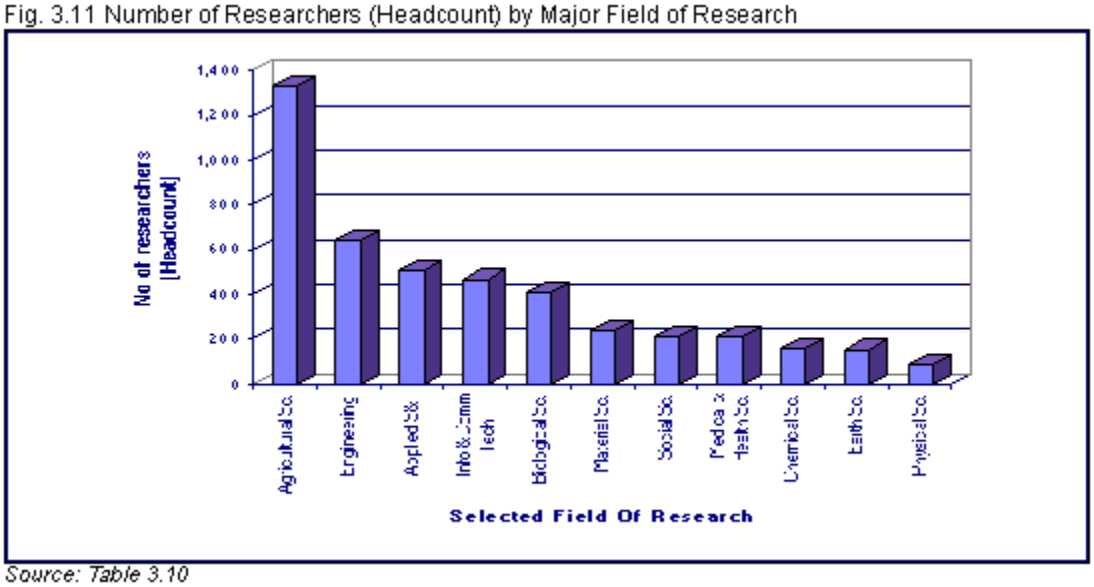
FOR Code	Field of Research	Researchers(FTE)								Total	Expenditure(RM)					
		Govt & Rls		Private Sector		IHL		NRO			Labour Cost	Operating Cost	Land & Building	Machine & Equipment	Total	% of Total
		M'sians	Foreigners	M'sians	Foreigners	M'sians	Foreigners	M'sians	Foreigners							
F10100	Mathematical Sciences	2.8	-	-	-	0.2	0.1	-	-	3.1	170,613	31,374	1,400	23,910	227,896	0.0
F10200	Physical Sciences	4.3	0.4	10.0	0.8	24.6	0.2	-	-	40.2	1,467,462	1,616,553	30,750	1,196,148	4,370,913	0.7
F10300	Chemical Sciences	12.9	0.1	40.9	2.3	17.1	1.0	-	-	74.3	5,935,901	3,477,484	2,817,675	6,730,867	24,961,927	4.1
F10400	Earth Sciences	25.7	0.5	37.4	2.3	17.8	0.2	-	-	83.9	7,872,616	5,344,086	453,165	3,343,290	17,013,157	2.8
F10500	Information, Computer & Comm Tech	30.7	-	32.6	11.9	8.7	2.3	-	-	77.2	31,014,913	3,762,587	964,472	18,147,063	53,889,035	8.8
F10600	Applied Sciences & Technologies	64.8	0.6	176.0	13.1	28.0	7.1	2.1	2.5	294.3	26,477,906	15,747,232	5,892,445	140,430,783	188,548,367	30.8
F10700	Engineering Sciences	61.3	1.4	26.8	21.3	26.2	4.5	-	-	384.5	31,622,744	29,335,376	5,703,446	27,021,166	94,282,732	15.4
F10800	Biological Sciences	75.9	-	10.7	-	83.6	3.6	-	-	173.8	14,534,827	7,630,081	576,385	2,303,628	25,104,921	4.1
F10900	Agricultural Sciences	333.1	3.6	77.6	1.1	60.9	3.1	3.0	-	548.3	70,568,949	43,322,250	4,391,122	13,416,597	132,236,917	21.6
F11000	Medical & Health Sciences	36.1	0.6	5.5	0.3	23.0	0.5	-	-	72.0	4,393,007	3,045,540	167,177	2,570,377	10,776,101	1.8
F11100	Environmental Sciences	5.5	-	11.0	0.5	10.1	0.5	0.5	0.6	28.8	1,394,396	2,378,089	1,107,569	1,684,977	7,175,641	1.2
F11200	Material Sciences	18.3	0.1	34.7	4.6	20.6	4.8	-	-	143.0	11,842,401	12,685,764	2,220,858	13,390,077	40,139,100	6.6
F11300	Marine Sciences	-	-	-	-	0.8	-	-	-	0.8	55,278	33,460	1,000	5,600	95,339	0.0
F20100	Social Sciences	23.1	-	1.0	0.4	16.4	0.2	10.0	-	51.1	3,630,130	2,353,396	8,200	209,602	6,201,328	1.0
F20200	Humanities	0.1	-	-	-	5.0	-	-	-	5.1	93,055	31,316	-	9,520	134,491	0.0
	Total	754.7	13.3	1,058.1	58.6	355.0	28.2	15.7	3.1	2,286.6	212,274,797	144,056,399	24,401,662	230,493,607	611,226,465	100.0

Researchers in institutes of higher learning focused relatively more of their efforts on biological sciences and agricultural sciences.

Researchers from the private sector on the other hand channelled more of their efforts into the fields of information, computers and communication technology. Engineering sciences and applied sciences were also important.

In terms of the actual number of researchers (headcount) as in Fig. 3.11, the largest was in the field of 'Agricultural Sciences'(30% of total researchers) followed by 'Engineering Sciences' (15%) and 'Applied Sciences and Technologies'(13%).
Fig. 3.11 Number of Researchers (Headcount) by Major Field of Research
Source : Table 3.10

Fig. 3.11 Number of Researchers (Headcount) by Major Field of Research



Source: Table 3.10

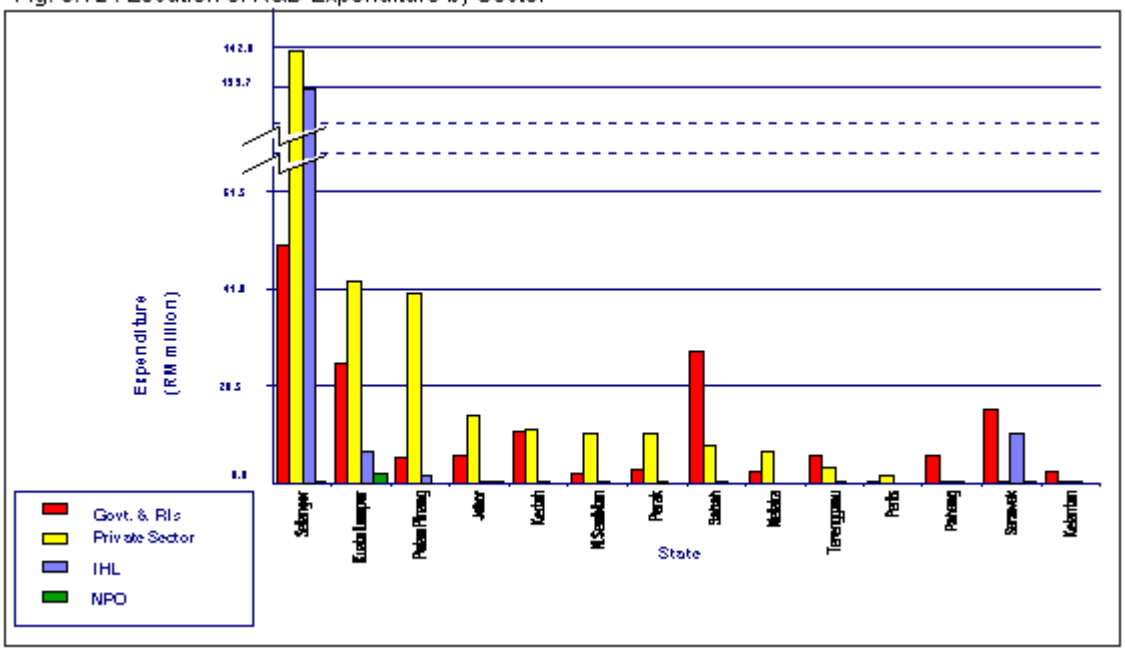
Table 3.10 Researchers (headcount) by Field of Research (FOR)

FOR Code	Field of Research	Malaysians					Foreigners					Grand Total
		Govt & RIs	Private Sector	IHL	NPO	Total	Govt & RIs	Private Sector	IHL	NPO	Total	
F10100	Mathematical Sciences	8.2	-	0.7	-	8.9	-	-	0.3	-	0.3	9
F10200	Physical Sciences	16.6	11.0	56.3	-	83.9	2.0	1.0	0.2	-	3.2	87
F10300	Chemical Sciences	31.9	68.0	58.7	-	158.5	1.0	4.0	1.3	-	6.3	165
F10400	Earth Sciences	52.3	51.0	44.5	-	147.8	2.9	3.0	0.2	-	6.1	154
F10500	Information, Computer & Comm Tech	49.0	348.0	49.7	-	446.6	-	15.0	6.7	-	21.7	468
F10600	Applied Sciences & Technologies	130.6	245.0	92.9	6.0	474.5	2.4	19.0	12.1	2.0	35.4	510
F10700	Engineering Sciences	184.0	339.0	85.6	-	608.5	1.8	25.0	8.0	-	34.8	643
F10800	Biological Sciences	188.4	14.0	201.1	-	403.5	-	-	6.0	-	6.0	409
F10900	Agricultural Sciences	1,101.0	88.0	111.8	5.0	1,305.8	21.8	1.0	5.5	-	28.3	1,334
F11000	Medical & Health Sciences	94.7	16.0	100.3	-	211.0	2.7	1.0	1.7	-	5.4	216
F11100	Environmental Sciences	12.3	24.0	29.6	1.0	66.9	-	1.0	2.3	1.0	4.3	71
F11200	Material Sciences	46.1	134.0	47.2	-	227.3	0.4	6.0	4.8	-	11.2	239
F11300	Marine Sciences	-	-	5.0	-	5.0	-	-	-	-	-	5
F20100	Social Sciences	69.7	1.0	123.6	19.0	213.3	-	1.0	2.0	-	3.0	216
F20200	Humanities	-	-	17.4	-	17.4	-		-	-	-	17
	Total	**1,985**	**1,339**	**1,024**	**31**	**4,379**	**35**	**77**	**51**	**3**	**166**	**4,545**

3.4 Location of R&D Activities

Fig. 3.12 reveals that R&D activities were concentrated in the state of Selangor. The state accounted for 54.8% of total R&D expenditure in 1994. Pulau Pinang which was the second most important location of R&D activities in 1992 dropped one place to third. Its place was taken up by Kuala Lumpur which accounted for 12.5% of total R&D expenditure.
Fig. 3.12 : Location of R&D Expenditure by Sector
Source : Table 3.14

Fig. 3.12 : Location of R&D Expenditure by Sector



Source: Table 3.14

Table 3.14 R&D Expenditure (RM) by Geographical Location

State	Govt. & RIs	Private Sector	IHL	NPO	Total	% of Total
Johor	5,869,443	14,047,341	144,400	280,000	20,341,184	3.33
Kedah	10,830,805	11,349,441	221,550	-	22,401,797	3.67
Kelantan	2,696,153	337,340	139,692	-	3,173,184	0.52
Melaka	2,568,343	6,589,205	18,804	-	9,176,352	1.50
Negeri Sembilan	1,871,224	10,660,011	131,834	-	12,663,069	2.07
Pahang	5,546,827	450,220	222,736	2,000	6,221,783	1.02
Perak	3,130,748	10,378,383	397,494	-	13,906,625	2.28
Perlis	559,495	1,693,019	5,504	-	2,258,017	0.37
Pulau Pinang	5,218,990	39,952,663	1,452,226	-	46,623,879	7.63
Selangor	52,260,152	142,828,559	139,700,787	179,200	334,969,088	54.80
Terengganu	5,587,068	3,273,440	292,406	-	9,152,914	1.50
Sabah	27,927,239	7,913,239	319,513	-	36,160,111	5.92
Sarawak	15,635,968	367,617	1,251,585	300,000	17,555,170	2.87
Kuala Lumpur	25,150,495	42,742,443	6,580,974	2,149,368	76,623,281	12.54
Total	164,853,011	292,583,381	150,879,504	2,910,568	611,226,464	100.00

3.5 Factors Limiting R&D Activities

A large variety of factors, both internal and external, were cited by respondents as limiting their organisations' R&D efforts. The most significant internal factor was 'Delays in making decisions'(9.5%). This was cited by more than 300 respondents from government research institutions, and 133 respondents from the higher education institutes, as compared to only 41 respondents from the private sector (see Fig. 3.13 and Table 3.15). The second most important factor was 'Lack of R&D management know-how', followed by 'Lack of demand for new products/ R&D strategy'.

Fig. 3.13 Overall Internal Factors Limiting R&D Activities *Source: Table 3.15*

Ranking	Factor
1	Delays in making decision
2	Lack of R&D management know-how
3	Lack of demand for new products / R&D strategy

Source : Table 3.15

However the external factor cited most frequently (11.5%) for all sectors was the 'Shortage of R&D personnel' (see Fig. 3.14 and Table 3.16). This was followed by 'Fast technology advancement' (9.1%) and 'Increasing labour cost'(8.6%).

Fig. 3.14 Overall External Factors Limiting R&D Activities *Source: Table 3.16*

Ranking	Factor
1	Shortage of R&D personnel s with requisite expertise
2	Fast technology advancement
3	Increasing labour cost

Source : Table 3.16

Table 3.16 External Factors Limiting R & D Cited by Respondents

	External Factors	Govt. & RIs	Private Sector	IHL	NPO	Total	% of total
a.	Fast technology advancement	359	90	109	1	558	9.1
b.	Changing consumer needs	329	74	57	1	460	7.5
c.	Shortening product life cycle	105	52	25	0	182	3.0
d.	Increasing competition	216	91	58	0	365	6.0
e.	Increasing labour cost	319	88	118	2	525	8.6
f.	Too many government regulations	265	43	109	1	417	6.8
g.	Lack of government incentives	278	63	129	2	470	7.7
h.	Increasing capital costs	296	83	130	1	509	8.3
i.	Shortage of risk capital	101	39	82	1	222	3.6
j.	Lack of competent suppliers	188	57	120	2	365	6.0
k.	Shortage of R & D personnels with requisite expertise	426	106	171	2	703	11.5
l.	Shortage of other personnels	306	60	112	2	478	7.8
m.	Lack of consultancy services	172	44	61	2	277	4.5
n.	Poor physical infrastructural support	264	30	125	2	419	6.9
o.	Patents hard to apply	85	18	60	1	163	2.7
	Total	**3,709**	**938**	**1,466**	**20**	**6,113**	**100.0**

'Increasing competition' was the second important factor by the private sector. However, the government research institutions nominated 'Fast technology advancement' as their second important factor. This is not surprising considering the different priorities and goals that exist between sectors.

3.6 Patents and Utility Innovation

In 1994, Malaysia received 3,587 applications for patents and utility innovations and granted a total of 105 (see Tables 3.22 and 3.23). The biggest number of applications came from the United States (34%), Japan (19%), and the U.Kingdom (9%). In terms of autosufficiency ratio for applications (Residents/Total) the figure for the country was 6.2% which is quite low compared with other Asean countries. For example the figure for Indonesia in 1992 was 14.6%, for Philippines in 1992 was 38.9% and for Thailand in 1992 was 11.7%. (see Table 3.24). Nevertheless, it is worth noting that the rapid pace of technological change (especially in electronics and information technology sector) is gradually reducing the importance of patents as an indicator of national R&D capabilities.

Table 3.22 Patent and Utility Innovation Applications by Country

No.	Country	1992	1994	No.	Country	1992	1994
				30	Malta	-	-
1	Australia	76	129	31	Mexico	-	2
2	Austria	5	5	32	Monaco	-	1
3	Argentina	-	1	33	Netherlands	73	84
4	Bahamas	-	1	34	Net. Antilles	-	1
5	Barbados	-	-	35	New Zealand	8	19
6	Belgium	20	45	36	Norway	15	5
7	Bermuda	-	1	37	Pakistan	-	-
8	Brazil	1	3	38	Panama	-	-
9	Canada	31	24	39	Philippines	1	-
10	Chile	-	1	40	Poland	-	2
11	China	-	3	41	Portugal	-	-
12	Cyprus	-	2	42	R.O. Domica	-	-
13	Denmark	6	9	43	R.O. Korea	40	50
14	Finland	2	17	44	Russia	-	1
15	France	81	98	45	Singapore	6	10
16	Germany	126	192	46	Soviet Union	-	1
17	Greece	1	-	47	Spain	7	8
18	Hong Kong	6	6	48	Sri Lanka	1	-
19	Hungary	7	4	49	Sweden	25	75
20	India	1	5	50	Switzerland	73	76
21	Indonesia	3	2	51	South Africa	-	17
22	Italy	27	41	52	Taiwan	95	148
23	Ireland	-	15	53	Thailand	1	1
24	Japan	301	682	54	U. Kingdom	215	334
25	Jordan	1	-	55	United States	992	1,234
26	Liberia	-	-	56	Ukraine	4	-
27	Liechtenstein	-	1	57	Venezuela	1	-
28	Luxembourg	-	1	58	Vanuatu	-	1
29	**Malaysia**	**151**	**223**	59	Others	7	6
					Total	**2,410**	**3,587**

Table 3.23 Patent and Utility Innovation Granted by Country

No.	Country	1992	1994
1	Australia	57	40
2	Austria	5	3
3	Belgium	8	14
4	Bermuda	-	-
5	Canada	12	15
6	China		2
7	Denmark	21	6
8	Finland	1	3
9	France	29	54
10	Germany	58	83
11	HongKong	1	4
12	Hungary	2	2
13	India	4	1
14	Italy	12	33
15	Japan	202	348
16	R.O. Korea	4	48
17	Liecittenstein	-	-
18	Luxemburg	-	-
19	**Malaysia**	**10**	**21**
20	Mexico	1	3
21	Netherlands	24	48
22	Net. Antilles	1	7
23	New Zealand	6	6
24	Norway	4	9
25	Panama	2	-
26	Russia	-	4
27	Singapore	10	4
28	Sout Africa	-	-
29	Spain	-	3
30	Sweden	23	19
31	Switzerland	36	39
32	Taiwan	6	26
33	Thailand	2	-
34	U. Kingdom	133	147
35	United States	459	637
36	Liberia	1	-
	Total	**1,134**	**1,629**

Table 3.24 National Patent Applications - ASEAN Countries

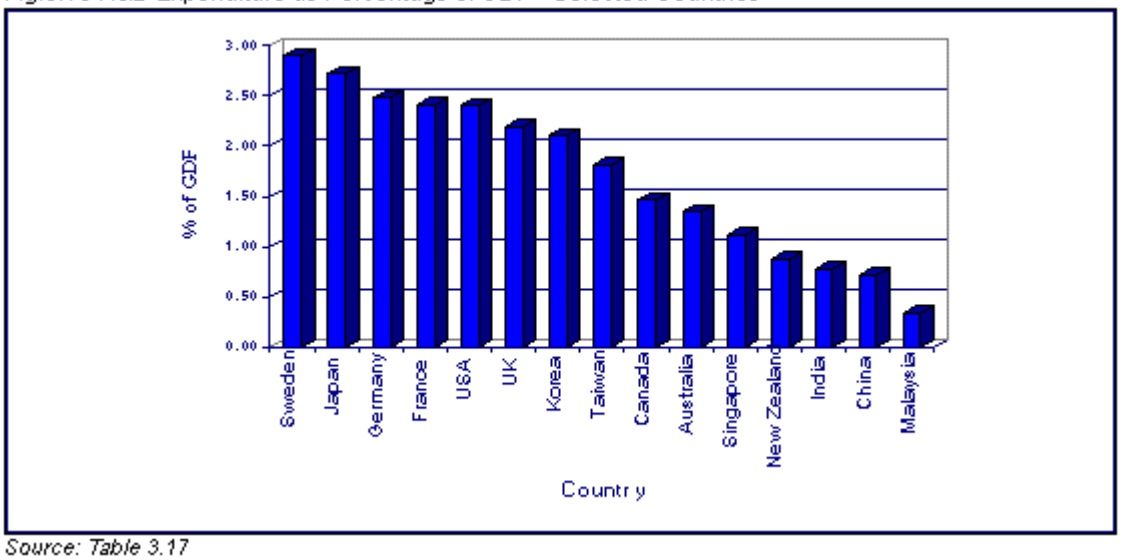
	Indonesia	Malaysia	Philippines	Singapore	Thailand
National patent applications - total	774	3587	3050	n.a.	2921
Resident patent applications - total	113	223	1186	n.a.	342
Non-resident patent applications	661	3364	1864	n.a.	2579
Autosufficiency ratio (Res/Total)	14.60%	6.22%	38.89%	n.a.	11.71%

Source:
"ASEAN Science & Technology Indicators for year 1992" report

3.7 International Comparisons

Total R&D expenditure for Malaysia was RM 611.2 million in 1994. This accounted for only 0.34 % of the country's GDP in that year. Compared to international standards this is quite low where for example Taiwan achieved 1.82%, Singapore 1.12% and South Korea 2.33% (see Fig. 3.15). To put the figure into perspective it is worth noting that SONY corporation alone spent RM3.675 billion (US$1.5 billion) in 1992.
Fig.3.15 R&D Expenditure as Percentage of GDP - Selected Countries
Source : Table 3.17

Fig.3.15 R&D Expenditure as Percentage of GDP - Selected Countries



Source: Table 3.17

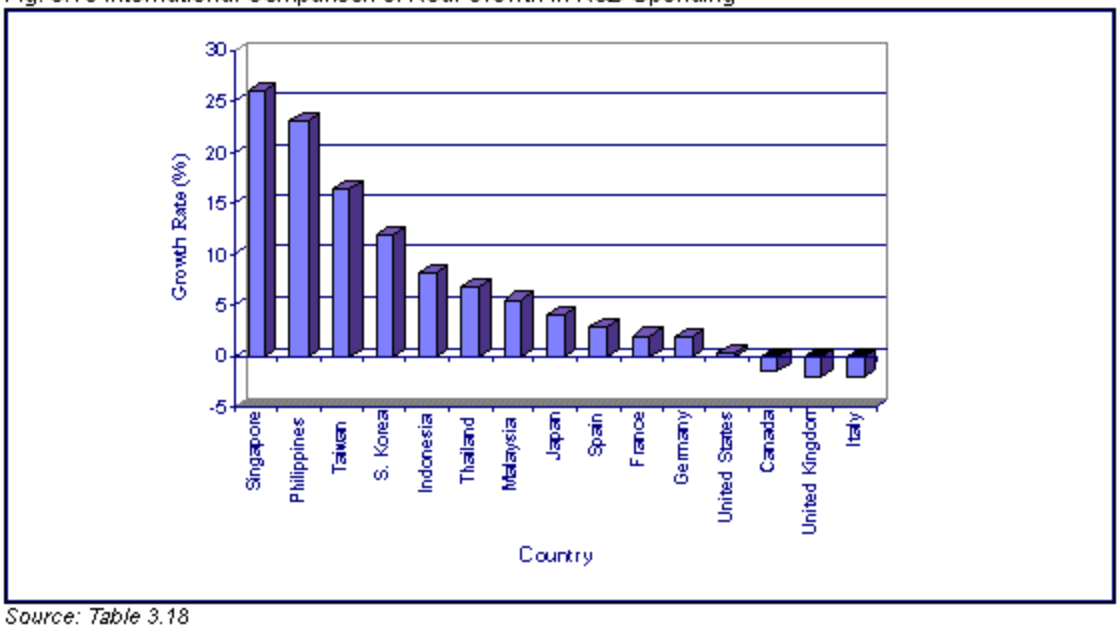
Table 3.17 International Comparison of R&D Expenditure as a Percentage of GDP

No.	Country	Year	%of GDP
1	Sweden	1991	2.90
2	Switzerland	1989	2.89
3	Japan	1993	2.72
4	Germany	1993	2.48
5	France	1993	2.41
6	U. States	1995	2.40
7	U. Kingdom	1993	2.19
8	Korea	1993	2.10
9	Finland	1991	2.02
10	Netherlands	1991	1.91
11	Norway	1991	1.84
12	Taiwan	1994	1.82
13	Belgium	1990	1.69
14	Denmark	1991	1.69
15	Austria	1992	1.54
16	Canada	1994	1.47
17	Australia	1990	1.35
18	Italy	1994	1.21
19	Ireland	1992	1.08
20	Singapore	1994	1.12
21	New Zealand	1990	0.88
22	Spain	1991	0.86
23	India	1990	0.79
24	China	1990	0.72
25	**Malaysia**	**1994**	**0.34**

However Malaysia exhibited an impressive R&D expenditure growth compared to other countries as shown in Fig. 3.16. The annual growth rate of 5.5% was higher than any OECD country, including Japan. However, other ASEAN countries and East Asian NICs such as Taiwan and South Korea exhibited far greater growth in R&D expenditure.

Fig. 3.16 International Comparison of Real Growth in R&D Spending
Source : Table 3.18

Fig. 3.16 International Comparison of Real Growth in R&D Spending



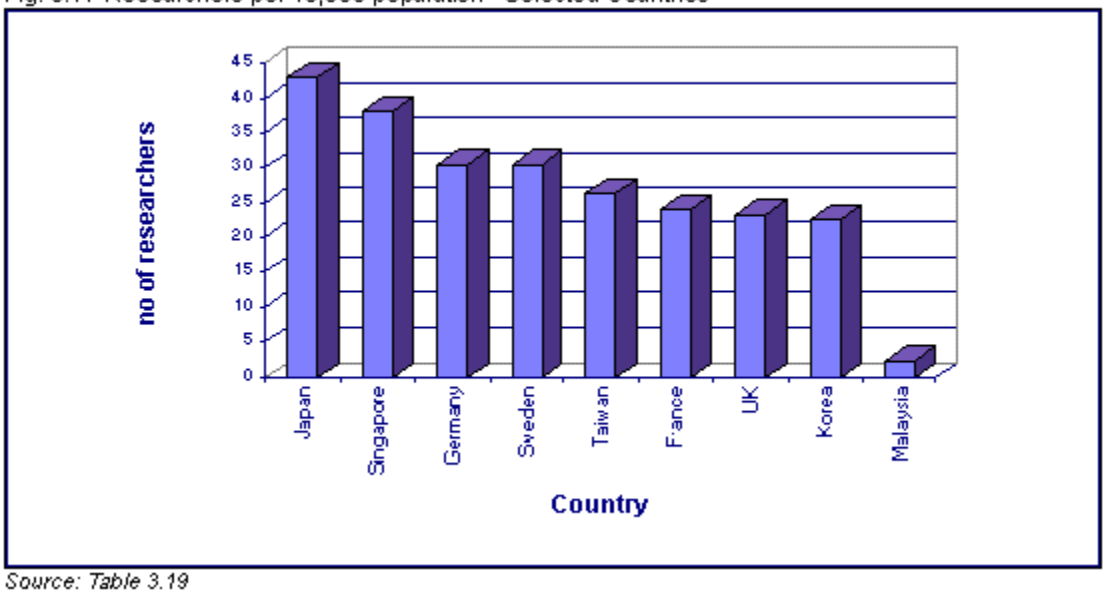
Source: Table 3.18

Table 3.18 Real Growth in R&D Spending (Annual Average 1989-93)

No.	Country	Growth rate (%)
1	Singapore (1988-92)	26.0
2	Philippines (1998-92)	23.1
3	Taiwan	16.5
4	S. Korea	12
5	Indonesia (1988-92)	8.2
6	Thailand (1988-92)	6.8
7	Malaysia (1992 - 94)	5.5
8	Japan	4.0
9	Spain	3.0
10	France	2.0
11	Germany	1.8
12	United States	0.3
13	Canada	-1.5
14	United Kingdom	-2.0
15	Italy	-2.1

In terms of the human resource efforts in R&D in 1994, Malaysia was also unimpressive by international standards. In terms of headcounts or persons, there were only 2.3 researchers (Headcount) per 10,000 population (Table 3.17). This is very low when compared to other NICs such as Taiwan, Singapore and Korea. For example, in 1993 Korea had 22 researchers (Headcount) per 10,000 population whilst Taiwan had 26 researchers (Headcount) per 10,000 population in 1994. Moreover Singapore had 37.9 researchers per 10,000 population (headcount) in 1992 (see Fig.3.17).
Fig. 3.17 Researchers per 10,000 population - Selected Countries
Source : Table 3.19

Fig. 3.17 Researchers per 10,000 population - Selected Countries



Source: Table 3.19

Table 3.19 Number of Researchers per 10,000 Population (Headcount)

No.	Country	Year	Number
1	Japan	1993	43
2	Germany	1991	31
3	Sweden	1991	30
4	Taiwan	1993	26
5	France	1992	24
6	U. Kingdom	1992	23
7	Korea	1993	22
8	Singapore	1992	38
9	Malaysia	1994	2.3

Sources :
a. "Indicators of Science and Technology" report dated 1995, Republic Of China
b. MASTIC

In terms of person year of effort (FTE), there were only 1.2 researchers (FTE) per 10,000 population (Table 3.20) and 2.9 person years (FTE) per 10,000 labour force (Table 3.21).