

CHAPTER 6 - INSTITUTES OF HIGHER LEARNING R&D ACTIVITIES

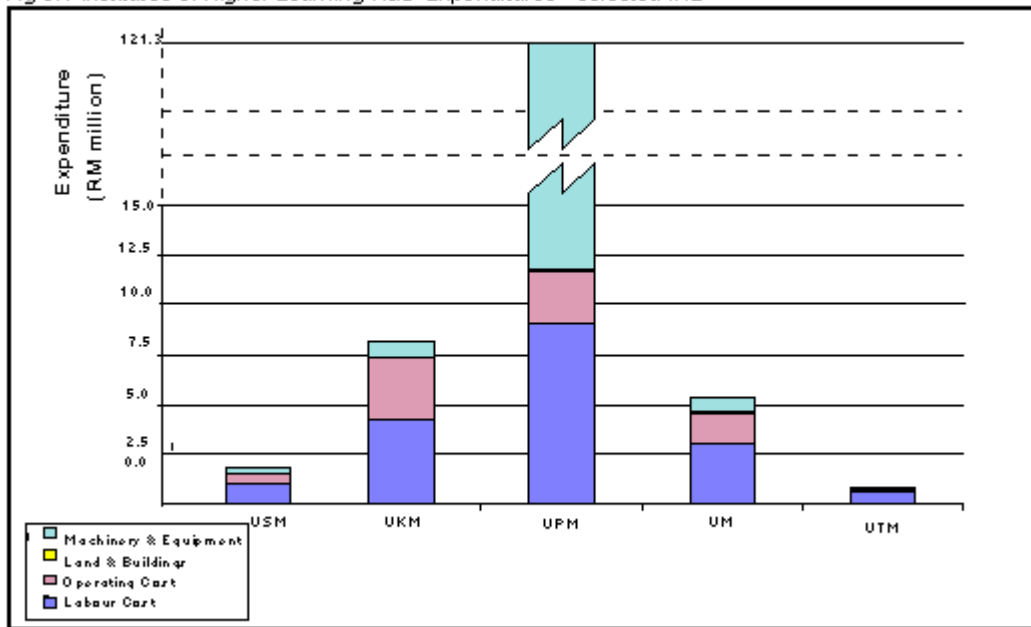
6.1 Structure of Sector

Malaysia's institutes of higher learning also play a significant role in the area of R&D. Apart from helping the organisations to fulfil their traditional role of the expansion of knowledge, R&D activities also serve to train future scientists, technicians and other research personnels.

6.2 R&D Expenditure by the Institutes of Higher Learning

Institutes of higher learning spent a total of RM150.9 million in 1994. This represents an increase of 197% from 1992. A breakdown by type of costs and institution is shown in Fig. 6.1. The biggest spender was UPM which accounted for 88% of total expenditures of Malaysian institutes of higher learning. The second biggest spender was UKM which accounted for 5.4%. Five institutions individually contributed less than 1% of the total expenditure. Fig 6.1 Institutes of Higher Learning R&D Expenditures - selected IHL
Source : Table 6.4

Fig 6.1 Institutes of Higher Learning R&D Expenditures - selected IHL



Source: Table 6.4

Table 6.4 Higher Education R & D Expenditure (RM) by Type of Cost

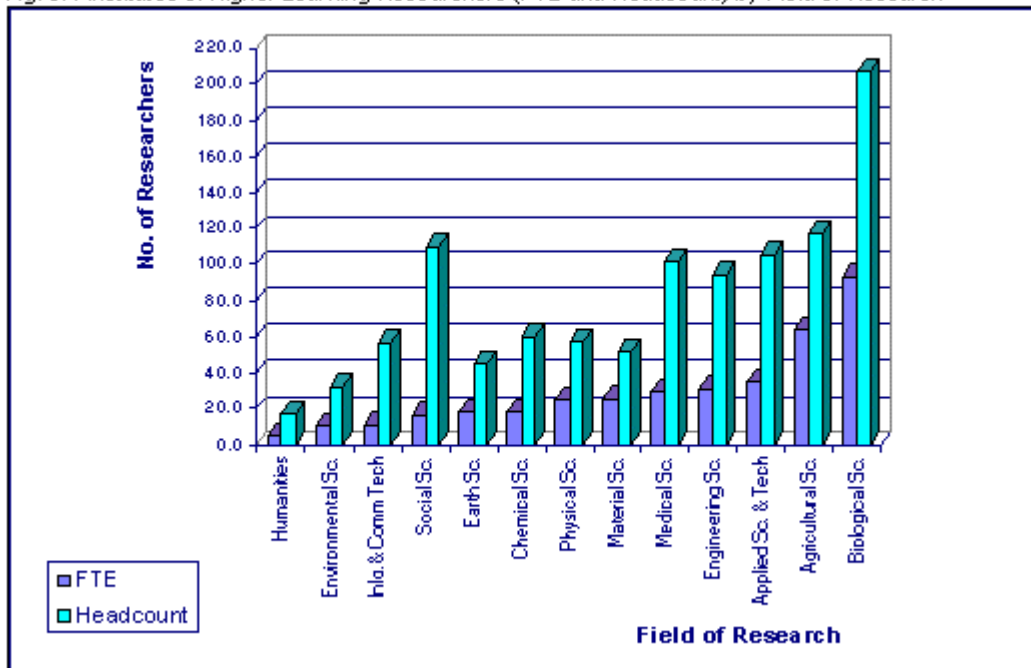
Institution	Current Expenditure (RM)		Capital Expenditure (RM)		Total	% of Total
	Labour Cost	Operating Cost	Land & Building	Machinery & Equipment		
UTM	698,215.28	50,590.00	33,000.00	41,180.00	822,975.28	0.55
UUM	93,935.84	104,431.66	-	-	198,367.50	0.13
USM	1,035,625.46	549,947.03	-	166,221.30	1,751,793.79	1.16
ITM	790,517.55	271,428.88	-	247,817.16	1,309,763.59	0.87
UIA	17,100.00	17,000.00	-	40,700.00	74,800.00	0.05
UKM	4,224,634.71	3,147,365.17	-	792,032.76	8,164,032.64	5.41
UPM	9,071,423.14	2,601,036.34	90,630.00	121,297,540.50	133,060,749.98	88.19
UNIMAS	170,217.86	17,962.14	-	-	188,180.00	0.12
UM	3,022,028.28	1,602,851.65	50,670.00	633,271.00	5,308,820.93	3.52
Total	19,123,698.12	8,362,682.87	174,360.00	123,218,762.72	150,879,503.71	100.00

The large differences between the reported expenditures between the universities point to a possible under-reporting of R&D activities to the survey at some of the institutions. This is not surprising since R&D activities at some universities are not completely planned and monitored centrally. Many researchers obtain R&D funding directly from outside sources and they fail to report their activities to university administrations. In addition, even if researchers were able to report expenditures from direct grants (e.g. from IRPA grant schemes), in some cases, salary costs, departmental and other overheads were not reported.

Machinery and equipment being part of the capital item, contributed 82% of the total R&D expenditures of institutes of higher learning (see Table 6.4). The bulk of the expenditure for this category was incurred at UPM (98%). The low percentage contribution of UTM, an engineering oriented institution, to total machinery and equipment expenditure (less than 1%) is probably one of the most surprising findings of this survey. A reason for this could be most of the capital items have already been in place well before 1994.

Overall, the higher education spent about RM18,700 per researcher on labour (see Table 6.15) and this is dominated by UPM with an expenditure of about RM27,000 per researcher, followed by UKM at RM19,800 and USM at RM 16,200.

Fig. 6.4 Institutes of Higher Learning Researchers (FTE and Headcount) by Field of Research



Source: Tables 6.9 and 6.10f

Table 6.15 Higher Education R & D Expenditure (RM) Per Researcher

Institution	No. of researchers	Types of Expenditure (RM)				Total Expenditure* (RM)	Cost per researcher (RM)	Labour Cost per researcher (RM)
		Labour Cost	Operating Cost	Land & Building	Machinery & Equipment			
UTM	51	688,215	50,580	33,000	41,180	783,375	15,490	13,690
UUM	51	33,336	104,432	-	-	138,368	3,890	1,842
USM	73	1,035,625	543,347	-	166,221	1,751,794	23,997	14,187
ITM	31	790,518	271,429	-	247,817	1,309,764	14,333	8,667
UIA	6	17,100	17,000	-	40,700	74,800	12,467	2,880
UKM	226	4,224,635	3,147,385	-	792,033	8,164,053	36,124	18,693
UPM	345	3,071,423	2,601,096	30,630	121,237,541	132,970,060	385,420	26,294
UNIMAS	16	170,218	17,362	-	-	188,180	11,761	10,639
UM	216	3,022,028	1,602,882	50,670	633,271	5,258,151	24,343	13,391
Total	1,075	13,123,698	8,362,683	174,360	123,218,763	150,705,144	140,191	17,789

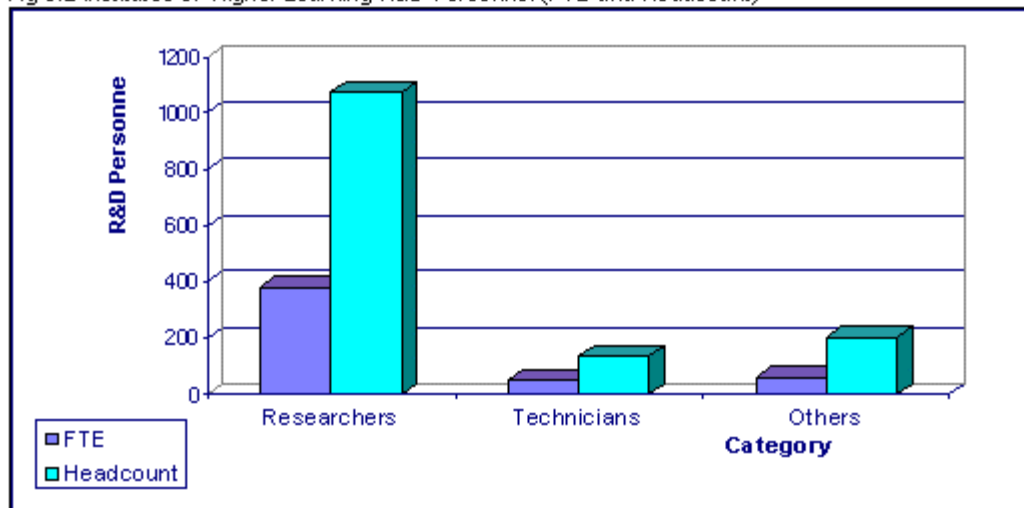
* Excluding land & building expenditure

6.3 Human Resources for R&D at the Institutes of Higher Learning

The total research efforts put in by the higher education in 1994 was 492 personnel (FTE): 383.1 researchers (FTE), 51.2 technicians (FTE) and 57.6 supporting staff (FTE). This total figure is a substantial decline from 519.2 in 1992 (see Fig 6.2).

Fig 6.2 Institutes of Higher Learning R&D Personnel (FTE and Headcount)
Source : Table 6.1 and Table 6.2

Fig 6.2 Institutes of Higher Learning R&D Personnel (FTE and Headcount)



Source: Tables 6.1 and 6.2

Table 6.1 Higher Education R & D Personnel (FTE) by Nationality and Category

Institution	Malaysians				Foreigners				Total
	Researchers	Technicians	Others	Total	Researchers	Technicians	Others	Total	
UTM	15.58	1.30	1.10	17.98	0.70	-	-	0.70	18.68
UUM	3.36	-	0.99	4.35	0.38	-	-	0.38	4.73
USM	20.70	7.20	10.30	38.20	3.95	-	-	3.95	42.15
ITM	5.98	1.80	2.30	10.08	0.08	-	-	0.08	10.16
UIA	0.45	0.05	-	0.50	2.00	-	-	2.00	2.50
UKM	76.70	11.92	8.00	96.62	9.25	-	-	9.25	105.87
UPM	159.23	19.33	23.22	201.77	6.50	-	-	6.50	208.27
UNIMAS	3.20	-	0.40	3.60	-	-	-	-	3.60
UM	69.78	9.66	11.34	90.77	5.28	-	-	5.28	96.05
Total	354.97	51.25	57.65	463.87	28.14	-	-	28.14	492.00

Table 6.2 Higher Education R&D Personnel (Headcount) by Nationality and Category

Institution	Malaysians			Foreigners			Total
	Researchers	Technicians	Others	Researchers	Technicians	Others	
UTM	48	7	8	3	-	-	66
UUM	48	-	12	3	-	-	63
USM	64	12	26	9	-	-	111
ITM	90	12	4	1	-	-	107
UIA	4	1	-	2	-	-	7
UKM	213	36	54	13	-	-	316
UPM	336	47	53	9	-	-	445
UNIMAS	16	-	4	-	-	-	20
UM	205	23	43	11	-	-	282
Total	1,024	138	204	51	-	-	1,417

As a proportion of R&D individuals (headcount), the efforts put in by researchers especially was only about 36%, a third of their official working hours; meaning that the bulk of 64% were for other activities including teaching and administration.

The female researchers contributed about 40% of the total higher education researcher's effort (see Table 6.3) with UPM dominating; UKM and UM both equally second ranking.

Also as a proportion of the country's total, researchers (FTE) from the higher education represent 17%, down from 32% in 1992.

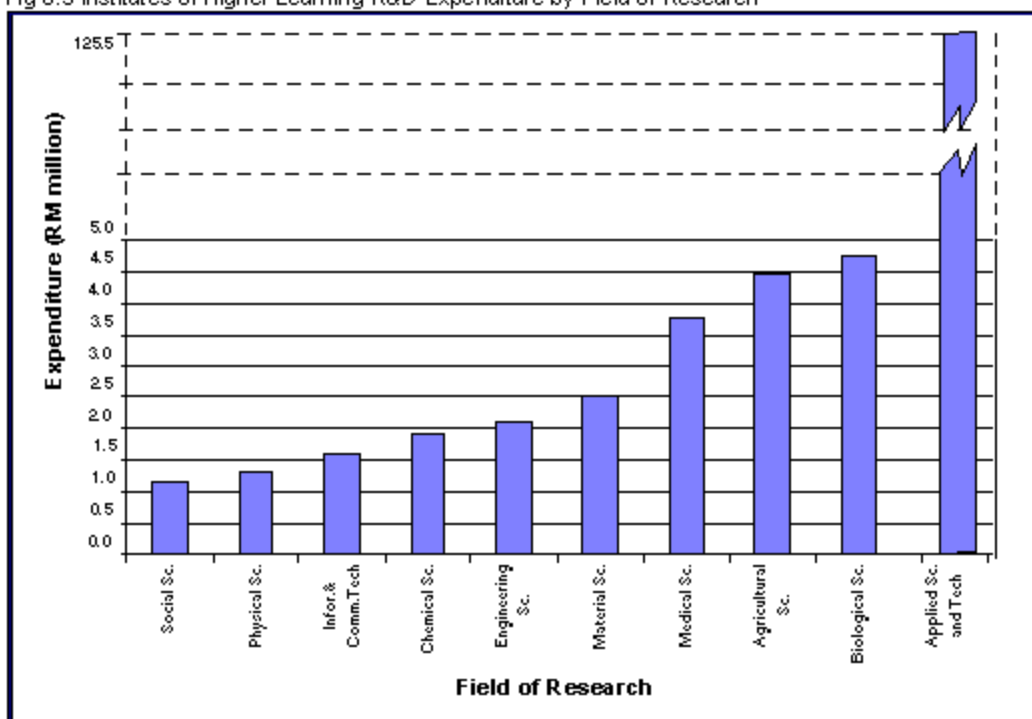
Table 6.3 Higher Education R & D Personnels (FTE & Headcount) by Category and Gender

Institution	FTE						Headcounts					
	Researchers		Technicians		Others		Researchers		Technicians		Others	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
UTM	12.45	3.83	1.30	-	0.05	1.05	41	10	7	-	2	6
UUM	2.34	1.40	-	-	0.67	0.32	38	13	-	-	8	4
USM	20.10	4.55	5.10	2.10	5.10	5.20	58	15	9	3	12	14
ITM	4.78	1.28	1.65	0.15	2.30	-	68	23	11	1	4	-
UIA	2.45	-	0.05	-	-	-	6	-	1	-	-	-
UKM	48.35	37.61	7.51	4.41	6.40	1.60	136	90	25	11	35	19
UPM	98.03	67.70	13.68	5.65	15.59	7.63	222	123	37	10	42	11
UNIMAS	2.45	0.75	-	-	0.40	-	13	3	-	-	4	-
UM	37.80	37.26	7.58	2.08	3.29	8.05	118	98	18	5	23	20
Total	228.74	154.37	36.86	14.39	33.80	23.85	700	375	108	30	130	74

6.4 Fields Of Research Conducted at the Institutes of Higher Learning

Institutes of higher learning in Malaysia spent the most amount of R&D money in the fields of Applied sciences and Technologies (83.2% of total institutes of higher learning research expenditure) followed by Biological sciences (3.2%) and Agricultural sciences (3.0%). (see Fig. 6.3).
 Fig 6.3 Institutes of Higher Learning R&D Expenditure by Field of Research
 Source : Table 6.11

Fig 6.3 Institutes of Higher Learning R&D Expenditure by Field of Research



Source: Table 6.11

The bulk of research expenditures in the above fields were spent at UPM. However the bulk of research expenditures on Environmental sciences and Material sciences were spent mostly at UKM. Social science and physical research expenditure on the other hand were mostly spent at UM (see Table 6.5).

Table 6.5 Higher Education R&D Expenditure (RM) by Institution and Socio-Economic Objective (SEO)

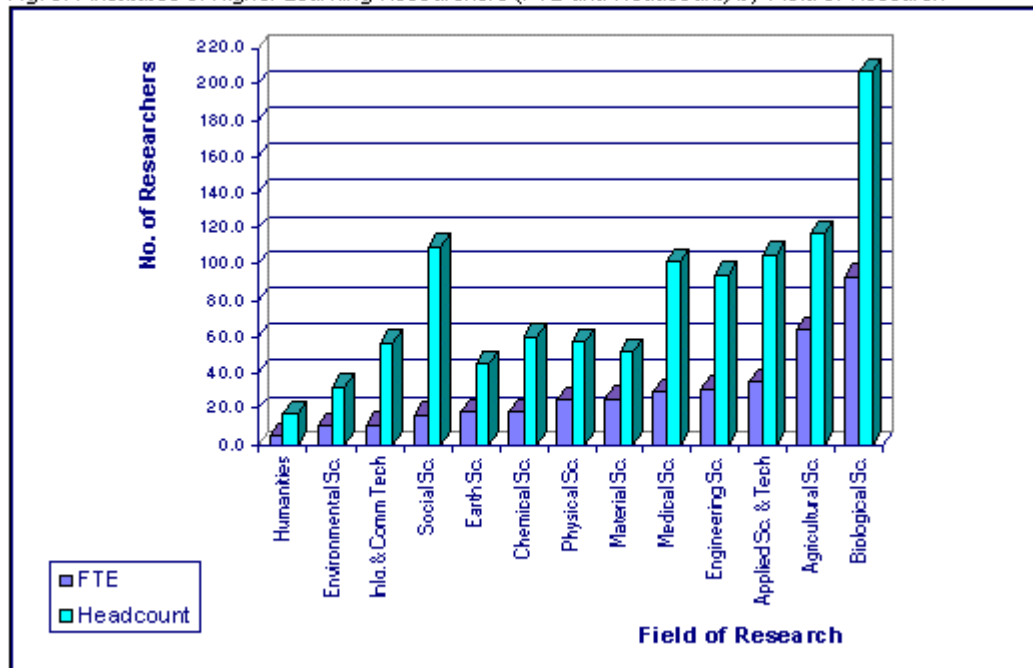
SEO Code	Socio-economic Objective	Institutes of Higher Learning									Total	% of Total
		UTM	UUM	USM	ITM	UIA	UKM	UPM	UNIMAS	UM		
S10100	Defence	43,000	-	-	-	2,420	165,086	-	-	-	210,506	0.1
S20100	Plant Prod. & Rank Primary Products	-	-	414,182	60,488	-	1,723,061	1,112,892	8,315	229,273	3,548,209	2.4
S30200	Animal Prod. & Animal Primary Products	-	-	154,240	-	-	-	1,838,748	17,337	43,750	2,054,075	1.4
S20300	Mineral Resources (excluding energy)	-	-	15,120	-	-	131,813	43,200	-	24,000	220,133	0.1
S20400	Energy Resources	63,000	-	10,050	-	18,810	102,860	123,848,000	-	-	124,043,720	82.2
S20500	Energy Supply	38,446	-	10,050	31,400	43,890	20,084	81,840	-	-	345,710	0.2
S20600	Manufacturing	189,665	10,123	408,781	335,435	3,680	3,487,383	2,087,061	-	1,141,892	7,730,679	5.1
S20700	Construction	2,600	-	-	45,638	-	1,400	-	24,565	40,000	115,263	0.1
S20800	Transport	2,265	-	-	-	-	63,389	57,250	-	-	122,904	0.1
S20900	Information & Comm Services	323,000	76,749	-	139,044	-	17,720	10,000	88,000	71,788	726,302	0.5
S21000	Commercial Services	-	11,650	3,462	-	-	128,520	160,220	-	101,000	410,892	0.3
S21100	Economic Framework	52,500	26,286	63,683	74,764	-	142,857	-	-	-	360,091	0.2
S21200	Natural Resources	-	-	24,600	84,615	-	3,000	160,332	30,359	100,000	409,505	0.3
S30100	Health	-	3,222	170,040	-	-	638,476	302,299	13,005	2,443,797	3,642,839	2.4
S30200	Education & Training	18,000	43,050	7,562	21,823	-	35,476	131,610	-	122,614	447,134	0.3
S30300	Social Development & Comm Services	-	3,977	-	45,397	-	12,400	27,857	-	373,518	470,749	0.3
S40100	Environmental Knowledge	22,500	1,053	114,430	35,433	-	329,430	1,000,488	-	26,582	1,529,315	1.0
S40200	Environmental Aspects of Development	-	-	17,300	33,714	-	54,094	82,658	-	61,352	258,718	0.2
S40300	Environmental Management	-	-	66,350	114,430	-	1,036,740	562,814	-	110,968	1,891,301	1.3
S50100	Natural Sciences, Technologies & Engineering	-	-	265,344	158,861	-	2,664	1,451,318	-	411,688	2,290,476	1.5
S50200	Social Sciences & Humanities	2,000	10,258	-	-	-	-	36,166	-	-	48,423	0.0
Total		822,375	136,368	1,751,794	1,303,764	74,800	8,164,053	133,060,750	188,180	5,308,821	150,873,504	100.0

In terms of total research efforts (FTE) by the researchers (see Fig 6.5), Biological sciences emerged as the most important field at institutes of higher learning (24%), followed by Agricultural sciences (17%) and Applied sciences and technology (9%) (Fig. 6.3).

Fig. 6.4 Institutes of Higher Learning Researchers (FTE and Headcount) by Field of Research

Source : Table 6.9

Fig. 6.4 Institutes of Higher Learning Researchers (FTE and Headcount) by Field of Research



Source: Tables 6.9 and 6.10f

Table 6.9 Higher Education Researchers (FTE) by Institution and Field of Research (FOR)

FOR Code	Field of Research	Institutes of Higher Learning										Total	% of Total
		UTM	UUM	USM	ITM	UIA	UKM	UPM	UNIMAS	UM			
F10100	Mathematical Sciences	-	-	-	-	-	0.16	0.06	-	0.11	0.32	0.08	
F10200	Physical Sciences	-	-	0.86	0.06	-	0.16	3.48	-	14.13	24.75	6.46	
F10300	Chemical Sciences	-	-	3.80	0.05	-	4.65	6.88	-	2.73	18.11	4.73	
F10400	Earth Sciences	-	-	1.35	-	-	3.32	11.38	-	0.78	17.38	4.63	
F10500	Info, Computer & Comm Tech	1.70	2.07	-	0.48	-	4.29	0.60	1.35	0.50	10.37	2.86	
F10600	Applied Sciences & Tech	5.77	-	1.10	1.23	1.67	4.85	3.26	-	11.26	35.13	9.17	
F10700	Engineering Sciences	7.61	-	0.48	1.36	0.74	12.04	5.86	0.68	1.38	30.74	8.02	
F10800	Biological Sciences	-	-	2.05	0.30	-	13.24	50.62	0.60	20.41	93.22	24.33	
F10900	Agricultural Sciences	-	-	3.63	0.20	-	4.73	48.68	-	6.63	63.38	16.70	
F11000	Medical & Health Sciences	-	-	2.34	-	-	11.38	5.36	-	3.84	29.52	7.71	
F11100	Environmental Sciences	-	-	1.84	-	0.05	3.12	4.10	-	1.48	10.58	2.76	
F11200	Material Science	0.08	-	6.18	0.08	-	10.34	8.28	-	0.42	25.38	6.63	
F11300	Marine Science	-	-	0.40	0.18	-	-	0.22	-	-	0.80	0.21	
F20100	Social Science	1.11	1.67	0.02	1.77	-	3.14	3.80	0.58	4.55	16.63	4.34	
F20200	Humanities	0.02	-	-	0.35	-	4.50	-	-	0.12	4.99	1.30	
Total		16.28	3.74	24.65	6.06	2.45	85.36	165.73	3.20	75.05	383.11	100.00	

Table 6.10 gives some indication of the relative R&D strengths of the major universities in Malaysia. UKM reflected to have the largest number of researchers (headcount) in the fields of Engineering, Chemical and Marine Sciences. UPM led others in a number of fields including Agricultural Sciences, Biological Sciences and Earth Sciences. UM had the largest number of researchers in the fields of Physical Sciences, Applied Science and Technology and Medical and Health Sciences. UUM however had the most researchers in the Information and Computers and Social Sciences.

Table 6.9 Higher Education Researchers (FTE) by Institution and Field of Research (FOR)

FOR Code	Field of Research	Institutes of Higher Learning									Total	% of Total
		UTM	UUM	USM	ITM	UIA	UKM	UPM	UNIMAS	UM		
F10100	Mathematical Sciences	-	-	-	-	-	0.16	0.06	-	0.11	0.32	0.08
F10200	Physical Sciences	-	-	0.86	0.06	-	0.16	3.48	-	14.19	24.75	6.46
F10300	Chemical Sciences	-	-	3.80	0.05	-	4.65	6.88	-	2.73	18.11	4.73
F10400	Earth Sciences	-	-	1.35	-	-	3.32	11.33	-	0.78	17.38	4.69
F10500	Info, Computer & Comm Tech	1.70	2.07	-	0.48	-	4.29	0.60	1.35	0.50	10.97	2.86
F10600	Applied Sciences & Tech	5.77	-	1.10	1.23	1.67	4.85	3.26	-	11.26	35.13	9.17
F10700	Engineering Sciences	7.61	-	0.48	1.36	0.74	12.04	5.86	0.68	1.38	30.74	8.02
F10800	Biological Sciences	-	-	2.05	0.30	-	13.24	50.62	0.60	20.41	33.22	24.33
F10900	Agricultural Sciences	-	-	3.63	0.20	-	4.79	48.68	-	6.69	63.38	16.70
F11000	Medical & Health Sciences	-	-	2.34	-	-	11.38	5.36	-	3.84	29.52	7.71
F11100	Environmental Sciences	-	-	1.84	-	0.05	3.12	4.10	-	1.48	10.58	2.76
F11200	Material Science	0.08	-	6.18	0.08	-	10.34	8.28	-	0.42	25.38	6.63
F11300	Marine Science	-	-	0.40	0.18	-	-	0.22	-	-	0.80	0.21
F20100	Social Science	1.11	1.67	0.02	1.77	-	3.14	3.80	0.58	4.55	16.63	4.34
F20200	Humanities	0.02	-	-	0.35	-	4.50	-	-	0.12	4.99	1.30
Total		16.28	3.74	24.65	6.06	2.45	85.35	165.73	3.20	75.05	383.11	100.00

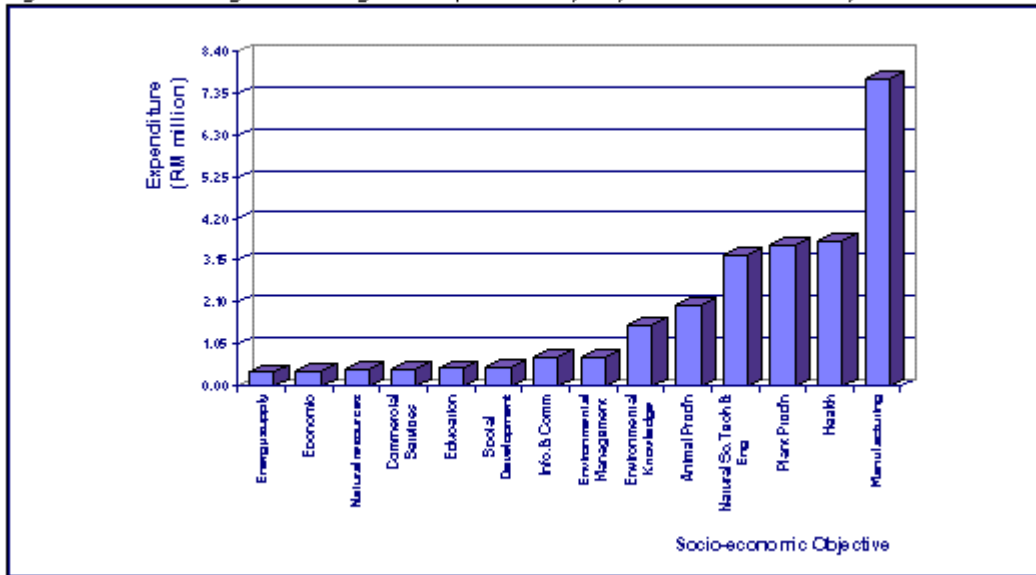
6.5 R&D Objectives of the Institutes of Higher Learning

In terms of socio-economic objectives, 83% of the expenditure went to research on Energy Resources with the bulk of it focusing on research on Non-conventional Energy Resources (see Fig 6.5). The next most important socio-economic objective was Manufacturing which constituted approximately only 5% of the expenditure followed by Health (2.4%). Research on Social Science and Humanities constituted less than 1% of the total expenditure by the higher education sector.

Fig. 6.5 Institutes of Higher Learning R&D Expenditure by Major Socio-Economic Objective

Source : Table 6.13

Fig. 6.5 Institutes of Higher Learning R&D Expenditure by Major Socio-Economic Objective

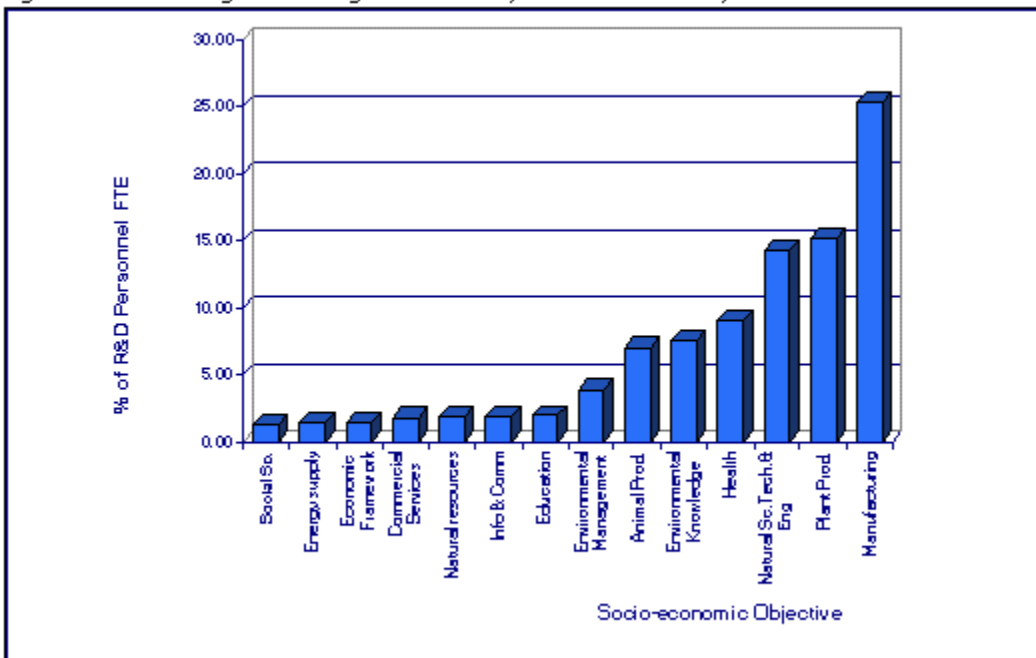


Source: Table 6.13

On the other hand, Manufacturing received the most research efforts (FTE), i.e. 25%, followed by Plant production and plant primary products(15%), (see Fig.6.6).

Fig 6.6 Institutes of Higher Learning R&D Efforts by Socio-Economic Objectives
Source : Table 6.13

Fig 6.6 Institutes of Higher Learning R&D Efforts by Socio-Economic Objectives



Source: Table 6.13

The researcher (FTE) figures in Table 6.7 gives some indication of the higher education research objectives and priorities in 1994. UPM, for example, dominated in performing research for the Manufacturing industry in addition to a number of area traditionally associated with it such as Agriculture and Natural Sciences. UM dominated its research for Health Sciences, Information and Computers as well as Social Development and Community Services. UTM on the other hand dominated its research for Energy Supply in 1994

6.6 Intensity of R&D in the Institutes of Higher Learning

Table 6.1 and 6.4 allow us to rank the higher learning institutes in terms of the amount of research activities conducted. The top three in terms of R&D expenditure are UPM, UKM and UM in that order. The ranking is also the same in terms of research effort (FTE). However this ranking must be treated with caution due to the fact that the universities differ from each other in many respects including academic orientations. Moreover some universities which achieved low rankings, in addition to being relatively young, place more emphasis on fields such as management or social sciences rather than on engineering and physical sciences where research expenditures and efforts are relatively large.

6.7 Factors Limiting R&D Activities in the Institutes of Higher Learning

Overall, the higher education sector nominated 'Delays in making decisions' as the top ranking internal factor (see Table 6.16). The top three factors nominated by the higher education institutions can be summarised as in Fig. 6.7.

Fig 6.7 Internal Factors Limiting R&D *Source: Table 6.16*

Ranking	Factor
1	Delays in making decisions
2	Lack of R&D management know-how
3	Lack of attention to new practices
3	Ineffective communication between function and department

Table 6.16 Internal Factors Limiting R & D by Institution in the Higher Education Sector

Institution	Internal Factors																Total
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	
UTM	7	6	7	8	10	10	5	8	3	2	6	1	9	10	6	2	100
UUM	6	9	9	5	7	10	10	8	6	5	6	8	8	8	5	4	114
USM	9	2	2	6	3	9	5	8	2	3	4	2	2	6	2	-	65
ITM	33	-	-	33	33	9	-	33	-	-	33	-	-	33	33	-	240
UIA	1	-	1	1	1	11	1	1	-	1	-	-	-	2	1	-	21
UKM	21	10	9	9	11	10	17	9	1	5	7	14	11	14	14	2	164
UPM	33	19	16	33	31	17	33	30	15	11	10	20	23	26	27	5	360
UNIMAS	3	1	2	1	3	9	3	3	2	2	1	1	6	7	2	1	47
UM	15	4	3	11	8	1	17	5	6	12	7	4	9	12	12	3	129
Total	133	51	49	107	107	86	91	105	35	41	74	50	74	118	102	17	1,240

- a. Delays in making decisions
- b. Emphasis on short-term gain/returns
- c. Inadequate market research
- d. Ineffective communication between function & dept.
- e. Lack of attention to new practices
- f. Lack of demand for new product R & D strategy
- g. Current organization structure
- h. Lack of measurement criteria
- i. Too much control by parent institution
- j. Excessive top management involvement in process detail
- k. Lack of commitment by top management
- l. Lack of proven analytical technique
- m. Lack of business skills with R & D organization
- n. Lack of R & D management know-how
- o. Lack of access to lead users/customers
- p. Difficult to interface with parent institution

The top three factors nominated by the higher education as external factors are summarised in Fig. 6.8.

Fig 6.8 External Factors Limiting R&D Source: Table 6.17

Ranking	Factor
1	Increasing capital cost
2	Lack of government incentives
3	Poor physical infrastructural support.

Table 6.17 External Factors Limiting R & D by Institution in the Higher Education Sector

Institution	External Factors															Total
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	
UTM	7	5	3	3	6	6	7	7	4	7	9	4	5	7	5	85
UUM	6	7	3	4	4	4	6	5	3	1	5	3	5	3	3	62
USM	9	3	2	3	6	12	9	10	1	11	13	13	3	10	1	106
ITM	-	-	-	-	33	33	33	33	33	33	32	-	1	33	32	236
UIA	1	1	-	1	1	1	1	1	1	2	1	2	-	1	-	14
UKM	23	13	10	11	15	12	18	18	7	16	33	23	12	19	5	235
UPM	38	19	3	25	37	27	35	42	26	32	46	34	25	33	7	430
UNIMAS	3	2	3	3	4	2	4	3	2	5	5	4	3	4	1	48
UM	21	7	1	8	12	12	16	11	5	13	27	29	7	15	6	190
Total	109	57	25	59	118	109	129	130	82	120	171	112	61	125	60	1,466

- a. Fast technology advancement
- b. Changing consumer needs
- c. Shortening product life cycle
- d. Increasing competition
- e. Increasing labour cost
- f. Too many government regulations
- g. Lack of government incentives
- h. Increasing capital costs
- i. Shortage of risk capital
- j. Lack of competent suppliers
- k. Shortage of R & D personnel with requisite expertise
- l. Shortage of other personnels
- m. Lack of consultancy services
- n. Poor physical infrastructural support
- o. Patents hard to apply