MOSTI

MINISTRY OF SCIENCE, TECHNOLOGY
& INNOVATION MALAYSIA

MALAYSIAN SCIENCE, TECHNOLOGY & INNOVATION (STI) INDICATORS REPORT 2013

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ISBN 978-983-41345-7-0

Malaysian Science, Technology and Innovation (STI) Indicators Report 2013

MALAYSIAN SCIENCE, TECHNOLOGY & INNOVATION (STI) INDICATORS REPORT 2013

MOSTI COMMERCIALISATION YEAR 2014

STI for Wealth Creation

Malaysian Science, Technology and Innovation (STI) Indicators Report 2013

Commissioned by:

Malaysian Science and Technology Information Centre (MASTIC)
Ministry Of Science, Technology and Innovation, Malaysia (MOSTI)

Published by:

Malaysian Science and Technology Information Centre (MASTIC),
Ministry of Science, Technology and Innovation (MOSTI),
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ACKNOWLEDGEMENTS

ACKNOWLEDGEMENTS

The Malaysian Science & Technology Information Centre (MASTIC) wishes to record its gratitude to all the individuals and organisations for their assistance and contribution toward the successful completion of the Malaysian Science, Technology and Innovation (STI) Indicators 2013 Report.

We would like to thank the Secretary General of the Ministry of Science, Technology and Innovation (MOSTI) for extending his invaluable guidance and unflinching support in the preparation of this report. We also wish to record our appreciation to all the members of the Technical Committee and also the data providers for their contributions, assistance, advice and suggestions.

Last but not least, I would like to thank to Prof. Dr. Ratnawati Mohd Asraf and her team members from IIUM Entrepreneurship & Consultancies Sdn. Bhd. as well as the MASTIC team, who were responsible for preparing the Malaysian Science, Technology and Innovation (STI) Indicators 2013 Report.

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CHAPTER 1

INTRODUCTION

1.0 PREAMBLE

Malaysia has been making efforts toward achieving its target of becoming a high-income and developed nation by 2020 through implementing measures that would enhance technological growth, productivity and efficiency in the economy. The innovation-led growth strategy via science, technology and innovation (STI) over the last 20 years has been marked, among others, by the establishment of the National Action Plan for Industrial Technology Development in 1990, the National Multimedia Plan in 1995, the Second National Science and Technology Policy in 2003, the National Biotechnology Policy in 2005, the National Innovation Model in 2007, the Green Technology Policy in 2009, and the Digital Transformation Program or Digital Malaysia in 2011.

The efforts continue with the National Transformation Policy (NTP) presented in the 2012 Budget that has, as one of its five focus areas, the objective of generating human capital excellence, creativity and innovation. In order to create a conducive ecosystem for the development of human capital with such qualities, the Budget introduced several strategic initiatives, which include the Total Innovation Movement, strengthening the education system, and human resource development.

Just as the Year 2010 was announced by the Government of Malaysia as the year of innovation and creativity, known as Innovative Malaysia 2010 to encourage creativity among the public, the year 2012 was earmarked as the Year of Science and National Innovation Movement. To encourage the development of new ideas and commercialisation of innovative products, the Malaysian Foundation for Innovation which was established in 2008, has selected 14 out of 260 products for incubation and commercialisation. The Government has also allocated RM30 million for the Market Validation Fund managed by the Malaysian Technology Development Corporation (MTDC) and the Malaysia Innovation Agency.In addition, the Shariah-compliant Commercialisation Innovative Fund was launched in May 2012 with an allocation of RM500 million (Economic Report, 2012-2013).

Of the three stages of development in economic theory, i.e., the factor driven, efficiency driven and innovation driven stages of development, the Global Competitiveness Report2012-13 places Malaysia in the Transition phase: from Stage 2 of efficiency driven to Stage 3 of innovation driven development. Hence, Malaysia's current emphasis on innovation is timely and necessary, as the country must be able to design and develop cutting-edge products and processes to maintain a competitive edge and move toward even higher value-added activities. This progression requires sufficient investment in research and development (R&D), the presence of high-quality scientific research institutions that can generate the basic knowledge needed to build the new technologies, extensive collaboration in research and technological developments between universities and industry, and the protection of intellectual property.

The 2012-2013 Global Competitiveness Index (GCI) has shown Malaysia's overall competitiveness ranking declining to the 25th from the 21st place in 2011-2012. Malaysia's technological readiness also declined from the 44th place in 2011-12 to 51st in 2012-2013. However, Malaysia improved on the innovation and sophistication factors from the 22nd in 2011-2012 to the 23rd place in 2012-2013. Considering the importance of science, technology and innovation in the country's growth and development, it is therefore necessary to periodically take stock of the trends in the progress of science, technology and innovation in Malaysia so as to ensure that the country is on track in its development path.

The *Malaysian Science, Technology and Innovation (STI) Indicators Report 2013* provides detailed information on the achievements and educational trends in the field of S&T, human resource for S&T, public support and awareness of S&T, R&D activities, innovation, balance of payments of technology, patents, bibliometrics, biotechnology, and information and communications technology (ICT). The Report has been carried out by MASTIC biennially since 1994, using data obtained from various government agencies, from studies commissioned by MASTIC and other agencies under MOSTI, as well as the Science & Engineering Indicators, the National Science Foundation (NSF), and the OECD S&T Indicators.

The compilation of comprehensive STI indicators in the Report can be used as a source of reference for academics and policy makers to chart the path for improvements of STI development in Malaysia, and for the assessment of the nation's achievement in STI. It also serves to determine the potential areas that could be advanced to enhance the development of STI in the nation.

1.1 HOW THE REPORT WAS PREPARED

The indicators presented in this report are based on surveys conducted by MASTIC and other MOSTI agencies as well as other secondary sources of data either published or obtained directly from various ministries and government agencies. Hence, the original sources should be referred to with regard to details on the methodology employed in generating the indices. The principal sources of information employed in this STI Indicators Report are shown in **Table 1.1**.

Table 1.1: Principal References Employed in Preparation of Malaysian Science, Technology and Innovation (STI) Indicators Report 2013

Chapter	Title	Principal Source of Information
2	Education in Science and Technology	• Ministry of Education, Malaysia (MOE) - Malaysian Examination Council (MPM) - Examinations Syndicate - Department of Higher Education
3	Research and Development (R&D) in Malaysia	• Malaysian Science, Technology and Innovation Centre (MASTIC) - National Survey of Research and Development 2012

4	Public Support for Research and Development (R&D) in Science, Technology and Innovation	• Malaysian Science, Technology and Innovation - National Survey of Research and Development 2012 - Funds Section, MOSTI • Various government agencies such as: - Small and Medium Enterprise Corporation Malaysia (SME Corp. Malaysia) - Malaysian Technology Development Corporation (MTDC) - Multimedia Development Corporation (MDeC) - Malaysian Communications and Multimedia Commission (MCMC) - Biotech Corp, MOSTI - Malaysian Life Sciences Capital Fund (MLSCF) - Inland Revenue Board Of Malaysia (LHDN) - Malaysia Industrial Development Authority (MIDA) - Ministry of Health (MOH) - Ministry of Education (MOE)
5	Public Awareness of Science and Technology	• Malaysian Science, Technology and Innovation Centre (MASTIC) - Public Awareness of Science and Technology Report
6	Bibliometrics: Publications and Citations	• Malaysian Science, Technology and Innovation Centre (MASTIC) - Bibliometrics Study
7	Innovation in the Malaysian Manufacturing and Services Sectors	• Global Innovation Index (GII) • 2013-2014 Global Competitiveness Index • World Competitiveness Yearbook 2013 • Malaysian Science, Technology and Innovation Centre (MASTIC) - National Survey of Innovation 2012
8	Intellectual Property Rights and Balance in Royalties and Licensing Fees	• Intellectual Property Corporation of Malaysia (MyIPO) • Small and Medium Enterprise Corporation Malaysia (SME Corp. Malaysia) • Central Bank of Malaysia (BNM) • World IP Organisation (WIPO) • United States Patent and Trademark Office (USPTO)
9	Information and Communication Technology (ICT)	• ICT Policy Division (DICT), MOSTI • International Data Corporation (IDC) • Ninth Malaysian Plan • Information Economy Report, UNCTAD • Malaysian Communications and Multimedia Commission (MCMC) • Multimedia Development Corporation (MDeC) • The National ICT Association of Malaysia (PIKOM)
10	Biotechnology	• Biotech Corp, BIOTEK Division, MOSTI • Malaysian Biotechnology Statistical Indicators 2010-2011

11	Knowledge- and Technology-Intensive (KTI) Industries and the Global Marketplace • Industry, Technology and Global Marketplace • Trade in Technology • Balance of Payment in Technology	• NSF Science and Engineering Indicators • Malaysia Industrial Development Authority (MIDA) • Ministry of International Trade and Industry (MITI) • Department of Statistics, Malaysia (DOSM) • Malaysia External Trade Development Corporation (MATRADE) • Central Bank of Malaysia (BNM) • United Nations Industrial Development Organization (UNIDO)
12	Energy and Green Technology	• Ministry of Energy, Green Technology and Water (KeTTHA) • Energy Commission
13	Recent Advancements in Science, Technology and Innovation • Nanotechnology • Oceanography	• National Oceanography Directorate Division (NND), MOSTI • National Nanotechnology Directorate Division (NOD), MOSTI

1.2 ORGANISATION OF THE REPORT

The report consists of this introductory chapter followed by 12 chapters on the specific areas and a final chapter that provides the conclusion. The chapters are as follows:

Chapter 1 : Introduction
Chapter 2 : Education in Science and Technology
Chapter 3 : Research and Development (R&D) in Malaysia
Chapter 4 : Public Support for Research and Development (R&D) in Science, Technology and Innovation
Chapter 5 : Public Awareness of Science and Technology
Chapter 6 : Bibliometrics: Publications and Citations
Chapter 7 : Innovation in the Malaysian Manufacturing and Services sectors
Chapter 8 : Intellectual Property Rights and Balance in Royalties and Licensing Fees
Chapter 9 : Information and Communications Technology (ICT)
Chapter 10 : Biotechnology
Chapter 11 : Knowledge- and Technology-Intensive (KTI) Industries and the Global Marketplace
Chapter 12 : Energy and Green Technology
Chapter 13 : New Initiatives in Science, Technology and Innovation
Chapter 14 : Conclusion & The Way Forward

There are a few changes in the content of the 2013 Report from the 2010 Report. The chapter on "Trade in High-Technology Products and Professional Services" in the previous report has been absorbed in a new chapter entitled, "Knowledge- and Technology-Intensive (KTI) Industries and the Global Marketplace", in the 2013 Report. The new chapter also includes two additional topics, i.e., Industry, Technology and Global Marketplace; and Balance of Payment in Technology.

CHAPTER 2:
EDUCATION IN S&T

CHAPTER 2

EDUCATION IN SCIENCE AND TECHNOLOGY

2.0 INTRODUCTION

Education plays a key role in disseminating knowledge, developing young minds and equipping them with the tools and skills required to survive in today's competitive world. As science and technology (S&T) becomes increasingly important for the growth of the nation, having knowledge of science and related fields is a necessity. The Malaysian government recognises such importance, which is why the Malaysian education system has always stressed on science and technology. This is also emphasised in the Malaysia Education Blueprint, which prioritises the mastery of important subjects such as mathematics and science by every child. The Blueprint also specifically aims to have Malaysia amongst the top performers in international assessments of mathematics and science. Policies such as the 2nd National Science and Technology Policy and Plan of action, which is aimed at bringing changes to the education curriculum for national schools to allow for a more innovative approach to learning, were introduced to achieve this target.

The Malaysian education system encompasses education beginning from pre-school to university. Pre-tertiary education (pre-school to secondary education) and tertiary or higher education, are both under the umbrella of the Ministry of Education (MOE). To identify and cultivate the abilities of students according to their interest, the education system streams students according to arts-related and science subjects. The streaming process begins at the upper secondary schooling stage and continues on into the matriculation or pre-tertiary level, and well into the tertiary level, which includes programmes at the certificate, diploma, bachelor's, master's and Ph.D levels.

This chapter discusses education in S&T in Malaysia, beginning from the secondary to the university level. The data presented in this chapter have been obtained from three main sources, the Ministry of Higher Education (MOHE), the Ministry of Education (MOE) and the Malaysian Examinations Syndicate (MES). The data obtained are both from public as well as private institutions to allow for comparisons of student enrolment and graduations at differing levels of the higher education system.

The chapter consists of four sections, the first being on S&T subjects at the upper secondary school level. The second and third sections are comparisons of enrolment and graduation statistics in S&T subjects as well as non-S&T subjects at the both undergraduate and postgraduate levels of private and public higher education institutions. These two sections also compare enrolment and graduation statistics between gender in S&T with non-S&T courses. The fourth and last section concludes the chapter with some recommendations for improving education in S&T in the future.

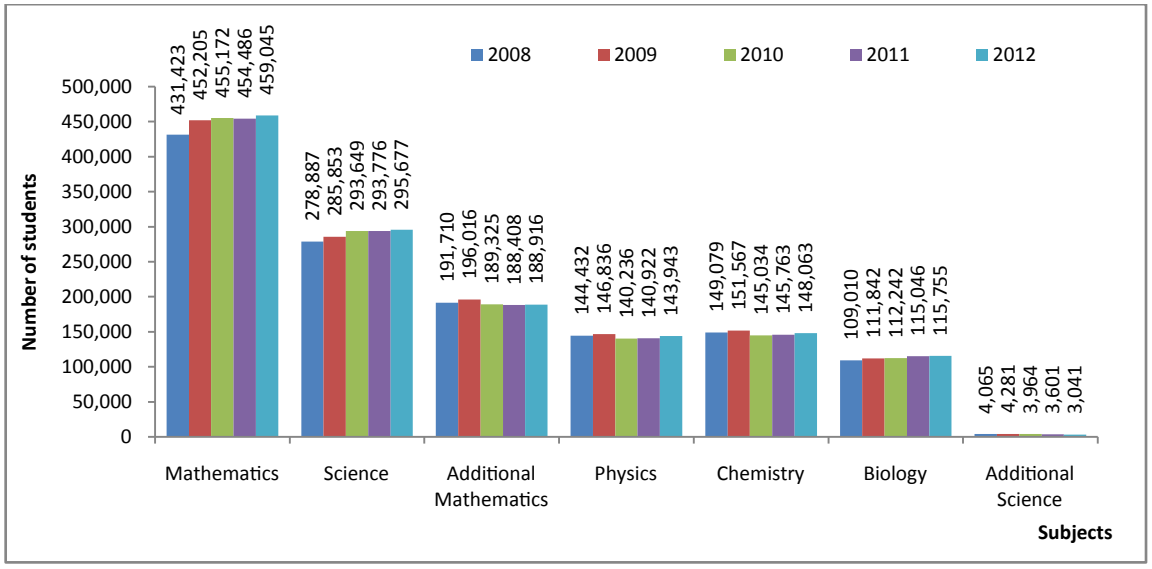
2.1 EDUCATION IN SCIENCE, MATHEMATICS AND TECHNOLOGY AT THE SPM AND STPM LEVEL

This section discusses education in science, mathematics and technology subjects at the secondary and STPM level, and how the students fare in these subjects. The statistics presented include the number of enrolments in science and technology subjects, the examination results for science and mathematics as well as comparisons of examination results based on gender.

2.1.1 Science, Mathematics and Technical Subjects at the SPM Level

Figure 2.1 shows that from 2008-2012, mathematics is the subject that most students registered for. This could be attributed to the fact that mathematics is a general subject that is required to be taken by all students sitting for the SPM. This is followed by science, where the number of students registering for this subject increase each year, from 278,887 in 2008 to 295,677 in 2012. More science-stream students also register for additional mathematics as opposed to other science subjects, with the number of students registered remaining relatively consistent throughout the period. This is followed by chemistry, physics and biology, where the number of students enrolled has also been constant. In contrast to the other subjects, additional science is the subject that appears to be least favoured by science students, only attracting 3,041 students in 2012.

Figure 2.1: Registration for Science and Mathematics at the SPM Level, 2008-2012

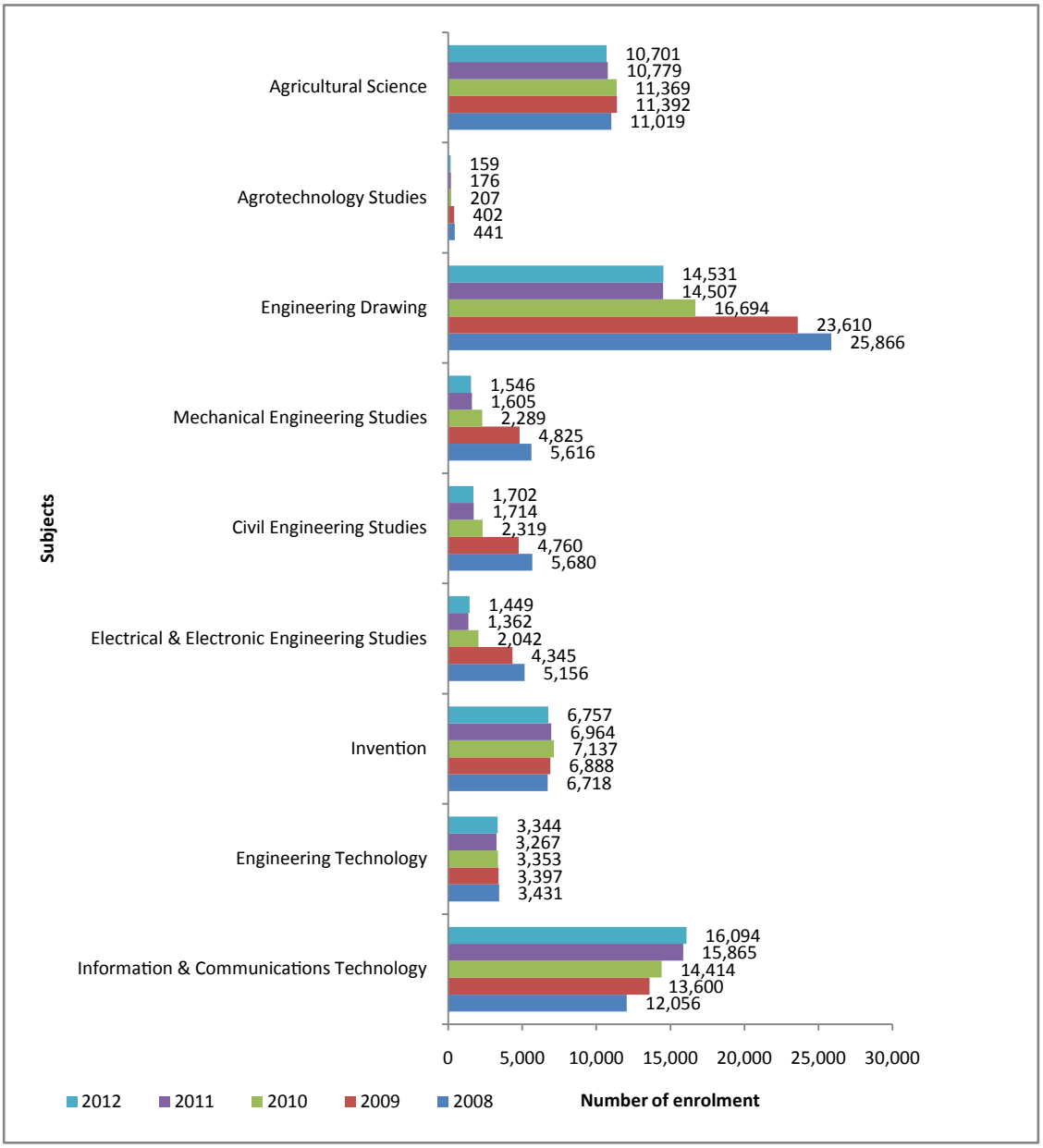


Source: Malaysian Examinations Syndicate

For students in technical schools, information and communications technology (ICT) is the subject that drew the highest number of students in 2011 and 2012, followed by engineering drawing. This is in contrast to the previous years, where engineering drawing recorded the highest number of students. The change in interest could be due to the Government's emphasis on ICT, which shows that national efforts to encourage interest in this area have been quite successful. The subject that attracted the third highest number of students from 2008 to 2012 was agricultural science, where registration remained relatively constant during the period, followed by invention and engineering technology, where registration was also relatively constant. Civil engineering studies, mechanical engineering studies, and electrical and electronic engineering studies, on the other hand, have seen a drop in the number of registrations during

the same period. The subject that seems to have failed to interest students at the SPM level, having recorded the lowest registration from 2008 to 2012, was Agrotechnology Studies.

Figure 2.2: Registration for Technical Subjects at the SPM Level, 2008-2012



Source: Malaysian Examinations Syndicate

2.1.2 Examination Grades for Science and Mathematics at the SPM Level

It is encouraging to see that the number of students that received A+ for mathematics and science for the SPM has generally increased from 2009 to 2012 **(Table 2.1)**. Mathematics is the subject that recorded the most number of A+'s each year compared to science (59,991 for mathematics and 7,279 for science in 2012). However, students have also consistently performed the worst (G) in mathematics compared to science from 2008-2012. It is important to note that although the number of failures for mathematics is high compared to science (86,199 for mathematics and 23,205 failures for science in 2012), the statistics also show the failures for mathematics has, in fact, decreased throughout the years, from 94,094 failures in 2008 to 86,199 failures in 2012. This also indicates an improvement in the performance of mathematics at the SPM level.

Table 2.1: Examination Grades for Science and Mathematics Subjects at SPM Level

Grade	2008		2009		2010		2011		2012	
	Science	Mathematics	Science	Mathematics	Science	Mathematics	Science	Mathematics	Science	Mathematics
A+	-	-	4,729	41,985	8,343	45,448	10,363	38,989	7,279	59,991
A	13,504	94,142	11,689	63,446	15,027	66,715	20,795	67,223	18,623	64,030
A-	14,951	21,630	14,516	23,261	21,741	27,731	22,905	24,424	26,062	25,507
B+	22,570	19,992	20,302	21,803	28,435	25,580	26,899	24,072	31,648	23,344
B	30,387	21,304	29,772	23,726	32,935	23,019	32,329	24,737	31,091	25,646
C+	37,029	22,612	36,050	24,305	34,170	23,845	32,769	25,680	31,899	24,634
C	40,880	26,408	35,577	23,610	34,359	28,655	30,048	28,327	31,867	27,435
D	48,157	54,261	47,505	53,450	44,658	51,529	46,890	56,815	46,224	54,301
E	37,709	65,049	48,359	64,330	38,219	60,998	36,924	64,433	35,881	55,116
G	22,766	94,094	25,039	98,866	22,781	86,840	22,061	87,173	23,205	86,199

Source: Malaysian Examinations Syndicate

2.1.3 Examination Grades for Science and Mathematics at the SPM Level by Gender

The statistics show that from 2008 to 2012, girls have done consistently better than boys in mathematics and science at the SPM level **(Table 2.2 & Table 2.3)**. This can be seen from the percentage of girls obtaining A+'s for these two subjects (63.83% for science and 57.42% for mathematics in 2012) being consistently higher than their male counterparts (36.17% for science and 42.58% for mathematics in 2012) throughout the period. Boys have fared the worst (receiving a G) in science and mathematics compared to girls each year. In 2012, 70.69% of the students who failed science were males while 29.31% were females. The same is seen for mathematics, where 65.52% of those who failed were males while 34.48% were females. The results are not affected by the percentage of male and female students that sat for science or mathematics at the SPM as the difference is negligible (for instance in 2012, 50.18% of the students that sat for science were females while 51.40% of the those that sat for mathematics were males, making the percentage of male and female students almost equal). The high number of failures amongst boys suggests that a lot needs to be done to boost their understanding of mathematics and science to bring them up to par with their female counterparts.

Table 2.2: Examination Grades for Science SPM Level by Gender (%)

Grade	2008		2009		2010		2011		2012	
	Female	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**
A+	-	-	66.19	33.81	65.53	34.47	67.03	32.97	63.83	36.17
A	61.72	38.28	66.25	33.75	66.01	33.99	65.69	34.31	63.57	36.43
A-	60.25	39.75	64.93	35.07	64.51	35.49	63.89	36.11	62.08	37.92
B+	58.95	41.05	64.03	35.97	62.09	37.91	60.48	39.52	59.94	40.06
B	56.85	43.15	61.15	38.85	58.39	41.61	56.52	43.48	56.26	43.74
C+	54.45	45.55	57.26	42.74	54.12	45.88	52.99	47.01	52.28	47.72
C	50.47	49.53	53.05	46.95	49.02	50.98	49.19	50.81	48.50	51.50
D	44.67	55.33	47.24	52.76	42.62	57.38	42.94	57.06	43.86	56.14
E	39.07	60.93	39.67	60.33	36.29	63.71	37.42	62.58	39.19	60.81
G	30.04	69.96	24.72	75.28	27.63	72.37	27.50	72.50	29.31	70.69
Total	49.19	50.81	50.75	49.25	50.18	49.82	50.34	49.66	50.18	49.82

Source: Malaysian Examinations Syndicate

Table 2.3: Examination Grades for Mathematics at the SPM Level by Gender (%)

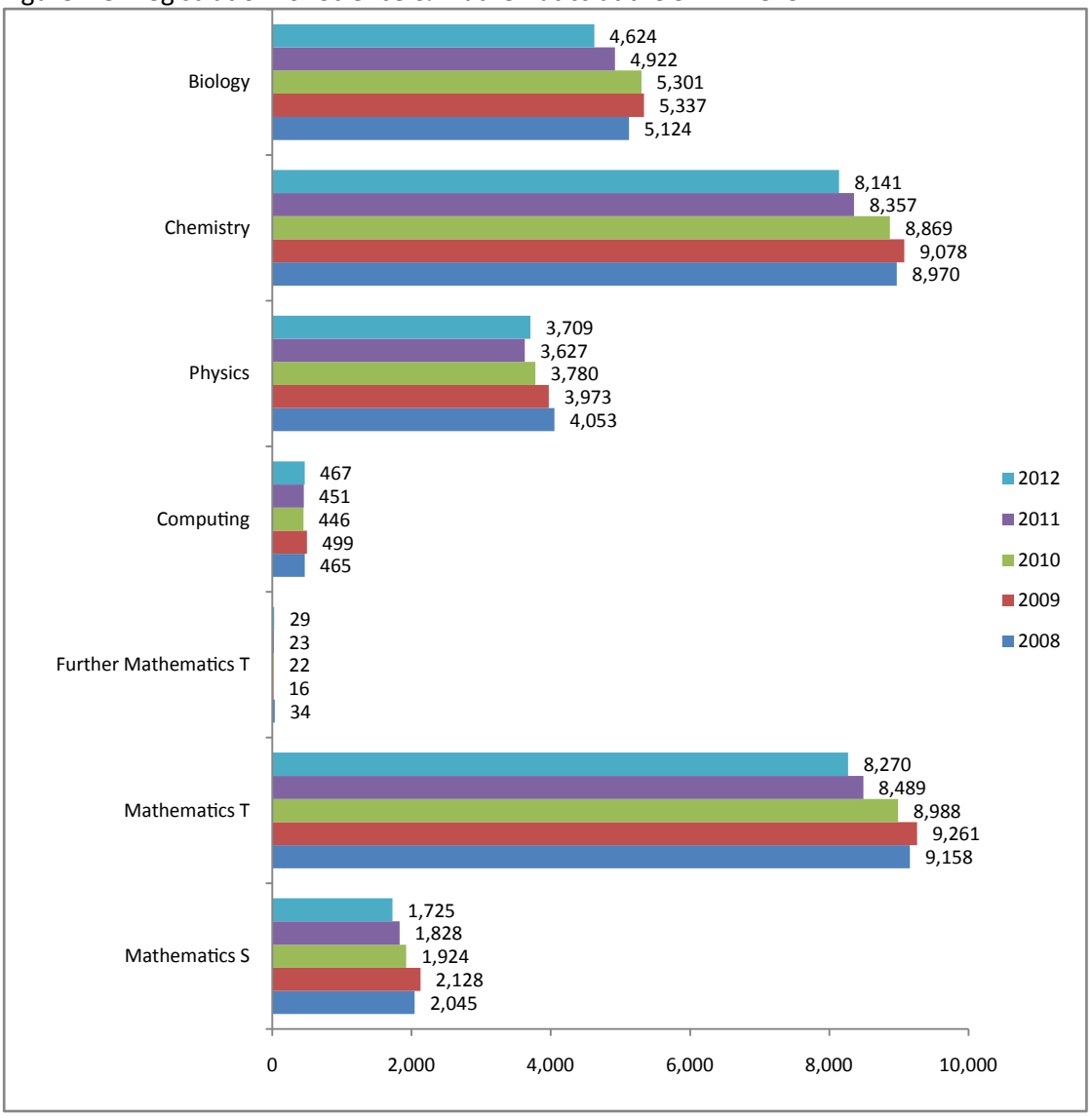
Grade	2008		2009		2010		2011		2012	
	Female	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**
A+	-	-	55.47	44.53	54.99	45.01	56.01	43.99	57.42	42.58
A	57.09	42.91	58.88	41.12	59.39	40.61	58.59	41.41	58.42	41.58
A-	59.55	40.45	59.09	40.91	58.49	41.51	58.50	41.50	58.91	41.09
B+	58.59	41.41	57.81	42.19	58.06	41.94	58.15	41.85	58.61	41.39
B	57.03	42.97	56.73	43.27	57.33	42.67	57.40	42.60	57.62	42.38
C+	56.13	43.87	55.56	44.44	56.20	43.80	55.49	44.51	56.30	43.70
C	54.59	45.41	55.42	44.58	55.64	44.36	55.68	44.32	55.23	44.77
D	53.26	46.74	53.25	46.75	53.38	46.62	53.48	46.52	52.92	47.08
E	50.85	49.15	50.06	49.94	47.75	52.25	49.67	50.33	48.14	51.86
G	37.72	62.28	37.69	62.31	35.42	64.58	35.98	64.02	34.48	65.52
Total	51.27	48.73	51.27	48.73	51.24	48.76	51.48	48.52	51.40	48.60

Source: Malaysian Examinations Syndicate

2.1.4 Science, Mathematics and Technology Subjects at the STPM Level

From 2008-2012, the subject mathematics T has received the highest number of students registration at the STPM level, followed by chemistry and biology **(Figure 2.3)**. Physics and mathematics S, as well as computing, did not receive as many registered students. This is surprising, especially since the Government has put in much effort to encourage interest in the knowledge of computer and information technology. The subject further mathematics T received very low registration of students each year. It is important to note that generally, the number of registrations for all the subjects decrease each year.

Figure 2.3: Registration for Science & Mathematics at the STPM Level



Source: Malaysian Examinations Council

2.1.5 Examination Results for Science and Mathematics at the STPM Level

The statistics indicate that from 2008-2012, more students obtained A's for science compared to mathematics. The number of A's for both science and mathematics have been relatively consistent throughout the years **(Table 2.4)**. Mathematics was the subject that received the highest number of failures as compared to science. However, the statistics show the number of failures for both subjects decreased each year. In 2008, there were 2,780 failures for mathematics and 1,504 for science as compared to 2,278 failures for mathematics and 1,406 for science in 2012. This suggests an improvement in the learning and understanding of mathematics and science.

Table 2.4: Examination Scores for Mathematics and Science at the STPM Level

Score	2008		2009		2010		2011		2012	
	Mathematics	Science	Mathematics	Science	Mathematics	Science	Mathematics	Science	Mathematics	Science
A	487	913	740	992	734	1,016	675	946	769	943
A-	513	951	781	1,107	685	1,134	637	1,086	585	1,049
B+	772	1,370	1,015	1,592	951	1,532	814	1,438	832	1,557
B	1,063	1,696	1,055	1,840	1,145	1,854	1,065	1,863	1,007	1,846
B-	1,255	2,095	1,173	2,217	1,145	2,098	1,031	2,064	933	2,163
C+	1,266	2,382	1,160	2,376	1,122	2,511	1,115	2,274	1,074	1,959
C	1,278	2,815	1,156	2,578	1,042	2,342	1,009	2,297	1,098	2,284
C-	373	1,209	353	1,088	349	1,060	320	1,051	309	863
D+	377	1,122	348	1,073	387	1,058	410	875	456	1,047
D	422	1,045	346	1,009	379	987	374	783	316	749
F	2,780	1,504	2,731	1,647	2,479	1,587	2,410	1,482	2,278	1,406

Source: Malaysian Examinations Council

2.1.6 Examination Results for Science and Mathematics at the STPM Level by Gender

Interestingly, the pattern of examination results by gender at the STPM level is different from that at the SPM level. From 2008-2012, more male students received A's for mathematics and science than their female counterparts (58.13% of the students receiving A's for mathematics and 58.43% receiving A's for science in 2012 were males). This is not to say that female students performed poorly in these two subjects, as they obtained more A-'s for mathematics and science than males (50.09% of the students obtaining A-'s for mathematics and 50.91% obtaining A-'s for science in 2012 were females). Surprisingly, more female students failed mathematics at the STPM level (57.86% of the students that failed mathematics and 50.21% that failed science in 2012 were females) even though the percentage of female students that sat for these two subjects at the STPM level was higher than that of males. This trend is in stark contrast to the gender performance at the SPM level, where female students surpassed male students in terms of examination results in science and mathematics.

Table 2.5: Examination Results for Science at the STPM Level by Gender (%)

Grade	2008		2009		2010		2011		2012	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
A	58.38	41.62	55.65	44.35	60.73	39.27	57.29	42.71	58.43	41.57
A-	48.90	51.10	47.24	52.76	51.50	48.50	51.38	48.62	49.09	50.91
B+	46.64	53.36	46.98	53.02	47.98	52.02	44.51	55.49	45.92	54.08
B	44.58	55.42	42.28	57.72	45.47	54.53	43.53	56.47	42.20	57.80
B-	42.20	57.80	41.90	58.10	40.99	59.01	42.15	57.85	42.63	57.37
C+	43.58	56.42	42.13	57.87	44.88	55.12	42.79	57.21	43.80	56.20
C	41.31	58.69	43.72	56.28	41.97	58.03	41.75	58.25	41.24	58.76
C-	42.27	57.73	40.53	59.47	36.89	63.11	35.39	64.61	37.54	62.46
D+	42.07	57.93	36.91	63.09	44.14	55.86	36.46	63.54	42.88	57.12
D	43.54	56.46	43.01	56.99	42.86	57.14	35.50	64.50	38.45	61.55
F	49.07	50.93	49.30	50.70	51.67	48.33	47.98	52.02	49.79	50.21
Total (%)	44.75	55.25	44.19	55.81	45.70	54.30	43.52	56.48	44.39	55.61

Source: Malaysian Examinations Council

Table 2.6: Examination Results for Mathematics at the STPM Level by Gender (%)

Grade	2008		2009		2010		2011		2012	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
A	54.83	45.17	57.03	42.97	57.08	42.92	57.78	42.22	58.13	41.87
A-	45.22	54.78	45.71	54.29	50.95	49.05	49.14	50.86	49.91	50.09
B+	42.75	57.25	40.79	59.21	44.06	55.94	42.51	57.49	47.00	53.00
B	43.27	56.73	40.66	59.34	42.88	57.12	41.03	58.97	40.91	59.09
B-	39.76	60.24	41.52	58.48	37.21	62.79	38.22	61.78	41.05	58.95
C+	38.63	61.37	38.97	61.03	38.59	61.41	40.18	59.82	40.69	59.31
C	42.25	57.75	36.51	63.49	39.06	60.94	38.16	61.84	36.61	63.39
C-	40.48	59.52	35.69	64.31	43.84	56.16	37.81	62.19	40.13	59.87
D+	41.38	58.62	42.24	57.76	39.02	60.98	40.00	60.00	35.75	64.25
D	43.84	56.16	40.46	59.54	37.73	62.27	37.43	62.57	37.03	62.97
F	42.48	57.52	42.26	57.74	46.59	53.41	41.58	58.42	42.14	57.86
Total (%)	42.41	57.59	41.90	58.10	43.64	56.36	41.99	58.01	42.75	57.25

Source: Malaysian Examinations Council

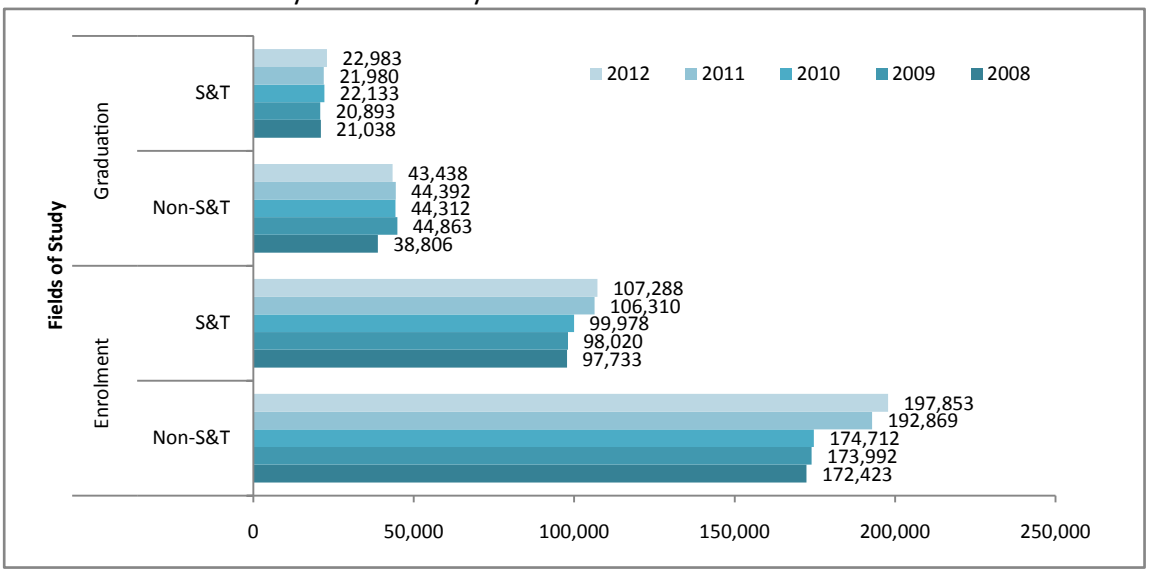
2.2 TERTIARY EDUCATION IN SCIENCE AND TECHNOLOGY AT PUBLIC HIGHER EDUCATIONAL INSTITUTIONS

Presently, there are roughly 20 public universities and around 30 private universities in Malaysia that offer courses leading up to certificate, diploma, bachelor's, master's and doctoral degrees. The degrees offer courses in various fields, amongst which are science and technology. This section discusses the enrolment and graduations at the undergraduate and postgraduate levels for science and technology courses as well as non-science courses in public and private institutions. It also includes a brief discussion on the number of degrees awarded in science and technology courses according to gender.

2.2.1 Enrolment and Graduations in First Degree Courses at Public Higher Educational Institutions

As can be seen from **Figure 2.4**, the number of students enrolled in non-science courses at the first-degree level is consistently more than that of science and technology courses. For non-science courses, the number of students enrolled increased from 172, 423 in 2008 to 197,853 in 2012. As for science and technology courses, the number of students has remained relatively constant from 2008 to 2010—averaging at around 98,000—but increased from 2011 to 2012. In 2012, the number of students enrolled in science courses totaled 107,288. The data also show that the number of non-science graduates is consistently higher than that of science and technology graduates. This is not surprising, given the higher number of non-science enrolments compared to science.

Figure 2.4: Enrolment and Graduations in First Degree Courses at Public Higher Educational Institutions by Fields of Study

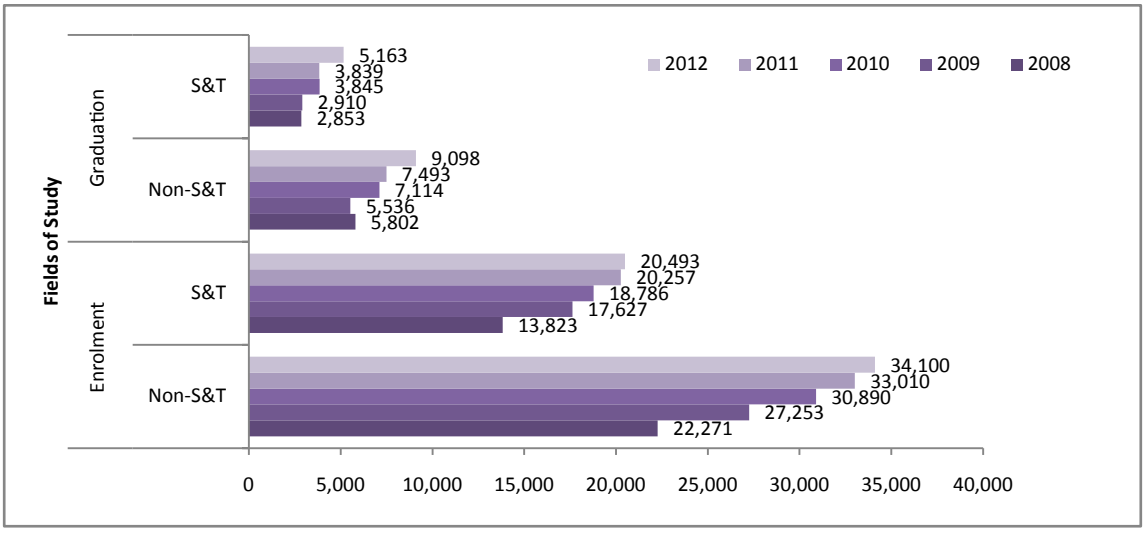


Source: Ministry of Education

2.2.2 Enrolment and Graduations in Master's Degree Courses at Public Higher Educational Institutions

Figure 2.5 shows that from 2008 to 2012, the number of master's degree enrolments in non-science courses is higher than that of science and technology courses. The data also show that the number of enrolments for non-science and science courses increase each year. As for the number of graduates, the trend is similar to that at the first degree level, where the number of graduates for non-science courses is consistently higher than that of science and technology.

Figure 2.5: Enrolment and Graduations in Master's Degree Courses at Public Higher Educational Institutions

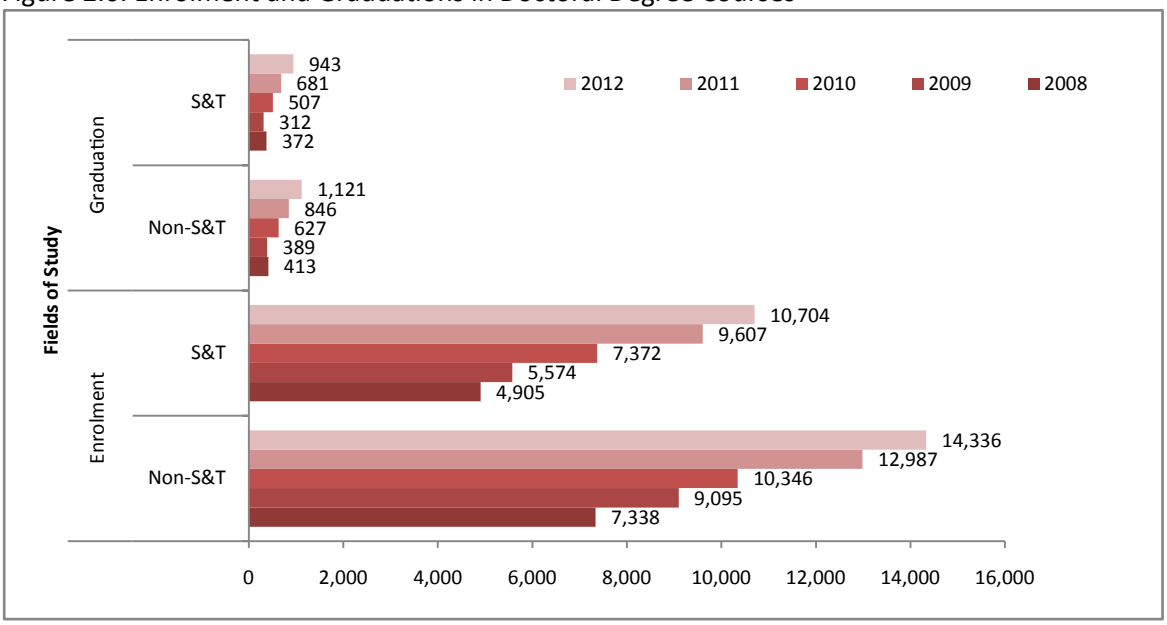


Source: Ministry of Education

2.2.3 Enrolment and Graduations in Doctoral Degree Courses

From 2008-2012, the trend in enrolments and graduations in doctoral degree courses is the same as that of the first degree and master's, with enrolments for non-science courses being consistently more than enrolments in science and technology courses **Figure 2.6**. Each year, there is an increase in student's enrolment in doctoral degree courses for non-science as well as science and technology courses. As in the bachelor's and master's courses, the number of graduates for non-science courses is higher than that of science and technology.

Figure 2.6: Enrolment and Graduations in Doctoral Degree Courses

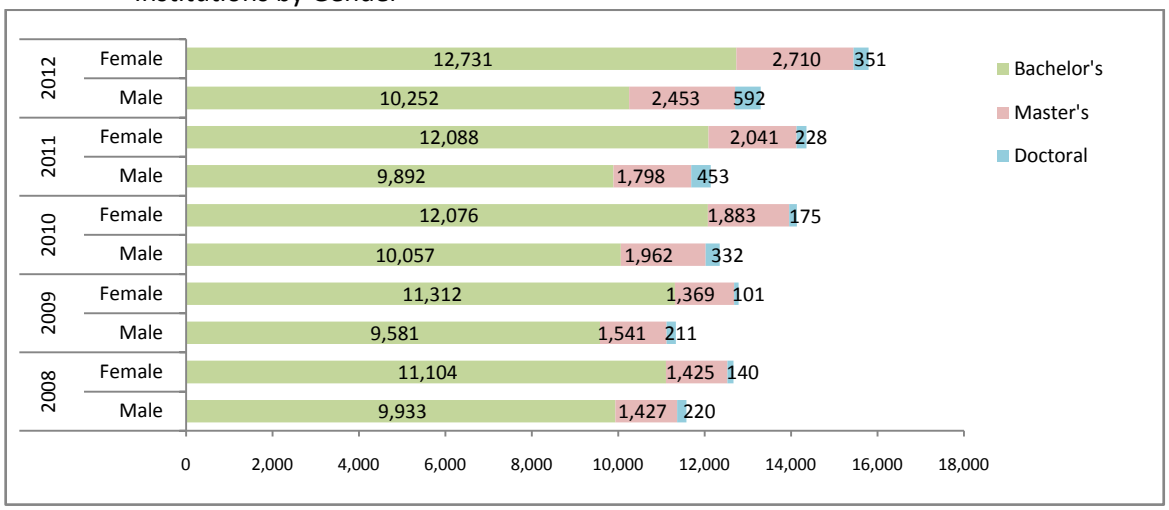


Source: Ministry of Education

2.2.4 Degrees Awarded in Science and Technology Courses from Public Higher Educational Institutions by Gender

From 2008-2012, an interesting trend can be observed with regard to the number of degrees awarded by gender. At the bachelor's degree level, more females have been consistently awarded their degrees in science and technology compared to males (For example, 12,731 females to 10,252 males in 2012). From 2008-2012, at the master's degree level, there have been more male graduates some years and more female graduates in other years, the difference not being too significant. Interestingly, at the PhD level, each year there are more male doctoral degrees awarded in science and technology compared to females (592 males to only 351 females in 2012).

Figure 2.7: Degrees Awarded in Science and Technology Courses from Public Higher Educational Institutions by Gender



Source: Ministry of Education

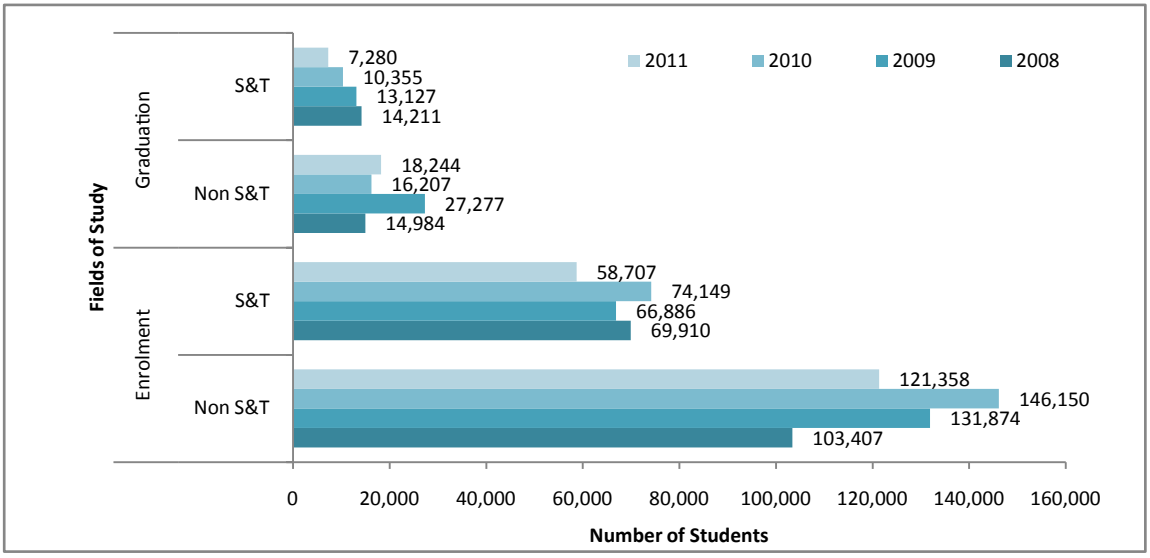
2.3 TERTIARY EDUCATION IN SCIENCE AND TECHNOLOGY AT PRIVATE HIGHER EDUCATIONAL INSTITUTIONS

Private higher educational institutions play an important role in this country, as they contribute significantly to the higher education system. This section discusses the number of enrolments and graduations of students for science and technology, as well as non-science courses at the bachelor's, master's and doctoral level.

2.3.1 Enrolment and Graduations in First Degree Courses at Private Higher Educational Institutions

As shown in **Figure 2.8**, the number of students enrolled in non-science courses at the first-degree level is consistently higher compared to those in science and technology courses (121,358 non-science and 58,707 S&T enrolments in 2011). For non-science courses, the number of enrolments has fluctuated from 2008-2011, but for S&T courses, the number of enrolments in has generally decreased; from 69,910 in 2008 to 58,707 in 2011. As for the number of graduates, the number of non-science graduates from 2008-2011 is higher than that of science and technology graduates (18,244 non-science and 7,280 science and technology graduates in 2011).

Figure 2.8: Enrolment and Graduations in First Degree Courses at Private Higher Educational Institutions

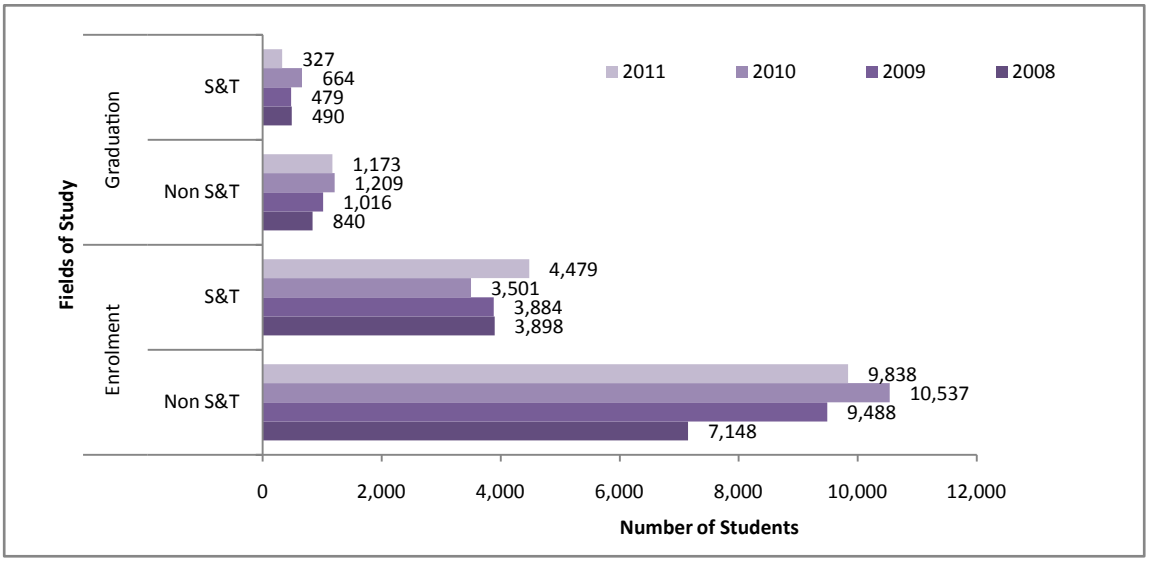


Source: Ministry of Education

2.3.2 Enrolment and Graduations in Master's Degree Courses at Private Higher Educational Institutions

Figure 2.9 shows that the number of master's degree enrolments in non-science courses is consistently higher than those of science and technology courses (9,838 non-science and 4,479 science and technology enrolments in 2011). As for the number of graduates, the trend is similar to that of the first degree level, whereby the number of graduates for non-science is higher than that of science and technology courses (1,173 non-science and 327 science and technology graduates in 2011).

Figure 2.9: Enrolment and Graduations in Master's Degree Courses at Private Higher Educational Institutions

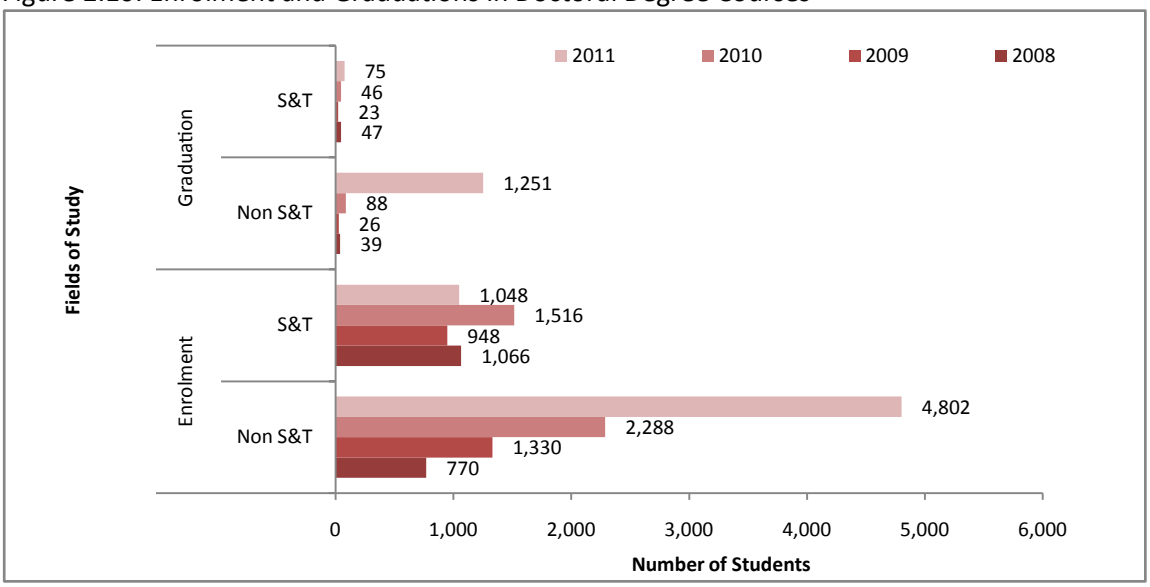


Source: Ministry of Education

2.3.3 Enrolment and Graduations in Doctoral Degree Courses

The trend in the enrolment and graduations in doctoral degree courses from 2008 to 2011 is the same as that of the first degree and master's degree. **Figure 2.10** shows that the number of enrolments for non-science courses is constantly higher than those of science and technology courses (4,802 non-science and 1,048 science and technology enrolments in 2011). There are also more graduates for non-science courses compared to science and technology courses.

Figure 2.10: Enrolment and Graduations in Doctoral Degree Courses

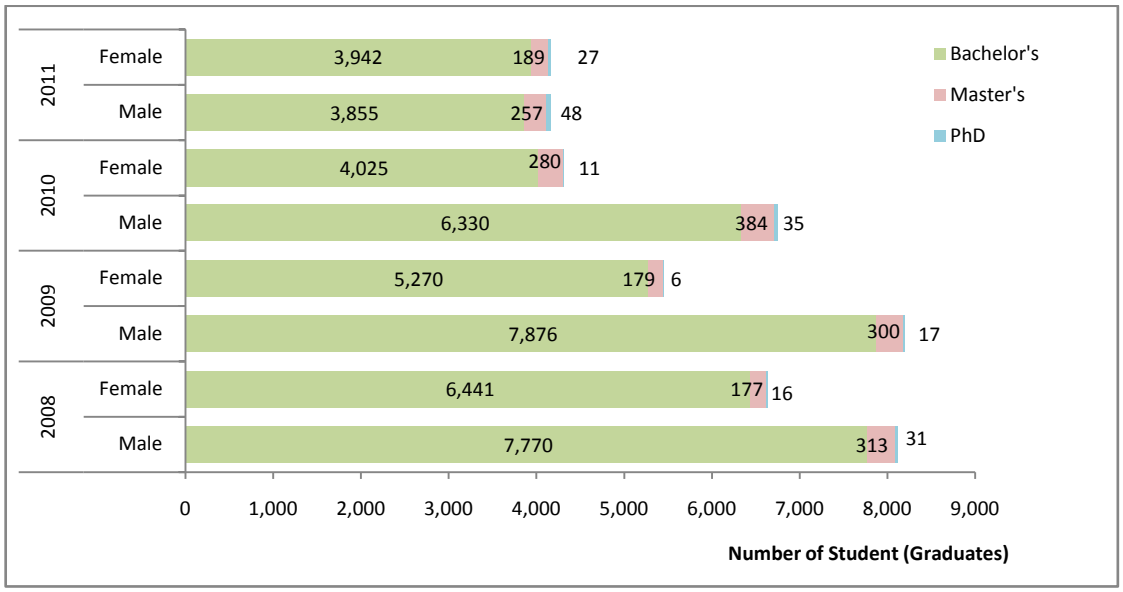


Source: Ministry of Education

2.3.4 Degrees Awarded in S&T Courses from Private Higher Educational Institutions by Gender

From 2008 to 2011, at the bachelor's degree level, more males have been awarded their degrees in science and technology, with the exception of 2011; where 3,855 males received their undergraduate degrees compared to 3,942 females **(Figure 2.11)**. The same is true at the master's degree and PhD level, where more males have consistently been awarded their master's and doctoral degree in S&T respectively.

Figure 2.11: Degrees Awarded in S&T Courses from Private Higher Educational Institutions by Gender



Source: Ministry of Education

2.4 MALAYSIAN STUDENTS' PERFORMANCE IN PISA

The Programme for International Student Assessment (PISA) is an international survey that is aimed at evaluating the performance of 15-year old students in three key areas such as reading, mathematics and science.[1] What sets PISA apart from other assessment surveys is the fact that the PISA tests are not directly related to the school's curriculum, but rather, on whether students can apply what has been learned in schools into real life situations. The results purport to indicate the level of applied knowledge a student has and hence, assess the success of implementation of educational policies.

In 2012, Malaysia was among the 65 economies that took part in PISA. The performance of Malaysian students in PISA's most recent assessment is rather discouraging, as they fared below the global average. According to the official report released by the Organisation for Economic Cooperation and Development (OECD), Malaysia obtained a mean score of 421 in Mathematics, 420 in Science and 398 in Reading **(Table 2.7)**. This is in contrast to the global average score of 494 in Mathematics, 501 in Science and 496 in Reading.

Table 2.7: Students Performance in Mathematics, Reading and Sciences, 2012

Countries	Mean score		
	Mathematics	Reading	Sciences
OECD average	**494**	**496**	**501**
Shanghai-China	613	570	580
Singapore	573	542	551
Hong Kong-China	561	545	555
Taiwan	560	523	523
Korea	554	536	538
Macao-China	538	509	521
Japan	536	538	547

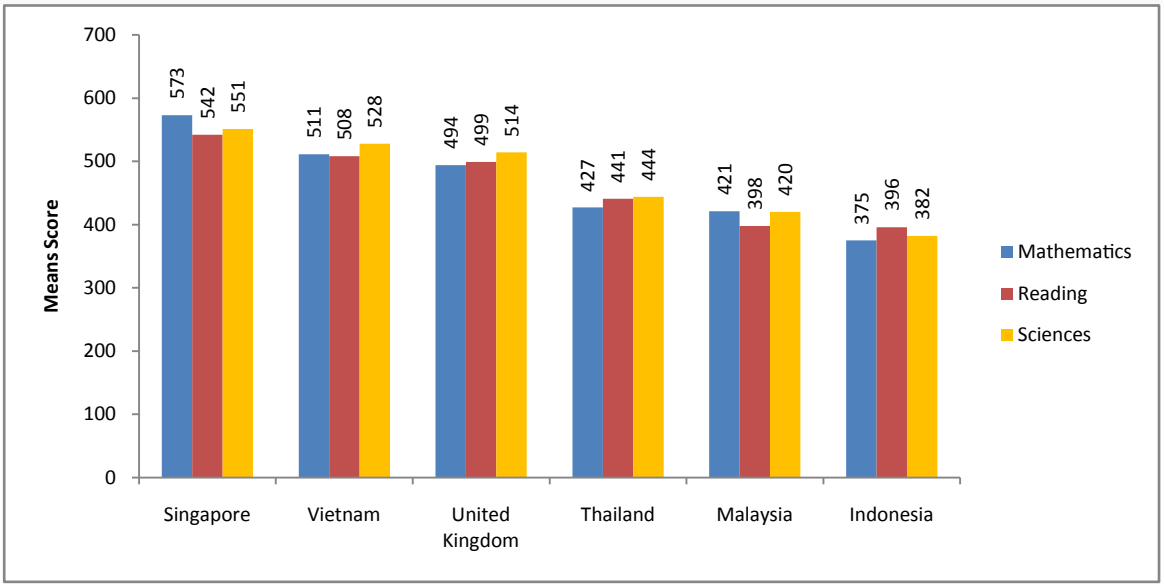
[1] See official report PISA 2012 Results in Focus by OECD

Liechtenstein	535	516	525
Switzerland	531	509	515
Netherlands	523	511	522
Estonia	521	516	541
Finland	519	524	545
Canada	518	523	525
Poland	518	518	526
Belgium	515	509	505
Germany	514	508	524
Vietnam	511	508	528
Austria	506	490	506
Australia	504	512	521
Ireland	501	523	522
Slovenia	501	481	514
Denmark	500	496	498
New Zealand	500	512	516
Czech Republic	499	493	508
France	495	505	499
United Kingdom	494	499	514
Iceland	493	483	478
Latvia	491	489	502
Luxembourg	490	488	491
Norway	489	504	495
Portugal	487	488	489
Italy	485	490	494
Spain	484	488	496
Russian Federation	482	475	486
Slovak Republic	482	463	471
United States	481	498	497
Lithuania	479	477	496
Sweden	478	483	485
Hungary	477	488	494
Croatia	471	485	491
Israel	466	486	470
Greece	453	477	467
Serbia	449	446	445
Turkey	448	475	463
Romania	445	438	439
Cyprus	440	449	438
Bulgaria	439	436	446
United Arab Emirates	434	442	448
Kazakhstan	432	393	425
Thailand	427	441	444
Chile	423	441	445
Malaysia	**421**	**398**	**420**
Mexico	413	424	415
Montenegro	410	422	410
Uruguay	409	411	416
Costa Rica	407	441	429
Albania	394	394	397
Brazil	391	410	405
Argentina	388	396	406
Tunisia	388	404	398
Jordan	386	399	409
Colombia	376	403	399
Qatar	376	388	384
Indonesia	375	396	382
Peru	368	384	373

Source: Based on official report PISA 2012 Results in Focus by OECD

Currently, Malaysia ranks 52 out of 65 countries based on the mean mathematics score for PISA 2012 **(Table 2.7)**, putting Malaysia in the bottom third of the countries participating in the survey. Malaysian students performed slightly better in PISA 2012 compared to our participation in 2009, where we were ranked 55 of 74 countries; with a mean score of 404 in Mathematics, 422 in Science and 414 in Reading. While Malaysia performed better than Indonesia **(Figure 2.12)**, we are still lagging behind that of other Asian countries such as Thailand, Vietnam and Singapore. Singapore performed even better that most countries, such as the UK, which did not do as well as expected. The results have prompted the Malaysian government to prioritise on the improvement in performance of students in these three areas, as stated in the Malaysian Education Blueprint.

Figure 2.12: Student Performance in Mathematics, Reading and Science (Selected Countries), 2012



Source: Based on official report PISA 2012 Results in Focus by OECD

2.5 CONCLUSION

The enrolment for science and mathematics at the SPM level has generally increased each year since 2008. Students have also performed relatively well in science and mathematics at the SPM level as seen from the increase in the number of students receiving A+'s for mathematics and science. These trends are encouraging, and suggest that the Government's initiatives to encourage a deeper appreciation for and better performance in science and mathematics amongst students is starting to bear fruit. However, the statistics also indicate a rather worrying trend regarding the performance of males and females at the SPM level. The male students seem not to perform as well as their female counterparts in mathematics and science. This educational gap between male and female students has been highlighted by the Malaysia Education Blueprint, which prompted the government to place more emphasis on the compulsory school years, encourage parent participation to further support their children's educational needs as well as to make reforms to the vocational education system to address the poor performance of male students at this level.

For the STPM level, however, the statistics show that from 2008-2012, the number of registrations for science, mathematics and technology subjects has generally decreased. This is could be attributed to the fact that at this particular level of education, students are beginning

to develop an interest in other streams. It is also very likely that students who have chosen to pursue tertiary education have chosen not to take the STPM, but instead, go through the matriculation system. The STPM examination results also indicate that the number of A's obtained for science and mathematics has generally been high and remained relatively consistent throughout the years. It is encouraging to note that the number of failures for both science and mathematics have generally decreased, which suggests an improvement in the understanding science and technology. The trend in gender performance in science and mathematics at the STPM level differs from that the SPM level where male students at the STPM level seem to perform better in math and science than their female counterparts. This suggests that the educational gap at the secondary school level between males and females has improved as the students advance in their education.

At public and private universities, the number of enrolments for science courses is consistently less than that of non-science courses at the undergraduate and postgraduate levels. This is a little discouraging, as this does not meet the Government's efforts achieve a ratio of 60:40 for S&T to non S&T enrolments. The statistics also show that at the undergraduate level for public universities, more females obtained a bachelor's degree in science courses. This is in contrast to private universities, where more males do so. However, the trend is the same for postgraduate science programs in public and private universities, where generally more male students received their postgraduate degrees in science and technology courses compared to female students. This trend suggests that the worrying problem of "lost boys" and their poor performance in secondary school is not longer evident at the higher education level. This could be attributed to the fact that male students develop a better appreciation for science and technology as they mature.

The data indicate that generally, there have been improvements in science and mathematics at the SPM, STPM and higher education level. However, much more can be done to improve education in science and technology in Malaysia, particularly at the secondary and tertiary level. There must be more effort made to encourage higher enrolments in science and technology courses by emphasizing the interesting aspects of these subjects and the high marketability of graduates from this stream. This could motivate students to not only enter the science stream in secondary school, but also pursue a bachelor's degree in S&T as well as further their education in these subjects at the postgraduate level. With a heightened understanding of and interest in science and technology, more Malaysians could contribute to the growth of the country by the findings of their research in science and technology.

CHAPTER 3:
RESEARCH DEVELOPMENT (R&D) IN MALAYSIA

CHAPTER 3

RESEARCH AND DEVELOPMENT (R&D) IN MALAYSIA

3.0 INTRODUCTION

The Malaysian government has stressed on the attainment of a knowledge-based economy as the basis for sustaining a rapid rate of economic growth and enhancing international competitiveness so as to achieve Vision 2020. The realization of a knowledge-based economy will require a strong foundation in S&T and high commitment to R&D and innovation, as these are widely recognized as being critical determinants of a nation's competitiveness. Through R&D, we are able to increase our stock of knowledge and to use this knowledge to devise new applications. R&D is also crucial in improving production processes, in raising the quality of products and services, and in cutting costs through the introduction of new methods. It is also through R&D that we are able to promote and support the production of high quality, up-to-date, and relevant output, products, and services to allow us to be, and to remain competitive[2].

This chapter presents an overview of R&D activities in Malaysia from 2000 to 2011 based on the data presented in the National R&D Survey Report 2012. The overview highlights the developments in R&D in Malaysia over the years with respect to gross expenditure, research intensity, sources of funds, fields of research (FOR), socio-economic objectives (SEO), human resource, full-time equivalence (FTE), and female participation in R&D. Malaysia's performance in these areas is also compared with that of selected foreign economies. The trends that are highlighted shed light on where Malaysia is, how far she has come, and what she needs to accomplish in terms of R&D.

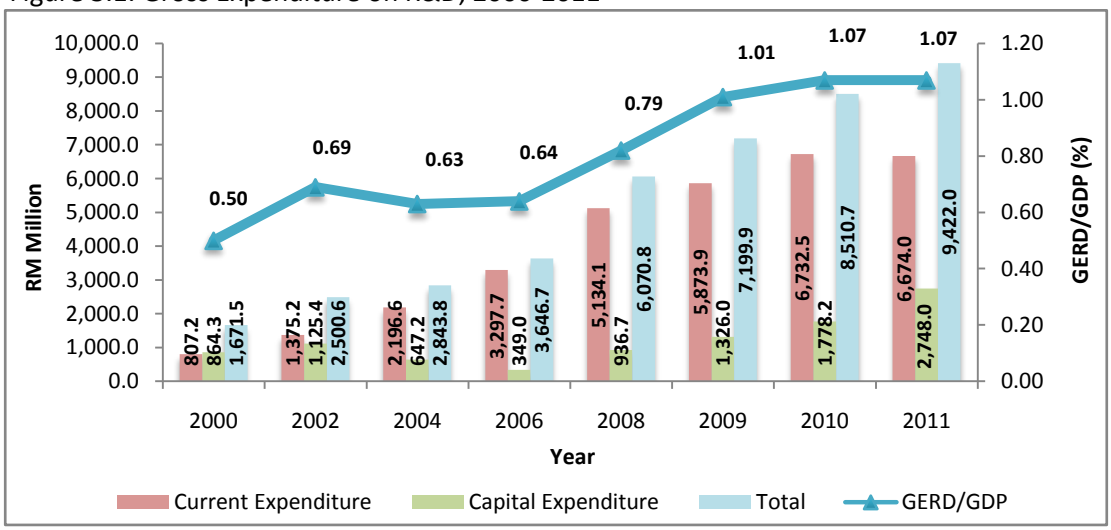
3.1 GROSS EXPENDITURE ON R&D

Since 2000, gross R&D expenditure (GERD) in Malaysia has steadily increased. A sharp increase in GERD is particularly notable between 2006 and 2009, reaching close to an estimated RM7.2 billion in 2009; an increase of 97.4% over that of 2006. In 2011, total R&D spending across all sectors of the economy, public and private, is estimated at RM9.4 billion, an increase of 10.7% from 2010 and 30.9% from 2009.

Malaysia's research intensity, which is the percentage of her GDP that is spent on R&D (GERD/GDP), has also charted a consistent increase since 2004. Indeed, her GERD/GDP rose from 0.64 in 2006 to 0.79 in 2008—an increase of 28.13%—and further to 1.01 in 2009, meeting the target of 1.0 set by the Economic Planning Unit (EPU) in RMKe-10 to be achieved by 2015. Our research intensity continued to improve, and in 2010 and 2011, Malaysia recorded an estimated GERD/GDP of 1.07%.

[2] OECD, "Frascati Manual: Proposed Standard Practice for Surveys on Research and Experimental Development, 2002"

Figure 3.1: Gross Expenditure on R&D, 2000-2011



Source: National Survey of Research & Development 2012

3.2 R&D EXPENDITURE BY SECTOR

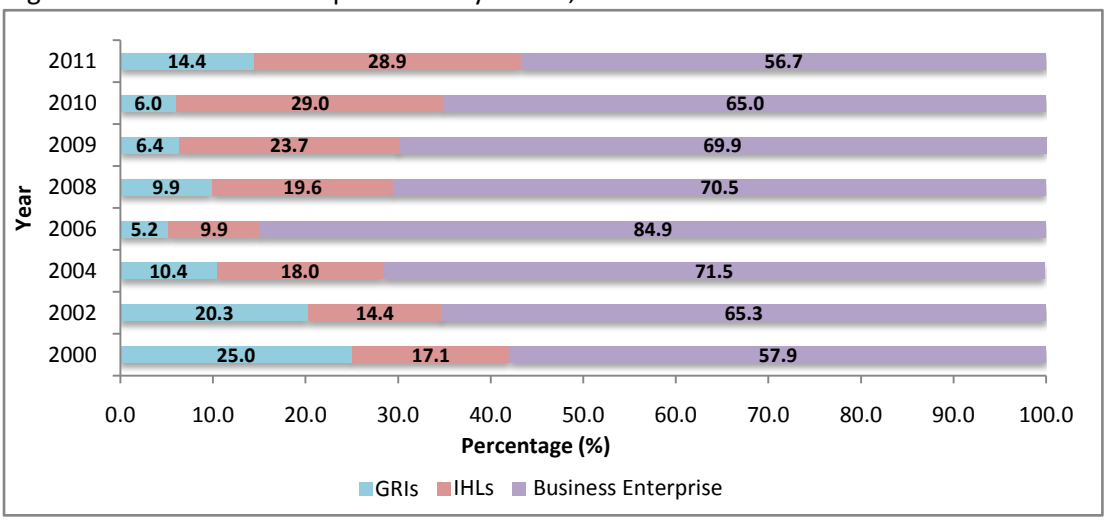
The business sector has consistently been the largest performer of R&D in Malaysia. Of the gross R&D expenditure in 2011, it is estimated that 56.7% was contributed by the business enterprise **(Figure 3.2)**. In 2011, the business enterprise is estimated to have spent RM5.3 billion on R&D activities, which was almost four times the estimated amount spent by GRIs (RM1.4 billion) and double that by IHLs (RM2.7 billion) **(Figure 3.3)**. However, although it still remains the largest performer of R&D in the country, the amount reported for 2011 is a decrease from the previous expenditure of RM5.5 billion in 2010 **(Figure 3.4)**.

Second to the business sector in R&D spending was the higher education sector, consisting of both public and private institutions of higher learning, whose expenditure has increased over the years, recording approximately 29% of the GERD in 2010 and 2011. While the R&D spending of the higher education sector continued to rise, suggesting the increased importance of academia as key players in Malaysia's R&D, that of the GRIs fluctuated in the range of 5.2% to 14.4% from 2006 to 2011, with 2011 recording the highest spending over the 5-year period.

The observed R&D trends by sector are consistent with those of other countries. The U.S. business sector, for example, accounted for 70% of her gross expenditures on R&D in 2009, while that of Japan accounted for almost 76%. China and South Korea were well above the U.S. level, while France and the United Kingdom were lower, at 62% and 60% respectively[3].

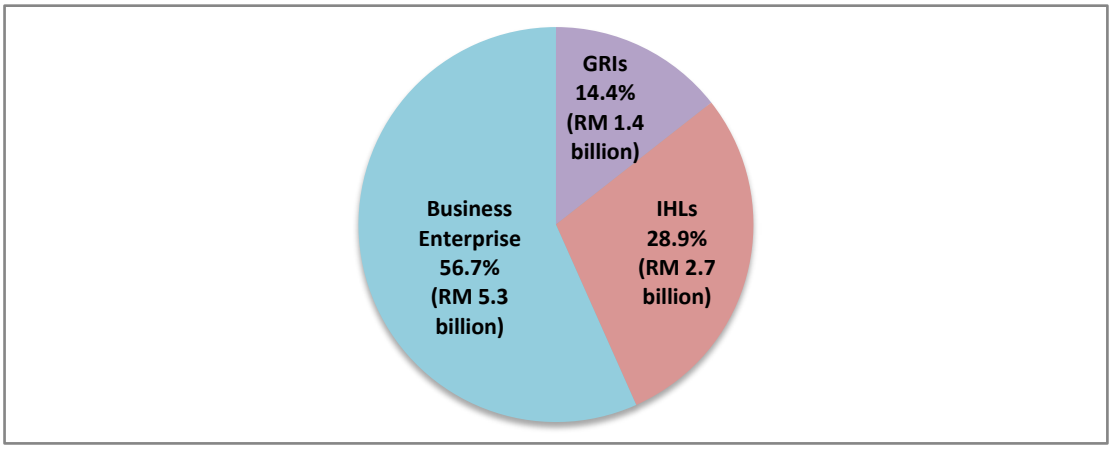
[3] Science and Engineering Indicators 2012; available at http://www.nsf.gov/statistics/ seind12/pdf/seind12.pdf

Figure 3.2: Share of R&D Expenditure by Sector, 2000-2011



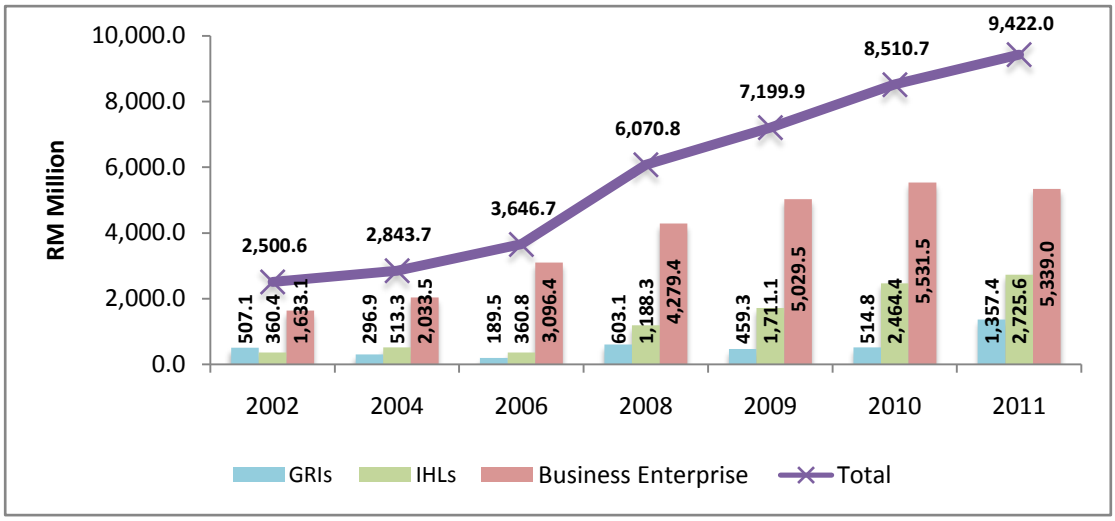
Source: National Survey of Research & Development 2012

Figure 3.3: Total R&D Expenditure by Sector, 2011



Source: National Survey of Research & Development 2012

Figure 3.4: Expenditure by Sector, 2002-2011



Source: National Survey of Research & Development 2012

3.3 EXPENDITURE BY TYPE OF ACTIVITY

3.3.1 R&D Expenditure by FOR

Malaysia's R&D activities were spread out over the study of ICT, engineering and technology, natural sciences, agriculture and forestry, biotechnology, medical and health sciences, social sciences, humanities, economics, business, and management. In 2011, based on the information obtained from the number of companies that responded to the survey, she invested the most in ICT research, estimated at 38.3% of the GERD, or RM3.6 billion. This finding parallels the fact that presently, ICT has become the key driver of the Government's Economic Transformation Programmes[4], contributing 9.8% to the national GDP in 2009[5]. The second highest R&D expenditure was in the field of Engineering and Technology, estimated at 24.2% of the GERD, or RM2.3 billion **(Figure 3.5)**.

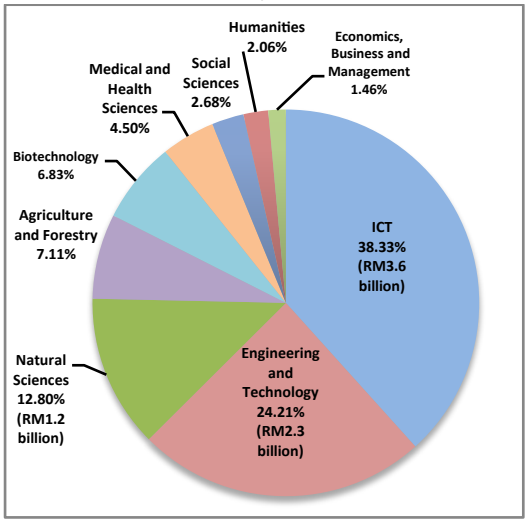
The natural sciences received close to 13% (RM1.2 billion) of the financial share, while agriculture and forestry had a share of slightly more than 7% of the total R&D expenditure. Malaysia spent the least on R&D in the areas of Economics, Business and Management (1.46%), Humanities (2.06%) and the Social Sciences (2.68%) in 2011, where research in these areas is not as costly as that in the business-dominated areas such as ICT and Engineering and Technology.

3.3.2 R&D Expenditure by SEO

Sustainable economic development was the primary objective of Malaysia's R&D activities in 2011, accounting for 41.5% of the GERD **(Figure 3.6)**. Advancement of knowledge was the second highest SEO (19.6%), while Advanced Experimental and Applied Science was the third highest (16.8%). Malaysia geared just a small portion of her R&D (RM217.6 million or 2.31% of GERD) for the purpose of national defence and security. This figure stands in stark contrast to some foreign economies that invest massive amounts annually on defence and security-related R&D, such as the U.S. and Israel.

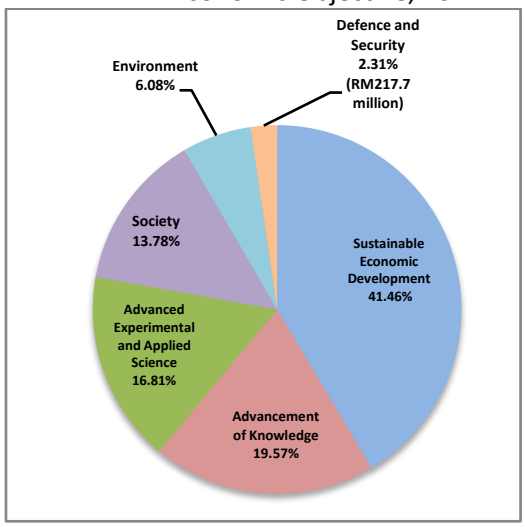
[4] http://www.matrade.gov.my/en/foriegn-buyers-section/70-industry-write-up--services/543-ict-industry
[5] ICT facts and figures, pg 1; and Frost and Sullivan: http://www.frost.com/prod/servlet/report-brochure.pag?id=4H22-01-00-00-00

Figure 3.5: R&D Expenditure by Field of Research, 2011



Source: National Survey of Research & Development 2012

Figure 3.6: R&D Expenditure by Socio-Economic Objective, 2011

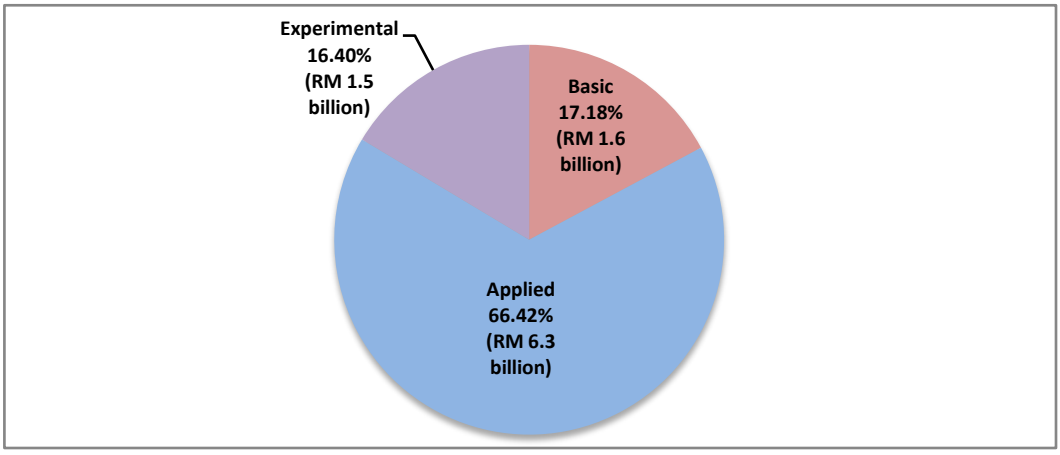


Source: National Survey of Research & Development 2012

3.4 R&D EXPENDITURE BY RESEARCH TYPE

In terms of expenditure by research type **(Figure 3.7),** more than 66.4% of the GERD went into the conduct of applied research (RM6.3 billion), while only about 16.4% (RM1.5 billion) was directed into experimental development. In this regard, Malaysia's focus differs from that of the U.S. and Australia, which tend to spend significantly more on experimental development research and less on applied R&D. The U.S., for example, reportedly spent 60% of GERD on experimental development, while Australia 80%[6]. However, the percentage that we spent on basic research (17.2%) is very close to that recorded in established economies, for instance the U.S., which spent 18% of her GERD in 2008 on basic research[7].

Figure 3.7: R&D Expenditure by Type of Research Activity, 2011



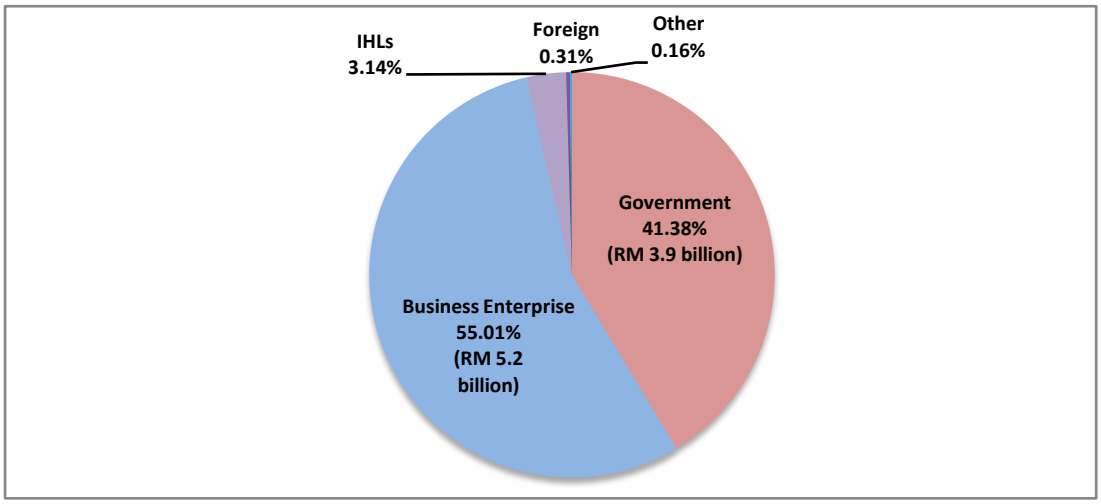
Source: National Survey of Research & Development 2012

[6] Australian Bureau of Statistics; available at http://www.abs.gov.au/ausstats/abs@ .nsf/mf/8112.0
[7] 2012 Global R&D Funding Forecast; available at http://battelle.org/ docs/default-document-library/2012globalforecast. pdf

3.5 SOURCES OF FUNDS FOR R&D

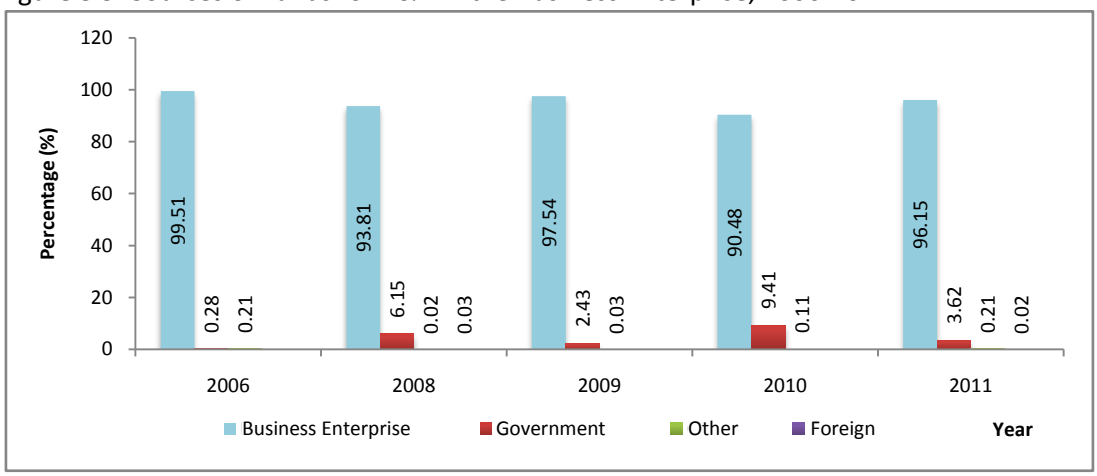
The major sources of funds for R&D in 2011 were business (55%), estimated at RM5.2 billion, followed closely by the federal government (41.4%), estimated at RM3.9 billion **(Figure 3.8)**. The government plays a major role in R&D, providing incentives for R&D in the form of various grants, double tax deduction, and other tax incentives to the business sector, and research grants to IHLs and GRIs. Federal support for business R&D has always been in the backdrop, with the government regularly channelling provisions of financial incentives in myriad forms. The total tax deduction submitted by the business enterprise to the Inland Revenue Board of Malaysia (LHDN) was estimated at RM90.0 million in 2011, RM136.6 million in 2010, and RM142.3 million in 2009[8], which are not reflected under sources of funds for R&D in the Business Enterprise as shown in **Figure 3.9**. The bulk of government funding for R&D, however, goes to the GRIs and IHLs, where 99.4% **(Figure 3.10)** of the funds in the GRIs and 86.4% **(Figure 3.11)** of the funds in the IHLs come from government.

Figure 3.8: Sources of Funds for National R&D, 2011



Source: National Survey of Research & Development 2012

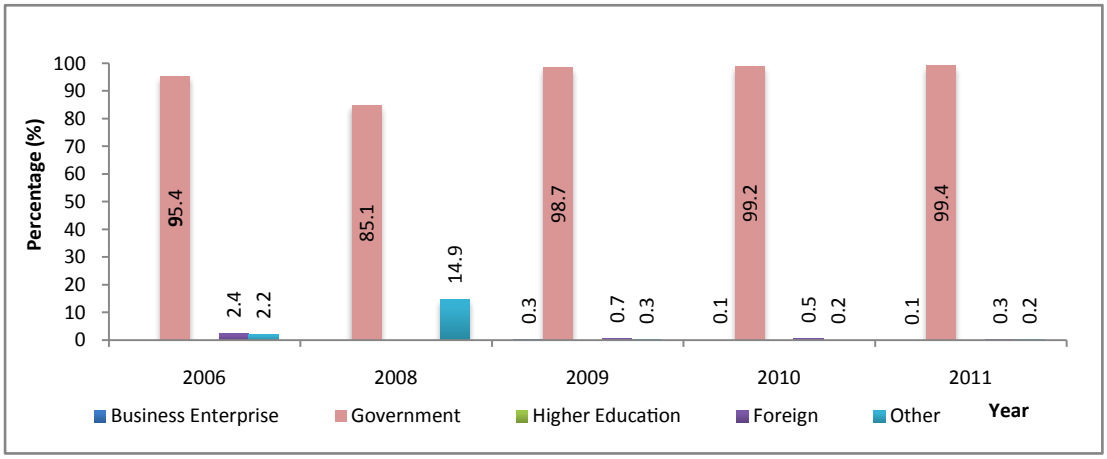
Figure 3.9: Sources of Funds for R&D in the Business Enterprise, 2006-2011



Source: National Survey of Research & Development 2012

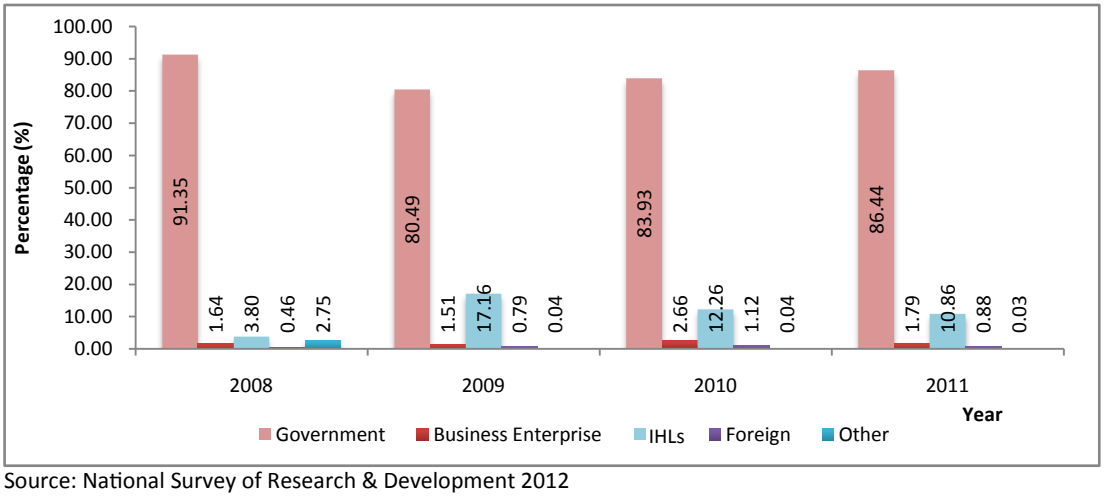
[8] National Survey of Research & Development 2012

Figure 3.10: GRI Sources of Funds, 2006-2011



Source: National Survey of Research & Development 2012

Figure 3.11: Sources of Funds for R&D in the IHLs, 2008-2011



Source: National Survey of Research & Development 2012

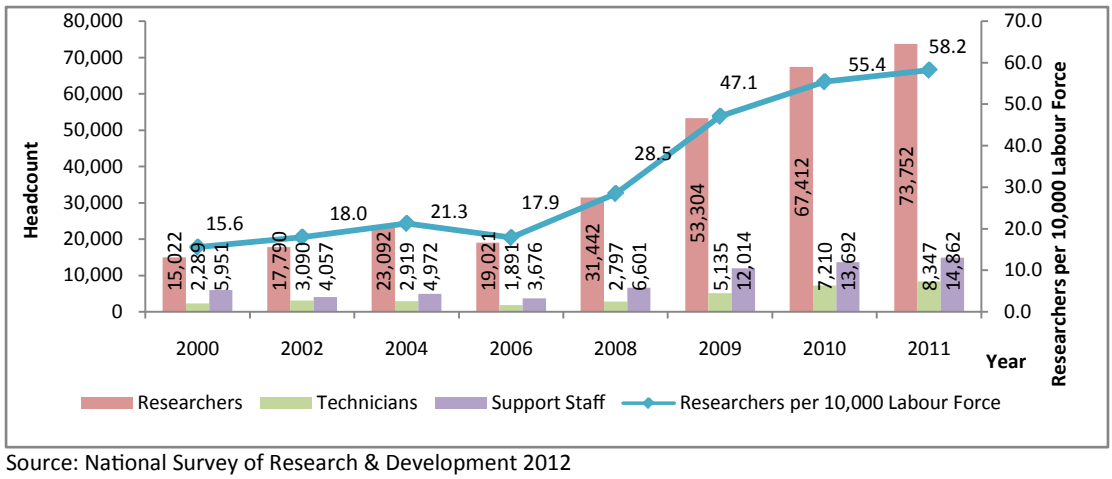
3.6 R&D PERSONNEL

Since 2008, there has been a marked growth in the country's R&D personnel (which includes researchers, technicians, and support staff). The total headcount of R&D personnel grew by 137.4%, from 40,840 persons in 2008 to 96,961 persons in 2011 **(Figure 3.12)**. Of interest is the total number of researchers, which has more than tripled—from 31,442 persons in 2008 to 73,752 in 2011—amounting to 58.2 researchers per 10,000 labour force. The number of technicians and support staff has also increased—from 2,797 technicians in 2008 to 8,347 in 2011; and from 6,601 support staff in 2008 to 14,862 in 2011.

3.6.1 Researcher Headcount by Qualifications, 2006-2011

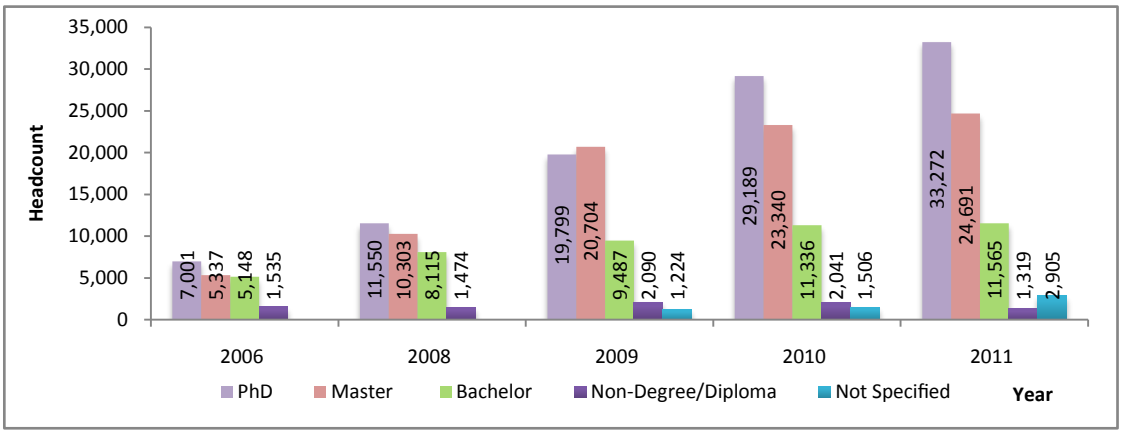
The quality of R&D personnel and the qualifications they hold are instrumental in the advancement of R&D. In 2011, the number of PhD qualified researchers involved in R&D was estimated at 33,272, close to 45.1% of the total researchers in Malaysia **(Figure 3.13)**. The share of PhDs among researchers was the highest among researchers in the IHLs **(Figure 3.14).**

Figure 3.12: Headcount of Research Personnel and Researchers per 10,000 Labour Force, 2000-2011



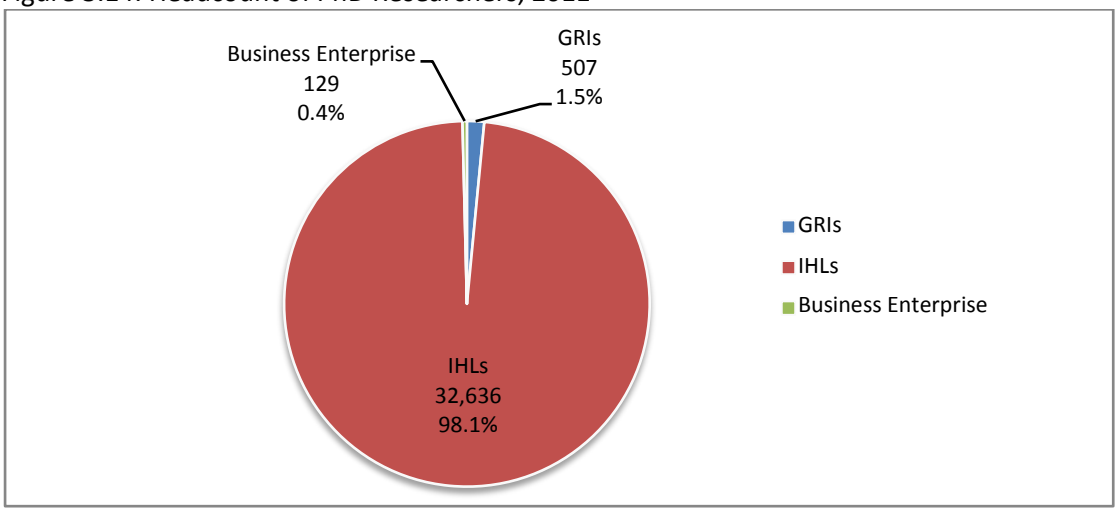
Source: National Survey of Research & Development 2012

Figure 3.13: Headcount of Researchers by Qualifications, 2006-2011



Source: National Survey of Research & Development 2012

Figure 3.14: Headcount of PhD Researchers, 2011

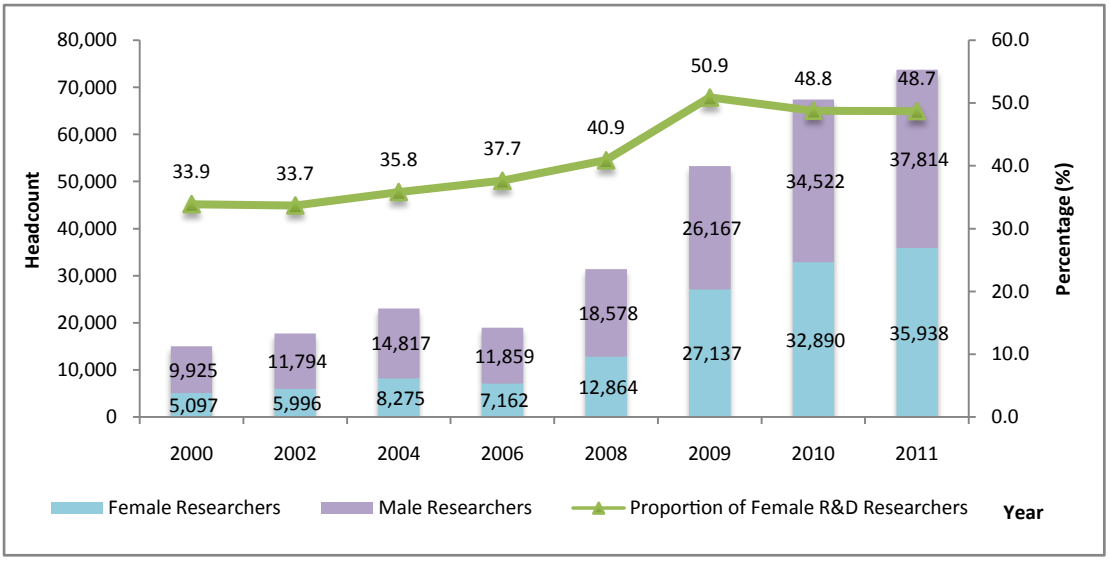


Source: National Survey of Research & Development 2012

3.6.2 Researcher Headcount by Gender, 2000-2011

An analysis of researchers by gender shows that female participation in R&D has steadily increased over the years. In 2008, women accounted for 40.9% of Malaysia's R&D workforce, 3.2% higher than that in 2006 (**Figure 3.15)**. Female researchers further increased in number in 2009, accounting for slightly more than half of the workforce (50.9%). This is the highest female participation recorded since 2000, where female researchers actually outnumbered their male counterparts. The figures then dropped slightly to 48.8% and 48.7% respectively in 2010 and 2011.

Figure 3.15: Headcount of Researchers by Gender, 2000-2011

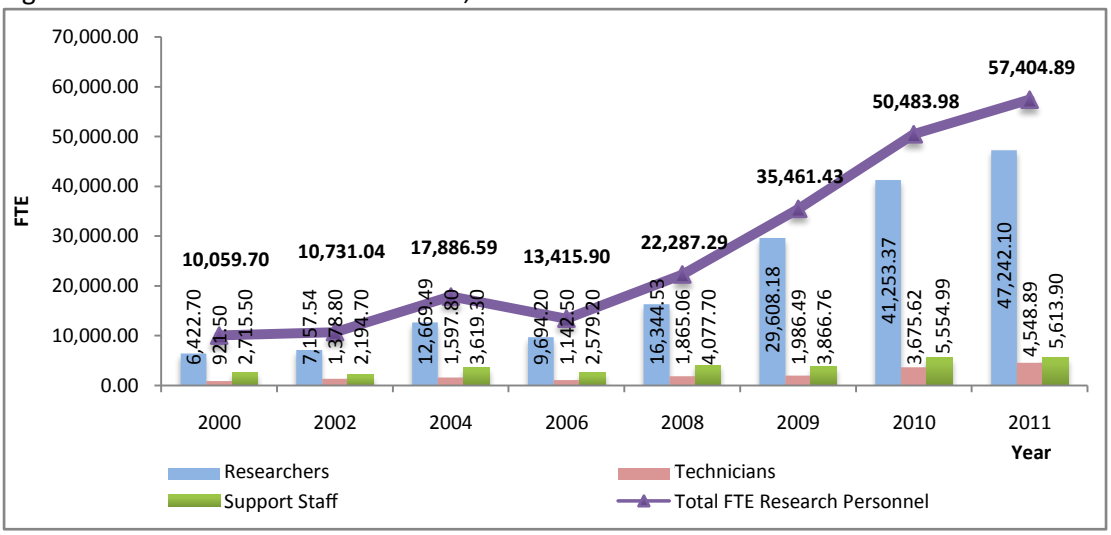


Source: National Survey of Research & Development 2012

3.6.3 Full-time Equivalence (FTE)

Full-time equivalence (FTE) is the amount of time in a year that a research personnel devotes to R&D. As a rule of thumb, the greater the FTE of research personnel, the greater is his or her R&D intensity. **Figure 3.16** shows a considerable growth of total FTE of research personnel from 2006 (13,415.90) to 2011 (57,404.89). This was largely brought about by the marked increase in researcher FTE, which grew by 387.3% over the 11-year period (2000-2011). On the other hand, the FTEs of technicians and support staff remained relatively constant from 2000 to 2009, but showed a small growth in 2010 and 2011.

Figure 3.16: FTE of Research Personnel, 2000-2011



Source: National Survey of Research & Development 2012

3.7 INTERNATIONAL COMPARISONS

Longitudinal studies have shown a positive relationship between R&D activities and productivity growth[9], and estimates of social returns on R&D have clustered in the range of 20 to 60 per cent, making R&D a major source of growth, responsible for at least half of all increases in per capita output[10]. These suggest that R&D plays a central role as the engine of a country's growth and development. Hence, it is important that a comparison of Malaysia's R&D activities vis-à-vis developed nations be made as this will help to indicate her potential in achieving a developed nation status by 2020.

This chapter compares Malaysia's R&D activities with those of selected countries in the East and South East Asian region and the advanced economies[11]. These country groups were selected for comparison to address the objectives of the national R&D survey, which were to compare Malaysia's R&D activities with those in the East Asian region, and benchmark her R&D achievement with that of developed nations. The comparison also aims at providing a picture of the distribution of R&D activities in the East Asian region and around the world.

The International data used in this chapter were obtained from the IMD World Competitiveness Yearbook 2012 (WCY) and the UNESCO Institute of Statistics. However, the Malaysian R&D indicators published in the WCY 2012 are estimated data, based on extrapolations of previous values. Hence, most of the charts in this chapter show two different numbers to represent Malaysia's R&D indicators, the first being indicators from the National R&D survey 2012 (marked as MALAYSIA*), and the second being estimated figures from the IMD World Competitiveness Yearbook 2012 (marked as MALAYSIA**).

[9] Frantzen, Dirk, 2000, "R&D, Human Capital and International Technology Spillovers: A Cross Country Analysis,"*Scandinavian Journal of Economics*, 102 ,pp. 57-75; and Griffith Rachel, Stephen Redding, and John Van Reenen, 2004, "Mapping the Two Facesof R&D: Productivity Growth in a Panel of OECD Countries," *Review of Economics and Statistics*, 86 ,pp. 883-895

[10] Griliches, Z. (1992). "The Search for R&D Spillovers," *Scandinavian Journal of Economics*, 94, pp. 29-47.

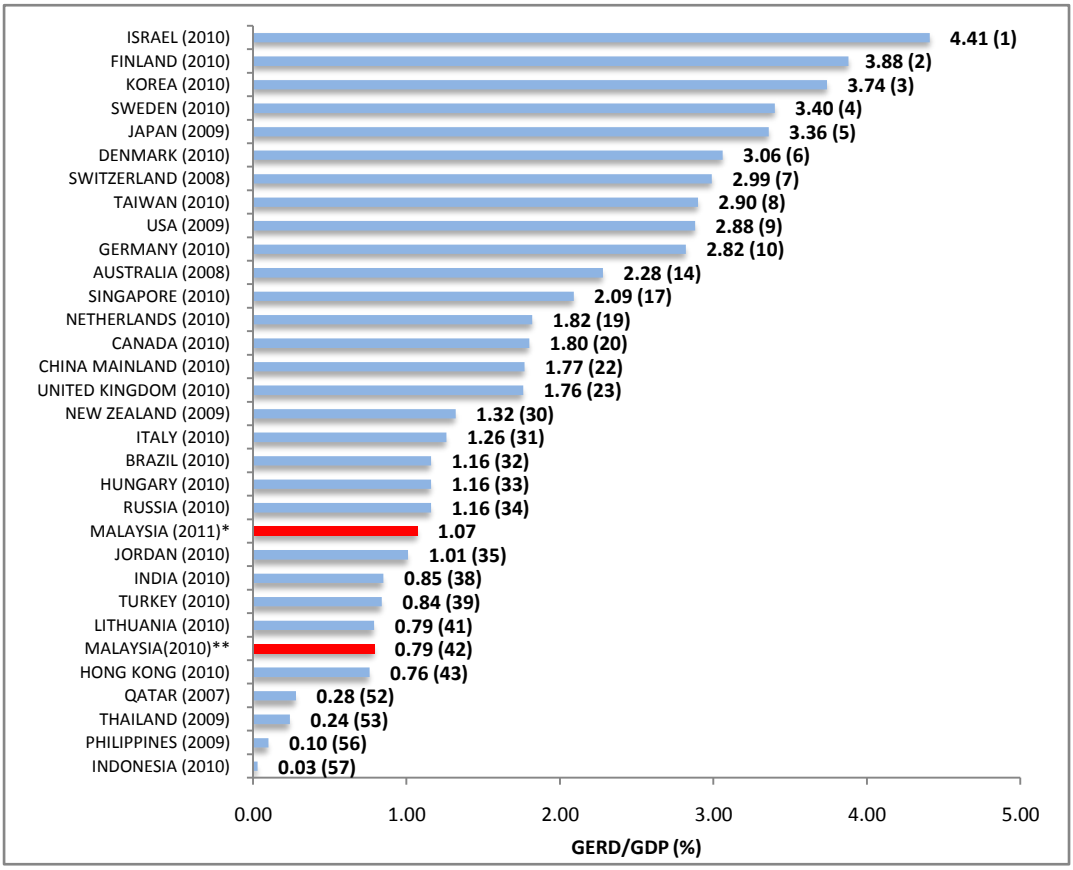
[11] Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, San Marino, Singapore, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, Taiwan, United Kingdom, United States.

3.7.1 R&D Intensity: GERD per GDP

The gross expenditure on R&D (GERD) is used as an indicator of a country's R&D activities. It is based on the expectation that the higher a country's R&D expenditure is, the greater are its R&D activities. However, to make GERD figures comparable across countries, measures of R&D intensity are used. This approach provides a means of adjusting for the differences in the sizes of national economies. One of these measures is the GERD per GDP.

Malaysia's GERD per GDP for 2011 is 1.07—which means that her gross expenditure on R&D accounted for 1.07% of her GDP. The country with the highest GERD/GDP is Israel, estimated at 4.41%, while Finland, Korea, Japan, Sweden and Denmark all have research intensities (GERD/GDP) of above 3.0% **(Figure 3.17)**. Among the advanced economies as listed by the WCY, Brazil, Hungary and Russia are the closest to Malaysia, with a GERD per GDP of 1.16%, while the average for the OECD countries stands at 2.3% in 2009. Closer to Malaysia, Singapore recorded a GERD per GDP of 2.09%, twice that of Malaysia, while the GERD/GDP recorded for Thailand, the Philippines and Indonesia is below 0.3%.

Figure 3.17: GERD per GDP (%)



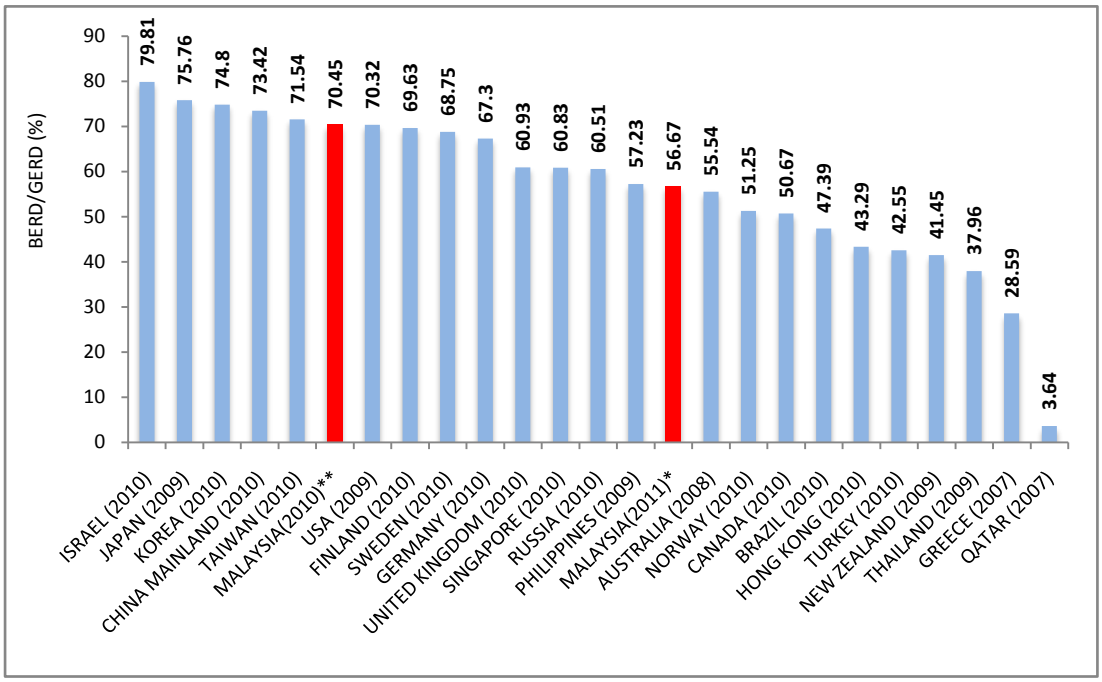
Source: The IMD World Competitiveness Yearbook (2012).

Note: MALAYSIA* is the GERD per GDP taken from the National Survey of R&D 2012 while MALAYSIA** is the GERD/GDP estimated by WCY. The numbers in parenthesis show the rank of the countries in terms of their GERD/GDP.

3.7.2 Business Expenditure on R&D

The importance of the business sector's involvement in R&D is manifested in the advanced economies' BERD per GERD, which shows the share of business-sector R&D relative to the total R&D expenditure. In 2011, Malaysia recorded a BERD of 56.67% of her GERD, several percentages smaller than the BERD/GERD shares of many advanced economies, which ranged between 60% and 80% **(Figure 3.18)**.

Figure 3.18: BERD per GERD

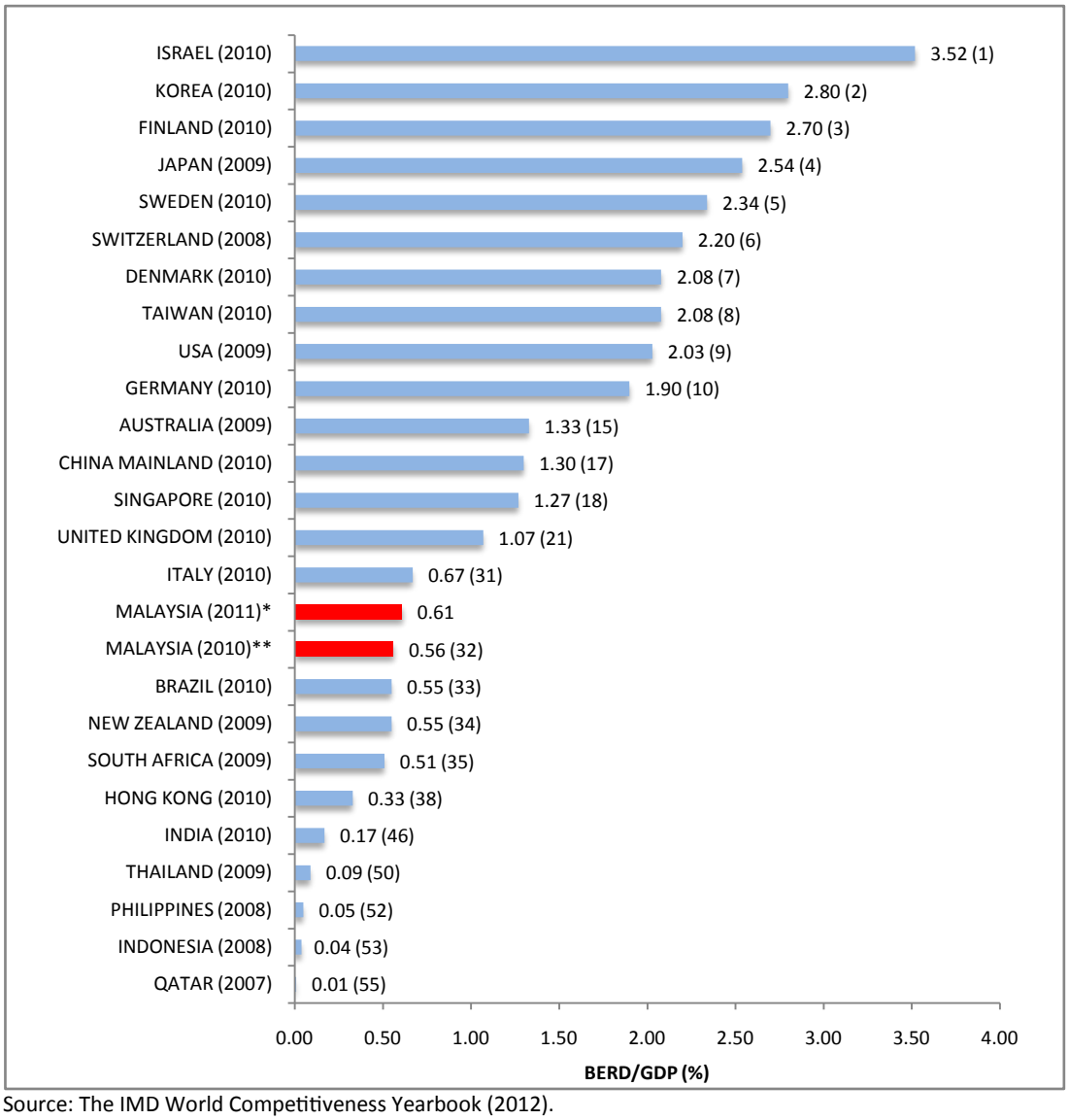


Source: The IMD World Competitiveness Yearbook (2012).
Note: MALAYSIA* is the BERD per GERD taken from the National Survey of R&D 2012 while MALAYSIA** is the BERD/GERD estimated by WCY.

BERD per GDP, on the other hand, shows the R&D intensity of the business sector. Specifically, it shows the percentage of the GDP that is spent on R&D by the business sector. Malaysia's BERD per GDP in 2011 is 0.61 **(Figure 3.19)**; which is quite low when compared to that of developed East Asian countries such as Singapore (1.27), South Korea (2.8), and Taiwan (2.08). The world's highest performer of business R&D is Israel (3.52), followed by South Korea (2.8) and Finland (2.7). The U.S., however, has a BERD per GDP of only 2.03%, far smaller than Israel's, even though the U.S. BERD for 2010 (USD282,393 million) is the highest globally[12].

[12] The IMD World Competitiveness Yearbook (2012)

Figure 3.19: BERD per GDP (%)



Source: The IMD World Competitiveness Yearbook (2012).
Note: MALAYSIA* is the BERD per GDP taken from the National Survey of R&D 2012 while MALAYSIA** is the BERD/GDP estimated by WCY. The numbers in parenthesis show the rank of the countries in terms of their BERD/GDP.

3.7.3 Human Resource Development in R&D

In the past, Malaysia's economic growth was driven predominantly by factor accumulation; especially of low skilled workers. However this model is not sustainable, and is inconsistent with the economic structure of most advanced economies. A transformational shift is needed for Malaysia to be among the advanced economies.

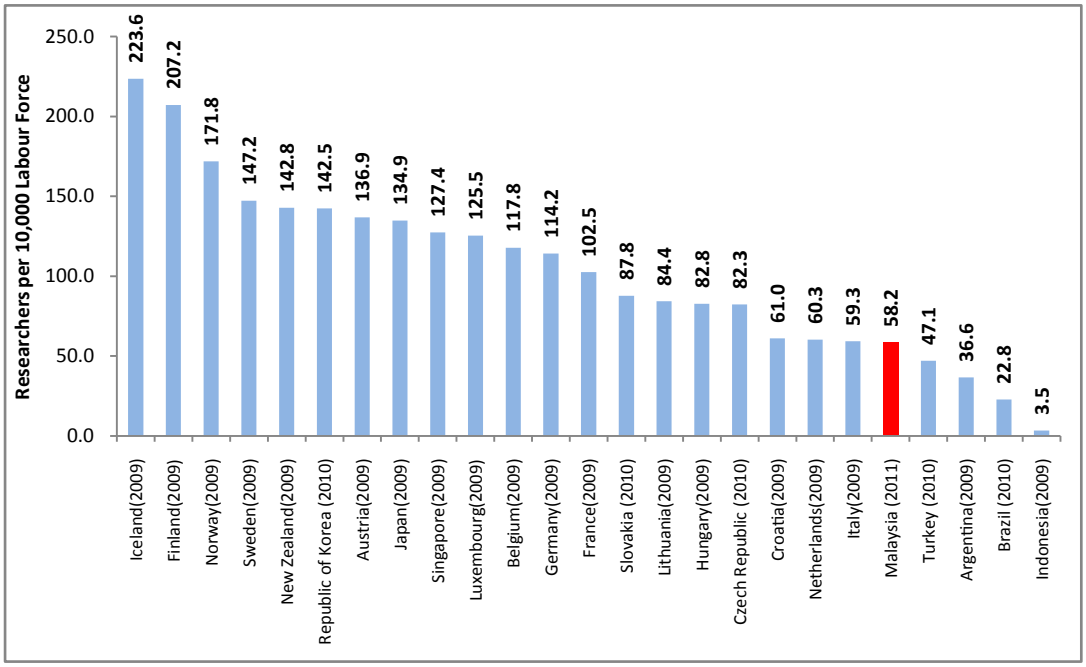
The stock of researchers is an indicator of Malaysia's competency in R&D, and provides a benchmark with regard to the possibility of moving up the value chain, as it is the researchers, those who are at the frontiers of technology, who will lead innovation and the transformation of the economy. Indeed, the Ninth Malaysia Plan had set the target of 50 researchers for every 10,000 members of the labour force by 2010.

3.7.4 Researchers per 10,000 Labour Force

In 2011, the number of researchers in Malaysia is estimated at 73,752. However, it should be mentioned that the headcount of researchers is a function of the size of the economy and the size of the population; hence countries with large populations will tend to have more researchers. To provide an indicator of researcher intensity, researchers per 10,000 labour force, which compares the proportion of researchers in the labour force across countries, is used.

In 2011, Malaysia recorded 58.2 researchers out of 10,000 labour force, close to that of Italy (59.3) and the Netherlands (60.3). Even though this topped the target set by the Ninth Malaysia Plan, it is still smaller than the proportion of researchers in other advanced economies such as South Korea and Singapore, with 142.5 and 127.4 researchers per 10,000 labour force respectively, and the OECD average of 76.0 researchers per 10,000 labour force[13].

Figure 3.20: Researchers per 10,000 Labour Force



Source: UNESCO Institute for Statistics (www.uis.unesco.org)
Note: Statistics for Malaysia are taken from the National Survey of R&D 2012. No data were available for the U.S.

3.7.5 Full Time Equivalence (FTE) of Research Personnel per Capita

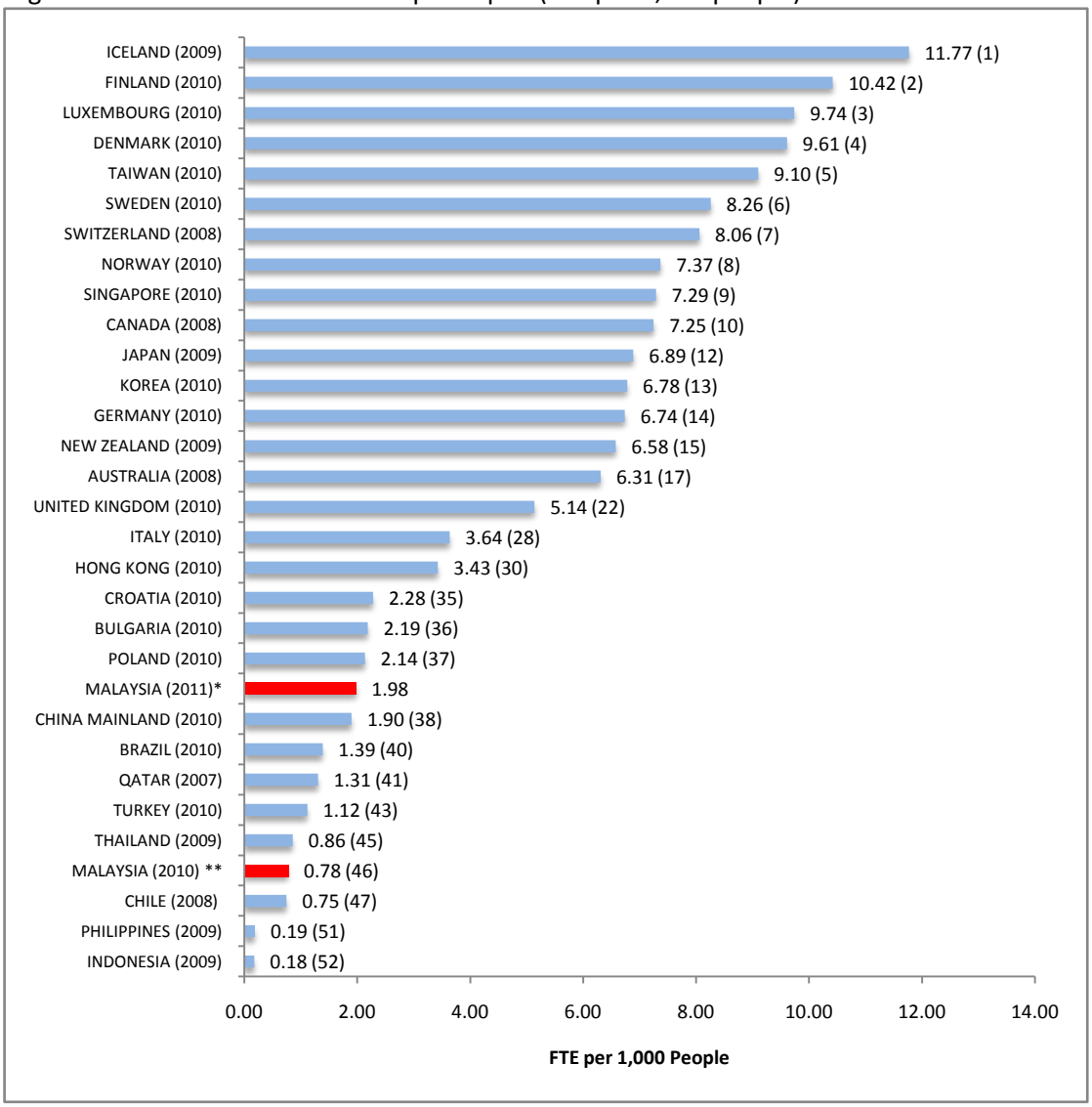
A nation's workforce must adequately respond to the needs of the productive sectors in the economy. Hence, it is important that we have qualified research personnel. However, this is not the only factor that determines the success of a nation's R&D. The amount time in a year that they have undertaken for R&D activities—or their full time equivalence (FTE) is also of primary importance.

However, to allow us to compare FTE across countries—in other words, researcher intensity—FTE per 1,000 people is used. Based on the data available, Iceland, with a

[13] Source: OECD Science, Technology and Industry Scoreboard 2011

research personnel FTE of 11.77 per 1,000 people, ranks the highest, while Malaysia's research personnel FTE per 1,000 people of 1.98 **(Figure 3.21)** would have placed her between Poland and Mainland China. China, the country with the greatest number of research personnel, has a research personnel FTE of 1.90 per 1,000 people—less than that of Malaysia—even though her total FTE is the highest globally at 2,553,800[14]. For the advanced economies, the minimum research personnel FTE per 1,000 people is about 3.

Figure 3.21: FTE of R&D Personnel per Capita (FTE per 1,000 people)



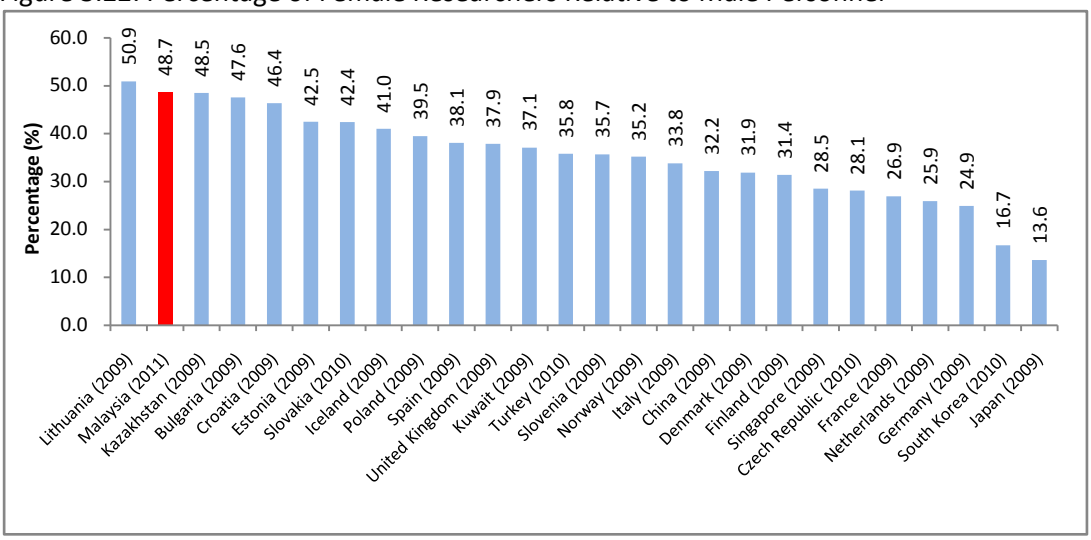
Source: The IMD World Competitiveness Yearbook (2012).
Note: MALAYSIA* is the FTE per 1,000 people taken from the National Survey of R&D 2012 while MALAYSIA** is the FTE per 1,000 people estimated by the WCY. The numbers in parenthesis show the rank of the countries in terms of their FTE per 1,000 People.

[14] The IMD World Competitiveness Yearbook (2012)

3.7.6 Female Researchers

As shown in **Figure 3.22**, the percentage of female researchers in many of the advanced Western European nations is smaller than that of their Eastern European counterparts. The data parallel the findings of the European Commission (2008), which found that only 15% of full professors in European universities are women and that women are under-represented in decision-making scientific boards in almost all European countries[15]. In contrast, Malaysia recorded a percentage of 48.7% female researchers relative to their male counterparts, which is far better than the situation in many advanced economies, including Denmark (31.9%), Finland (31.4%), Singapore (28.5%), Germany (24.9%), South Korea (16.7%), and Japan (13.6%).

Figure 3.22: Percentage of Female Researchers Relative to Male Personnel



Source: UNESCO Institute of Statistics (www.uis.unesco.org)
Note: Statistics for Malaysia are taken from the National Survey of R&D 2012.

3.8 CONCLUSION

The marked increase in the various measures of R&D, i.e. GERD, GERD/GDP, headcount of researchers and research personnel, and researcher intensity, point to the fact that Malaysia is making steady progress in R&D. In addition, there is also an increase in the quality of researchers, as reflected in the substantial increase in those with PhD and Masters degrees, as well as in the participation of women in R&D. However, these achievements, though notable, are not sufficient to allow us to reach the goal of being a high-income nation by 2020 as emphasised in the New Economic Model and the 10th Malaysia plan. To achieve this goal, we need to invest sufficiently in R&D as this will lead to greater economic growth. Our researcher intensity of 58.2 researchers per 10,000 labour force is still below that of many advanced economies such as Singapore (127.4), Germany (114.2), and France (102.5), and the OECD average of 76 researchers per 10,000; while our GERD/GDP of 1.07% is also below that of advanced economies and the OECD average of 2.3%.

In addition to developing our research and researcher intensity, there is also a need to improve our Business Expenditure on R&D (BERD) as it plays a significant role in propelling developed nations well ahead of less developed nations. BERD in developed countries range

[15] European Commission. (2008) *Mapping the Maze: Getting More Women to the Top in Research*. Luxembourg: Office for Official Publications of the European Communities.

from 60% to 80%; with 70% being the OECD average. Given Malaysia's relatively small share of BERD relative to her GERD, the New Economic Model's aim of having the business sector as the nation's primary driver for long-term economic growth may be hampered unless Malaysia makes serious efforts to push for greater, stronger, more diverse, and more resilient R&D. To this end, the shifting of economic incubators towards the private or business sector, as articulated in the 10th Malaysia Plan, can be considered as a smart economic move for increasing Malaysia's performance in R&D, although it should also be emphasised that the role of the government is to facilitate R&D, and not to provide the bulk of the investment for business R&D, which should come from its own funds. Thus, it is important that business and government work closely together so that long-term economic growth may be sustained.

CHAPTER 4:
PUBLIC SUPPORT FOR R&D IN STI

CHAPTER 4

PUBLIC SECTOR SUPPORT FOR RESEARCH AND DEVELOPMENT (R&D) IN SCIENCE, TECHNOLOGY AND INNOVATION

4.0 INTRODUCTION

Malaysia has provided public sector support for Research and Development (R&D) in Science, Technology, and Innovation (STI) since the 1980s to companies, research institutions; government science, technology, and innovation agencies; and public and private institutions of higher learning (IHLs). In 1988, the Intensification of Research in Priority Areas (IRPA) grant under the Ministry of Science, Technology, and Innovation (MOSTI) was launched and later extended to the private sector via the Industrial R&D Grant Scheme (IGS) (launched in 1997, but discontinued in 2005), the Multimedia Super Corridor (MSC) R&D Grant Scheme (MGS), and the Demonstrator Application Grant Scheme (DAGS). In the 1990s, other grants were established, such as the Technical Acquisition Fund (TAF) and Commercialisation of R&D Fund (CRDF), administered by the Malaysian Technology Development Corporation (MTDC) to promote the commercialisation of local research results, introduce strategic technologies, and manufacture products widely used as industrial inputs. Later, MOSTI introduced the ScienceFund, TechnoFund, InnoFund, e-Content, and DAGS Roll Out aimed at financing projects from the research and development to the commercialisation phase.

The Biotechnology R&D Grant Scheme was established in 2001 under the National Biotechnology Directorate (NBD) to support biotechnology R&D activities and the commercialisation of research findings in specific areas of the Malaysian biotechnology industry. In addition, the Biotechnology Commercialisation Fund (BCF) was established under the Tenth Malaysia Plan as a funding scheme that combines term loans and grants to facilitate on-going commercialisation of biotechnology products and services and/or expansion of existing biotechnology business. The Industrial Technical Assistance Fund (ITAF) is another scheme where a matching grant incentive is given to assist small and medium-scale enterprises (SMEs) to become technologically proficient as well as cost competitive. Apart from the various non-fiscal incentives above, Malaysia also provides a number of fiscal incentives to promote R&D in the form of tax exemption for the promotion of exports of goods and services with value-added element.

This chapter describes the various public sector support programmes and incentives for R&D undertaken through MOSTI and the designated agencies, such as the Multimedia Development Corporation (MDeC), the Malaysian Technology Development Corporation (MTDC), and the Malaysian Industrial Development Authority (MIDA). In addition, the various grants provided by the Ministry of Higher Education (now merged with the Ministry of Education) are also presented. This chapter also presents the trends and patterns in the performance of existing incentive programmes over the years covered in this Report. However, it does not purport to be all inclusive of the funds made available by the Malaysian government; and it includes only funds for which data are available. The next section presents the trends for STI-related grant schemes, for grants supported by the Ministry of Education, followed by the section on R&D investment incentives.

4.1 THE SPECTRUM OF PUBLIC FUNDING & OTHER STI-RELATED GRANT SCHEMES

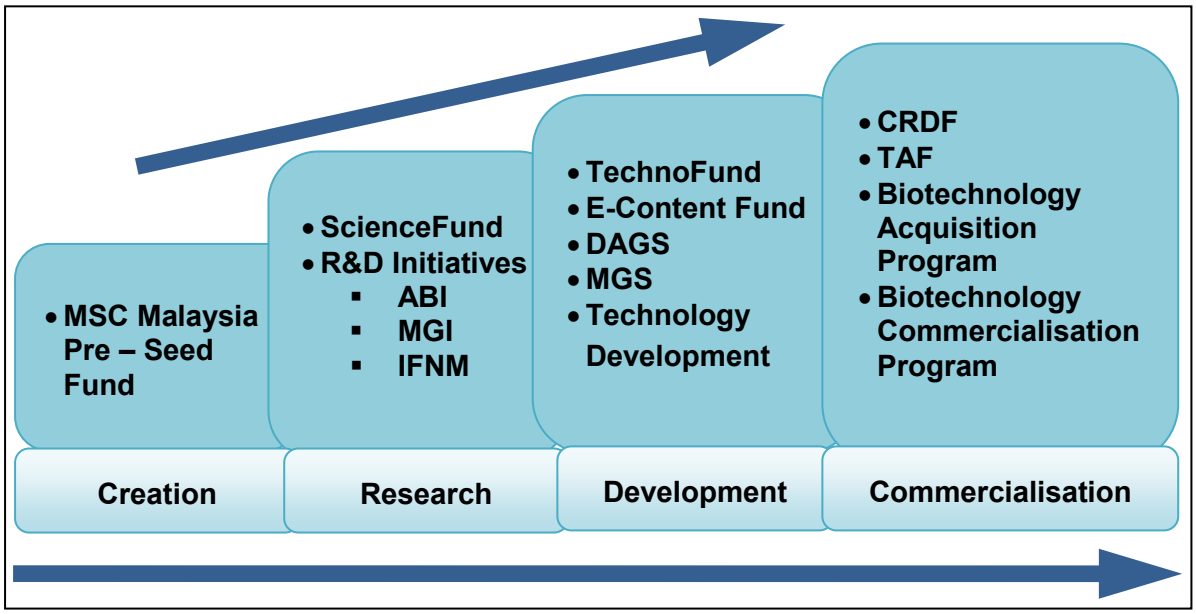
The spectrum of public funding encompasses four stages of Research & Development (R&D) activities, beginning from the 'Creation' stage followed by the 'Research', 'Development' and 'Commercialisation' stages, as shown in **Figure 4.1**. The initial 'Creation' stage is supported by grants to individuals and early-startup companies by MSC Malaysia in the form of:

- The MSC Malaysia Pre-Seed Fund Programme, which plays a role to boost the development of commercially viable ICT projects and stimulate a chain reaction in the creation of new local K-SMEs in ICT.

- The ICONedu (Online Education Content Creation Grant) for the local SMEs and technopreneurs who want to be innovative and commercially focused on putting their educational projects up for online consumption.

- The ICONity (Online Social and Community Content Creation Grant) for the development of social and community content platforms and eco-systems by Malaysians.

Figure 4.1: The Spectrum of Public Funding of Research, Development, and Commercialisation



Source: Ministry of Science, Technology and Innovation (MOSTI)

Based on **Figure 4.1**, this section examines the performance of grant schemes in the subsequent stages of the spectrum of public funding for STI-related R&D from the research to the commercialisation stage. Due to data constraints, the grant schemes covered are as follows:

The Research Stage:

- ScienceFund (including Nanotechnology)
- Biotechnology R&D Grant Scheme
    - Agro-Biotechnology R&D Initiatives (ABI)
    - Pharmaceutical & Nutraceutical R&D Initiatives (IFNM)
    - Genomic & Molecular Biology R&D Initiatives (MGI)

The Development Stage:

- TechnoFund
- InnoFund
- MSC Malaysia R&D Grant Scheme (MGS)

The Commercialisation Stage:

- Commercialisation of R&D Fund (CRDF)
- Technology Acquisition Fund (TAF)
- Biotechnology Commercialisation Fund (BCF)
- Industrial Technical Assistance Fund (ITAF)

4.1.1 The Research Stage

4.1.1.1 ScienceFund

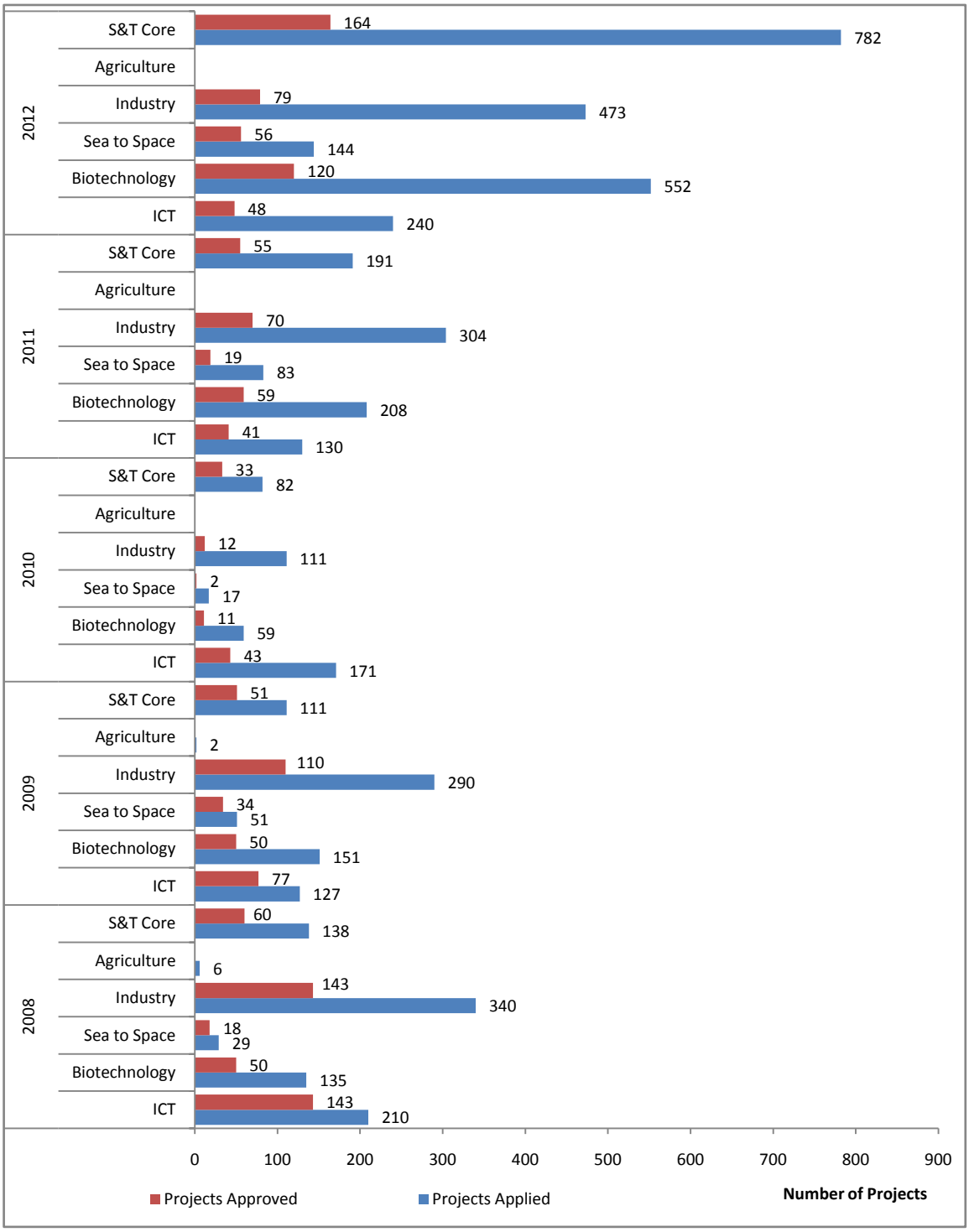
The ScienceFund is a grant provided by the Government to eligible entities to undertake R&D projects that can contribute to the discovery of new ideas and the advancement of knowledge in applied sciences, focusing on high impact and innovative research. Eligible entities included are all research scientists and engineers employed on a permanent or contractual basis in Government Research Institutions, Government STI Agencies, and Public and Private Institutions of Higher Learning (IHLs) with accredited research programmes.

The fund has the objectives of supporting R&D projects that can lead to the innovation of products or processes for further development and commercialisation; and generating new scientific knowledge and strengthening national research capacity and capability. The ScienceFund has a ceiling value up to RM500,000 per proposal, and it focuses on six main clusters, namely, information and communications technology (ICT), biotechnology, agriculture, industry, sea to space, and science & technology core. The outcome of research under ScienceFund that has commercial potential can be considered for additional funding under the TechnoFund.[16]

The total number of projects applied for saw a declining trend over the earlier years from 858 in 2008, to 732 in 2009, to only 440 in 2010. A similar trend is seen for the projects approved, which declined from 414 in 2008, to 322 in 2009, to only 101 in 2010. However, the number of projects applied for increased in the subsequent years to 916 in 2011 and 2,191 projects in 2012, while the number of projects approved also increased to 244 and 467 in 2011 and 2012, respectively **(Figure 4.2).**

[16] http://ernd.mosti.gov.my/eScience/download/GUIDELINES%20-%20SCIENCEFUND.pdf

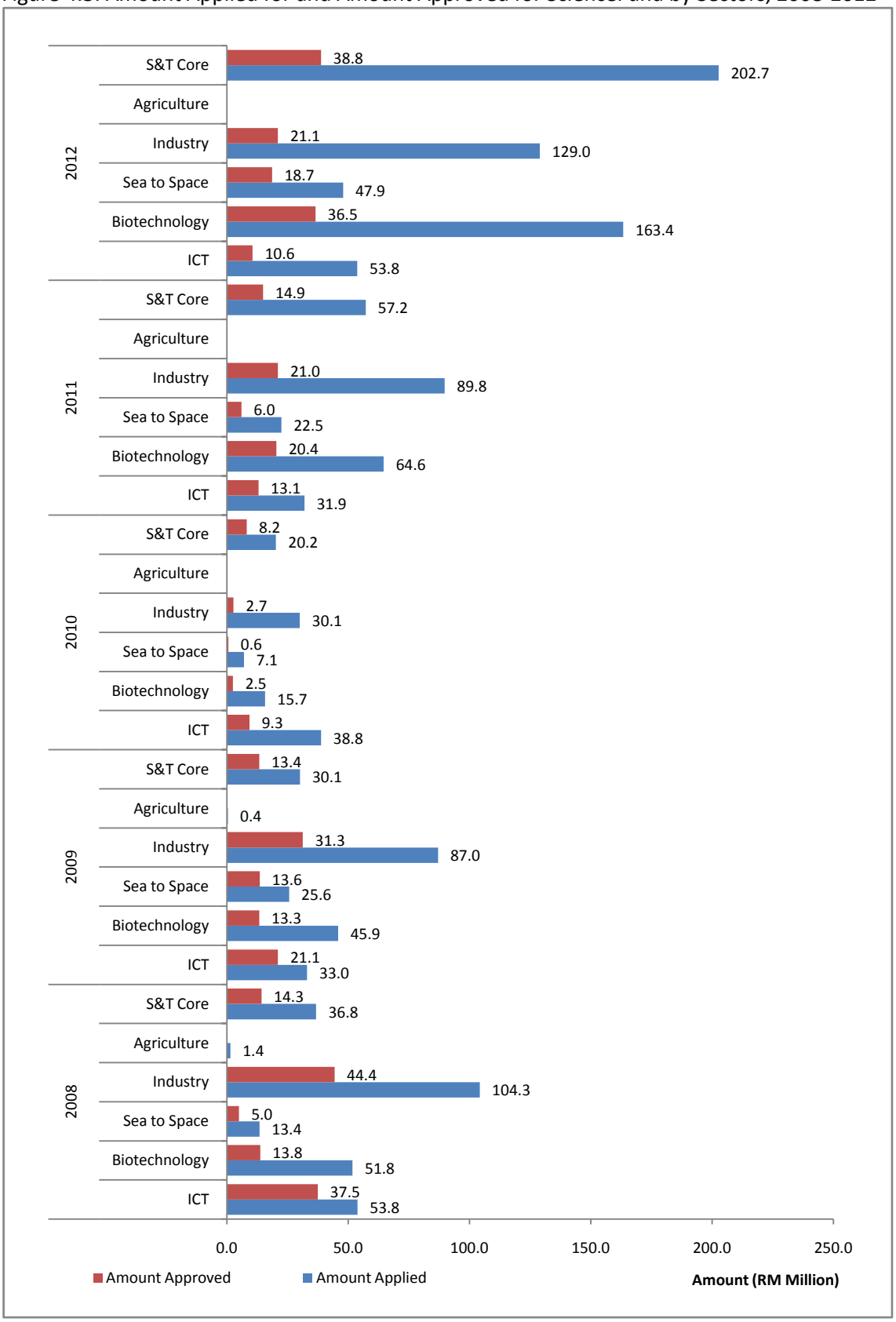
Figure 4.2: Number of Projects Applied for and Projects Approved for ScienceFund by Sector, 2008-2012



Source: Ministry of Science, Technology and Innovation (MOSTI)

The Industry sector is observed to have received the highest number of projects applied for and approved, as well as in terms of amount applied for and approved on average between 2008 and 2011. However, in 2012 the S&T core sector became the highest recipient in terms of the number of projects and amount applied for and approved **(Figure 4.3).**

Figure 4.3: Amount Applied for and Amount Approved for ScienceFund by Sectors, 2008-2012

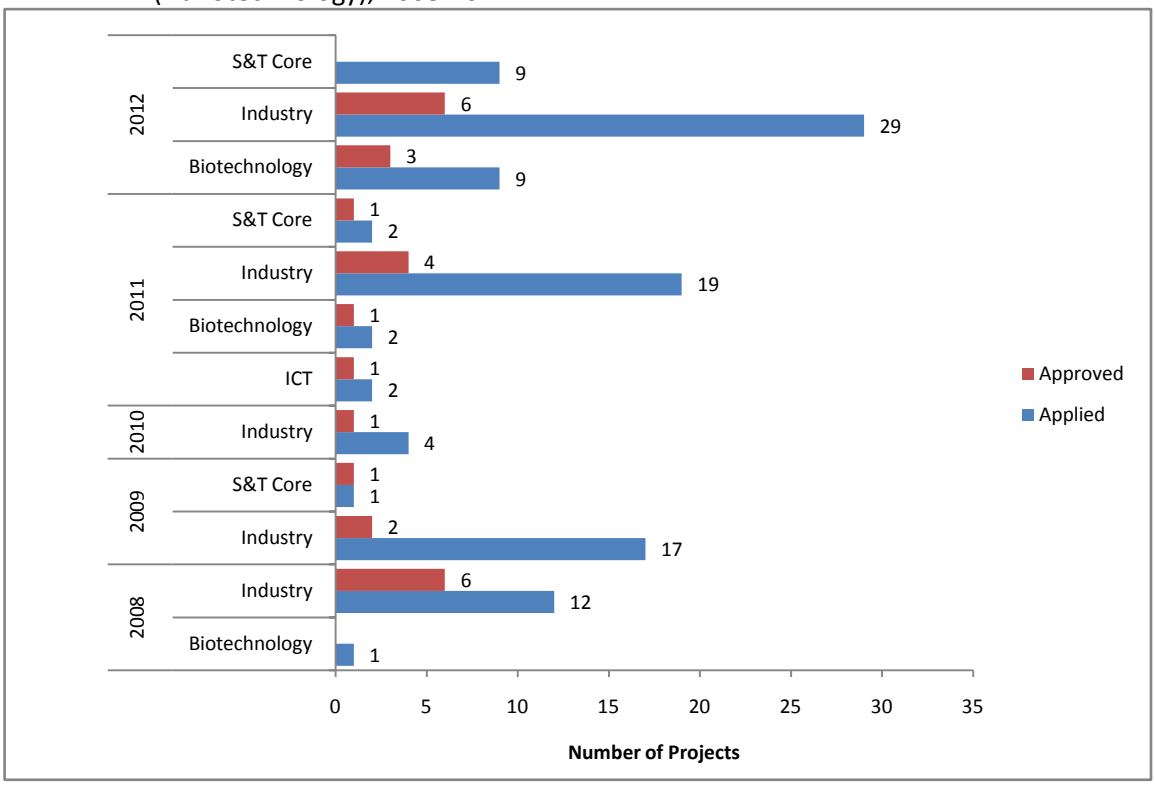


Source: Ministry of Science, Technology and Innovation (MOSTI)

As for ScienceFund in nanotechnology, the number of projects approved declined from 6 in 2008 to only 1 in 2010, but increased to 7 and 9 in 2011 and 2012, respectively. However, the number of projects approved was far below the number applied for, especially in the last 2 years where the number applied was 25 and 47 in 2011 and 2012, respectively **(Figure 4.4)**.

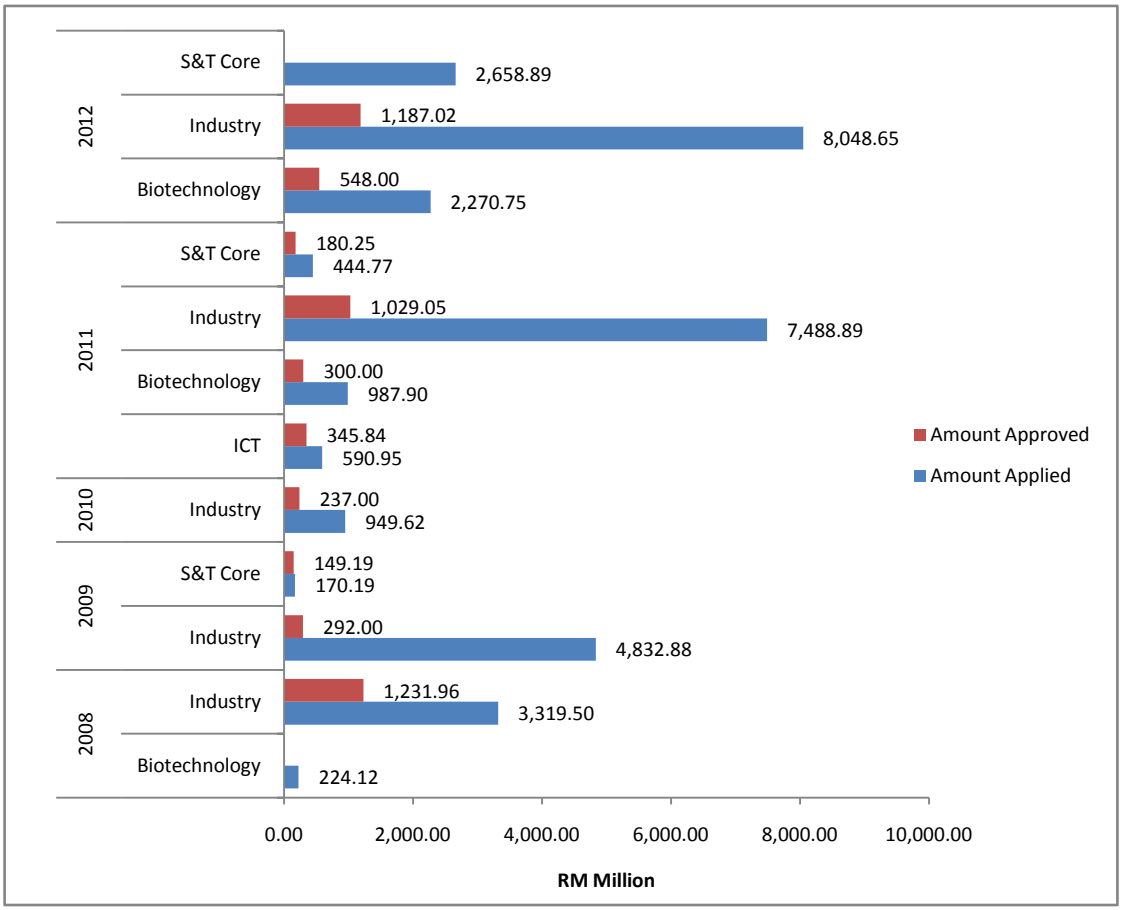
A similar trend can be seen for the amount applied for and approved, where they declined from 2008 to 2010 but recovered back in 2011 and 2012. Research projects in the Industry sector remains the dominant sector in all the years, in terms of projects applied and approved as well as in terms of amount applied and approved **(Figure 4.5)**.

Figure 4.4: Number of Projects Applied for and Projects Approved for Sciencefund (Nanotechnology), 2008-2012



Source: Ministry of Science, Technology and Innovation (MOSTI)

Figure 4.5: Amount Applied for and Amount Approved for ScienceFund (Nanotechnology), 2008-2012



Source: Ministry of Science, Technology and Innovation (MOSTI)

4.1.1.2 Biotechnology R&D Grant Scheme

The Biotechnology R&D Grant Scheme was established in 2001 under the National Biotechnology Directorate (NBD) to support biotechnology R&D activities and the commercialisation of research findings in specific areas that are of national importance to the Malaysian biotechnology industry. Three types of R&D initiatives are given under this scheme, namely, agro-biotechnology R&D initiatives, pharmaceutical & nutraceutical R&D initiatives, and genomic & molecular biology R&D initiatives **(Table 4.1)**. However, the agro-biotechnology and pharmaceutical & nutraceutical R&D initiatives were only offered during the Ninth Malaysia Plan, 2006-2010.

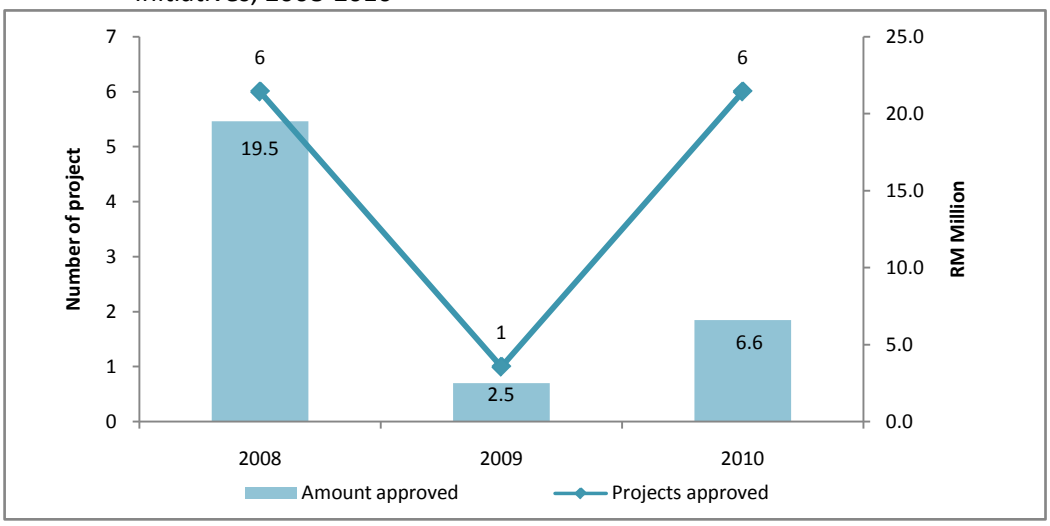
Table 4.1: Types of Biotechnology R&D Grant Schemes

Fund name	Fund size (RM)	Purpose of funding	Maximum amount per company
Agro - Biotechnology R&D initiatives	80 million	R&D in strategic areas of agro-biotech that will lead to modernization and transformation of the agricultural sector.	Up to a maximum of the total project cost or RM2.5 million, whichever is lower.
Pharmaceutical & Nutraceutical R&D Initiatives	90 million	To develop 'proof of concept' products or services developed by local scientists to comply with the international standards imposed by the regulatory authorities, such as good research practice (GRP) and good laboratory practice (GLP).	Up to a maximum of the total project cost or RM5 million, whichever is lower.
Genomic & Molecular Biology R&D Initiatives	100 million	Generation of intellectual properties and technologies for application in modern bio-manufacturing of high value products such as biocatalysts, fine chemicals, and diagnostics.	Up to a maximum of the total project cost or RM5 million, whichever is lower.

Source: Ministry of Science, Technology and Innovation (MOSTI)

The number of approved projects for Agro-Biotechnology R&D Initiatives decreased from 6 in 2008 to only 1 project in 2009. In 2010, 6 projects were approved. A similar trend is seen in terms of amount approved, where it dropped from RM19.5 million in 2008 to only RM2.5 million in 2009. The amount approved increased slightly to RM6.6 million in 2010 (**Figure 4.6)**.

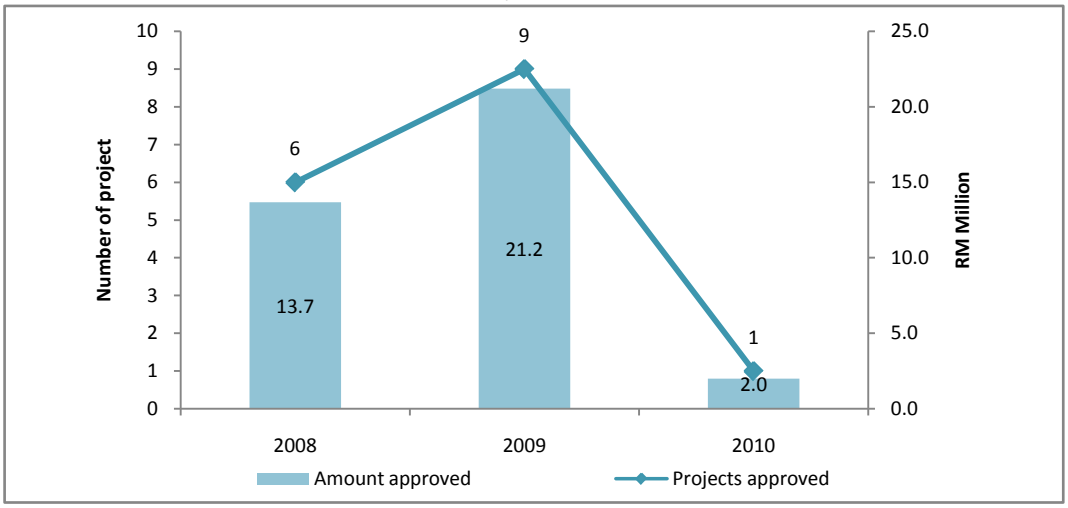
Figure 4.6: Number of Projects and Amount Approved (RM) under Agro-Biotechnology R&D Initiatives, 2008-2010



Source: Ministry of Science, Technology and Innovation (MOSTI)
*Note: This R&D Initiative is only approved under the Ninth Malaysia Plan, 2006-2010.

The opposite can be seen for Pharmaceutical & Nutraceutical R&D Initiatives, where the number of projects and amount approved first went up from 6 projects in the amount of RM13.7 million in 2008 to 9 projects valued at RM21.2 million in 2009. However, by 2010 it decreased to only 1 project with a value of RM2.0 million **(Figure 4.7)**.

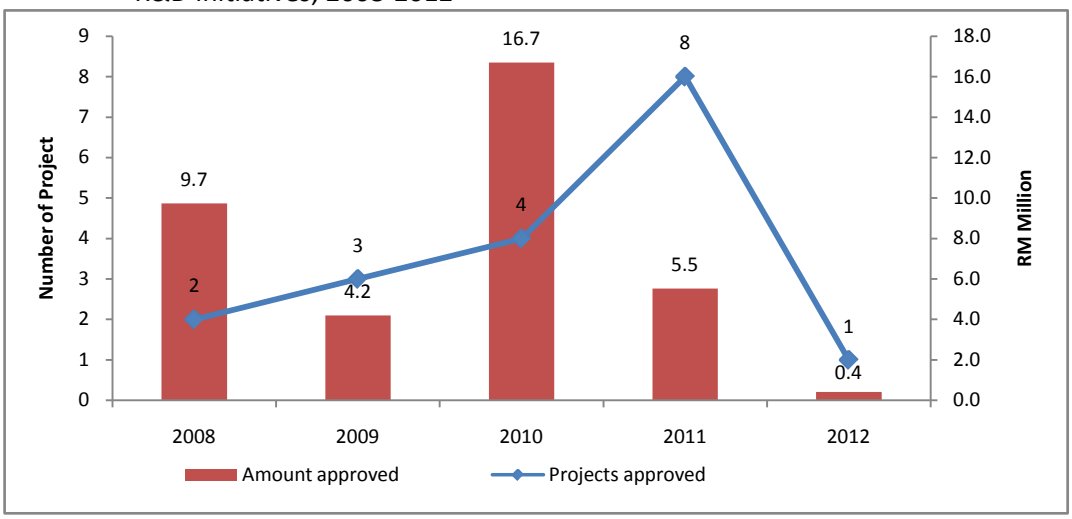
Figure 4.7: Number of Projects and Amount Approved (RM) under Pharmaceutical & Nutraceutical R&D Initiatives, 2008-2010



Source: Ministry of Science, Technology and Innovation (MOSTI)

The number of projects under the Genomic & Molecular Biology R&D Initiatives increased from 2 projects in 2008 to 4 projects in 2010; and increased further to 8 projects in 2011, only to decrease to 1 project in 2012. The amount approved, however, fluctuated over the years, with the highest amount approved at RM16.7 million in 2010, after which it declined to only RM5.5 million in 2011 despite the sharp increase in the number of projects approved in the same year. The amount approved continued to fall to only RM0.4 million the following year **(Figure 4.8)**.

Figure 4.8: Number of Projects and Amount Approved (RM) under Genomic & Molecular Biology R&D Initiatives, 2008-2012



Source: Ministry of Science, Technology and Innovation (MOSTI)
Note: Projects approved in 2011, 2012 and 2013 are under the ScienceFund ER-PS Biotech and ScienceFund Special Allocation

4.1.2 The Development Stage

4.1.2.1 TechnoFund

The TechnoFund is a grant scheme that aims to stimulate the growth and successful innovation of Malaysian enterprises by increasing the level of R&D and its commercialisation. The scheme provides funding for technology development, up to pre-commercialisation stage, with the commercial potential to create new businesses and generate economic wealth for the nation. Specifically, the objectives of the fund are as follows:

- to undertake the development of new or cutting edge technologies or further develop/value add existing technologies/products in specific areas for the creation of new businesses and generation of economic wealth for Malaysia;

- to undertake market driven R&D towards commercialisation of R&D outputs;

- to encourage institutions, local companies and inventors to capitalise their intellectual work through intellectual property (IP) registration; and

- to stimulate the growth and increase capability and capacity of Malaysian technology-based enterprises, Malaysian Government Research Institutes (GRI) and Institutions of Higher Learning (IHL) through both local and international collaborations.

The Pre Commercialisation (TechnoFund) covers the acquisition of technology (foreign and/ or local), the up-scaling of laboratory-scale prototype or the development of commercial ready prototype, and pre-clinical testing/clinical testing/field trials. The amount allocated for each project is between RM1.5 million to RM3 million depending on the merit of the proposed project. The project must contain elements of technological innovation leading to commercialisation of innovative products, processes and services and should be in the pre commercialisation stage with established Proof of Concept (POC).

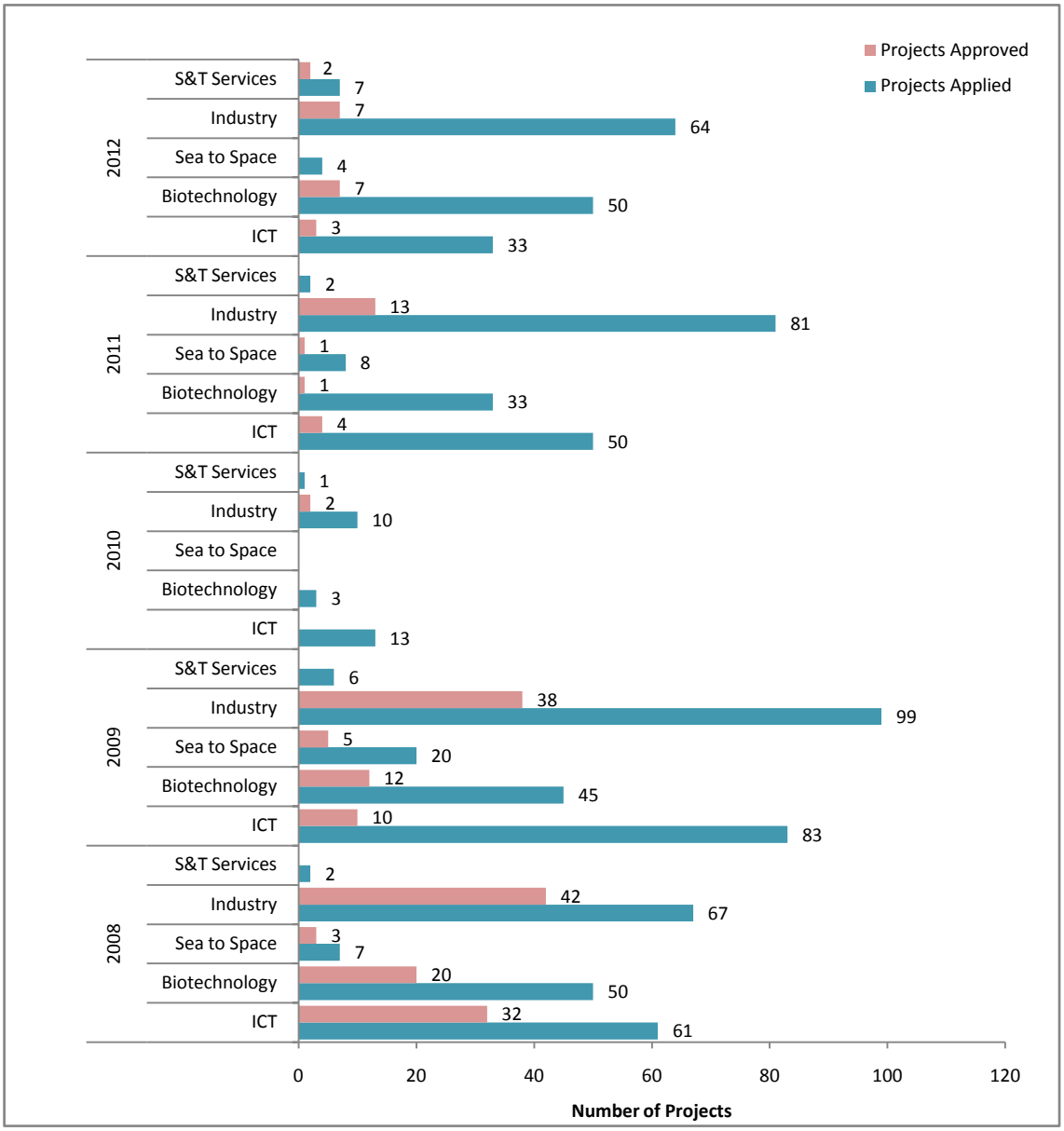
The funding can be used for the following:

- pilot plant/ prototype – equipment and supporting infrastructure which is directly related to the pilot plant;
- IP Preparation and Registration in Malaysia only (excluding maintenance)—existing and new IP;
- market testing / assessment and/or evaluation;
- regulatory and standards compliance;
- expenditure for services (consultancy/ testing) not exceeding 20% of project cost;
- contract expenditure applicable to IHLs and GRIs only (research assistant);
- raw materials/consumables; and
- technology/IP acquisition (if applicable).

The fund focuses on 10 research and priority areas, namely, Engineering Sciences, Advanced Material Sciences, Chemical Sciences, Physical and Mathematical Sciences, Life Sciences, Agricultural Sciences, Medical and Health Sciences, Environmental Sciences, Computer Sciences & ICT, and Social Sciences & Humanities. In addition, there are 13 flagship programmes, which are Renewable Energy, Advanced Manufacturing, Electronics, Wireless Sensor Network, Predictive Analytics, 3-Dimension Internet, Space Technology, Oceanography, Meteorology,

Production System & Precision Agriculture, Biosurveilance, Tropical Emerging Infectious Diseases & Cancer, and Food Technology & Food Biotechnology-based products.[17]

Figure 4.9: Number of Projects Applied for and Projects Approved for TechnoFund by Sector, 2008-2012



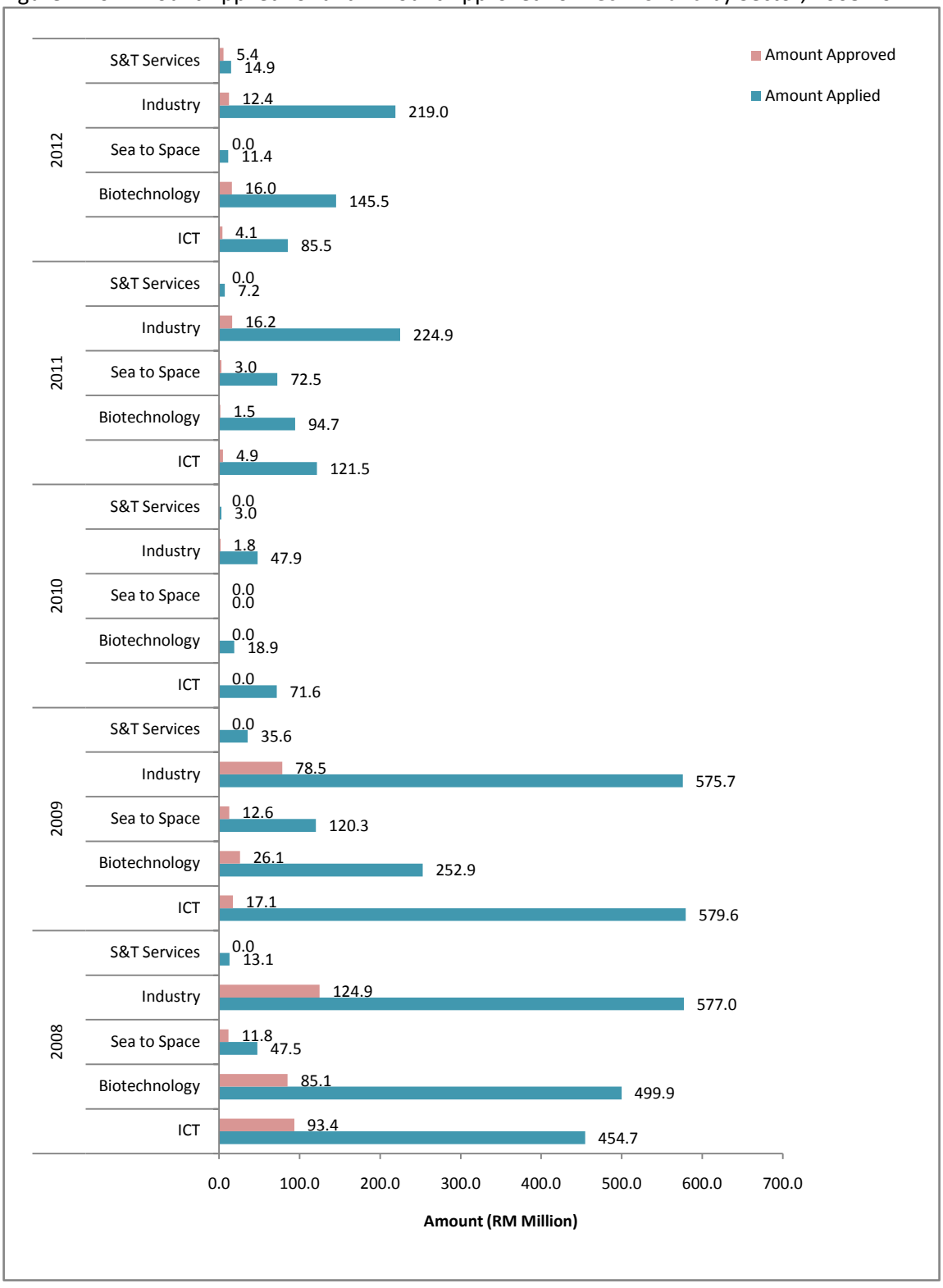
Source: Ministry of Science, Technology and Innovation (MOSTI)

The number of projects applied for and approved under the Technofund suffered a sharp decrease in 2010 from the previous year but recovered gradually in subsequent years and across all sectors. A similar trend is observed for the amount applied for and approved. In fact, there was no grant approved in 2012 except for the Industry sector, where only 2 projects were approved at RM1.8 million out of 10 projects applied for in the amount of RM47.9 million. There was no project applied for under the S&T services sector for all the years except in 2012, where 2 out of 7 projects applied for was approved with a value of RM5.5 million from the RM14.9 million applied for **(Figure 4.9).** The top three sectors across all years in terms of the number of

[17] http://mosti.gov.my/images/stories/divisions/dana/techno/technofundguideline1jan2012.pdf

projects and amount applied for and approved are the industry sector, followed by biotechnology and ICT. The Industry sector has consistently been the leading sector except for the year 2012, where the amount approved in biotechnology at RM16 million surpassed that of the Industry sector at RM12.4 million **(Figure 4.10)**.

Figure 4.10: Amount Applied for and Amount Approved for TechnoFund by Sector, 2008-2012



Source: Ministry of Science, Technology and Innovation (MOSTI)

4.1.2.2 InnoFund

In view of the importance of innovation to national wealth creation and social well-being, the Government initiated the Innovation Fund (InnoFund) during the Ninth Malaysia Plan (2006 – 2010). The InnoFund is comprised of the Enterprise Innovation Fund (EIF) and Community Innovation Fund (CIF).

i. The Enterprise Innovation Fund (EIF)

The EIF has the objective of assisting individuals/sole-proprietors, micro and small businesses/enterprises[18] to develop new or improved existing products, process or services with elements of innovation for commercialisation. The Project proposal must contain elements of technological innovation leading to commercialisable applications, products or services. InnoFund focuses on the following research areas: Life Sciences, Computer Sciences and Information and Communication Technology (ICT), Agriculture Sciences/Agricultural Engineering, Environmental Sciences, Advanced Materials Science, Chemical Sciences, Physical and Mathematical Sciences, Engineering, Medical and Health Sciences, and Social Sciences and Humanities. The quantum of the funding is as given in **Table 4.2**.

Table 4.2: The Enterprise Innovation Fund (EIF) Quantum of Funding

Target Group	Quantum
Individual/Sole Proprietor	Up to RM50,000
Micro/Small Companies	Up to RM500,000

Source: Pre-Commercialisation Fund (InnoFund) Guidelines for Applicants, MOSTI, 1 January 2012 (http://mosti.gov.my/images/stories/divisions/dana/inno/innofundguidelineterkiniedited1jan2011.pdf)

ii. Community Innovation Fund (CIF)

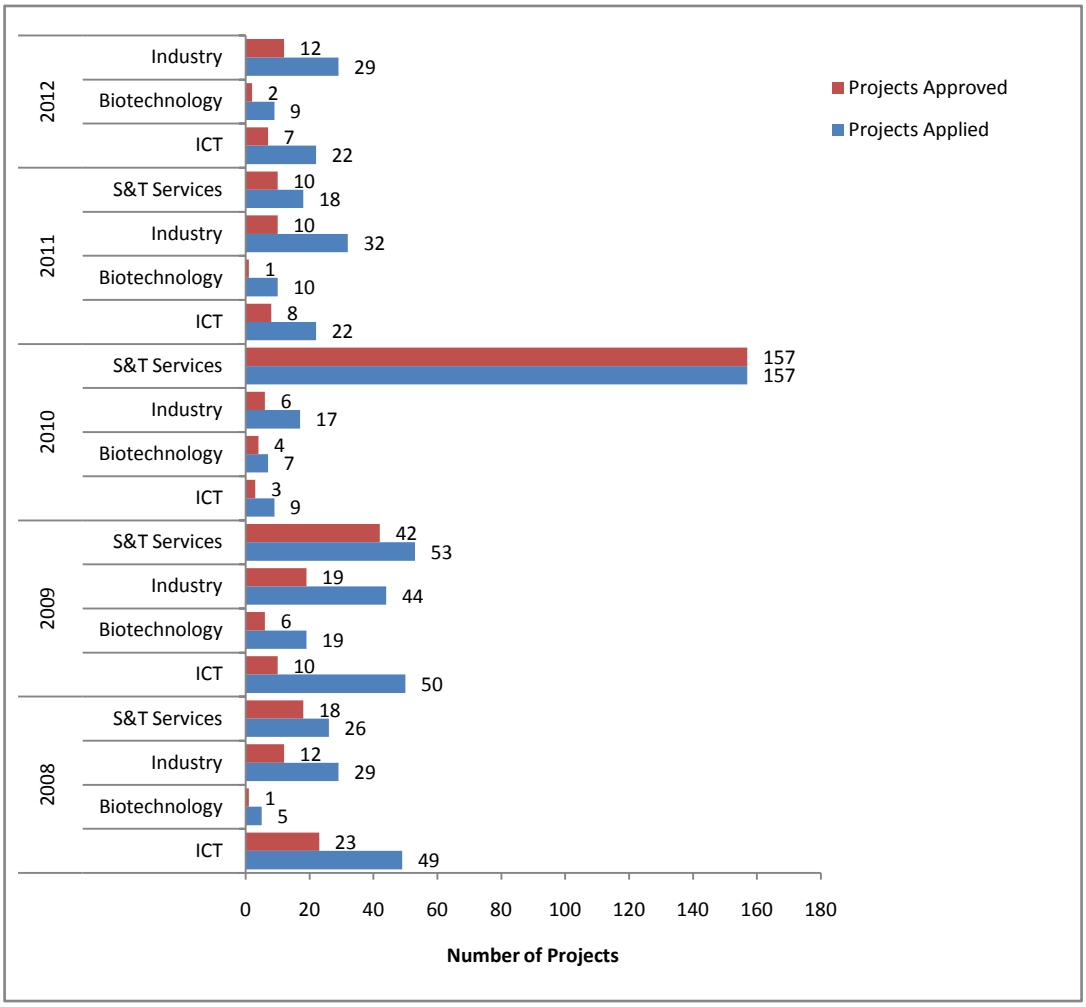
The Community Innovation Fund (CIF) is aimed at assisting community groups (such as Non Governmental Organisations, Community Associations, Village Development and Security Committees (JKKK)) to convert knowledge/ideas into products/processes/services that improve the socio-economic standing and the quality of life of communities. The maximum amount of funding under the CIF is RM500,000 with a maximum duration of 18 months, and the project must contain innovative elements leading to the development of products/services/processes that improve societal well-being.[19]

In terms of the number of projects applied for and approved, the S&T Services sector showed a sharp increase in 2010 where all the 157 applications were approved, the highest of all the years and across all sectors. However, it fell drastically in 2011 and continued to fall in the following year. On the other hand, for all the other sectors, the number of projects applied for and approved fell in 2010, the direct opposite of what was happening to the S&T Services sector **(Figure 4.11)**.

[18] A Micro Enterprise is an enterprise with annual sales turnover of less than RM250,000 or full time employees of less than 5, while a Small Enterprise is an enterprise with annual sales turnover of RM250,000 to less than RM10 million or full time employees of 5 to 50.

[19] Pre-Commercialisation Fund (InnoFund) Guidelines for Applicants, MOSTI, 1 January 2012 (http://mosti.gov.my/images/stories/divisions/dana/inno/innofundguidelineterkiniedited1jan2011.pdf)

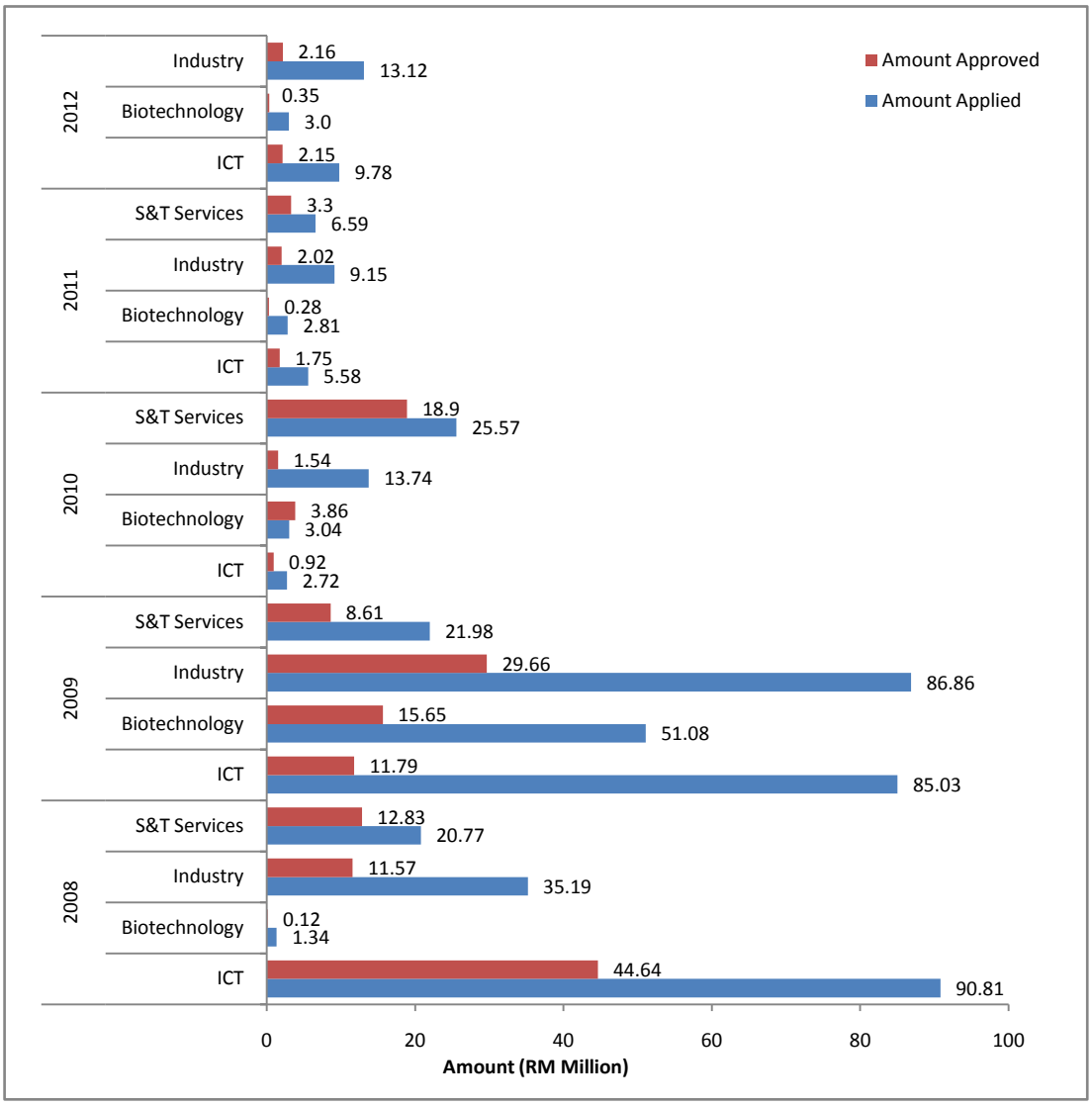
Figure 4.11: Number of Projects Applied for and Projects Approved for InnoFund by sectors, 2008-2012



Source: Ministry of Science, Technology and Innovation (MOSTI)

The ICT sector had the highest amount of funds applied for in 2008 in the amount of RM90.81 million but only RM44.64 million or 49.0% was approved. In 2009, the Industry, ICT and Biotechnology sectors presented the highest amount of funding applications, but funds approved were only RM29.66 million from the RM86.86 million applied for (34.1%) by the Industry sector, RM11.79 million from the RM85.03 million applied for (13.9%) by the ICT sector, and RM15.65 million from the RM51.08 million applied for (30.6%) by the Biotechnology sector. The low success rate may have led to the large fall in the amount of funding applied for in these sectors in the following year and subsequent years after that **(Figure 4.12)**.

Figure 4.12: Amount Applied for and Amount Approved for InnoFund by Sectors, 2008-2012



Source: Ministry of Science, Technology and Innovation (MOSTI)

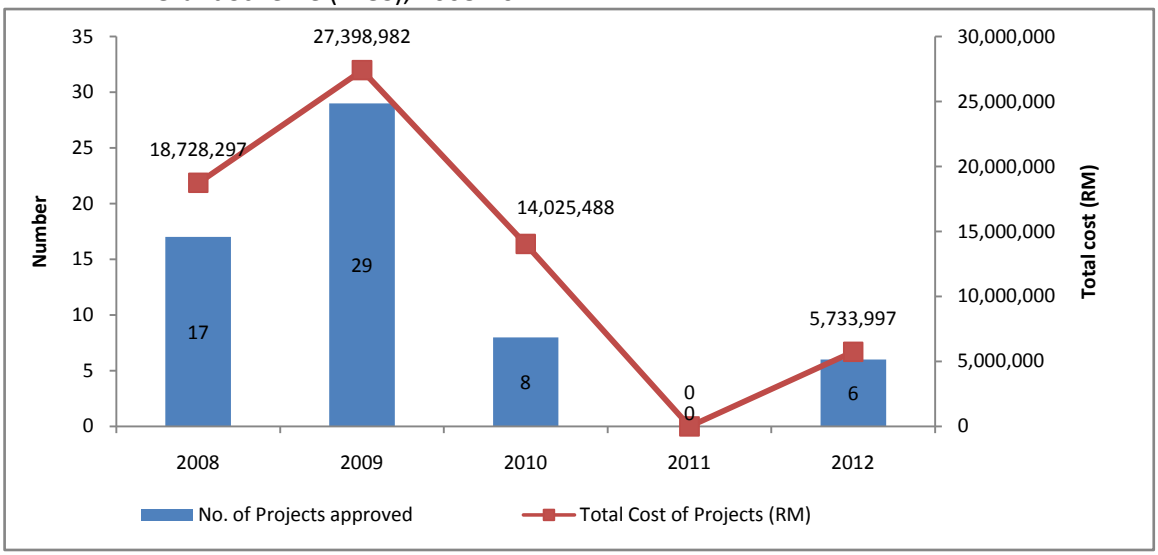
4.1.2.3 MSC Malaysia Research & Development Grant Scheme (MGS)

The MSC Malaysia Research & Development Grant Scheme (MGS) is a scheme administrated by the Multimedia Development Corporation (MDeC), offered to locally-owned or joint-venture MSC Malaysia status companies to develop ICT and multimedia technologies which would contribute to the overall development of the MSC. It is aimed at encouraging and establishing vibrant R&D activities by local companies; leading to innovative ICT/multimedia products that possess significant commercial potential. It is also aimed at increasing the creation of Intellectual Property (IP) that enables companies to compete globally, and at strengthening the R&D capabilities of Malaysian knowledge workers. The MGS will provide a grant of up to 50% of the approved total project cost or RM1.2 million, whichever is lower.[20]

[20] http://www.mscmalaysia.my/sites/default/files/pdf/business/grow_your_business/msc_status_funding/rnd_grant_scheme/MGS_MsMeiYuet.pdf

Seventeen (17) projects were approved under the MGS in 2008 (valued at RM18.7 million). The number of projects approved increased to 29 in 2009 (valued at RM27.4 million) but fell the following year to only 8 (valued at RM14 million), and zero in 2011. However, six projects were approved in 2012 in the amount of RM5.7 million **(Figure 4.13)**.

Figure 4.13: Number of Projects and Amount Approved for the MSC Research and Development Grant Scheme (MGS), 2008-2012



Source: Multimedia Development Corporation (MDeC)

4.1.3 The Commercialisation Stage

4.1.3.1 Commercialisation of R&D Fund (CRDF)

The Commercialisation of R&D Fund (CRDF) is established to fund the commercialisation activities of locally developed technologies undertaken by Malaysian owned companies. The technologies can be those developed by the public sector or they can also be the output of in-house R&D activities by the companies. The CRDF has the following objectives:

- To enhance the competitiveness and capacity of the Malaysian industrial sector by promoting the commercialisation of indigenous technology, and

- To accelerate the commercialisation of R&D results undertaken by local universities and research institutions, companies, and individual researchers or inventors.

There are three types of CRDF grants, namely, CRDF 1, CRDF 2 and CRDF 3. Both the CRDF 1 and CRDF 2 are grants for the commercialisation of R&D output from public and private universities (PPU) or Government Research Institutes (GRIs) by a Spin-Off company[21] ("Syarikat Terbitan Universiti, STU") under CRDF 1,and by a Start-Up company[22]under CRDF 2. Under both grants, the STU and the Small & Medium-scale Enterprise (SME) are required to operate their business from any recognised Technology Centre locally. The company is also required to focus their

[21] A Spin-Off company is defined as a company with local Public and Private University/Government Research Institution ownership.

[22] A Start-Up company is defined as a newly set up Small & Medium-scale Enterprise (SME) established specifically as a vehicle for the commercialisation activities of the specific project. An 'SME' is defined as a company with less than RM25 million annual turnover or having less than 150 employees.

commercialisation activities on business development while producing their products via out-sourcing. The CRDF 3, on the other hand, is divided into 2 categories: CRDF 3(a) which is a grant for the commercialisation of any local R&D by SMEs; and CRDF 3(b) which is a grant for the commercialisation of public sector R&D by a non-SMEs. **Table 4.3** shows the different types of CRDF grants, with CRDF 3 providing a maximum amount of RM4 million in funding.

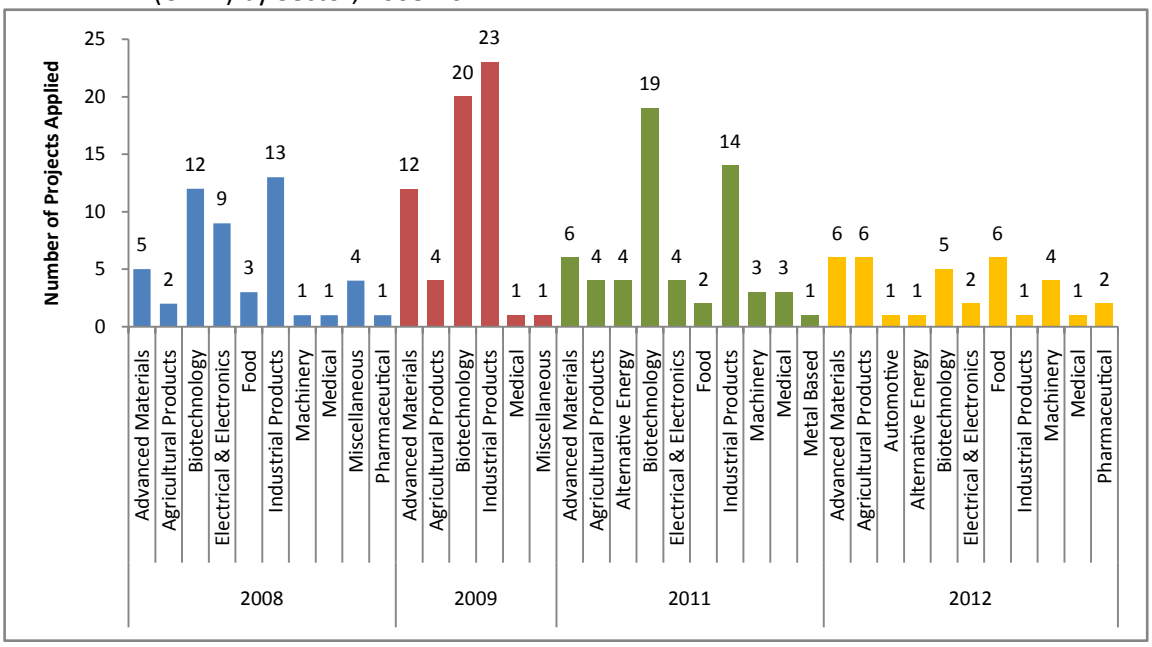
Table 4.3: Types of CRDF Grants and Quantum of Funding

Types of CRDF Grants	Quantum of Funding
CRDF 1: Commercialisation of R&D output from public and private universities (PPU) / Government Research Institutes (GRI) by a Spin-Off company ("Syarikat Terbitan Universiti, STU").	Partial grants with a maximum of RM500,000 or 90% of the eligible expenses (whichever is lower)
CRDF 2: Commercialisation of R&D output from Public and Private Universities (PPU) / Government Research Institutes (GRI) by a Start Up company	Partial grants with a maximum of RM500,000 or 70% of the eligible expenses, whichever is lower
CRDF 3 (a): Commercialisation of any local R&D by SMEs;	Partial grants with a maximum of RM4,000,000 or 70% of the eligible expenses (whichever is lower
CRDF 3 (b): Commercialisation of public sector R&D by a non-SME	Partial grants with a maximum of RM4,000,000 or 50% of the eligible expenses (whichever is lower)

Source: http://www.mtdc.com.my/crdf-1.php
http://www.mtdc.com.my/crdf-2.php
http://www.mtdc.com.my/crdf-3.php

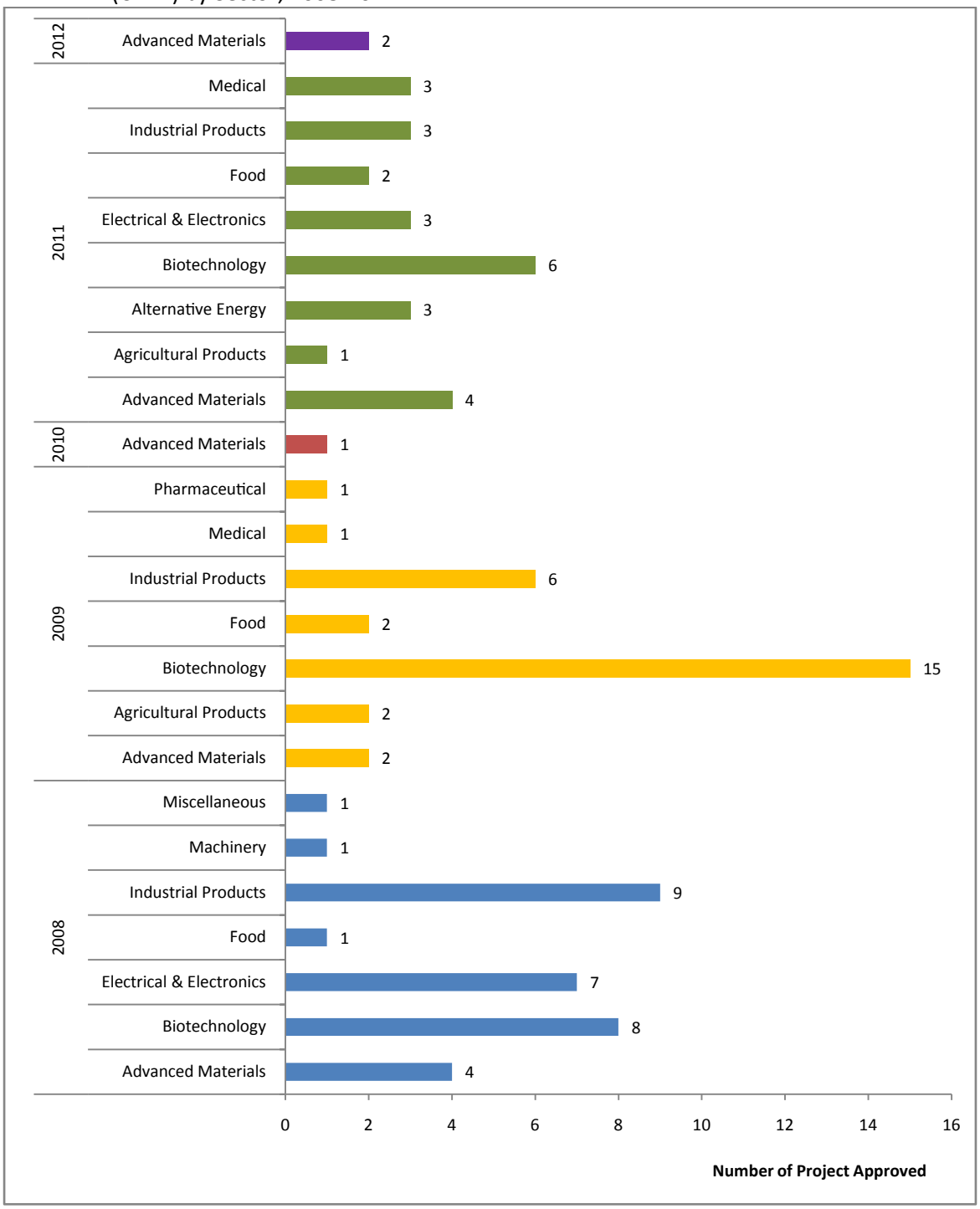
From 2008 to 2011, Industrial Products and Biotechnology were the dominant sectors in terms of having the highest number of projects/companies applying for the CRDF. The year 2009 recorded the highest number, namely 23 and 20, respectively **(Figure 4.14)**. A similar trend can be seen in the number of projects/companies approved for 2012 **(Figure 4.15)**.

Figure 4.14: Number of Projects/Companies that Applied for the Commercialisation of R&D Fund (CRDF) by Sector, 2008-2012



Source: Malaysian Technology Development Corporation (MTDC)

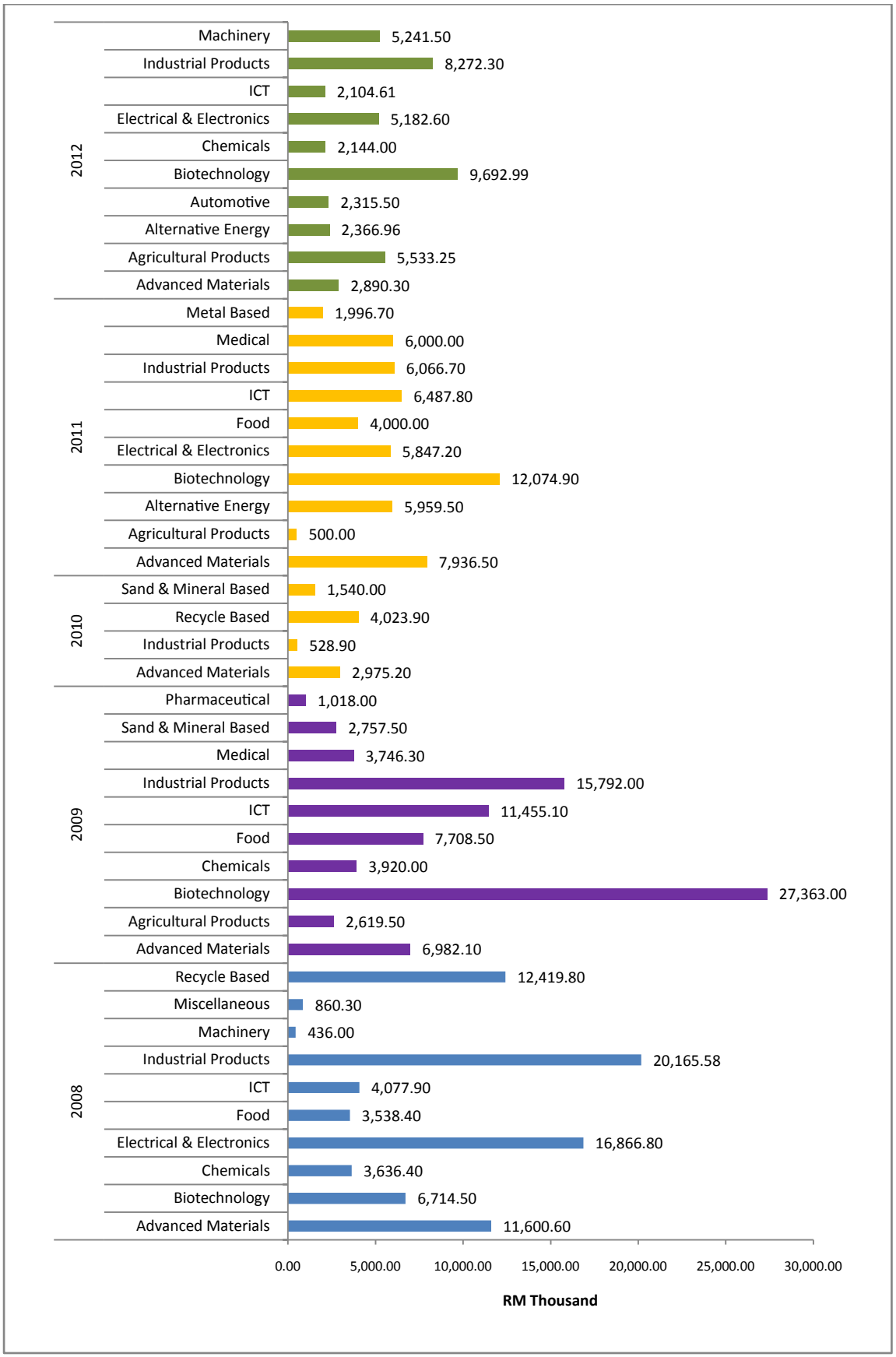
Figure 4.15: Number of Projects/Companies Approved for Commercialisation of R&D Fund (CRDF) by Sector, 2008-2012



Source: Malaysian Technology Development Corporation (MTDC)

The year 2009 recorded the highest amount approved for CRDF in the Biotechnology sector at RM27.3 million. The Biotechnology sector remained the dominant recipient sector of CRDF for subsequent years in 2010 and 2011 at RM12.1 million and RM9.7 million, respectively **(Figure 4.16)**. The total approved amount for CRDF fluctuated over the years where the amount was RM80.3 million in 2008, RM83.4 million in 2009, RM9.1 million in 2010, RM56.9 million in 2011, and RM45.7 million in 2012.

Figure 4.16: Amount Approved for Commercialisation of R&D Fund (CRDF) by Sector, 2008-2012



Source: Malaysian Technology Development Corporation (MTDC)

Table 4.4 shows the number of CRDF approved projects and approved grant amounts for the first 2 years of the Tenth Malaysia Plan, 2011-2015. The Biotechnology sector again had the highest share of the number of approved projects at 19.3% followed by Industrial Products at 15.79%, ICT and Advanced Materials at 10.53% and 10.52% respectively. In terms of the share of the approved amount, Biotechnology also received the highest share at 21.21%, followed by Industrial Products at 13.97%, Electrical & Electronics at 10.75%, and Advanced Materials at 10.55%.

Table 4.4: Number of CRDF Approved Projects and Approved Grant Amount for first 2 years of the Tenth Malaysia Plan, 2011-2015

Technology Industry / Cluster	Approved Projects		Approved Amount	
	No. of Companies	Share of Total (%)	Value (RM million)	Share of Total (%)
Advanced Materials	6	10.52%	10.83	10.55%
Agriculture Products	5	8.77%	6.03	5.88%
Alternative Energy	4	7.02%	8.33	8.11%
Automotive	1	1.75%	2.32	2.26%
Bio-technology	11	19.30%	21.77	21.21%
Chemicals	1	1.75%	2.14	2.09%
Electrical & Electronics	5	8.77%	11.03	10.75%
Food	2	3.51%	4.00	3.90%
ICT	6	10.53%	8.59	8.37%
Industrial Product	9	15.79%	14.34	13.97%
Machinery	3	5.26%	5.24	5.11%
Medical	3	5.26%	6.00	5.85%
Metal based	1	1.75%	2.00	1.95%
Miscellaneous	0	0%	0	0%
Pharmaceutical	0	0%	0	0%
Recycle-based	0	0%	0	0%
Sand & Mineral based	0	0%	0	0%
Total	57	100%	102.61	100%

Source: Malaysian Technology Development Corporation (MTDC)

4.1.3.2 Technology Acquisition Fund (TAF)

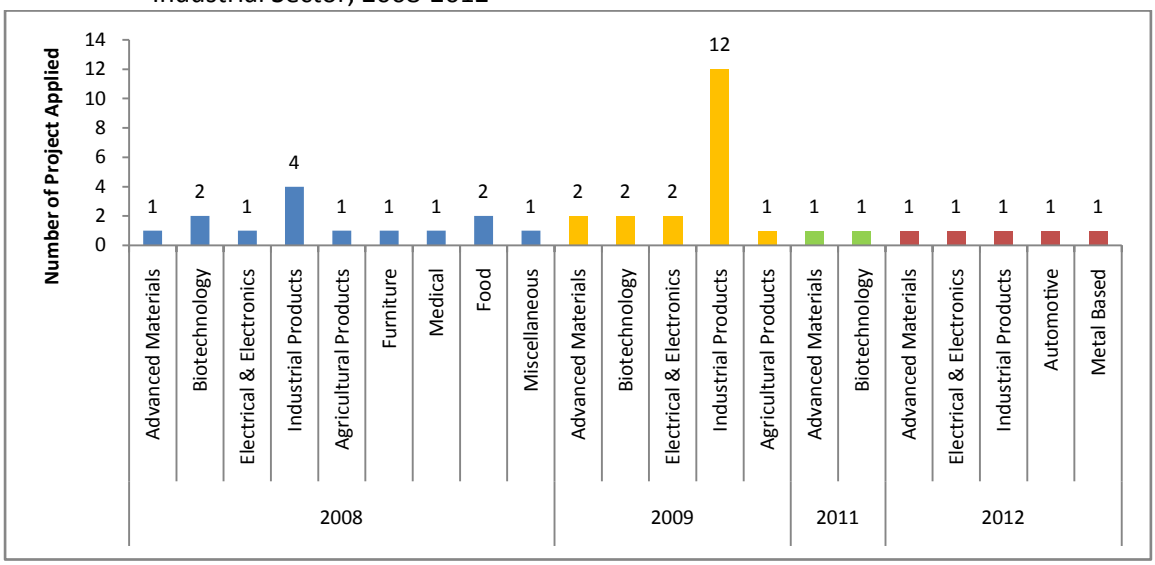
The Technology Acquisition Fund (TAF) is a scheme to facilitate the acquisition of foreign strategic and relevant technologies for immediate incorporation into the company's manufacturing activity. A maximum of 50.0%, or RM2 million partial grants, whichever is lower, is provided to eligible Malaysian companies to acquire new technology and enhance their technological capabilities and production processes. The TAF is administered by the Malaysian Technology Development Corporation (MTDC), and covers the following activities:[23]

- Purchase of high technology equipment and machinery;
- Technology licensing;
- Acquisition of patent rights, prototypes, and designs;
- Training in foreign companies for high technology; sourcing of experts; and
- Organising of seminars on technology by industry associations

[23] http://www.mtdc.com.my/taf.php

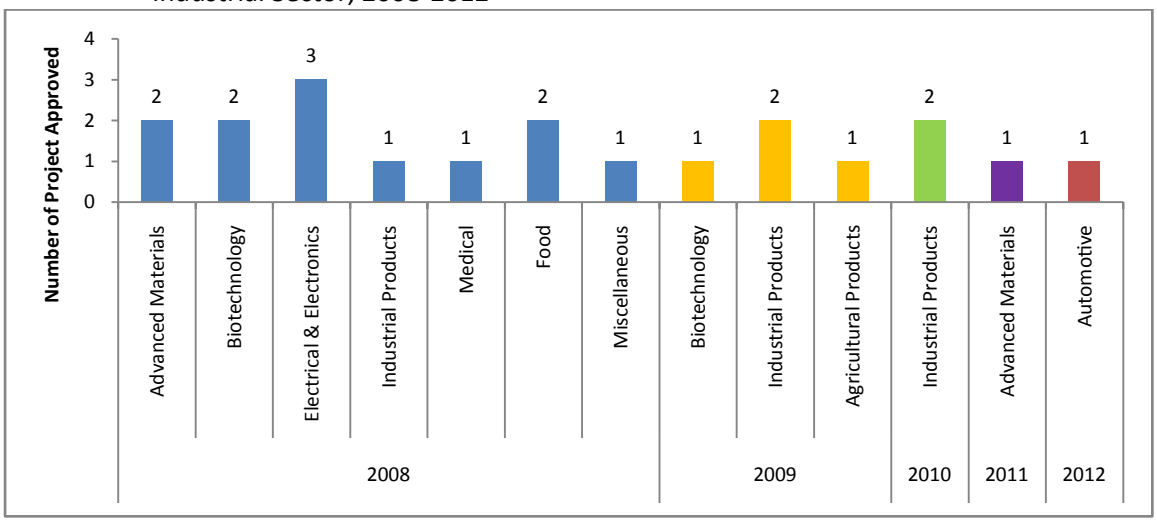
The number of project applications for TAF increased from 14 in 2008 to 19 in 2009, but fell to 2 and 5 in 2011 and 2012, respectively. Project applications in Industrial Products presented the highest number among all Industrial sectors, at 4 projects in 2008 and 12 projects in 2009 **(Figure 4.17)**. The number of projects approved also fell gradually from 12 in 2008 to only 1 in 2011 and 2012. Project approvals were highest for Industrial Products only in 2009 and 2010, while Electrical & Electronics presented the highest number in 2008 **(Figure 4.18)**.

Figure 4.17: Number of Project Applications for the Technology Acquisition Fund (TAF) by the Industrial Sector, 2008-2012



Source: Malaysian Technology Development Corporation (MTDC)

Figure 4.18: Number of Projects Approved for the Technology Acquisition Fund (TAF) by the Industrial Sector, 2008-2012

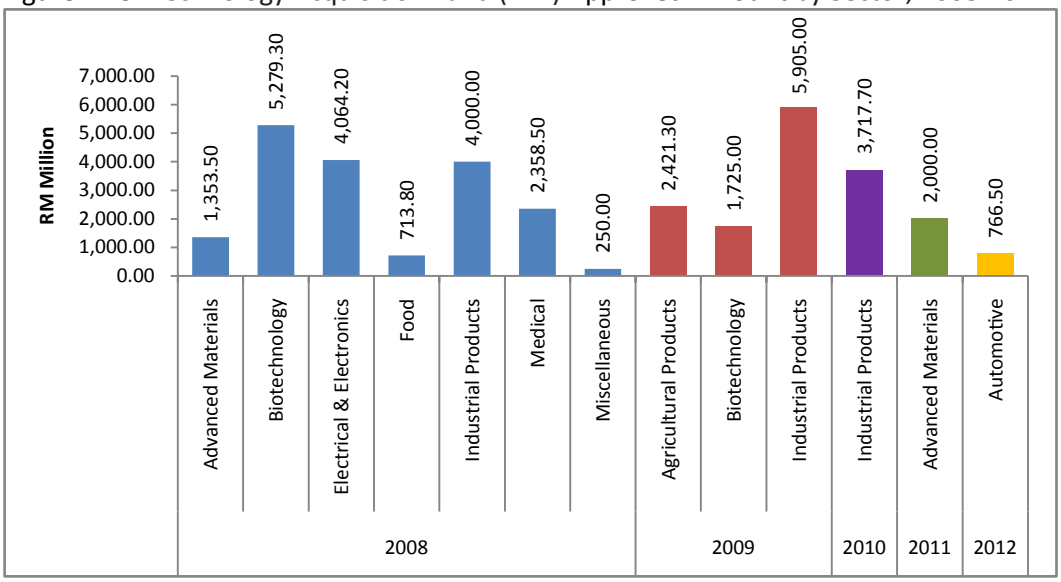


Source: Malaysian Technology Development Corporation (MTDC)

Although Electrical & Electronics obtained the highest number of project approvals in 2008, the largest approved amount went to Biotechnology at RM5.3 million. Industrial Products obtained RM5.9 million in 2009 and RM3.7 million in 2010 in terms of TAF grants **(Figure 4.19)**. For the first 2 years (2011 and 2012) of the Tenth Malaysia Plan (2011-2015), TAF grants only went to Advanced Materials and Automotive sectors, with one project each. Advanced Materials obtained a higher share of 72.29% of the total grants, while the remaining 27.71% of the share

went to Automotive **(Table 4.5)**. This represents a shift in emphasis of TAF grants from the traditional sectors of Industrial Products and Electrical & Electronics to the higher value-added sectors of Advanced Materials and Automotive sectors in the Tenth Malaysia Plan.

Figure 4.19: Technology Acquisition Fund (TAF) Approved Amount by Sector, 2008-2012



Source: Malaysian Technology Development Corporation (MTDC)

Table 4.5: Number of TAF Approved Projects and Approved Grant Amount for first 2 years of the Tenth Malaysia Plan, 2011-2015

Technology Industry / Cluster	Approved Projects		Approved Amount	
	No. of Companies	Share of Total (%)	Value (RM)	Share of Total (%)
Advanced Materials	1	50%	2,000,000	72.29%
Agriculture Products	0	0%	0	0%
Automotive	1	50%	766,500	27.71%
Biotechnology	0	0%	0	0%
Electrical & Electronics	0	0%	0	0%
Food	0	0%	0	0%
Industrial Product	0	0%	0	0%
Machinery	0	0%	0	0%
Medical	0	0%	0	0%
Metal based	0	0%	0	0%
Miscellaneous	0	0%	0	0%
Pharmaceutical	0	0%	0	0%
Total	2	100%	2,766,500	100%

Source: Malaysian Technology Development Corporation (MTDC)

4.1.3.3 Biotechnology Commercialisation Fund (BCF)

The Biotechnology Commercialisation Fund (BCF) was developed under the Tenth Malaysia Plan as a funding scheme that combines term loan and grant. The BCF Facility is managed by BiotechCorp as part of overall incentives for BioNexus status companies,[24] and is granted to facilitate on-going commercialisation of biotechnology products and services and/or expansion of existing biotechnology business. The BCF is a term loan/financing facility that is offered based on conventional principles primarily for the financing of capital expenditure and working capital which includes intellectual property filing and registration; clinical or field trial costs; raw materials, consumables or livestock; compliance and regulatory costs; expenses directly related to R&D activities towards improving existing products/services (with the exception of payroll/human capital emolument expenses); and expenses directly related to business expansion activities to introduce products/services into the global market with exception of payroll/human capital emolument expenses.

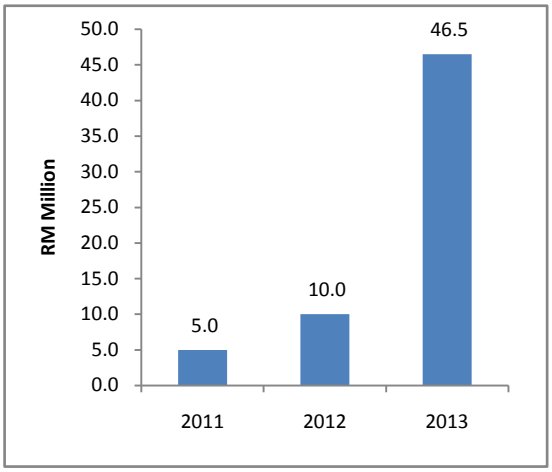
The BCF Facility provides a minimum funding of RM500,000 and a maximum funding of RM3 million per BioNexus status company. BiotechCorp may grant up to a maximum margin of 90% of the total project cost and an interest/profit rate of between 5.00% - 6.25% per annum will be charged on monthly rest. A processing fee of 0.25% of the loan amount per applicant is payable for each approved application, the margin of financing is up to a maximum of 90% of the total project cost.[25]

The total allocation for Biotechnology Commercialisation Fund (BCF) has increased tremendously; from only RM5 million and RM10 million in 2011 and 2012 to RM46.5 million in 2013 **(Figure 4.20)**. The number of projects approved, however, is still very low, at only 1 project valued at RM3 million in 2012 and 7 projects valued at RM18.9 million as of 20 September 2013 **(Figure 4.21)**. A higher utilisation of the BCF Facility will assist in accelerating the commercialisation of biotechnology products and services in the country.

[24] BioNexus is a special status awarded to qualified international and Malaysian biotechnology companies. The status endows fiscal incentives, grants and other guarantees to assist growth. This status is awarded to qualified companies undertaking value-added biotechnology and/or life sciences activities. Apart from the overall benefits and support, BioNexus companies are assured a list of privileges as stipulated in the BioNexus Bill of Guarantees.

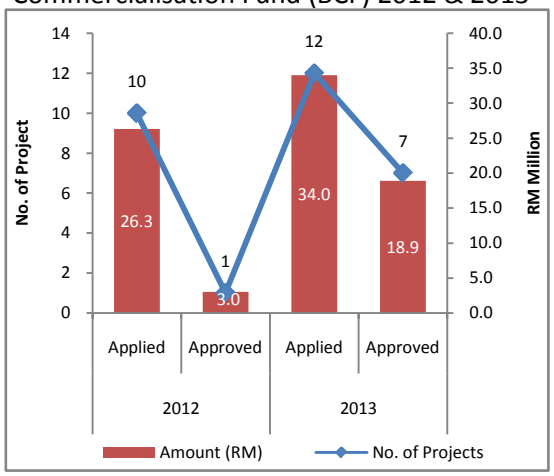
[25] *Guidelines on Biotechnology Commercialisation Fund Credit Facility Applications*, Biotechcorp, 5 June 2012.

Figure 4.20: Total Allocation for Biotechnology Commercialisation Fund (BCF), 2011-2013



Source: Ministry of Science, Technology and Innovation (MOSTI)

Figure 4.21: Number of projects / amount applied and approved for Biotechnology Commercialisation Fund (BCF) 2012 & 2013



Source: Ministry of Science, Technology and Innovation (MOSTI)
Note: Approvals as at September 2013

4.1.3.4 Industrial Technical Assistance Fund (ITAF)

The Industrial Technical Assistance Fund (ITAF) was established in 1990 with an initial allocation of RM50 million to assist SMEs to become technologically proficient as well as cost competitive. The grant is in the form of matching grants, where 50.0% of the project cost is borne by the government and the remainder is borne by the applicant. Four categories of this fund have been established to address the specific requirements of SMEs as shown in **Table 4.6.**

Table 4.6: Types of ITAF Grants and Quantum of Funding

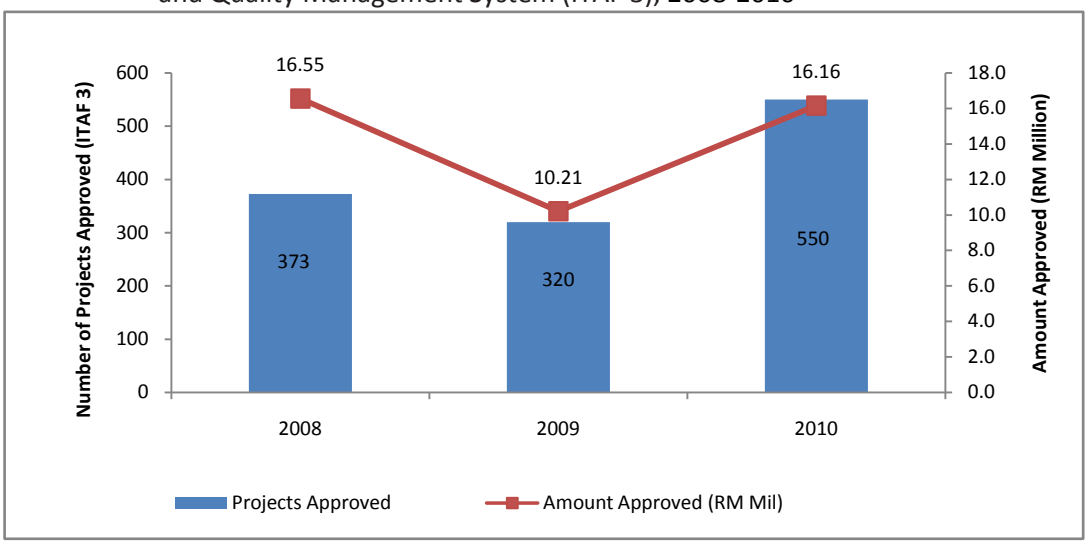
Types of ITAF Grants	Quantum of Funding
ITAF 1: Business Planning and Development Scheme Assistance for market and technology pre-feasibility and feasibility studies, Business planning, market strategy and branding	• 50% matching grants of the project • Up to a maximum of RM 40,000
ITAF 2: Product and Process Improvement Scheme Assistance to improve and upgrade existing products, product designs, and processes, and to develop new products, new designs or new processes	• 50% matching grants of the project • Up to a maximum of RM 500,000
ITAF 3: Certification and Quality Management System Scheme Assistance for productivity and quality improvement and to achieve international quality standards and certification	Up to a maximum RM 250,000
ITAF 4: Market Development Scheme Assistance for market development through participation in trade missions, International trade fairs overseas and locally, catalogue shows overseas, in-store promotion programmes and promotional programmes held in Malaysian trade centres overseas.	• 50% matching grant with the remainder of the cost to be borne by the applicant • Up to a maximum RM 60,000

Source: http://www.prinsipmahir.net/itaf.asp

Under the Matching Grant for Certification and Quality Management System (ITAF 3),the number of projects and amount approved dropped slightly in 2009 but increased again in 2010 **(Figure 4.22)**. The highest cumulative approval over the period 2008-2010 goes to the Food &

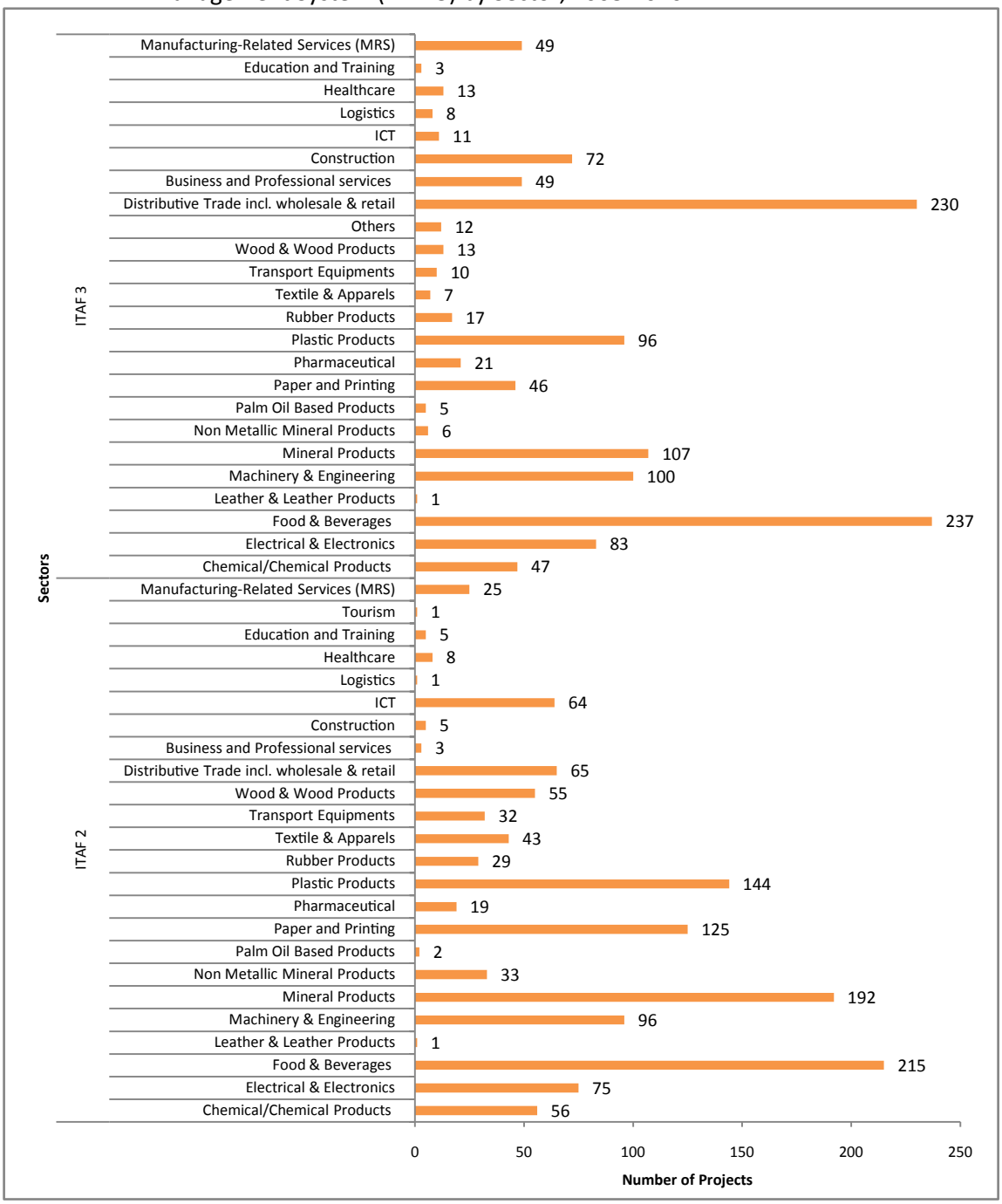
Beverages sector with 237 approvals, followed by the Distributive Trade sector with 230 approvals. Under the Matching Grant for Product and Process Improvement (ITAF 2), the Food & Beverages sector also received the highest number of approvals of 215, followed by the Mineral Products sector with 192 approvals **(Figure 4.23)**.

Figure 4.22: Number of Projects and Amount Approved Under Matching Grant for Certification and Quality Management System (ITAF 3), 2008-2010



Source: SME Corp. Malaysia, September 2013

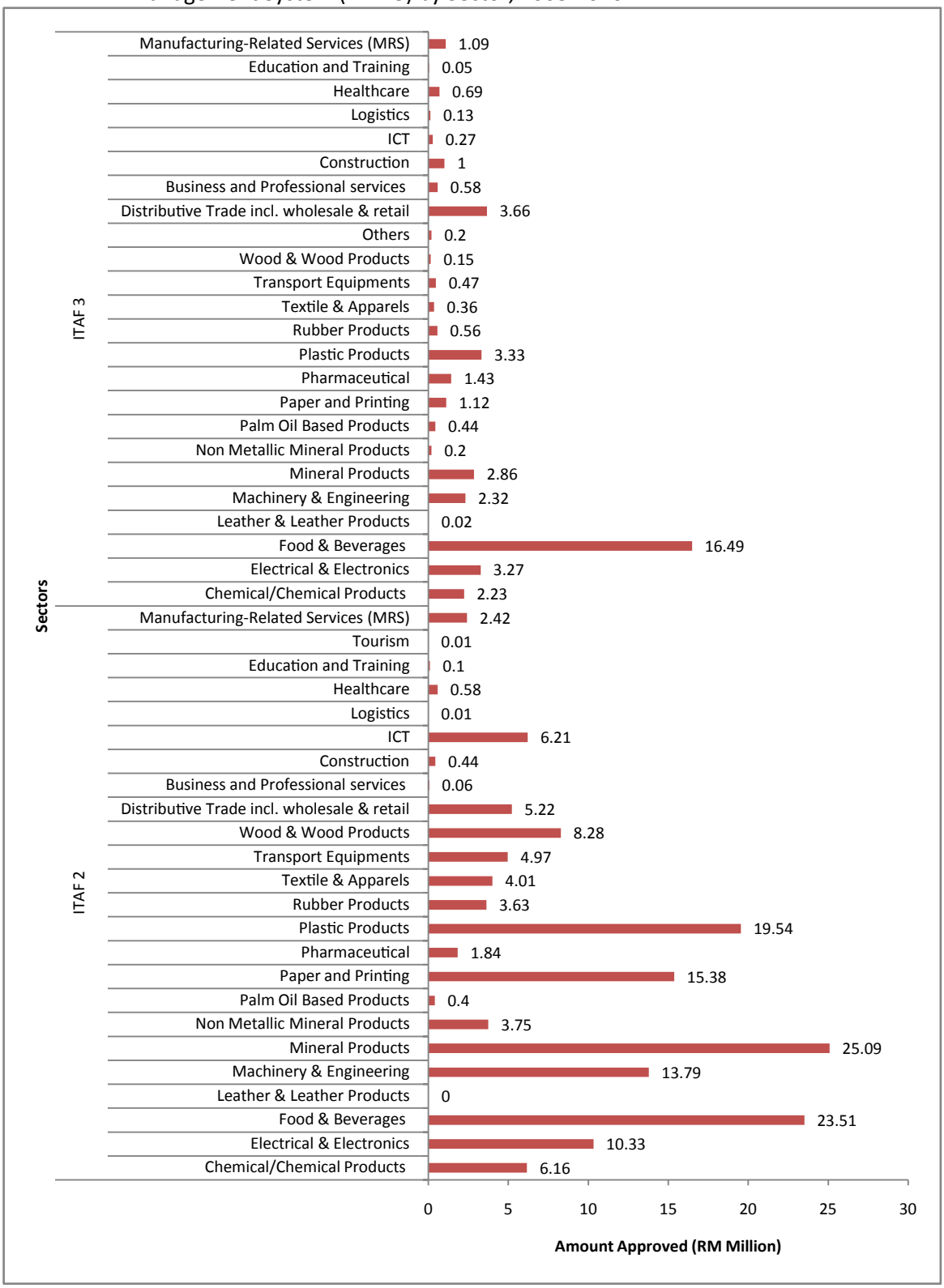
Figure 4.23: Cumulative Approvals under the Matching Grant for Product and Process Improvement (ITAF 2) and Matching Grant for Certification and Quality Management System (ITAF 3) by Sector, 2008-2010



Source: SME Corp. Malaysia, September 2013

Although the Mineral Products sector received the second highest number of approvals, this sector received the highest cumulative amount approved at RM25.09 million under ITAF 2 for the same period 2008-2010. The Food & Beverages sector received the next highest cumulative amount approved under ITAF 2 at RM23.51 million as well as ITAF 3 at RM16.49 million **(Figure 4.24)**.

Figure 4.24: Cumulative Amount Approved under the Matching Grant for Product and Process Improvement (ITAF 2) and Matching Grant for Certification and Quality Management System (ITAF 3) by Sector, 2008-2010



Source: SME Corp. Malaysia, September 2013

4.2 GRANTS SUPPORTED BY THE MINISTRY OF EDUCATION

The Ministry of Higher Education (now merged with the Ministry of Education) has been given allocations under the Tenth Malaysia Plan to provide funding for research activities that are fundamental in nature as a means to encourage knowledge generation that can contribute towards the enhancement of intellectual capacity and the development of new technologies. The research funding is managed by the Department of Higher Education through the provision of the Fundamental Research Grant Scheme (FRGS), Exploratory Research Grant Scheme (ERGS), Long-term Research Grant Scheme (LRGS), and Prototype Research Grant Scheme (PRGS). Two additional grant schemes have also been introduced, namely the Research Acculturation Grant Scheme (RAGS) and the Research Acculturation Collaborative Effort (RACE) Grant.

The Fundamental Research Grant Scheme (FRGS) is aimed at developing new theories, concepts and ideas that can serve as a catalyst for new discoveries and innovative inventions that have the ability to expand the frontiers of knowledge. The research areas under the FRGS are Pure Sciences, Applied Sciences, Technology and Engineering, Clinical and Health Sciences, Sciences, Arts and Applied Arts, and Natural Sciences and National Heritage.[26]

The Exploratory Research Grant Scheme (ERGS) was developed to promote inquisitive minds to explore new ideas and concepts that can generate new discoveries and innovative inventions. The ERGS covers the areas of Pure and Applied Sciences, Technology and Engineering, Clinical and Health Sciences, Social Sciences, Arts and Applied Arts, Natural Sciences and National Heritage, Defence and Security, Information and Communication Technology.[27]

The Long-term Research Grant Scheme (LRGS) is a fundamental research grant with a more extensive scope that requires a longer duration of time and a high level of commitment. The LRGS has the objective of promoting excellence in the creation of theories, new ideas and innovative and advanced inventions in strategic niche areas for the expansion of the frontiers of knowledge. The grant encompasses high-impact niche areas that have been identified, in both top-down and bottom-up approaches. The LRGS niche research areas include Global warming, Contagious diseases, Tropical medicine, Water and Energy Security, Food Security, Advanced Manufacturing, and Information and Communication Technology (ICT).[28]

The Prototype Research Grant Scheme (PRGS) was created for prototype development and to bridge the gap between laboratory/research findings and pre-commercialisation. The PRGS is open to all areas of research that already have output that requires Prototype development.[29]

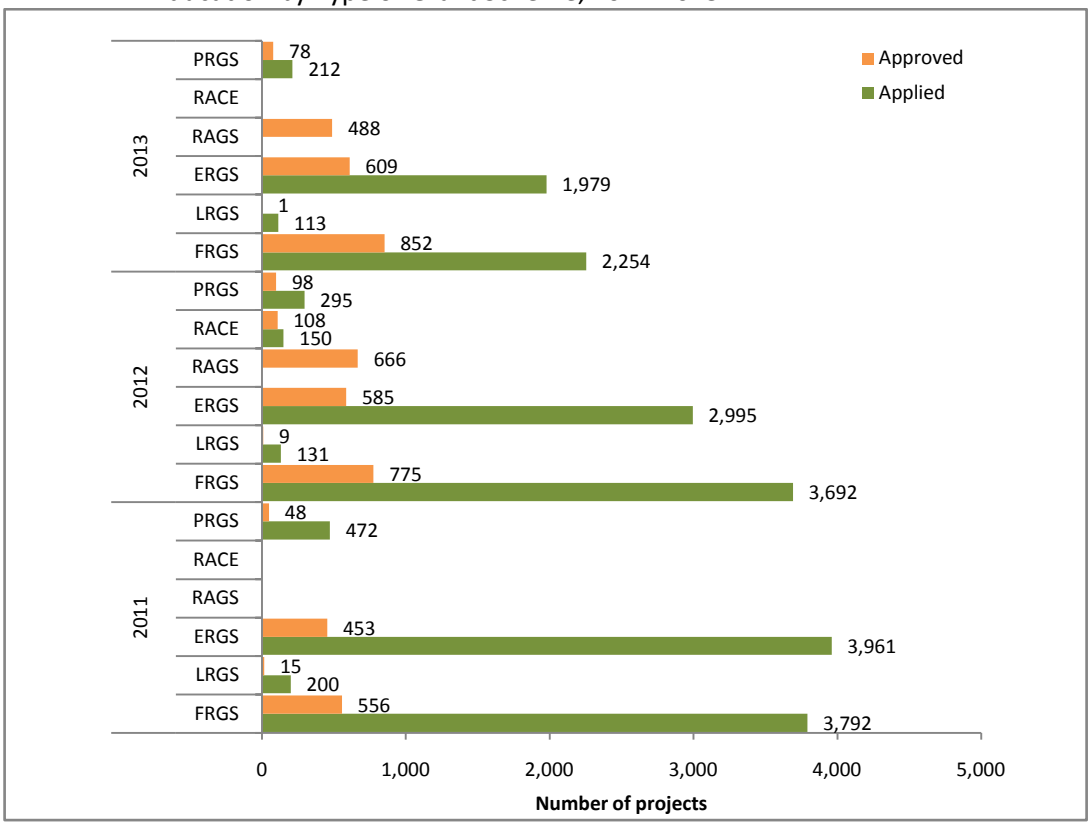
The Research Acculturation Grant Scheme (RAGS) is a seed fund aimed at acculturing research among young researchers at public institutions of higher learning that are non-research universities (non-RU) to enhance their research performance and develop their ability to compete locally and internationally.The RAGS covers the same fundamental areas as the FRGS, and unlike other grants, RAGS funds are given directly to the universities for disbursement to their researchers.[30]

As for the Research Acculturation Collaborative Effort (RACE) Grant, it is a new inititaive to mobilize collaborative research efforts between Rus and non-RUs (rakan RU). This effort is to

[26] http://jpt.mohe.gov.my/PENYELIDIK/FRGS_Garis_Panduan.pdf
[27] http://jpt.mohe.gov.my/PENYELIDIK/ergs/Garis%20Panduan%20ERGS%20pindaan%202012.pdf
[28] http://jpt.mohe.gov.my/PENYELIDIK/lrgs/GarisPanduanLRGS.pdf
[29] http://jpt.mohe.gov.my/PENYELIDIK/prgs/Garis%20Panduan%20PRGS%20pindaan%20tahun%202012.pdf
[30] *Guidelines for Research Acculturation Grant Scheme (RAGS)*. Department of Higher Education.

promote a growing research culture in non-Rus in order to increase research output, including the publication of research findings, innovative discoveries / IP, etc.[31]

Figure 4.25: Number of Projects Applied for and Projects Approved Under the Ministry of Education by Type of Grant Scheme, 2011-2013



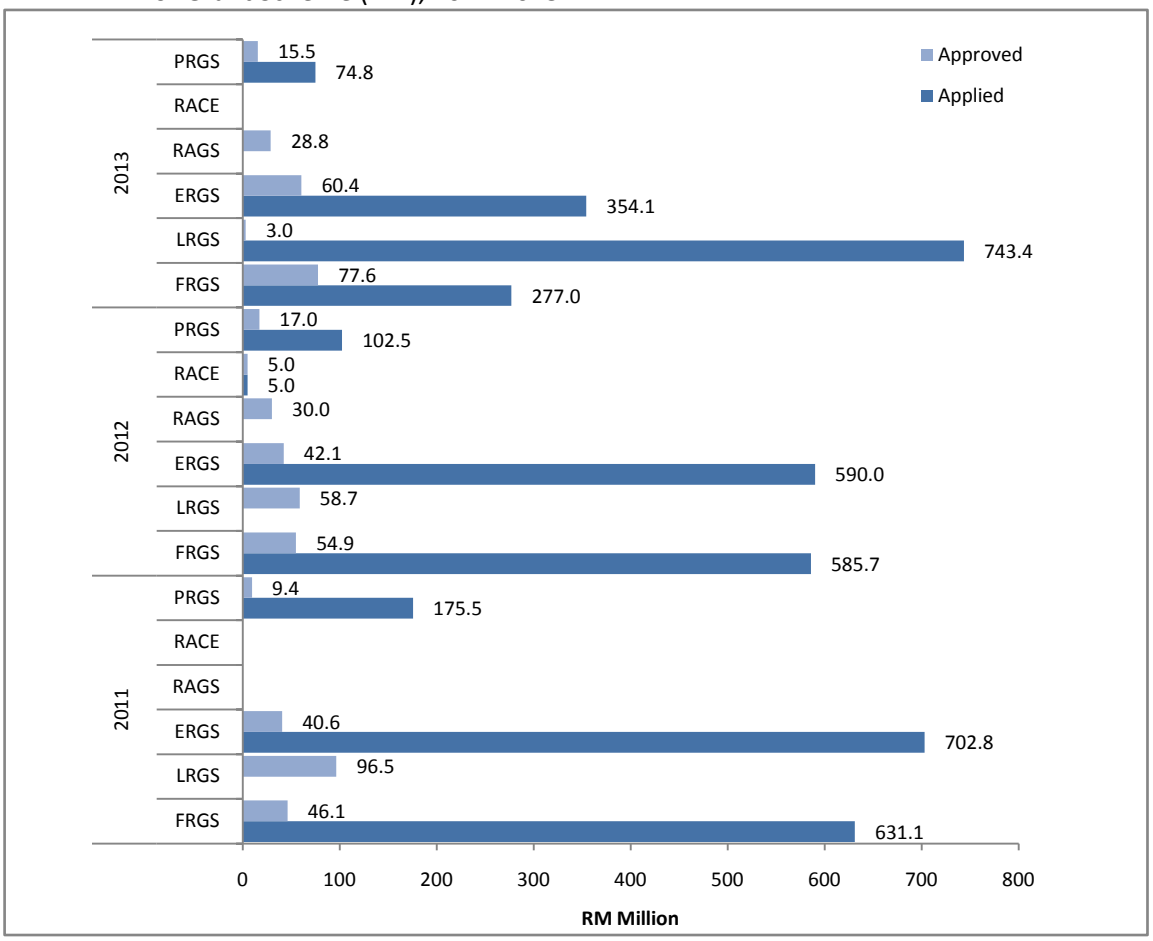
Source: Ministry of Education

The FRGS and ERGS generally have the highest number of applications throughout the years, and the same is seen in terms of the number of projects approved, with the success rate increasing over the years **(Figure 4.25)**. For the FRGS, the success rate increased from 11.4% in 2011 to 19.5% and 31% in 2012 and 2013 respectively. For the ERGS, the rate increased from 14.7% in 2011 to 21% and 38% in 2012 and 2013 respectively. The number of applications and approved projects for the PRGS and LRGS is very low compared to the FRGS and ERGS in all the three years, and there were no applications for the RACE funds in 2011 and 2013. There were also no applications for the RAGS funds, as the grant is not based on applications but by direct disbursement to the respective universities.

For the FRGS, the amount applied for declined over the three years, but the amount approved increased from RM46 million in 2011 to RM54.9 million in 2012 and RM77.6 million in 2013. A similar trend is seen for the ERGS, where the amount approved increased from RM40.6 million in 2011 to RM42.1 million in 2012 and RM60.4 million in 2013. For the LRGS, only data on the amount approved were available, while data on the amount applied were not available for 2011 and 2012. In 2013, the amount applied for the LRGS was RM743 million, the highest in all the grants, but only RM3 million was approved. As for RAGS , the disbursement remained almost the same at RM30.0 million and RM28.8 million in 2012 and 2013 respectively **(Figure 4.27)**.

[31] *Guidelines for Research Acculturation Collaborative Effort (RACE) Grant,* 2013

Figure 4.26: Amount Applied for and Amount Approved Under the Ministry of Education by Type of Grant Scheme (RM), 2011-2013



Source: Ministry of Education

4.3 R&D INVESTMENT INCENTIVES

Recognising the importance of industry involvement in developing indigenous technologies and in bringing the country up the value-chain, the government has, in recent years, expanded the range of incentives for R&D to further enhance industry's participation in undertaking R&D activities. Under the Promotion of Investments Act 1986, a number of incentives have been introduced for the following types of companies:[32]

(i) Contract R&D Company

It is a company that provides R&D services in Malaysia to a company other than its related company, and it is eligible for:

- Pioneer Status, with income tax exemption of 100% of the statutory income for 5 years. Unabsorbed capital allowances as well as accumulated losses incurred during the pioneer period can be carried forward and deducted from the post pioneer income of the company; or

[32] http://www.accaglobal.com/content/dam/acca/global/pdf/sa_nov2011_RandD3.pdf

- Investment Tax Allowance (ITA) of 100% on the qualifying capital expenditure incurred within 10 years. The allowance can be offset against 70.0% of the statutory income for each year of assessment.

(ii) R&D Company

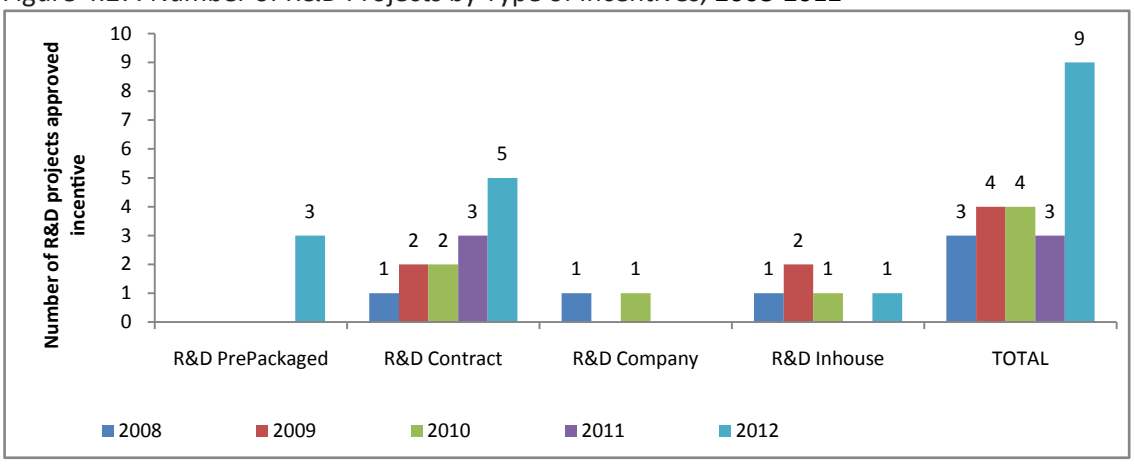
An R&D company is a company that provides R&D services in Malaysia to its related company or to any other company. It is eligible for an ITA of 100% on the qualifying capital expenditure incurred within 10 years. The allowance can be offset against 70% of the statutory income for each year of assessment. Should the R&D company choose not to avail itself of its allowance, its related companies can enjoy double deduction for payments made to the R&D company for services rendered.

(iii) In-house Research

A company that undertakes in-house R&D to further its business can apply for an ITA of 50% of the qualifying capital expenditure incurred within 10 years. The company can offset the allowance against 70% (100% for promoted areas) of its statutory income for each year of assessment.

For all the three types of arrangements, any unutilised allowances of the ITA can be carried forward to subsequent years until fully utilised. To further strengthen Malaysia's foundation for more integrated R&D, companies which carry out design development and prototyping as independent activities are also eligible for incentives.

Figure 4.27: Number of R&D Projects by Type of Incentives, 2008-2012



Source: Malaysian Industrial Development Authority (MIDA)

The total number of R&D projects undertaken in 2012 tripled from only 3 projects in 2011 to 9 projects in 2012, with 5 out of the 9 projects undertaken by R&D Contract companies. The total number of projects undertaken from 2008 to 2012 is highest for R&D Contract companies, with a total of 13 projects over the 5 years, followed by In-house R&D with 5 projects and R&D companies with 2 projects.

4.4 CONCLUSION

Innovation is a key contributor to productivity, economic growth and higher living standards. Nations and businesses that can achieve high levels of performance in innovation will be well placed to be leaders in the future. Innovation is not just about invention. It also encompasses the process by which ideas are taken to market.

Public funding is critical to innovation, but requires government support in its early stages of development and commercialisation. The continuous provision of the various grants and incentives to promote R&D activities is necessary, especially in high technology sectors in Malaysia, in tandem with the government's objective of bringing Malaysia up the value chain to become a high income developed nation by 2020. As illustrated earlier, a shift in emphasis of TAF grants from the traditional sectors of Industrial Products and Electrical & Electronics to the higher value-added sectors of Advanced Materials and Automotive sectors in the Tenth Malaysia Plan, for instance, is a good sign towards this end.

From the trends in the various schemes and incentives discussed earlier, the positive response observed from both the public as well as the private research institutions or companies reflects their keen interest in being involved in R&D activities. In addition, the tremendous increase in the total allocation for the Biotechnology Commercialisation Fund (BCF) from only RM5 million and RM10 million in 2011 and 2012 to RM46.5 million in 2013 is an indication of the high degree of importance placed on not just R&D but also commercialisation of R&D output. However, the number of projects approved is still very low, at only 1 project valued at RM3 million in 2012 and 7 projects valued at RM18.9 million as of 20 September 2013. A higher utilisation of the BCF Facility will assist in accelerating the commercialisation of biotechnology products and services in the country.

CHAPTER 5:
PUBLIC AWARENESS, KNOWLEDGE AND ATTITUDES TOWARDS S&T

CHAPTER 5

PUBLIC AWARENESS OF S&T IN MALAYSIA

5.0 INTRODUCTION

S&T has become an integral aspect of the lives of Malaysians, particularly due to the government's encouragement of S&T through national policies such as the Second National Science and Technology Policy. Given the importance of S&T for the nation's economy, the government has taken the necessary measures to ensure that Malaysia is at par with other developed countries. Among these efforts are to ensure that Malaysians aware of important issues in S & T, that they are interested in S&T, that they have positive attitudes towards S&T, and that they have an adequate understanding of S&T. Hence, it is important to assess how Malaysians fare on these aspects so that the government can strive to develop ways to increase the public's awareness of and interest in S&T.

It is because of these considerations that the Malaysian Science and Technology Information Centre (MASTIC) has been conducting, since 1994, the Public Awareness Surveys to assess the people's interest in, and awareness and understanding of S&T. This chapter describes the results of the latest Public Awareness Survey, conducted in 2008, which obtained the responses of 18,447 respondents—randomly selected and stratified according to zone, location, ethnicity, gender and age—on various S&T issues.

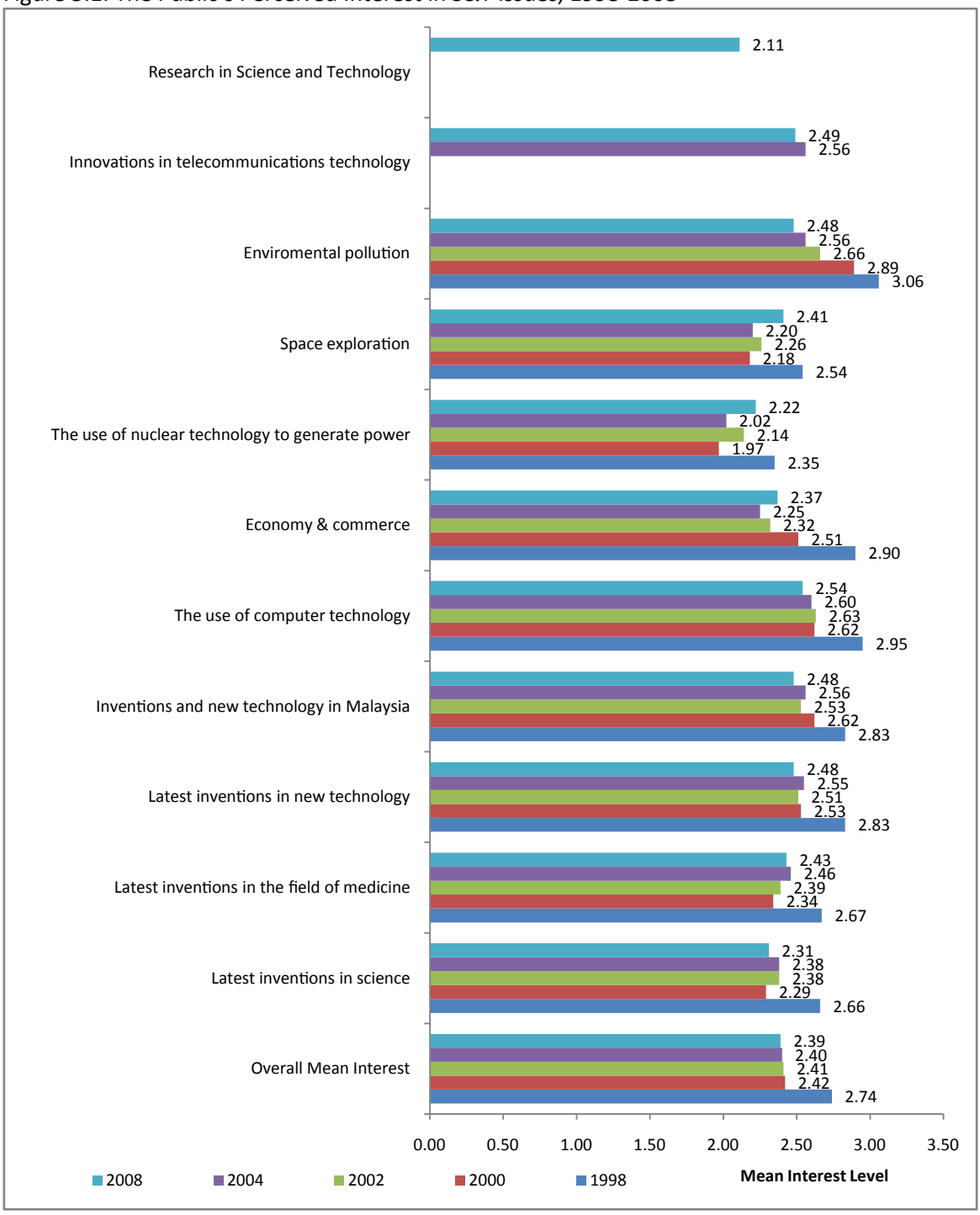
5.1 THE PUBLIC'S PERCEIVED INTEREST IN S&T ISSUES

In the 2008 survey, just like the surveys before it, perceived interest refers to what the respondent has reported as being his or her interest.

From 1998 to 2008, the Malaysian public's interest in S&T has been between slightly to moderately interested in S&T, as indicated by the overall mean of 2.42 in 2000 to 2.39 in 2008. It is worthy to note that the highest mean of 2.74 was recorded in 1998 **(Figure 5.1)**.

A number of S&T issues were surveyed and the level of interest among the respondents varied throughout the years, depending on the issue surveyed. However, the interest in *space exploration*, *the use of nuclear technology to generate power* as well as *the use of computer technology* increased in contrast to other issues. The heightened interest in *space exploration* could very well be attributed to the "National Angkasawan Programme" and Datuk Sheikh Muzaffar's successful flight to space, which was given broad coverage by the media. With regard to *computer technology*, the interest could be traced to the fact that computer technology is becoming a necessity not only in the workplace but also in the social lives of Malaysians with the use of social media. On the other hand, there is a steady decline of interest in *environmental pollution* issues, which is a cause for concern as this is considered to be a vital and important issue affecting the community and environment.

Figure 5.1: The Public's Perceived Interest in S&T Issues, 1998-2008



Source: The Public Awareness of Science & Technology Malaysia, 2008

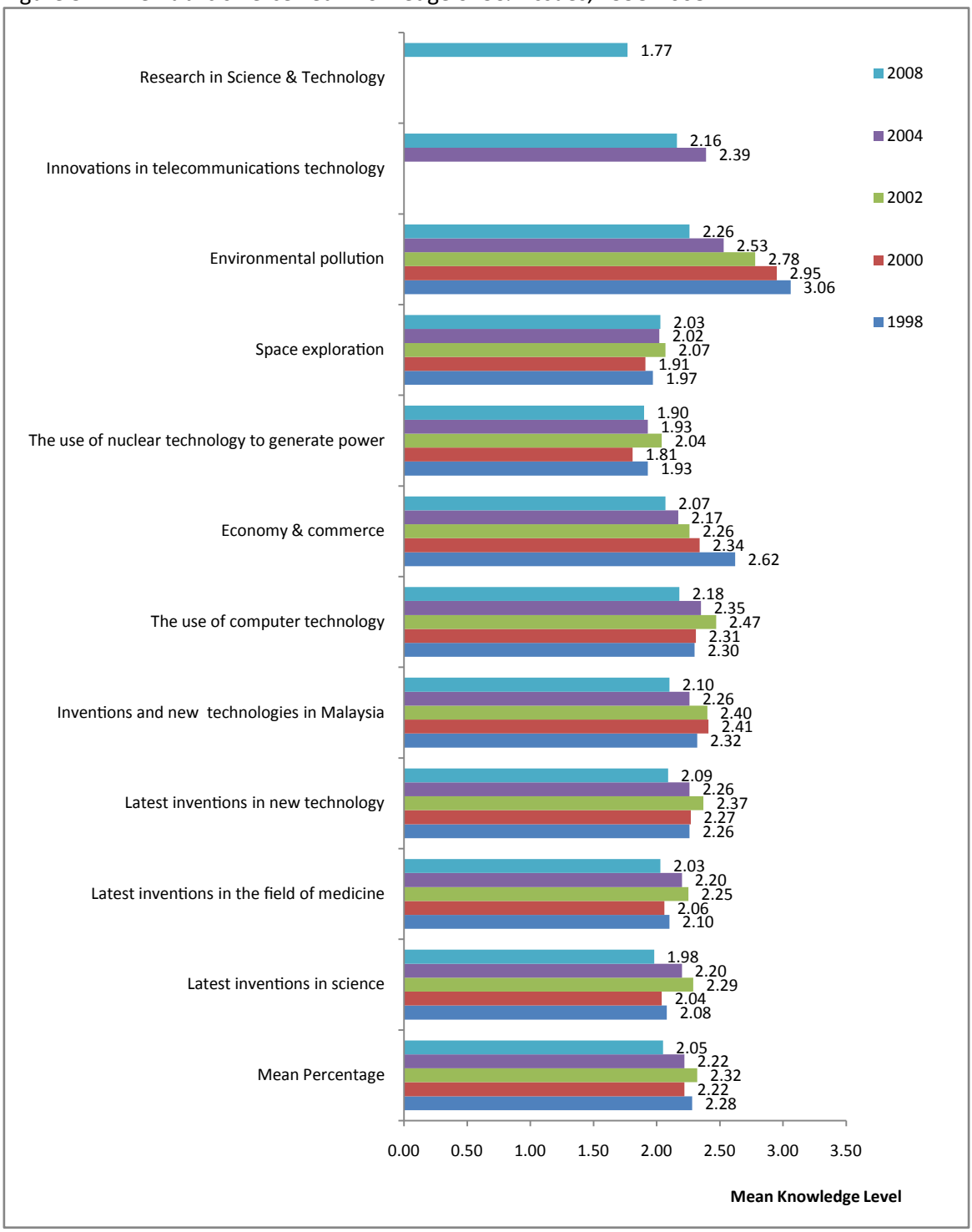
5.2 THE PUBLIC'S PERCEIVED KNOWLEDGE OF S&T ISSUES

As in previous surveys, the respondents were asked to rate their perceived knowledge of 11 S&T issues as being *"none at all", "weak", "average" or "good".*

An analysis of the trends from 1998 to 2008 indicates that Malaysians perceived themselves as having a poor or average understanding of S&T. This can be seen from the overall mean percentage of 2.28 for the year 1998, 2.22 for that of 2000, 2.32 for 2002, 2.22 for 2004 and 2.05

for 2008. With the exception of 2002, there seems to be a decline in the Malaysian public's perceived knowledge of S&T issues despite national efforts to equip the public with a solid foundation in S&T **(Figure 5.2)**.

Figure 5.2: The Public's Perceived Knowledge of S&T Issues, 1998-2008

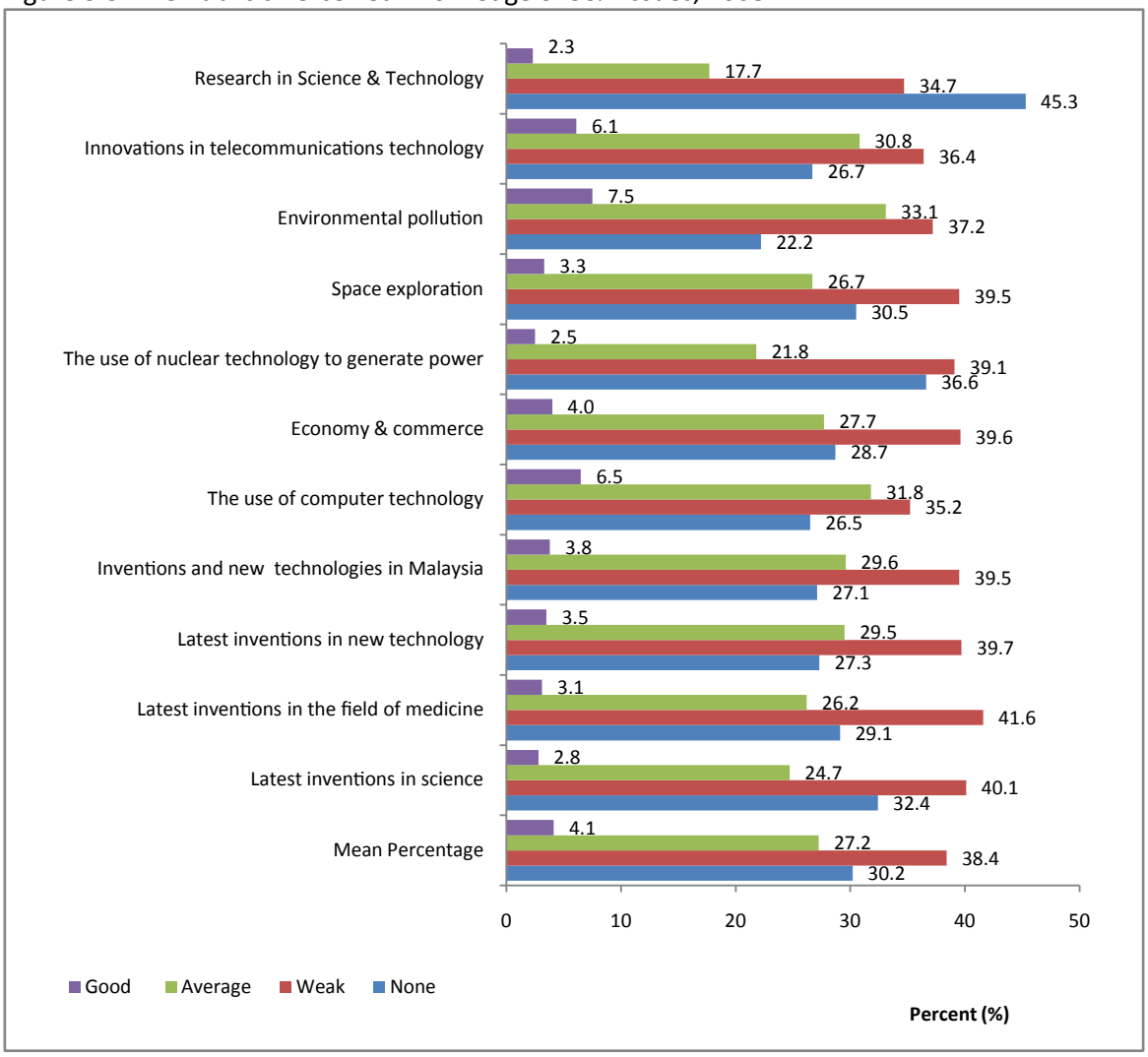


Source: The Public Awareness of Science & Technology Malaysia, 2008

In 2008, the majority of Malaysians believed themselves as having a weak knowledge on S&T issues, particularly with regard to the latest *inventions in medicine* (41.6%), followed closely by the latest *inventions in science* (40.1%), *space exploration* (39.5%), *the use of nuclear technology to generate power* (39.1%), and *research in science and technology* (34.7%). Indeed, 45.3% of

the Malaysian public perceived themselves as having no knowledge of research in science and technology **(Figure 5.3)**.

Figure 5.3: The Public's Perceived Knowledge of S&T Issues, 2008

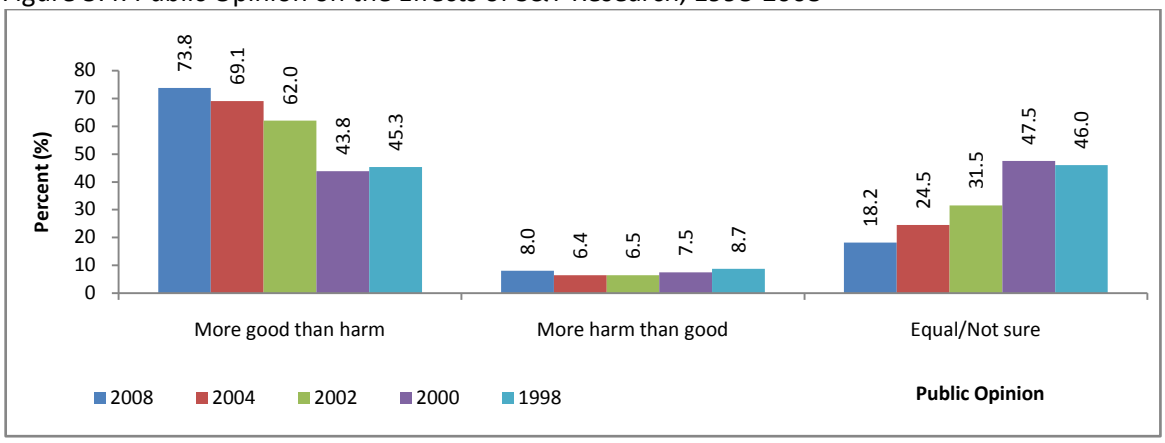


Source: The Public Awareness of Science & Technology Malaysia, 2008

5.3 PUBLIC ATTITUDES TOWARDS S&T

Generally, the attitudes of Malaysians towards S&T have improved over the years. For example, in 2008, 73.8 % of the respondents believed that S&T research does more good than harm while only 45.3% did so in 1998, with 46.0% being unsure **(Figure 5.4)**.

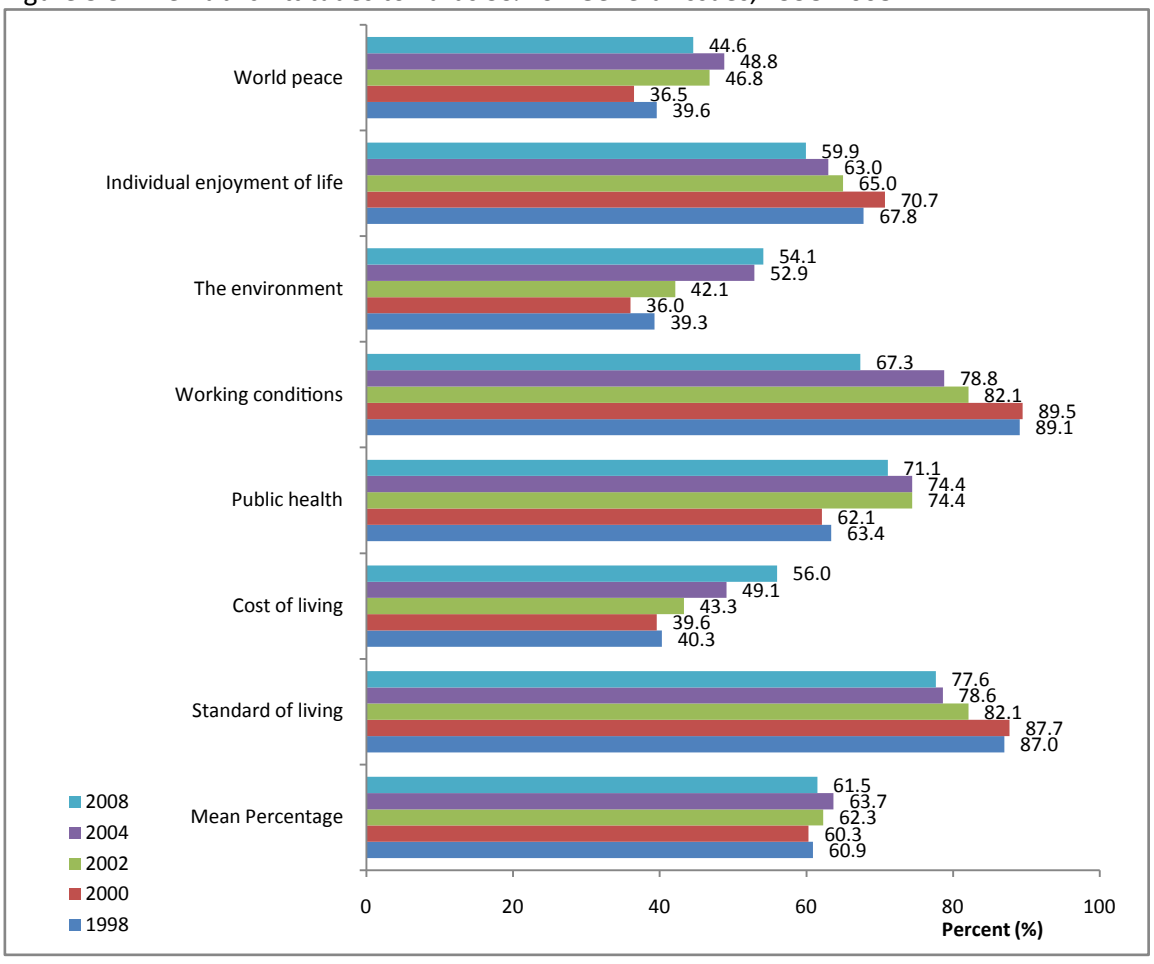
Figure 5.4: Public Opinion on the Effects of S&T Research, 1998-2008



Source: The Public Awareness of Science & Technology Malaysia, 2008

The respondents were also asked to give their opinions on the effects of S&T on a number of issues. 77.6% felt that S&T has positive effects on the standard of living, public health (71.1%), working conditions (67.3%), individual enjoyment of life (59.9%), cost of living (56.0%) and the environment (54.1%) **(Figure 5.5)**. It is interesting to note that with regards to world peace, only 44.6% of respondents felt that S&T had a positive effect. The same pattern can be seen in the previous surveys.

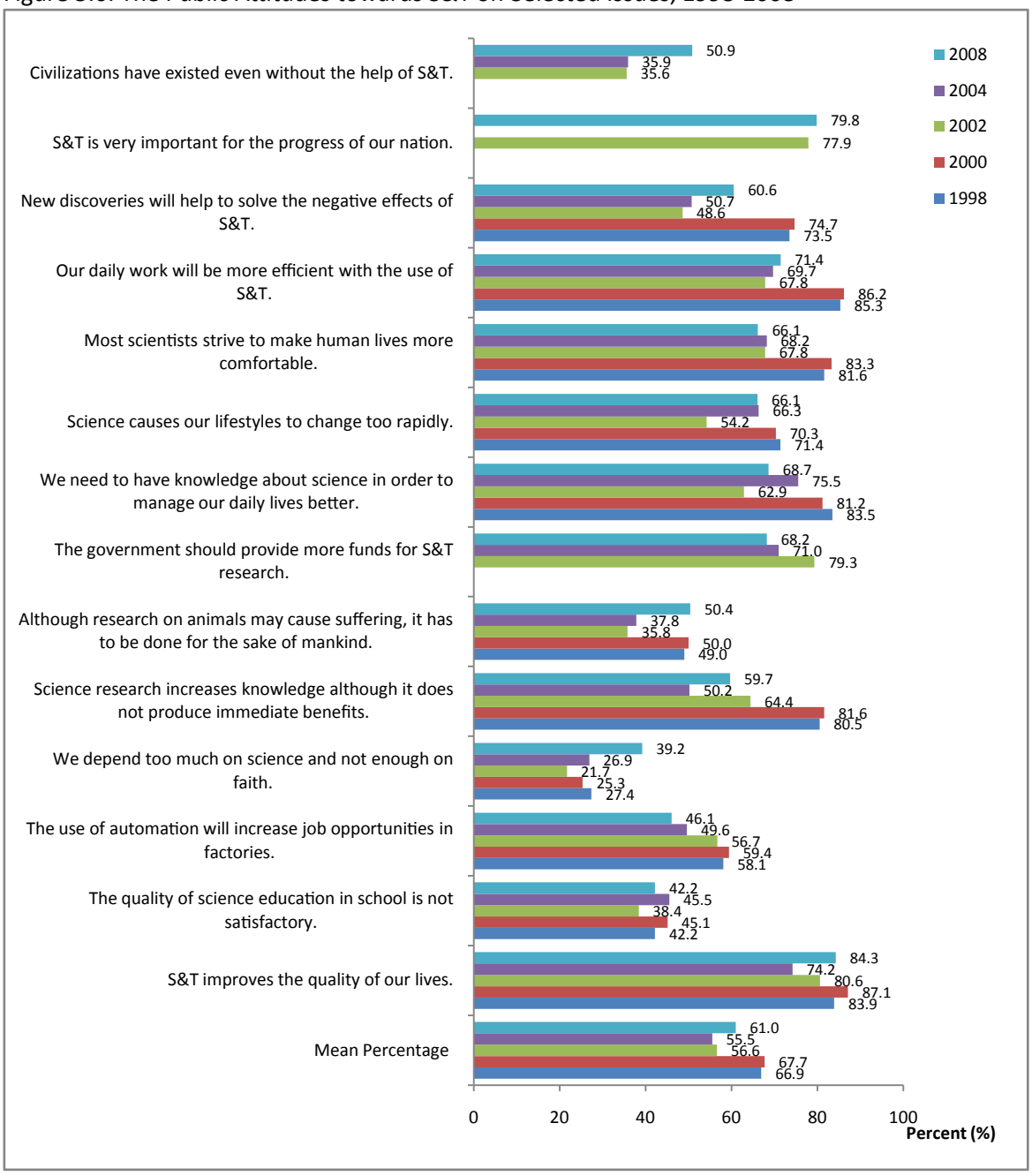
Figure 5.5: The Public Attitudes towards S&T on General Issues, 1998-2008



Source: The Public Awareness of Science & Technology Malaysia, 2008

The trends from 1998 to 2008 also show that Malaysians have generally viewed S&T in a positive light. Throughout the years, the majority of Malaysians felt that S&T *is very important for the progress of our nation*, that *S&T would improve the quality of our lives,* and that *our daily work will be more efficient with the use of S&T* **(Figure 5.6)**. This is indeed a very encouraging attitude towards S&T. In 2008, when asked about research on animals, 50.4% of the respondents agreed that although *research on animals may cause suffering, it has to be done for the sake of mankind.* This is a significant increase from the surveys conducted in 2000, 2002, and 2004, and indicates that half of the Malaysian public is supportive of S&T research, even though it may be accompanied by some bad effects. However, with regard to the issue of whether *we depend too much on science and not on faith*, the data for 2008 show that Malaysians are divided, with 39.2% agreeing, 33.4% disagreeing, and another 27.4% being unsure **(Figure 5.6)**.

Figure 5.6: The Public Attitudes towards S&T on Selected Issues, 1998-2008



Source: The Public Awareness of Science & Technology Malaysia, 2008

5.3.1 Public Understanding of S&T Issues

The understanding of Malaysians towards S&T issues was also assessed. They were asked to state "TRUE", "FALSE" or "NOT SURE" to various statements on S&T. A correct answer is taken as an indication of their understanding of the specific S&T issue in question, and an incorrect answer is taken to indicate otherwise.

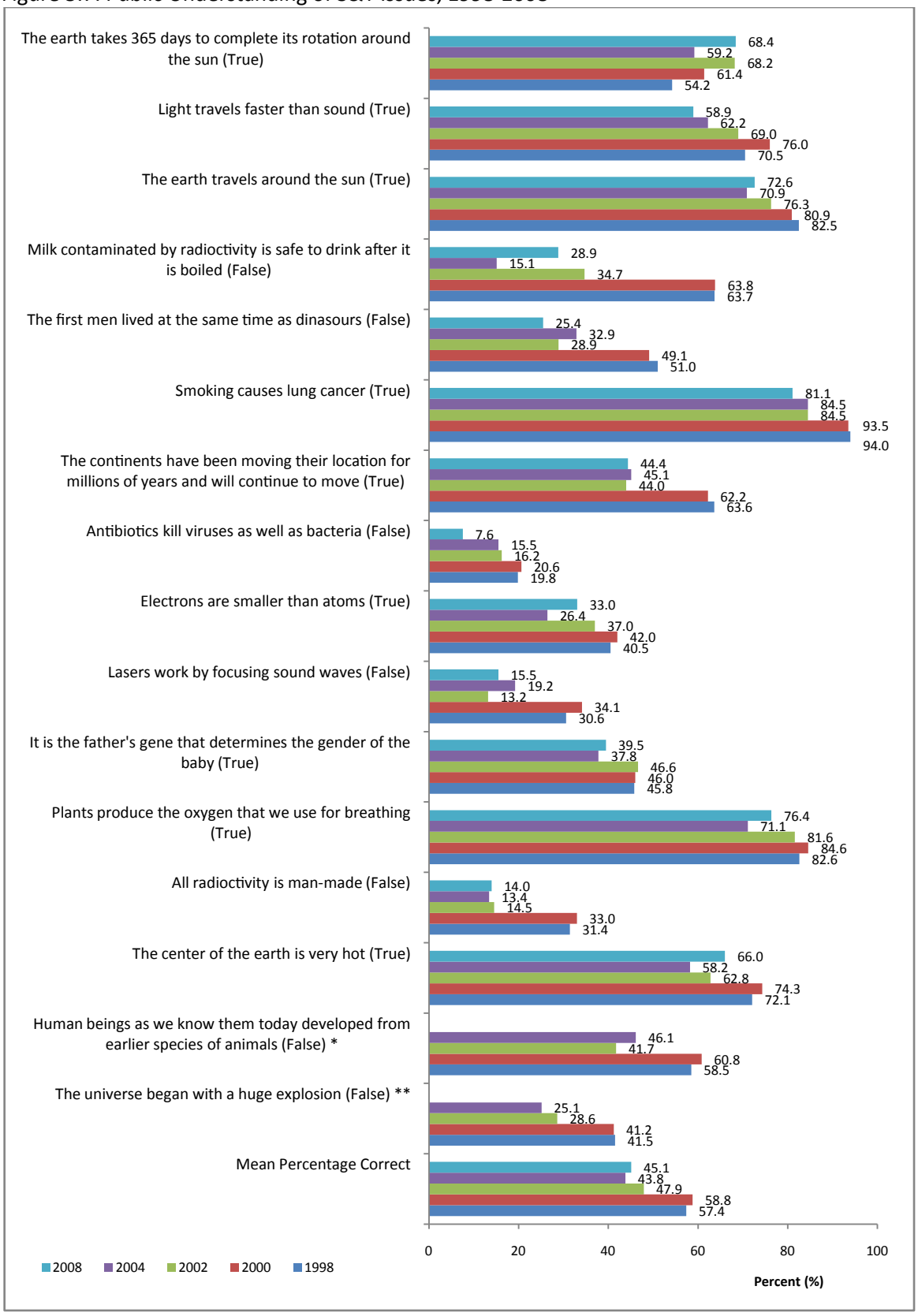
The results of the survey show that Malaysians have different levels of understanding with regard to different S&T issues. In 2008, there was an increase in the percentage of correct answers to statements such as, *"Plants produce the oxygen that we use for breathing"* (76.4%), *"The earth travels around the sun"* (72.6%), *"The centre of the earth is very hot"* (66.0%) and *"Light travels faster than sound"* (58.9%). These are the issues that Malaysians understand the most, and this could be due to the fact that these are basic S&T issues taught in school. The highest number of correct answers were given to the statement, *"Smoking causes lung cancer"* (81.8% in 2008, 84.5% in 2004 and 2002), which suggests that the national campaign on smoking was successful in exposing the bad effects of smoking to the Malaysian public **(Figure 5.7)**.

Although the results are encouraging, the survey also found that not many Malaysians answered correctly to statements such as *"All radioactivity is man-made"* (Only 14.0% did so in 2008, 13.4% in 2004 and 14.5% in 2002), *"Lasers work by focusing sound waves"* (Only 15.5% answered correctly in 2008, 19.2% in 2004 and 13.2% in 2002) and *"Milk contaminated by radioactivity is safe to drink after it is boiled"* (Only 28.9% did so in 2008, 15.1% in 2004 and 34.7% in 2002).

A possible reason why many Malaysians did not respond to these statements correctly is because these issues are more specialised, and would require a deeper understanding of S&T. Those that answered correctly to these issues are probably those that have a higher appreciation for and knowledge of S&T, particularly those that have gone through formal education. Be that as it may, the understanding of the public with regard to most of these issues has improved in contrast to the 2004 survey.

The fact that the percentage of correct responses to the specialised questions is quite low suggests that a lot more needs to be done to improve the public's understanding of S&T. Perhaps the best starting point would be to stimulate interest in S&T among Malaysian children at an early age, through interactive programmes such as S&T expositions, national and international competitions, interesting and affordable science camps, as well as theme parks or family entertainment centers that incorporate the learning of S&T. It is hoped that in this way, children will be gain an appreciation for and understanding of S&T at an early age, and that this appreciation and understanding will grow and evolve as they become adults.

Figure 5.7: Public Understanding of S&T Issues, 1998-2008



Source: The Public Awareness of Science & Technology Malaysia, 2008

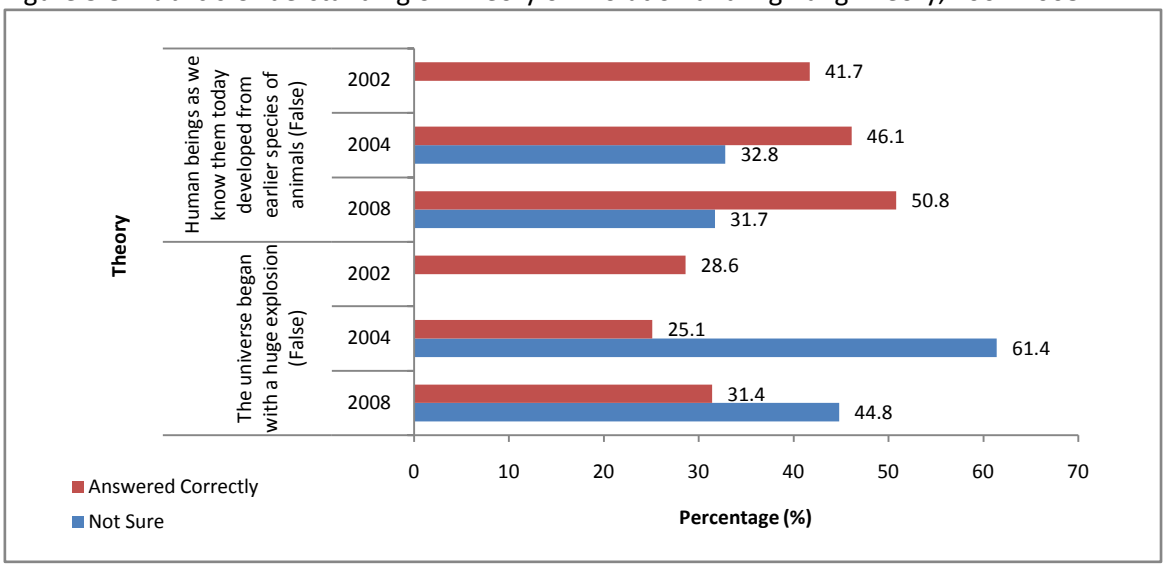
*Note: In the 2008 S&T survey, the items marked *and ** have been excluded from the calculation of the mean percentage of correct answers*

5.3.2 Theories of Evolution and the Big Bang

The reason why statements such as *"Human beings as we know them today developed from earlier species of animals"* and *"The universe began with a huge explosion"* were excluded from the assessment of the public's understanding of S&T issues is because such statements are theories as opposed to scientific facts. In addition, a person's beliefs regarding these statements are a reflection of his or her scientific or philosophical outlook or religious stand. This position is in contrast to that of the NSF and Eurobarometer surveys, which regard these statements as true. Nevertheless, respondents were still asked these questions to find out their *beliefs,* not understanding, regarding these issues and to compare these beliefs with those of the respondents of the Eurobarometer and NSF surveys.

In the 2008 survey, 31.4% of the Malaysian respondents believed that the statement, *"The universe began with a big explosion"* is false. This is in contrast to the previous years, where only 25.1% of those in 2004 and 28.6% of those in 2002 felt so. Concerning the *statement "Human beings as we know them today developed from earlier species of animals",* more than 50% responded that the statement is FALSE, compared to only 46.1% and 41.7% in 2004 and 2002 who did so **(Figure 5.8)**.

Figure 5.8: Public's Understanding on Theory of Evolution and Big Bang Theory, 2002-2008



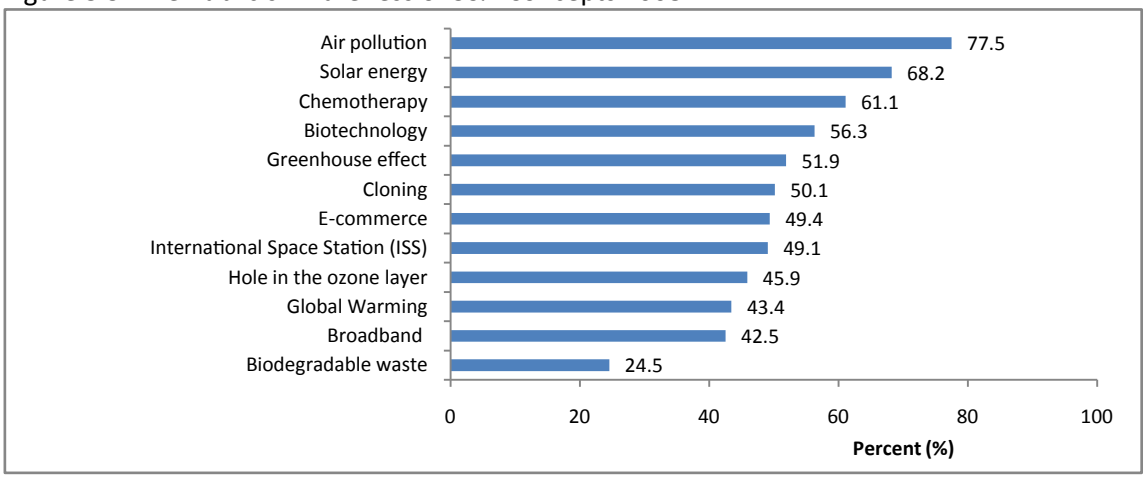
Source: The Public Awareness of Science & Technology Malaysia, 2008

As has been explained above, the public's responses to the above two issues does not indicate their understanding—or lack thereof—of the theories of evolution and Big Bang. Rather, they are a reflection of their belief system or philosophical stand. This is illustrated by the sharp increase in the positive responses to the statement on evolution in a national survey conducted in the USA when the phrase, *"according to the theory of evolution",* was added. This led the National Science Foundation (NSF) of the USA to conclude that Americans hold religious beliefs that caused them to be skeptical of the theory of evolution (as judged from the lower percentage of agreement, in previous NSF surveys, to this statement when it was worded as if it were a fact)–although there were familiar with the theory.

5.3.3 Awareness of S&T Concepts

On the awareness of S&T concepts, a substantial number of the Malaysian public have heard or read about *air pollution (77.5%), solar energy (68.2%), chemotherapy (61.1%) and biotechnology (56.3%)*. However, a smaller percentage are aware of issues on *hole in the ozone layer (45.9%), global warming (43.4%), biodegradable waste (24.5%)* and surprisingly, *broadband (42.5%).* On the other hand, an encouraging amount of the public have heard or read about *e- commerce, the greenhouse effect, cloning* and *the International Space Station*, with the percentage being at or around 50% **(Figure 5.9)**.

Figure 5.9: The Public's Awareness of S&T Concepts 2008



Source: The Public Awareness of Science & Technology Malaysia, 2008

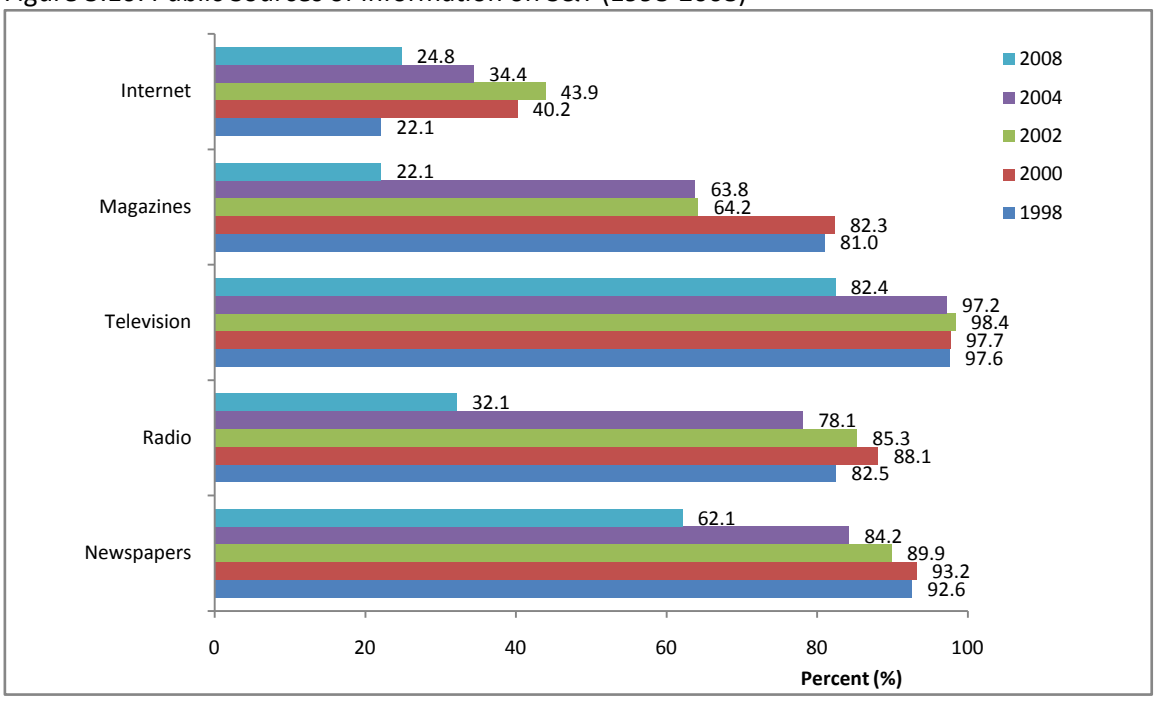
5.4 INFORMATION SOURCES ON S&T

It appears as though the majority of Malaysians are still choosing *television* (82.4%) and *newspapers* (62.1%) as their main sources of information on S&T. Only 32.1% referred to radio and 22.1% to magazines. Surprisingly, only 24.8% reported getting their S&T information through the *Internet* **(Figure 5.10)**.

An interesting point to note is that the 2008 survey results show a decline in the percentage of Malaysians citing them as sources of information and news on S&T. This could be attributed to the fact that two new items were included, such as *school* and *books*, which accounted for 16.1% and 19.3% respectively.

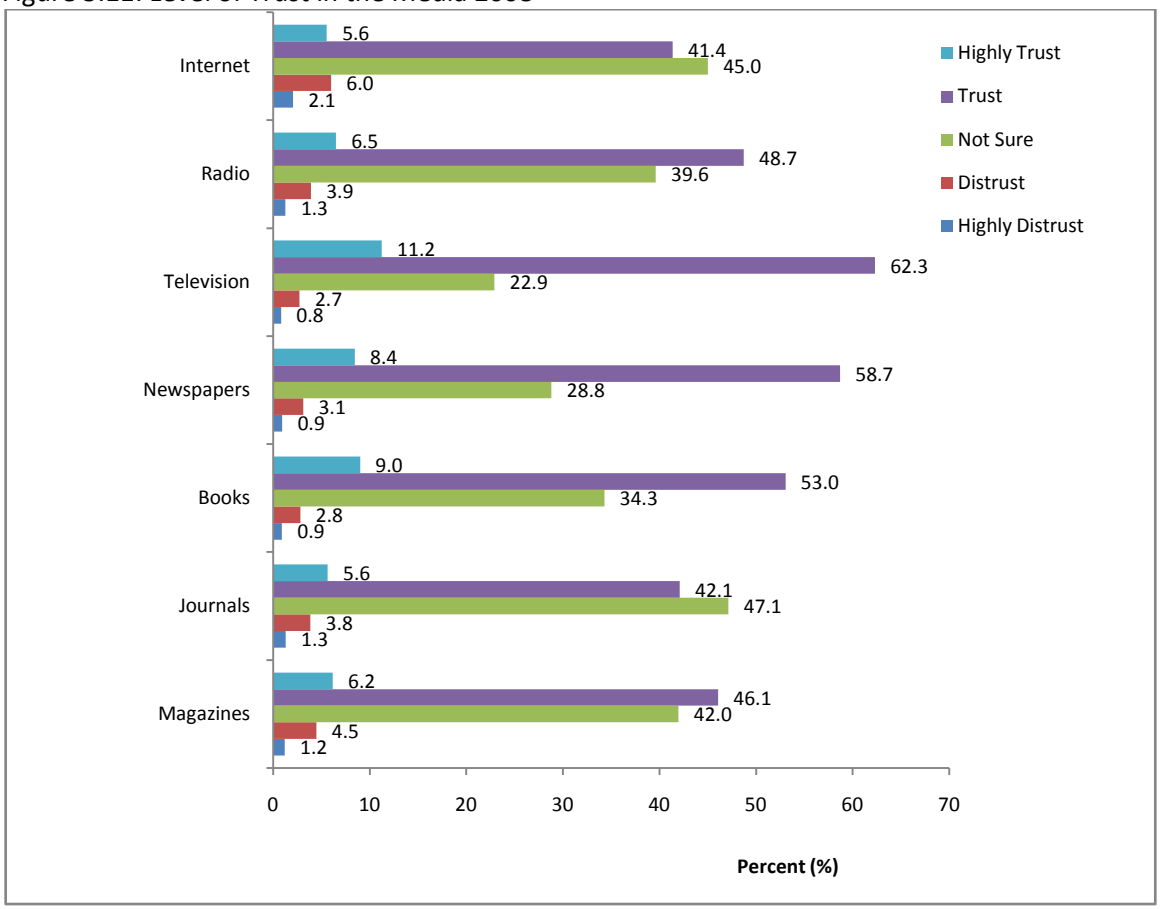
The relatively small amount of people that use the *Internet* as a tool for obtaining information on S&T show that the Malaysian public have not fully utilised the *Internet*, despite the advancement of telecommunications in Malaysia. In fact, in 2008, the percentage is smaller than that recorded in 2004 (34.4%), 2002 (43.9%) and 2000 (40.2%). There could be a number of reasons for this, one being not all Malaysians have access to computers and the *Internet,* especially those that live outside of the city. It could also be because not many people have come to trust the *Internet* as a reliable source of information (only 5.6% highly trust the *Internet*) as compared with *television* (11.2%), *books* (9.0%) and *newspapers* (8.4%) **(Figure 5.11)**.

Figure 5.10: Public Sources of Information on S&T (1998-2008)



Source: The Public Awareness of Science & Technology Malaysia, 2008

Figure 5.11: Level of Trust in the Media 2008



Source: The Public Awareness of Science & Technology Malaysia, 2008

5.5 INTENATIONAL COMPARISON

In this section, the Malaysian public's awareness and understanding of, interest in and attitude towards S&T as well as our main sources of S&T information are compared with that of other countries. Only the data concerning adults were used to allow for comparability with other international surveys.

5.5.1 Knowledge and Understanding of S&T Issues

16 issues were posed to the Malaysian public in the 2008 survey to assess their knowledge and understanding of S&T issues. Out of 16 issues, only 9 were the same as or similar to the ones used in international surveys, such as the Eurobarometer Survey in Europe and the National Science Foundation survey in the United States. These 9 issues were made the subject of the international comparison **(Table 5.1)**.

38.8% was the mean percentage of correct answers by the adult Malaysian public on items constructed to assess knowledge of S&T. This puts Malaysia below the USA, Europe and Korea (by 23.6%, 24.1% and 20.8% respectively). However, Malaysia fared better than India by 6.8% (this was based on the mean percentage of 7 items on which they were identical).

The results indicate that Malaysians did not fare as well as the Americans and Europeans on nearly all of the 8 and 9 S&T concepts in which we were identical to Europe and the USA respectively, with exception of: *"The earth travels around the sun"* where 70.3% of the Malaysian respondents answered correctly while only 56.0%, 65.0% and 68.5% of Americans, Europeans and Indians respectively, scored correctly; and *"The earth takes 365 days to complete its rotation around the sun* where Malaysians did better than the Americans by 10.6% and Indians by 24.6%.

Table 5.1: Malaysians' Knowledge of Selected S&T Issues Compared to That of Other Countries

Test Items		Malaysia (2008)	USA (2006)	Europe (2005)	S. Korea (2004)	India (2004)
1.	The earth travels around the sun (True)	70.3	56.0	65.0	88.5	68.5
2.	The earth takes 365 days to complete its rotation around the sun (True)	65.6	55.0	*	*	41.0
3.	The center of the earth is very hot (True)	63.8	80.0	87.0	87.0	56.5
4.	The continents have been moving their location for millions of years and will continue to move (True)	44.6	80.0	88.5	88.7	31.5
5.	It is the father's gene that determines the gender of the baby (True)	38.7	63.5	62.0	59.0	38.0
6.	Electrons are smaller than atoms (True)	30.8	54.5	46.0	46.0	30.0
7.	Lasers work by focusing sound waves (False)	14.5	47.0	49.5	30.0	*
8.	All radioactivity is manmade (False)	13.3	70.5	59.0	48.0	*
9.	Antibiotics kill viruses as well as bacteria (False)	7.2	55.5	46.0	29.5	8.0
Mean percentage		**38.8**	**62.4**	**62.9**	**59.6**	**39.1**

Sources: Science and Engineering Indicators 2006; Eurobarometer 2005 as cited in The Public Awareness of Science & Technology Malaysia, 2008

Note: * Data not recorded in the sources retrieved

The issues on which Malaysians performed the worst in 2008 were: *"Antibiotics kills viruses as well as bacteria"* (only 7.2% answered correctly in comparison to 46.0% of the European and 55.5% of the American respondents), *"All radioactivity is manmade"* (13.3% answered correctly whereas 59.0% of the Europeans and 70.5% of the Americans did so), and *"Lasers work by focusing sound waves"* (where only 14.5% of the Malaysians answered correctly compared to 50.0% of the Europeans and 47.0% of the Americans). The poor scores by Malaysians with regard to these issues suggest that we are lacking when it comes to specialised knowledge of S&T.

There are also other issues in which Malaysians did not do too well. The item, *"Electrons are smaller than atoms"* managed to get correct answers from 30.8% of the Malaysian respondents compared to 54.5% of the American and 46.0% of the European respondents, the statement, *"It is the father's genes that determine the gender of the baby"*, received correct answers from 38.7% of the Malaysians in comparison to 63.5% of the Americans and 62.0% of the Europeans; while the statement, *"The continents have been moving their location for millions of years and will continue to move"* manage to record correct answers from 44.6% of the Malaysians compared to 88.5% of the Europeans, 80.0% of the Americans, 88.7% of the South Koreans and 31.5% of the Indians.

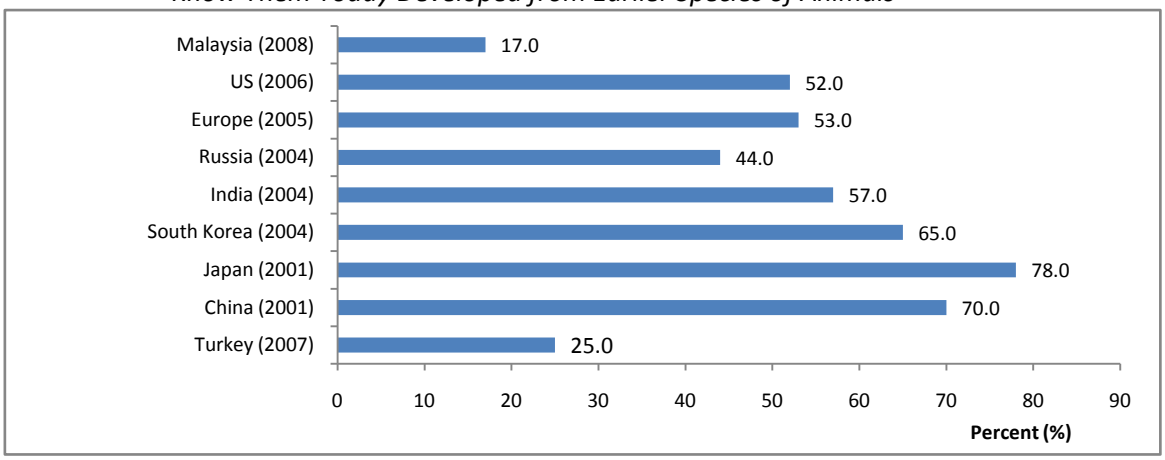
However, Malaysians did quite well on some issues such as: *"The center of the earth is very hot", "The earth takes 364 days to complete its rotation around the sun"* and "*The earth travels around the sun".* More than 60.0% of the Malaysian respondents answered correctly on these issues. Overall, Malaysians did better than Indians on 8 out of 9 issues compared, Americans on the first two issues, and Europeans with regard to only the first issue.

5.5.4 Malaysian's responses on the Theory of Evolution and Big Bang

The following two statements, *"Human beings as we know them today developed from earlier species of animals"* and *"The universe began with a huge explosion"* were not included in assessing the public's understanding of S&T—although they are used in Public Awareness surveys worldwide—because they do not represent scientific facts, but are theories on which people may have differing views. However, the items were still included in a different section of the questionnaire to compare Malaysian's epistemological beliefs in science with that of their international counterparts.

The statement, *"The universe began with a huge explosion"* did not record a high level of agreement from either Malaysians (only 27.0%), Americans (32.0%), Russians (35.0%), Indians (35.0%) or Chinese (17.0%) **(Figure 5.12).** In contrast, 67.0% of South Koreans and 60.3% of Japanese believed this statement to be true. With regard to the statement, *"Human beings as we know them today developed from earlier species of animals",* only 17.0% of Malaysians believed this to be true, in contrast to 52.0% of the Americans, 53.0% of the Europeans, 44.0% of the Russians and 57.0% of the Indians. Interestingly, in Turkey, a predominantly Muslim country, only 25.0% of the respondents agreed to this, while 16.0%, 8.0% and 14.0% of those Indonesia, Egypt and Pakistan respectively did so.

Figure 5.12: International Comparison of Public Agreement with the Idea "*Human Beings as We Know Them Today Developed from Earlier Species of Animals*"



Sources: Science and Engineering Indicators 2006; Eurobarometer 2005 as cited in The Public Awareness of Science & Technology Malaysia, 2008

5.5.6 Main Sources of S&T Information

The television and newspapers are the main sources of S&T information for Malaysians **(Table 5.2)** while for the Americans, the *Internet* and the television are the most important sources. However, the percentage of Americans that actually access these sources is actually lower than the Malaysian percentage of Malaysians. The Indians depended more on television and the radio than on the printed media such as the Internet, books and the newspaper. Indians also reported getting S&T information from their relatives (11.6%). An interesting trend that appears between these countries is despite the advancement in the telecommunications field and ICT, only a few Malaysians as well as Americans reported using the *Internet* as their source of S&T information.

Table 5.2: Percentage International Comparison on Sources of Information on S&T

Sources	Malaysia (2008)	Malaysia (2004)	US (2006)	India (2004)	S. Korea (2006)
Television	82.4	87.5	39.0	64.7	*
Newspaper	62.1	68.9	11.0	7.6	16.0
Radio	32.1	41.3	2.0	13.0	*
Internet	24.8	21.4	23.0	0.2	23.0

Sources: Science and Engineering Indicators 2006; India Science Report 2005, as cited in The Public Awareness of Science & Technology Malaysia, 2008

Note: * Data not recorded in the sources retrieved

5.6 CONCLUSION

Malaysians have reported themselves as being only moderately interested in some S&T issues and possessing a weak knowledge of S&T ever since the Malaysian Public Awareness Surveys were conducted. Malaysians also seem to have poorer knowledge of specialised S&T issues, although they do seem to have a good understanding of the more general S&T issues taught in school. In general, Malaysia falls behind some international countries such as America, Europe and South Korea on their level of knowledge of S&T, suggesting that a lot more needs to be done to enable Malaysians to have the specialized knowledge that is necessary for research and development and for the advancement of S&T.

On the other hand, the results of the surveys conducted from 1998-2008 also show that Malaysians have been consistently showing a positive attitude towards S&T. More than 60% of Malaysians viewed S&T as having a positive impact on *individual enjoyment of life, public health, standard of living* and *working conditions*. These results are encouraging, and suggest that the Malaysian public is receptive to S&T. Hence, the Government should capitalise on this in its efforts to improve S&T awareness through the promotion of various programmes so that further improvements with regard to the public's understanding of S&T can be achieved.

CHAPTER 6:
BIBLIOMETRICS: PUBLICATIONS AND CITATIONS

CHAPTER 6

BIBLIOMETRICS: PUBLICATIONS AND CITATIONS

6.0 INTRODUCTION

Academic publications in the field of science, technology and social sciences are important indicators of the generation of new ideas, knowledge and technology. Tracking the trends of academic and scientific publications and citations through bibliometrics assists policy makers in understanding the robustness of the scholarly communication process.

Bibliometrics is the enumeration and statistical analysis of scientific output in the form of articles, publications and citations[33]. It is an important tool in evaluating scholarly publications and the dynamism of the scientific community and an important indicator of research productivity. At the country level, it provides information on the scientific orientation and dynamism of the country's scientists and their participation in science and technology worldwide. As it also measures collaboration among scientists, it is a useful tool for assessing the scientist's interaction with his fellow scientists and his standing in his global community.

Citation is an indication of the importance that the scientific community attaches to the research. It is not a measurement of the quality of the paper but rather the impact of a particular piece of work or an individual artist to its community.

This chapter reports scholarly publication performance for Malaysia for the period 2001-2011. The report is based on *MOSTI Science and Technology Knowledge Productivity in Malaysia: Bibliometric Study 2012,* which sourced data from Thomson Reuters' 3 main databases i.e. Science Citation Index Expanded, Social Sciences Citation Index, and Essential Science Indicators. This is unlike the *Malaysian Science and Technology Indicators 2010*, which drew its sources from the SCOPUS database. The disadvantage is that the Thomson Reuters Web of Science's coverage is not as broad as SCOPUS. Due to that, the number of articles and the total count of citations may not be reflective of the actual number of articles and citations produced by Malaysian authors. Scholarly work here refers to articles published in peer-reviewed journals. As not many of the local journals are listed in the Thomson Reuters Index, it does not capture articles in local journals, notes, conference papers, or reviews. The total count of scholarly articles documented in this report is thus not reflective of the actual dynamism of local research activity.

This chapter analyses the current performance and trends in the production and citation of peer-reviewed articles for Malaysian institutions, specifically, institutions of Higher Learning (IHLs) and Government Research Institutes (GRIs). Areas reported include total count of publications, areas of strength in research, collaboration in research, ranking of institutions in terms of total publications, and finally, benchmarking publication activity in Malaysia with that of other countries. The second part of the report assesses citations in terms of total numbers as well as the H index and the ranking of Malaysian higher educational institutions. The H index (Hirsch

[33] Yoshiko Okubo, (1997) Bibliometric indicators and analysis of research systems: Methods and examples, OECD Science and Technology and Industry Working Papers (1997/01)

index) is a measure of the number of an author's publications and citations per publication.[34] In other words, an author with an index of *h* has published *h* papers, each of which has been cited by others at least *h* times.

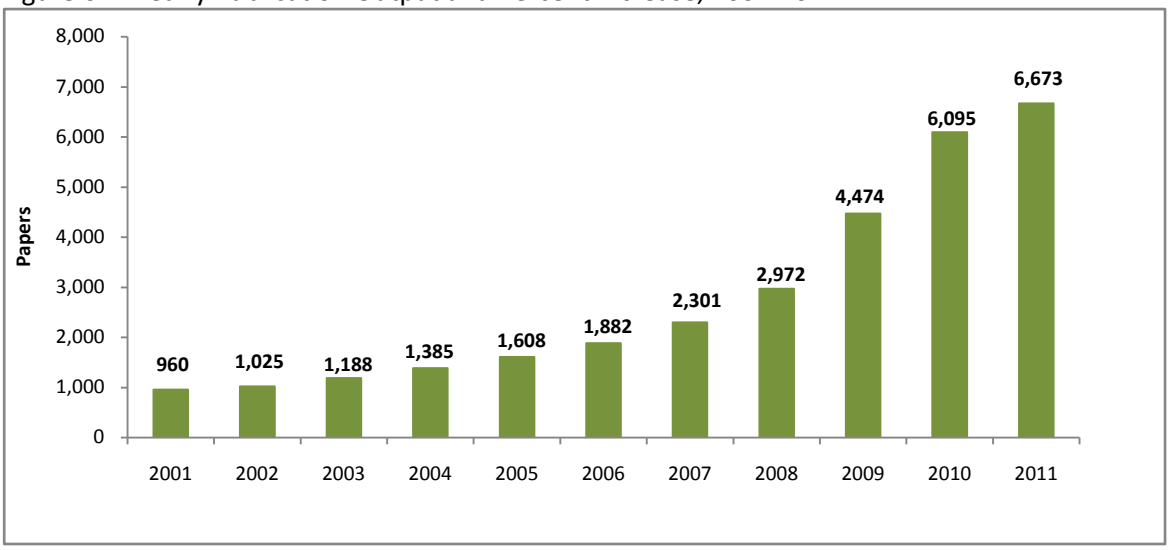
6.1 ARTICLE OUTPUT BY AUTHORS AFFILIATED WITH INSTITUTIONS IN MALAYSIA

6.1.1 Total Count of Scholarly Publications

The total count of scholarly publications by authors affiliated with institutions in Malaysia listed in the Thomson Reuters Web of Science from 2001 to 2011 is 30,563 papers. The rapid increase in the total number of scholarly publications can be attributed to the increase in the number of institutions of higher learning in Malaysia. Currently there are 20 public universities, 33 private universities and university colleges, 4 foreign university branch campuses, 32 polytechnics, 37 community colleges and about 500 private colleges operating in Malaysia. This is in line with the government's mission to turn Malaysia into an education hub.

Malaysia's total count of publications amounts to 0.22% of the world's total of 13,551,916—still modest in comparison to the USA as the top country in the world in terms of total numbers (3,269,947 papers). In terms of percentage, Malaysia's total papers amount to only 0.94% of the US papers. The total number of publications shows an upward trend between 2001 and 2011. From a total of 1,025 papers in 2002, this grew to 6,673 in 2011 **(Figure 6.1)**.

Figure 6.1: Yearly Publication Output and Percent Increase, 2001-2011



Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

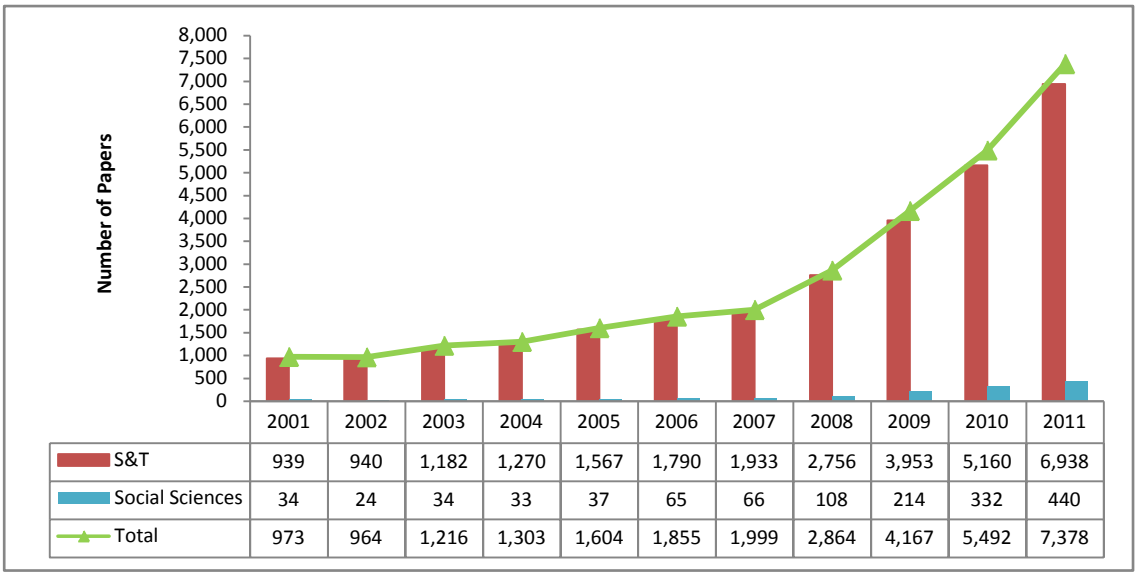
[34] Hirsch, J.E. [2005]. An index to quantify an individual's scientific research output, Proceedings of the National Academy of Sciences, 102(46):16,659-16,572.

6.1.2 Total Count of Publications: Science and Social Science

The scholarly publications from Malaysia are on a diverse range of disciplines including science and social science. It is useful to see how many of the total publications are from science field and how many from the social science. It is also interesting to evaluate the growth trend of the social science publications. The *MOSTI Science and Technology Knowledge Productivity in Malaysia: Bibliometric Study 2012* does not carry such an analysis. For that purpose, an independent investigation is made on the Thomson Reuters (ISI) database, selecting areas that have been categorized as social science. As the methodology adopted in this independent investigation is different than that employed by the Bibliometric Study 2012, the results derived are different. [35]

Figure 6.2 demonstrates that the number of publications in the social sciences is also on the increase; in tandem with the number in science and technology. In terms of percentage, papers in social sciences recorded 3.62% of total publications in 2001, and this grew to 6.34% in 2011. Again, it has to be cautioned here that because data in this section are only drawn from Thomson Reuters' (ISI) Database, they may not represent the total number of social science papers published in Malaysia.

Figure 6.2: Division between Science and Social Science



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
S&T	939	940	1,182	1,270	1,567	1,790	1,933	2,756	3,953	5,160	6,938
Social Sciences	34	24	34	33	37	65	66	108	214	332	440
Total	973	964	1,216	1,303	1,604	1,855	1,999	2,864	4,167	5,492	7,378

Source: Thomson Reuters (ISI) 2001-2011

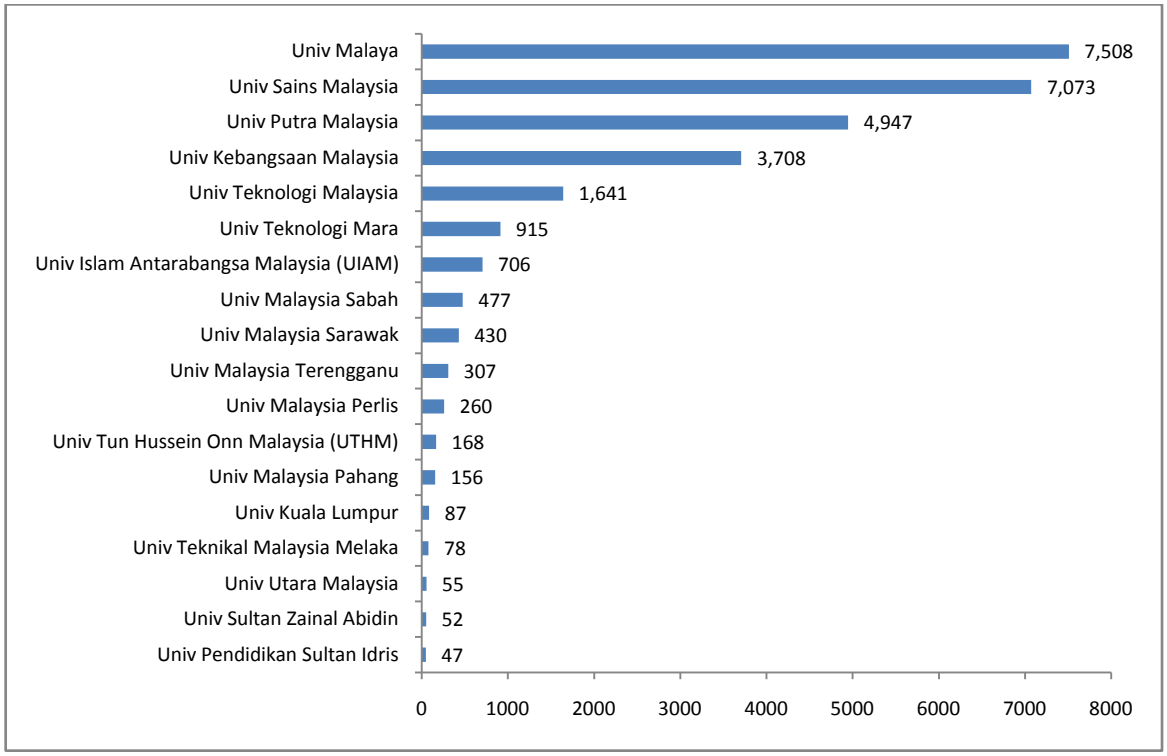
[35] The following areas are categorized as social science by the Index: anthropology, area studies, business, finance, communication, criminology & penology, demography, economics, history & philosophy of science, history of social sciences, hospitality, leisure, sport & tourism, industrial relations & labour, information science & library science, international relations, language and linguistics, law, experimental psychology, mathematical psychology, multidisciplinary psychology, psycho-analysis, social psychology, public administration, public environmental and occupational health, rehabilitation, education and educational research, special education, environmental studies, ergonomics, ethics, ethnic studies, family studies, geography, geriatrics and gerontology, health policy and services, history, linguistics, management, nursing, planning and development, political science, psychiatry, social science, bio-medical, mathematical methods, social work, sociology, substance abuse, transportation, urban studies and women's studies.

6.1.3 S & T Article Output: Public IHLs

The public IHLs produce a major portion of Malaysian scholarly works listed in the Thomson Reuters' Web of Science in terms of absolute numbers and percentage, led by the five research universities. Universiti Malaya heads the list, contributing 7,508, followed closely by Universiti Sains Malaysia, at 7,073. These two universities alone account for about 51% of the total publications by Malaysian authors affiliated with Malaysian institutions. The third largest contributor is Universiti Putra Malaysia (4,947), followed by Universiti Kebangsaan Malaysia (3,708), and Universiti Teknologi Malaysia (1,641). This indicates the strength of the five research universities, which account for about two thirds of the scholarly publications in Malaysia.

Following suit are other public universities, with total publications in the Thomson Reuters (Web of Science) Database not exceeding 1,000 in the ten-year period. Leading is Universiti Teknologi MARA, with 915 papers, and Universiti Islam Antarabangsa, with 706 papers. Universiti Malaysia Sabah and Universiti Malaysia Sarawak, set up in the 1990s, showed commendable effort—with a total count of over 400 papers. Meanwhile, the university colleges that have been upgraded into universities in the last decade, i.e. Universiti Malaysia Terengganu, Universiti Malaysia Perlis, Universiti Tun Hussein Onn Malaysia, and Universiti Malaysia Pahang are all showing good progress, as shown in the publication of between 150-300 scholarly papers in the ten-year period.

Figure 6.3: S&T Publication Output: Public IHLs, 2001-2011

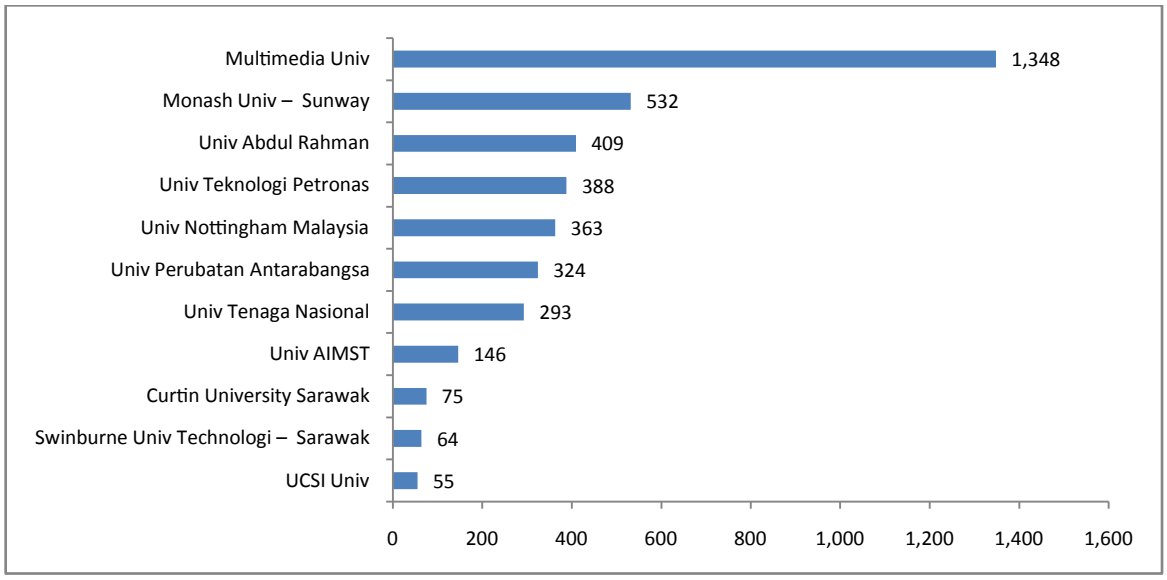


Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

6.1.4 S&T Article Output: Private IHLs

With regard to private universities, Multimedia University is leading, with 1,348 papers to its credit, or 3.8% of the total number of publications nationally. This university, which was set up in 1996, performed as well as Universiti Teknologi Malaysia, a research university and the oldest public engineering and technological university in Malaysia. The setting up of branch campuses of foreign universities has also shown a beneficial outcome in terms of publications. Both Monash University and Nottingham University performed considerably well, being 2nd and 5th in the list respectively. Private universities account for 3,997 of the scholarly papers published in the Thomson Reuters' Web of Science Database.

Figure 6.4: S&T Output: Private IHLs, 2001-2011



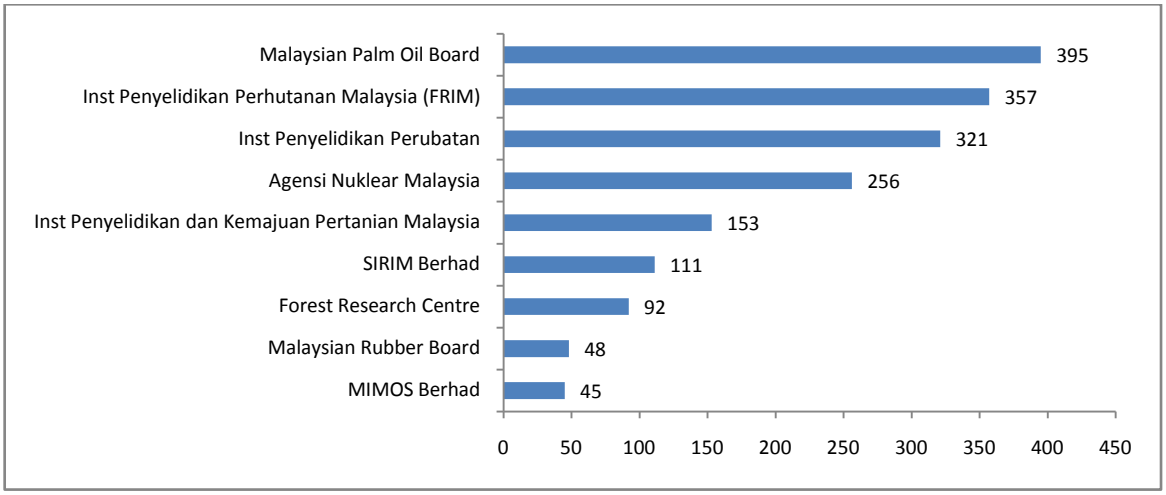
Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

6.1.5 S&T Article Output: GRIs

The main purpose behind the setting up of government research institutes is to conduct research in specific areas of interest to the country. These research institutes focus on the development of new technologies and products for Malaysia. As a result there is less emphasis on publication.

The total count of papers produced by the GRIs is 1,778 of the total number of Malaysian scientific articles published in the Thomson Reuters' Web of Science Database. Leading is Malaysian Palm Oil Board (395 papers), followed by FRIM (357 papers), IMR (321 papers) and Agensi Nuklear Malaysia (256 papers).

Figure 6.5: S&T Output: Private GRIs, 2001-2011



Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

6.1.6 S&T Article Output by Broad Subject Field

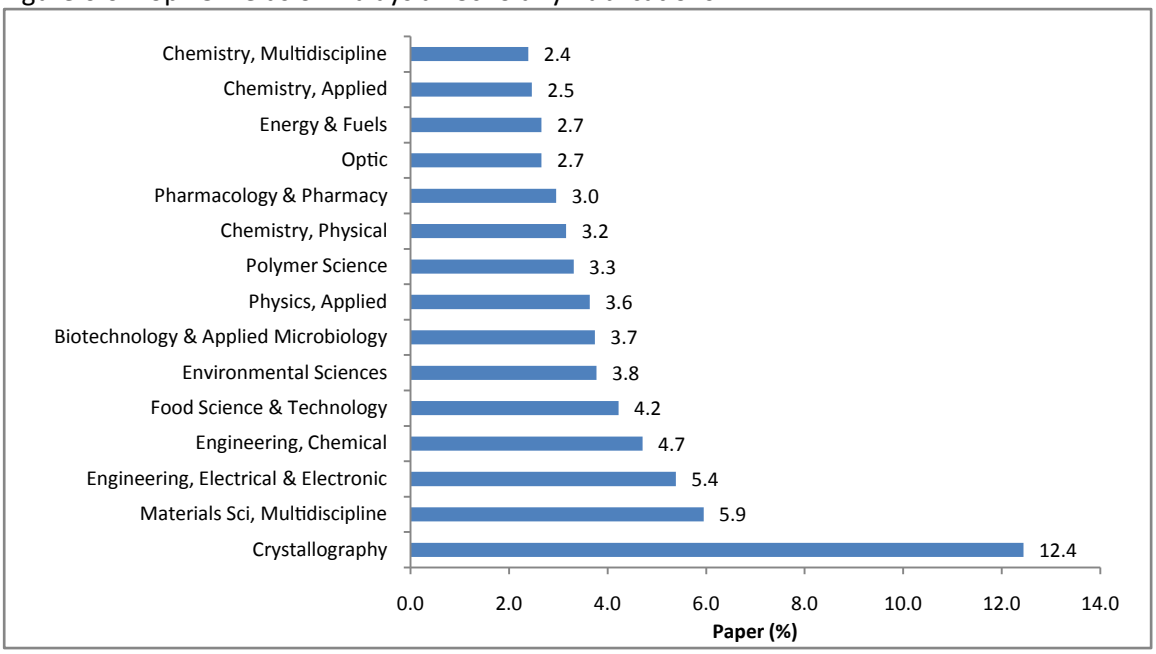
In terms of subject categories, crystallography appears to have the highest number of publications in the Thomson Reuters' Web of Science Database, with 3,802 papers, or 12.4% of the total count. Materials sciences (5.9%), electrical and electronic engineering (5.4%), chemical engineering (4.7%), and food science and technology (4.2%) follow suit. The fields in which less than 1,000 papers were published in the ten-year period are physical chemistry, pharmacology & pharmacy, optics, energy and fuels, applied chemistry and multidisciplinary subjects.

Table 6.1: Top 15 Fields of Malaysian Scholarly Publications and Percentage Share

Fields	Total number of papers 2001-2011	%
Crystallography	3,802	12.4
Materials Science, Multidiscipline	1,818	5.9
Engineering, Electrical & Electronic	1,646	5.4
Engineering, Chemical	1,440	4.7
Food Science & Technology	1,291	4.2
Environmental Sciences	1,154	3.8
Biotechnology & Applied Microbiology	1,144	3.7
Physics, Applied	1,112	3.6
Polymer Science	1,012	3.3
Chemistry, Physical	965	3.2
Pharmacology & Pharmacy	903	3.0
Optics	813	2.7
Energy & Fuels	812	2.7
Chemistry, Applied	753	2.5
Chemistry, Multidiscipline	730	2.4
Others	11,168	36.5

Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

Figure 6.6: Top 15 Fields of Malaysian Scholarly Publications

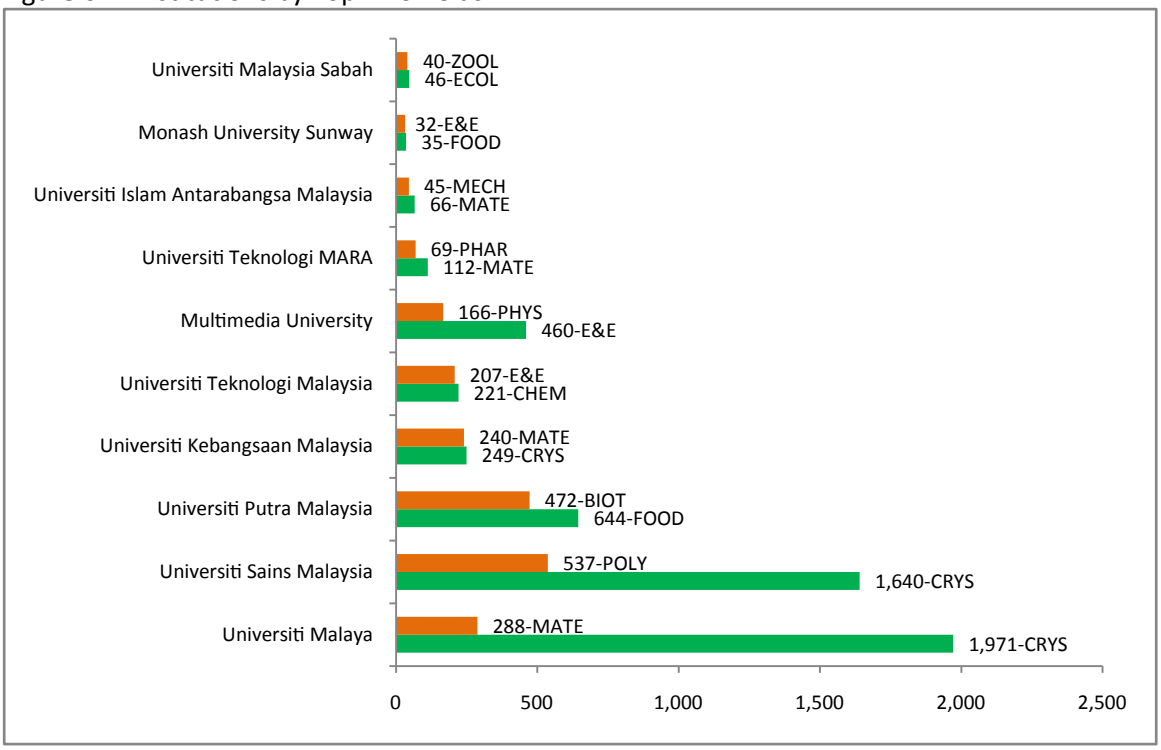


Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

6.1.7 Institutions and Fields of Research

The data on publications can further be taken as evidence of an institution's specialization and focus on research, as shown in **Figure 6.7**, which demonstrates the two areas of specialization for each of the top ten institutions. It also shows that both Universiti Malaya and USM's strength is in crystallography, which comes up to 95.0% of the total number of scholarly articles published in the Thomson Reuters Database, while Universiti Malaya and Universiti Kebangsaan Malaysia share the same areas of specialisation; i.e. crystallography and material sciences. Universiti Putra Malaysia, on the other hand, has published most in the fields of food science and technology and biotechnology and applied microbiology, while Universiti Teknologi Malaysia's specialisation in the field engineering is evident from its article output in electrical and chemical engineering.

Figure 6.7: Institutions by Top Two fields



Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

BIOT	Biotechnology & Applied Microbiology
CHEM	Chemical Engineering
CRYS	Crystallography
E&E	Engineering, Electrical & Electronic
ECOL	Ecology
FOOD	Food Science & Technology
MATE	Materials Science, Multidisciplinary
MECH	Engineering, Mechanical
PHAR	Pharmacology & Pharmacy
PHYS	Physics, Applied
POLY	Polymer Science
ZOOL	Zoology

6.2 S&T ARTICLE OUTPUT THROUGH THE COLLABORATIVE PROCESS

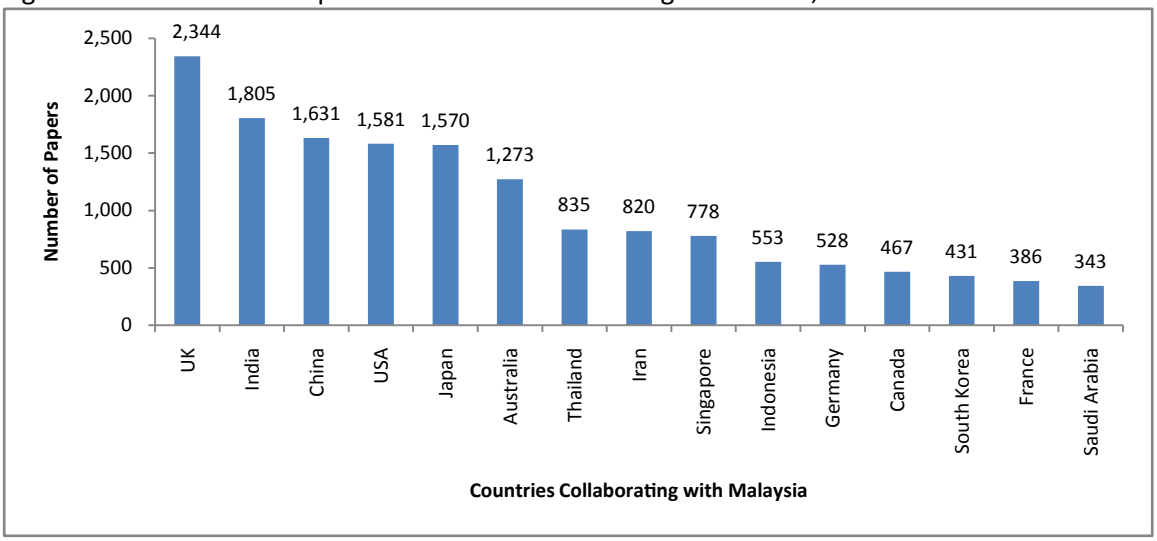
The increase in the number of co-authored papers is testimony to the fact that modern science is increasingly collaborative. Scientific collaboration in R&D occurs at two levels; international and national or intra-national scientific collaboration. Involvement in collaborative projects results in the exchange of knowledge and expertise within the scientific community internationally or intra-nationally. It has been suggested that international co-authorship, on average, results in publications with higher citation rates than purely domestic papers. This section discusses the patterns of scientific collaboration in terms of production productivity and the main players involved.

6.2.1 International Collaboration

International collaboration in the production of scholarly works suggests the increasing interconnectedness of scientists within and across countries due to the trans-disciplinary nature of research and their willingness to cooperate in R&D, as evident from the number of internationally co-authored publications. The Royal Society (2011) reported that science in 2011 is becoming increasingly global. The scientific community is becoming increasingly interconnected, with international collaborations on the rise.[36] The benefits brought about by international collaborations as alluded to by the Royal Society Report includes increased citation impact, access to new markets and broadening research horizons[37].

Figure 6.8 highlights the number of internationally co-authored papers from the top 15 countries, with the UK being the top collaborating country, with 2,344 papers. This is followed by India (1,805), China (1,631), USA (1,581), Japan (1,570), and Australia (1,273). The other countries in Asia that have co-authored papers internationally include Thailand, Singapore, Indonesia and South Korea.

Figure 6.8: S&T Article Output: Collaboration with Foreign Countries, 2001-2011



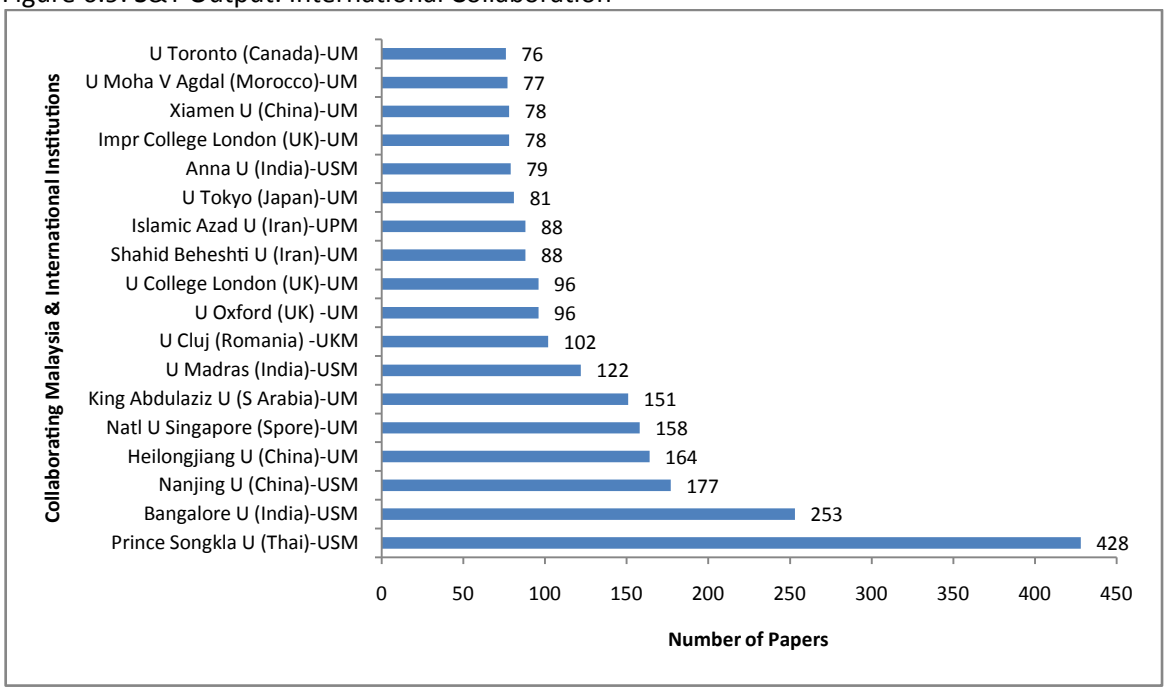
Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

Figure 6.9 shows the main players in international collaboration. At the forefront is Universiti Sains Malaysia, which managed to produce a total of 428 papers from its collaboration with the University of Songkhla, 253 papers with the University of Mangalore, and 177 papers with the Nanjing University of China. Universiti Malaya followed suit, with 164 papers with Heilongjiang University of China, 151 papers with King Abdul Aziz University, and 158 with the National University of Singapore. From the top 15 collaborating institutions, University of Malaya appears ten times, making it the most active academic institution in terms of production of joint papers.

[36] The Royal Society (2011) Knowledge, networks and nations: Global Scientific Collaboration in the 21st Century, available online at http://royalsociety.org/policy/projects/knowledge-networks-nations/report/

[37] The Royal Society (2011) Knowledge, networks and nations: Global Scientific Collaboration in the 21st Century, p. 6, available at http://royalsociety.org/policy/projects/knowledge-networks-nations/report/

Figure 6.9: S&T Output: International Collaboration



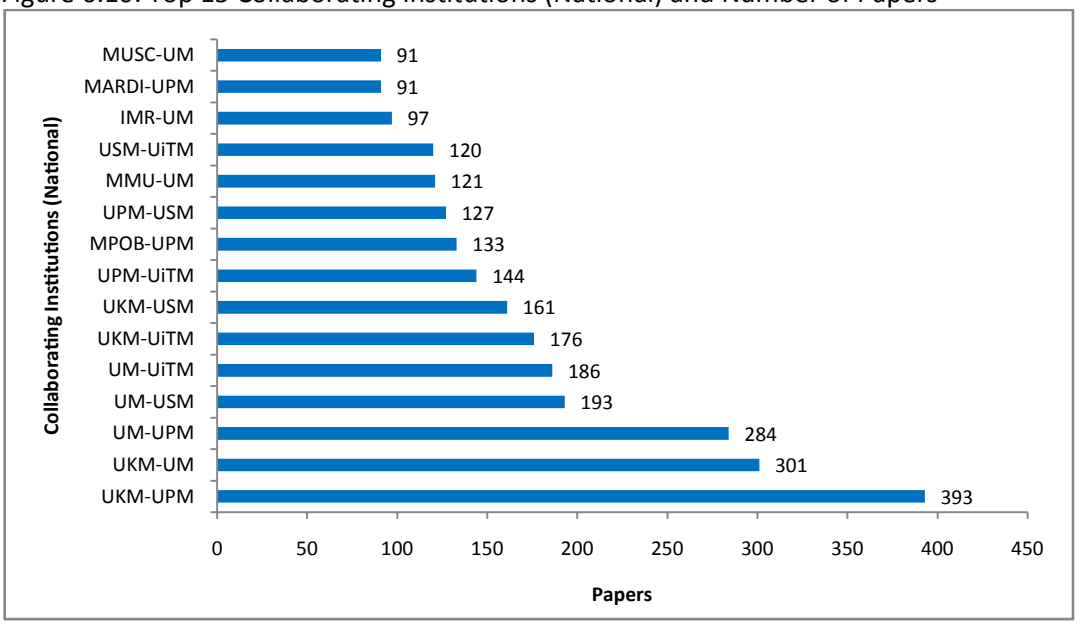
Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

6.2.2 Institutional Collaboration (National)

Figure 6.10 demonstrates that Universiti Malaya is the most active in terms of national collaboration as it appears six times in the top 15 national collaborating institutions. In terms of the total count of joint papers, the highest number is produced through the collaboration between Universiti Kebangsaan Malaysia and Universiti Putra Malaysia (393 papers). This is followed by UKM-UM (301 papers) and UM-UPM (284 papers).

Active collaboration between the IHLs and RIs is evident from the number of articles produced. As the research institutes' primary objective is to conduct applied research within specific areas of national interest, the collaboration between the IHLs and RIs demonstrates the readiness of the IHLs to align their research projects to national interest. The collaboration between UPM and MPOB has generated 133 papers and with MARDI, 91 papers. UM has collaborated with IMR to produce 97 papers.

Figure 6.10: Top 15 Collaborating Institutions (National) and Number of Papers



Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

6.3 CITATION OF S&T ARTICLES

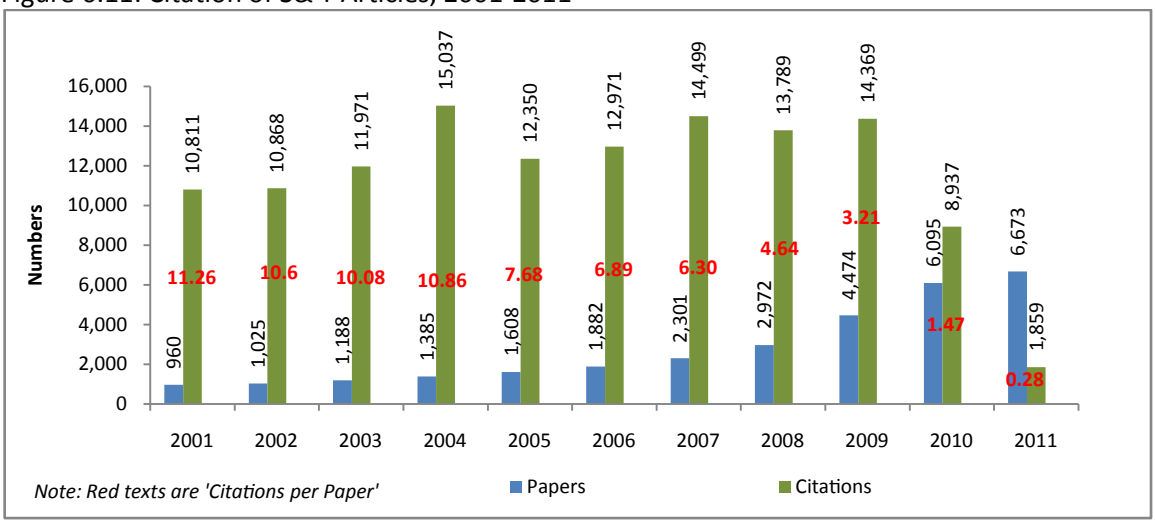
A citation is a form of acknowledgement that one research paper gives to another. Publication alone is not an accurate measurement of the value that the paper has in the eyes of the scientific community. A citation analysis, instead, measures the impact and influence of a scientific paper as a source by others to build on as new knowledge. The simple assumption is that the more cited a work is the more important it is within the academic circles.

This section assesses the citations received by Malaysian papers (sourced from Thomson Reuters' 3 main databases) between 2001-2011. The citation patterns of Malaysian papers are gauged from total annual count, average citation per paper, by field of research and by institutions. The performance of our national universities *vis a vis* each other is further measured both in terms of total citations as well as the 'h' index.

The annual count of citations of Malaysian papers is on a downward trend; despite the upward trend in publications. In 2001, for a total of 960 papers, the total citation is 10,811; with an average of 11.26 per paper. On the other hand, in 2011, the total citations received are 1,859 for a total of 6,673 papers. The highest number of citations is in 2004, with 15,037 counts, and the lowest is in 2011, with 1,859 citations **(Figure 6.11)**. It has to be stressed, however, that as the Thomson Reuters' Database only measures citations within its database, it does not represent the full picture with regard to Malaysian citations.

The average citations per article are also on a downward trend; with the highest citations per paper in 2001 at 11.26 citations per paper, with the lowest count in 2011, at 0.28 citations paper. This demonstrates that even though Malaysia is producing more papers by year, these papers do not receive enough citations **(Figure 6.11)**.

Figure 6.11: Citation of S& T Articles, 2001-2011



Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

When examined by field of research, chemical engineering attracts the most number of citations, followed by Crystallography and Environmental Science. However, when examined from the average citations per paper, energy and fuels rank the highest, followed by applied chemistry and chemical engineering.

Table 6.2: Citations of S&T Article by Fields of Research

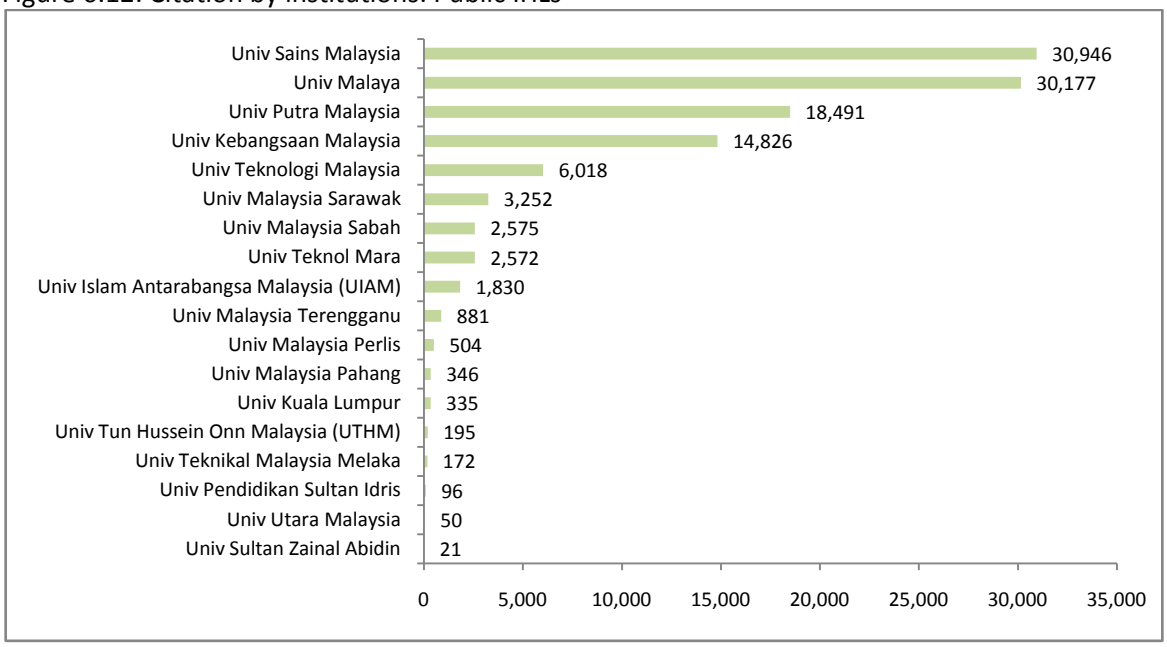
Fields of Research	Citations	Citations per Paper
Engineering, Chemical	9,143	6.35
Crystallography	7,947	2.09
Environmental Sciences	7,804	6.76
Materials Science, Multidisciplinary	6,438	3.54
Food Science & Technology	6,126	4.75
Polymer Science	6,108	6.04
Chemistry, Physical	6,073	6.29
Energy & Fuels	6,045	7.44
Biotechnology & Applied Microbiology	5,970	5.22
Chemistry, Applied	5,447	7.23

Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

6.3.1 Citations by Institutions

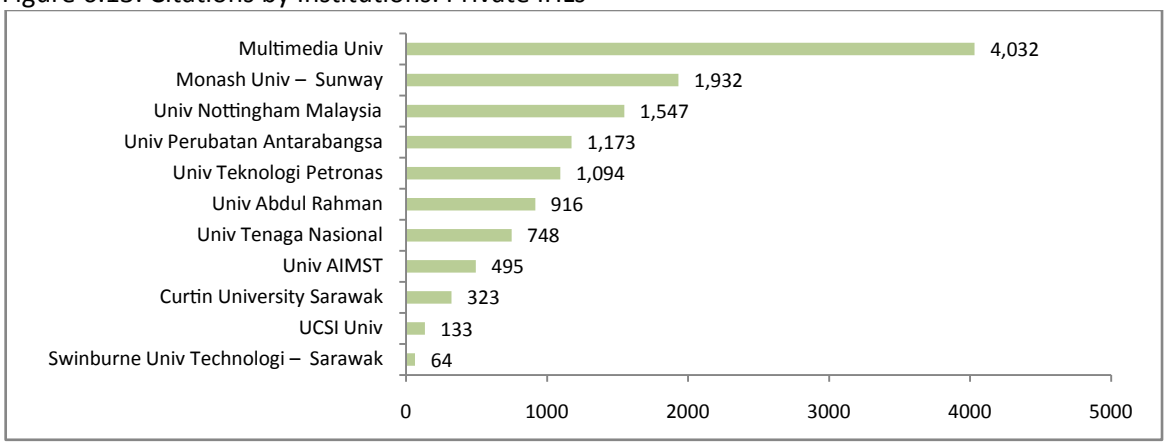
With regard to the number of citations for S&T articles among the public IHLs, the research universities lead. Topping the list is USM, followed by UM, UPM, UKM and UTM **(Figure 6.12)**. As for the private IHLs, Multimedia University topped the list with 4,032 citations followed by Monash University Sunway branch, University Nottingham Malaysia branch and Universiti Teknologi Petronas **(Figure 6.13)**. The research institutes are also getting a considerable amount of citations with MPOB leading, followed by FRIM, IMR and MINT **(Figure 6.14)**. The lack of publications and citations from the research institutes are understandable considering the fact that the main objective of the research institutes is R&D and not publications.

Figure 6.12: Citation by institutions: Public IHLs



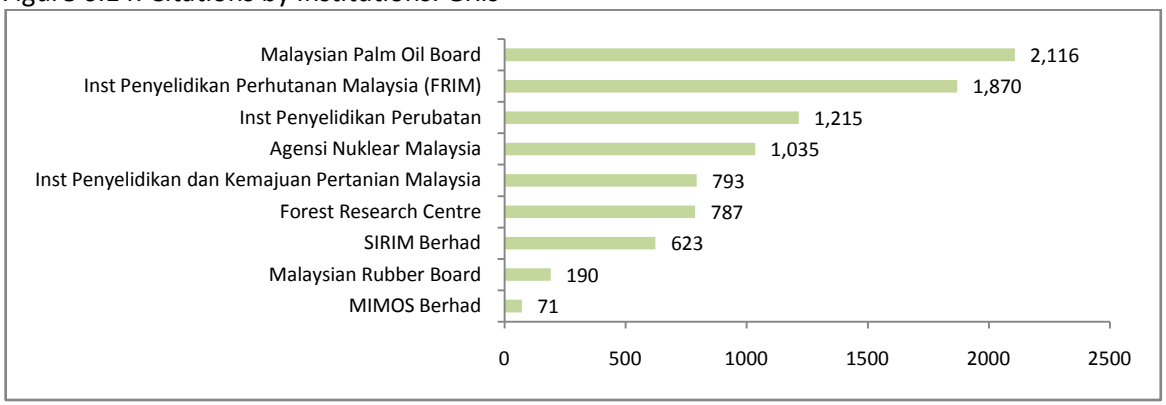
Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

Figure 6.13: Citations by Institutions: Private IHLs



Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

Figure 6.14: Citations by Institutions: GRIs

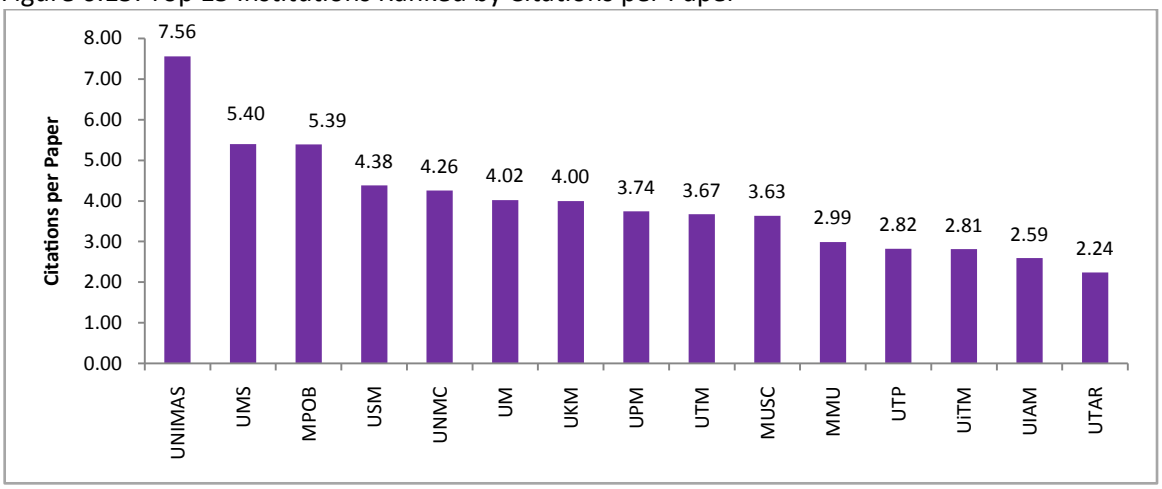


Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

When compared with average citations per paper, Universiti Malaysia Sarawak tops the list, with an average citation of 7.56 per paper (11th in total papers) followed by Universiti Malaysia Sabah

(5.40 average citation, ranked 10th in total papers), and The Malaysian Palm Oil Board, which ranks 3rd for total citations when it is only 13th in the total publications. UM, which topped the total count of publications **(Figure 6.3),** ranks 6th in terms of average citation per paper. The other two institutions that were leading in total number of publications (i.e. USM and UPM) now rank 4th and 8th respectively in average citations **(Figure 6.15).** Foreign branch campuses again make a strong presence in the citations count with the University of Nottingham Branch Campus at 5th place and Monash University Branch Campus at 10th place.

Figure 6.15: Top 15 Institutions Ranked by Citations per Paper



Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

6.4 INSTITUTIONAL RANKING ACCORDING TO H-INDEX

The h-index of an institution can also be used as a quantitative measure of its impact, influence or quality. It is a covert indicator of the performance of a particular institution.

Universiti Malaya appears 1st in the rank by having an h-index of 55, followed closely by Universiti Sains Malaysia, with 51, and Universiti Putra Malaysia with 44. Indeed, public universities top the first seven places in the rank. Universiti Islam Antarabangsa, a public university, has fallen lower in the rank to the 14th position, while Multimedia University, a private university, has been consistently in the middle rank: 8thin the h-index, 6th in total papers, and 11th in average citations per paper.

Branch universities appear strong in the h-index rank, with Monash University Branch Campus at the 8th position and the University of Nottingham Branch Campus at the 9th position. A good number of research institutes appear in the rank of the top 15 *h*-index, although not listed among the top 15 publications and citations. Among them are Institut Penyelidikan Perhutanan Malaysia (8th, h-index 22), Institut Penyelidikan Perubatan (16th, h-index 22) Agensi Nuklear Malaysia (16th, h-index 16), Forest Research Centre (Sabah/Sarawak) (16th, h-index 16) and Institut Penyelidikan dan Kemajuan Pertanian Malaysia (16th, h-index 14).

Table 6.3: The Top 15 H-index Values among Malaysian Institutions

Rank	Institution	H-index
1	Universiti Malaya	55
2	Universiti Sains Malaysia	51
3	Universiti Putra Malaysia	44
4	Universiti Kebangsaan Malaysia	38
5	Universiti Teknologi Malaysia	29
6	Universiti Malaysia Sarawak	26
7	Universiti Malaysia Sabah	23
8	Multimedia University	22
8	Monash University – Sunway	22
8	Inst Penyelidikan Perhutanan Malaysia	22
9	University of Nottingham Malaysia	21
10	Universiti Teknologi MARA	19
10	Malaysian Palm Oil Board	19
11	Hosp Kuala Lumpur	18
12	Universiti Perubatan Antarabangsa	16
12	Institut Penyelidikan Perubatan	16
12	Agensi Nuklear Malaysia	16
12	Forest Research Centre (Sabah / Sarawak)	16
13	Institut Penyelidikan dan Kemajuan Pertanian Malaysia	14
13	SIRIM Berhad	14
14	Universiti Islam Antarabangsa Malaysia	13
14	Universiti Tunku Abdul Rahman	13
14	Universiti Teknologi Petronas	13
15	Universiti AIMST	12

Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

6.5 INTERNATIONAL COMPARISON

As demonstrated **Table 6.4**, the USA still dominates in terms of scientific publications, at a share of 24.13% of total world publications. China is fast following suit, by being the second largest publisher of scientific articles in the world. However, in terms of total numbers China's share is only a quarter of the US at 6.91%. The third in the rank is Germany, followed by Japan in the fourth position and England in the fifth position.

This finding is consistent with that of the Royal Society Report (2011), which highlights the rapid rise of China in the ranking. Together with India (11th), South Korea (12th), Brazil (15th) and Taiwan (17th), their emergence as scientific nations and rising powers in science could be attributed to the increase in their investment in R&D[38]. It has to be noted here that the Royal Society Report recorded publications in SCOPUS, which has a wider range of publications compared to Thomson Reuters's Web of Science Database.

[38] The Royal Society (2011) Knowledge, networks and nations: Global Scientific Collaboration in the 21st Century, p. 19 available online at http://royalsociety.org/policy/projects/knowledge-networks-nations/report/

Table 6.4: Total Count of Papers, Share of World Total

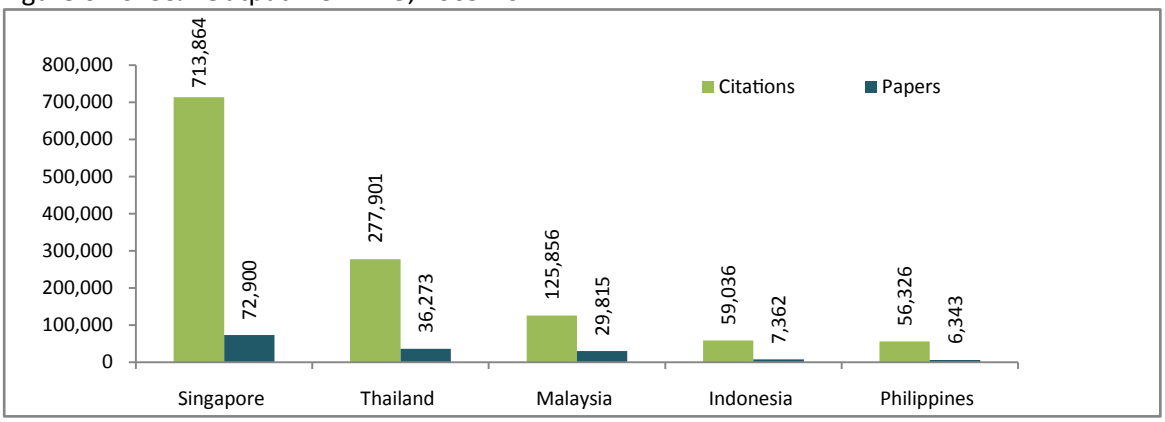
Country	Papers	
	Number	Share (%)
World	**13,551,916**	
USA	3,269,947	24.13
Peoples R China	936,803	6.91
Germany	850,110	6.27
Japan	826,586	6.10
England	750,538	5.54
France	607,708	4.48
Canada	487,744	3.60
Australia	329,488	2.43
India	320,835	2.37
Taiwan	196,214	1.45
Sweden	192,422	1.42
Iran	89,071	0.66
Singapore	72,900	0.54
New Zealand	62,276	0.46
Thailand	36,273	0.27
Malaysia	**29,815**	**0.22**
Vietnam	8,032	0.06
Indonesia	7,362	0.05
Philippines	6,343	0.05

Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

6.5.1 Publications and Citations in ASEAN-5

Figure 6.16 demonstrates the position of Malaysia's papers and citations in comparison to ASEAN 5 countries. In terms of total publications and citations, Malaysia (rank 46) is behind Singapore and Thailand but ahead of Indonesia and Philippines. Malaysia's share of papers for the ASEAN-5 is 19.53% while the total citations is 10.21%.

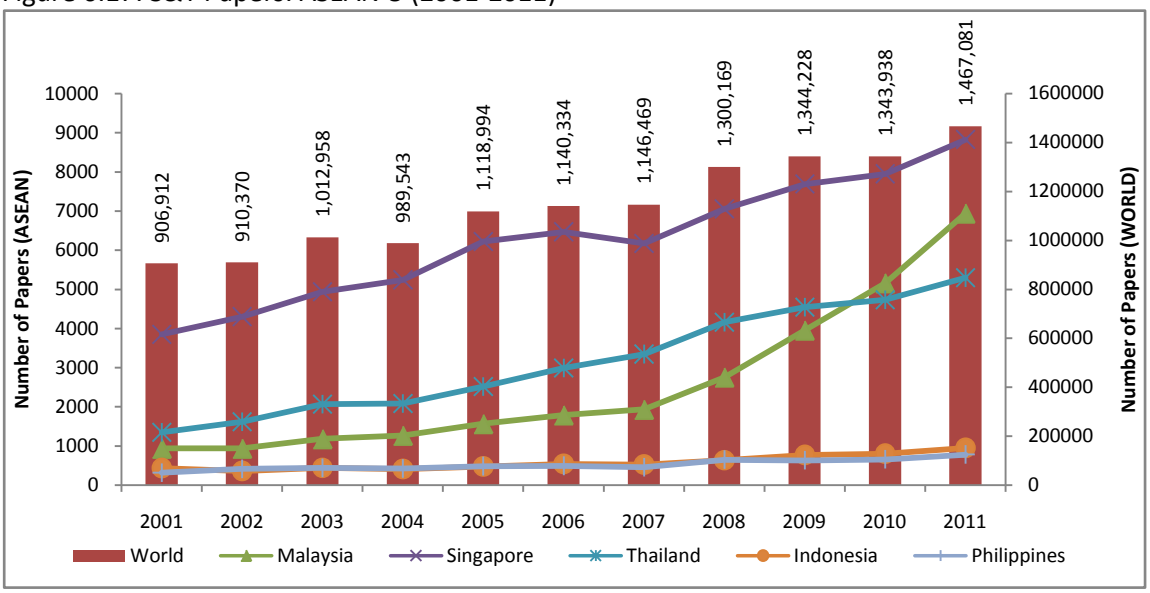
Figure 6.16: S&T Output: ASEAN-5, 2009-2011



Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

Figure 6.17 records the annual growth of S&T papers in five ASEAN countries. Data from this part were extracted from the Thomson Reuters (ISI) database through an independent investigation. From the results, it shows that the trend in the growth of scientific papers from Singapore and Thailand correlates with that of the world growth. Malaysia seems to have accelerated its growth from 2008 onwards whilst Indonesia and the Philippines seem to be maintaining the same growth rate since 2001.

Figure 6.17: S&T Papers: ASEAN-5 (2001-2011)



Source: Thomson Reuters' (ISI) Database, 2001-2011.

When the data are examined further to determine the percentage of growth, it is apparent that Malaysia's share has been increasing, from 13.6 % in 2001 to 30.4% in 2011 **(Table 6.5)**. Similarly, Thailand's share of the ASEAN-5 is on an upward trend. On the other hand, Singapore's share is on a decreasing trend, like that of Indonesia and the Philippines.

Table 6.5: Share (%) of ASEAN S&T Papers (2001-2011)

Year	Malaysia	Singapore	Thailand	Indonesia	Philippines
2001	13.6	55.8	19.6	6.3	4.7
2002	12.3	56.3	21.1	4.8	5.5
2003	13.0	54.4	22.8	4.9	4.9
2004	13.5	55.6	22.1	4.4	4.5
2005	13.9	55.2	22.3	4.2	4.3
2006	14.6	52.6	24.3	4.4	4.0
2007	15.5	49.6	26.9	4.3	3.7
2008	18.1	46.2	27.3	4.2	4.3
2009	22.5	43.7	25.8	4.4	3.6
2010	26.7	41.2	24.5	4.2	3.4
2011	30.4	38.7	23.2	4.2	3.4

Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

6.5.2 Citation Counts

Papers from the United States registered the highest number of citations, with an average of 16 citations per paper. Germany and England follow closely behind, with more than 11 million citations. Malaysian papers, on the other hand registered 50th in the rank, lower than her neighbour Thailand (41st in the rank). Thailand produced 17.8% more papers than Malaysia, and yet its citations are more than double that of Malaysia. The average citation of papers from Thailand is also higher than that of Malaysia, by 55.09%. One simple deduction is that even though Malaysia has produced a considerably good numbers of papers, they have not attracted many citations. Indonesia, which is ranked 61st, and with a total number of papers of one fourth of the number of Malaysian papers, has an average citation per paper of nearly double that of Malaysia (90.04%).

Table 6.6: International Comparison of Citations, Papers and Citations per Paper (C/P), Sorted by Citations

Country	Ranked by Citations	Citations	Papers	Citation per Paper C/P
USA	1	52,313,583	3,269,947	16.00
Germany	2	11,350,722	850,110	13.35
England	3	11,299,445	750,538	15.06
Japan	4	8,653,823	826,586	10.47
France	5	7,577,257	607,708	12.47
Canada	6	6,487,005	487,744	13.30
Peoples R China	7	5,833,770	936,803	6.23
Australia	10	3,985,136	329,488	12.09
India	16	1,907,537	320,835	5.95
Taiwan	21	1,397,694	196,214	7.12
Singapore	29	713,864	72,900	9.79
New Zealand	30	683,376	62,276	10.97
Iran	39	376,249	89,071	4.22
Thailand	41	277,901	36,273	7.66
Malaysia	50	125,856	29,815	4.22
Indonesia	61	59,036	7,362	8.02
Philippines	64	56,326	6,343	8.88

Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

6.5.3 Citations According to Field of Research Compared to Top Countries

With regard to field of research, Malaysia's highest average citation per paper is in the area of immunology, with an average citation per paper of about one third of the USA, the top country in the field. In the area of environment and ecology, the total citations is 7,904; with an average citation of 7.45 per paper. Chemistry, with the highest number of citations of 7,019, has an average citation of 3.95 per paper, which is about one fifth of the average citation of a US paper in the same field (18.91). Clinical science has a citation count of 20,304; yet the average citation per paper is 5.49—about one third of the average citation of a US paper (18.12). **Table 6.7** highlights the fact that the USA tops other countries in most fields—with the exception of material science, which has been dominated by China.

Table 6.7: Malaysian Papers, Citations and Citations per Paper According to 22 Fields of Research Sorted by Citations per Paper (C/P) Malaysia

No	Field	Total Papers Malaysia	Total Citations Malaysia	C/P Malaysia	Top Country in the Field	Total Papers for Top Country	Total Citations for Top Country	C/P Top Country
1	Immunology	144	1,376	9.56	USA	56,974	1,546,117	27.14
2	Environment, Ecology	1,245	7,904	7.45	USA	95,268	1,424,054	14.95
3	Space Science*	22	143	6.50	USA	61,558	1,255,352	20.39
4	Biology & Biochemistry	1,324	8,350	6.31	USA	207,850	4,944,850	23.79
5	Psychiatry, Psychology	155	903	5.83	USA	133,436	1,846,649	13.84
6	Neuroscience & Behaviour	166	923	5.56	USA	134,087	3,358,307	25.05
7	Clinical Medicine	3,695	20,304	5.49	USA	796,257	14,428,434	18.12
8	Molecular Biology & Genetics	284	1,518	5.35	USA	132,650	4,389,625	33.09
9	Agricultural Sciences	1,334	6,704	5.03	USA	46,251	460,698	9.96
10	Geosciences	401	1,772	4.42	USA	99,623	1,419,888	14.25
11	Pharmacology & Toxicology	616	2,704	4.39	USA	57,545	956,880	16.63
12	Microbiology	1,021	4,065	3.98	USA	59,768	1,317,708	22.05
13	Plant & Animal Science	1,904	7,544	3.96	USA	161,107	1,676,386	10.41
14	Chemistry	7,019	27,710	3.95	USA	244,087	4,616,356	18.91
15	Materials Science	2,240	8,014	3.58	China	102,875	555,078	5.4
16	Engineering	3,772	13,145	3.48	USA	217,220	1,451,305	6.68
17	Physics	1,805	5,922	3.28	USA	232,284	3,174,986	13.67
18	Mathematics	397	919	2.31	USA	76,087	377,485	4.96
19	Economics & Business	536	1,230	2.29	USA	76,348	734,032	9.61
20	Social Sciences, general	851	1,821	2.14	USA	221,049	1,353,884	6.12
21	Computer Science	800	1,450	1.81	USA	76,873	506,496	6.59
22	Multidisciplines*	84	66	0.79	USA	4,851	54,649	11.27
	All 22 Fields	29,815	125,856	4.22	USA	3,269,947	52,313,583	16

Source: MASTIC, Bibliometric Study 2012, data coverage Web of Science (WoS), 2001-2011

*Except for Multidisciplines, 2005-2011; and Space Science, 2004-2011

6.6 CONCLUSION

Malaysia has accelerated her growth in scientific publications in the last five years, doubling her share of publications in ASEAN 5 in the ten-year period (2001-2011), and ranked 46th in total publications, and 50th in citations in the world. The last five years have also seen the aggressive growth of China in publications, which corresponds with its growth in patents. China is now ranked second in total publications and first in total patent filings.

The growth of publications in Malaysia can be attributed to the expansion in the number of institutions of higher learning and government research institutes. The emphasis put on research and publications has borne fruit, as evidenced in the growth of scientific articles produced. While the Research Universities continue to dominate in terms of total count and citations, the branch universities such as University of Nottingham Branch Campus and Monash University Branch Campus are fast gaining prominence. The newer universities are also starting to make a strong presence in the publications arena, including Universiti Malaysia Sabah and Universiti Malaysia Sarawak.

CHAPTER 7:
INNOVATION IN THE MALAYSIAN MANUFACTURING AND SERVICES SECTOR

CHAPTER 7

INNOVATION IN MALAYSIAN MANUFACTURING AND SERVICES SECTORS

7.0 INTRODUCTION

Malaysia has adopted the National Innovation Model in 2007 that proposes an innovation-led growth strategy driven by two models, namely the technology-driven innovation model and the market-driven innovation model. In a technology-driven innovation model, scientists are funded for R&D, and technology is developed for commercialisation in the global market. On the other hand, in a market-driven innovation model, the market is first determined by knowledge entrepreneurs who will acquire the best relevant technology to meet the needs of the market.[39]The National Innovation Model was adopted in recognition of the fact that innovation is an important factor for long-term economic growth and for enhancing the country's competitive edge in the international markets. Hence, it is important to know where Malaysia stands with regard to innovation so that steps can be taken to improve our competitive advantage.

This chapter discusses innovation in the manufacturing and services sectors in Malaysia, and is based primarily on the data from the Sixth National Survey of Innovation (NSI-6) as described in the *National Survey of Innovation 2012 Report* which covers a period of 3 years from 2009-2011. In the section on International Comparisons, the discussion on the Global Competitiveness Index is based on the data and information from the Global Competitiveness Report 2012-2013 (GCR 2012-2013) and the Malaysia Productivity Centre (MPC), while the discussion on Malaysia's ranking in the World Competitiveness Yearbook 2013 (WCY 2013) is based on the data obtained from the WCY 2013, and *Malaysia in the World Competitiveness Yearbook 2013*, a publication by the MPC.

This chapter is organised into five sections. The first section provides an overview of innovation activities in the Malaysian manufacturing and services sectors. The second section discusses innovation in the manufacturing sector, while the third section discusses innovation in the services sector. The fourth section presents where Malaysia stands with regard to innovation when compared with other countries. The conclusion is presented in the final section.

7.1 OVERVIEW OF INNOVATION IN THE MALAYSIAN MANUFACTURING AND SERVICES SECTORS

This section provides an overview of innovation activities in the manufacturing as well as the services sectors in Malaysia. It is important to note that the services sector was first introduced in the *National Survey of Innovation 2005-2008 Report*. Innovation is also important in the

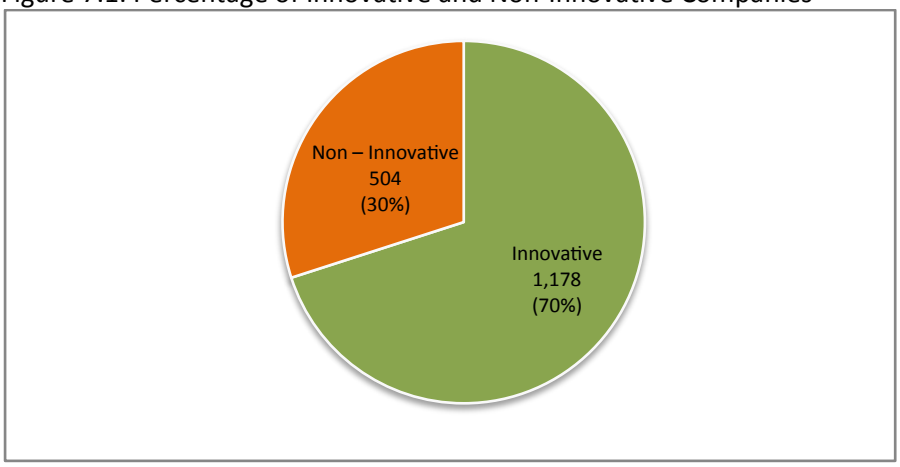
[39] *National Innovation Model* (http://www.mosti.gov.my/mosti/images/pdf/innovation%20model%20jtpin.pdf)

services sector, given the fact that Malaysia's services sector was the largest contributor to the GDP in 2012, accounting for 54.6% of Malaysia's GDP[40].

7.1.1 Level of Innovation

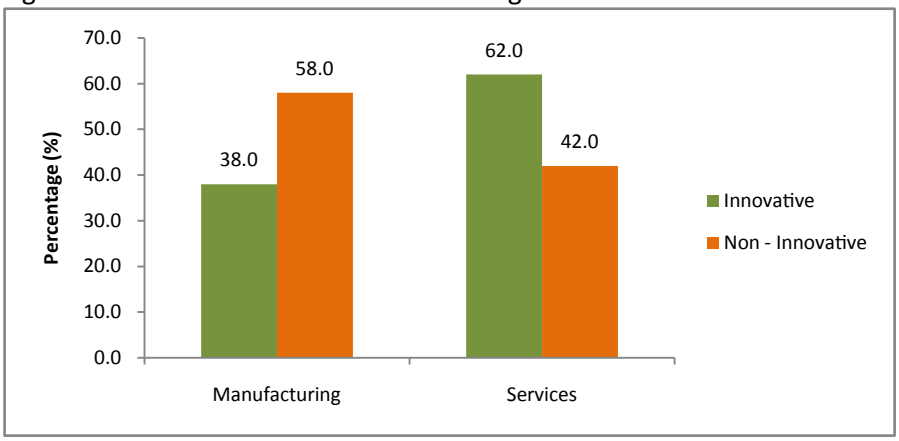
One of the most important indicators to measure the level of innovation in a country is the number or percentage of companies that carry out innovation[41]. In the NSI-6 (2009-2011 Survey), 1,178 companies (that is, 70% of the 1,682 companies that responded to the survey and that returned usable responses) reported that they carried out innovation activities while 504 (or 30%), did not **(Figure 7.1)**. This is a marked improvement from the previous findings in the Fifth National Survey of Innovation (NSI-5) (2005-2008 Survey), where only 624 of the companies surveyed reported that they carried out innovation activities while 588, did not[42]. The number and percentage of firms in the services sector that carried out innovation activities from 2009-2011 (i.e., 733 firms or 62.0% of the innovative firms) are higher than those in the manufacturing sector (445 firms or 38.0 % of the 1,178 innovative firms) **(Figures 7.2 and 7.3)**.

Figure 7.1: Percentage of Innovative and Non-Innovative Companies



Source: National Survey of Innovation 2012

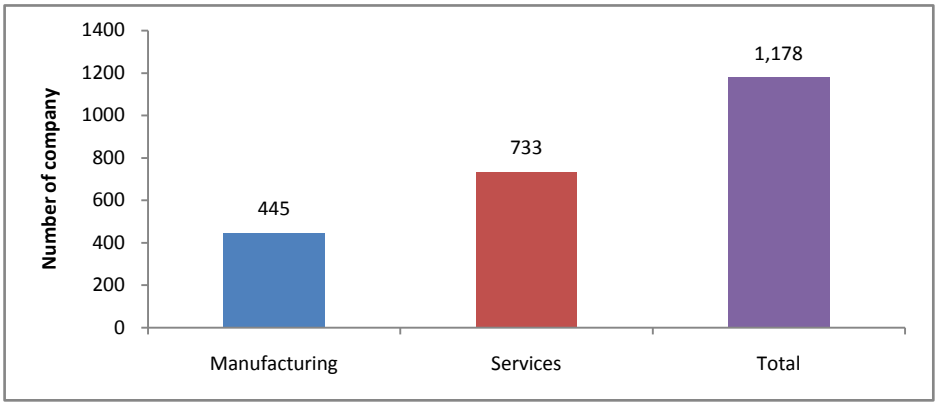
Figure 7.2: Innovation in the Manufacturing and Services Sector



Source: National Survey of Innovation 2012

[40] Economic Report 2013/2014, Ministry of Finance Malaysia
[41] The Oslo Manual (2005)
[42] *Malaysian Science and Technology Indicators 2010*, MOSTI.

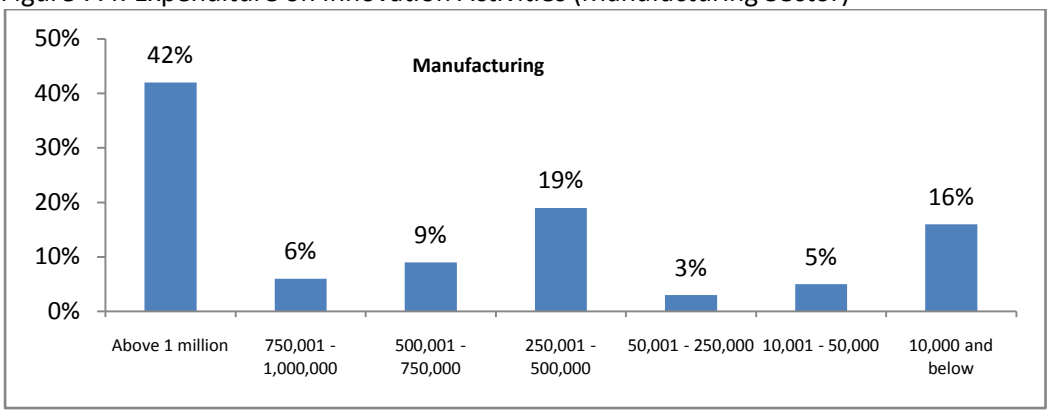
Figure 7.3: Innovative Companies



Source: National Survey of Innovation 2012

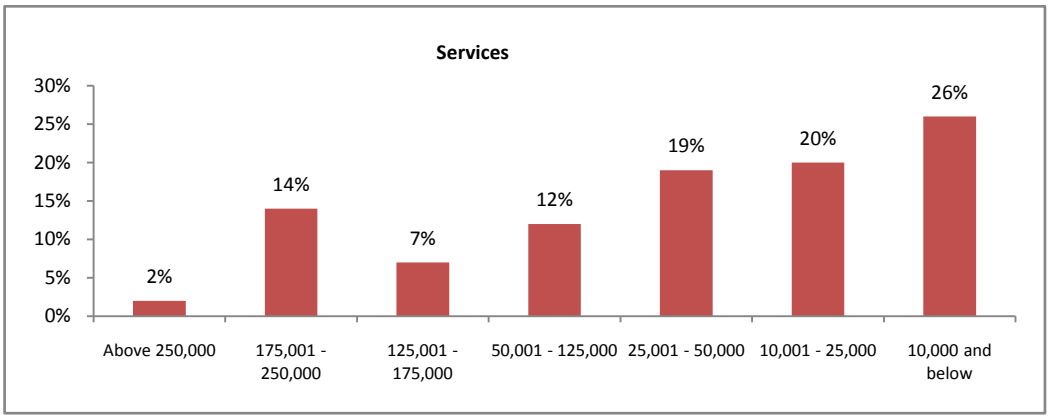
Although a higher number of firms in the services sector undertook innovation activities compared to those in the manufacturing sector, only 2.0% of the services sector's expenditure on innovation activities are above the value of RM250,000 compared to 76.0% of those in the manufacturing sector during the period 2009-2011. In addition, the manufacturing sector has 42.0%, i.e., the highest share, of expenditure on innovation activities of above RM1 million in value, while the services sector's highest share of 26.0% goes to expenditure of RM10,000 and below **(Figures 7.4 and 7.5)**. This is by virtue that services companies are less capital intensive and consist mostly of small and medium-scale companies, hence the lower expenditure on innovation activities compared to companies in the manufacturing sector.

Figure 7.4: Expenditure on Innovation Activities (Manufacturing Sector)



Source: National Survey of Innovation 2012

Figure 7.5: Expenditure on Innovation Activities (Services Sector)

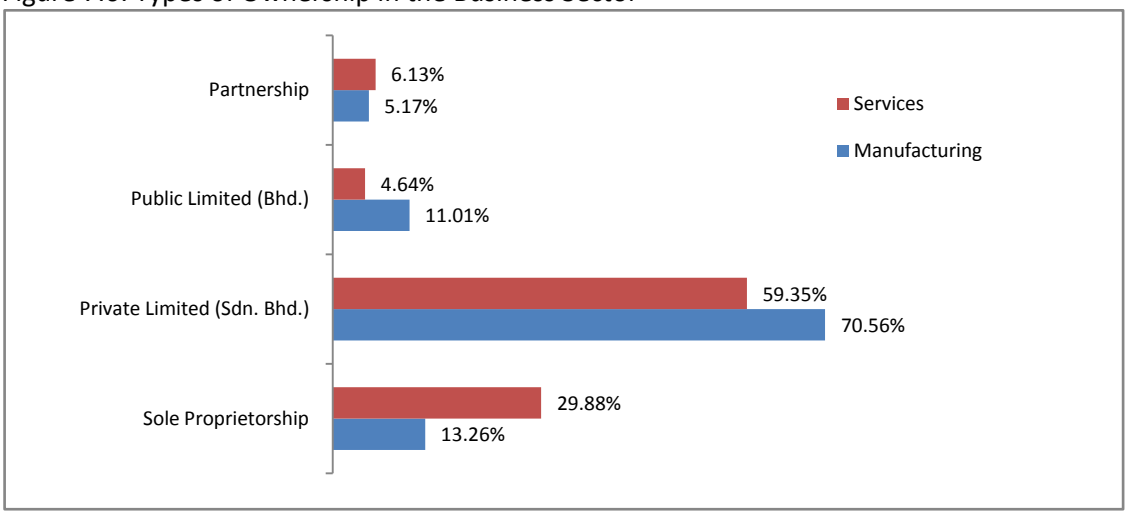


Source: National Survey of Innovation 2012

7.1.2 Characteristics of the Innovating Companies Surveyed

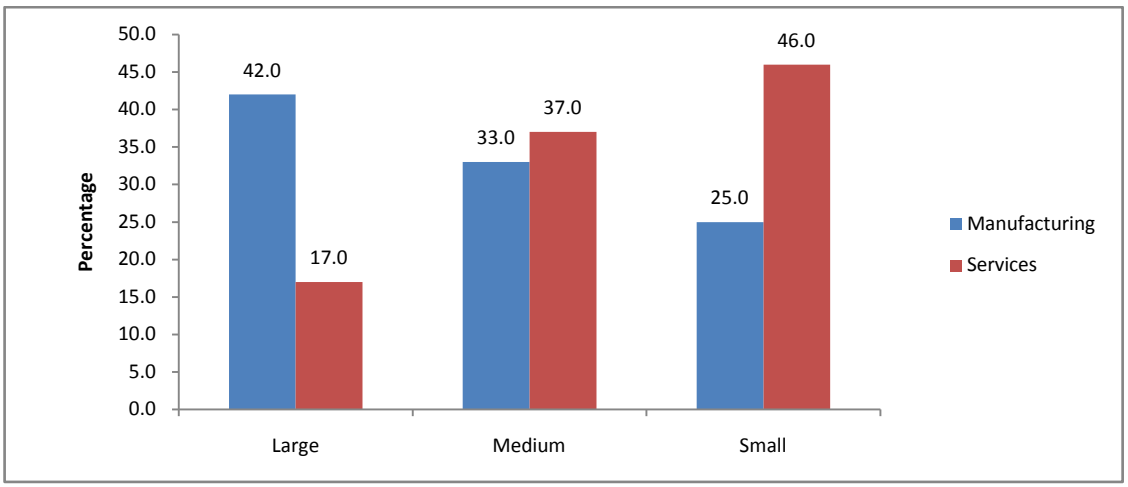
In terms of the characteristics of the innovating companies, the results of the 2009-2011 survey show that the highest percentage of innovations were conducted by Private Limited (Sdn. Bhd.) companies in both the manufacturing and services sectors at 70.6% and 59.4%, respectively **(Figure 7.6)**. In terms of firm size and turnover, large companies had the highest share of 42.0% with turnover of RM25 million to RM30 million in the manufacturing sector, while the opposite was the case for the services sector where small companies had the highest share of 46.0% with turnover of RM200,001-RM500,000 **(Figures 7.8 and 7.9)**.[43]

Figure 7.6: Types of Ownership in the Business Sector



Source: National Survey of Innovation 2012

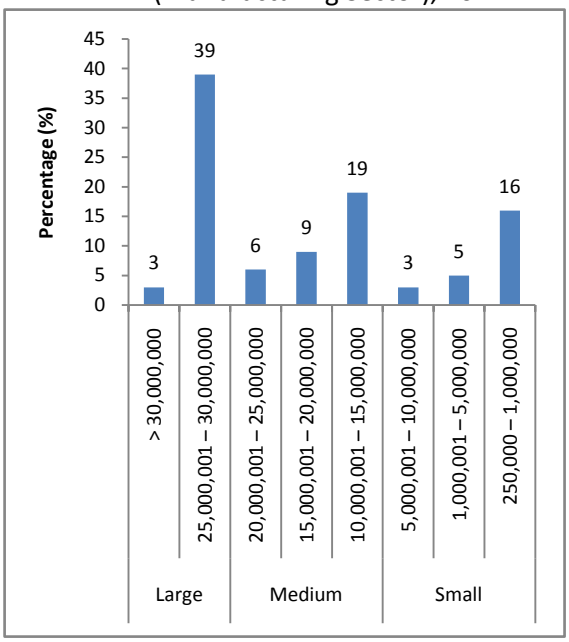
Figure 7.7: Size of Companies in the Business Sector



Source: National Survey of Innovation 2012

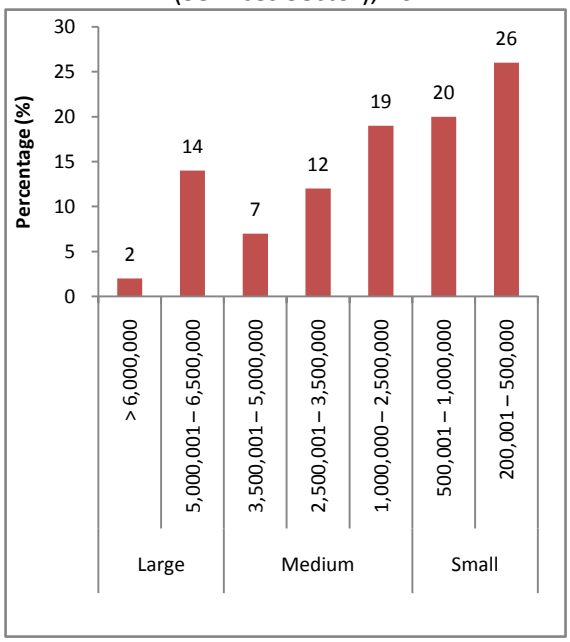
[43] The definitions of small, medium and large industries for the manufacturing and services sectors were based on those adopted by the SME Corp (National Innovation Survey, 2012, pg. 8).The size of companies as shown in **Tables 7.8** and **7.9** are based on these definitions.

Figure 7.8: Innovating Firms by Turnover (Manufacturing Sector), 2012



Source: National Survey of Innovation 2012

Figure 7.9: Innovating Firms by Turnover (Services Sector), 2012



Source: National Survey of Innovation 2012

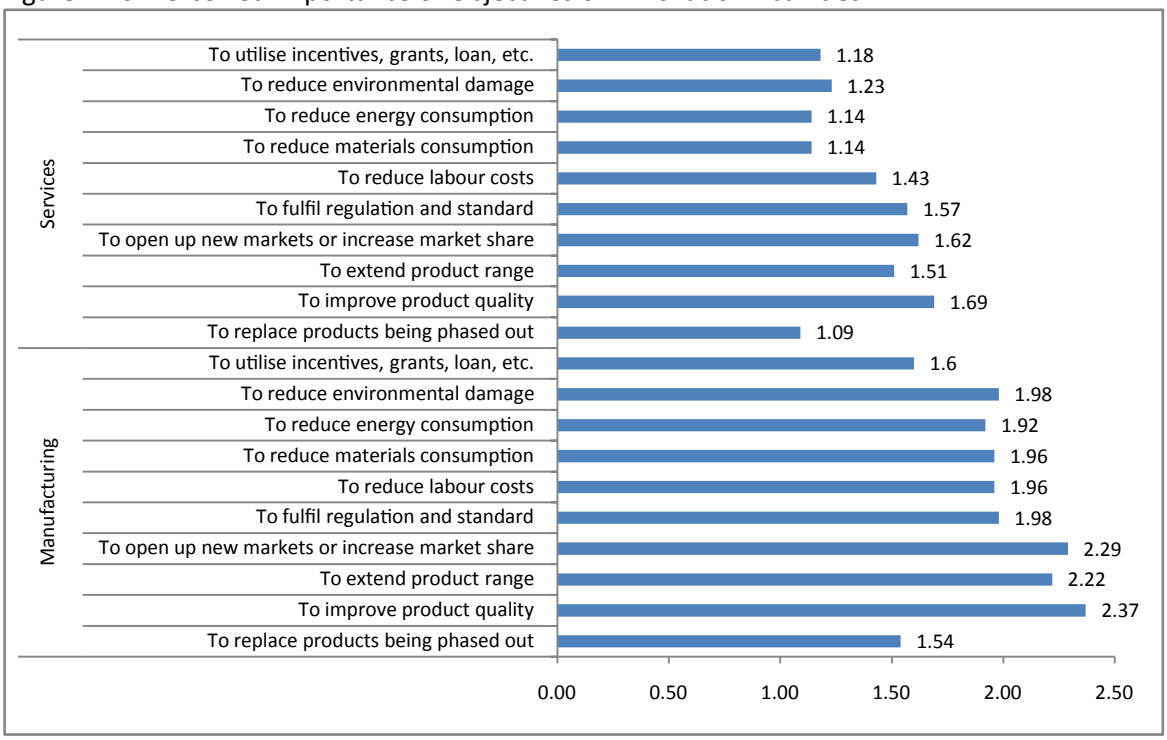
7.1.3 Motives for Innovation

As done in the previous year, the NSI-6 also asked the companies to list the reasons, in order of importance, as to why they undertook innovation activities. According to the Oslo Manual 2005, identifying the companies' motives for innovating—and their importance—is helpful when we would like to examine the forces that drive innovation activity, such as competition and opportunities for entering new markets. To this question, the respondents for both the manufacturing and services sectors stated that the most important reasons for undertaking innovation are to improve product quality and to open up new markets or to increase market share. This is followed by the need to extend product range for the manufacturing sector, and to fulfill regulation and standards requirements for the services sector **(Figure 7.10)**.

7.1.4 Effects of Innovation

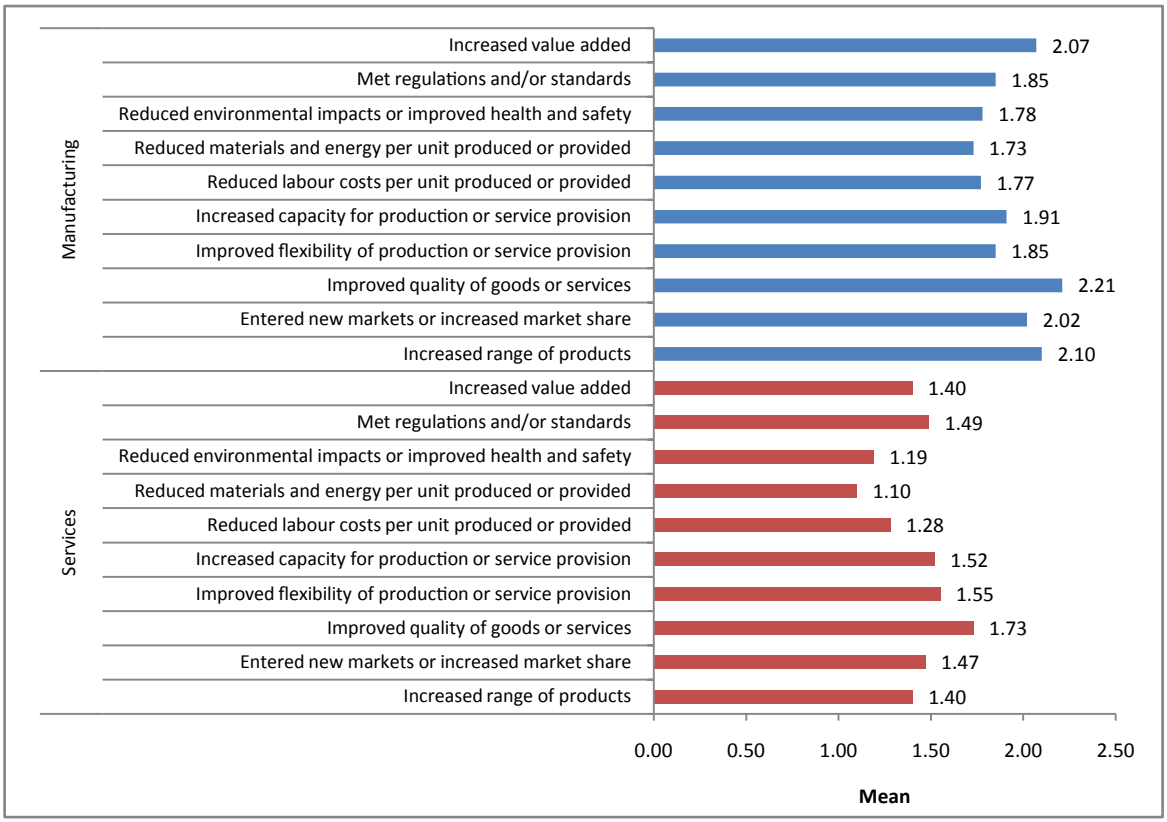
The NSI-6 decomposed the effects of innovation into (i) the effects of product and process innovation, and (ii) the effects of marketing and organisational innovation. Companies in both the manufacturing and services sector rated improved quality of goods or services as being the highest effect of product and process innovation as well as marketing and organisational innovation **(Figures 7.11** and **7.12)**. This response is consistent with their reasons for conducting innovation **(Figure 7.10)** as described earlier.

Figure 7.10: Perceived Importance of Objectives on Innovation Activities



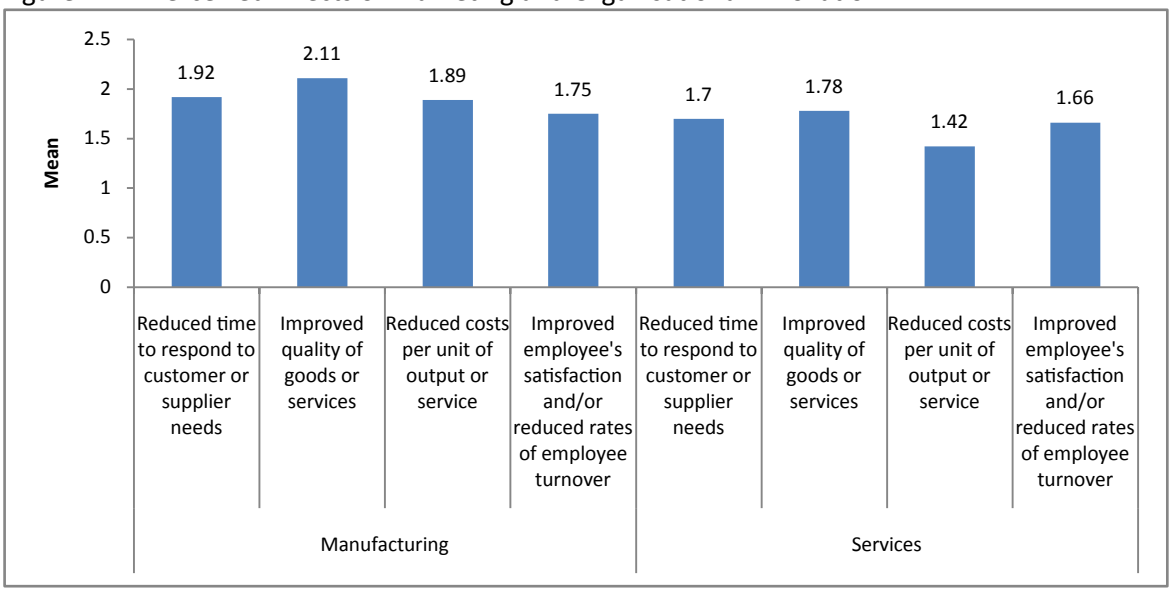
Source: National Survey of Innovation 2012
Note: Mean indicator: 0 = not relevant – 3 = highly important

Figure 7.11: Perceived Effects of Product and Process Innovation



Source: National Survey of Innovation 2012
Note: Mean indicator: 0 = not relevant – 3 = highly important

Figure 7.12: Perceived Effects of Marketing and Organisational Innovation



Source: National Survey of Innovation 2012
Note: Mean indicator: 0 = not relevant – 3 = highly important

7.1.5 Factors Hampering Innovation

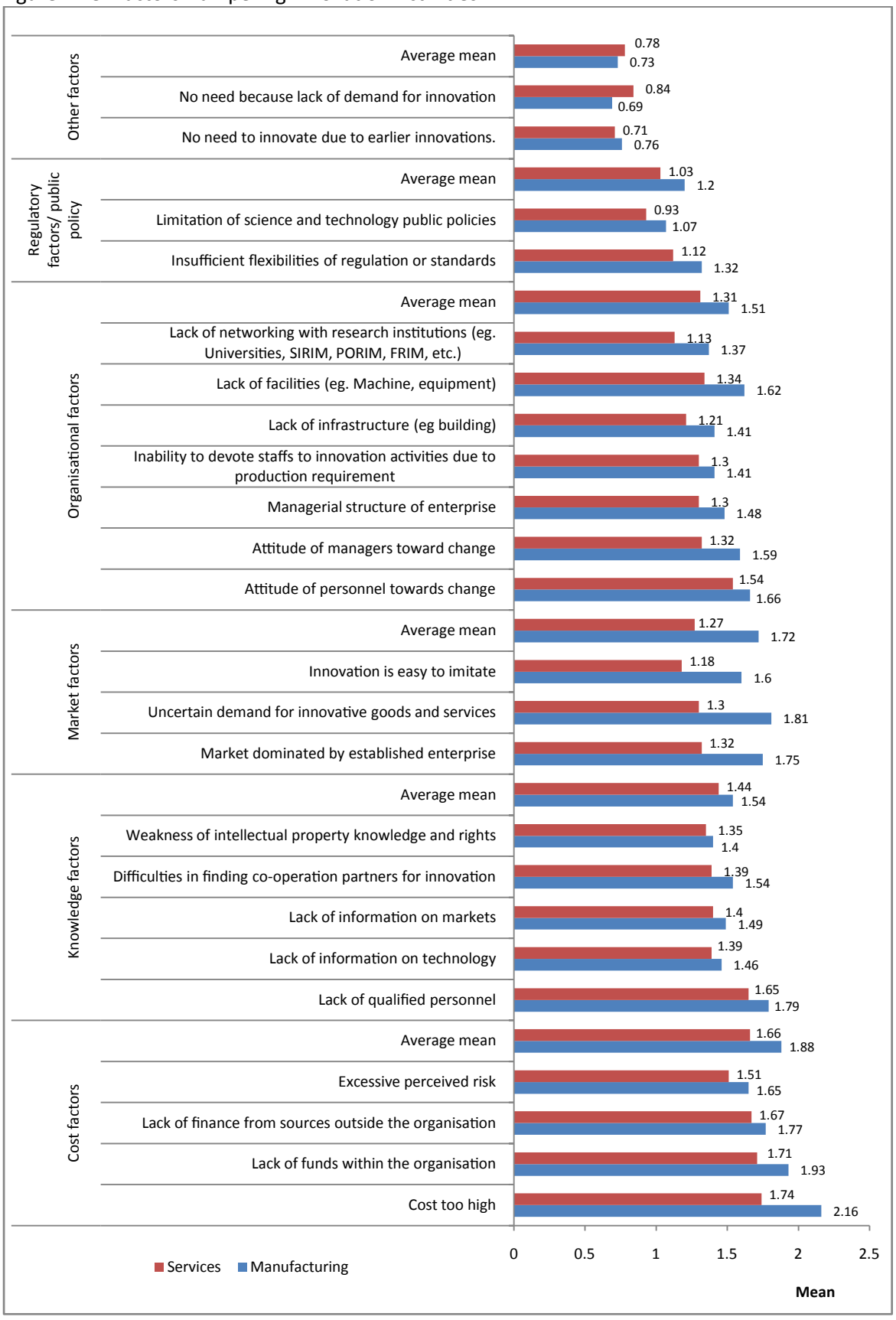
Finally, the NSI-6 also investigated the firm's perceptions of the factors hampering innovation. This is also an important aspect to be investigated because it can provide information on a number of issues relevant for innovation policy (Oslo Manual 2005). With regard to this question, and based on the average mean response figures, cost factors are considered to be the most important factor hampering innovation by companies in both the manufacturing and services sectors (See **Figure 7.13**, pg. 7-9). This is followed by market factors for the manufacturing sector and knowledge factors for the services sector as the second most important factor hampering innovation activities.

7.2 INNOVATION IN THE MANUFACTURING SECTOR

The manufacturing sector is an important contributor to Malaysia's economic growth and development. In 2012, the manufacturing sector accounted for 25.0% of Malaysia's GDP[44]. It was also the leading sector, in terms of contribution to total exports, and accounted for 73.7% share of Malaysia's total exports[45] in 2011. The challenge for the Malaysian manufacturing sector in the next few years will be how to maintain its competitiveness in the local and global trade environment that is becoming increasingly competitive. To meet this challenge, the manufacturing sector needs to plan for and carry out innovation, which has been identified as being essential to competitiveness. This section presents a summary of innovation in Malaysia's manufacturing sector, describing the percentage of companies carrying out innovation, the types of innovation carried out, the support received, as well as the output of innovation.

[44] Economic Report 2012/2013, Ministry of Finance Malaysia
[45] MATRADE, Media Conference on Malaysia's Trade Performance March 2009 by the Minister of International Trade and Industry.http://www.matrade.gov.my/cms/content.jsp?id=com.tms.cms.article.Article_hide_MTS_Mar_09

Figure 7.13: Factors Hampering Innovation Activities



Source: National Survey of Innovation 2012

Note: Mean indicator: 0 = not relevant – 3 = highly important

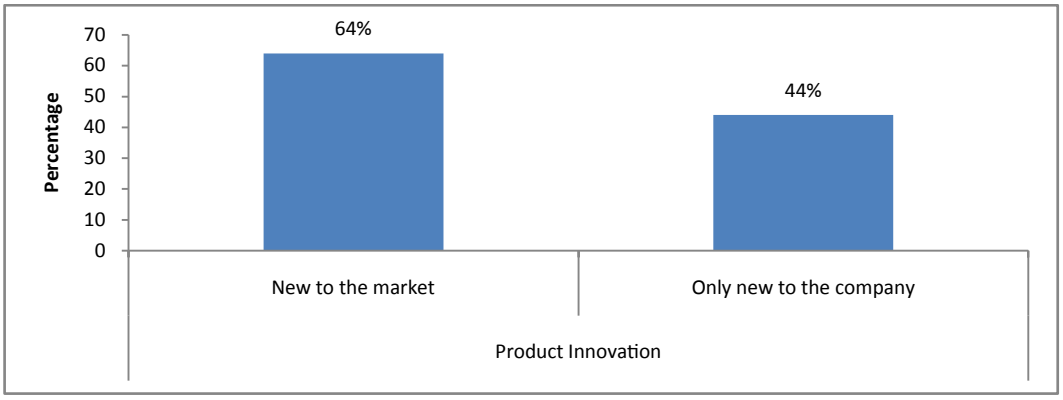
7.2.1 Types of Innovation carried out in the Manufacturing Sector

Innovation, as specified in the second edition of the Oslo Manual, included *product innovations* and *process innovations*. However, starting from the 3rd edition of the Manual, two additional types of innovations—*marketing innovations* and *organizational innovations*—were added. This is intended to broaden the definition and range of innovations covered by the Manual, and this development is reflected in the NSI-6 Survey. Hence in the NSI-6 Survey, the companies in the manufacturing sector were asked about whether they conduct *marketing* and *organisational innovation*s, in addition to *product* and *process innovations,* as has been done in previous surveys.

7.2.1.1 Product Innovation

In terms of product innovation, which, according to the Oslo Manual 2005 is "the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses" (pg 48), the majority of the companies (64.0%) reported introducing products that are new to the market, while only 44.0% introduced products new to the firm **(Figure 7.14)**.

Figure 7.14: Novelty of New Product or Significantly Improved Products in the Manufacturing Sector

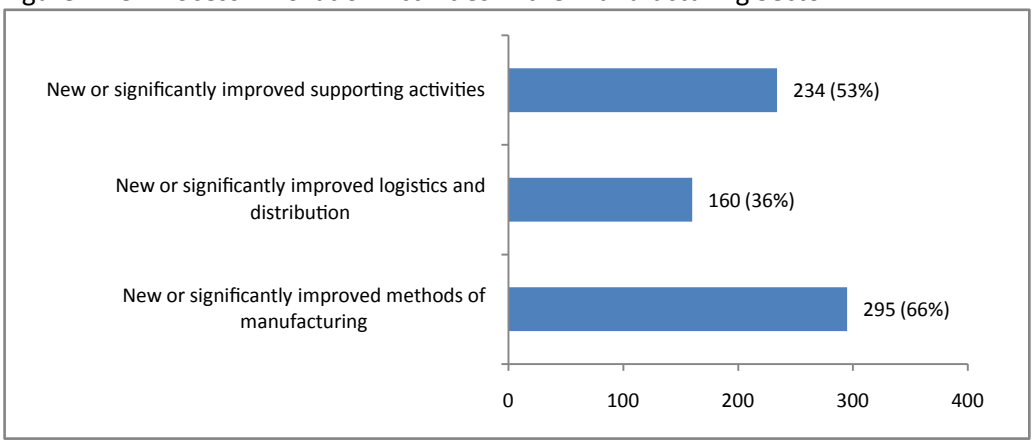


Source: National Survey of Innovation 2012

7.2.1.2 Process Innovation

In terms of *process innovation*, which is defined by the Oslo Manual 2005 as the implementation of a new or significantly improved production or delivery method, including significant changes in techniques, equipment and/or software, the majority of the companies (66.0%), innovated in terms of improved methods of manufacturing and producing goods **(Figure 7.15)**. This is followed by 53.0% that innovated in terms of supporting activities for their processes, and only 36.0% innovated in terms of logistics, delivery, or distribution methods for their inputs, goods, and services.

Figure 7.15: Process Innovation Activities in the Manufacturing Sector

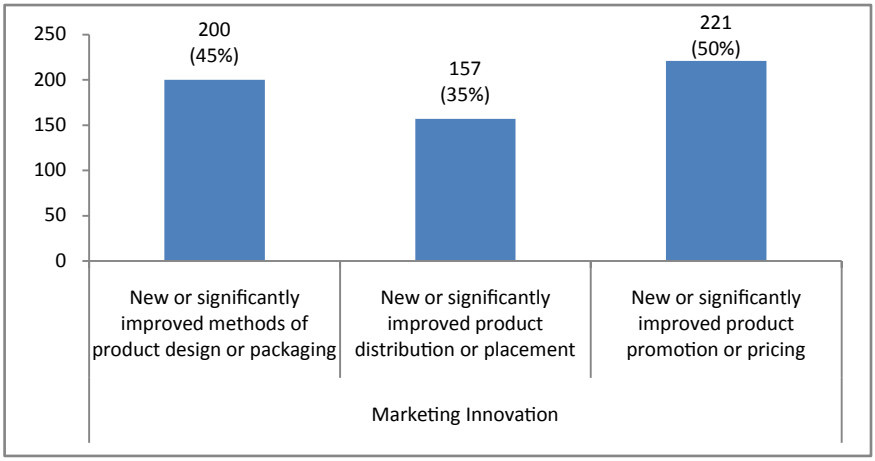


Source: National Survey of Innovation 2012

7.2.1.3 Marketing Innovation

The innovating companies surveyed also carried out marketing innovation, which is defined by the Oslo Manual (2005) as "the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion, or pricing" (pg. 49). The NSI-6 Survey found that the highest occurrence of innovation **(Figure 7.16)** was in the area of product promotion or pricing (50.0% of the firms) followed by product design and packaging (45.0% of the firms) and product distribution or placement (35.0% of the firms).

Figure 7.16: Marketing Innovation Activities in the Manufacturing Sector

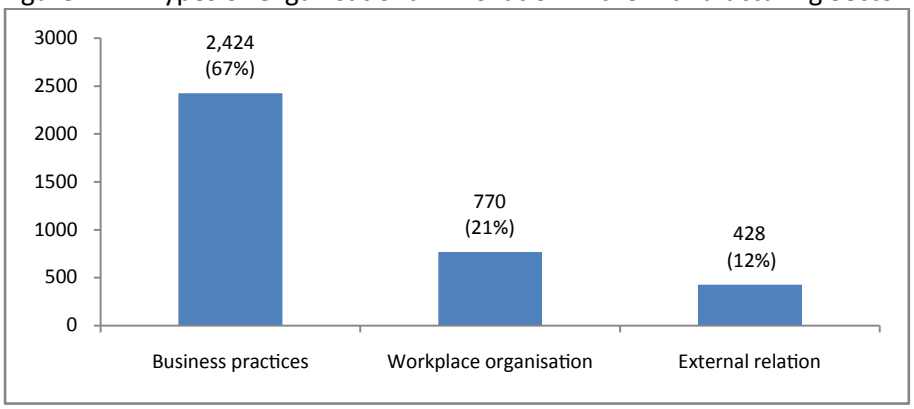


Source: National Survey of Innovation 2012

7.2.1.4 Organisational Innovation

Finally, the companies were also asked whether they conducted *organisational innovation*, which the Oslo Manual 2005 defines as "the implementation of a new organisational method in the firm's business practices, workplace organisation, or external relations". As shown in **Figure 7.17**, the majority of the firms carried out innovations in the firm's business practices (67.0%), followed by innovations in the workplace organisation (21.0%). Only 12.0% of the companies reported conducting innovations pertaining to external relations.

Figure 7.17: Types of Organisational Innovation in the Manufacturing Sector

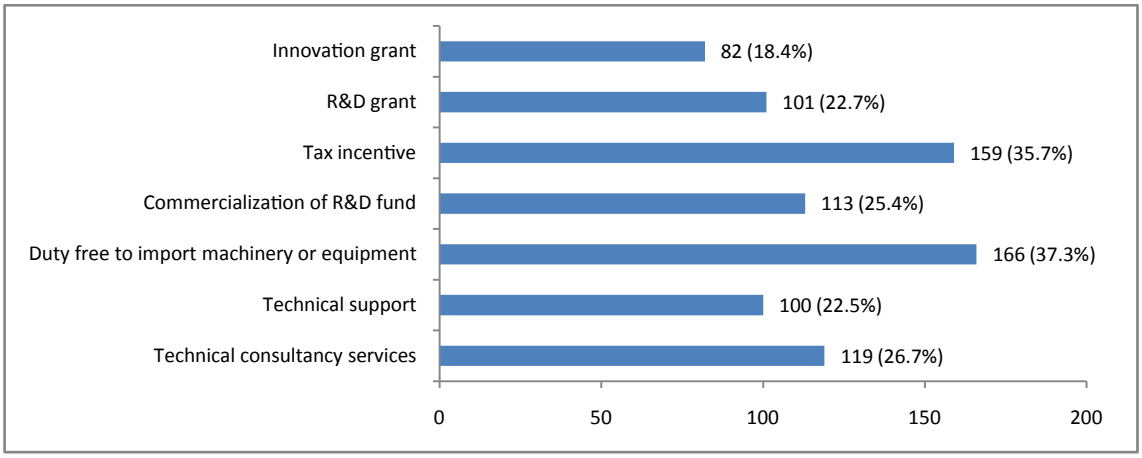


Source: National Survey of Innovation 2012

7.2.2 Government Support for Innovation

The manufacturing companies were also surveyed on the extent of government support that they received. As shown in **Figure 7.18**, duty-free importation of machinery or equipment (37.3%), followed by tax incentives (35.7%) were reported as being the most utilized government support. Technical consultancy services (26.7%) and commercialisation of R&D fund (25.4%) come in as a close second.

Figure 7.18: Types of Government Support for Innovation in the Manufacturing Sector



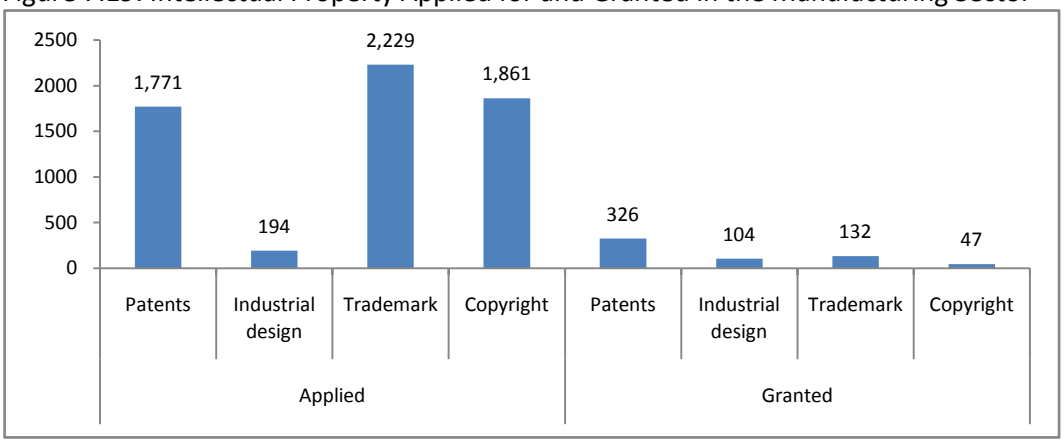
Source: National Survey of Innovation 2012
Note: The graph shows the percentage of respondents that received the above government support.

7.2.3 Intellectual Property

The impact of innovation can be measured by the number of patents, industrial designs, trademarks, and copyrights applied for and granted, although the Oslo Manual (2005) provides a cautionary note that not all the results of innovations are patented. Be that as it may, statistics on the applications for various types of intellectual property and the number granted are somewhat useful as an indicator of innovation activities. This section describes the applications for Intellectual Property as well as the number granted in the Manufacturing Sector.

As shown in **Figure 7.19**, the number of intellectual property applied for and granted have increased tremendously in the period 2009-2011 when compared to the period 2005-2008. The number of patents, trademarks, and copyrights applied for increased manifold when compared to the 2005-2008 period, from 951 to 1,771 patents, from 998 to 2,229 trademarks, and from 873 to 1,861 copyrights. However, for industrial design, the number decreased dramatically from 1,881 in 2005-2008 to only 194 in the period 2009-2011. However, as shown in **Figure 7.19** shows, despite the large number of intellectual property filed, the number that was actually granted was far less.

Figure 7.19: Intellectual Property Applied for and Granted in the Manufacturing Sector



Source: National Survey of Innovation 2012

7.3 INNOVATION IN THE SERVICES SECTOR

The Services Sector is a very strong and important sector in the nation's economy. Malaysia's services sector was the largest contributor to the GDP in 2012, accounting for 54.6% of Malaysia's GDP, up from 54.1% in 2011. Malaysia's trade in services as a share of GDP increased from 25.7% in 2011 to 26.3% in 2012[46].The services sector recorded an increase in productivity growth of 4.74% in 2010 from 1.67% in 2009, but declined slightly to 4.30% in 2011. Total Factor Productivity (TFP) growth of various services sub-sectors have also increased from the period 2001-2005 to the period 2006-2010, such as Construction (0.11% to 1.47%), Utilities (1.20% to 1.44%), Transport (0.94% to 2.45%), Wholesale and Retail Trade (0.94% to 3.12%) and Finance (0.96% to 3.03%)[47]. Hence, the challenge for the Malaysian services sector will be to further improve its productivity growth, which necessitates the fostering of the culture of innovation, which has been identified as being the key contributing factor to high productivity and competitiveness.

7.3.1 Types of Innovation Carried Out in the Services Sector

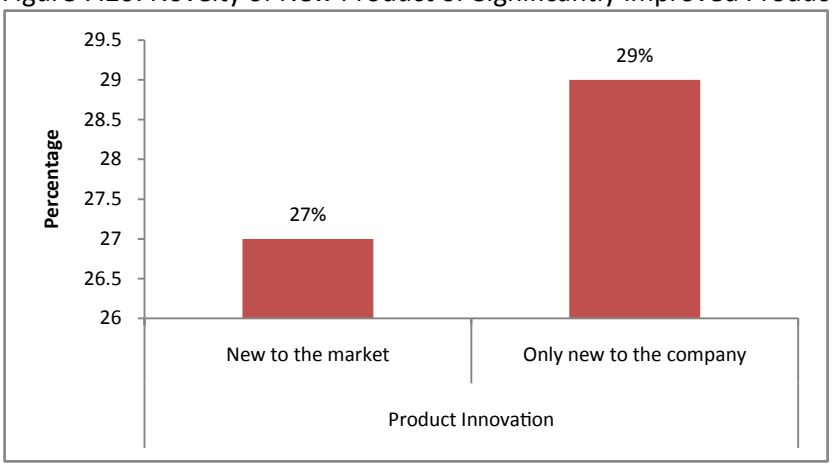
As in the manufacturing sector, the companies in the services sector were asked whether they conducted product, process, marketing, and organisational innovation from 2009-2011, as recommended by the 3rd Edition of the Oslo Manual (2005).

[46] http://www.indexmundi.com/facts/malaysia/trade-in-services
[47] 18th Productivity Report, 2010/2011, Malaysia Productivity Corporation.

7.3.1.1 Product Innovation

In terms of product innovation, which, according to the Oslo Manual 2005 is "the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses" (pg 48), 29.0% of the firms innovated in terms of products new to the firm, while 27.0% introduced products that are new to the market **(Figure7.20)**.

Figure 7.20: Novelty of New Product or Significantly Improved Products in the Services Sector

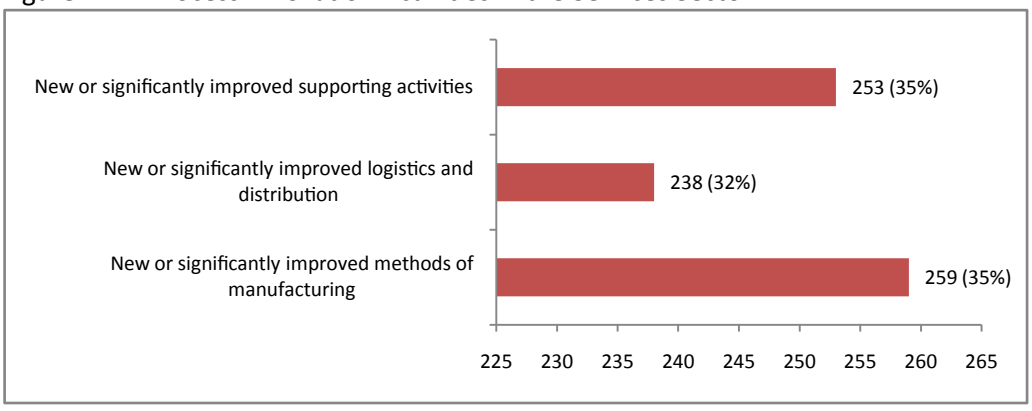


Source: National Survey of Innovation 2012

7.3.1.2 Process Innovation

In terms of *process innovation*, which is defined by the Oslo Manual 2005 as the implementation of a new or significantly improved production or delivery method, including significant changes in techniques, equipment and/or software, 35.0% of the companies innovated both in terms of improved methods of manufacturing and improved supporting activities, while 32.0% in terms of logistics, delivery, or distribution methods for their inputs, goods, or services **(Figure 7.21)**.

Figure 7.21: Process Innovation Activities in the Services Sector

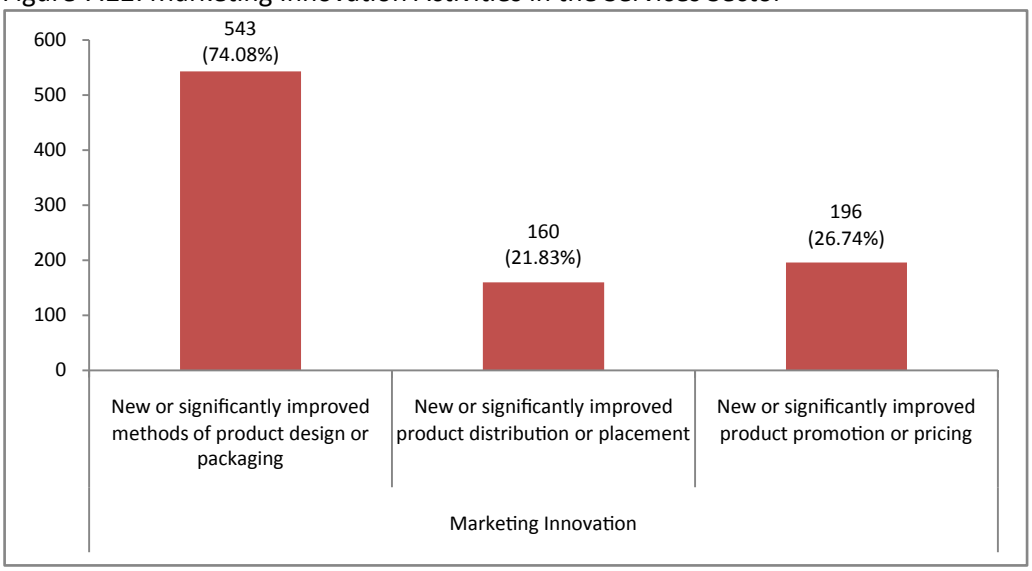


Source: National Survey of Innovation 2012

7.3.1.3 Marketing Innovation

With regard to marketing innovation, which is defined by the Oslo Manual (2005) as "the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion, or pricing" (pg. 49), most of the companies innovated in terms of product design and packaging (74.08%), followed by product promotion or pricing (26.74%) and product placement (21.83%) **(Figure 7.22)**.

Figure 7.22: Marketing Innovation Activities in the Services Sector

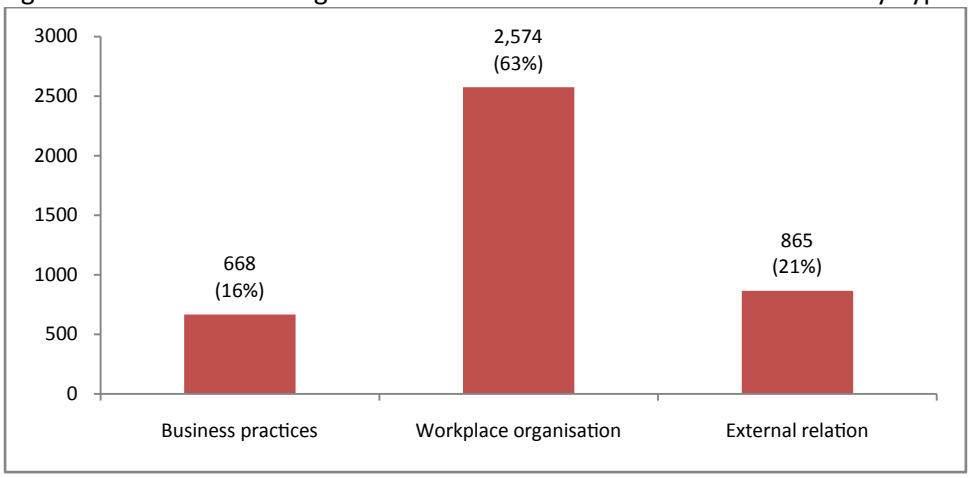


Source: National Survey of Innovation 2012

7.3.1.4 Organisational Innovation

Finally, in terms of organisational innovation, which the Oslo Manual 2005 defines as "the implementation of a new organisational method in the firm's business practices, workplace organisation, or external relations", 63.0% of the companies conducted innovations in their workplace organisations, 21.0% innovated in terms of their workplace relations, while 16.0% introduced new methods in their firm's business practices **(Figure 7.23)**.

Figure 7.23: Number of Organisational Innovation in the Services Sector by Type

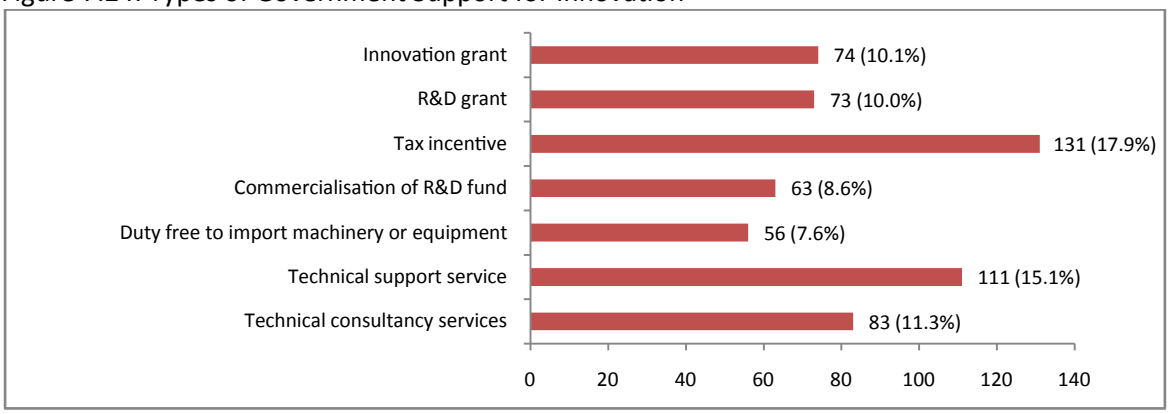


Source: National Survey of Innovation 2012

7.3.2 Government Support for Innovation

The companies in the Services Sector were also asked about government support for innovation. 17.9% of the companies reported that they received tax incentives **(Figure 7.24)**. This is followed by technical support services (15.1%), technical consultancy services (11.3%), and innovation grants (10.1%). The majority of the companies rated government assistance as being very important for their innovation activities **(Figure 7.24)**.

Figure 7.24: Types of Government Support for Innovation



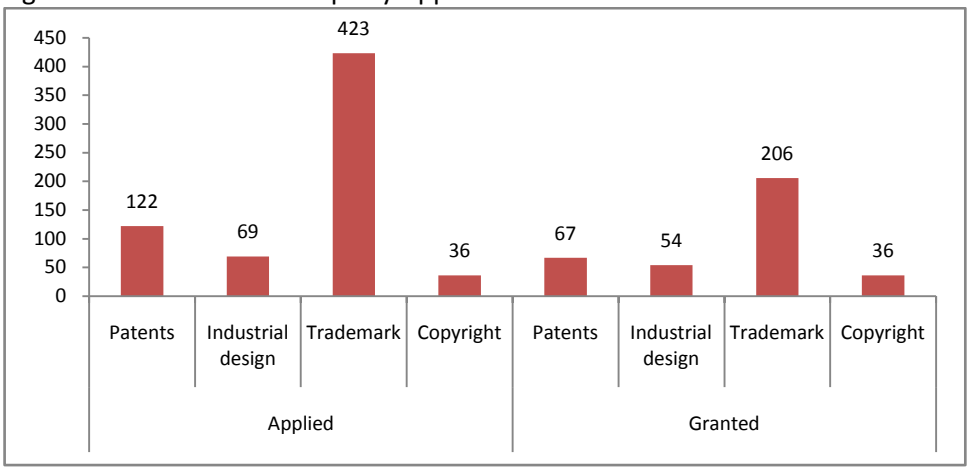
Source: National Survey of Innovation 2012
Note: The graph shows the percentage of respondents that received the above government support.

7.3.3 Intellectual Property

As mentioned in Section 7.2.3, the impact of innovation can be measured by the number of patents, industrial designs, trademarks, and copyrights applied for and granted, although the Oslo Manual (2005) provides a cautionary note that not all the results of innovations are patented. This section describes the applications for Intellectual Property as well as the number granted in the Services Sector.

From 2009-2011, the intellectual property that received the most applications was trademarks (423), followed by patents (122), industrial design (69), and copyrights (36). As would be expected, the number of intellectual property granted was less than that applied for **(Figure 7.25)**.

Figure 7.25: Intellectual Property Applied for and Granted in the Services Sector



Source: National Survey of Innovation 2012

7.4 INTERNATIONAL COMPARISONS

This section compares Malaysia's performance on innovation and competitiveness with that of other countries through the following indices:

i. The Global Competitiveness Index
ii. The World Competitiveness Yearbook

This will be followed by a discussion on the difference in ratings that Malaysia received on innovation in the above two indices and on world competitiveness.

7.4.1 The Global Competitiveness Index

According to the Global Competitiveness Report 2012 – 2013 (GCR 2012-2013), published by the World Economic Forum (WEF), the Global Competitiveness Index (GCI) is a highly comprehensive index for measuring *national competitiveness*, defined as *the set of institutions, policies, and factors that determine the level of productivity of a country,* which, in turn, sets the sustainable level of prosperity that can be earned by an economy. In addition, the level of productivity also determines the *rates of return* obtained by investments (physical, human, and technological) in an economy. The Report asserts that because the rates of return are "the fundamental drivers of the growth rates of the economy, a more competitive economy is one that is likely to grow faster in the medium to long run" (pg. 4).

The Global Competitiveness Index for 2012 – 2013 (GCI 2012-2013) was calculated based on publicly available, statistical data from 144 countries as well as the annual Executive Opinion Survey, conducted by the WEF. The calculation of the index is based on 30 percent statistical data (encompassing 32 criteria) and 70 percent survey data (encompassing 79 criteria), and is based on 12 pillars: institutions, infrastructure, macroeconomic environment, health and primary education, higher education and training, labour market efficiency, financial market development, technological readiness, market size, business sophistication, goods market efficiency, and *innovation*, which, in turn, comprises the following seven elements:

i. Capacity for Innovation
ii. Quality of Scientific Research Institutions
iii. Company Spending on R&D
iv. University – Industry Collaboration in R&D
v. Government Procurement of Advanced Technology Product
vi. Availability of Scientists and Engineers
vii. Utility Patents

In essence, the Global Competitiveness Report (GCR) is aimed at examining the factors that enable national economies to achieve sustained economic growth and long term prosperity through its 12 pillars of competitiveness involving 111 indicators. A total of 144 executives from Malaysian companies responded to the Executive Opinion Survey. The results of the survey, as well as the statistical data obtained, were used to rank Malaysia with respect to other countries in terms of innovation and global competitiveness. **Table 7.1** shows the innovation competitiveness and global competitiveness of 15 selected countries and Malaysia's ranking in these two indices.

7.4.2 Malaysia's Ranking on Innovation and Competitiveness in the GCI 2010-2011

As shown in **Table 7.1**, Malaysia ranks 23rd in terms of *Innovation Competitiveness*, while the first place was given to Switzerland, with a score of 5.79, and the second to Japan, with a score of 5.67. Among the ASEAN member countries, Singapore ranked 11th, while Indonesia and Thailand, are ranked 40th and 55th, respectively. Malaysia's score on innovation competitiveness, together with her scores on the 11 other pillars, led her to be ranked 25th on global competitiveness, four points below the GCI 2011-2012 ranking. On global competitiveness as discussed in the GCI Report 2012-2013, both Switzerland and Singapore maintained their first and second rankings, respectively, as in the previous GCI Report, followed by Finland, Sweden, Germany, and the United States.

Table 7.1: Ranking of Selected Countries According to the GCI 2012-2013 and the GCI 2011-2012

No.	Country/Economy	IC		GCI 2012-2013		GCI 2011-2012	
		Rank	Score	Rank	Score	Rank	Score
1	Switzerland	1	5.79	1	5.72	1	5.74
2	Singapore	11	5.27	2	5.67	2	5.63
3	Finland	3	5.62	3	5.55	4	5.47
4	Sweden	5	5.56	4	5.53	3	5.61
5	Germany	4	5.57	6	5.48	6	5.41
6	United States	7	5.42	7	5.47	5	5.43
7	United Kingdom	9	5.32	8	5.45	10	5.39
8	Japan	2	5.67	10	5.40	9	5.40
9	Taiwan, China	14	5.08	13	5.28	13	5.26
10	Korea Republic	17	4.96	19	5.12	24	5.02
11	Australia	28	4.56	20	5.12	20	5.11
12	**Malaysia**	**23**	**4.70**	**25**	**5.06**	**21**	**5.08**
13	China	34	4.05	29	4.83	26	4.90
14	Thailand	55	3.72	38	4.52	39	4.52
15	Indonesia	40	3.96	50	4.40	46	4.38

Source: Global Competitiveness Report 2012-2013
Note: GCI: Global Competitiveness Index; IC: Innovation Competitiveness
Ranking over 144 countries (2012-2013); 142 countries (2011-2012)

Malaysia's ranking on global competitiveness, at the 25th position, is essentially the result of unfavourable assessment, particularly in terms of the respondents' perceptions of the *women in labor force as a ratio to men,* where the country is ranked 119 (down from 114th) and *redundancy cost in terms of weeks of salary* (108th, down from 104th). We also did not fare very well in terms of the *government budget balance as a percentage of GDP* as perceived by the respondents (ranked 110th, down from 96th) as well as *secondary education enrolment* (ranked 103rd, down from 101st). With regard to technological readiness, Malaysia was assessed rather unfavourably in terms of *international internet bandwidth* (at 10.7 kb/s per user, ranked 83rd), *mobile broadband subscription* (at 12.3 per 100 population, ranked 64th) and *availability of latest technology*, ranked 35th. In terms of education, Malaysia is also perceived to be weak in the *primary education enrolment rate* of 95.9%, ranked at 46th (compared to countries such as Japan, New Zealand, United Kingdom, and Canada—which had close to 100% enrolment in primary education), and *quality of primary education*, ranked at 24th (down from 21st). (Global Competitiveness Report 2012-2013, p. 247; Global Competitiveness Report 2011-2012, p.249).

Nevertheless, despite the areas of weaknesses—as assessed by the Global Competitiveness Report 2012-2013 (GCR 2012-2013)—Malaysia also performed well in a number of areas.

Malaysia maintained its rank in the 1st place in the Legal Rights Index, together with Hong Kong and Singapore. The country is also ranked 4th on our Strength of Investor Protection. These high rankings are due to the reforms that Malaysia introduced in recent years, including the establishment of Intellectual Property Courts, the passing of an Anti-Competition Law, and a prospective review of the Arbitration Act and the Legal Profession Act[48]. The overall quality of education in Malaysia has also improved, such as the *quality of mathematics and science education*, ranked 20th (23rd in GCR 2011-2012). The GCR 2012-2013 also stresses that Malaysia does have a *well-developed financial market* (ranked 6th) and an *efficient goods market* (ranked 11th). Malaysia does relatively well in the more complex categories, namely *business sophistication* (20th) and *innovation* (25th), which, according to the report, matter the most for advanced economies, as this augurs well for the future. Finally, the GCR 2012-2013 also states that Malaysia remains the most competitive country among the 29 countries in the Efficiency-driven stage (Stage 2) of development, being ranked 8th among 22 Asia Pacific countries—ahead of China, Brunei, Thailand, Indonesia, India, Vietnam, and the Philippines **(Table 7.2)**—and second out of 8 countries in ASEAN **(Table 7.3)**.

Table 7.2: The GCI 2012–2013 Rankings for Asia-Pacific Countries

Country/Economy	GCI 2012–2013		Country/Economy	GCI 2012–2013	
	Rank	Score		Rank	Score
Singapore	1	5.67	**Indonesia**	12	4.40
Hong Kong SAR	2	5.41	**India**	13	4.32
Japan	3	5.40	**Philippines**	14	4.23
Taiwan, China	4	5.28	**Sri Lanka**	15	4.19
Australia	5	5.12	**Vietnam**	16	4.11
Korea, Rep.	6	5.12	**Cambodia**	17	4.01
New Zealand	7	5.09	**Mongolia**	18	3.87
Malaysia	**8**	**5.06**	**Bangladesh**	19	3.65
Brunei Darussalam	9	4.87	**Pakistan**	20	3.52
China	10	4.83	**Nepal**	21	3.49
Thailand	11	4.52	**Kyrgyz Republic**	22	3.44

Source: Performance of Malaysia in the Global Competitiveness Report 2012-2013, MPC

Table 7.3: The GCI2012–2013 Rankings for ASEAN Countries

Country/Economy	GCI 2012–2013	
	Rank	Score
Singapore	1	5.67
Malaysia	**2**	**5.06**
Brunei Darussalam	3	4.87
Thailand	4	4.52
Indonesia	5	4.40
Philippines	6	4.23
Vietnam	7	4.11
Cambodia	8	4.01

Source: Performance of Malaysia in the Global Competitiveness Report 2012-2013, MPC

Innovation and innovation competitiveness being the prime requisite for the economic and technological growth of any nation has been further decomposed into seven elements, namely:

[48] Global Competitiveness Report (GCR) 2010-2011: The Way Forward by Dato' Sri Mustapa Muhamed http://www.mpc.gov.my/home/index.php?kod1=k&kod2=news&item=000030&sstr_lang=en&t=3

capacity for innovation (CI), quality of scientific research institutions (RI), company spending on research and development (RD), university-industry collaboration in R&D (UC), government procurement of advanced technology product (GP), availability of scientists and engineers (SE), and utility patents (UP). The ranking of countries based on these components are as shown in **Table 7. 4**.

Table 7.4: Country Rankings for Components of Innovation Factor

No.	Country/Economy	CI	RI	RD	UC	GP	SE	UP
1	Switzerland	2	2	1	1	22	14	2
2	Singapore	20	12	8	5	2	13	13
3	Finland	4	13	3	4	14	1	3
4	Sweden	5	9	5	7	12	4	1
5	Germany	3	10	4	11	21	40	7
6	United States	7	6	7	3	15	5	12
7	United Kingdom	12	3	12	2	45	12	18
8	Japan	1	11	2	16	48	2	5
9	Taiwan, China	15	19	10	12	9	7	N/A
10	Korea Republic	19	24	11	25	33	23	9
11	Australia	32	7	30	13	58	53	20
12	**Malaysia**	**17**	**28**	**16**	**18**	**4**	**20**	**34**
13	China	23	44	24	35	16	46	38
14	Thailand	79	60	74	46	98	57	72
15	Indonesia	30	56	25	40	29	51	101

Source: Global Competitiveness Report 2012-2013
Note:
CI Capacity for innovation
RI Quality of scientific research institution
RD Company spending on R&D
UC University – industry collaboration in R&D
GP Government procurement of advanced technology product
SE Availability of scientists and engineers
UP Number of patent application filed under patent co-operation treaty (PCT) patent per million populations

Malaysia performed very well in terms of Government procurement of advanced technology products (GP), ranking 4th in this component. The country ranked 16th for company spending on R&D (RD) and 18th for University-industry collaboration in R&D (UC) out of 144 countries, which is a relatively good achievement. In terms of capacity for innovation (CI), Malaysia is ranked higher than Singapore at the 17th place compared to 20th for Singapore. Malaysia also ranks higher than Thailand and Indonesia for all components of innovation.

7.4.3 The World Competitiveness Yearbook

The IMD World Competitiveness Yearbook (WCY)—often considered as being a worldwide reference point on the competitiveness of nations—ranks and analyses a nation's economy in terms of how it manages the totality of its resources and competencies to increase the prosperity of its population. Published since 1989, it purports to be one of the most renowned studies comparing the competitiveness of 60 economies (for 2013) on the basis of 392 criteria, two thirds of which are addressed by hard data, and one-third of which are answered by the

IMD's executive opinion survey. The WCY divides the national environment into four main factors, each with five sub-factors:

1) **Economic Performance**
(Domestic economy, international trade, international investment, employment, and prices)

2) **Government Efficiency**
(Public finance, fiscal policy, institutional framework, business legislation, and societal framework)

3) **Business Efficiency**
(Productivity and efficiency, labor market, finance, management practices, attitudes and values)

4) **Infrastructure**
(Basic infrastructure, technological infrastructure, scientific infrastructure, health and environment, and education)

The 20 sub-factors above comprise a total of 392 criteria that are then used to calculate the overall competitiveness ranking.

7.4.4 Malaysia's Ranking on Innovative Capacity in the WCY 2013

One of the criteria in the World Competitiveness Yearbook is *Innovative Capacity*, where respondents are asked to judge the innovative capacity of firms in generating new products and processes. As shown in **Table 7.5**, Malaysia was rated highly on this item, and was ranked 13th, behind countries such as Israel (ranked 1st), the USA (ranked 2nd), Switzerland, Germany, Denmark, Sweden, Taiwan, the Netherlands, Austria, Finland, Ireland and the UAE. Malaysia is, however, ahead of Japan (ranked 14th), Norway, Canada, Singapore, the United Kingdom and Korea. This favourable assessment that Malaysia received on Innovative Capacity is in line with the Malaysian government's emphasis on innovation and creativity to achieve growth.

Table 7.5: Malaysia's Ranking on Innovative Capacity in the WCY 2013

Country	Rank	Score	Country	Rank	Score
Israel	1	8.81	**Ireland**	11	6.90
USA	2	7.96	**UAE**	12	6.86
Switzerland	3	7.81	**Malaysia**	**13**	**6.83**
Germany	4	7.71	**Japan**	14	6.61
Denmark	5	7.56	**Norway**	15	6.60
Sweden	6	7.51	**Canada**	16	6.60
Taiwan	7	7.10	**Singapore**	17	6.59
Netherlands	8	7.09	**United Kingdom**	18	6.44
Austria	9	7.05	**Korea**	19	6.43
Finland	10	6.91	**Luxembourg**	20	6.43

Source: World Competitiveness Yearbook 2013

7.4.5 Malaysia's Ranking on Competitiveness in the WCY 2013

Malaysia's ranking on the Innovative capacity of firms, as well as her ranking on the other 392 criteria has led her to be ranked 15th in the WCY 2013 (down one place from her 14th position in 2012), behind the USA (ranked 1st), Switzerland (2nd), Hong Kong (3rd), Sweden, Singapore, Norway, Canada, UAE, Germany, Qatar, Taiwan, Denmark, Luxembourg, and the Netherlands. Hong Kong has lost its leading position as being the most competitive nation in the WCY, while Japan is ranked only 24th. Indeed, in the WCY 2013, Asian economies such as Hong Kong, Singapore, Taiwan, and Malaysia, are seen as being among the most competitive economies.

Table 7.6: The WCY Scoreboard 2013 Overall Ranking

Countries	2013		2012	
	Index	Rank	Index	Rank
USA	100.00	1	97.755	2
Switzerland	93.357	2	96.679	3
Hong Kong	92.783	3	100.00	1
Sweden	90.531	4	91.393	5
Singapore	89.857	5	95.923	4
Norway	89.585	6	89.673	8
Canada	89.128	7	90.289	6
UAE	88.439	8	82.486	16
Germany	86.197	9	89.257	9
Qatar	85.505	10	88.475	10
Taiwan	85.193	11	89.959	7
Denmark	83.514	12	84.876	13
Luxembourg	83.305	13	86.052	12
Netherlands	83.158	14	87.158	11
Malaysia	**83.145**	**15**	**84.217**	**14**
Australia	80.513	16	83.185	15
United Kingdom	79.150	18	80.142	18
China Mainland	77.040	21	75.769	23
Japan	74.529	24	71.354	27
Thailand	72.966	27	69.001	30

Sources: World Competitiveness Yearbook 2012, 2013

Malaysia's ranking on the WCY is based on her performance on the four competitiveness factors, where improvements in ranking are achieved in three out of the four factors. The country has been ranked 4th on business efficiency, up 2 notches from her 6th position in 2012; 7th on economic performance, from the 10th position in 2012; 15th on government efficiency, down two places from her 13th position in 2012; and infrastructure factors, 25th (up from the 26th position in 2009) **(Table 7.7).**

Table 7.7: Malaysia's Competitiveness Ranking on the WCY, 2009-2013

		WCY2013 (n=60 economies)	WCY2012 (n=59 economies)	WCY2011 (n=59 economies)	WCY2010 (n=58 economies)	WCY2009 (n=57 economies)
Overall Scoreboard	Rank	**15**	**14**	**16**	**10**	18
	Index	**83.145**	**84.217**	**84.120**	**87.228**	77.162
Economic Performance	Rank	**7**	**10**	**7**	**8**	9
Government Efficiency	Rank	**15**	**13**	**17**	**9**	19
Business Efficiency	Rank	**4**	**6**	**14**	**4**	13
Infrastructure	Rank	**25**	**26**	**27**	**25**	26

Source: Malaysia in the IMD World Competitiveness Yearbook 2013, MPC

Malaysia's performance on the four competitiveness factors has also led her to maintain her rank of being 4th among the Asia Pacific countries **(Table 7.8)**, surpassing Australia, China, Korea, Japan, New Zealand, Thailand, Indonesia and India; and second in ASEAN **(Table 7.9)** for the last three years.

Table 7.8: The World Competitiveness Scoreboard 2013 (12 selected Asia-Pacific countries)

Countries	2013		2012		2011	
	Index	Rank	Index	Rank	Index	Rank
Hong Kong	92.783	1	100.000	1	100.000	1
Singapore	89.857	2	95.923	2	98.557	2
Taiwan	85.193	3	89.959	3	92.011	3
Malaysia	**83.145**	**4**	**84.217**	**4**	**84.12**	**5**
Australia	80.513	5	83.185	5	89.259	4
China Mainland	77.04	6	75.769	7	81.1	6
Korea	75.169	7	76.747	6	78.499	8
Japan	74.529	8	71.354	9	75.214	9
New Zealand	73.942	9	74.881	8	79.799	7
Thailand	72.966	10	69.001	10	74.886	10
Indonesia	61.805	11	59.499	12	64.61	12
India	59.888	12	63.596	11	70.649	11

Source: Malaysia in the IMD World Competitiveness Yearbook 2013, MPC

Table 7.9: The World Competitiveness Scoreboard 2013 (ASEAN)

Countries	2013		2012		2011	
	Index	Rank	Index	Index	Rank	Index
Singapore	89.857	1	95.923	1	98.557	1
Malaysia	**83.145**	**2**	**84.217**	**2**	**84.12**	**2**
Thailand	72.966	3	69.001	3	74.886	3
Philippines	63.146	4	59.271	5	63.291	5
Indonesia	61.805	5	59.499	4	64.61	4

Source: Malaysia in the IMD World Competitiveness Yearbook 2013, MPC

7.4.6 The Difference in the Rankings

As seen in the preceding discussion, Malaysia has been ranked quite differently on innovation and on competitiveness in the GCI 2012-2013 and the WCY 2013. On *Innovation Competitiveness* in the GCI, she has been ranked 23rd out of 144 countries, and on her performance on global competitiveness, she has been ranked 25th. On the WCY 2013, on the other hand, Malaysia has been ranked 13th on *Innovative Capacity*, and 15th on World Competitiveness. The question that naturally arises is why there is such a big discrepancy in our ranking on the two indices.

One explanation for this lies in the different methodologies adopted by the GCI and the WCY. The GCI uses 30 percent statistical data and 70 percent survey data, while the reverse is true for the WCY. Two thirds of the calculation of the competitiveness index in the WCY is based on hard data, and one-third on the IMD's executive opinion survey. Hence, the GCI contains a higher percentage of data based on the perceptions of respondents as opposed to the WCY.

7.5 CONCLUSION

The period 2009-2011 saw a significant increase in the percentage of companies that undertook innovation activities compared to the previous NSI-5 (2005-2008) Survey. A higher percentage of these innovating firms (62.0%) are from the services sector compared to only 38.0% from the manufacturing sector. However, the manufacturing sector's expenditure on innovative activities is found to be much higher in terms of value compared to the services sector, mainly due to its higher capital intensity and larger firm size compared to the services sector.

On the international front, however, Malaysia ranks 23rd in terms of Innovation Competitiveness and 25th on global competitiveness[49], i.e., one point and four points below the GCI 2011-2012 ranking, respectively. In addition, the World Competitiveness Yearbook 2013 ranked Malaysia at the 15th place, which is one point below her 14th position in 2012. Nevertheless, Malaysia performed very well in terms of Government procurement of advanced technology products (4th ranking), and relatively well in company spending on R&D (16th ranking), capacity for innovation (17th ranking), and University-industry collaboration in R&D (18th ranking).

It is important to note that the success of the market- and technology-driven approaches to innovation as embodied in the National Innovation Model are critically shaped by effective institutions (e.g. administrative infrastructure and rule of law) that facilitate effective relations and interactions among stakeholders. Hence, it is important to undertake measures to continuously mitigate the key elements of the innovation-led economy, such as developing human resource in science, technology and innovation, complemented by cross-ministry and agency consultations to align policies and prioritise reform measures that are supported by an effective monitoring process,[50] in order to ensure the desired outcomes of innovative activities are achieved.

[49] The Global Competitiveness Report 2012-2013
[50] *National Innovation Model* (http://www.mosti.gov.my/mosti/images/pdf/innovation%20model%20jtpin.pdf)

CHAPTER 8:
INTELECTUAL PROPERTY INTELLECTUAL PROPERTY RIGHTS AND BALANCE IN ROYALTIES AND LICENSING FEES

CHAPTER 8

INTELLECTUAL PROPERTY RIGHTS AND BALANCE IN ROYALTIES AND LICENSING FEES

8.0 INTRODUCTION

Intellectual property (IP) has been recognised as the driving force of innovation and economic growth worldwide. IP is an important indicator of economic development as a relatively high ratio of resident to non-resident activity in the area of patents and trade marks may imply a strong local technological capability as well as a country's openness and attractiveness to foreign companies. Most experts consider intellectual property to be the most relevant factor for the encouragement of FDI and innovation[51].

At the firm level, the effective use of the tools of IP plays an important role in facilitating the process of taking innovative technology to the market place. At the country level, the intellectual property created signifies knowledge creation and business innovation.

This chapter focuses on four areas of intellectual property rights; i.e., patents, trade marks, industrial designs, and geographical indications. As they are registerable interests, statistics on their application and registration are compelling indicators of the generation of new technologies in Malaysia. In addition, since Malaysia acceded to the Patent Cooperation Treaty (PCT) in 2006, an avenue is provided for patent applicants to file for international patents through a single filing. The trends in PCT applications can then be studied to give us an indication of Malaysia's competitive strength in global research and development (R&D). The same is true for the utilisation of technologies protected under intellectual property, which will entail the payment of royalties and licensing fees. Countries that are producers of intellectual property will experience a high rate of income in terms of receipts of royalties and licensing fees while those that are technology dependent will experience a deficit in the receipts of royalties and licensing fees. The trends in the payment and receipts of such fees are telling factors with regard to the diffusion of technology and innovation in a particular country.

This chapter is divided into four sections. The first section assesses the trends in the domestic filing of patents, trade marks, and geographical indications. The second part examines the trends in international filing under the Patent Cooperation Treaty while the third part analyses the trends in global patenting activities. Finally, the fourth part evaluates the trends in payments, receipts, and balance in royalties and licensing fees in Malaysia and the world.

[51] Kamil Idris and Hisamitsu Arai, The Intellectual Property Conscious Nation: Mapping the Path From Developing to Developed, WIPO at p. 14

8.1 INTELLECTUAL PROPERTY

In economic terms, the term "Intellectual Property" refers to unique, value-adding creations of the human intellect that results from human ingenuity, creativity and inventiveness[52]. Generally, Intellectual Property (IP) refers to creations of the mind: inventions, literary and artistic works and symbols, names, images, and designs used in commerce.

The primary source for data on intellectual property in Malaysia is the Intellectual Property Corporation Malaysia (MyIPO). Data from the World Intellectual Property Organisation constitutes the main source of information for the discussion on global trends on intellectual property and PCT applications.

The Patent Cooperation Treaty (PCT) administered by WIPO is the cornerstone of the international patent system. The treaty was concluded in 1970 and currently is a host to 148 member countries. Malaysia acceded to the Patent Cooperation Treaty on 16 August 2006.

There is yet to be a mechanism for the international filing of trade marks and industrial design in Malaysia. The Madrid Agreement Concerning the International Registration of Trade Marks (1891) and the Protocol Relating to the Madrid Agreement (1989) facilitate the acquisition of trade mark rights in multiple jurisdictions. Malaysia has also yet to sign up to the Hague System for the International Registration of Industrial Design (Hague System), which facilitates international filing of industrial design.

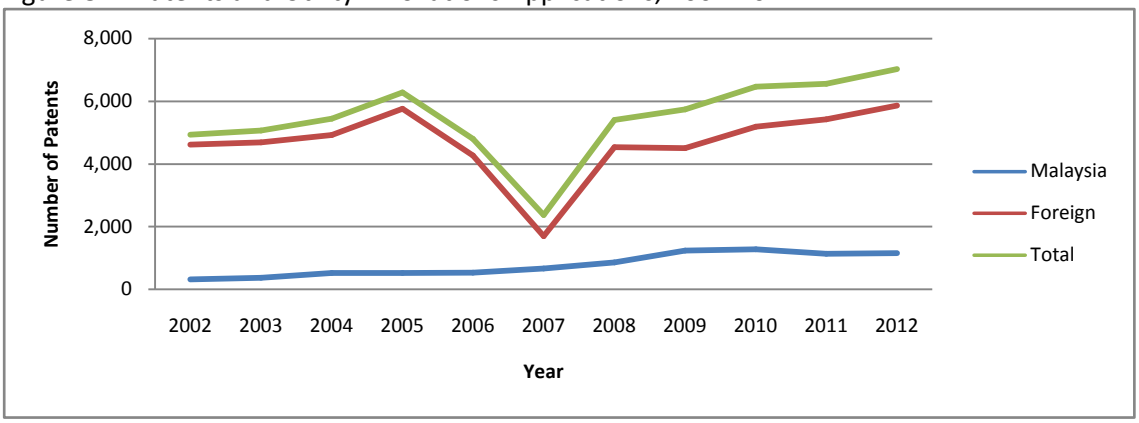
8.2 PATENTS AND UTILITY INNOVATION (DOMESTIC PATENTS)

The patent system has evolved as a mechanism to promote innovation by providing innovators with time-limited exclusive legal rights, thus enabling them to appropriate the returns of their innovative activity. Malaysia practices a two-tier system—patents and utility innovations. Unlike patents, utility innovations are issued for a shorter duration (10 years) and without the need to prove inventive step.

In Malaysia, the local indigenous system for the protection of patents commenced with the enactment of the Patents Act 1983, which took force in 1986. Since then patent filings saw continued strong growth. The 23% drop in 2006 and the major dip (50.6%) in patent applications in 2007 **(Figure 8.1)** was a result of Malaysia's accession to the Patent Cooperation Treaty, which has given an alternative to foreign applicants to file in countries other than Malaysia. This explains the radical reduction in the filing of patent applications among the foreigners. However, the position returned to pre-crisis high in 2008—with 5,403 applications (an increase of 17.8%)—before it recorded a 12.7% increase in 2010 to 6,464 applications. 2012 signifies the peak of patent applications during the period when the total number of applications reached a record number of 7,027. The total number of applications in 2013 is also quite encouraging, with 4,221 by July.

[52] Christopher M. Kalanje, Role of Intellectual Property in Innovation and New Product Development.

Figure 8.1: Patents and Utility Innovations Applications, 2002-2012

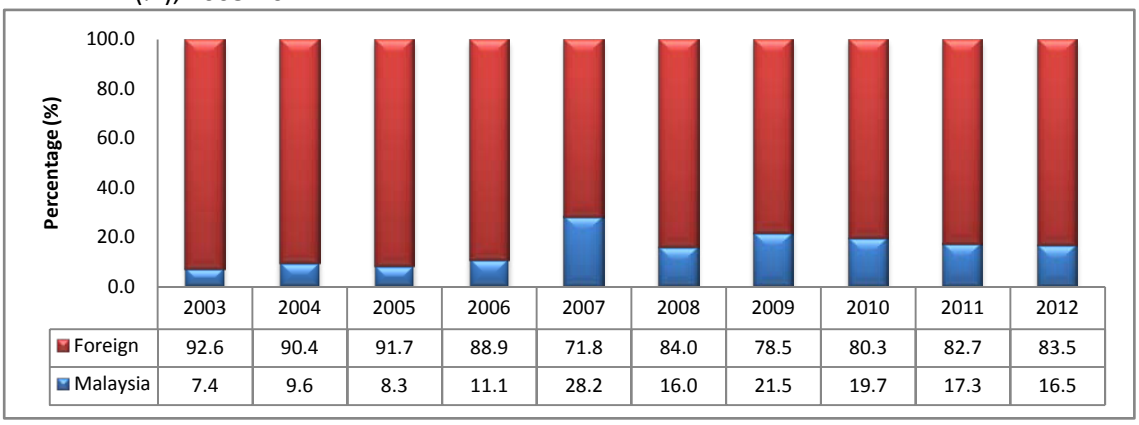


Source: Intellectual Property Corporation of Malaysia (MyIPO)

Like other developing countries, a substantial share of patent applications is filed by non-Malaysians. In 2003 the percentage of applications by non-Malaysians is 92.6% of the total applications **(Figure 8.2)**. This share has steadily decreased over the years. The decrease by 23.6% in 2006 and the sharp drop by 50.6% in 2007 was a result of the accession to the Patent Cooperation Treaty.

Another trend that could be seen from 2009 onwards is the increase in patent filing by Malaysians. In 2003, the percentage was 7.4%, and has been steadily increasing. The upward growth of filing among Malaysians is encouraging, as it is an indicator of continued persistence in local research and development. The peak of patent filings by Malaysians is in 2009, when it constitutes 21.5 % of total patent applications. Since then the percentage of filing among Malaysians has been relatively constant, at the level of 16-19% of the total number of patent applications.

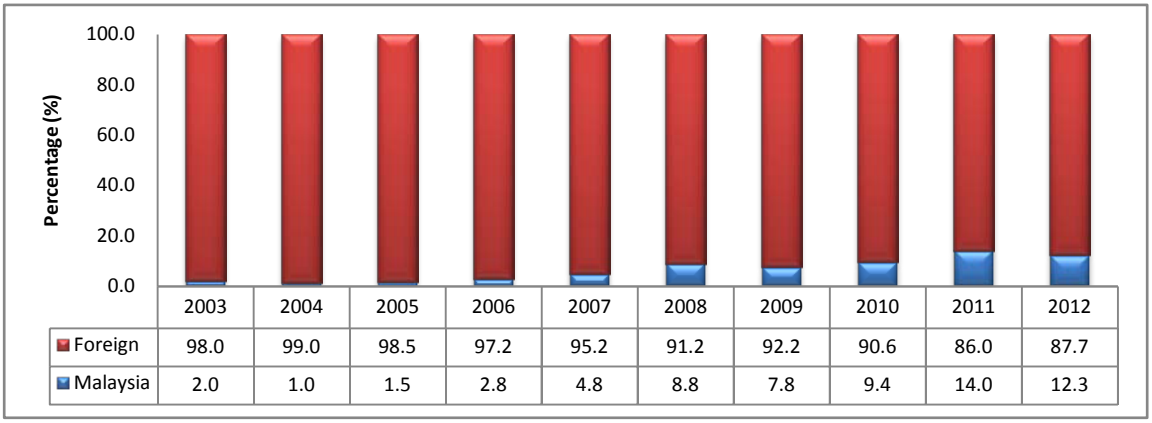
Figure 8.2: Share of Patents and Utility Innovations Applications by Malaysians and Foreigners (%), 2003-2012



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Foreign	92.6	90.4	91.7	88.9	71.8	84.0	78.5	80.3	82.7	83.5
Malaysia	7.4	9.6	8.3	11.1	28.2	16.0	21.5	19.7	17.3	16.5

Source: Intellectual Property Corporation of Malaysia (MyIPO)

Figure 8.3: Share of Patent and Utility Innovation Grants by Malaysians and foreigners (%), 2003-2012

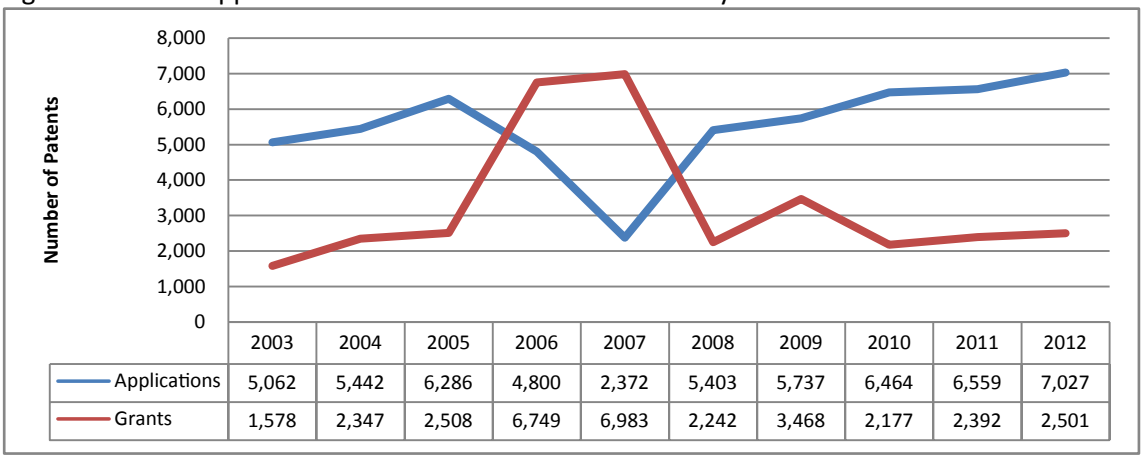


	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Foreign	98.0	99.0	98.5	97.2	95.2	91.2	92.2	90.6	86.0	87.7
Malaysia	2.0	1.0	1.5	2.8	4.8	8.8	7.8	9.4	14.0	12.3

Source: Intellectual Property Corporation of Malaysia (MyIPO)

From the number of patent grants, a substantial proportion of patents that have been disposed of are foreign patents. The share of foreign patent grants ranges from 98.3% in 2003 to 87.7% in 2012. This could be attributed to the modified substantive examination process, which allows foreign patents with priority dates from certain prescribed countries to be examined in a speedier manner. In February 2011, the patent expedited examination process was introduced, and this has cut down further the pendency period of a patent to 20 months from the date of filing. However, the availability of expedited examination has not resulted in a major increase in patent grants as the facility is underutilised. The big gap between the number of filings and the number of granted patents denotes the continued increase in pending applications and pendency period for patent examination in Malaysia as shown in **Figure 8.4.**

Figure 8.4: Total Applications and Granted Patents and Utility Innovations from 2003-2012



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Applications	5,062	5,442	6,286	4,800	2,372	5,403	5,737	6,464	6,559	7,027
Grants	1,578	2,347	2,508	6,749	6,983	2,242	3,468	2,177	2,392	2,501

Source: Intellectual Property Corporation of Malaysia (MyIPO)

8.2.1 Patent Applications by Research & Development Institutes (2010 – 2012)

In Malaysia, institutions of higher learning (IHLs) and government research institutes (GRIs) are the major contributors to local patents, as captured in **Table 8.1** below. In 2010, the share of applications by public and private IHLs amounted to 45.0% of total patent applications by Malaysian residents. The share has, however, dropped from 45.0% in 2010 to 35.1% in 2012. The second largest patent application contributors are the research institutes. Their share of patents was 17.1% in 2010, to rise a bit in 2011 to 19.2% in 2011, only to drop again to 15.3% in 2012.

Table 8.1: Local Patent Applications by Type of Applicants, 2005-2012

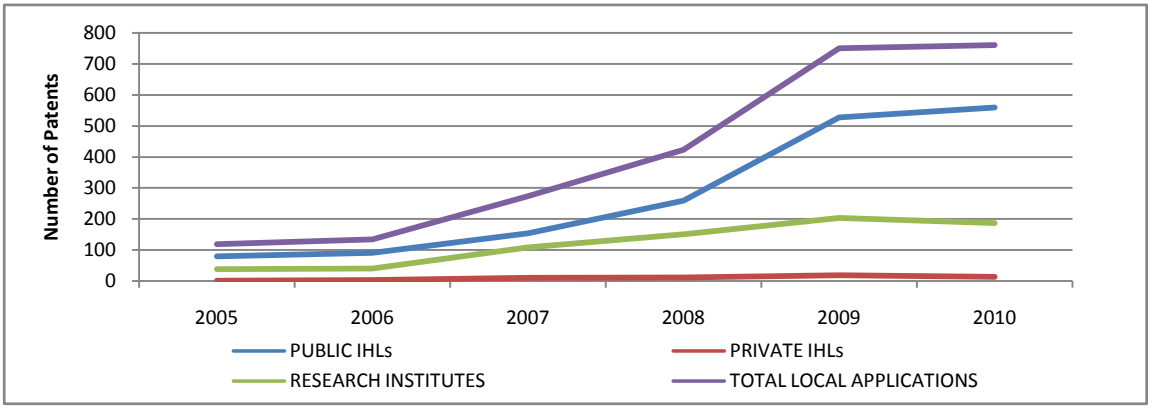
Year	Total local applications	Applications from universities (public IHLs and private IHLs)	% share	Applications from research institutes	% share
2005	522	81	1.5	38	6.9
2006	531	94	1.7	40	6.8
2007	670	165	4.8	109	16.0
2008	864	272	2.4	151	15.3
2009	1,234	547	3.4	204	12.0
2010	1,275	574	45.0	222	17.1
2011	1,136	442	45.0	164	19.2
2012	1,160	407	35.1	177	15.3

Source: Intellectual Property Corporation of Malaysia (MYiPO)

The significant increase in patent applications by IHLs and GRIs may be attributed to the Intellectual Property Commercialisation Policy for Research and Development (R&D) Projects funded by the Government of Malaysia since 2009. Under the policy, generally, the recipient of a government R&D fund is the owner of any intellectual property resulting from the research. This paves the way for a more robust commercialisation of academic research output as the academic institution has full disposition over its intellectual capital. Under the Policy, the term "Commercialisation" is defined to mean the taking of an idea to an outcome – whether a product, service, process or organisational system in order to market by way of licensing, assignment, spin-off, or joint ventures. The Policy imposes the requirement that the invention must be 'manufactured substantially in Malaysia'[53]. The rationale of the policy is to ensure that all government-funded inventions are worked in Malaysia. The express requirement for the application of intellectual property under the policy has indeed injected a boost in the utilisation of IP by the IHLs and GRIs as evident from **Figure 8.5**. Commercialisation, however, is dependent on many other factors such as additional funding, market demand, business acumen, and strategies—or even trial and error. Many of these factors may be new to the academic community; and as a result, this hampers the effective commercialisation of IP.

[53] Clause 10.9, MOSTI Intellectual Property Commercialisation Policy for Research and Development (R&D)(2009)

Figure 8.5: Total Patent Applications by Public and Private Institutions of Higher Learning and Research Institutes, 2005-2010



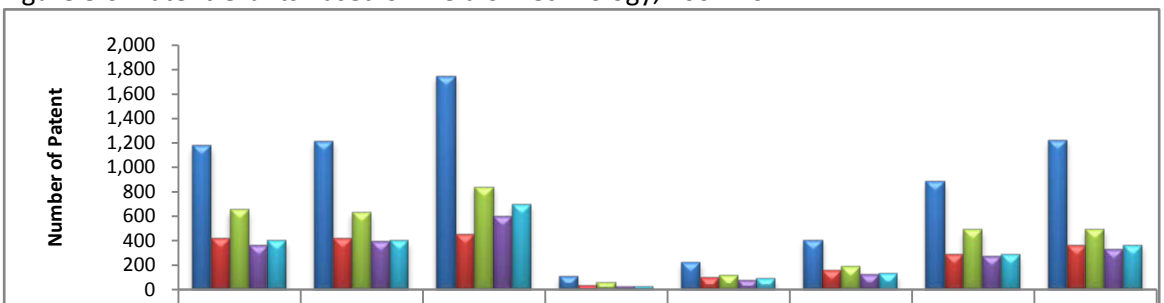
Source: Intellectual Property Corporation of Malaysia (MYiPO)

8.2.2 Patent Grants Based on Field of Technology

Data on patent grants will provide us with a clear view of the field of technology for which the patents are filed and hence an indicator as to where our technological strength lies.

From the total number of patent applications during the period 2007-2011, the highest number of patent grants is in 2007, in the field of chemistry and metallurgy (1,748), followed by electricity (1,223), performing operations and transporting (1,213), human necessities (1,179), and physics (883); as illustrated in **Figure 8.6**.

Figure 8.6: Patent Grants Based on Field of Technology, 2007-2011



	A	B	C	D	E	F	G	H
2007	1,179	1,213	1,748	109	221	407	883	1,223
2008	423	421	451	33	98	159	293	364
2009	656	633	837	53	119	185	488	497
2010	364	390	599	22	75	125	274	328
2011	404	402	693	28	90	126	283	366

Source: Intellectual Property Corporation of Malaysia (MyIPO)
Note: International Patents Classification (IPC)

Section A Human Necessities
Section B Performing Operations; Transporting
Section C Chemistry ; Metallurgy
Section D Textiles ; Paper
Section E Fixed Constructions
Section F Mechanical Engineering; Lighting; Heating; Weapons; Blasting
Section G Physics
Section H Electricity

As shown in **Figures 8.7** and **8.8**, from 2010 to 2011, there is a small increase in the percentage of patents granted in the field chemistry and metallurgy, from 27.5% to 29.0%; in human necessities, from 16.7% to 16.9%; and electricity, from 15.1% to 15.3%. However, there is a decrease in the share of patents granted in performing operations and transporting; physics; and mechanical engineering, lighting, heating, weapons, and blasting.

Figure 8.7: Patents Granted by Field of Technology, 2010

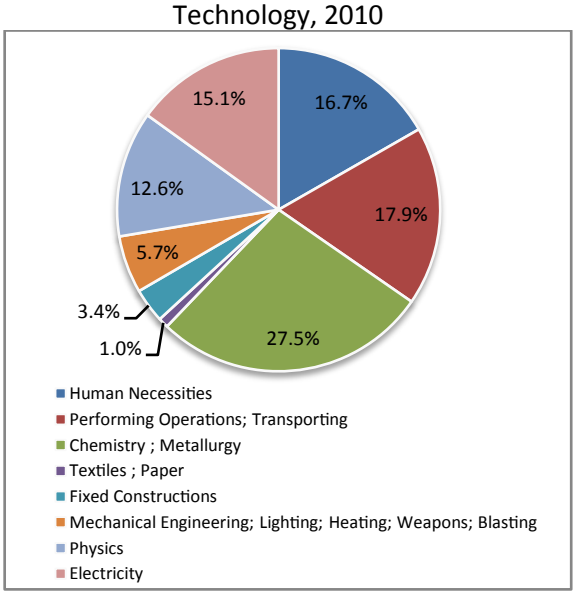
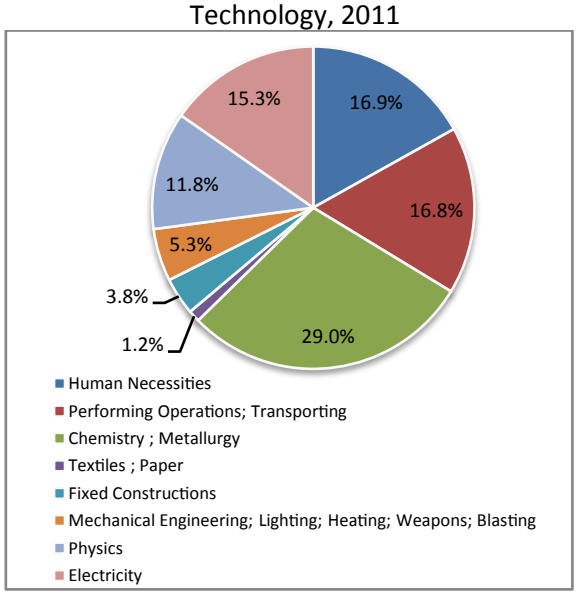


Figure 8.8: Patents Granted by Field of Technology, 2011

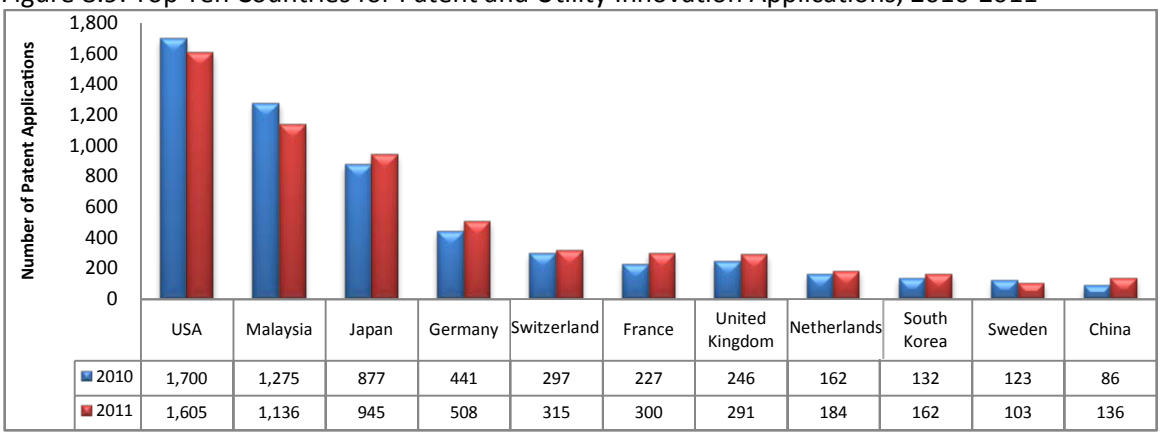


Source: Intellectual Property Corporation of Malaysia (MyIPO)

8.2.3 Top Ten Countries

The top ten countries for patent and utility innovations in 2011 are the USA, Malaysia, Japan, Germany, Switzerland, France, United Kingdom, Netherlands, South Korea, and China. US applications amounted to 26.3% of the total patent applications for 2010 and 24.5% for 2011. Malaysia was the second largest country in terms of patent filing, with a share of 24.6% in 2010 and 21.0% in 2011. Japan and Germany, two world IP giants, constituted the third and fourth largest countries in terms of patent filing; with a share of 16.9% and 7.9% respectively in 2010 and 17.4% and 9.4% respectively in 2011. **Figure 8.9** demonstrates a cross comparison of filings between the top ten countries for patent and utility innovations.

Figure 8.9: Top Ten Countries for Patent and Utility Innovation Applications, 2010-2011



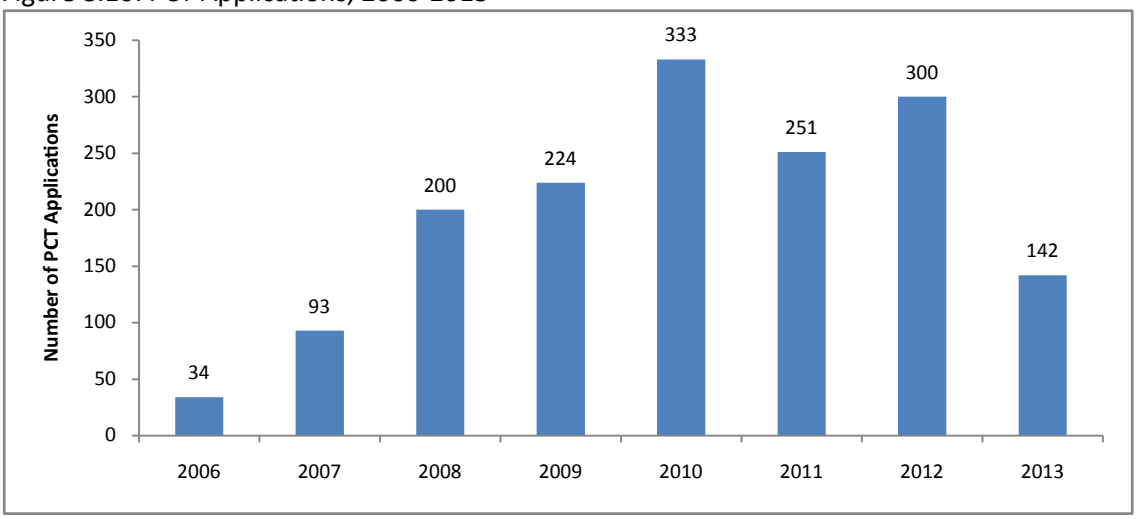
	USA	Malaysia	Japan	Germany	Switzerland	France	United Kingdom	Netherlands	South Korea	Sweden	China
2010	1,700	1,275	877	441	297	227	246	162	132	123	86
2011	1,605	1,136	945	508	315	300	291	184	162	103	136

Source: Intellectual Property Corporation Malaysia (MyIPO)
Note: China was not in the top 10 countries, 2010 and Sweden was not in the top 10 countries, 2011

8.3 INTERNATIONAL FILING OF PATENTS AND UTILITY INNOVATIONS VIA PATENT COOPERATION TREATY

The Patent Cooperation Treaty (PCT) is an international treaty administered by the World Intellectual Property Organization (WIPO). The treaty, which was concluded on 19 June 1970, now has 148 Contracting States. Outside the PCT system, a patent applicant needs to file for a patent in each country for which protection is sought. Malaysia became an official member of the PCT on 16 August 2006. PCT offers patent applicants the opportunity to file for international patents in multiple countries with a single filing. Upon filing at WIPO, an applicant has 30 months to decide whether he or she wishes to enter into the national phase, thereby giving him or her a longer time to make decisions as to which counties' protection is being sought. The PCT provides the opportunity for an applicant to conduct an international search, which enables him to evaluate his chances of obtaining a patent and to make an informed choice as to which markets he wishes to seek patent protection. Since Malaysia's entrance into the PCT system, the number of filings from Malaysia as the receiving office (RO) has been on the increase, with the exception of a drop in 2011. Beginning 2006 with a total count of 34, the figure grew to 93 in 2007, to 200 in 2008, and 224 in 2009. The highest count was in 2010, with 333 applications.

Figure 8.10: PCT Applications, 2006-2013

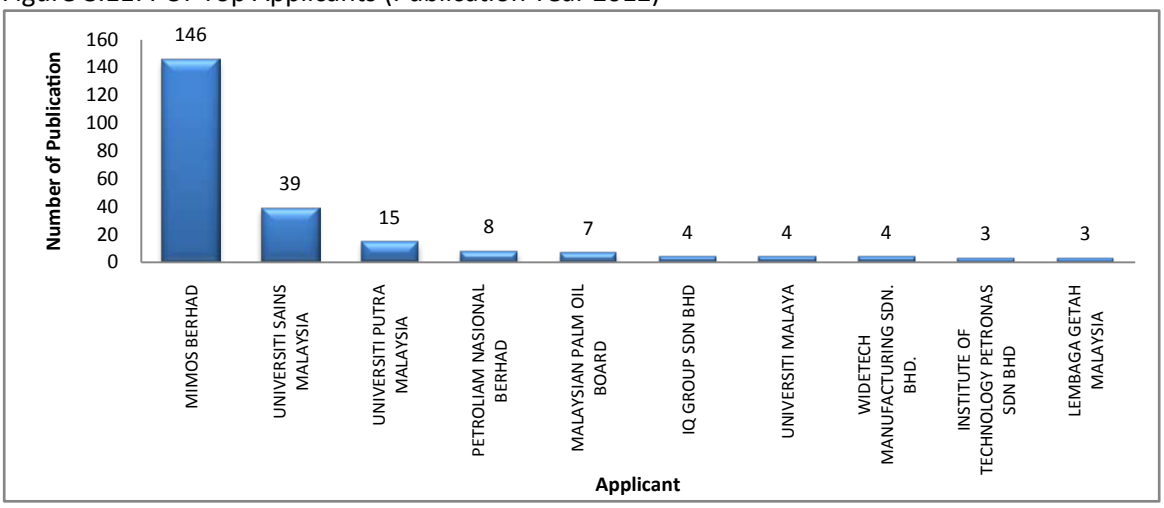


Source: Intellectual Property Corporation of Malaysia (MyIPO)

8.3.1 Top PCT Applicants

The top applicant for PCT for 2012 **(Figure 8.11)** based on the number of publications was MIMOS Berhad, with 146 applications. This was followed by University Sains Malaysia (39 applications), Universiti Putra Malaysia (15 applications), Petroliam Nasional Berhad (8 applications), and Malaysian Palm Oil Board (7 applications).

Figure 8.11: PCT Top Applicants (Publication Year 2012)



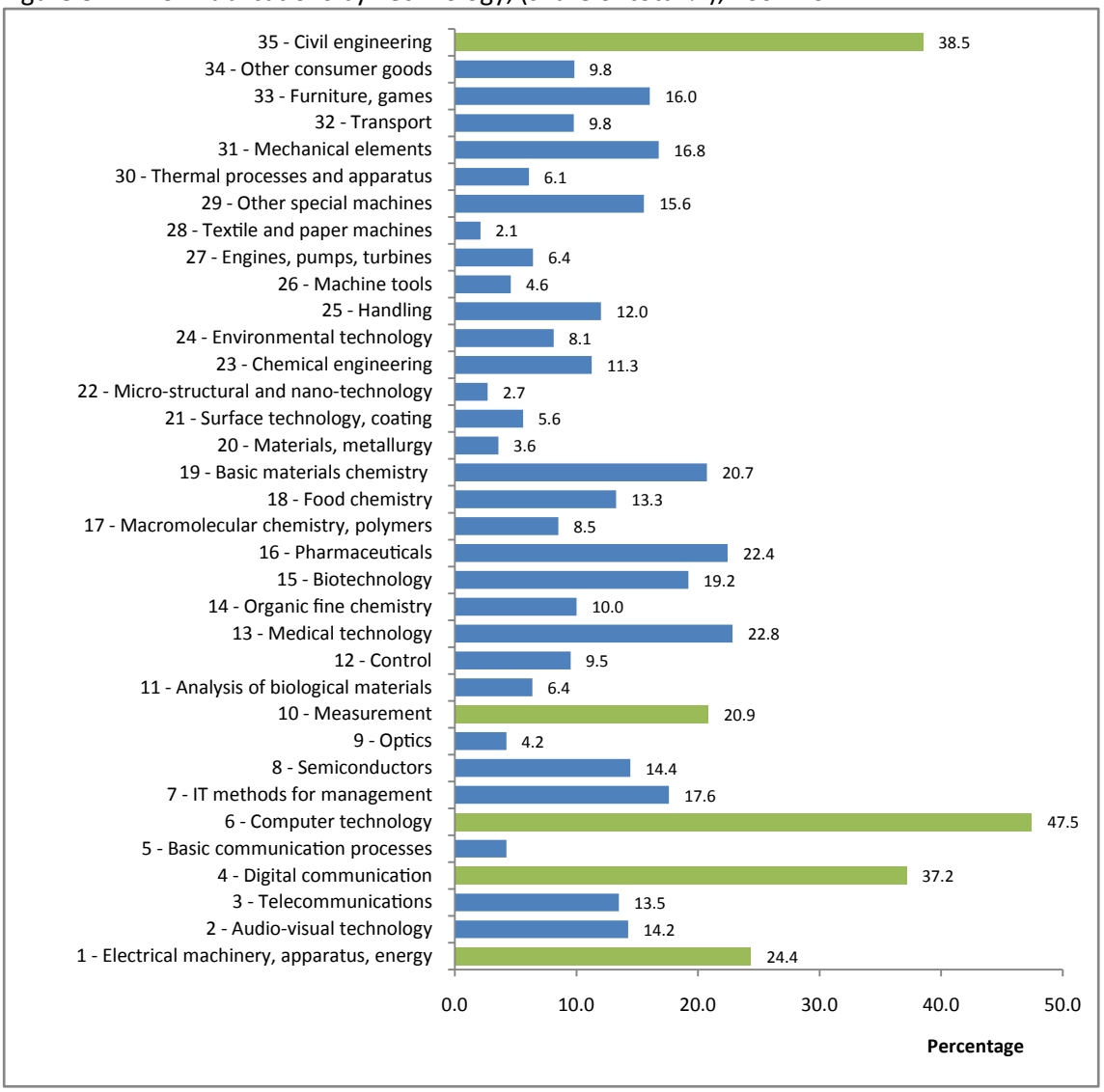
Source: Intellectual Property Corporation Malaysia (MyIPO)

In terms of areas of technology, computer technology recorded the highest number of applications from 2007-2011 at (47.5%), followed by civil engineering (38.5%), digital communications at (37.2%), pharmaceuticals (22.4%), measurement (20.9%), and basic materials chemistry (20.7%), as captured in **Figure 8.12**.

8.3.2 National Phase

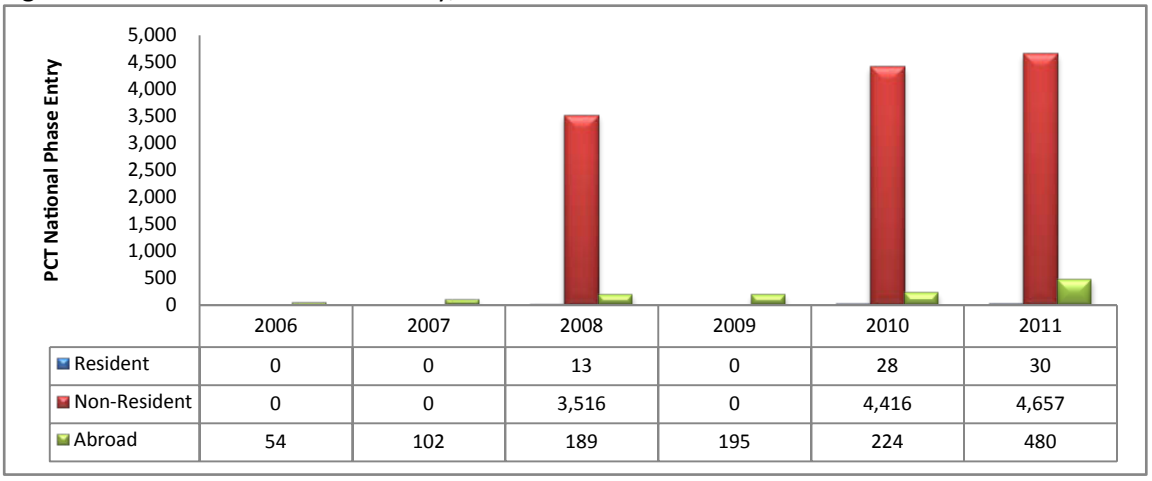
PCT allows member countries to enter national phase 18 months from the date the PCT application was filed. The number of PCT applications that have chosen Malaysia as the designated office can be seen in **Figure 8.13**, which shows a consistent increase in the number of PCT applications that have entered into the Malaysian national phase. **Figure 8.13** also illustrates the number of Malaysians that have chosen foreign countries as the designated office. The trend of national phase entry abroad is also on the rise, with the percentage of growth highest in 2011, at 114.3%.

Figure 8.12: PCT Publications by Technology, (share of total %), 2007-2011



Source: WIPO statistics database. Last updated: March 2013

Figure 8.13: PCT National Phase Entry, 2006-2011



	2006	2007	2008	2009	2010	2011
Resident	0	0	13	0	28	30
Non-Resident	0	0	3,516	0	4,416	4,657
Abroad	54	102	189	195	224	480

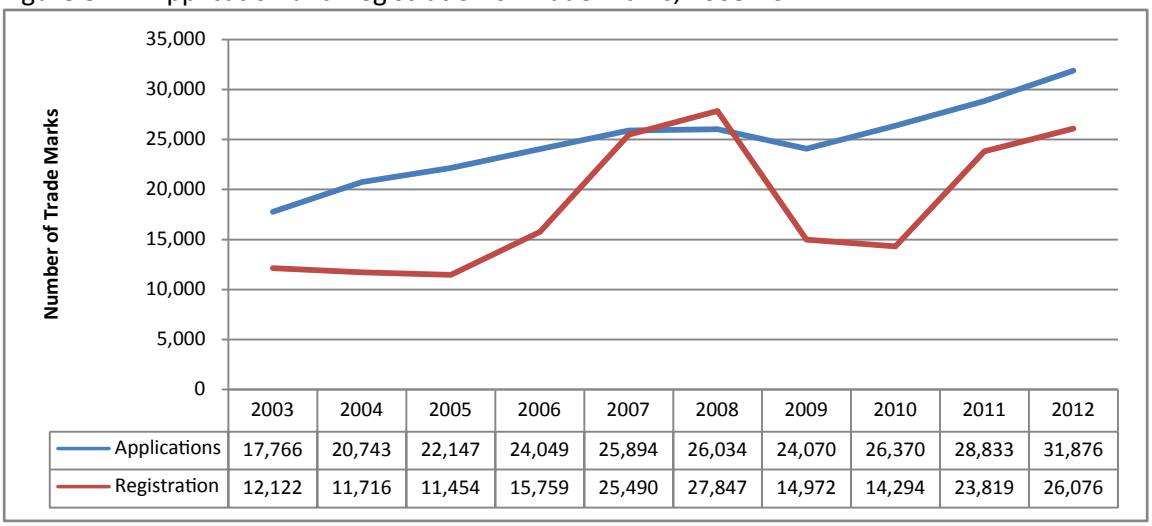
Source: WIPO statistics database. Last updated: March 2013

8.4 TRADE MARKS

A trade mark is a distinctive sign that identifies certain goods or services as those produced or provided by a specific person or enterprise. Trade mark statistics are a good indicator of the robustness of business activity in a particular country.

The trend in trade mark filing in Malaysia seems to be more stable in comparison to patents during the period 2003-2012. The peak in the filing of trade marks is in 2008. There seems to be a sharp decline of 46.2% from the number filed in 2009. This could be attributed to the economic downturn faced by Malaysia during that period. The gap between the filing and registration of trade marks is also evident, as illustrated in **Figure 8.14**.

Figure 8.14: Application and Registration of Trade Marks, 2003-2012

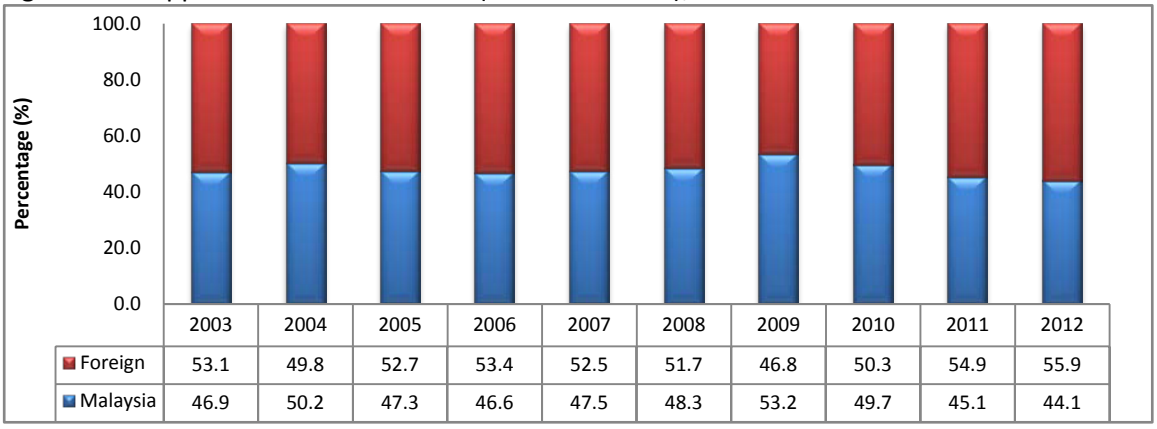


	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Applications	17,766	20,743	22,147	24,049	25,894	26,034	24,070	26,370	28,833	31,876
Registration	12,122	11,716	11,454	15,759	25,490	27,847	14,972	14,294	23,819	26,076

Source: Intellectual Property Corporation Malaysia (MyIPO)

Trade marks is one area where the percentage of applications filed by Malaysians and foreigners is almost equal. As shown in **Figure 8.15**, in 2003, foreigners filed a total of 53.1% of the total applications and in 2012, 55.9%. The lowest count in the number of foreign applications is in 2009, at 46.8%. 2004 and 2009 are the two years in the 10-year period in which Malaysian applications exceeded those of foreigners.

Figure 8.15: Application of Trade Marks (share of total %), 2003-2012



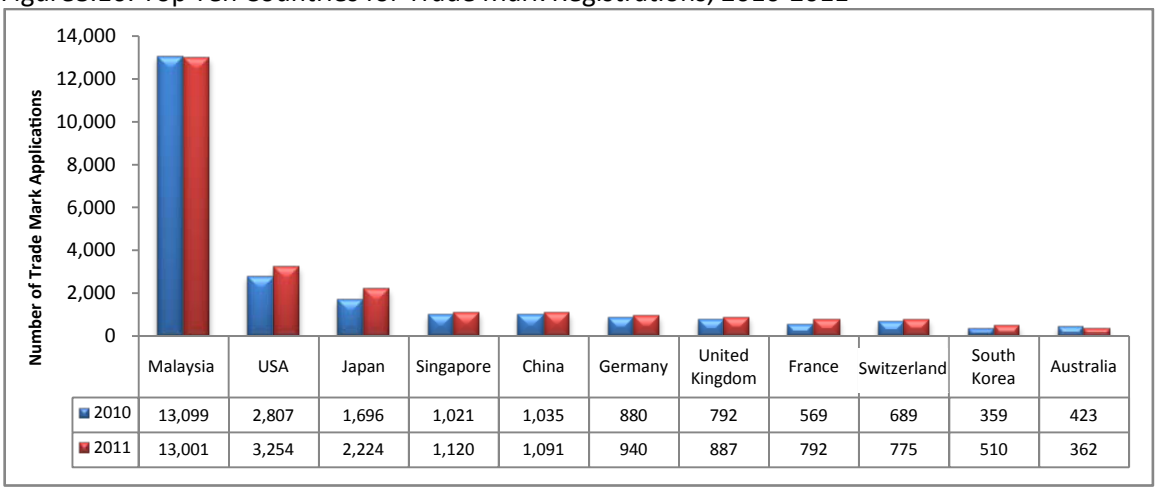
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Foreign	53.1	49.8	52.7	53.4	52.5	51.7	46.8	50.3	54.9	55.9
Malaysia	46.9	50.2	47.3	46.6	47.5	48.3	53.2	49.7	45.1	44.1

Source: Intellectual Property Corporation of Malaysia (MyIPO)

From the total number of applications, the largest share accounts for Malaysian applications (56.1% in 2010 and 52.1% in 2011), followed by the USA (12% in 2010 and 13.0 % in 2011), Japan

(7.3% in 2010 and 8.9% in 2011), Singapore (4.4% in 2010 and 4.5% in 2011), China (4.4% for both 2010 and 2011), and Germany (3.8% for both 2010 and 2011). In total, the number of Malaysian trade mark applications from 2010-2011 is substantially higher than that of the US applications **(Figure 8.16 and Table 8.2)**.

Figure8.16: Top Ten Countries for Trade Mark Registrations, 2010-2011



Source: Intellectual Property Corporation of Malaysia (MyIPO)
Note: South Korea was not in the top 10 countries in 2010. Australia was not in the top 10 countries in 2011

Table 8.2: Top Ten Countries for Trade Mark Applications (% share), 2010-2011

COUNTRY	2010	2011	% share 2010	% share 2011
Malaysia	13,099	13,001	56.1	52.1
USA	2,807	3,254	12.0	13.0
Japan	1,696	2,224	7.3	8.9
Singapore	1,021	1,120	4.4	4.5
China	1,035	1,091	4.4	4.4
Germany	880	940	3.8	3.8
United Kingdom	792	887	3.4	3.6
France	569	792	2.4	3.2
Switzerland	689	775	2.9	3.1
South Korea	359	510	1.5	2.0
Australia	423	362	1.8	1.5
Total	23,370	24,956	100.0	100.0

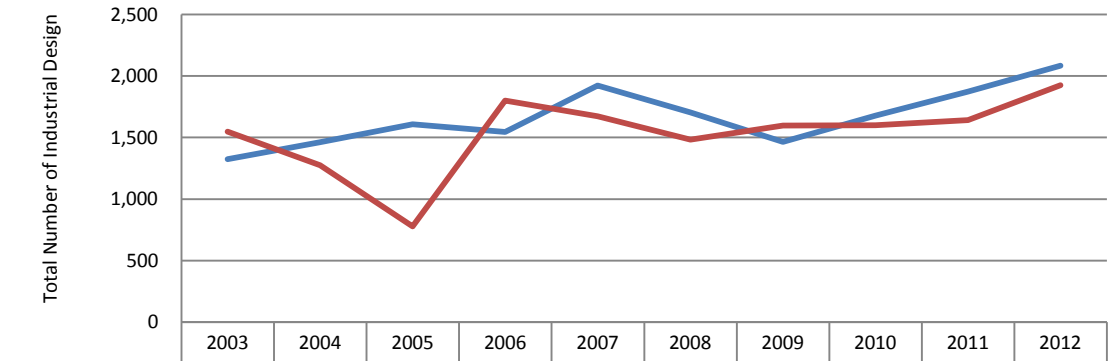
Source: Intellectual Property Corporation of Malaysia (MyIPO)

8.5 INDUSTRIAL DESIGN

Industrial design plays an increasingly important role in the world economy. At the firm level, a sizeable share of investments has been put into designing money-making designs that would render a particular product more attractive to consumers. As a result of this, the utilization of industrial design protection is a factor that cannot be ignored by policy makers. Industrial design filings in Malaysia have seen a continued growth over the last decade except for a dip in 2006 and 2009 as a result of the economic downturn. Since then it has gone back to the pre-crisis level, with a recorded growth of 14.5% in 2010; 11.6% in 2011 and 11.3% in 2012.

The pendency period for industrial design is much shorter in comparison to patents and trade marks. There seems to be less rejection and waiting time for industrial design registration. As a result, industrial design applications get to be cleared at a much faster rate.

Figure 8.17: Total Applications and Registration of Industrial Design, 2003-2012

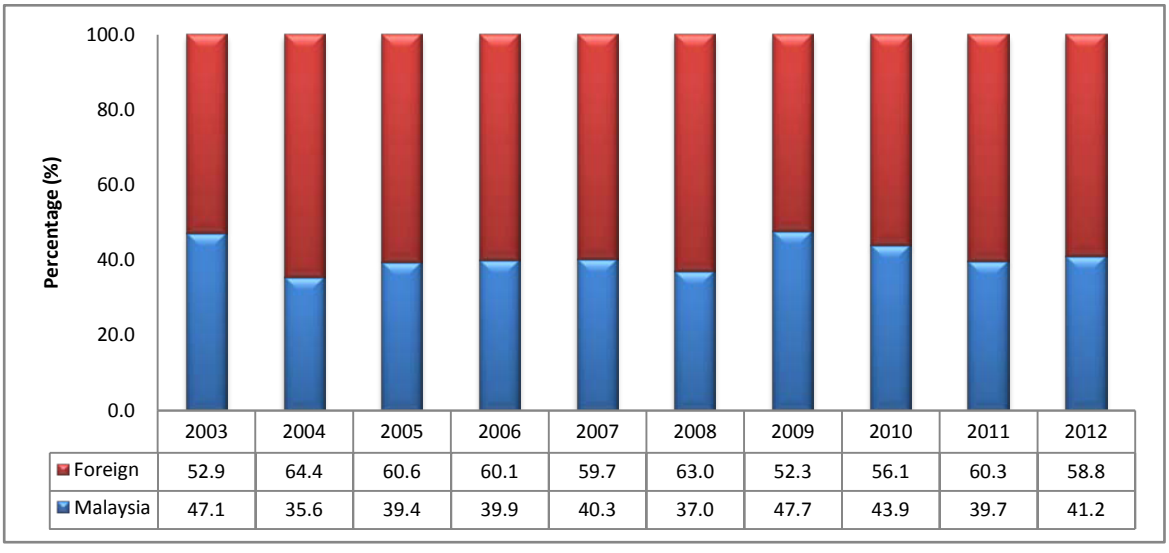


	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Applications	1,324	1,461	1,607	1,544	1,920	1,702	1,465	1,677	1,871	2,082
Registration	1,547	1,273	777	1,800	1,673	1,483	1,596	1,598	1,641	1,924

Source: Intellectual Property Corporation of Malaysia (MyIPO)

In terms of percentage share, foreign applications to Malaysian applications have ranged from 52.9% foreign and 47.1% Malaysian in 2003 to 58.8% foreign and 41.2% Malaysian in 2012 **(Figure 8.18)**. The gap between foreign applications and Malaysian applications is less apparent in the case of industrial design. Similar trends can be seen in the share of Malaysian to non-Malaysian registration of industrial design grants as shown in **Figure 8.19**.

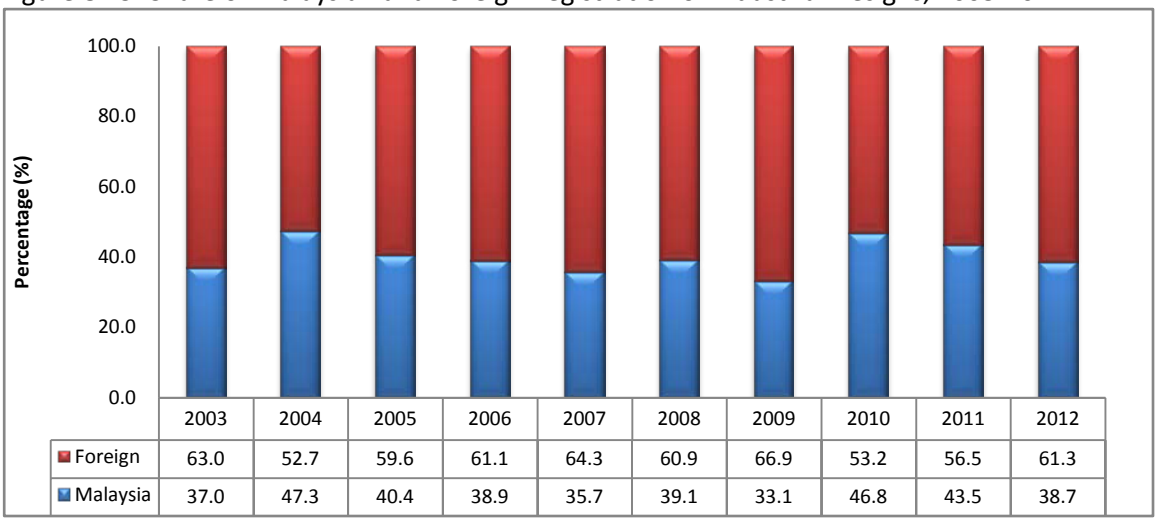
Figure 8.18: Share of Malaysian and Non Malaysian Application of Industrial Designs (%), 2003-2012



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Foreign	52.9	64.4	60.6	60.1	59.7	63.0	52.3	56.1	60.3	58.8
Malaysia	47.1	35.6	39.4	39.9	40.3	37.0	47.7	43.9	39.7	41.2

Source: Intellectual Property Corporation of Malaysia (MyIPO)

Figure 8.19: Share of Malaysian and Foreign Registration of Industrial Designs, 2003-2012



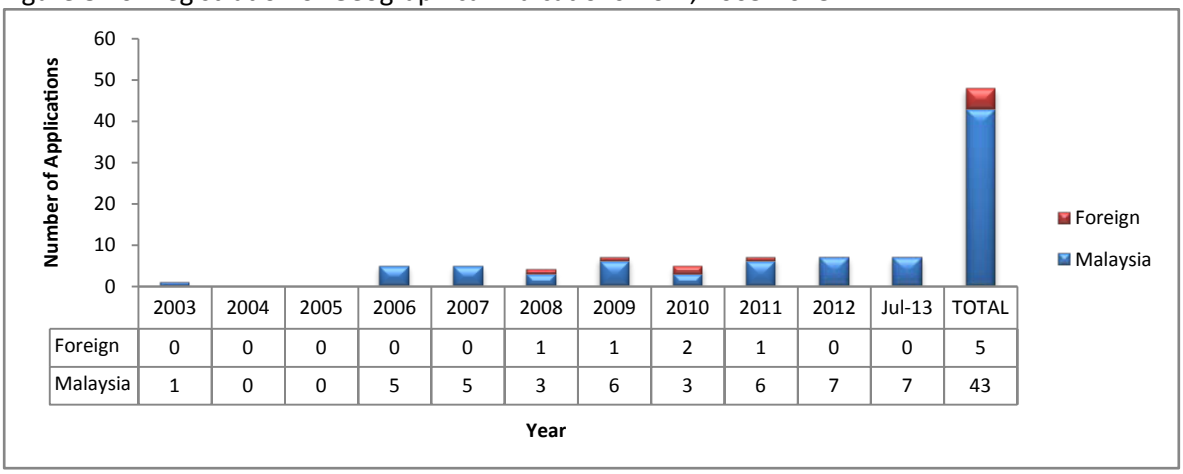
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Foreign	63.0	52.7	59.6	61.1	64.3	60.9	66.9	53.2	56.5	61.3
Malaysia	37.0	47.3	40.4	38.9	35.7	39.1	33.1	46.8	43.5	38.7

Source: Intellectual Property Corporation of Malaysia (MyIPO)

8.6 GEOGRAPHICAL INDICATIONS

Geographical indications are the newest form of registerable intellectual property rights in Malaysia. Introduced in 2000, the number of applications for the filing of geographical indications is less than other types of intellectual property rights. **Figure 8.20** and **Table 8.3** illustrate the trend in the application for and registration of geographical indications in Malaysia and the share of foreign and Malaysian applications. As shown in **Table 8.3** from the list of the 22 granted geographical indications, only 5 are foreign GIs: Pisco, Scotch Whisky, Cognac and Champagne (wines and alcohol) and Parmigiano Reggiano, the only foreign cheese registered as a geographical indication.

Figure 8.20: Registration of Geographical Indications from, 2003-2013



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Jul-13	TOTAL
Foreign	0	0	0	0	0	1	1	2	1	0	0	5
Malaysia	1	0	0	5	5	3	6	3	6	7	7	43

Source: Intellectual Property Corporation of Malaysia (MyIPO)

Table: 8.3: List of Registered Geographical Indications

No.	Geographical Indication
1.	Sarawak Pepper
2.	Sabah Tea
3.	Borneo Virgin Coconut Oil
4.	Tenom Coffee
5.	Sabah Seaweed
6.	Bario Rice
7.	Buah Limau Bali Sungai Gedung
8.	Pisco
9.	Scotch Whisky
10.	Sarawak Beras Biris
11.	Sarawak Beras Bajong
12.	Kuih Lidah Kampung Berundong Papar
13.	Tambunan Ginger
14.	Sarawak Sour Eggplant
15.	Sarawak Layered Cake
16.	Sarawak Dabai
17.	Cognac
18.	Parmigiano Reggiano
19.	Langkawi Cheese
20.	Sarawak Litsea
21.	Perlis Harumanis Mango
22.	Champagne

Source: Intellectual Property Corporation of Malaysia (MyIPO)

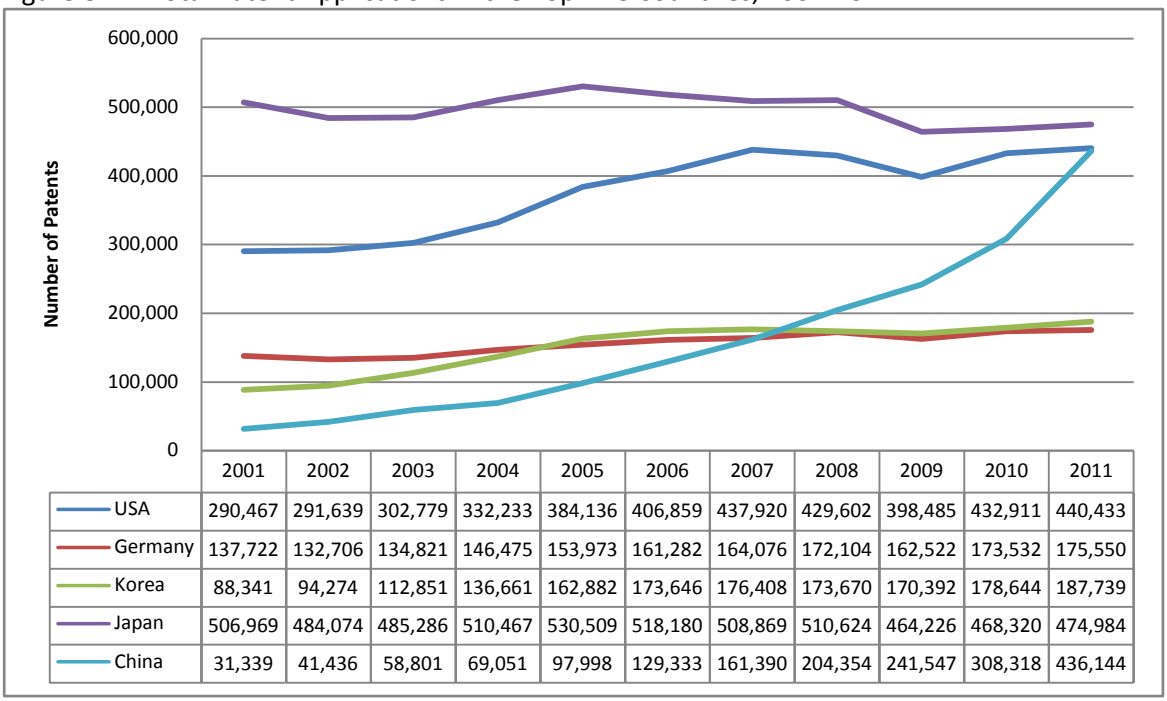
8.7 TRENDS IN GLOBAL APPLICATIONS AND GRANTS

8.7.1 Global Trends in Patent Applications

Figure 8.21 shows the filing trend among the top five countries in the world between 2001-2011. During this period, only three countries have accelerated their patent filing: China, the US, and Korea. Between the three, China's patent application increased at a much faster rate to become the top applicant in 2012. The compound annual growth rate (CAGR) of China's application is 30.1% in the ten-year period. The increase is largely attributed to the significant growth in PCT filing. Japan had the highest number of applications from 2001 to 2005, after which there was a decline in the number of applications. With its compound annual growth rate (CAGR) at -0.7%, Japan was overtaken by China in 2010. Similarly, the USA, which was the largest patent applicant until 2011, also had a much slower growth rate (annual average growth of 4.3%) in comparison to China such that it was overtaken by China in 2012. Korea's applications also show an increasing trend, with a compound annual growth rate (CAGR) of 7.1%. As reported by WIPO, for the first time in 100 years, China has become the top patent office in the world, overtaking Germany, Japan, and the United States.[54]

[54] WIPO, 2012 World Intellectual Property Indicators, available online at http://www.wipo.int (last viewed 19 October 2013)

Figure 8.21: Total Patent Applications in the Top Five Countries, 2001-2011



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
USA	290,467	291,639	302,779	332,233	384,136	406,859	437,920	429,602	398,485	432,911	440,433
Germany	137,722	132,706	134,821	146,475	153,973	161,282	164,076	172,104	162,522	173,532	175,550
Korea	88,341	94,274	112,851	136,661	162,882	173,646	176,408	173,670	170,392	178,644	187,739
Japan	506,969	484,074	485,286	510,467	530,509	518,180	508,869	510,624	464,226	468,320	474,984
China	31,339	41,436	58,801	69,051	97,998	129,333	161,390	204,354	241,547	308,318	436,144

Source: WIPO Statistics Database, September 2013.

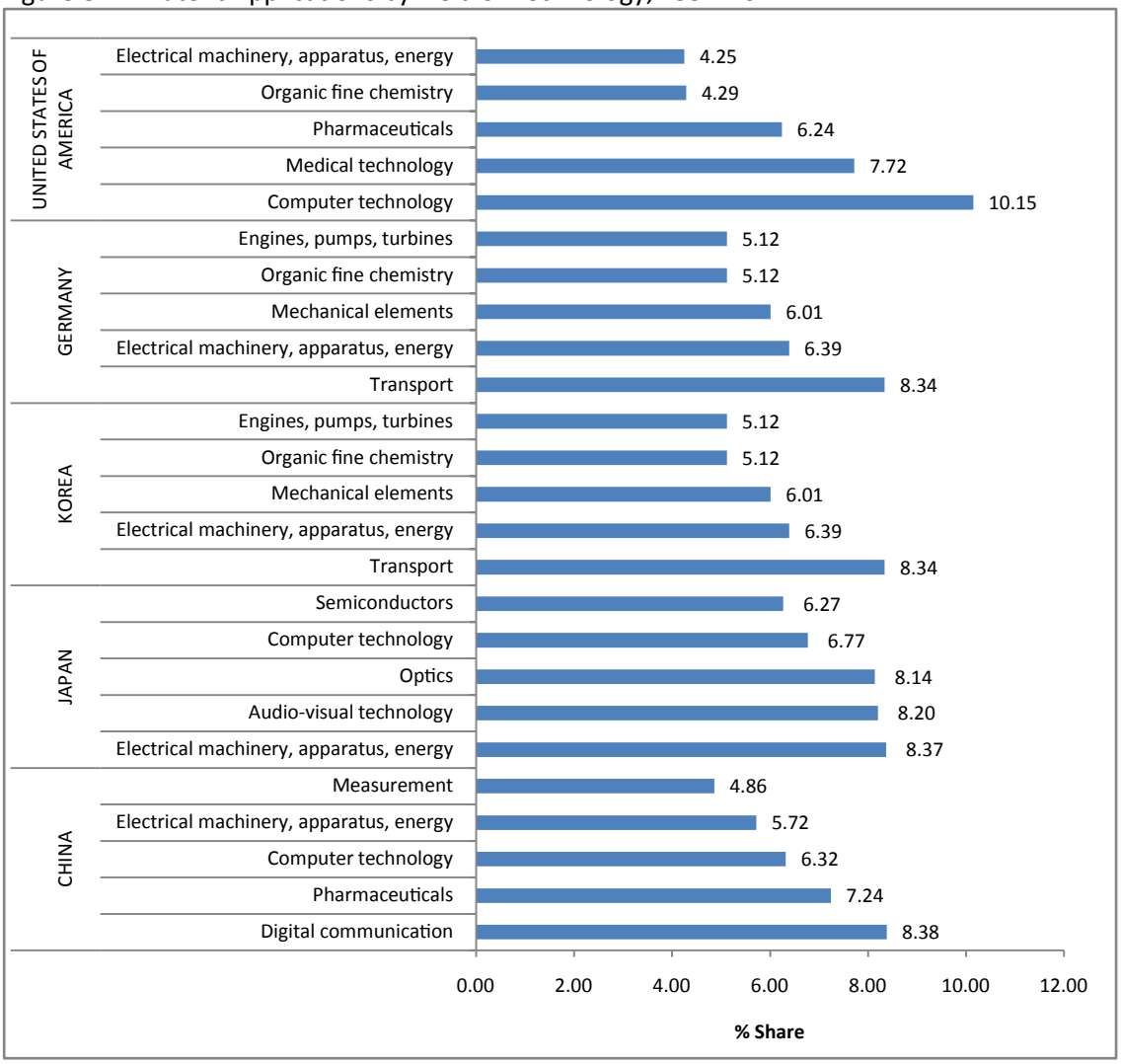
8.7.2 Top Five Applicants by Sector of Technology

From patent grant statistics, the United States' largest number of patent grants is in the area of computer technology followed by electrical machinery, medical technology, and pharmaceuticals. Korea's largest patent grant is for transport, electrical machinery, apparatus, energy, organic fine chemistry and engines, and pump and turbines. China's strength is in the area of digital communications and pharmaceuticals and Germany's strength is in transport and electrical machinery, apparatus and energy, and mechanical elements. Japan has strength in 3 areas; electrical machinery, apparatus and energy, and audio visual technology and optics.

There is a widespread belief that in developing countries, foreign applicants dominate the domestic patent system. The percentage of resident vs. non-resident filing shows the robustness of local innovation. The high percentage of foreign patents, on the other hand, demonstrates the attractiveness of the country for foreign investment and suitable market for their products. **Figure 8.23** compares the percentage of patents granted to residents *vis a vis* non-residents in selected middle income countries.

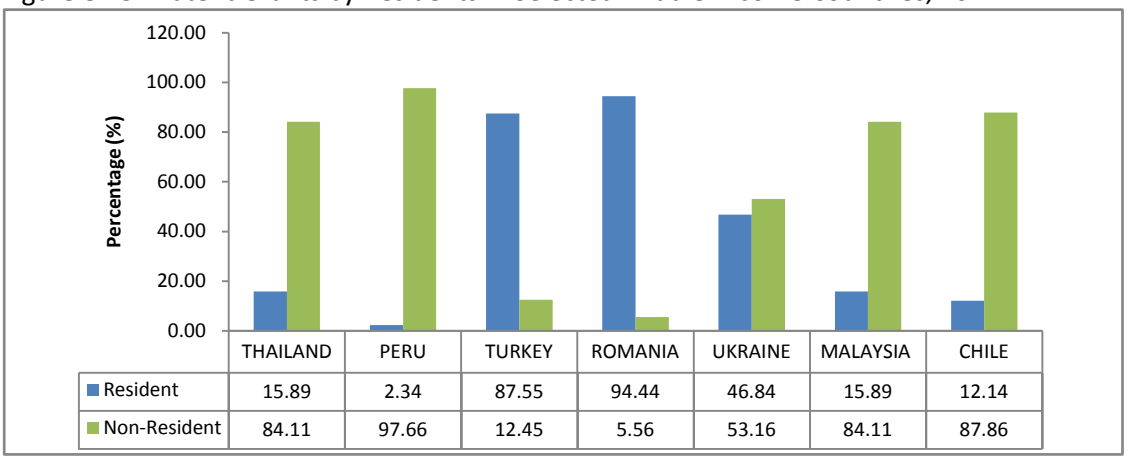
Malaysia, Thailand and Chile have about a 70% gap between patents granted to non-residents *vis a vis* residents. The large gap is attributed to the lack of local innovation in these countries. The gap in Peru comes up to 95%. On the other hand, patents in countries such as Turkey and Romania are dominated by residents. The gap between resident and non-resident patent grants in Turkey is about 70% and in Romania about 90%. The Ukraine, despite having more patents granted to non-residents, has a very minimal gap amounting to only 5%.

Figure 8.22: Patent Applications by Field of Technology, 1997-2011



Source: WIPO Country Statistical Database

Figure 8.23: Patent Grants by Residents in Selected Middle-Income Countries, 2011



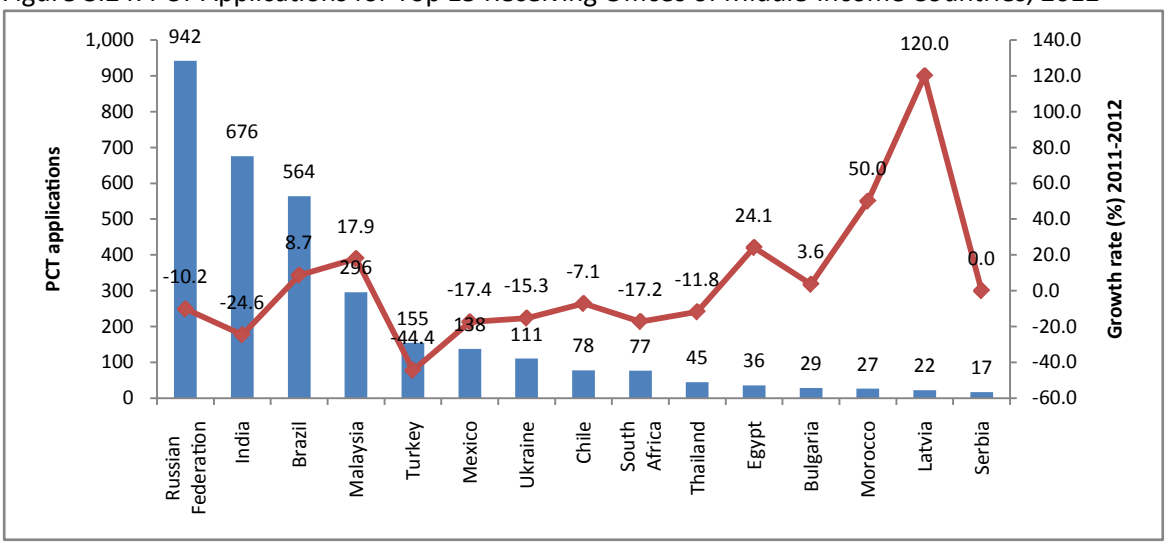
	THAILAND	PERU	TURKEY	ROMANIA	UKRAINE	MALAYSIA	CHILE
Resident	15.89	2.34	87.55	94.44	46.84	15.89	12.14
Non-Resident	84.11	97.66	12.45	5.56	53.16	84.11	87.86

Source: WIPO Statistic Database, March 2013

8.7.3 Global Trends in PCT Applications (International Filing)

The WIPO Reports on PCT applications[55] recorded Malaysia as among the top 15 receiving offices of middle-income countries in 2012. Malaysia came fourth after the Russian Federation, India and Brazil; with 296 applications and a growth rate of 17.9% as featured in **Figure 8.24**.

Figure 8.24: PCT Applications for Top 15 Receiving Offices of Middle-income Countries, 2012



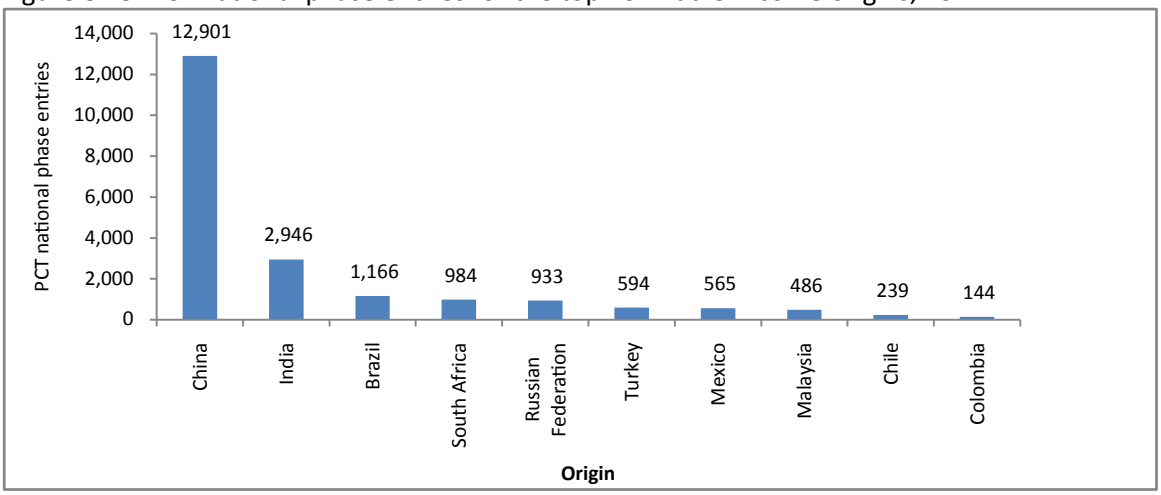
Note: The figures given for PCT applications filed in 2012 are WIPO estimates.
Source: WIPO, (2013) PCT Yearly Review: The International Patent System

The total number of PCT applications that have chosen a particular country as the designated office is indicative of the faith that the business community has in that country. It also shows that the country has been chosen as the preferred market for the patented goods. From the WIPO Report[56], Malaysia, being a small market, has emerged as being a relatively attractive market for the business community, just behind Mexico (565 applications) and Turkey (594 applications) as shown in **Figure 8.25**. China, being the largest PCT applicant in the world, has also registered the highest number of national phase entries. Although India was second in the list, the gap between China and India is quite large, i.e., 77.2%. Within Asia, PCT count in Malaysia is among the top five middle-income countries; behind Turkey, India and China.

A notable achievement in PCT applications is that Universiti Sains Malaysia has emerged as among the top 50 university applicants in the world as featured in WIPO Report (2013)[57], one rank behind Duke University of the United States of America and 6 ranks higher than the renowned University of Cambridge **(Table 8.4)**.

[55] WIPO, (2013) PCT Yearly Review: The International Patent System available at www.wipo.int (viewed 24th November 2013) at p. 25
[56] WIPO, (2013) PCT Yearly Review: The International Patent System available at www.wipo.int (viewed 24th November 2013) at p. 46
[57] WIPO, (2013) PCT Yearly Review: The International Patent System available at www.wipo.int (viewed 24th November 2013) at p.35

Figure 8.25: PCT national phase entries for the top 10 middle-income origins, 2011



Note: WIPO estimates
Source: WIPO, (2013) PCT Yearly Review: The International Patent System

Table 8.4: Top 50 PCT Applicants: Universities

Rank	Applicant's Name	Origin	PCT applications			Change compared to 2011
			2010	2011	2012	
1	UNIVERSITY OF CALIFORNIA	United States of America	304	277	351	74
2	MASSACHUSETTS INSTITUTE OF TECHNOLOGY	United States of America	146	179	168	-11
3	HARVARD UNIVERSITY	United States of America	91	88	146	58
4	JOHNS HOPKINS UNIVERSITY	United States of America	89	111	141	30
5	COLUMBIA UNIVERSITY	United States of America	91	82	114	32
5	UNIVERSITY OF TEXAS SYSTEM	United States of America	129	127	114	-13
7	SEOUL NATIONAL UNIVERSITY	Republic of Korea	97	99	101	2
8	LELAND STANFORD JUNIOR UNIVERSITY	United States of America	54	79	95	16
9	PEKING UNIVERSITY	China	26	29	92	63
10	UNIVERSITY OF FLORIDA	United States of America	107	84	89	5
11	CALIFORNIA INSTITUTE OF TECHNOLOGY	United States of America	50	59	88	29
12	KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY	Republic of Korea	51	103	82	-21
13	CORNELL UNIVERSITY	United States of America	81	88	73	-15
14	UNIVERSITY OF TOKYO	Japan	105	98	66	-32
15	YONSEI UNIVERSITY	Republic of Korea	38	43	65	22
16	TSINGHUA UNIVERSITY	China	24	36	62	26
16	ISIS INNOVATION LIMITED	United Kingdom	46	62	62	0
18	KYOTO UNIVERSITY	Japan	47	70	61	-9
19	UNIVERSITY OF MICHIGAN	United States of America	79	96	59	-37
20	PURDUE UNIVERSITY	United States of America	50	41	57	16
21	TOHOKU UNIVERSITY	Japan	41	51	56	5
22	UNIVERSITY OF UTAH	United States of America	59	50	55	5
23	NATIONAL UNIVERSITY OF SINGAPORE	Singapore	24	50	54	4

24	POSTECH FOUNDATION	Republic of Korea	31	36	50	14
25	NANYANG TECHNOLOGICAL UNIVERSITY	Singapore	22	29	49	20
26	STATE UNIVERSITY OF NEW YORK	United States of America	32	40	48	8
27	UNIVERSITY OF NORTH CAROLINA	United States of America	42	43	47	4
27	KYUSHU UNIVERSITY	Japan	27	41	47	6
29	TEL AVIV UNIVERSITY	Israel	39	43	46	3
29	UNIVERSITY OF PENNSYLVANIA	United States of America	76	64	46	-18
29	WISCONSIN ALUMNI RESEARCH FOUNDATION	United States of America	47	46	46	0
29	HANYANG UNIVERSITY	Republic of Korea	46	50	46	-4
33	UNIVERSITY OF SOUTHERN CALIFORNIA	United States of America	47	38	45	7
33	INDIAN INSTITUTE OF TECHNOLOGY	India	8	20	45	25
35	UNIVERSITY OF ILLINOIS	United States of America	59	47	44	-3
35	KOREA UNIVERSITY	Republic of Korea	27	60	44	-16
35	UNIVERSITY OF COLORADO	United States of America	34	47	44	-3
35	OSAKA UNIVERSITY	Japan	60	59	44	-15
35	ARIZONA STATE UNIVERSITY	United States of America	64	55	44	-11
35	IMPERIAL INNOVATIONS LTD.	United Kingdom	37	35	44	9
41	OHIO STATE UNIVERSITY RESEARCH FOUNDATION	United States of America	32	30	43	13
41	INDIANA UNIVERSITY	United States of America	37	34	43	9
43	HEBREW UNIVERSITY OF JERUSALEM	Israel	43	51	41	-10
44	ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE	Switzerland	23	32	40	8
45	DUKE UNIVERSITY	United States of America	48	51	39	-12
45	UNIVERSITI SAINS MALAYSIA	Malaysia	10	16	39	23
47	TOKYO INSTITUTE OF TECHNOLOGY	Japan	26	43	38	-5
49	EMORY UNIVERSITY	United States of America	34	25	37	12
49	YALE UNIVERSITY	United States of America	24	37	37	
51	CAMBRIDGE UNIVERSITY	United Kingdom	35	40	36	-4
51	DANMARKS TEKNISKE UNIVERSITET	Denmark	24	36	36	0
51	NEW YORK UNIVERSITY	United States of America	26	34	36	2

Source: WIPO, (2013) PCT Yearly Review: The International Patent System

Note: The university sector includes applications from all types of educational institutions. Due to confidentiality requirements, the PCT data are based on the publication date.

Another major achievement is that MIMOS has emerged as the sixth in the top 30 applicants from government and research institutes as reported by WIPO Report[58], higher than some of the

[58] WIPO, (2013) PCT Yearly Review: The International Patent System available at www.wipo.int (viewed 24th November 2013) at p. 36

institutes from France, Australia, United States, Germany, Japan, and Korea as featured in **Table 8.5** below. Applications from MIMOS in 2012 have increased by 38% in comparison to 2011.

Table 8.5: Top 30 PCT Applicants: Government and Research Institutions

Rank	Applicant's Name	Origin	PCT applications			Change compared to 2011
			2010	2011	2012	
1	COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES	France	308	371	391	20
2	FRAUNHOFER-GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG E.V.	Germany	297	294	264	-30
3	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE (CNRS)	France	207	196	197	1
4	CHINA ACADEMY OF TELECOMMUNICATIONS TECHNOLOGY	China	-	119	171	52
5	INSTITUTE OF MICROELECTRONICS OF CHINESE ACADEMY OF SCIENCES	China	1	74	161	87
6	MIMOS BERHAD	Malaysia	67	108	146	38
7	INSTITUT NATIONAL DE LA SANTE ET DE LA RECHERCHE MEDICALE (INSERM)	France	83	90	116	26
7	ELECTRONICS & TELECOMMUNICATIONS RESEARCH INSTITUTE OF KOREA	Republic of Korea	174	104	116	12
9	AGENCY OF SCIENCE, TECHNOLOGY AND RESEARCH	Singapore	154	180	108	-72
10	CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS (CSIC)	Spain	126	120	90	-30
11	UNITED STATES OF AMERICA, REPRESENTED BY THE SECRETARY, DEPARTMENT OF HEALTH AND HUMAN SERVICES	United States of America	113	98	88	-10
12	NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY	Japan	91	100	84	-16
13	COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH	India	56	53	77	24
14	KOREA RESEARCH INSTITUTE OF BIOSCIENCE AND BIOTECHNOLOGY	Republic of Korea	44	45	76	31
15	NEDERLANDSE ORGANISATIE VOOR TOEGEPAST- NATUURWETENSCHAPPELIJK ONDERZOEK TNO	Netherlands	116	82	66	-16
16	MAX-PLANCK-GESELLSCHAFT ZUR FORDERUNG DER WISSENSCHAFTEN E.V.	Germany	57	49	59	10
16	BATTELLE MEMORIAL INSTITUTE	United States of America	50	54	59	5
17	KOREA INSTITUTE OF INDUSTRIAL TECHNOLOGY	Republic of Korea	17	30	49	19
18	COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION	Australia	61	48	49	1
19	MAYO FOUNDATION FOR MEDICAL EDUCATION AND RESEARCH	United States of America	60	49	48	-1
21	RIKEN (THE INSTITUTE OF PHYSICAL AND CHEMICAL RESEARCH)	Japan	24	33	45	12
22	KOREA RESEARCH INSTITUTE OF CHEMICAL	Republic of	26	35	42	7

	TECHNOLOGY	Korea				
23	CLEVELAND CLINIC FOUNDATION	United States of America	23	18	38	20
24	NATIONAL INSTITUTE FOR MATERIALS SCIENCE	Japan	35	34	36	2
25	KOREA INSTITUTE OF MACHINERY & MATERIALS	Republic of Korea	15	36	33	-3
26	KOREA INSTITUTE OF ENERGY RESEARCH	Republic of Korea	13	23	32	9
27	SHANGHAI INSTITUTE OF MICROSYSTEM AND INFORMATION TECHNOLOGY CHINESE ACADEMY OF SCIENCES	China	-	17	31	14
28	DEUTSCHES ZENTRUM FUR LUFT- UND RAUMFAHRT E.V.	Germany	29	29	29	
29	KOREA ELECTRONICS TECHNONLOGY INSTITUTE	Republic of Korea	10	19	28	9
30	VIB VZW	Belgium	12	13	27	14

Source: WIPO, (2013) PCT Yearly Review: The International Patent System

Note: Government and research institutions include private non-profit organizations and hospitals. Due to confidentiality requirements, the PCT data are based on the publication date. Top applicants are selected according to the 2012 total.

8.8 ROYALTIES AND LICENSING FEES

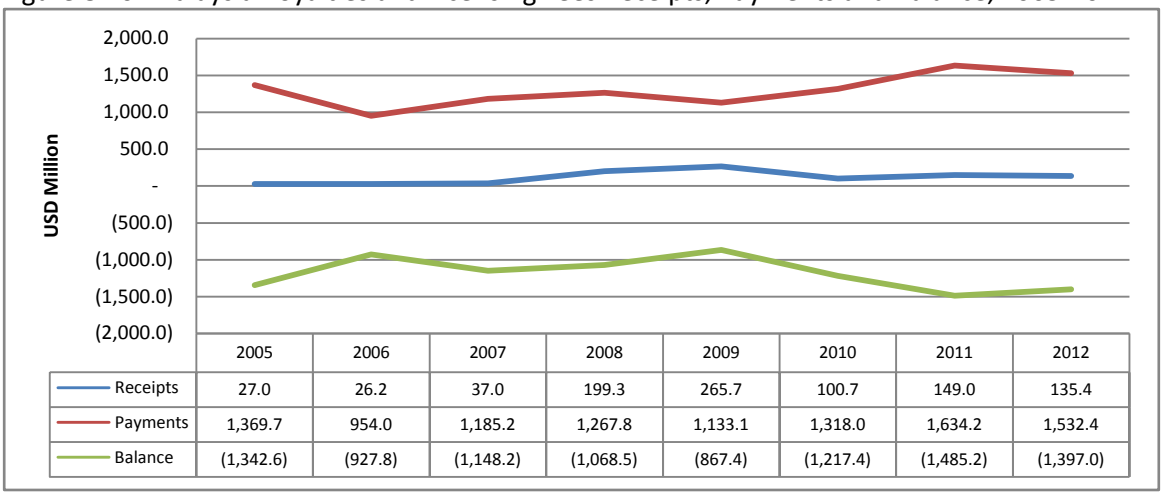
This section features the trends in total receipts and payments of royalties and licensing fees in Malaysia and in the world. Royalties and licensing fees represent revenues and payments for the intellectual property trade. Malaysia, like other developing countries, is a net importer in the intellectual property trade. The analysis of the trends in the global receipts and payments of royalties and licensing fees relies on data extracted from the World Bank Statistical Database.

Charges for the use of intellectual property are the payments and receipts between residents and non-residents for the authorized use of proprietary rights (such as patents, trade marks, copyrights, industrial processes and designs including trade secrets, and franchises) and for the use, through licensing agreements, of produced originals or prototypes (such as copyrights on books and manuscripts, computer software, cinematographic works, and sound recordings) and related rights (such as for live performances and television, cable, or satellite broadcast). Data are in current U.S. dollars.

8.8.1 Trends in Royalties and Licensing Fees

As the major portion of intellectual property filed in Malaysia is by non-Malaysians, Malaysia is paying more for the usage of intellectual property than generating revenue from her intellectual property. **Figure 8.26** illustrates the gap between receipts and payment of royalties for the usage of intellectual property, which has widened from 2010 onwards. The deficit in the trade of intellectual property was as high as USD1.3 billion in 2005 and USD1.4 billion in 2011 and 2012. The trade deficit seemed to contract in 2009 as a result of decreased trade in IP due to the economic downturn.

Figure 8.26: Malaysia Royalties and Licensing Fees Receipts, Payments and Balance, 2005-2012



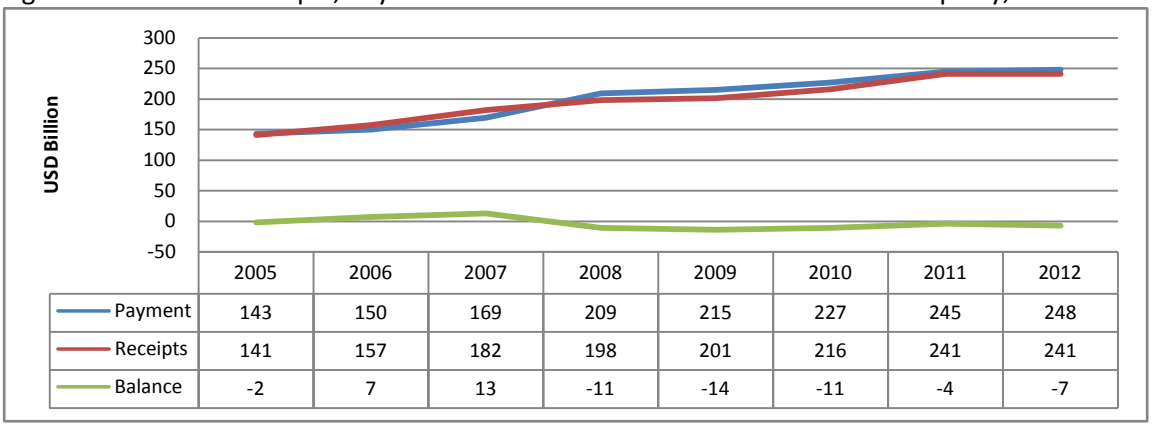
	2005	2006	2007	2008	2009	2010	2011	2012
Receipts	27.0	26.2	37.0	199.3	265.7	100.7	149.0	135.4
Payments	1,369.7	954.0	1,185.2	1,267.8	1,133.1	1,318.0	1,634.2	1,532.4
Balance	(1,342.6)	(927.8)	(1,148.2)	(1,068.5)	(867.4)	(1,217.4)	(1,485.2)	(1,397.0)

Source: The World Bank Data

8.8.2 Global Royalties and Licensing Fees Receipts and Payments

Globally, the amounts for the payment of royalties and receipts of royalties are almost balanced. Even if there is some surplus, it is not much; and ranges from USD7 billion in 2006 to USD13 billion in 2007.

Figure 8.27: Global Receipts, Payments and Balance of Trade in Intellectual Property, 2005-2012



	2005	2006	2007	2008	2009	2010	2011	2012
Payment	143	150	169	209	215	227	245	248
Receipts	141	157	182	198	201	216	241	241
Balance	-2	7	13	-11	-14	-11	-4	-7

Source: The World Bank Data

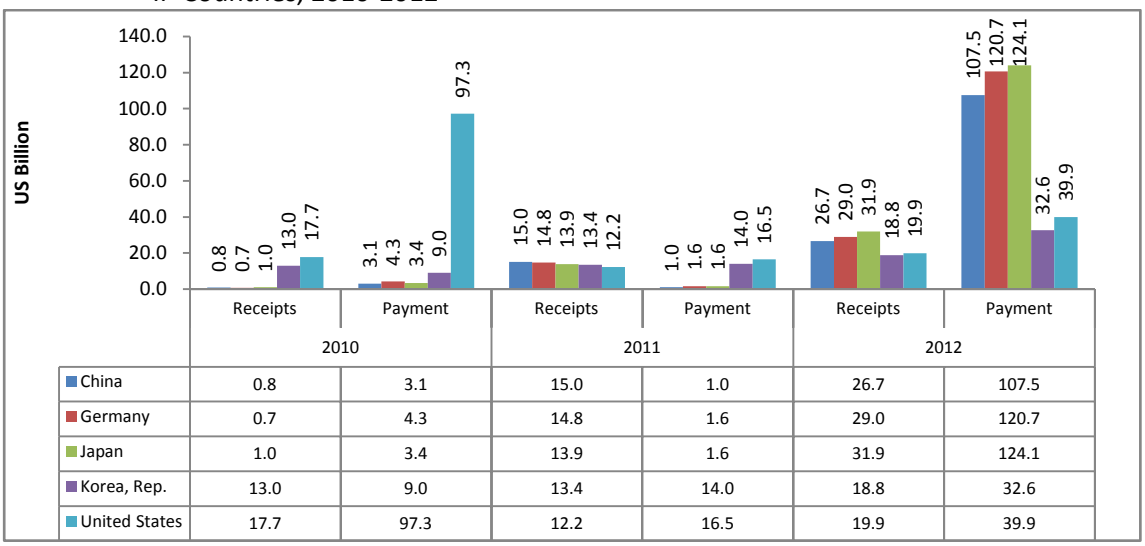
Royalty payment for the usage of intellectual property, even by the top 5 IP countries, is also on the increase. This indicates the growing use and dependence on the intellectual property owned by others with regard to the products and services in the market.

For all the top 4 IP countries, payment for the usage of intellectual property exceeds the amount of receipts in royalties. Japan paid a total USD3.4 billion in 2010 and it received only USD1 billion. The amount of royalties paid grew exponentially by 504.2% in the two-year period as shown in **Figure 8.28** below. The increase in the payment of royalties indicates Japan's extensive reliance on foreign technology for her products. Germany has also increased her reliance on foreign technology by paying substantially more on royalties, at an annual growth of 429.8%. However, Germany has also managed to increase her receipt of royalties by 543.7%. China's growth in both payment and receipt is more than 400% (487.8% for payment and 477.7% for

receipts). Similarly, the United States is paying more for technologies used in US products at a growth of 117.9%; whilst growth for receipts is 6.0%.

This trend indicates the dependence on technological products, resulting in the large payment of royalties for the usage of other technologies to develop, innovate and improve existing products. It also indicates the growing interconnectedness in the production of technological products and the fact that there is no single nation that can survive by just using local technologies alone and turning a blind eye to foreign technologies. To build a local competitive technological base, the way forward is to collaborate with foreign technologies.

Figure 8.28: Charges for the Use of Intellectual Property as Payments and Receipts in the Top 5 IP Countries, 2010-2012

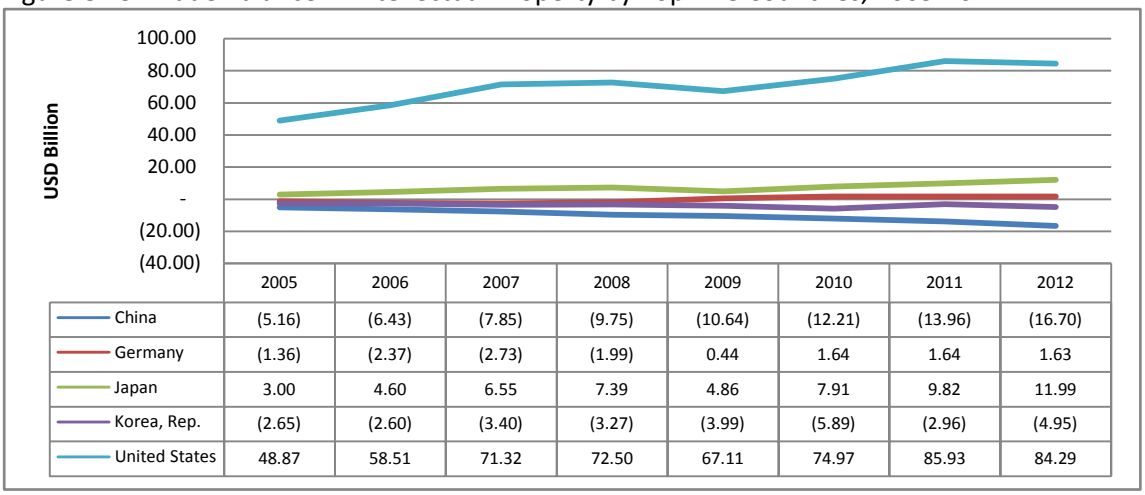


	2010		2011		2012	
	Receipts	Payment	Receipts	Payment	Receipts	Payment
China	0.8	3.1	15.0	1.0	26.7	107.5
Germany	0.7	4.3	14.8	1.6	29.0	120.7
Japan	1.0	3.4	13.9	1.6	31.9	124.1
Korea, Rep.	13.0	9.0	13.4	14.0	18.8	32.6
United States	17.7	97.3	12.2	16.5	19.9	39.9

Source: The World Bank Data

For some countries, the discrepancy between the amount of payment made and money received for royalty has resulted in deficit. **Figure 8.29** illustrates the trade balance in intellectual property in the top five IP countries. From the five countries, the US is the only country that is reaping the most from intellectual property trade; with its trade balance as high as USD85 billion in 2011. The United States' receipts from intellectual property trade has increased every year since 2005 (except for 2009) and reached its peak at USD120.7 billion. Japan is another country with a surplus in its IP trade; ranging from USD3 billion to nearly USD12 billion in 2012. Germany suffered from trade deficit from 2005-2008; and thereon recorded a surplus of USD438 million in 2009. Germany's surplus grew at a much more moderate pace to reach USD1.6 billion in 2012. Both China and Korea experienced trade deficit in their trade in intellectual property.

Figure 8.29: Trade Balance in Intellectual Property by Top Five Countries, 2005-2012



	2005	2006	2007	2008	2009	2010	2011	2012
China	(5.16)	(6.43)	(7.85)	(9.75)	(10.64)	(12.21)	(13.96)	(16.70)
Germany	(1.36)	(2.37)	(2.73)	(1.99)	0.44	1.64	1.64	1.63
Japan	3.00	4.60	6.55	7.39	4.86	7.91	9.82	11.99
Korea, Rep.	(2.65)	(2.60)	(3.40)	(3.27)	(3.99)	(5.89)	(2.96)	(4.95)
United States	48.87	58.51	71.32	72.50	67.11	74.97	85.93	84.29

Source: World Bank Data

8.9 CONCLUSION

Malaysia has made significant inroads into international patenting as evidenced from the promising growth in the application of PCT patents by the IHLs and RIs. To that extent, Malaysia has been successful in building its technological base, enough to vie for international patents and compete with foreign technologies. Within Asia, Malaysia is among the top five middle-income countries in the application of PCT patents; behind Turkey, India and China. A notable achievement for Malaysia is that Universiti Sains Malaysia has emerged as among the top 50 university applicants for PCT patents in the world as featured in the WIPO Report (2013)[59], one rank behind Duke University of the United States of America and 6 ranks higher than the renowned University of Cambridge; while MIMOS has emerged as the sixth among the top 30 applicants from government and research institutes[60], higher than some of the institutes from France, Australia, United States, Germany, Japan, and Korea.

All these events indicate that the current policy on the development of intellectual property by the IHLs and RIs using government funds is beginning to show success. From 2010 onwards, patent applications from IHLs amounted to 40% of local patents, while from the RIs, it 15-20%. It is important that Malaysia maintains this success by continuing to produce high quality patents that can attract international licensing. In the long run, the current deficit between the payment and receipts of royalties can be reduced. The transformation of China from a technology copier to the number one patent applicant in the world is through the rapid acceleration of local patents. The lesson from China is that in order to reach the global market one has to focus first on local patents.

[59] WIPO, (2013) PCT Yearly Review: The International Patent System available at www.wipo.int (viewed 24th November 2013) at p.35

[60] WIPO, (2013) PCT Yearly Review: The International Patent System available at www.wipo.int (viewed 24th November 2013) at p. 36

CHAPTER 9:
INFORMATION AND COMMUNICATIONS TECHNOLOGY (ICT)

CHAPTER 9

INFORMATION AND COMMUNICATIONS TECHNOLOGY IN MALAYSIA

9.0 INTRODUCTION

Global economies are now shifting to a higher level of competition driven by innovation-led growth strategies empowered by Information and Communications Technology (ICT). For Malaysia, ICT has been identified as the main driver of economic growth since the majority of the national transformation projects under the Economic Transformation Programme being identified to propel the economy towards a high-income status by 2020 are ICT-driven or ICT-intensive[61]. Fuelled by the numerous government strategic programmes that are critically dependent on ICT as the enabler, the output of the ICT sector is expected to increase threefold; from RM22 billion in 2009 to RM57.7 billion in 2020, expanding the sector's contribution to 17% of Gross National Income in 2020.

This chapter focuses on the advancements in the ICT sector in Malaysia. It provides an update on the ICT infrastructure and access, followed by recent developments in the ICT industry in the country over the last five years. Amid continuous government commitment to ensure the rapid growth of the sector, funding and support for the ICT sector are highlighted. The chapter also provides an update on the recent developments and issues in the ICT job market in Malaysia. Last but not least, international comparisons are presented to indicate how Malaysia fares when compared with other countries with regard to ICT advancements.

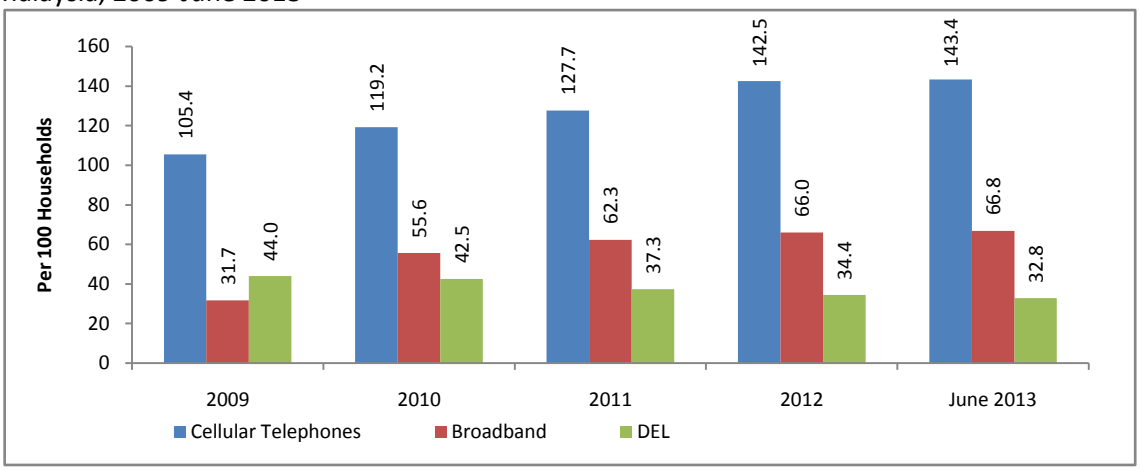
9.1 ICT ACCESS AND INFRASTRUCTURE

The main indicators for ICT access, namely the penetration rates[62] for cellular telephones and broadband, have further increased over the years; reflecting continuous improvement in ICT technology adoption among the Malaysian population. The penetration rate for cellular telephones reached 143.4 at end-June 2013 compared to 105.4 at end-2009 **(Figure 9.1)**. The cellular telephone penetration rate, which has been above the 100 level since 2009, indicates that it is becoming increasingly common for a person to have multiple cellular connections in the country. In line with this, the number of cellular telephone subscriptions increased by 41.5% to 42.6 million in June 2013, from 30.1 million at end-2009.

[61] Hai, W. T. and Keong, C. Y. (2013) "Malaysia Economic and Information Communications Technology Outlook" in *ICT Strategic Review 2012/2013*, published by MOSTI/PIKOM.

[62] Penetration rate = (Total number of subscriptions/ total population)*100
(Source: Malaysian Communications and Multimedia Commission, 2013)

Figure 9.1: Penetration Rates for Cellular Telephones, Broadband and Direct Exchange Line in Malaysia, 2009-June 2013



Source: Malaysian Communications and Multimedia Commission

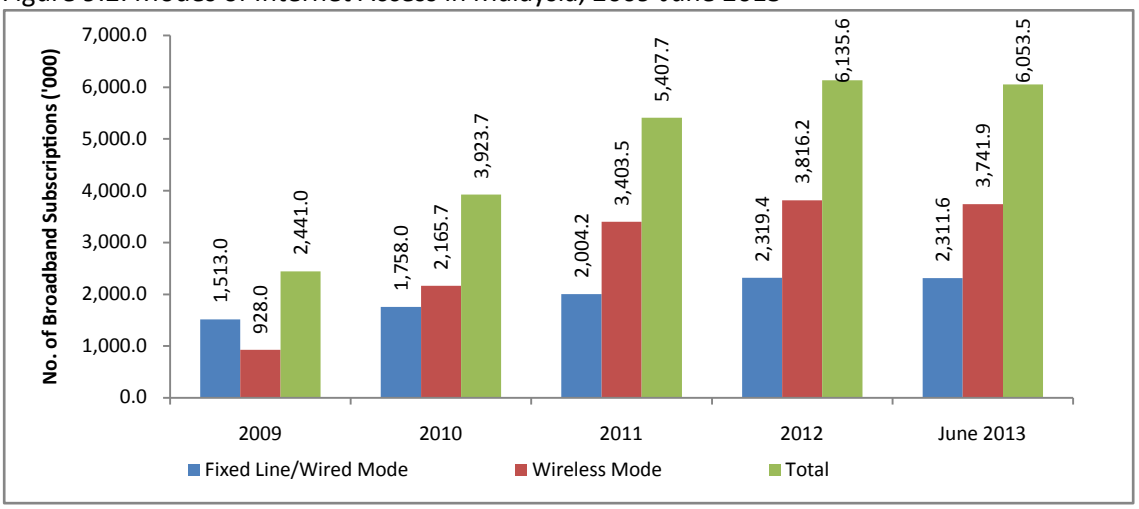
Another indicator for ICT access, namely the households' broadband penetration rate, has also shown an encouraging trend. The rate grew to 66.8 per 100 households at end-June 2013 compared to only 31.7 per 100 households at end-2009, reflecting the rapid adoption of internet technology across the country. A similar trend is shown by the population broadband penetration rate (measured by the sum of household and non-household subscriptions divided by the number of inhabitants and multiplied by 100), which shows a steady increase to 22.3 at end-June 2013 from 16 at end-2009.

The penetration rate for the direct exchange line (DEL), which has been conventionally adopted as a common indicator for ICT access, however, has continued to decline in view of the increased preference for mobile telecommunications technology in the country. In June 2013, the rate further dropped to 32.8 per 100 households; from 44 per 100 households in 2009 and 66.4 in 2000.

9.1.1 Mode of Internet Access in Malaysia

The significant improvements in ICT access can largely be attributed to the government's continuous efforts to improve the country's ICT infrastructure. This is well-reflected by the improved indicators for modes of internet access in Malaysia **(Figure 9.2)**. For the fixed line/wired mode of access (which include ADSL, SDSL, VDSL, fiber, satellite and fixed wireless), subscriptions rose to 2,311 million at end-June 2013—from 1,513 million at end-2009. Of the total fixed line subscriptions in June 2013, 1,909 million (or 82.6%) were household subscriptions and 0.402 million (or 17.4%) were non-household subscriptions. Meanwhile, the wireless mode of access (which include Mobile Broadband, Pay Per Use, WiMax and EVDO) rose substantially in terms of number of subscribers to 3,742 million in June 2013—from 0.928 million at end-2009. In terms of growth, wireless subscriptions recorded an impressive growth rate of 303.2% in the 2009-June 2013 period compared to a 52.7% growth for the fixed line mode during the same period.

Figure 9.2: Modes of Internet Access in Malaysia, 2009-June 2013

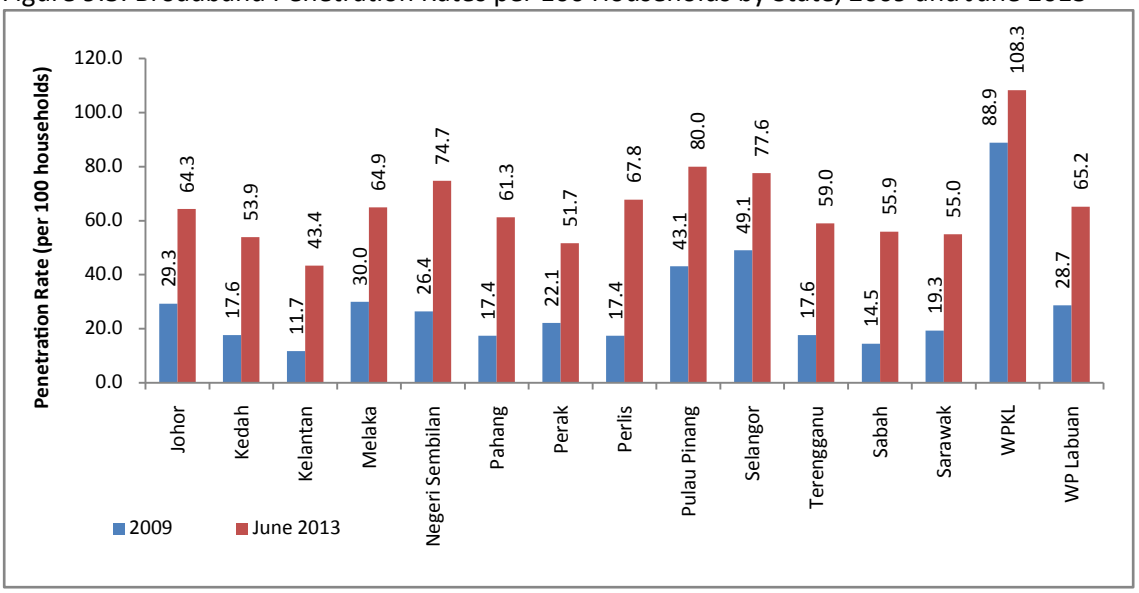


Source: Malaysian Communications and Multimedia Commission

The improved access can also be attributed to the growing number of providers in the ICT sector as reflected by the increasing number of licences issued. As at end-June 2013, a total of 1,232 licences were issued by the government, of which 150 were for the Network Facilities Provider (2011: 126), 146 for the Network Service Provider (2011: 134), 870 for the Applications Service Provider (2011: 745) and 66 for the Content Applications Service Provider (2011: 63). Further advancement in the wireless telecommunications infrastructure in the country is reflected by the adoption of the Long Term Evolution (LTE) and 4G wireless data communications technology launched in December 2012. With the continuous upgrading of network sites by major network providers, more users are able to enjoy better quality and faster voice and internet connections across the country.

Reflecting significant improvements in ICT access and infrastructure, Malaysia's household broadband penetration rate increased to 66.8 per 100 households in June 2013, a substantial increase compared to 31.7 per 100 households in 2009. During the same period, total number of broadband subscriptions grew by an impressive 138.2%; from 2,620 million in 2009 to 6,241 million in June 2013. A detailed breakdown of the penetration rates by states revealed an interesting observation. Compared to 2009, the broadband penetration rates by state in June 2013 clearly showed a significant reduction in the digital divide between the urban and rural areas in the country **(Figure 9.3)**. As at end-June 2013, all states in Malaysia (except for Kelantan) recorded a broadband penetration rate of greater than 50, with the highest broadband penetration rate recorded in Kuala Lumpur at 108.3 per 100 households, followed by Penang at 80.0, Selangor at 77.6, Negeri Sembilan at 74.7 and Perlis at 67.8. Despite having the lowest broadband penetration rate at 43.4, the state of Kelantan actually showed a significant improvement compared to the 11.7 per 100 households recorded in 2009.

Figure 9.3: Broadband Penetration Rates per 100 Households by State, 2009 and June 2013

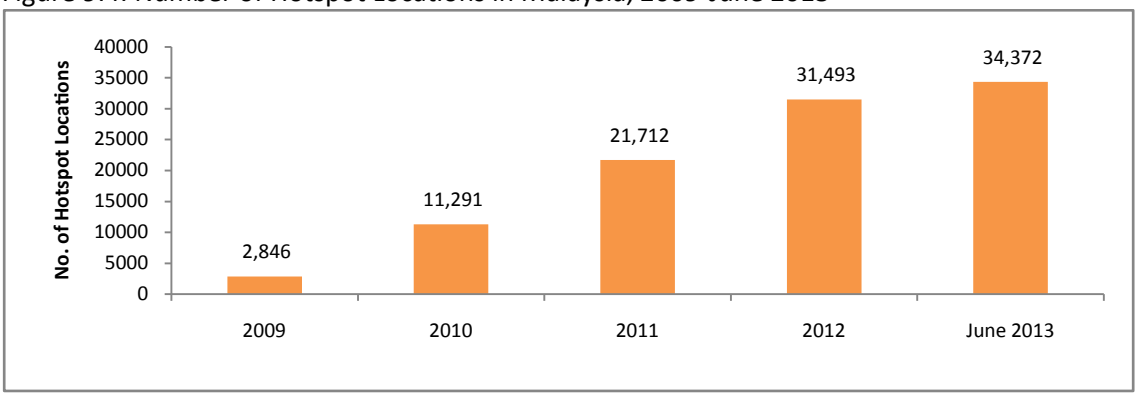


Source: Malaysian Communications and Multimedia Commission

It is important to note that while the high broadband subscriptions in the high-income states such as Kuala Lumpur, Penang and Selangor are attributed to private household subscriptions, the improvements in the other states are mainly due to the community access projects embarked on by the government under the National Broadband Initiatives (NBI) launched in 2008. Four community access projects initiated to meet the objective of reducing the urban-rural digital divide under the NBI are the 1Malaysia Community Broadband Centres (CBC), Mini Community Broadband Centres (Mini CBC), 1Malaysia Community Broadband Libraries (CBL) and Kampung Tanpa Wayar 1Malaysia (KTW). In June 2013, there were 339 CBC centers with 290,454 members, 121 Mini CBCs, 99 CBLs and 4,210 KTWs which are located in community centers throughout the country. Based on surveys conducted by the Malaysian Communications and Multimedia Commission, the urban-rural household ratio of internet usage has improved from 85:15 in 2008 to 82:18 in 2011, reflecting a reduction in the urban-rural digital divide in the country.

In line with the increased adoption of mobile telecommunications and internet technology, hotspots and WiFis have become an indispensable mode of technology access to Malaysians. This is well-reflected by the mushrooming of hotspot locations throughout the country, from merely 1,227 in 2005 and 2,846 in 2009 to 34,372 in June 2013 **(Figure 9.4)**. Most of the hotspot locations in June 2013 are available in major cities in Malaysia, namely Kuala Lumpur (6,223), followed by Penang (6,195), Selangor (5,096) and Johore (3,496). The substantial increase in the availability of hotspots and WiFis in the recent period can be attributed to the national WiFi broadband projects launched together with the NBI in 2008.

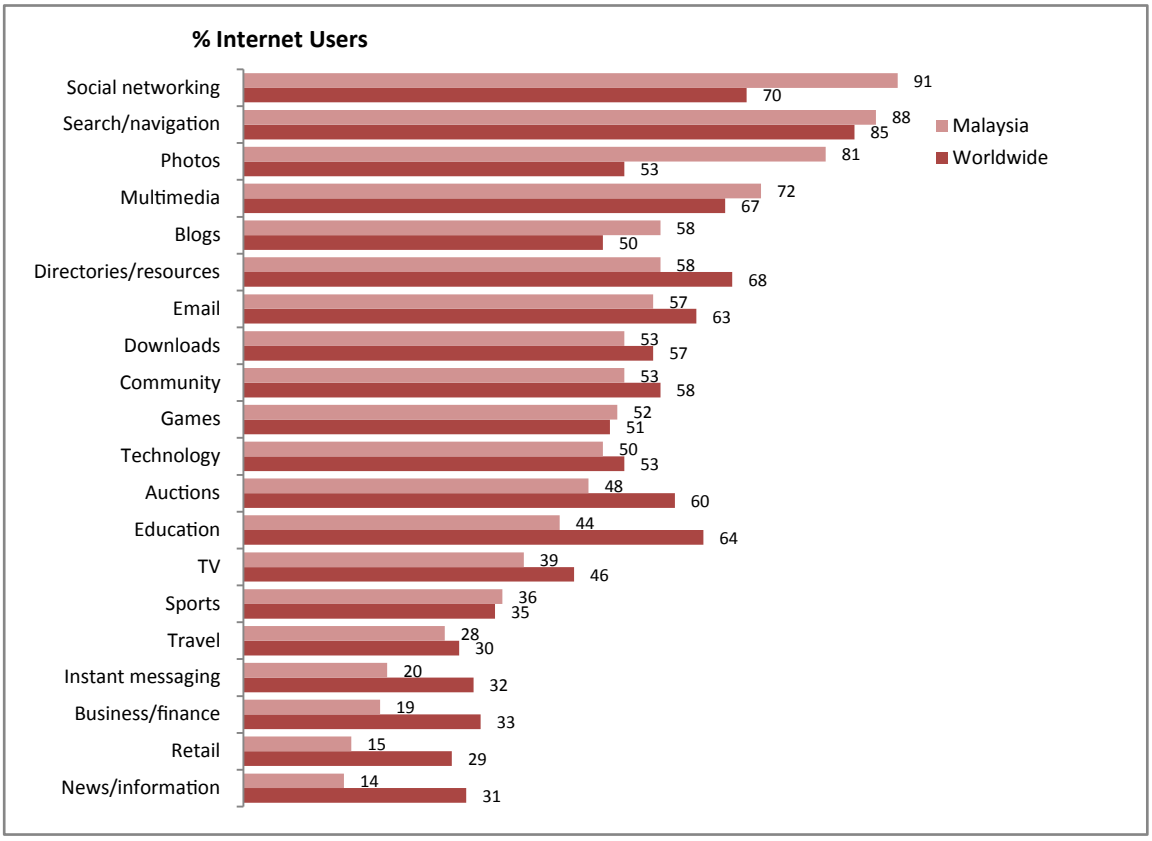
Figure 9.4: Number of Hotspot Locations in Malaysia, 2009-June 2013



Source: Malaysian Communications and Multimedia Commission

In terms of the usage of the internet, a survey conducted by McKinsey and Co. in 2011 on internet usage among Malaysians suggests that Malaysians can be considered internet-savvy. In several types of internet-based activities, Malaysians rank high compared to that of the world's average **(Figure 9.5)**. For example, 91% of the internet users in Malaysia used the internet for social networking compared to the global average of 70%, while other internet-based activities in which Malaysians outpaced that of the global averages are search/navigations, photos, multimedia, blogs, games and instant messaging. With the current measures undertaken to increase access to the internet as well as the efforts made to increase internet awareness among school children, the usage of various types of internet-based activities among the Malaysian populace is expected to increase.

Figure 9.5: Internet Usage Distribution in Malaysia, 2011

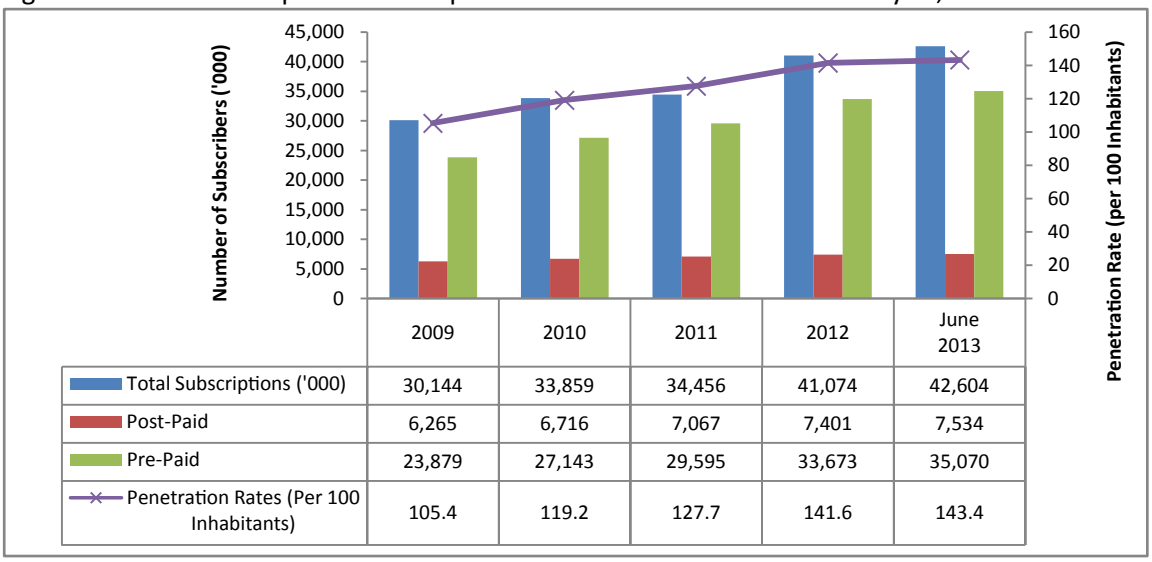


Source: McKinsey and Co. (2011)

9.1.2 Cellular Telephones in Malaysia

Known as the "most prolific consumer device on the planet[63]", the wave of cellular telephones has swept Malaysia, with the household penetration rate currently at 143.4 per 100 inhabitants as at end-June 2013, surpassing the 100 mark since 2009. Total subscriptions of cellular telephones reached 42,604 million in June 2013, recording a significant 41.3% increase compared to 30,144 million in 2009 **(Figure 9.6)**. Of the total cellular telephone subscriptions in June 2013, 82.3% are pre-paid subscriptions, while the remaining 17.7% are post-paid subscriptions. In addition, the number of 3G/4G subscribers has more than doubled in June 2013, at 16,415 million (8.67 million in 2010); and is estimated to reach 16.9 million[64] by end-2013.

Figure 9.6: Cellular Telephone Subscriptions and Penetration Rates in Malaysia, 2009-June 2013



	2009	2010	2011	2012	June 2013
Total Subscriptions ('000)	30,144	33,859	34,456	41,074	42,604
Post-Paid	6,265	6,716	7,067	7,401	7,534
Pre-Paid	23,879	27,143	29,595	33,673	35,070
Penetration Rates (Per 100 Inhabitants)	105.4	119.2	127.7	141.6	143.4

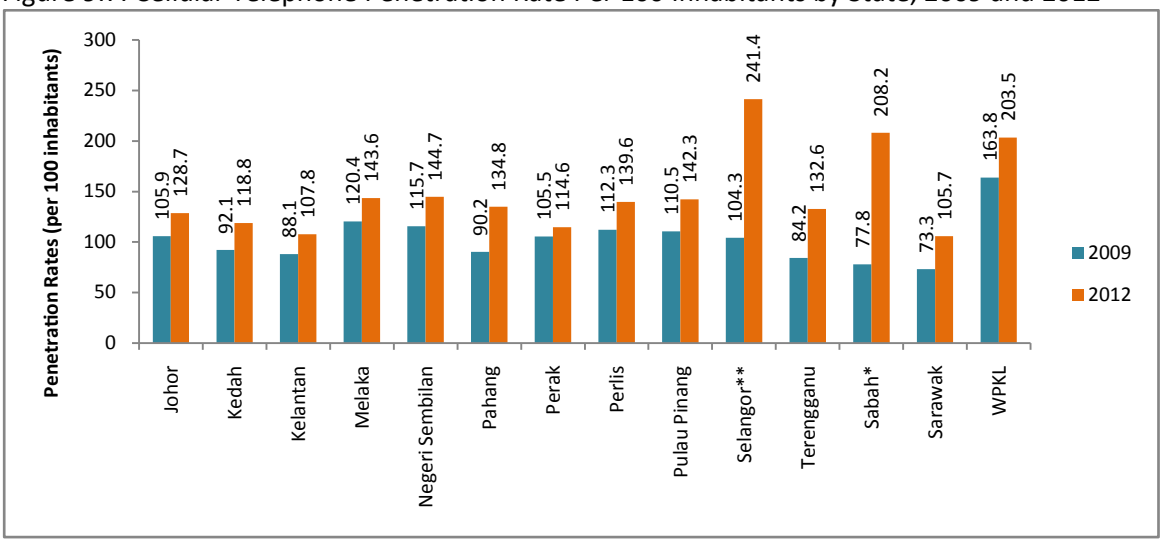
Source: Malaysian Communications and Multimedia Commission

A breakdown of cellular telephone penetration rates by states in Malaysia indicates increased access to mobile telecommunications technology among the people throughout the country. All the major states in Malaysia, except for Sabah, recorded more than 100 cellular phone penetration rates in 2012. While Kuala Lumpur recorded a penetration rate of 203.5, other states have recorded improvements in the penetration rates of greater than 100 in June 2013 compared to 2009 where six states, namely Sarawak, Sabah, Kelantan, Kedah and Terengganu had cellular telephones penetration rates of less than 100. In line with this improvement, the urban-rural cellular telephone usage ratio improved from 74:26 in 2007 to 69:31 in 2012.

[63] Source: Wood, B. (2010) *CCS Insight*, July.

[64] Based on the estimate by Business Monitor International. *Malaysia Telecommunications Report* Q2 2013.

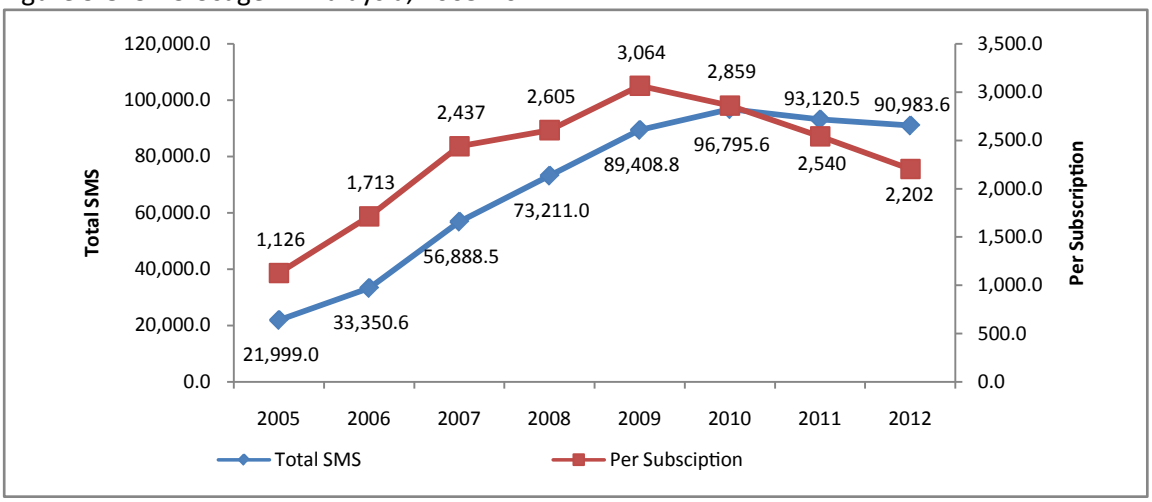
Figure 9.7: Cellular Telephone Penetration Rate Per 100 Inhabitants by State, 2009 and 2012



* Including WP Labuan; ** Including WP Putrajaya

The short message services (SMS), which used to be one of the favorite communication channels among the Malaysian cellular telephone users, has started to show some decline due to the increasing use of various free texting services through mobile applications such as *WhatsApp* and *Viber*. While SMS recorded phenomenal increases in the years 2005 to 2009, its usage has started to slow down as reflected by the number of SMS sent in 2012 (90,983.6 million) and 2009 (89,409 million). Due to the increasing number of cellular telephone subscriptions but a lesser number of SMS sent, the number of SMS per subscription declined to 2,202 per subscription in 2012 compared to 3,064 per subscription in 2009 **(Figure 9.8)**.

Figure 9.8: SMS Usage in Malaysia, 2005-2012



Source: Malaysian Communications and Multimedia Commission

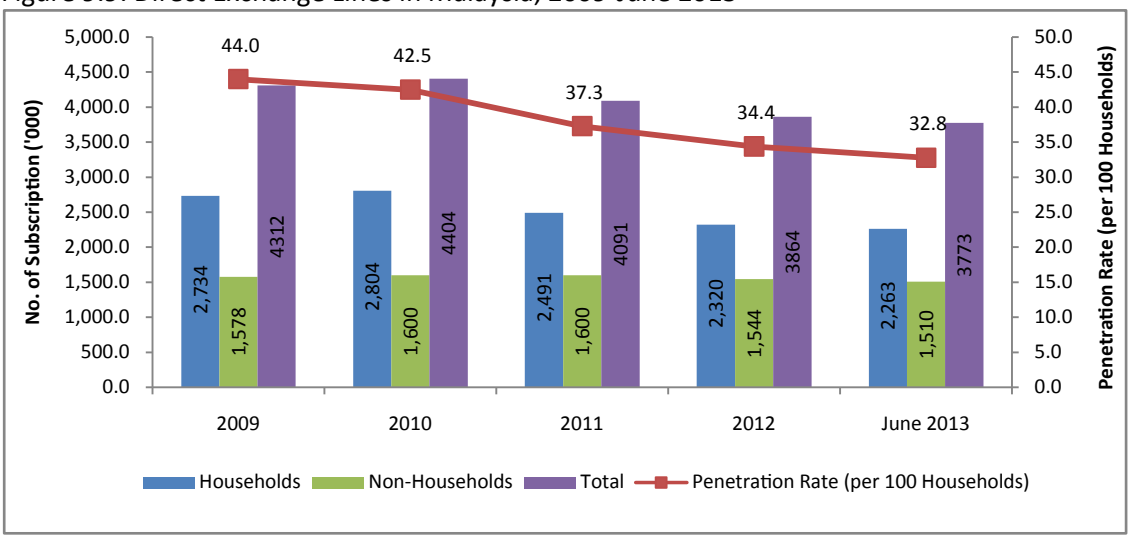
An important advancement in telecommunications technology involves the use of smart-phones among Malaysians. According to the *Hand-phone Users Survey 2012* conducted by the Malaysian Communications and Multimedia Commission on 2,401 hand-phone users across Malaysia, about 69% of the respondents surveyed have access to internet via smart-phones; using either 3G or WiFi. The survey found that the majority (around 80%) of the respondents have downloaded various mobile applications during the specified period. The availability of the mobile applications had enabled the cellular telephone users to do several tasks via their telephones; namely reading e-books (about 28.6%), using spreadsheets and Word processing

applications (35.6%), using free call services applications (42.3%) and using free texting services (56.3%).

9.1.3 Direct Exchange Lines in Malaysia

Reflecting increased adoption of mobile telecommunications and the internet as the preferred channel for communication in the country, the penetration rate for the direct exchange line (DEL) has continued to decline. The household penetration rate for the DEL further declined to 32.8 in June 2013 (2009: 44.0) as the number of subscriptions declined to 2,263 million in June 2013 (2009: 2.734 million subscriptions). Similarly, the number of subscriptions by the non-households also declined gradually to 1,510 million in June 2013; from 1,578 million in 2009. As a result, the total number of subscriptions of DEL in Malaysia further dropped to 3,773 million in June 2013, from 4,312 million in 2009 **(Figure 9.9)**.

Figure 9.9: Direct Exchange Lines in Malaysia, 2009-June 2013



Source: Malaysian Communications and Multimedia Commission

9.2 ICT FUNDING AND SUPPORT

Public support has been critical in ensuring the sustained development of the ICT sector in Malaysia. Various sources of funding have been provided by the government, realizing the critical role to be played by the sector in driving the economy, particularly in the foreseeable future. Reflecting the continuous support by the government to boost the sector, several types of public funding are readily available from both the ministries and specific government entities to cater for the development of the sector. **Table 9.1** provides selected sources of public funding for ICT-related activities that have been provided by the government. In particular, various funding opportunities are available from the Ministry of Science, Technology and Innovation (MOSTI) and the Ministry of Finance (MOF), while the specific government entities that are providing funding support include the Multimedia Development Corporation (MDec), the Malaysian Technology Development Corporation (MTDC) and the National Information Technology Council (NITC). While some funds continued to be available, others are being replaced with more specific fund type in line with the changing funding need of the industry. For example, the MSC Grant Scheme which was introduced in 1997 has been phased out and replaced by the Product Commercialisation Fund launched in 2013.

Table 9.1: Malaysia: Sources of Public Funding for ICT-Related Activities

Funding Agency	Fund Name	Funding Essence
Multimedia Development Corporation (MDeC)	MSC R&D Grant Scheme	This grant scheme was introduced in 1997 to stimulate R&D and innovation capabilities among local companies and Malaysian workers as well as producing products that have commercial and IP rights potential. This grant is subject to a maximum sum of RM1.2 million.
	MSC Pre-seed Fund	This fund focuses on idea generation and facilitation of local start-ups, technopreneurs or K-SME's with ICT products for growth into MSC Malaysia status companies. The Pre-Seed Fund is limited to RM150,000, and is valid for 12 months.
	MAC3 Co-Pro Fund	This fund was introduced in 2009 to assist local companies in producing animation and game development, and enhancing the local creative content industry.
	MSC Malaysia Innovation Handbook	This fund is intended to increase the number of collaborations between MSC Malaysia companies and service providers to produce more innovative proof-of-concepts, products, services and solutions, thus supporting the development of triple helix model fundamentals.
	MSC Intellectual Property (IP) Grant Scheme	This scheme was started in 2007 to develop Intellectual Property Rights (IPR) in view of protecting and capitalising intellectual assets of MSC Malaysia-status companies.
Ministry of Science, Technology and Innovation (MOSTI)	Science Fund	The fund provides financial support for basic research aimed at developing novel products, processes or services that can enhance knowledge skills and expertise among researchers in Institutes of Higher Learning (IHL) and Research Institutions (RI).
	Techno Fund	This fund is intended to foster innovation and collaboration between technology-based enterprises, RIs and IHLs and to improve the state of R&D and commercialisation through intellectual property (IP) registration, leading to spin-offs or licensing.
	Inno Fund	The fund is targeted at small businesses and individuals aimed at developing technology innovation that can give rise to new products, services and processes including IP rights and patent registration.
	eContent Fund	This fund is aimed at spurring the growth of high quality creative content for both local and global markets.
	Industry R&D Grant Scheme	This scheme was started to stimulate research & development as well as innovation activities among Malaysian companies towards creating globally-competitive new technologies, products and processes. A total of 27 ICT-related projects have been funded at a cost of RM28 million.
Malaysian Technology Development Corporation (MTDC)	Commercialisation of R&D Fund	CRDF was introduced by MTDC in 1996 with the aim of generating greater commercialisation through R&D. A total of 155 projects were funded between 2006 and 2010.
	Business Growth Fund	This grant was introduced in 2010 to provide business funding to accelerate the growth of local technology-based companies towards building value for the company so as to attract venture capitalists and financial institutions.
	Business Start Up Fund	This fund was started in 1996 towards encouraging entrepreneurship and to start up a company.
	Technology Acquisition Fund	The main purpose of TAF is to promote technology upgrading including acquisition of foreign technology in view of enhancing company-level competitiveness.

Ministry of Finance (MOF)	Cradle Fund	Initiated for the purpose of idea generation, it is geared to create an innovative business-building environment for technology entrepreneurs and technology start-ups.
	Malaysian Venture Capital	MAVCAP provides an alternative source of high-risk financing for start-ups, seed capital and early stage ventures in the ICT sector and high-growth industries. Since 2001, RM82.6 million have been disbursed to 258 entrepreneurs.
	Soft Loan Scheme for SME	This scheme was established in 2001 to promote the development of SMEs and comes with a ceiling loan limited to RM3 million.
National Information Technology Council (NITC)	Demonstrator Application Grant Scheme	DAGS was started in 2006 to acculturate Malaysians to ICT applications at work and home as well as nurturing web shapers or web developers and networked entrepreneurial communities. Public, private and third sector participation was the essence of this scheme.
	Creative Industry Fund	Creative Industry Fund, established in 2009, provides funding in the form of loans needed for the publication, purchase of assets or other related activities for the commercialisation of local creative industries. The funding amount is limited to RM5 million.
	MSC Malaysia ICON 2	MSC Malaysia ICON 2 started in 2009, and aims to develop compelling local content that can spur demand for broadband.

Source: Adopted from Shaifulbahrim Saleh. "Prelude: Disruptive Innovation the Way Forward for High Value Adding Economy" in MOSTI/PIKOM *ICT Strategic Review 2012/2013*, pp. 8.

The ICT sector has been identified as playing a critical role in ensuring the success of the Economic Transformation Programme (ETP), which aims to raise the country to a developed nation status by the year 2020. The ETP, which was launched in 2010, has identified 12 National Key Economic Areas (NKEAs), which include communications content and infrastructure, education, healthcare, business services and financial services; in which ICT has been recognised as being the enabler to the specific Entry Point Projects under the NKEAs. Specifically, 113 of the 176 national transformation projects are ICT-driven or dependent on ICT as the enabler. Specific projects currently being pursued under the Economic Transformation Programme in which ICT has a role as the prime mover are: My Rapid Transit (MRT) linking Kajang to Sungai Buluh (the country's largest ever infrastructure project undertaken with a total estimated cost of RM36 billion spanning a six-year period from 2011 to 2017); Tun Razak Exchange (formerly known as the Kuala Lumpur Business and Financial District, expected to be completed by 2016); and the economic corridors development programmes, such as Iskandar Malaysia, Northern Corridor Economic Region and East Coast Economic Region. On the backdrop of these developments favouring the ICT sector, the output of the sector is set to further increase to RM61.7 billion in 2013, maintaining the double-digit growth of 12% compared to 2012.

Additionally, the Digital Malaysia Initiative (DMI), launched in October 2011, is expected to generate RM31.2 billion's worth of investment in the ICT sector by 2020 through the private-public sector venture. The DMI is aimed at transforming Malaysia into a developed digital innovation economy by 2020. So far, eight ICT projects have been approved in 2012 and are currently implemented, namely (i) Asian e-Fulfillment Hub (RM620 million's worth of investment); (ii) e-payment services for small and mid-size business and micro-enterprises (RM600 million); (iii) shared cloud enterprises (RM300 million); (iv) micro-sourcing for income generation (RM413 million); (v) on-demand customized online education (RM39.8 million); (vi) facilitating societal up-liftment (RM72 million); (vii) embedded system industry (RM10.2 billion) and (viii) mobile digital wallet (RM74 million). While the DMI is intended to achieve specific national objectives, it is also loaded with business opportunities for the private sector as well as providing job opportunities in the industry. With the support from the DMI, the ICT industry has

the potential to increase its contribution to RM294 billion, or 17% of the country's GNI in 2020 from the current 12.5% in 2012, bringing along with it 160,000 ICT-related job opportunities.

The future of the ICT sector in Malaysia is carefully and extensively planned in the *National ICT Roadmap 2012*, realizing the sector's critical role, particularly in supporting the country's economic aspiration to achieve the developed nation status by 2020. In line with the emerging trends in the ICT industry, five proposed technology areas highlighted in the *ICT Roadmap 2012* are e-services, ubiquitous connectivity, security and platforms, wireless intelligence, and big data and cloud computing **(Table 9.2)**. Continuous efforts and resources are needed to strengthen the ICT infrastructure in these focus areas, which would then pave the way for more rapid and effective growth of the ICT sector in the country.

Table 9.2: Malaysia: Technology Focus Areas for ICT Roadmap 2012

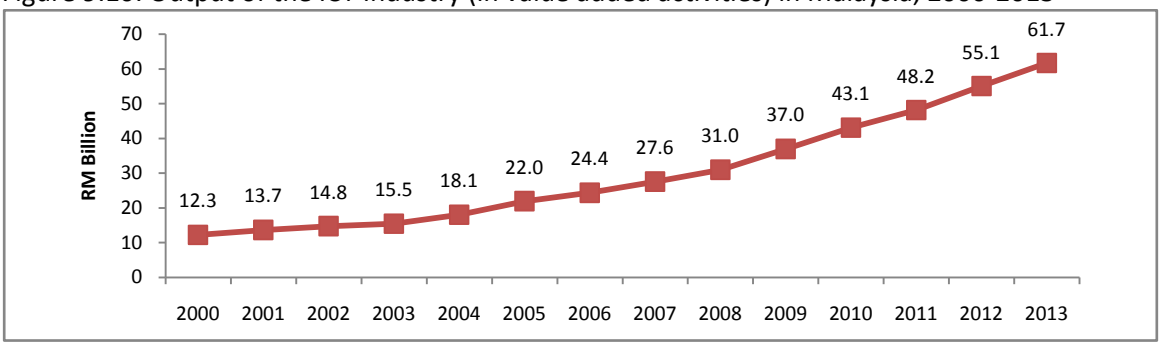
Technology Focus Areas	Point Technologies
e-Services	Digital Commerce, e-governance, Online Finance, Virtual Education, Telemedicine, Digital Pathology
Wireless Intelligence	Wireless Data Encryption Technology, Wireless Sensors, M2M, Device Interconnection, Gestural interface, 3-D Displays, RFID, Image Recognition
Ubiquitous Connectivity	NFC, Social Media, Payment Processing Software, Location-based Services, Wireless Broadband, WiMax, LTE , GPS and GIS
Big Data/Analytics	Inline Analytics, MPP - massively parallel processing databases, Advanced Analytics Apps based on Ontology, Data Management Systems
Security and Platforms	Antivirus Software, Intrusion Detection System, intrusion Prevention System, Identity Management Software and Hardware, Biometrics, Video Surveillance, Next Generation Firewalls, Data Encryption
Cloud Computing	Datacentres, Homomorphic Encryption, Virtualisation

Source: National ICT Roadmap (2008), MOSTI and Frost & Sullivan as quoted in Amirudin Abdul Wahab. "Essence of ICT Roadmap 2012 for Innovative Driven Growth" in MOSTI/PIKOM *ICT Strategic Review 2012/2013*, pp. 34.

9.3 ICT INDUSTRY

Malaysia's ICT industry continues to be boosted by the scores of technology and capital intensive projects under the current 10th Malaysia Plan. The rapid growth of the industry is well reflected by the double-digit growth in the output of the sector. In terms of value-added services, the output of the ICT industry continued to expand to RM55.1 billion in 2012 (2009: RM37 billion), riding on the favorable economic environment and supportive policy backdrop **(Figure 9.10)**. Indeed, the output of the ICT industry has maintained its steady uptrend since the early 2000s, recording a double-digit compounded annual growth of 13.3% throughout the 2001-2012 period. According to the IDC, Malaysia's ICT spending is expected to surpass the US$10 billion (RM30 billion) mark for the first time in 2013 on the back of sustained demand for IT services and software, which offset the decline in hardware purchases. The higher spending on IT services and software partly reflects Malaysia's mature hardware install base and gradual advancement of the Malaysian ICT industry towards less hardware based technologies such as cloud computing and e-Services.

Figure 9.10: Output of the ICT Industry (in value added activities) in Malaysia, 2000-2013



Source: Department of Statistics and PIKOM estimates as cited in *ICT Job Market Outlook in Malaysia (June 2013)*

The MSC Malaysia initiative continues to be the catalyst of growth of the ICT industry. Currently, there are approximately 3,202 MSC Malaysia status companies, with an accumulated number of jobs created of 124,447 **(Table 9.3)**. Of the total number of MSC Malaysia status companies, 810 are foreign-owned companies, providing about 57,713 ICT-related jobs. The total sales of these companies reached RM49.612 billion in 2012, growing at an annual compounded growth rate of 12.4% since 2009. Of the total sales in 2012, RM28.833 billion (58.1%) are for local market, while RM20.779 billion (41.9%) are for export market.

Table 9.3: Total MSC Malaysia Status Companies and Jobs Created (Cumulative)

Year	MSC Malaysia Status Companies		Foreign-Owned Companies		Locally-Owned Companies	
	Number	Job Created	Number	Job Created	Number	Job Created
2009	2,520	99,590	566	33,547	1,954	66,043
2010	2,738	111,367	608	42,113	2,130	69,254
2011	2,954	119,138	650	46,662	2,304	72,476
2012	3,167	128,850	714	66,021	2,453	62,829
March 2013	3,202	124,447	810	57,713	2,329	66,734

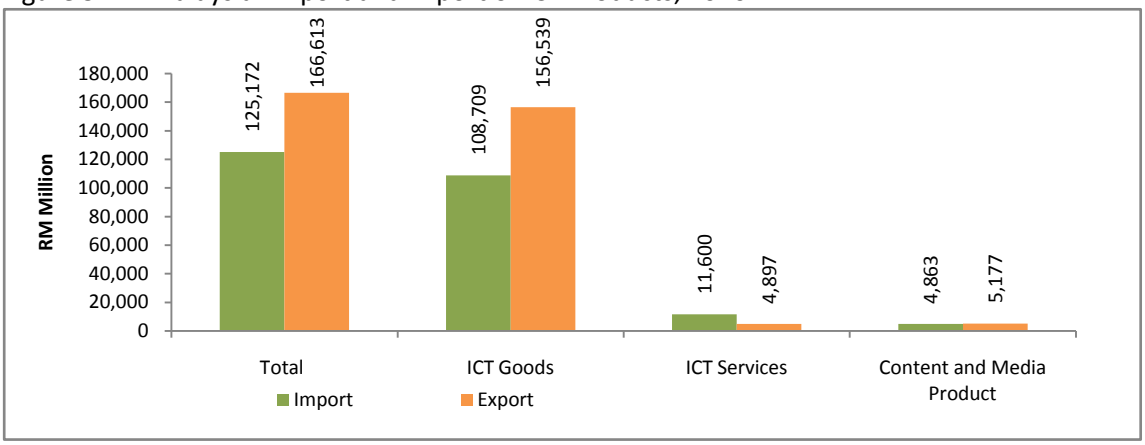
Source: MSC Malaysia *Annual Industry Report Q1 2013*

IT spending is expected to maintain its double-digit growth of 12% by end-2012. The Malaysian IT market is expected to record an annual increase of 8.3%, totaling RM17.1 billion in 2013 as higher demand for computer tablets by consumers offset the slower sales of desktops and notebooks[65]. However, the enterprise market growth is expected to be slower as the corporate customers are more hesitant as a result of ongoing global economic uncertainty. Of the total IT spending projected in 2013, computer hardware sales remained the major type of expenditure, contributing RM8.79 billion (recording an annual increase of 6.3%, contributing 51.4% of total IT spending), IT services sales contributing RM5.46 billion (9% increase, contributing 31.9% of total IT spending), and software sales contributing RM2.88 billion (9% increase, contributing 16.8% of total IT spending). The government's push for greater broadband penetration, procurement of netbooks for education and strong consumption growth over the medium term are the main factors contributing to the overall sustained growth in IT spending in the country.

[65] Business Monitor International. *Malaysia Information Technology Report*, Q1 2013.

On the external front, exports of ICT products reached RM166.6 billion (22.4%) of the country's total exports in 2010 **(Figure 9.11)**. The ICT exports are mainly in the form of ICT goods, representing a significant proportion of 94% of the total ICT exports (RM156.5 billion), while the contribution of ICT services, and content and media products are relatively small, at 2.9% (RM4.9 billion) and 3.1% (RM5.1 billion), respectively. Similarly, imports of ICT products reached RM125 billion (20.6%) of the country's total imports in 2010, which are largely contributed by ICT goods, representing 86% of the total ICT imports (RM108.7 billion). The imports of ICT services, and content and media products are minimal; at 9.3% (RM11.6 billion) and 4% (RM4.9 billion), respectively.

Figure 9.11: Malaysia: Import and Export of ICT Products, 2010



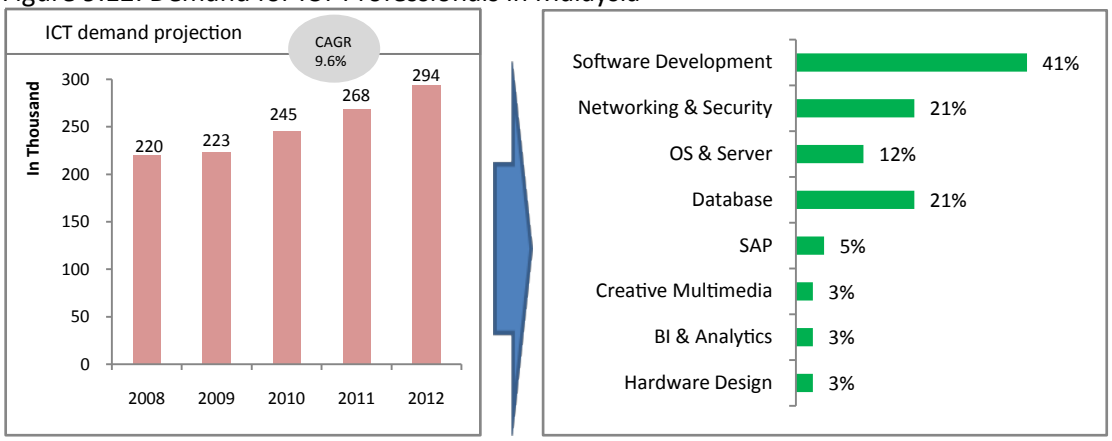
Source: Department of Statistics, Malaysia (2005&2010), *Information and Communication Technology Satellite Account*

In 2012, the 213 companies granted the MSC status had approved investment amounting to RM2.9 billion. Moving forward, the development of the Malaysian ICT industry is expected to be shaped by the emerging global ICT trends. In particular, the increasing adoption and growing importance of smart devices and tablets, social media for businesses and enterprises, cloud computing, and big data would require the industry players in Malaysia to be ready for these new industry trends in order to remain competitive and relevant.

9.4 WORKFORCE IN ICT

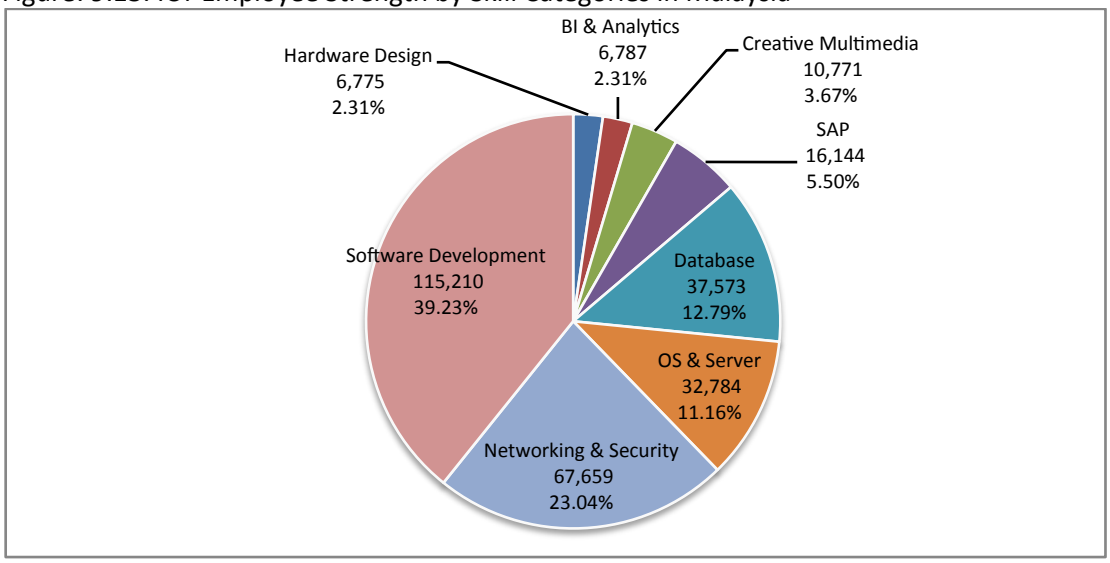
The ICT labor requirements continue to increase in line with the expanding ICT industry. The industry demand for ICT professionals is expected to have reached 293,703 in 2012, growing at approximately 10% on average since 2008 **(Figure 9.12)**. Currently, ICT employment in Malaysia is mainly in software development; contributing 39.2% to total employment, followed by networking and security (23.0%), database (12.8%), and OS and server (11.2%) **(Figure 9.13)**. While there is ample supply of talents in the area of software and programming, there are shortages in the more advanced areas of ICT such as hardware design and sensors, analytics, and 3-D internet tools. This is well-reflected by rapid growth in employment in four skill categories, namely multimedia tools, networking and security, SAP, and database; which are growing at double digit growth of around 11-14% during the period 2008-2012, indicating high demand for talents in these categories.

Figure 9.12: Demand for ICT Professionals in Malaysia



Source: MDeC, Frost and Sullivan Study 2009 as cited in the Department of Higher Education, Ministry of Higher Education Malaysia. *ICT Human Capital Development Framework*

Figure: 9.13: ICT Employee Strength by Skill Categories in Malaysia

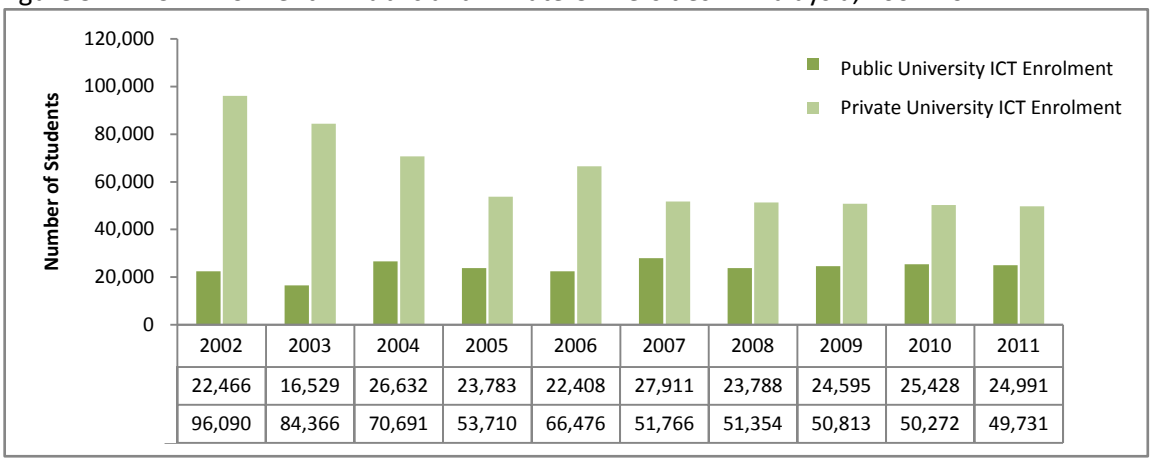


Source: *Malaysia ICT Human Capital Study*, MDeC and Frost & Sullivan

Despite the increasing demand for talent due to the expanding ICT industry in Malaysia, the industry is currently facing several challenges in ensuring that there is an ample supply of ICT talents that would meet the requirements of the industry. First, there is a mismatch between the supply of new ICT talents provided by the universities and that demanded by the industry. In particular, the new entrants in the ICT sector are declining as reflected by the number of ICT enrolments in public and private universities **(Figure 9.14)**. The number of ICT enrolments in public universities increased only by 11.2%, to 24,991 in 2011; from 22,466 in 2002, while enrolments in private universities have actually been halved to 49,731 in 2011 from 96,090 in 2002. Part of the reason for the lower enrolment in ICT is due to the relatively low remuneration in the sector compared to other sectors such as banking. While the supply of new entrants is declining, retaining the current talent is another issue. The relatively low remuneration when compared with other countries is also a major issue in the industry; which has resulted in many Malaysian ICT experts being employed by ICT companies in other countries such as Australia, China and Singapore. Additionally, there is also the issue of mismatch between employers'

expectations and employee's skill. Based on a survey conducted in 2008[66], employer satisfaction gaps were recorded in several skill categories, namely in the SAP skill category, followed by hardware design, BI & analytics, and creative multimedia **(Figure 9.15)**.

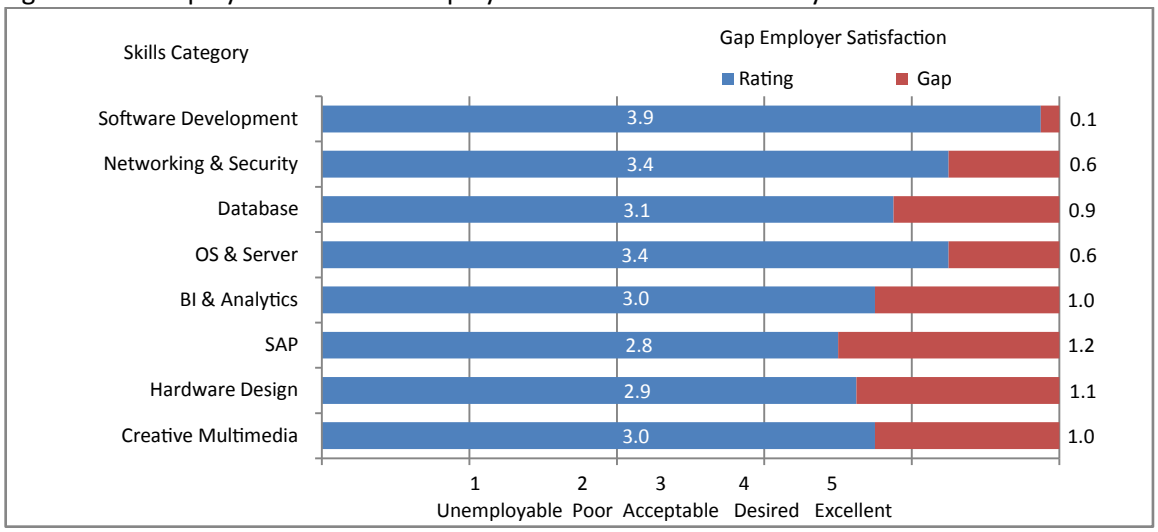
Figure 9.14: ICT Enrolment in Public and Private Universities in Malaysia, 2002-2011



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Public University ICT Enrolment	22,466	16,529	26,632	23,783	22,408	27,911	23,788	24,595	25,428	24,991
Private University ICT Enrolment	96,090	84,366	70,691	53,710	66,476	51,766	51,354	50,813	50,272	49,731

Source: Department of Statistics and PIKOM Estimates

Figure 9.15: Employer Satisfaction Gap by ICT Skills Set Area in Malaysia

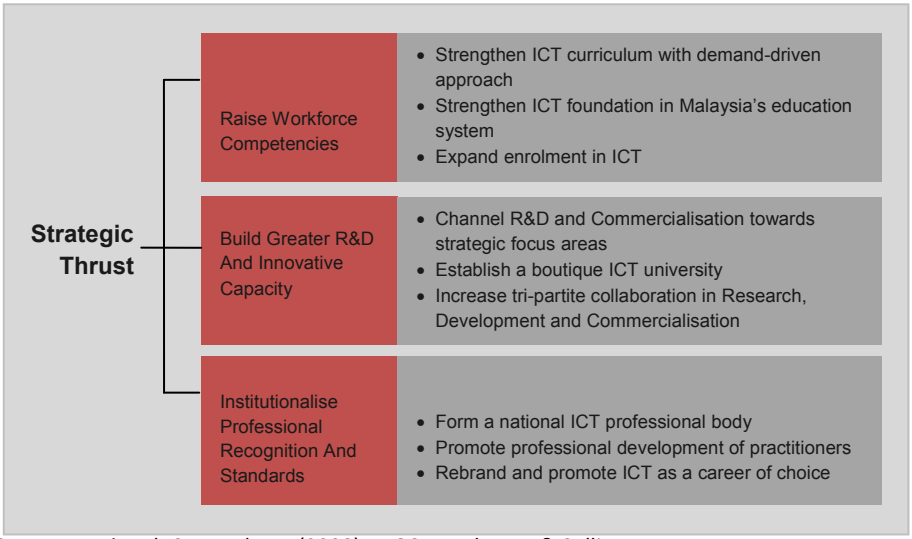


Source: *National ICT Roadmap* (2008), MOSTI and Frost & Sullivan

Several efforts have been undertaken to address this concern, realizing the fact that having sufficient and competent workers and professionals is a critical factor in ensuring the sustainability of the ICT industry. In this regard, the National ICT Roadmap 2012 highlights three strategic thrusts in developing the human resource capabilities in the ICT sector, including establishing an academy for the Technology Focus Areas, re-training of existing talents as well as importing foreign talents; particularly in critical areas of the industry **(Figure 9.16)**.

[66] Source: *National ICT Roadmap (2008)* MOSTI and Frost & Sullivan as reported in Abdul Wahab, Amirudin (2013) "Essence of ICT Roadmap 2012 for Innovation Driven Growth" in *ICT Strategic Review 2012/2013*, published by MOSTI/PIKOM. The "employer satisfaction gap" is measured by taking the difference between the skills desired by the employers and the rating given on the actual skill performed by employees.

Figure 9.16: National ICT Human Capital Development Framework



Source: *National ICT Roadmap* (2008), MOSTI and Frost & Sullivan

9.5 INTERNATIONAL COMPARISONS

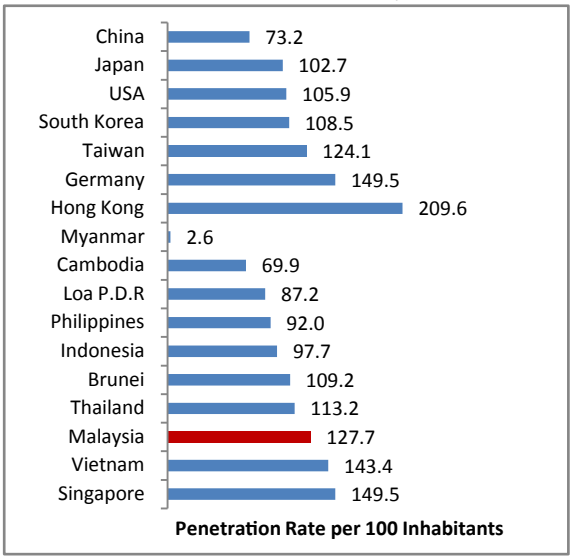
Malaysia has shown a commendable performance in terms of accessibility to technology when compared with other countries globally. The latest data on ICT accessibility— a 124.7% mobile penetration rate, 61.4% broadband household penetration rate, and 62% internet user penetration rate are considered high by world standards[67]. In particular, Malaysia's mobile penetration rate of 124% in 2012 is higher than the world's; at 91.2%, and that of developing countries, at 84.3%. Indeed, it is also comparable to that of the developed countries, of 123.6%. Similarly, Malaysia's broadband[68] penetration rate at 61.2% is high compared to the world's, at 29.5% and that of developing countries, at 19.8%. However, it is below that of the developed countries, at 74.8%. As for the internet user penetration rate at 62%, the level is higher than the world's, at 38.8% and that of the developing countries, at 30.7%; but slightly lower than that of the developed countries, at 76.8%.

Specific-country comparisons have also been favorable for Malaysia. Among the ASEAN countries, Malaysia's cellular telephone and wired broadband penetration rates are among the highest. Based on 2011 data, Malaysia ranked third among the ASEAN countries with regard to cellular telephone penetration rate, after Singapore and Vietnam, while for wired broadband penetration rate, Malaysia ranked second after Singapore **(Figure 9.17)**. However, Malaysia's ICT access indicators are still lagging behind those of selected major trading partners. In particular, the cellular telephone penetration rates of Hong Kong at 209.6, Singapore at 149.5 and Germany at 132.2 are significantly higher compared to that of Malaysia, at 127.7 in 2011. Similarly, the fixed (wired) broadband penetration rate of selected major trading partners such as South Korea at 36.9, Germany at 32.5, Hong Kong at 31.5, the USA at 28.8, Japan at 27.4, Singapore at 25.5, Taiwan at 23.7 and China at 11.6 are far above Malaysia's, at 7 in 2011 **(Figure 9.18)**.

[67] Based on statistics provided by Information Telecommunications Union (ITU).
http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx
Website accessed on October 11, 2013.

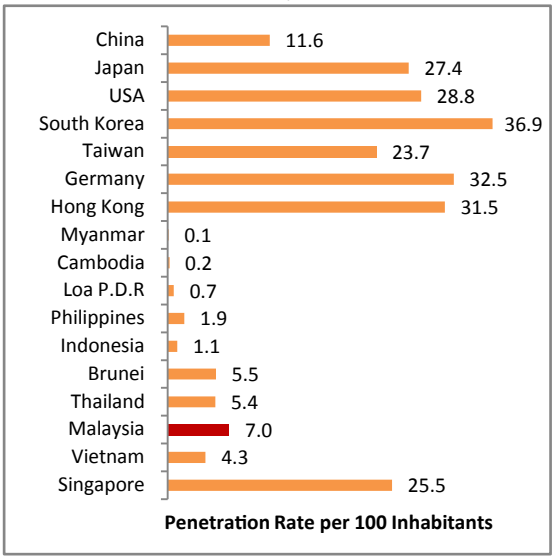
[68] Figures reported are for active mobile-broadband. The ITU provided two classifications for broadband penetration rate, namely active mobile-broadband and fixed (wired)-broadband.

Figure 9.17: Cellular Telephone Penetration Rate, Malaysia Compared to Selected Countries, 2011



Source: MCMC, ITU

Figure 9.18: Broadband Penetration Rate, Malaysia Compared to Selected Countries, 2011



Source: MCMC, ITU

Additionally, Malaysia ranked high in several ICT-related indicators. In 2013, Malaysia ranked second among 26 resource and efficiency-driven economies according to the Connectivity Scoreboard conducted by the World Economic Forum. The rating assesses countries' ICT infrastructure role in connecting governments, businesses and consumers to improve social and economic prosperity. In the Digital Economy Ranking conducted by the Economist Intelligent Unit on countries' ICT infrastructure readiness and the ability of the consumer, business and government to use ICT for their benefit, Malaysia is ranked 36 out of the 70 countries surveyed in 2010. This reflects an improvement, when compared to the 38th position recorded in 2009. In terms of Network Readiness Index (which measures the ability of countries to exploit the opportunities offered by ICT), Malaysia is ranked 29th of the 144 countries according to the World Economic Forum's *The Global Information Technology Report 2013*.

9.6 CONCLUSION

The ICT sector has continued to benefit from the country's efforts to achieve the developed country status by 2020. The sector remains pivotal in supporting economic growth; as the scores of the economic transformation programmes are largely ICT intensive. Several indicators showed that there are clear indications in ICT advancements at all levels in Malaysia. Despite its bright growth prospects, there are several challenges facing the industry. Talent development and human resource remain one of the major issues in the ICT sector. Serious efforts needed to be undertaken to address the mis-match in the supply of and demand for workforce in the ICT as well the skill gaps that could hinder the healthy growth of the industry. In this regard, there is an urgent need to address this issue to ensure that the significant investment in infrastructure development would be supported by capable human resource so as to achieve the various economic and social aspirations of the country.

Additionally, green ICT is another major issue facing the sector. The local ICT sector was estimated to have spent approximately RM3.7 billion on electricity bills, while producing about 8.4 million metric tons of carbon dioxide (CO_2) in 2011. Amid the increasing role expected to be

played by ICT in supporting the economic activities of the country, these trends are likely to further increase and become a serious concern for the sector; with estimated electricity expenditure to increase by 400% and carbon footprint to increase by 55% by 2020. In view of this, serious and collaborative efforts are needed towards the development of green jobs and towards de-carbonizing the ICT sector, while at the same time contributing positively to the Malaysian economy.

CHAPTER 10:
BIOTECHNOLOGY

CHAPTER 10

BIOTECHNOLOGY

10.0 INTRODUCTION

The National Biotechnology Policy aims at harnessing biotechnology as a key economic driver for Malaysia. The Policy set targets for the growth of biotechnology[69] in three distinct phases: Phase 1 (2005-2010), Phase 2 (2011-2015) and Phase 3 (2016-2020). Each phase has different milestones for GDP Contribution, Employment, Revenue and Investment. Phase 1 milestone has been achieved for employment, while the other three are slightly below target. Six programmes have been introduced to develop the biotechnology sector, i.e. Biotechnology Commercialisation Grant (BCG), Biotechnology Entrepreneur Programme (BEP), Biotechnology Entrepreneurship Special Training Programme (BeST), Intellectual Property Research and Management Programme (IPRM), BioNexus Acquisition Programme (BAP), and BioNexus Programme (BNP).

This chapter discusses the key indicators for the biotechnology industry in Malaysia. The core issues addressed are: 1) The main sources of technology application; 2) The revenues for the biotechnology sectors; and 3) The number of patents have been filed. For the purpose of benchmarking, Malaysia's performance in the biotechnology industry is compared with that of selected countries, using OECD Key Indicators and Ernst & Young (2012). This chapter relies primarily on *Malaysian Biotechnology Statistical Indicators (Based on BioNexus Status companies, Research Institutes and Institutes of Higher Learning 2010-2011)*—a report prepared by the National Biotechnology Division (BIOTEK), Ministry of Science, Technology and Innovation—as the source of data. The data on the expenditure in the institutions of higher learning (IHLs) and research institutes (RIs) were obtained from the *National Survey of Research & Development 2012 Report*, published by the Malaysian Science and Technology Information Centre (MASTIC).

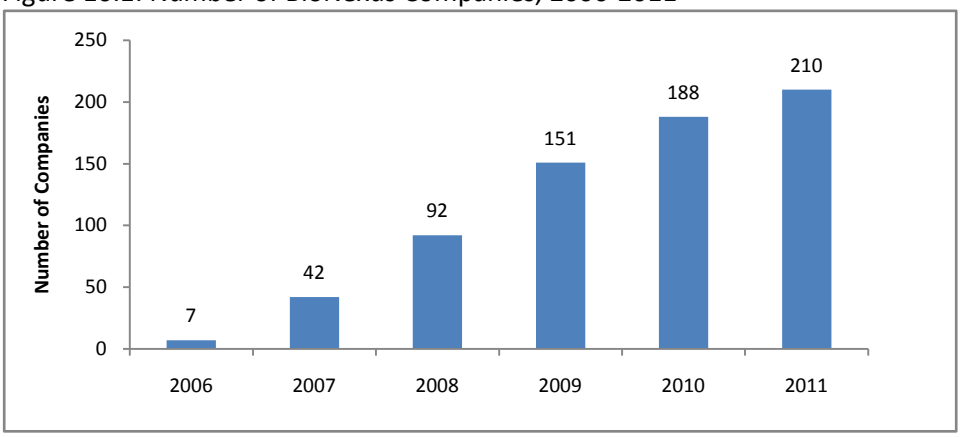
10.1 THE BIOTECHNOLOGY INDUSTRY IN MALAYSIA

One of the indicators for the status of the biotechnology industry in a country is the number of biotechnology companies operating within the country. This is used to measure the size of the biotechnology companies present in the industry as well as their stage of development. This section presents data on BioNexus companies. BioNexus is a recognition awarded by the Malaysian Government to qualified biotechnology companies that participate in and undertake value-added biotechnology activities. This status, which is conferred by the Malaysian Biotechnology Corporation (BiotechCorp), entitles such companies to special fiscal incentives, grants, and access to capacity building programmes and research facilities.

[69] Biotechnology has been defined by the *Convention on Biological Diversity, 1992* as "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use".

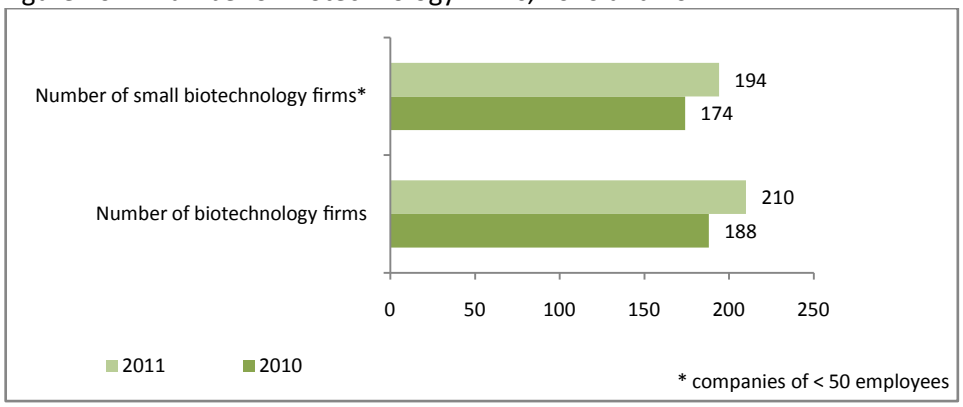
Figure 10.1 demonstrates that there has been positive growth in the number of BioNexus companies; from 7 firms in 2006, to 151 firms in 2009, to 210 firms in 2011. The majority of the biotechnology companies in Malaysia are considered as small firms, following the OECD's definition of small companies as being those that have less than 50 employees. In 2010, 92.6% of the biotechnology companies in Malaysia were small firms, while in 2011, the percentage was slightly smaller, i.e., 92.4% **(Figure 10.2)**.

Figure 10.1: Number of BioNexus Companies, 2006-2011



Source: Malaysian Biotechnology Statistical Indicators (2010-2011)

Figure 10.2: Number of Biotechnology Firms, 2010 and 2011



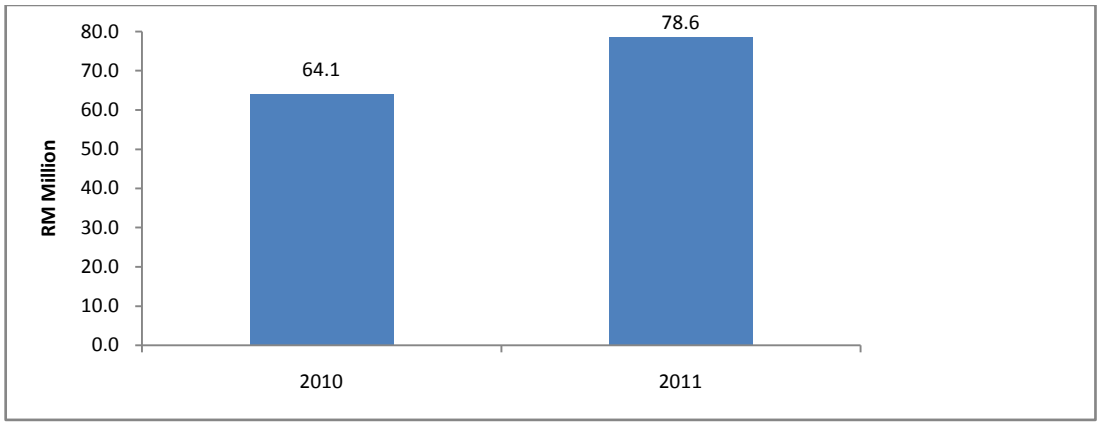
Source:Malaysian Biotechnology Statistical Indicators (2010-2011) (MOSTI)

10.2 R&D EXPENDITURE ON BIOTECHNOLOGY

10.2.1 R&D Expenditure in the BioNexus Companies

Malaysian biotechnology firms have increased their overall R&D expenditures in order to improve their competitive position in the market. **Figure 10.3** demonstrates an increase of 22.6% in the companies' total R&D expenditure in 2011 totaling RM78.6 million, from RM64.1 million in 2010.

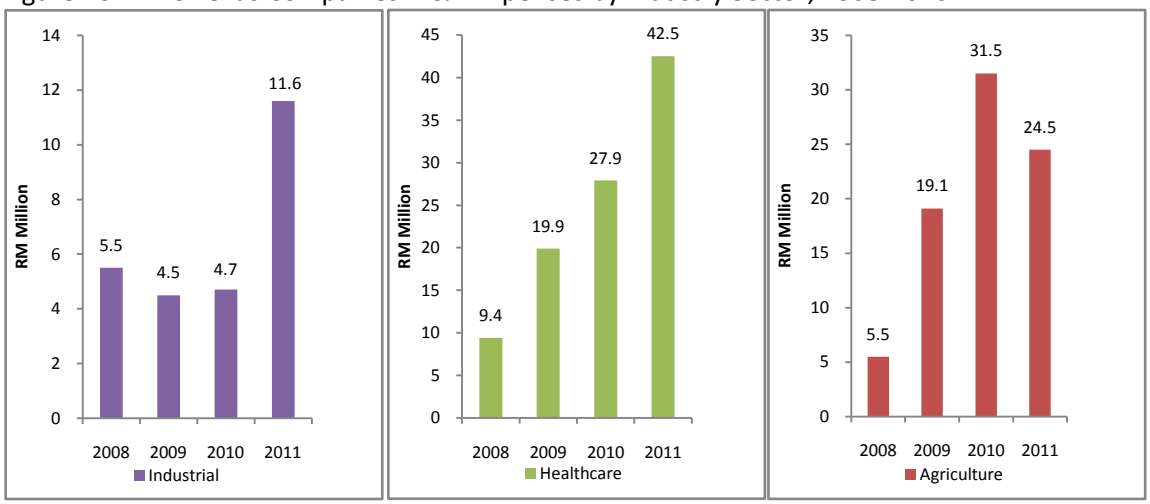
Figure 10.3: Total Biotechnology R&D Expenditure by BioNexus Status Companies, 2010 and 2011



Source: Malaysian Biotechnology Statistical Indicators (2010-2011)

Figure 10.4 demonstrates that between 2008 and 2011, the total R&D expenditure in the healthcare and the industrial sectors is on an increasing trend. The largest increase is experienced by the industrial sector, where the R&D expenditure rose from RM5.5 million in 2008 to RM11.6 million in 2011. The R&D expenditure in the healthcare sector also recorded a steady increase over the years, expanding from RM9.4 million to RM42.5 million. In the agricultural sector, there was a steady increase in the total R&D expenditure between 2008 and 2010; however, in 2011 the amount spent on R&D in the sector recorded a decline.

Figure 10.4: BioNexus Companies: R&D Expenses by Industry Sector, 2008-2010



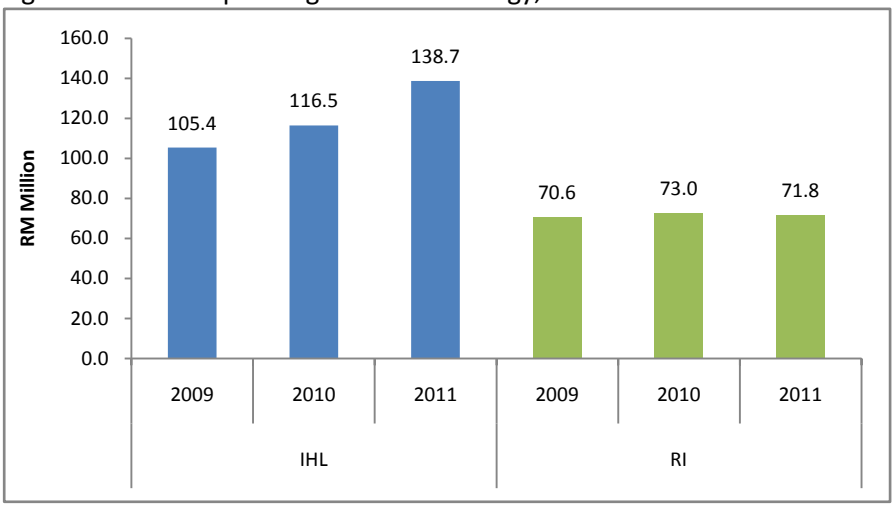
Source: Malaysian Biotechnology Corporation Annual Report, 2009, 2010, 2011

10.2.2 R&D Expenditure in the IHLs and RIs

The Research Institutes (RIs) and Institutions of Higher Learning (IHLs) are the other two main players in the biotechnology R&D sector. **Figure 10.5** shows the data obtained from the National Survey of R&D 2012, which captured the biotechnology R&D expenditure of 36 out of the 42 IHLs in 2009; 40 out of the 42 IHLs in 2010, and 47 out the 49 IHLs in 2011. The survey also obtained the participation of 30, 34, and 40 research institutions in Malaysia in 2009, 2010, and 2011 respectively, representing a response rate of 96.5%, 97.0%, and 100%.

As illustrated in **Figure 10.5**, the total R&D expenditure on biotechnology has increased substantially in the IHLs. In 2009, the IHLs are estimated to have spent a total of RM105.4 million on biotechnology research. This increased to RM116.5 million in 2010, and further, to RM138.7 million in 2011. Expenditure on biotechnology research in the RIs, on the other hand, has remained relatively constant, averaging at around RM71.8 million during the three-year period, with highest being in 2010, at an estimated RM73.0 million **(Figure 10.5).**

Figure 10.5: R&D Spending on Biotechnology, 2009-2011

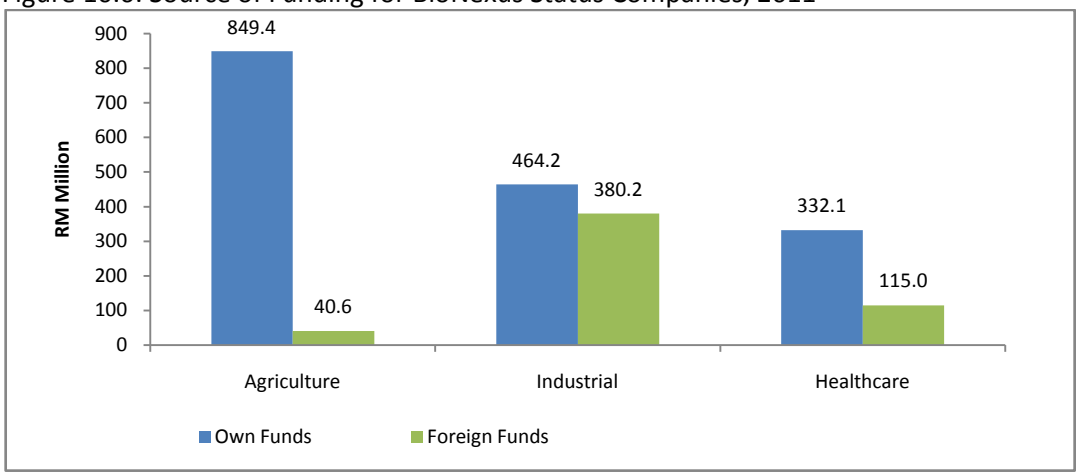


Source: National Survey of Research & Development 2012

10.3 FUNDING FOR BIOTECHNOLOGY SECTOR PARTICIPANTS

Figure 10.6 shows that in 2011, more than 75% of the funding for BioNexus Status Companies comes from their own funds; whilst the remaining comes from foreign funds. The sector that is least dependent on foreign funds is the agriculture sector, with 95.4% of the funds being local funds. Nearly three quarters of the funding in the healthcare sector comes from the companies' own funds, and a quarter from foreign funds. The industrial sector constitutes the largest recipient of foreign funding which amounts to 45.03% of the total funding for R&D.

Figure 10.6: Source of Funding for BioNexus Status Companies, 2011



Source: Malaysian Biotechnology Statistical Indicators (2010-2011)

10.4 BIOTECHNOLOGY APPLICATIONS

The Malaysian agricultural industry can be broadly categorised into three main sectors; i.e., the industrial, agricultural, and healthcare biotechnology sectors. The term agricultural biotechnology encompasses a variety of technologies used in food and agriculture, for a range of different purposes such as the genetic improvement of plant varieties and animals; genetic characterization and conservation of genetic resources; plant or animal disease diagnosis; vaccine development; and improvement of feeds[70]. Malaysia, being one of the biggest mega diversity countries and world leader in the production of industrial crops like palm oil, rubber and cocoa has enormous potential in agricultural biotechology. Key research areas for the agricultural sector are agricultural genomics, tissue culture technology, livestock, farming, animal health and nutrition, bio-pesticides and bio-fertilizers, extraction of metabolites, and nutritionally enhanced agriculture products[71].

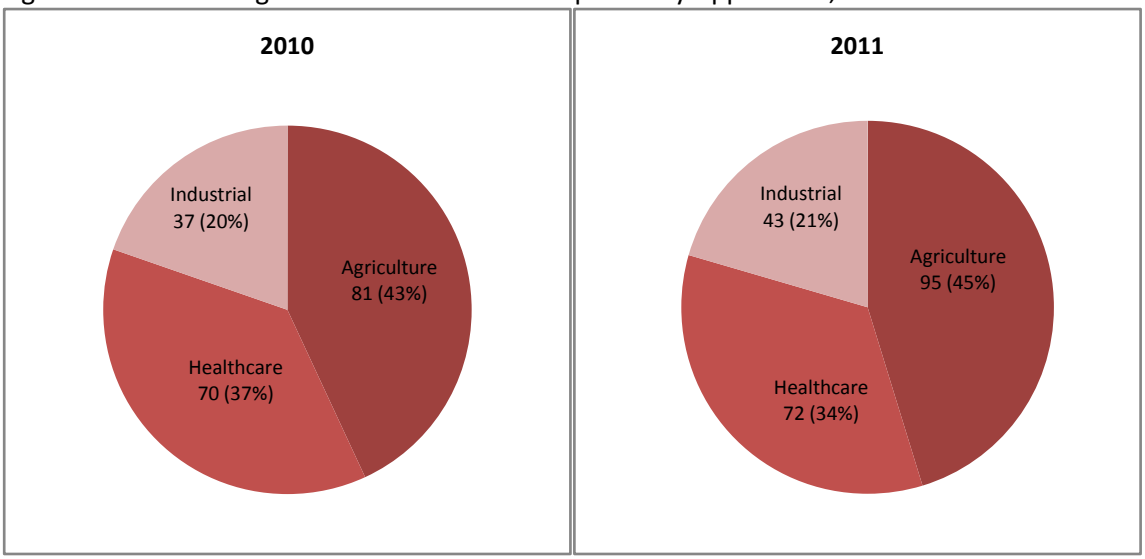
Industrial biotechnology is the application of biological-based systems and their components in the manufacture of industrial products or in the support of industrial process.[72] In the field of industrial biotechnology, Malaysia is gearing towards capitalising its position as the world's second largest exporter of palm oil. The enormous amount of palm oil waste can potentially be developed into high value industrial applications; ranging from biofuels to bioplastics.

[70] Malaysian Biotechnology Corporation, 'Overview: Malaysian Agricultural Biotechnology, A Frost & Sullivan Whitepaper 2009', p. 6, available online at http://www.biotechcorp.com.my/wp-content/uploads/2011/11/publications/White_Paper_Agricultural.pdf (last accessed 6 Oct 2013)
[71] Ibid.
[72] Malaysian Biotechnology Corporation, 'Overview: Malaysian Industrial Biotechnology, A Frost & Sullivan Whitepaper 2009' p. 4, available online http://www.biotechcorp.com.my/wp-content/uploads/2011/11/publications/White_Paper_Industrial.pdf (last accessed 6 Oct 2013)

Healthcare biotechnology refers to a medicinal or diagnostic product or a vaccine that consists of, or has been produced in, living organisms and may be manufactured via recombinant technology.[73] Malaysia is poised to leverage on its strong herbal industry as well as well regulated pharmaceutical industry to spearhead its healthcare biotechnology initiatives. Key research areas for healthcare biotechnology, pharmaceuticals/biopharmaceuticals, therapeutics (stem cells, topical medicine, infectious diseases, medical devices & diagnostics, and drug discovery and drug delivery.[74]

Figure 10.7 compares the share of the three sectors in 2010 with 2011. The agricultural sector constitutes the biggest sector for both 2010 and 2011. In 2010, the number of agricultural biotechnology firms was 81; constituting 43% of the total count. This increased to 95; or 45% of the total in 2011. The second biggest sector is healthcare sector, which stood at 37% of the total industry in 2010. Industrial biotechnology is the smallest sector, with a share of 20% in 2010. Of the three sectors, two recorded growth from 2010 to 2011; while the healthcare sector contracted by 3%.

Figure 10.7: Percentage of BioNexus Status Companies by Application, 2010 and 2011



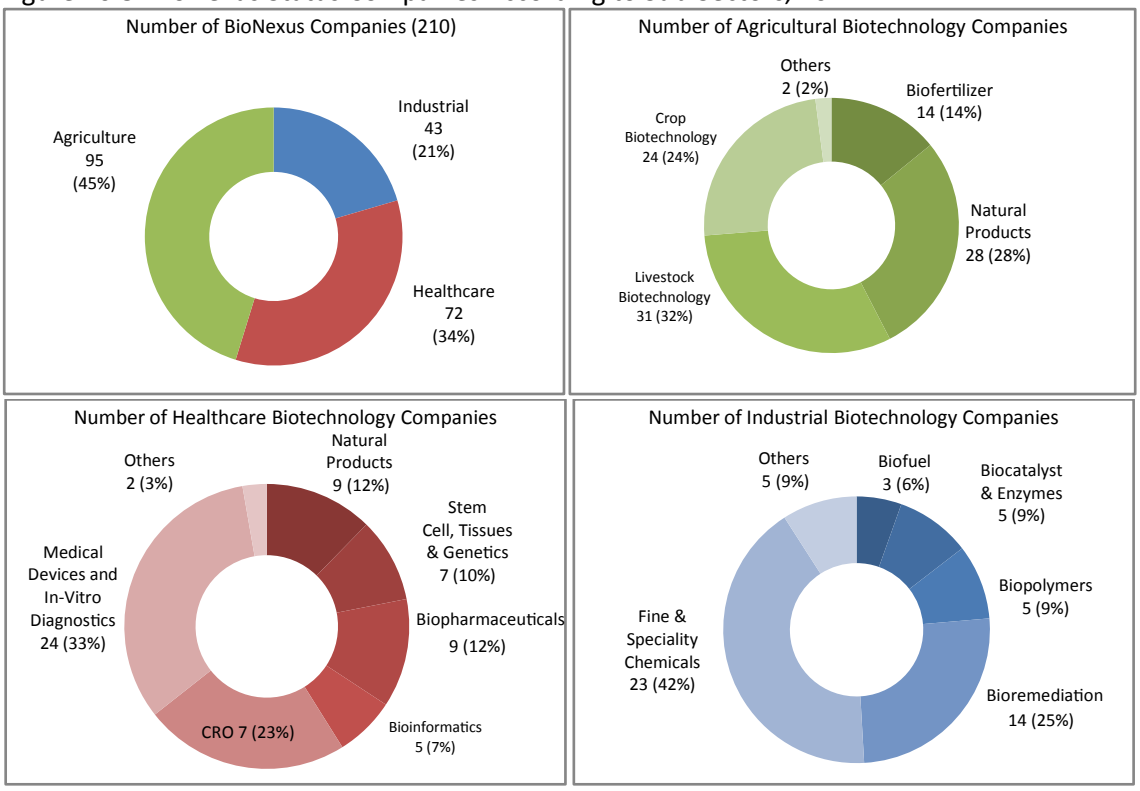
Source: Malaysian Biotechnology Statistical Indicators (2010-2011)

In terms of sub sectors, livestock biotechnology and natural products constitute the two biggest shares for the agricultural sector while fine and speciality chemicals and bioremediation were the two largest sub sectors for the industrial biotechnology sector **(Figure 10.8)**.

[73] Recombinant DNA is a form of DNA that does not exists naturally. It is created by combining DNA sequences that would not normally occur together. EuropaBio, available at www.europabio.org (last accessed 6 Oct 2013)

[74] Malaysian Biotechnology Corporation, 'Overview: Malaysian Healthcare Biotechnology, A Frost & Sullivan Whitepaper 2009', p.10, available online at http://www.biotechcorp.com.my/wp-content/uploads/2011/11/publications/White_Paper_HealthCare.pdf (last accessed 6 Oct 2013)

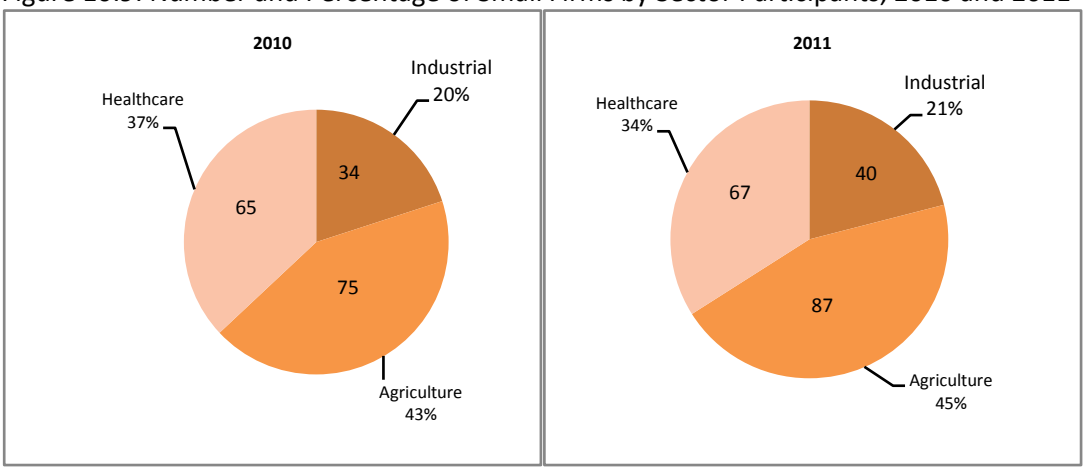
Figure 10.8: BioNexus Status Companies According to Sub-Sectors, 2011



Source: Malaysian Biotechnology Statistical Indicators (2010-2011)

As shown in **Figure 10.9**, the agricultural sector had the biggest number of small firms in 2010, with 75 companies, or 43% of the total. This grew to 87 companies, or 45% of the total, in 2011. This is followed by the healthcare sector (65 small firms in 2010 and 67 in 2011) and the industrial sector (34 small firms in 2010 and 40 in 2011).

Figure 10.9: Number and Percentage of Small Firms by Sector Participants, 2010 and 2011



Source: Malaysian Biotechnology Statistical Indicators (2010-2011)

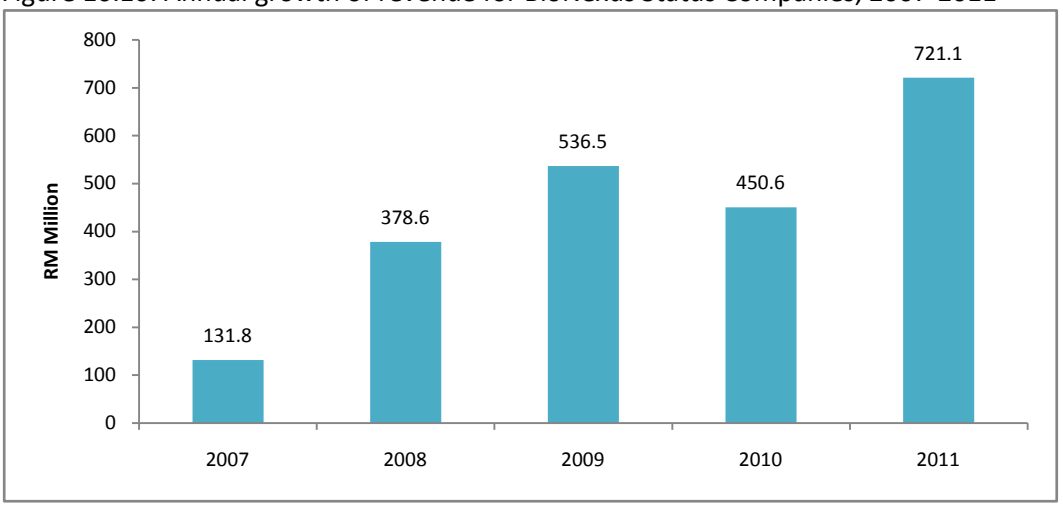
10.5 BIOTECHNOLOGY SECTOR REVENUES

10.5.1 Revenue generation by the BioNexus Status Companies

Biotechnology as a business segment for Malaysia has the potential for generating revenues and creating jobs through products and services. In this regard, the growth in the revenue of BioNexus status companies from RM131.8 million in 2007 to RM536.5 million in 2009 is an encouraging sign **(Figure 10.10).** However, in 2010, there was a drop of RM85.9 million in revenue to RM450.6 million—very likely to be due the long gestation period in the production of commercially viable products in this sector—before rising substantially to RM721.1 million in 2011.

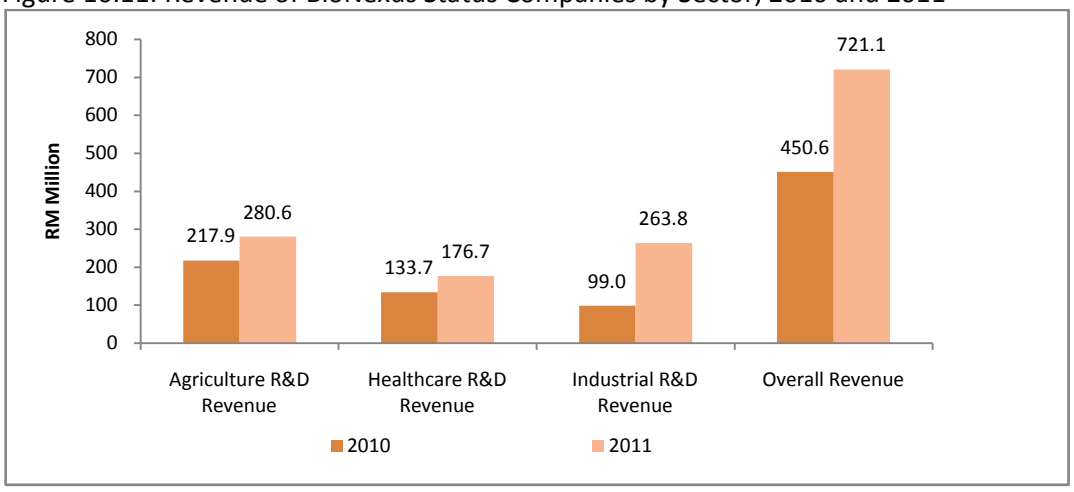
The positive growth between 2010 and 2011 is recorded in all the three sectors, as illustrated in **Figure 10.11**. The industrial sector recorded the highest increase in revenue, from RM99 million in 2010 to RM263.8 million in 2011, followed by the agricultural and healthcare sectors. It should also be highlighted that despite the positive growth in revenue between 2010 and 2011, 37.6% of the BioNexus companies have yet to generate any revenues **(Figure 10.12)**. Most of these companies were from the agricultural sector (33 companies) followed by the healthcare (27) and industrial sectors (19). The Malaysian Biotechnology Statistical Indicators (2010-2011) justified this by pointing to the fact that biotechnology requires a longer time to generate revenue in comparison to other industries, especially since, a majority of the BioNexus companies are start-ups (37%), micro SMEs (21%), and small SMEs (36%) that will need a longer time to stabilise and generate income.

Figure 10.10: Annual growth of revenue for BioNexus Status Companies, 2007-2011



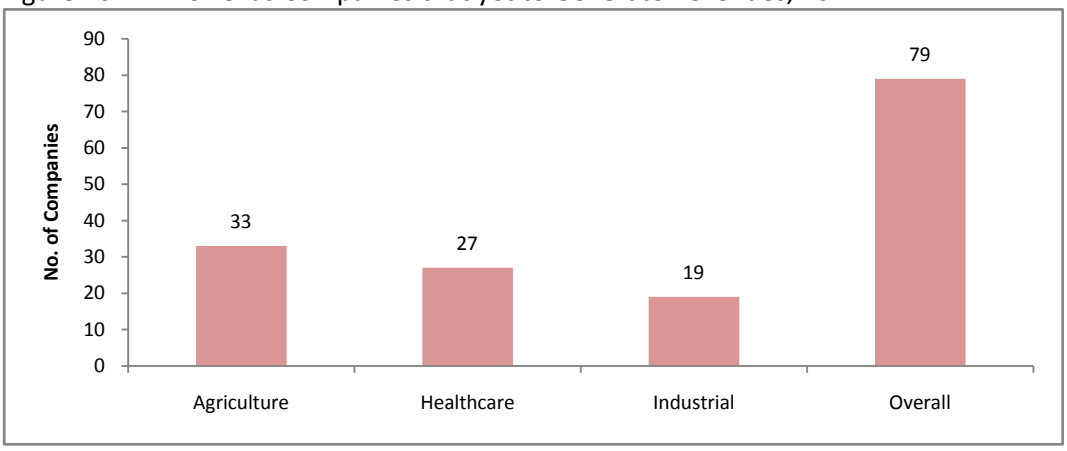
Source: Malaysian Biotechnology Corporation Annual Report, 2009, 2010, 2011.

Figure 10.11: Revenue of BioNexus Status Companies by Sector, 2010 and 2011



Source: Malaysian Biotechnology Statistical Indicators (2010-2011)

Figure 10.12: BioNexus Companies that yet to Generate Revenues, 2011



Source: Malaysian Biotechnology Statistical Indicators (2010-2011)

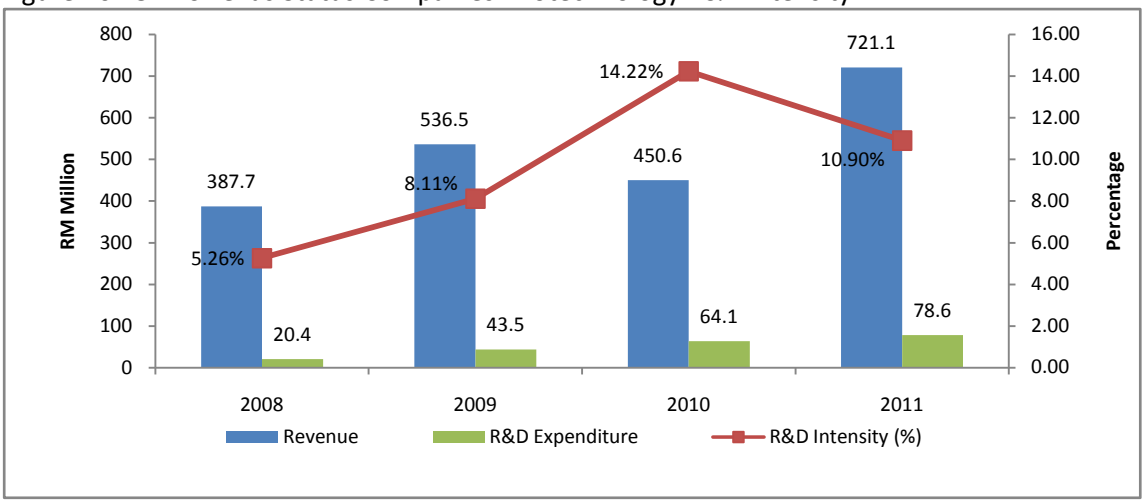
10.6 R&D INTENSITY

The intensity of R&D in each sector is evaluated to determine which one is most active. R&D intensity is the ratio of the BioNexus companies' investment in R&D compared to the total revenue generated from biotechnology products.

As shown in **Figure 10.13**, R&D intensity stood at 5.26% in 2008, growing to 8.11% in 2009 and 14.22% in 2010 before it contracted to 10.90% in 2011. As reported by the Malaysian Biotechnology Statistical Indicators, the decrease in R&D intensity is most likely to be attributed to the fact that companies are starting to generate revenues thereby diluting the percentage figure, or alternatively, are currently struggling to find funds to continue with R&D activities.

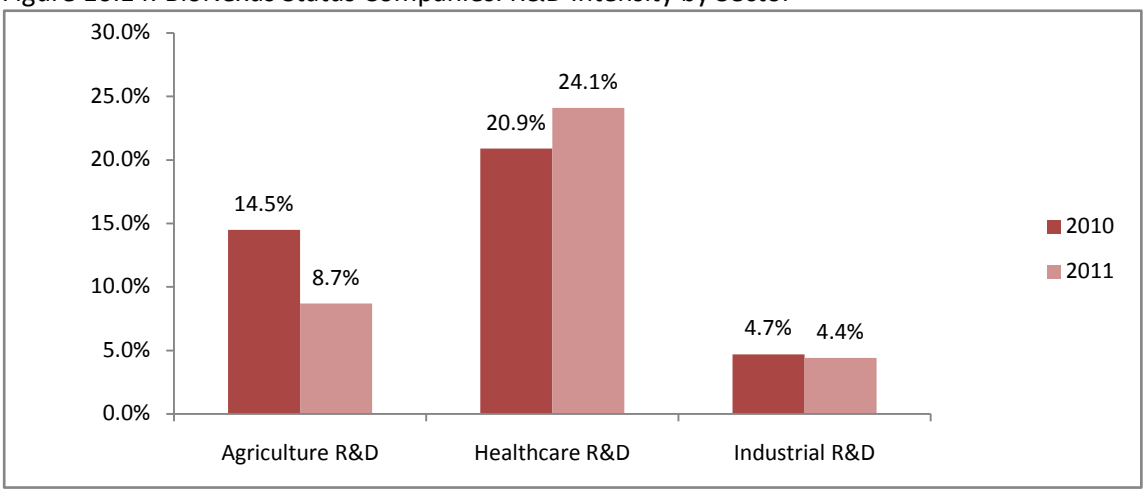
When examined further, the decline in the R&D intensity is mainly due to the agricultural sector, which saw a decrease by nearly 6%, and the healthcare sector by 4% between 2010 and 2011 **(Figure 10.14)**. The decline in R&D intensity in the healthcare sector is justifiable; as healthcare products require a longer time to reach the market.

Figure 10.13: BioNexus Status Companies: Biotechnology R&D Intensity



Source: Malaysian Biotechnology Statistical Indicators (2010-2011), Malaysian Biotechnology Corporation Annual Report, 2009, 2010, 2011.

Figure 10.14: BioNexus Status Companies: R&D Intensity by Sector



Source: Malaysian Biotechnology Statistical Indicators (2010-2011)

10.7 PATENTS

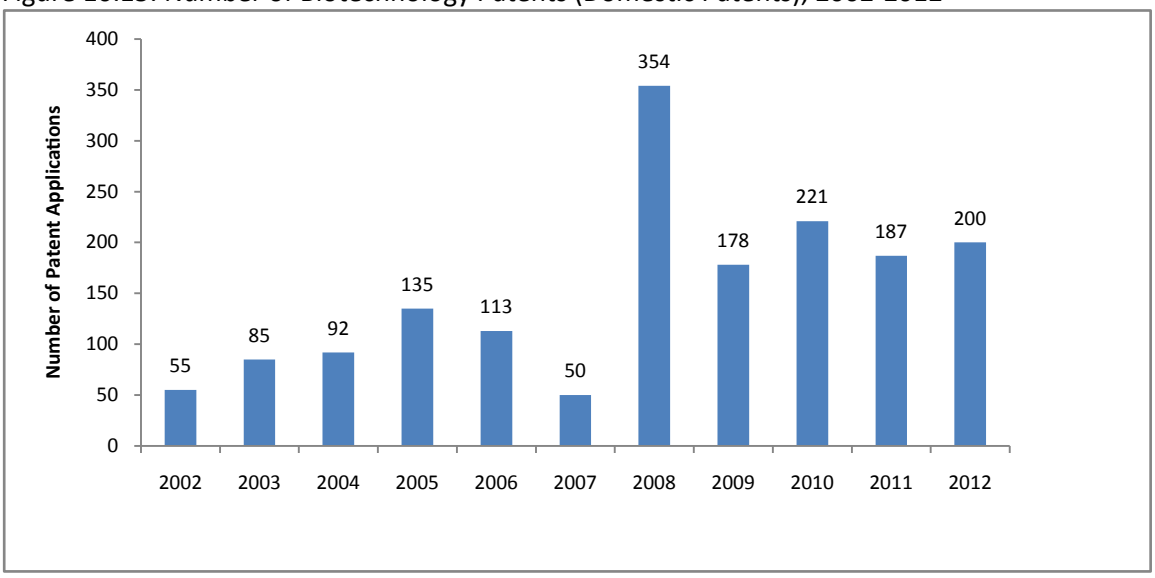
Patents are indicators for the evaluation of industrial research output. Patent indicators are used in policy-level applications to look at industrial research capability from a national or global viewpoint. In evaluating industrial research output, the OECD Key Biotechnology Indicators Report compares the share of biotechnology PCT patents in a particular country with the total number of biotechnology PCT patent applications filed by all countries.

This section also records the number of biotechnology patents filed through the Intellectual Property Corporation Malaysia (MyIPO), as this is an important indicator as to the strength of the R&D in biotechnology by Malaysian companies. As the data include all patents filed from Malaysia, it may also include PCT filing by Malaysians.

10.7.1 Biotechnology Patents (Domestic Patents)

Figure 10.15 shows that between 2002 and 2005, there is an upward trend in the application for biotechnology patents. However, the number of patent applications declined from 135 in 2005 to only 50 in 2007—most likely to be the result of Malaysia's accession to the Patent Cooperation Treaty (PCT). Nevertheless, in 2008 the number of patents filed peaked at 354, before settling at about 170 to 200 patent applications in years between 2009 and 2012.

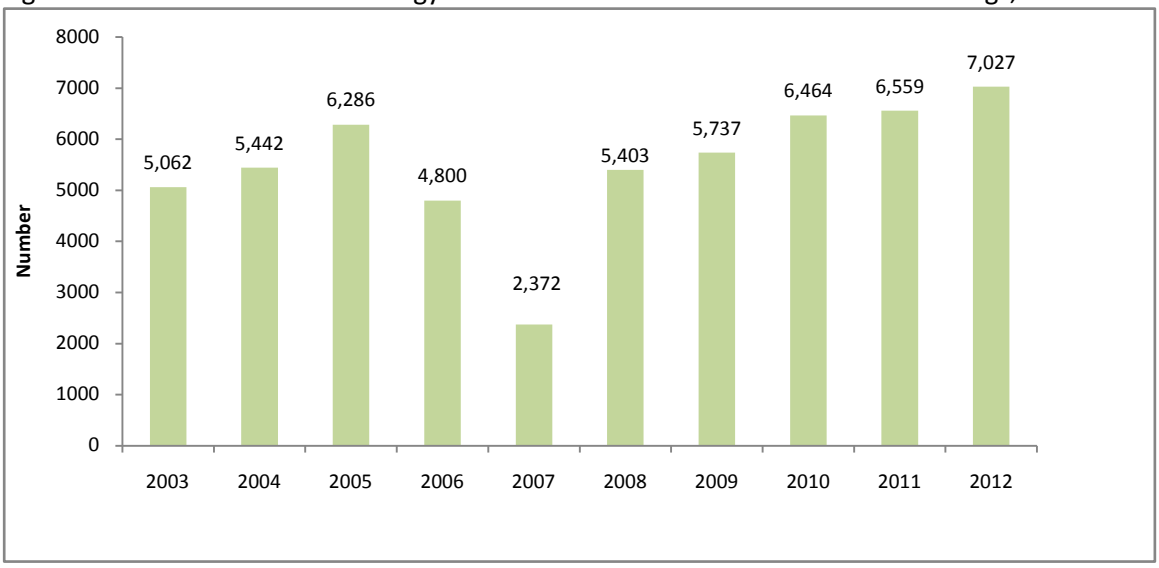
Figure 10.15: Number of Biotechnology Patents (Domestic Patents), 2002-2012



Source: Intellectual Property Corporation Malaysia (MyIPO)

The number of biotechnology patents in total patent applications is relatively small but has registered a steady increase since 2003. **Figure 10.16** shows that the share improved from 5,062 in 2003 to 6,286 in 2005. In 2008, the number peaked at 5,403. However, between 2009 and 2012, the number of biotechnology patents ranged between 5,737 to 7,027.

Figure 10.16: Share of Biotechnology Patents Vis a Vis Total Number of Patent Filings, 2003-2013



Source: Intellectual Property Corporation Malaysia (MyIPO)

10.7.2 International patent filing under the Patent Cooperation Treaty

The Patent Cooperation Treaty (PCT) is an international treaty administered by WIPO that enables the filing of international patents in multiple countries with a single filing. PCT patents are considered to be stronger as they withstand the test of patentability in more than one jurisdiction. It also indicates the market value of the patents as these patents are meant for international markets and not for the domestic market alone.

Table 10.1 demonstrates the share of BioNexus Companies' Biotechnology patents filed under PCT compared to the share of total biotechnology patents under PCT globally. In 2010, the share was 1.9%, but in 2011 increased to 2.8%. Proportionate to the growth of domestic patents, PCT filings for biotechnology patents have also increased.

Table 10.1: Share of BioNexus Status Companies' Biotechnology Patents Filed Under PCT

Patent Information	2010	2011
Total Biotechnology Patents Filed Under PCT Globally	5,219	5,232
Biotechnology Patents Filed Under PCT in Malaysia	97	145
Share of Malaysia's Biotechnology Patents	1.9%	2.8%

Source: Malaysian Biotechnology Statistical Indicators (2010-2011)

10.8 INTERNATIONAL COMPARISON

This section draws an international comparison of Malaysia's performance in biotechnology from selected OECD and Asia Pacific countries. Part of the data were drawn from the Malaysian Statistical Biotechnology Indicators 2010-2011, which drew its sources from Ernst & Young (2012), Beyond Borders[75], IBIS World Industry Report (2010) Biotechnology in Australia; RNCOS (2012), Asia-Pacific Biotechnology Markets; Korea BioVenture Association (2011); Industrial Development Bureau/MOEA (2012), and Biotechnology Industry in Taiwan. Other parts of this section draw its information from the OECD Key Biotechnology Indicators[76] and Ernst & Young (2012).

10.8.1 Number of biotechnology Firms in Malaysia and Selected Countries

This section compares the number of biotechnology firms in Malaysia with the United States of America (USA), Australia, South Korea and Taiwan as reported in the Malaysian Biotechnological Statistical Indicators (2010-2011). The United States is chosen for comparison as it is the world leader in terms of R&D and commercialisation of biotechnology products; while South Korea, Australia and Taiwan are included as they are a fast growing economy in biotechnology.

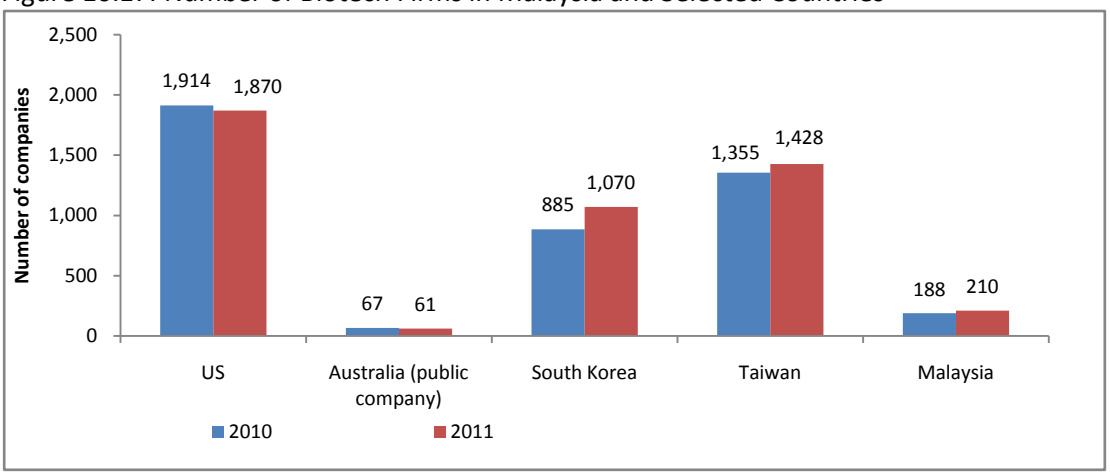
As shown in **Figure 10.17**, the United States dominates the biotechnology industry by having the highest number of biotechnology firms in the world. In 2010, there was 1,914 of such firms, while in 2011, 1,870; recording a decrease of 23%. Taiwan had a total of 1,355 firms in 2010 and

[75] Available online at http://www.ey.com/GL/en/Industries/Life-Sciences/Beyond-borders---global-biotechnology-report-2012 (viewed 24th November 2013)

[76] OECD, Key Biotechnology Indicators, available at http://www.oecd.org/sti/biotech/keybiotechnologyindicators.htm (viewed 24th November 2013)

this increased to 1,428 in 2011. In South Korea, the number of biotechnology firms increased by 20% between 2010 and 2011; from 885 firms to 1,070 firms. The data from Australia only involve public companies and not other types of business entities. This may explain the small number of firms captured in biotechnology R&D in Australia. In Malaysia, the number of biotechnology firms in 2010 was 188, which grew to 210 in 2011.

Figure 10.17: Number of Biotech Firms in Malaysia and Selected Countries



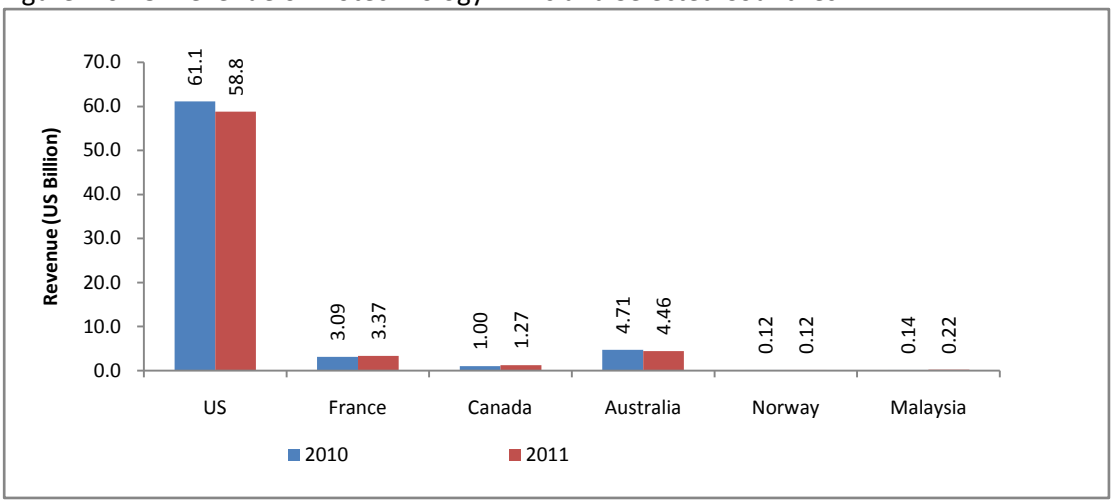
Source: Malaysian Biotechnology Statistical Indicators (2010-2011)

10.8.2 Revenue of Biotechnology Firms

This section compares the total revenue of Malaysian biotechnology firms with those in France, Canada, Australia and Norway. Data from this part are taken from Ernst and Young, Beyond Borders (2012).[77] The US, due to her large R&D expenditure and number of biotechnology firms, undoubtedly performed the best in terms of revenue. The total revenue for US firms in 2010 was USD61.1 billion and USD58.8 billion in 2011. In comparison, the total revenue for Malaysia's firms recorded only USD0.22 billion. Nevertheless, this is at par with Norway's biotechnology firms that received USD0.12 billion in 2011. Australia, with her huge resources, garnered a higher revenue of USD4.5 billion in comparison to Canada, at USD1.3 billion in 2011.

[77] Available online at http://www.ey.com/GL/en/Industries/Life-Sciences/Beyond-borders---global-biotechnology-report-2012 (viewed 24th November 2013)

Figure: 10.18: Revenue of Biotechnology Firms and Selected Countries



Source: E&Y Beyond Borders, 2011 & 2012

10.9 CONCLUSION

Malaysia has shown promising progress in biotechnology, as evident from the positive growth of biotechnology firms, R&D, and revenue figures in terms of absolute numbers. Understandably, the core sector is the agricultural sector, but the industrial and health biotechnological sectors are fast growing in importance.

Because Malaysia is still in the growth stage of the life cycle of the biotechnology industry, the slow rate of its annual growth is understandable. The United States is in a different league as their industries have achieved maturity. On the other hand, South Korea and Taiwan are fast expanding their competitive edge by increasing their R&D expenditure in biotechnology. Malaysia has a lot to learn from the experience of these two countries in propelling their biotechnology industry forward.

CHAPTER 11:
KNOWLEDGE AND TECHNOLOGY INTENSIVE (KTI) INDUSTRIES AND THE GLOBAL MARKETPLACE

CHAPTER 11

KNOWLEDGE- AND TECHNOLOGY-INTENSIVE (KTI) INDUSTRIES AND THE GLOBAL MARKETPLACE

11.0 INTRODUCTION

The changing dynamics of the global economy and the need to remain internationally competitive have driven countries to shift to a knowledge- and technology-based economy. Hence, the high-technology manufacturing and knowledge-intensive services have become increasingly important, and are a key part of the economic growth of developed and emerging economies. The United States, the EU, Japan, and China are the major producers and exporters of high-technology products and knowledge-intensive services in the world.

High-technology products or knowledge-intensive services refer to the products or services that embody advanced technologies and skills, and have a high level of R&D content. High-technology industries are defined by the Organisation for Economic Co-operation and Development (OECD) by comparing industry R&D expenditures or the number of technical people employed with industry production or value added. These include the manufacture of aircraft and spacecraft; pharmaceuticals; office, accounting, and computing machinery; semiconductors and communications equipment; and medical, precision, and optical instruments[78]. Knowledge-intensive services sectors are comprised of financial services, business services, communications services, education services and health and social services. Combined together, these industries are known as knowledge- and technology-intensive industries.

This chapter uses data from three key sources. For the analysis on high-technology manufacturing and knowledge-intensive services value added, data were extracted from the US Science and Engineering 2012 Report[79]. Data for high-technology exports for Malaysia were obtained from the Department of Statistics Malaysia, while the export data for the other countries were extracted from the US Science and Engineering 2012 Report. Data for knowledge-intensive services exports were taken from UNCTAD's Statistics database, namely UNCTADStats. It has to be noted that the database does not have data for all the knowledge-intensive (KI) service sectors. In fact, the categorisation of the KI service sectors in UNCTADStats database differs from that classified by the OECD. Out of the 11 sub-sectors that were listed in the UNCTADStats database for services exports, only 5 categories can be considered as KI services sectors. These include other business services[80], computer and information services, communications services, insurance services and financial services.

[78] Appendix 1 provides a detailed breakdown of the industry.

[79] The US Science and Engineering Indicators Report is published by the US National Science Board. The report provides quantitative information on the U.S. and international science and engineering enterprise.

[80] Other business services include merchanting, other trade related services; operational leasing services; miscellaneous business, professional and technical services; advertising, market research and public opinion polling; research and development; architectural engineering and other technical services; agricultural, mining and on-site processing services ; other business services; and services between related enterprises n.e.c.

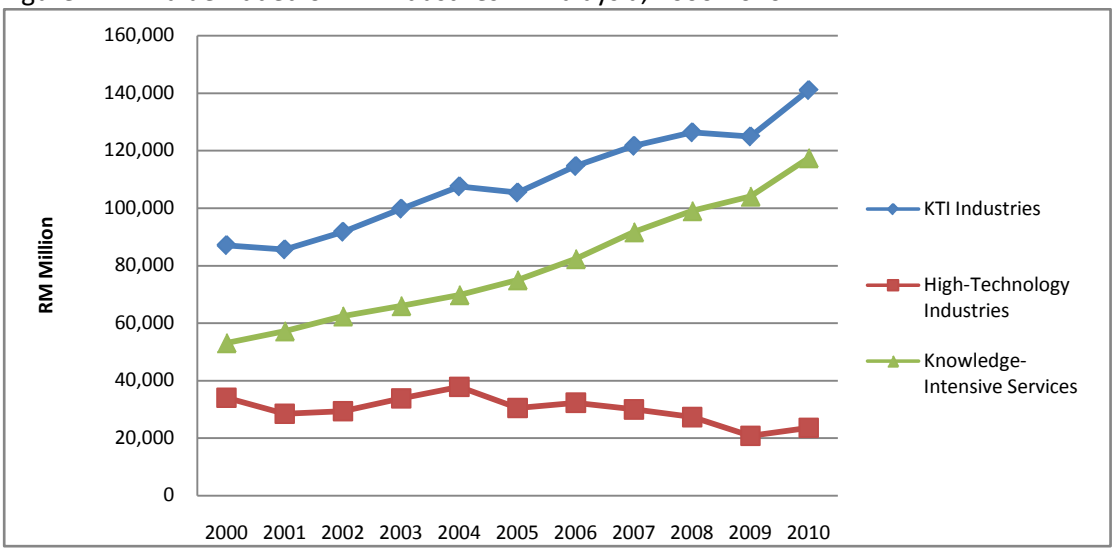
This chapter is organised into ten sections. The first section evaluates the knowledge and technology-intensive sectors in Malaysia and other major economies in the world. The second and third sections examine the trends in high-technology manufacturing value added in Malaysia and in the world respectively. The developments in the knowledge-intensive services sectors in terms of value added in Malaysia as well as in other leading economies are discussed in the fourth and fifth sections, while trade and trade balance in both the high-technology products and knowledge-intensive services sectors are discussed in the remaining sections. The last section concludes the chapter with some recommendations for future reports.

11.1 KNOWLEDGE- AND TECHNOLOGY-INTENSIVE INDUSTRIES

This section will examine the trends and advancements in the economic activities of the knowledge- and technology-intensive (KTI) industries in Malaysia and in the global economy. As mentioned earlier, the KTI industries include both high-technology (HT) manufacturing products and knowledge-intensive (KI) services. The industry's activity will be measured in terms of value added. Value added is a commonly used indicator to measure the contribution of each producer, industry, or sector to the economy; and it excludes the purchases of domestic and imported inputs from other countries, industries or firms.

The value added of KTI industries in Malaysia has doubled from RM87.1 billion in 2000 to RM141.0 billion in 2010 **(Figure 11.1)**. This is mainly contributed by the knowledge-intensive services that have increased steadily from RM53.1 billion to RM117.4 billion during the period. The sector's share in total value added of KTI industries rose from 61% in 2000 to 83% in 2010. On the other hand, the high-technology manufacturing industries experienced a continual decline over the years, where its share of the KTI value added fell from 39% to 17% during the same period.

Figure 11.1: Value Added of KTI Industries in Malaysia, 2000-2010



Source: Data extracted from US Science and Engineering Indicators 2012

Table 11.1 shows that the share of KTIs in Malaysia's gross domestic product (GDP) declined from 24% to 18% between 2000 and 2010, as a result of the shrinking share of high-technology industries in the GDP that dropped from 10% to 3%. Meanwhile, the share of the KI services in the GDP has remained at about 14-16% over the years.

Table 11.1: Share of Malaysian KTI Industries Value Added in GDP, 2000-2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
VA KTI (RM Billion)	87.1	85.6	91.8	99.8	107.6	105.4	114.6	121.6	126.6	124.9	141.0
Share of KTI in GDP (%)	24	24	24	24	23	20	20	19	17	18	18
Share of HT in GDP (%)	10	8	8	8	8	6	6	5	4	3	3
Share of KI in GDP (%)	15	16	16	16	15	14	14	14	13	15	15

Source: Based on data extracted from US Science and Engineering Indicators 2012

The global value added of KTI industries totaled US$18.2 trillion in 2010 and is worth 30% of the global gross domestic product (GDP). The United States has been the leading producer of knowledge- and technology-intensive products and services. In 2010, the United States' share in global KTI value added was 32%. Other key global producers of KTI products and services are the EU (with a global share of 27.8%), Japan (8.9%), and China (6.8%). Within Europe, the leading countries are Germany (with a global share of 5.7%), France (5.0%), UK (4.7%), Italy (3.0%), Spain (2.1%), and Netherlands (1.5%).

Table 11.2: Value Added of KTI Industries in Major Economies and Selected Asian Countries, 2000 and 2010

Region/country	2000		2010	
	US$ Million	% of Total World Value Added	US$ Million	% of Total World Value Added
World	9,156,162	-	18,185,317	-
United States	3,611,164	39.4	5,910,136	32.5
EU	2,367,538	25.9	5,057,030	27.8
Japan	1,327,614	14.5	1,614,634	8.9
China	251,014	2.7	1,242,323	6.8
Asia-8	420,303	4.6	1,066,661	5.9
India	78,519	0.9	331,904	1.8
South Korea	133,494	1.5	293,286	1.6
Taiwan	91,462	1.0	137,136	0.8
Indonesia	22,478	0.2	95,031	0.5
Singapore	39,170	0.4	83,019	0.5
Thailand	17,068	0.2	46,225	0.3
Malaysia	22,926	0.3	43,791	0.2
Philippines	15,186	0.2	36,269	0.2

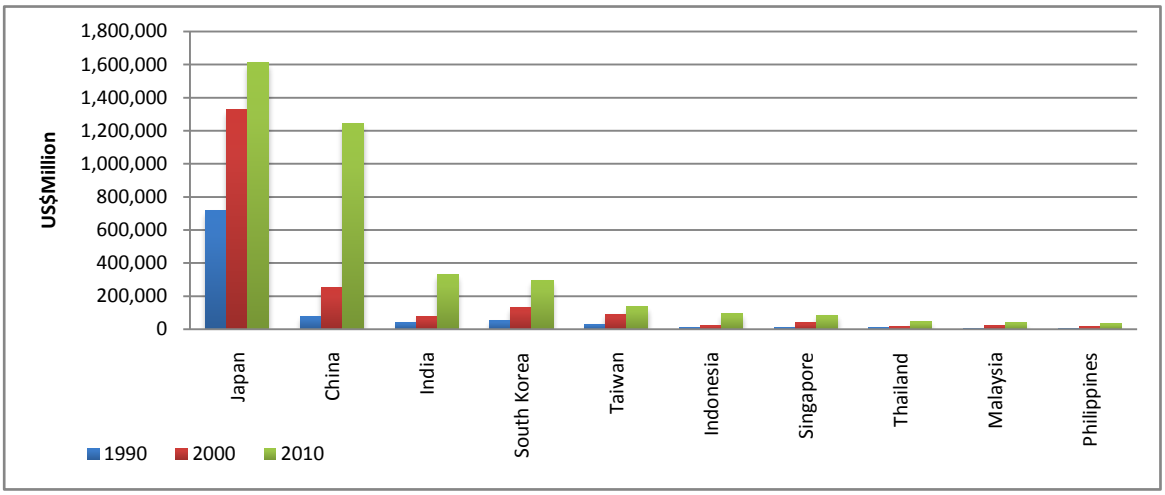
Source: Based on data extracted from US Science and Engineering Indicators 2012

In Asia, Japan and China hold the largest percentage of value added of KTI Industries, as shown in **Table 11.2**. Japan has remained the third largest producer of KTI products and services in the world despite Japan's waning share in the global value added that fell from 14.5% to 8.9% in the 10-year period. China's KTI production has grown impressively over the years; from US$251 billion in 2000 to US$1.2 trillion in 2010, driven mainly by expanding high-technology manufacturing industries and commercial services (US Science and Engineering Indicators,

2012). In 2010, China became the 4th largest producer of KTI products and services in the world, an outstanding advancement from its 7th position one decade earlier. **Figure 11.2** shows that the growth of China's KTI industries has outperformed the KTI value added growth of other countries in the region.

In addition to China, India has also experienced a notable growth in KTI value added, contributed largely by the expansion of commercial and public KI services (US Science and Engineering Indicators, 2012). Its KTI value added grew from US$78.5 billion in 2000 to US$331.9 billion in 2010. India's share in global value added has doubled from 0.9% to 1.8% during this period. As for the other selected Asian countries that are included in **Figure 11.2**, their shares in the global KTI value added increased only marginally over the years due to sluggish growth.

Figure 11.2: Value Added of KTI Industries in Asia-10 Countries, 1990-2010



Source: Based on data extracted from US Science and Engineering Indicators 2012

11.2 HIGH-TECHNOLOGY INDUSTRIES IN MALAYSIA

The high-technology industries play an important role in the Malaysian manufacturing output and trade. Malaysia ventured into high-technology manufacturing in the early 1970s, especially in the electrical and electronics (E&E) sector. The sector grew impressively since then, and by 1980, Malaysia became one of the leading exporters of E&E products in the world.

The value added of Malaysian high-technology industries has experienced a steady decline for the past one decade. In 2000, the total value added of the industry totaled RM34.1 billion. However, the value added declined gradually over the years and registered a total of RM29.9 billion in 2007, and further declined to RM23.6 billion in 2010. Consequently, the share of high-technology products in total manufacturing output steadily fell from 31% in 2000 to 17% in 2007. In 2010 the share is only 11% **(see Table 11.3).**

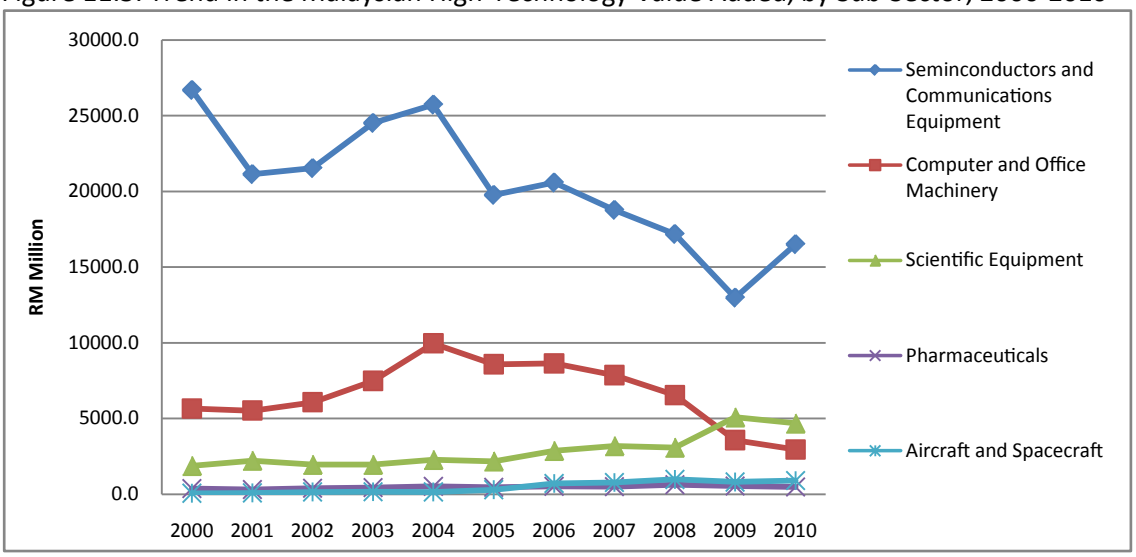
Table 11.3: Malaysia's High-Technology Manufacturing Value Added, 2007-2010

Sub-Sectors	Value-added in RM Million				Share in Total High-Tech Manufacturing (%)	
	2007	2008	2009	2010	2000	2010
Semiconductors and Communications Equipment	18,772	17,181	12,978	16,509	78.4	70.0
Computers and Office Machinery	7,860	6,543	3,576	2,956	16.6	12.5
Scientific Instruments	2,071	2,001	2,943	2,727	3.7	11.6
Aircraft and Spacecraft	771	979	803	905	0.2	3.8
Pharmaceuticals	499	631	539	489	1.1	2.1
Total High-Tech Manufacturing	29,973	27,335	20,838	23,587	100.0	100.0
Share of HT in All Manufacturing	17.0%	14.0%	12.0%	11.0%		

Source: Based on data extracted from the US Science and Engineering Indicators 2012

The semiconductors and communications equipment sub-sector has been the largest contributor to the high-technology industry. The sector accounted for 78.4% of total high-technology manufacturing value added in 2000 **(see Table 11.3)**. However, the share declined to 70.0% in 2010. The computer and office machinery sub-sector is the second most important high-technology industry in Malaysia, contributing 16.6% and 12.5% of the total high-technology value-added in 2000 and 2010 respectively. These two sub-sectors accounted for 95.0% of high-technology value added in 2000, but declined to 82.5% in 2010. On the other hand, the share of the scientific instruments sub-sector experienced a notable increase; from 3.7% in 2000 to 11.6% in 2010. Aircraft and spacecraft and pharmaceuticals value added also recorded gradual expansion over the years, but their share remained small due to slow growth.

Figure 11.3: Trend in the Malaysian High-Technology Value Added, by Sub-Sector, 2000-2010



Source: Based on data extracted from US Science and Engineering Indicators 2012

Figure 11.3 shows that the value added of semiconductors and communications equipment and the computer and office machinery sub-sectors declined steadily since 2004. The value added of semiconductors and communications equipment recorded a significant fall from RM26.7 billion in 2000 to RM16.5 billion in 2010. Computer and office machinery's value added fell from RM5.7 billion to RM RM2.9 billion. On the other hand, the scientific equipment sub-sector experienced gradual expansion from RM1.9 billion to RM4.9 billion.

11.3 HIGH-TECHNOLOGY INDUSTRIES IN THE DEVELOPED AND EMERGING ECONOMIES

Between 2000 and 2010, the global value added of high-technology industries grew steadily at 5.1% annually and totaled US$1.4 billion in 2010. The sector's share in global GDP, however, declined from 2.7% to 2.3% during the same period **(see Table 11.4)**.

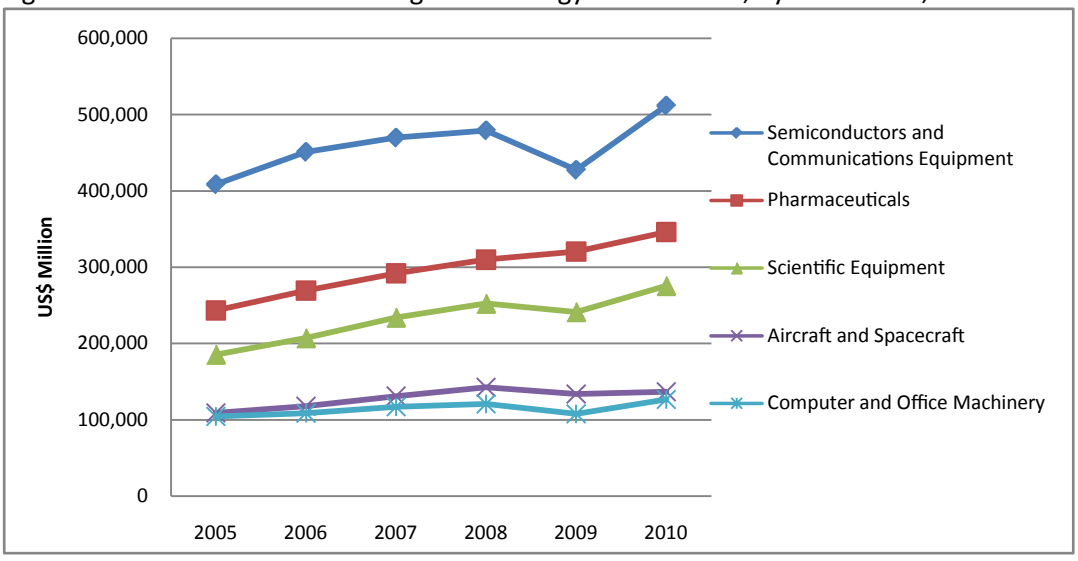
Table 11.4: Global Key Producers of High-Technology Products, 2007-2010

Country/Region	Value-Added in US$ Million				% of World VA	% of GDP	
	2007	2008	2009	2010	2010	2000	2010
World	1,244,297	1,304,945	1,231,142	1,397,037	-	2.7	2.3
United States	352,802	355,227	367,624	385,941	27.6	2.8	2.6
EU	312,220	317,606	265,536	272,892	19.5	2.2	1.7
China	155,624	194,519	212,053	263,015	18.8	2.6	4.3
Japan	150,235	153,742	138,689	177,935	12.7	4.0	3.3
South Korea	57,482	49,965	48,446	53,908	3.9	6.0	5.3
Taiwan	43,436	43,532	37,728	51,700	3.7	7.5	12
Brazil	20,427	25,301	22,582	28,162	2.0	2.0	1.3
Singapore	18,332	16,912	15,313	21,611	1.5	14	9.7
India	8,557	9,427	9,087	11,600	0.8	0.7	0.7
Indonesia	5,192	6,203	5,870	7,557	0.5	1.5	1.1
Malaysia	8,715	8,183	5,919	7,325	0.5	9.5	3.1
Thailand	5,725	5,734	4,904	5,791	0.4	1.6	1.8
Philippines	4,138	4,487	3,661	4,111	0.3	5.7	2.2

Source: Based on data extracted from the US Science and Engineering Indicators 2012

The leading producers of high-technology products in the world in 2010 were the United States, the EU, China, and Japan, accounting for 78.6% of global HT value added **(see Table 11.4)**. Other major producers are South Korea (with a global share of 3.9%), Taiwan (3.7%), Brazil (2.0%), ASEAN member countries (Singapore, Malaysia, Thailand, Indonesia and Philippines with total share of 3.2%), and India (0.8%). **Figure 11.4** shows that the value added of all the major HT producers has experienced steady growth in the value added.

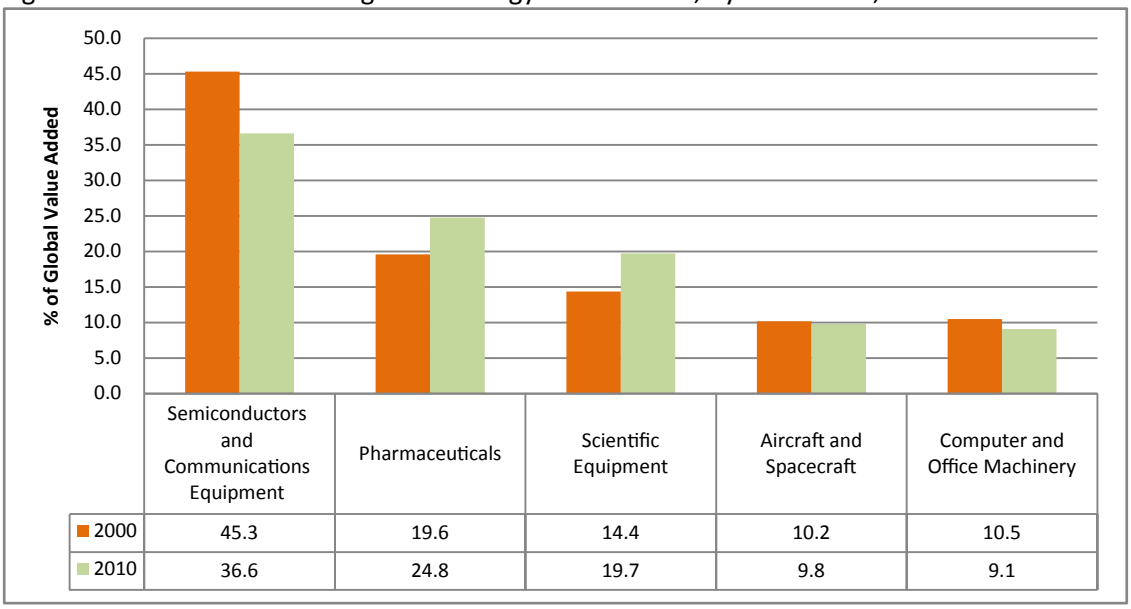
Figure 11.4: Trend in the Global High-Technology Value Added, by Sub-Sector, 2005-2010



Source: Based on data extracted from US Science and Engineering Indicators 2012

At the sectoral level, the semiconductors and communications equipment sector accounted for 36.6% of the total global HT value added in 2010 **(see Figure 11.5)**, followed by pharmaceuticals (24.8%), scientific equipment (19.7%), aircraft and spacecraft (9.8%) and computers and office machinery (9.1%). The share of semiconductors and communications equipment in the global HT value added was 45.3% in 2000. Similarly, the share of aircraft and spacecraft and computer and office machinery recorded a slight decline. On the other hand, the pharmaceuticals and the scientific equipment sub-sectors' share increased significantly during the period, contributed by outstanding value added growth.

Figure 11.5: Share in Global High-Technology Value Added, by Sub-Sector, 2000 and 2010

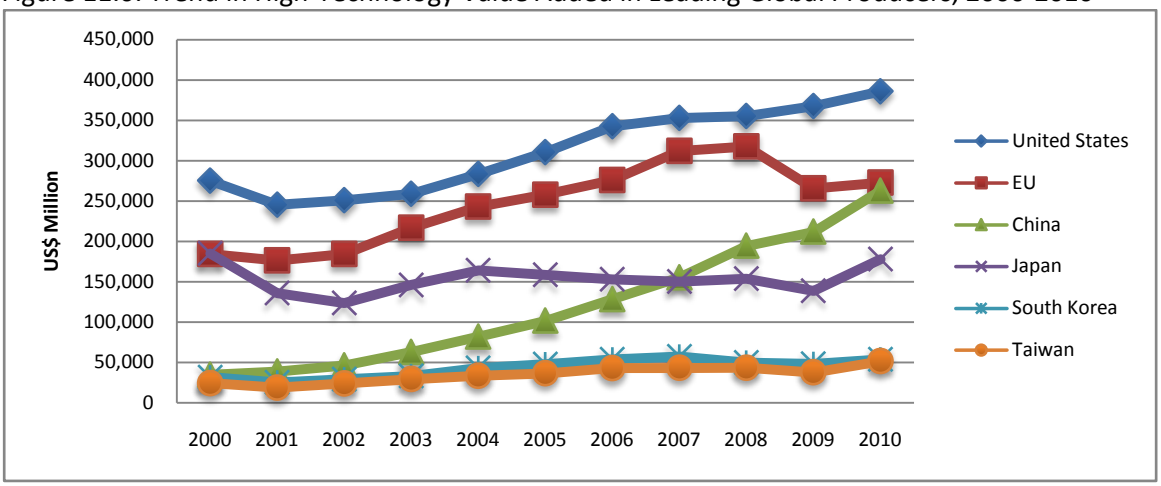


	Semiconductors and Communications Equipment	Pharmaceuticals	Scientific Equipment	Aircraft and Spacecraft	Computer and Office Machinery
2000	45.3	19.6	14.4	10.2	10.5
2010	36.6	24.8	19.7	9.8	9.1

Source: Based on data extracted from US Science and Engineering Indicators 2012

Figure 11.6 shows the leading global producers of high-technology products. The United States' high-technology value added grew steadily between 2000 and 2010 and therefore maintained its position as the leading producer in the world. China's output grew at an impressive rate of 22.4% per annum during this period, and by 2007, China surpassed Japan's total value added and became the third largest producer in the world.

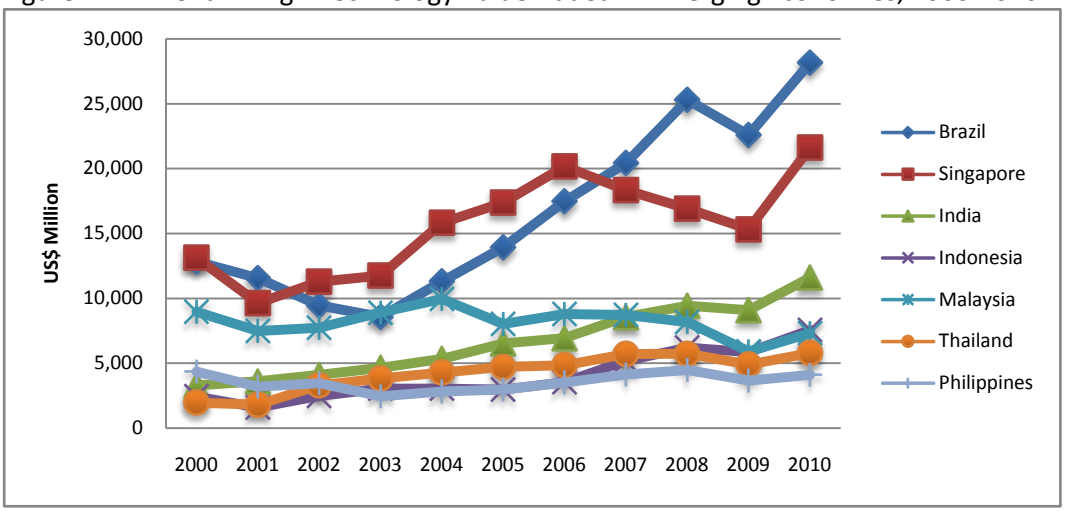
Figure 11.6: Trend in High-Technology Value Added in Leading Global Producers, 2000-2010



Source: Based on data extracted from US Science and Engineering Indicators 2012

Among the emerging economies, India, Brazil, Indonesia, Singapore and Thailand grew steadily during this period **(see Figure 11.7)**. India's high-technology value added expanded by 13.5% per annum while Indonesia's growth is 11.9%, Thailand (11.4%), Brazil (8.2%) and Singapore (5.1%). Malaysia and the Philippines experienced a negative growth of -2.0% and -0.6% respectively.

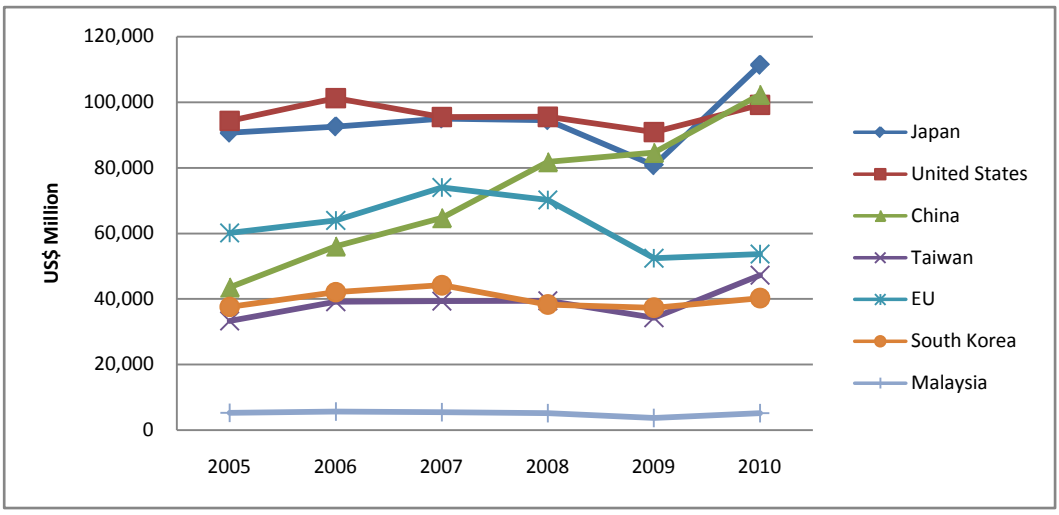
Figure 11.7: Trend in High-Technology Value Added in Emerging Economies, 2000-2010



Source: Based on data extracted from the US Science and Engineering Indicators 2012

In the semiconductors and communications equipment sub-sector, Japan and the United States have been the leading producers in the world. Japan's value added rose from US$90.6 billion in 2005 to US$111.4 billion in 2010 **(see Figure 11.8)**. However, the value added grew sluggishly in the United States during this period. China registered an outstanding growth of 18.6% per annum, with the value-added expanding from US$43.5 billion to US$102.3 billion. The EU, on the other hand has experienced a downward trend since 2007, with the value added falling from US$73.9 billion in that year to US$53.7 billion in 2010.

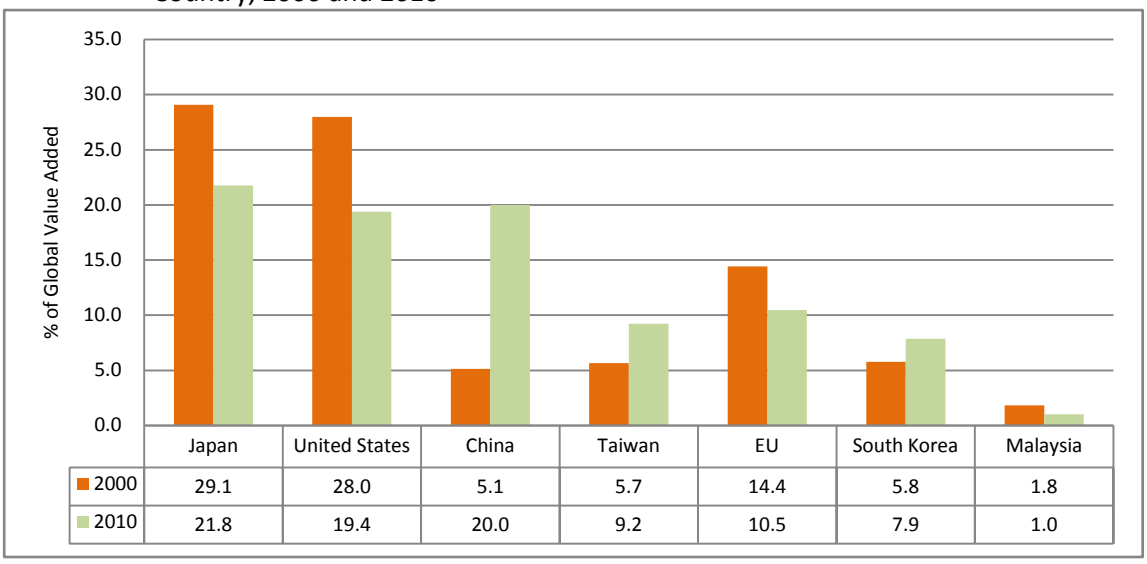
Figure 11.8: Leading Global Producers of Semiconductors and Communications Equipment, 2005-2010



Source: Based on data extracted from US Science and Engineering Indicators 2012

Figure 11.9 shows the global share of the key semiconductors and communications equipment producers for 2000 and 2010. China's share in the global value added rose from 5.1% to 20.0%. Taiwan and South Korea registered an increased share as well. Other countries, including Malaysia, recorded a decline, with the largest fall experienced by the United States and Japan.

Figure 11.9: Share in Global Semiconductors and Communications Equipment Value Added, by Country, 2000 and 2010

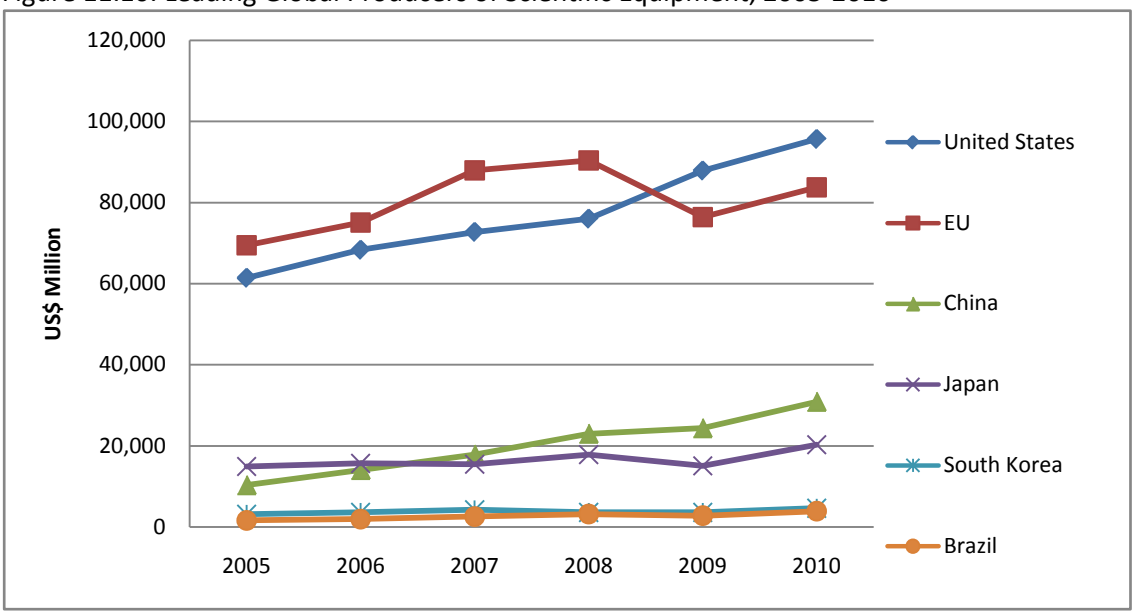


	Japan	United States	China	Taiwan	EU	South Korea	Malaysia
2000	29.1	28.0	5.1	5.7	14.4	5.8	1.8
2010	21.8	19.4	20.0	9.2	10.5	7.9	1.0

Source: Based on data extracted from the US Science and Engineering Indicators 2012

All the major producers of scientific instruments recorded an upward trend in value added **(see Figure 11.10)**. The fastest growing economies are the United States (CAGR: 9.3%) and China (CAGR: 24.3%). The United States became the leading global producer of scientific instruments in 2009.

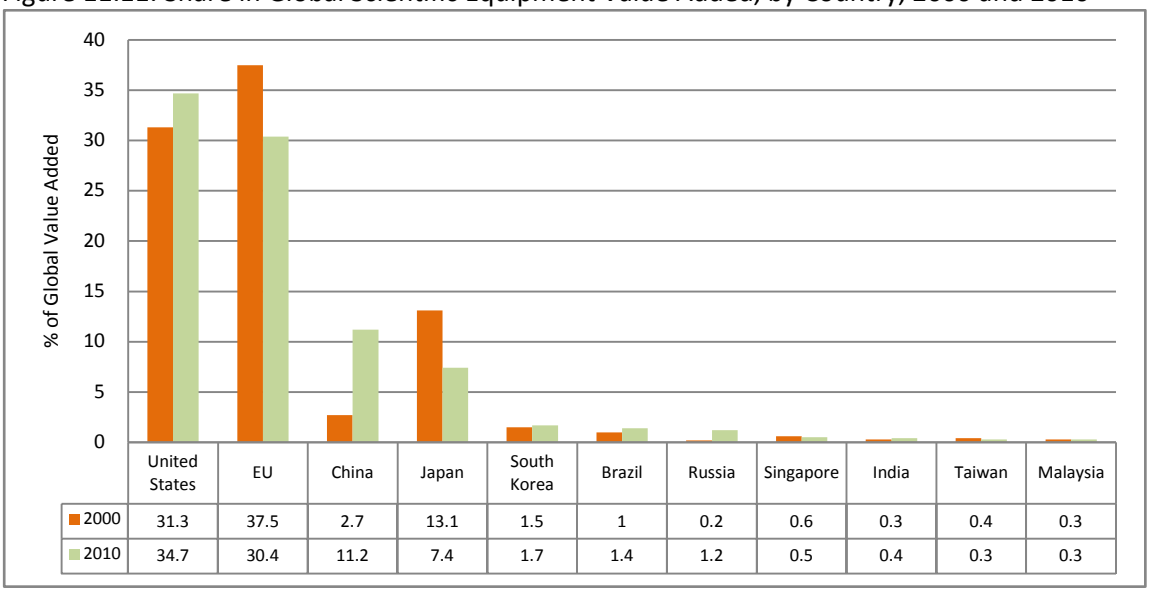
Figure 11.10: Leading Global Producers of Scientific Equipment, 2005-2010



Source: Based on data extracted from US Science and Engineering Indicators 2012

The EU and the United States dominate the global production of scientific instruments, and their combined share of global value added were 68.8% and 65.1% in 2005 and 2010 respectively **(see Figure 11.11)**. China's share increased from 2.7% to 11.2%.

Figure 11.11: Share in Global Scientific Equipment Value Added, by Country, 2000 and 2010

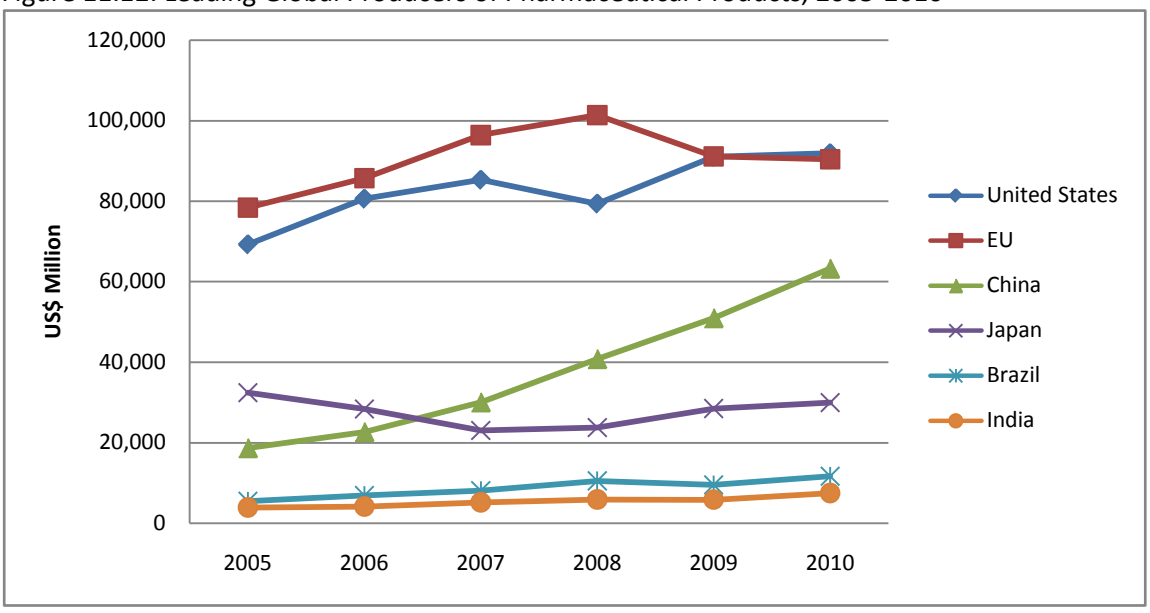


	United States	EU	China	Japan	South Korea	Brazil	Russia	Singapore	India	Taiwan	Malaysia
2000	31.3	37.5	2.7	13.1	1.5	1	0.2	0.6	0.3	0.4	0.3
2010	34.7	30.4	11.2	7.4	1.7	1.4	1.2	0.5	0.4	0.3	0.3

Source: Based on data extracted from US Science and Engineering Indicators 2012

The leading producers of pharmaceutical products in the world are the United States and the EU **(see Figure 11.12)**. Other key producers include China, Japan, South Korea, Brazil and Russia. China recorded an outstanding growth of 27.6% per annum between 2005 and 2010, and became the third largest producer of pharmaceuticals in 2007. The value added expanded from US$18.2 billion to US$63.3 billion in the span of 5 years, i.e. between 2005 and 2010.

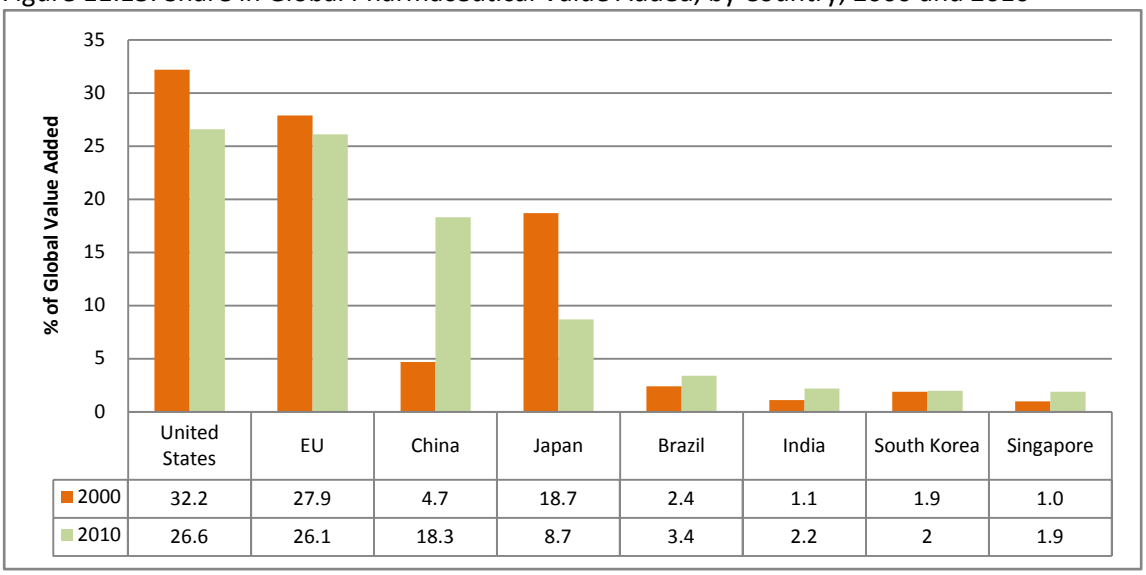
Figure 11.12: Leading Global Producers of Pharmaceutical Products, 2005-2010



Source: Based on data extracted from US Science and Engineering Indicators 2012

In 2005, the United States, the EU and Japan held 78.8% of global pharmaceutical value added **(see Figure 11.13)**. However, by 2010 the share decreased to 60%. China's share, on the other hand, increased from 4.7% in 2005 to 18.3% in 2010, while India's and Singapore's contribution to global value added doubled during the period.

Figure 11.13: Share in Global Pharmaceutical Value Added, by Country, 2000 and 2010

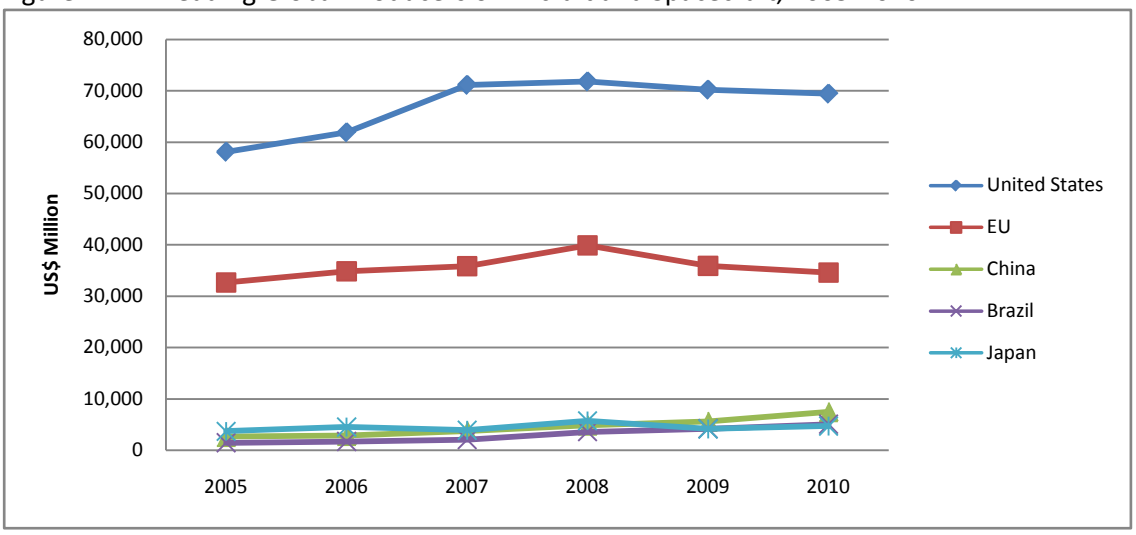


	United States	EU	China	Japan	Brazil	India	South Korea	Singapore
2000	32.2	27.9	4.7	18.7	2.4	1.1	1.9	1.0
2010	26.6	26.1	18.3	8.7	3.4	2.2	2	1.9

Source: Based on data extracted from the US Science and Engineering Indicators 2012

In the aircraft and spacecraft sector, the leading producers are the United States and the EU. The value added in the United States grew notably from US$58.1 billion in 2005 to US$71.7 billion in 2008, but has recorded a downward trend since then **(see Figure 11.14)**. In 2010, the value added was US$69.4 billion. A similar trend was found for the EU. China's value added, on the hand, grew at a rate of 23.3% per annum between 2005 and 2010, thereby expanding its value added from US$2.6 billion to US$7.4 billion.

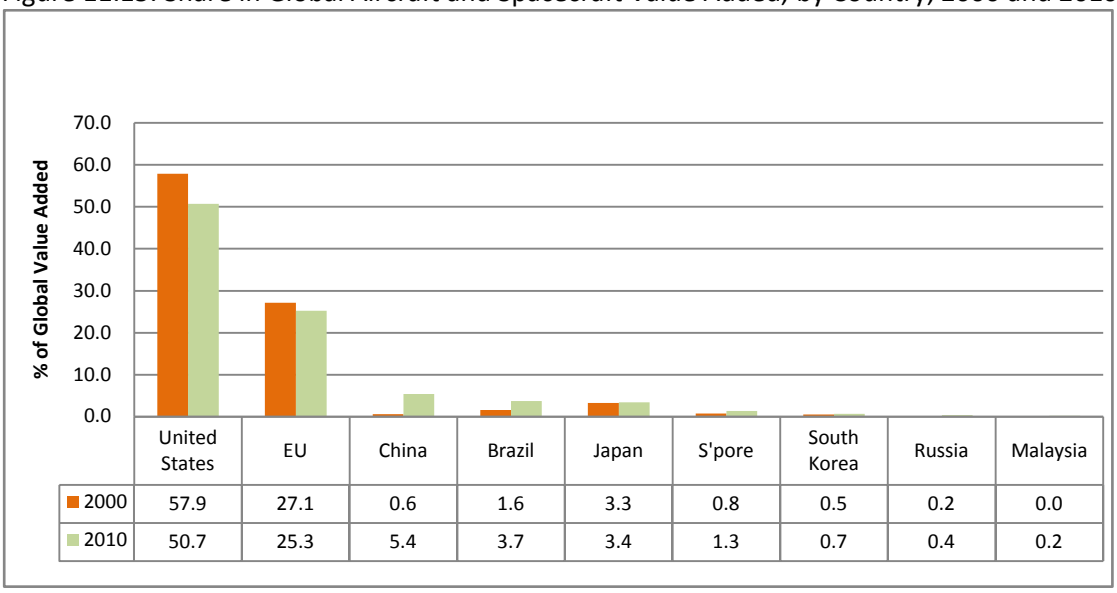
Figure 11.14: Leading Global Producers of Aircraft and Spacecraft, 2005-2010



Source: Based on data extracted from US Science and Engineering Indicators 2012

In terms of the global value added share, the United States outperformed other key producers. In 2010, half of the world's production came from the United States **(see Figure 11.15)**. The second largest producer was the EU, with a global share of 25.3%. Nevertheless, the US and the EU has experienced a decline in the global share since 2005. Other major producers, namely China, Brazil, Japan, as well as the newly emerging producers such as Singapore, South Korea, Russia and Malaysia registered a rising global share.

Figure 11.15: Share in Global Aircraft and Spacecraft Value Added, by Country, 2000 and 2010

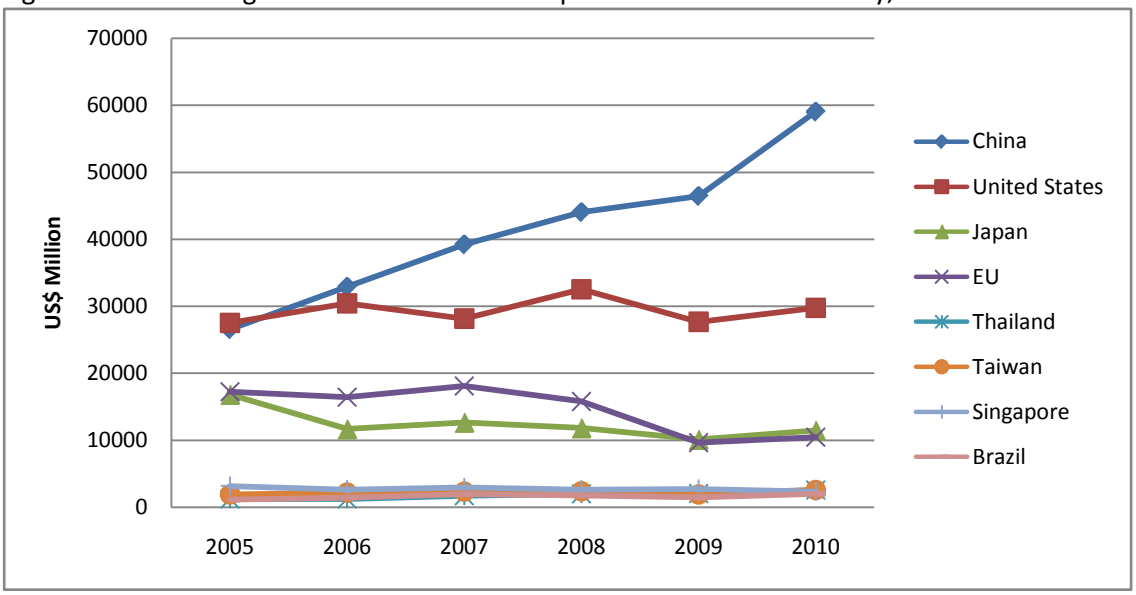


	United States	EU	China	Brazil	Japan	S'pore	South Korea	Russia	Malaysia
2000	57.9	27.1	0.6	1.6	3.3	0.8	0.5	0.2	0.0
2010	50.7	25.3	5.4	3.7	3.4	1.3	0.7	0.4	0.2

Source: Based on data extracted from US Science and Engineering Indicators 2012

The leading global producer of computer and office machinery in 2010 is China. Between 2005 and 2010, China's value added growth in this sector was phenomenal, growing at 17.3% annually, from US$26.6 billion in 2005 to US$59.0 billion in 2010. Other key producers in the sector experienced either declining or sluggish growth **(see Figure 11.16)**.

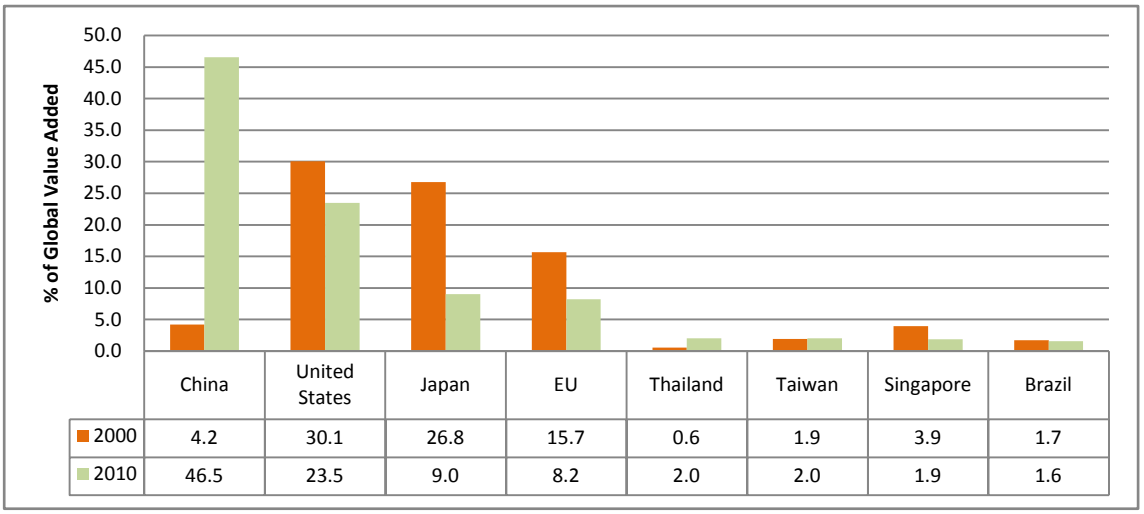
Figure 11.16: Leading Global Producers of Computer and Office Machinery, 2005-2010



Source: Based on data extracted from US Science and Engineering Indicators 2012

In the global computer and office machinery industry, China's value added share expanded from 4.2% in 2000 to 46.5% in 2010. Consequently, the share of other leading producers such as the United States, the EU, and Japan recorded a substantial reduction. Singapore also experienced a notable decrease in the share, from 3.9% to 1.9% during the same period. Thailand's contribution rose from 0.6% to 2.0% **(see Figure 11.17)**.

Figure 11.17: Share in Global Computer and Office Machinery Value Added, by Country, 2000 and 2010



	China	United States	Japan	EU	Thailand	Taiwan	Singapore	Brazil
2000	4.2	30.1	26.8	15.7	0.6	1.9	3.9	1.7
2010	46.5	23.5	9.0	8.2	2.0	2.0	1.9	1.6

Source: Based on data extracted from US Science and Engineering Indicators 2012

11.4 KNOWLEDGE-INTENSIVE SERVICES INDUSTRY IN MALAYSIA

The services sector has gained importance over time in the Malaysian economy, with its overall contribution to GDP expanding from 38.3% in 1970 to 46.8% in 1990, and gradually increasing to 55.0% in 2012. Knowledge-intensive (KI) services are increasingly becoming an important component of the services sector.

The value added of knowledge intensive services industries doubled from RM53.1 billion in 2000 to RM117.4 billion in 2010, representing 83.3% of the total KTI value added in 2010. The industry grew at 9.6% annually during the period, with commercial KI services contributing more than 90.0% of KI services value added.

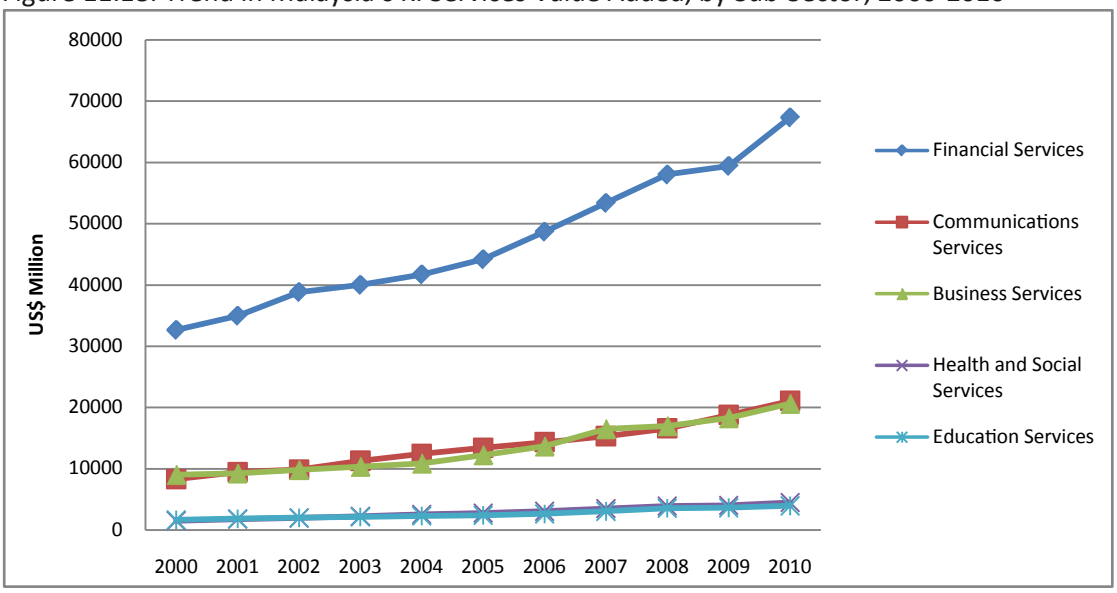
Table 11.5: Malaysia's Knowledge Intensive (KI) Services Value Added, 2000-2010 (RM Billion)

Sectors	2000	2005	2006	2007	2008	2009	2010
Knowledge Intensive Services	53.1	74.9	82.3	91.6	99.0	104.1	117.4
Commercial KI Services	49.9	69.4	76.6	85.1	91.6	96.5	109.0
Financial Services	32.6	44.2	48.7	53.4	58.0	59.4	67.3
Communications Services	8.3	13.4	14.3	15.3	16.6	18.8	21.0
Business Services	9.0	12.2	13.7	16.5	17.0	18.3	20.1
Health And Social Services	1.5	2.8	3.0	3.5	3.9	4.0	4.5
Education Services	1.6	2.4	2.6	3.0	3.5	3.6	3.9

Source: Based on data extracted from US Science and Engineering Indicators 2012

Financial services was the key contributor to the KI services industry in terms of value added, totaling RM67.3 billion in 2010. This was 57.4% of the knowledge-intensive industry's total value added. **Figure 11.18** shows that the sector has progressed and outperformed other KI sectors since 2000. In fact, the financial services growth outpaced the nation's economic growth for the past decade, driven mainly by bank lending activities. The sector has also benefitted significantly from the government's policy initiatives to position Malaysia as an Islamic financial hub in the world.

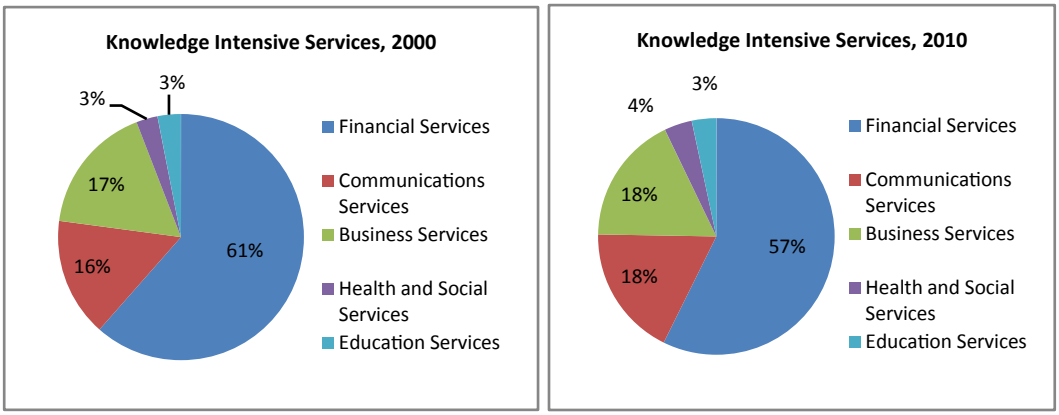
Figure 11.18: Trend in Malaysia's KI Services Value Added, by Sub-Sector, 2000-2010



Source: Based on data extracted from US Science and Engineering Indicators 2012

The communications services and the business services value added grew steadily over the years. These sectors accounted for 17.9% and 17.6% of the total KI industry's value added in 2010 respectively **(see Figure 11.19)**. The health and social services and the education services accounted for only about 3-4% in total KI services value added.

Figure 11.19: Share in Total KI Services Value Added, by Sub-Sector, 2000 and 2010



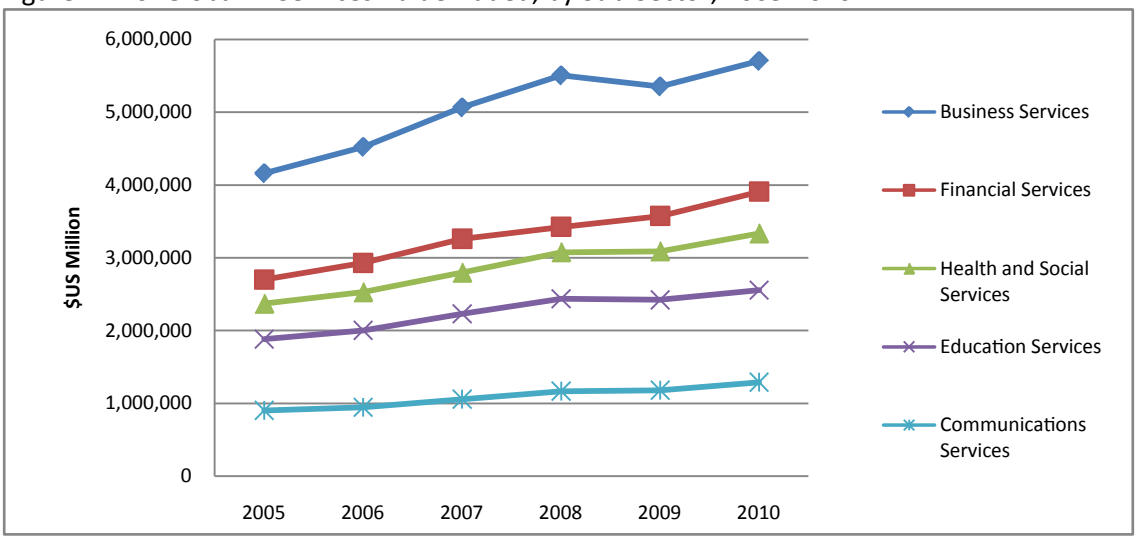
Source: Based on data extracted from the US Science and Engineering Indicators 2012

The education services value added grew steadily from RM1.6 billion in 2000 to RM3.9 billion in 2010 **(see Figure 11.18)**. The health and social services' value added tripled from RM1.5 billion in 2000 to RM4.5 billion in 2010 as a result of expanding private healthcare services that benefited from health tourism promotions. In 2011, there were 221 private hospitals and the number is expected to reach 239 by 2018. Other private health care service facilities, namely maternity homes, nursing homes, ambulatory care centres, blood banks, haemodialysis centres, and combinatorial facilities also experienced outstanding growth. The sector's share in total KI services industry increased from 3% in 2000 to 4% in 2010 **(see Figure 11.19)**.

11.5 KNOWLEDGE-INTENSIVE SERVICES INDUSTRY IN THE DEVELOPED AND EMERGING ECONOMIES

The global value added of KI services doubled from US$8.3 trillion in 2000 to US$16.8 trillion in 2010, representing 92.3% of the value added of all KTI services (US$18.2 trillion in 2010). **Figure 11.20** shows that all the KI services experienced positive growth between 2005 and 2010, with their value added doubling during the period. The business services represented 34% of total global KI services value added in 2010, followed by financial services (23%), health and social services (20%), education services (15%) and communications services (8%).

Figure 11.20: Global KI Services Value Added, by Sub-Sector, 2005-2010

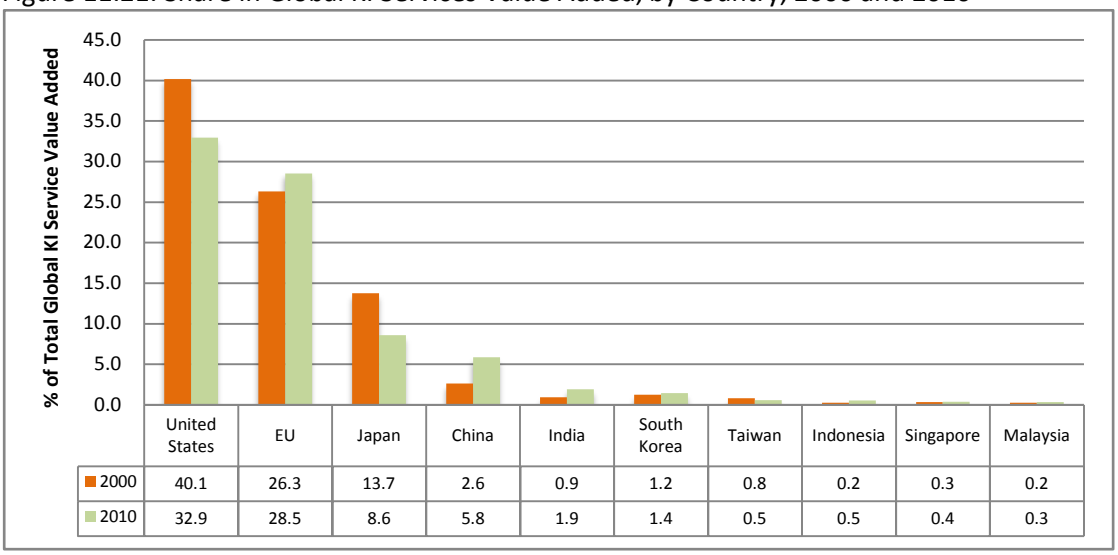


Source: Based on data extracted from US Science and Engineering Indicators 2012

The share of the KI services in world nominal GDP increased from 26% in 2000 to 28% 2010. The United States had the highest share of KI services in its economic activities, which expanded from 34% to 38% between 2000 and 2010. In the EU, the share rose from 26% to 30% in the same period. Other economies that had a relatively high KI services share in their GDP are Japan (26%), Singapore (28%), South Korea (24%), Taiwan (21%) and Malaysia (21%). India's and China's share are 19% and 16% respectively, while Indonesia's share is the lowest in the region (13%). It is important to note here that the variations in the share reflect the level of economic development and complications in measuring the service sector's contribution to the economy (US Science and Engineering Indicators, 2012).

Figure 11.21 presents the share of leading KI service suppliers in global value added. In 2010, the United States held a two-third share of global KI services value added (in 2000: 40.1%). The EU's KI services value added experienced a notable expansion from US$2.2 trillion in 2000 to US$4.8 trillion in 2010; thus increasing its share in global KI services value added from 26.3% to 28.5%. Other key producers in the world are all from Asia. Japan and Taiwan's contribution to global KI services value added has decreased over the years, while the share of other Asian countries expanded. The biggest increase is recorded by China, where its share rose from 2.6% to 5.8%.

Figure 11.21: Share in Global KI Services Value Added, by Country, 2000 and 2010

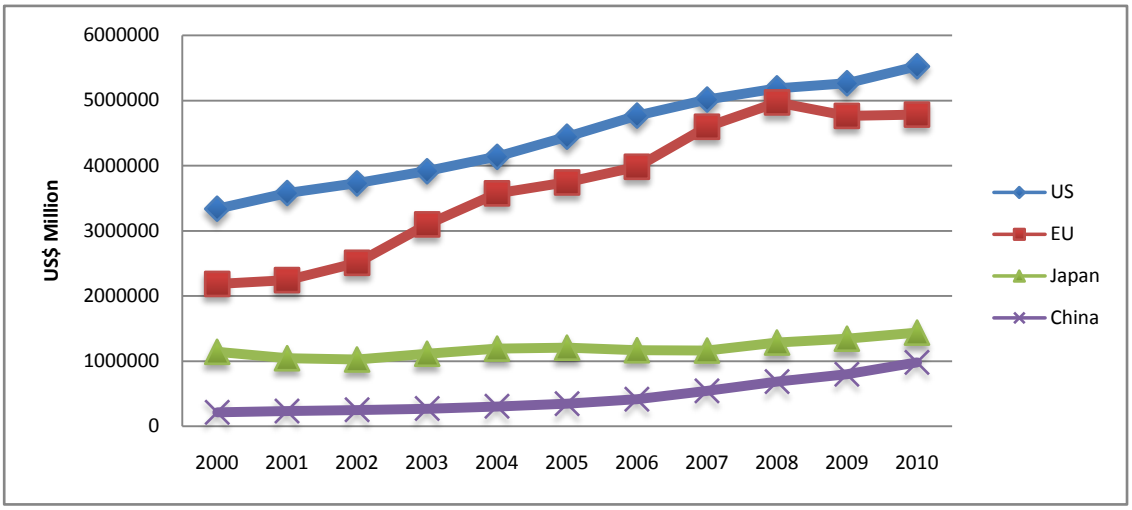


	United States	EU	Japan	China	India	South Korea	Taiwan	Indonesia	Singapore	Malaysia
2000	40.1	26.3	13.7	2.6	0.9	1.2	0.8	0.2	0.3	0.2
2010	32.9	28.5	8.6	5.8	1.9	1.4	0.5	0.5	0.4	0.3

Source: Based on data extracted from US Science and Engineering Indicators 2012

The United States KI services value added expanded steadily between 2000 and 2010 from US$3.3 trillion to US$5.5 trillion **(see Figure 11.22)**. However, KI industries in the EU grew at a faster rate (CAGR between 2000 and 2010 is 8.2%) than that of the US (CAGR: 5.2%), thus narrowing the gap between the two nations. The growth of Japanese KI industries is the lowest (CAGR: 2.3%). On the other hand, Chinese KI industries recorded the fastest growth of 16.3% per year.

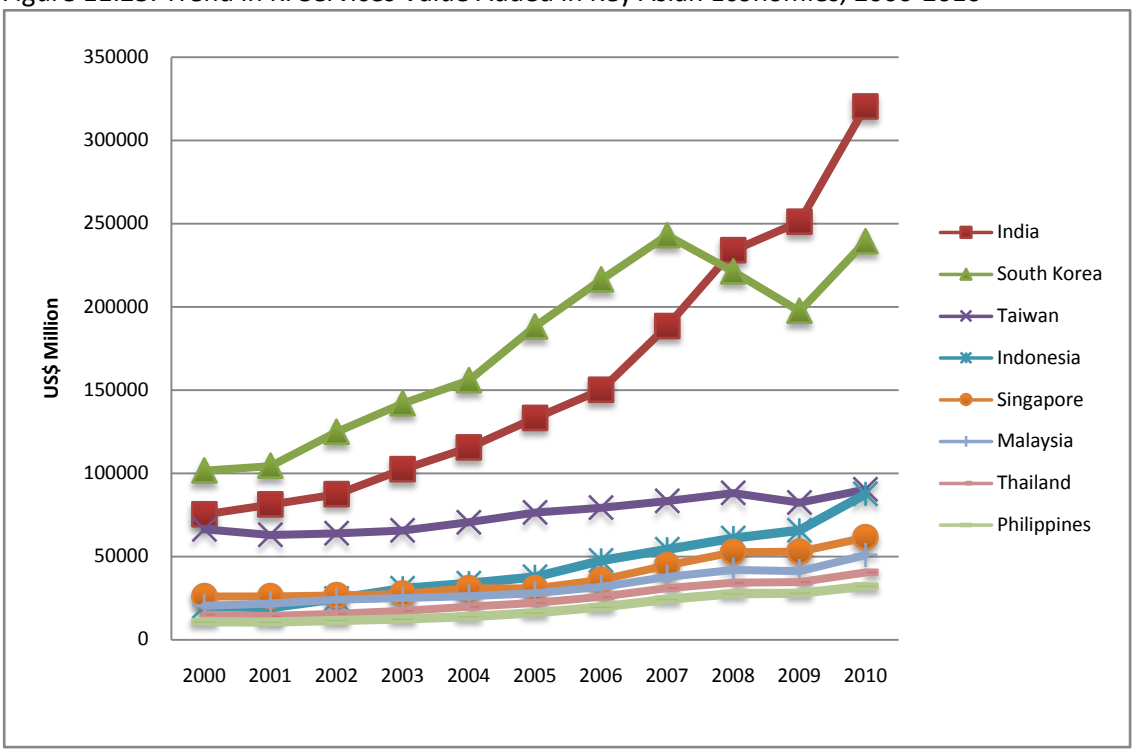
Figure 11.22: Leading Global Producers of KI Services, 2000-2010



Source: Based on data extracted from US Science and Engineering Indicators 2012

Other Asian producers experienced positive growth during the period between 2000 and 2010. India quickly caught up in the industry with its outstanding value added growth of 15.6% per annum. It became the third largest producer of KI services in Asia after overtaking Korea in terms of total value added in 2008 **(see Figure 11.23)**.

Figure 11.23: Trend in KI Services Value Added in Key Asian Economies, 2000-2010



Source: Data extracted from US Science and Engineering Indicators 2012

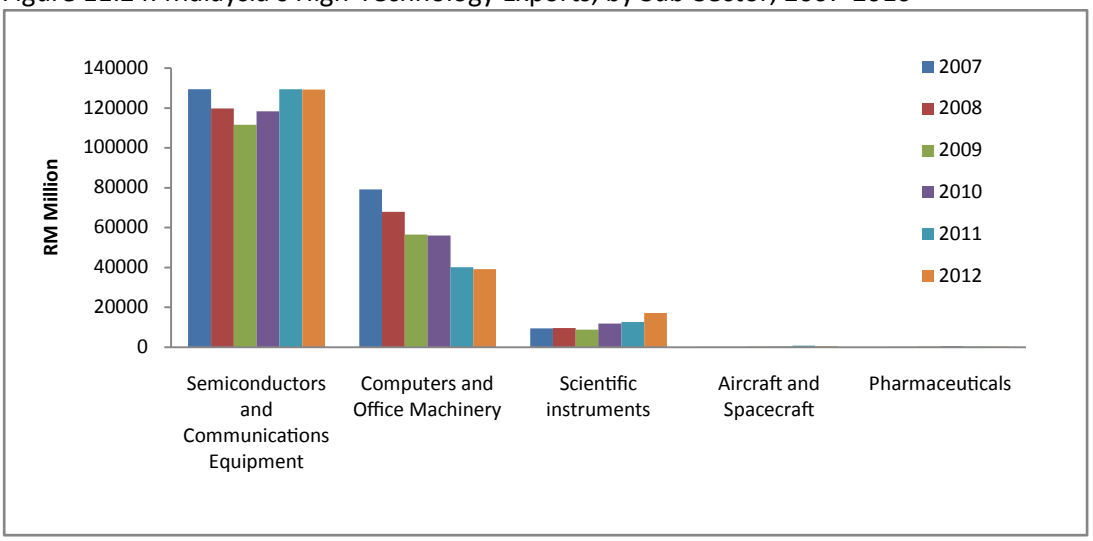
South Korea's KI services value added grew at 8.9% per annum between 2000 and 2010, despite a significant fall in 2009. Indonesia recorded an outstanding performance between 2000 and 2010 with a CAGR of 15.9%. Consequently, by 2010, Indonesia's KI services value added reached the same level as that of Taiwan (CAGR: 3.1%).

11.6 MALAYSIA'S TRADE AND TRADE BALANCE IN HIGH-TECHNOLOGY PRODUCTS

Malaysia's total exports of high-technology products decreased from RM218.4 billion in 2007 to RM187.1 billion in 2010, and further declined to RM186.4 billion in 2012. The sector's share in total manufacturing exports steadily declined from 46.1% in 2007 to 38.4% in 2010. By 2012, the share is reduced to 35.9%.

High-technology industry exports in Malaysia have been consistently dominated by two industrial sub-sectors, namely the semiconductors and communications equipment and the computers and office machinery. In 2012, these sub-sectors represented 90.3% of the total high-technology manufacturing exports **(see Figure 11.24)**.

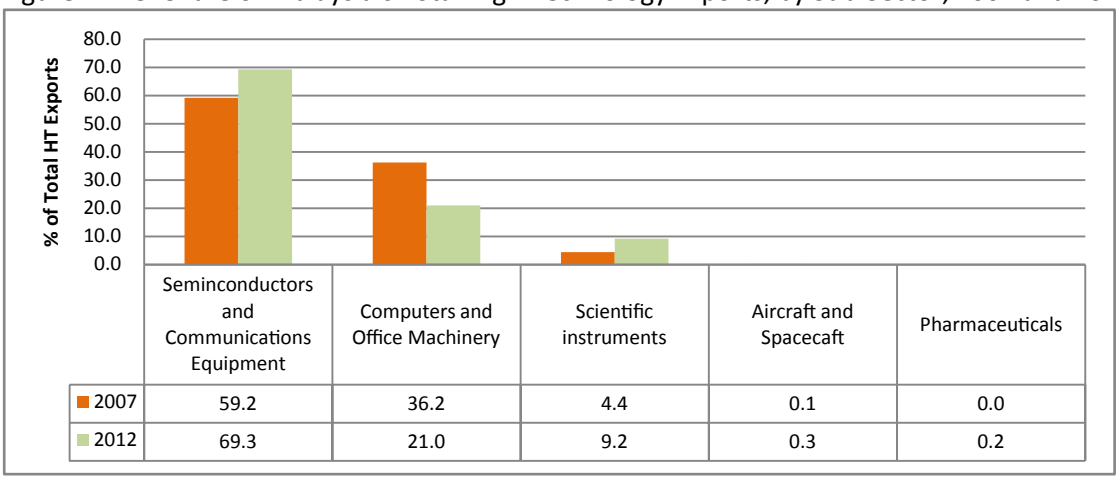
Figure 11.24: Malaysia's High-Technology Exports, by Sub-Sector, 2007-2010



Source: Data extracted from the Department of Statistics Malaysia

The semiconductors and communications equipment exports have experienced sluggish growth since 2007, where the value of exports remained at about RM129 billion. However, in terms of share in total HT exports, it rose from 59.2% in 2007 to 69.3% in 2012 **(see Figure 11.25)**. The computers and office machinery sector registered a continuous decline in exports since 2007; consequently, its share of total HT exports dropped from 36.2% in 2007 to 21.0% in 2012. The other three sectors recorded positive growth. Scientific equipment exports doubled from RM9.5 billion in 2007 to RM17.2 billion in 2012, and the sector's share in total HT exports increased from 4.4% to 9.2% during the period. The growth in aircraft and spacecraft sub-sector was much slower, registering an increase from RM306.1 billion in 2007 to RM466.7 billion in 2012. Pharmaceuticals exports tripled during the period; from RM95.8 billion to RM338.1 billion.

Figure 11.25: Share of Malaysia's Total High-Technology Exports, by Sub-Sector, 2007 and 2010

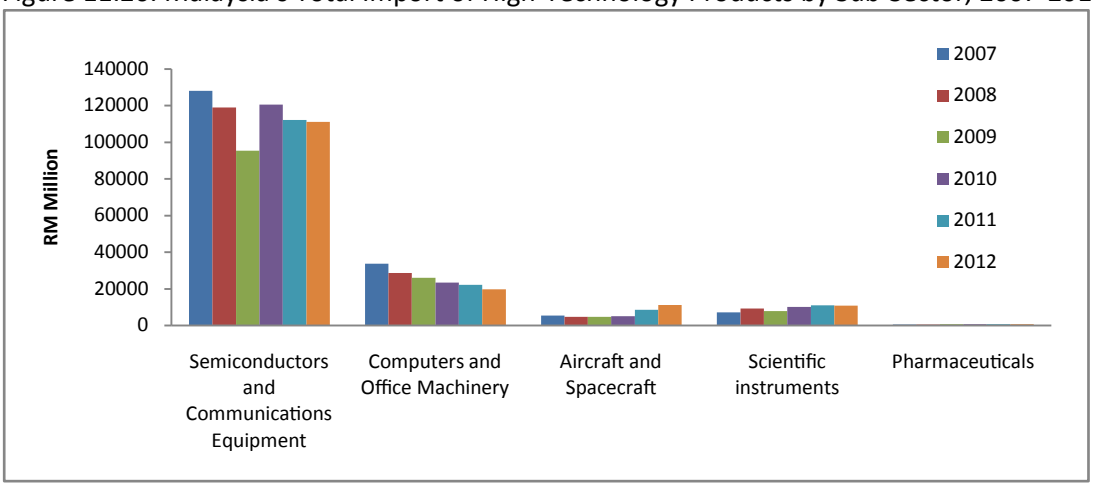


	Seminconductors and Communications Equipment	Computers and Office Machinery	Scientific instruments	Aircraft and Spacecaft	Pharmaceuticals
2007	59.2	36.2	4.4	0.1	0.0
2012	69.3	21.0	9.2	0.3	0.2

Source: Data extracted from the Department of Statistics Malaysia

Imports of high-technology products are largely comprised of semiconductors and communications equipment. However, the total value of import of these products has been trending downward since 2007. It reduced from RM128.1 billion in 2007 to RM112.2 billion in 2012 **(see Figure 11.26)**. Consequently, its share in total HT import reduced accordingly from 73.2% to 72.3% **(see Figure 11.27)**. Computers and office machinery import has also declined over the years, from RM33.6 billion in 2007 to RM19.8 billion in 2012.

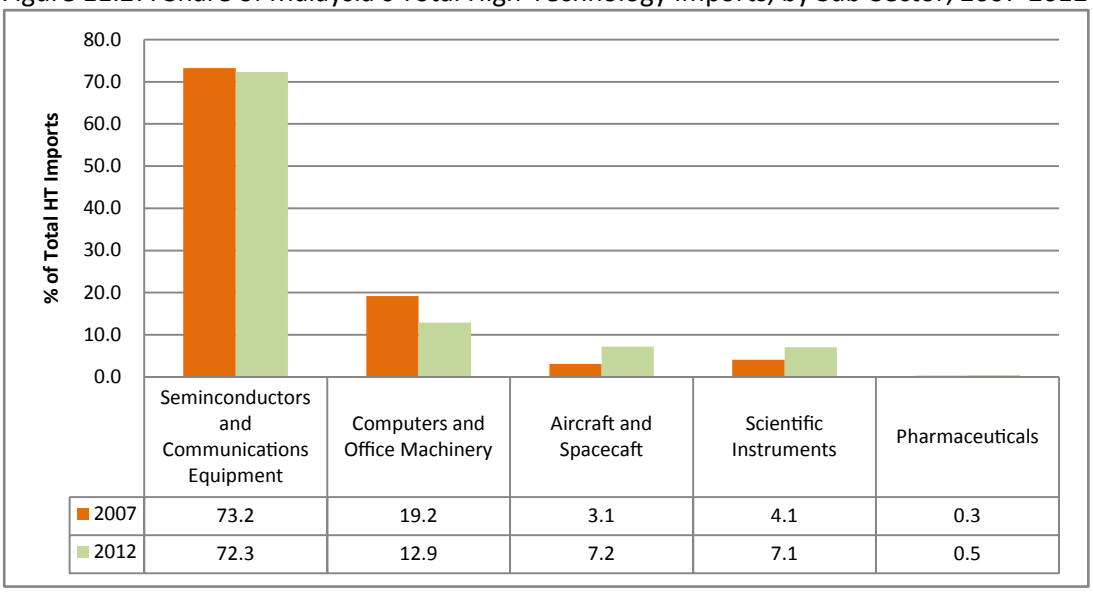
Figure 11.26: Malaysia's Total Import of High-Technology Products by Sub-Sector, 2007-2012



Source: Data extracted from the Department of Statistics Malaysia

Other HT manufacturing product imports registered an increase since 2007. Scientific instruments imports rose from RM7.2 billion in 2007 to RM10.9 billion in 2012, while the aircraft and spacecraft products import expanded from RM5.5 billion to RM11.1 billion. The import of pharmaceutical products recorded a small growth, from RM0.5 billion to RM0.7 billion. In terms of their share of total HT imports, that of electronics and telecommunications equipment and computers and office machinery products declined between 2007 and 2012. However, the share of imports of the other three sub-sectors increased during this period **(see Figure 11.27)**.

Figure 11.27: Share of Malaysia's Total High-Technology Imports, by Sub-Sector, 2007-2012

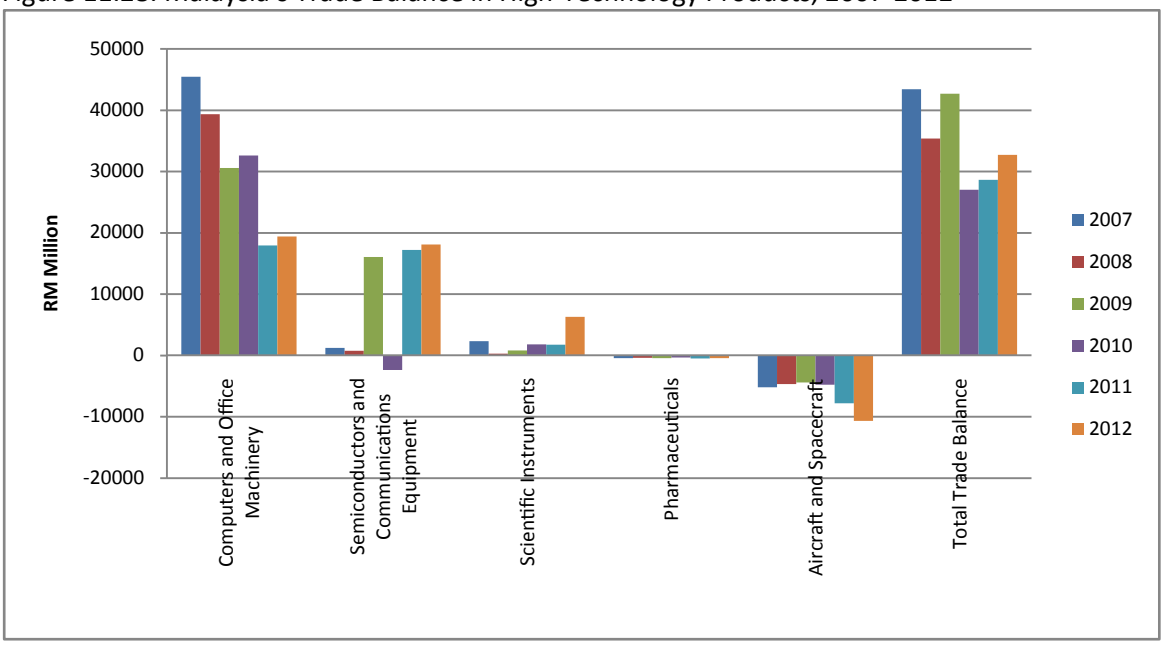


	Seminconductors and Communications Equipment	Computers and Office Machinery	Aircraft and Spacecaft	Scientific Instruments	Pharmaceuticals
2007	73.2	19.2	3.1	4.1	0.3
2012	72.3	12.9	7.2	7.1	0.5

Source: Data extracted from the Department of Statistics Malaysia

The trade balance of the high-technology products registered a surplus for all the years between 2007 and 2012, largely contributed by the semiconductors and computers and office machinery sub-sectors **(Figure 11.28)**. In 2012, the trade surplus for the HT industry totaled RM32.7 billion. However, there has been a downward trend in the total trade balance for the HT products since 2007, mainly contributed by shrinking surplus in the office machines category and rising deficit in the aerospace and spacecraft sector.

Figure 11.28: Malaysia's Trade Balance in High-Technology Products, 2007-2012



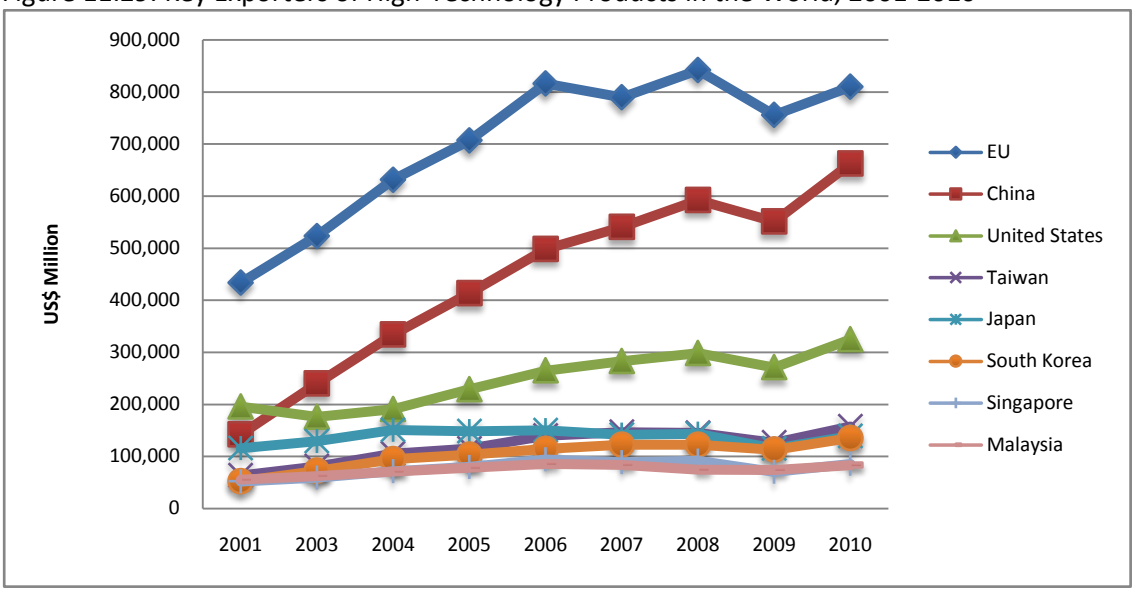
Source: Data extracted from the Department of Statistics Malaysia

The largest surplus is recorded in the computers and office machines sector despite the diminishing surplus over the years from RM45.5 billion in 2007 to RM19.4 billion in 2012. Semiconductors and telecommunications equipment trade balance improved notably from RM1.2 billion to RM18.1 billion during the same period. Similarly, the trade surplus in scientific instruments also registered positive growth from RM2.3 billion in 2007 to RM6.3 billion 2012. The trade balance for aircraft and spacecraft and pharmaceutical products recorded persistent and mounting deficit.

11.7 TRADE AND TRADE BALANCE IN HIGH-TECHNOLOGY IN THE DEVELOPED AND EMERGING ECONOMIES

Global exports of HT goods in 2010 amounted to US$2.8 trillion (2001: US$1.3 trillion). The major exporting countries are the EU, China and the United States **(see Figure 11.29)**; together they accounted for 64.2% of global high-technology product exports in 2010. During the period, all the leading global exporters experienced a rising trend in their exports, especially the EU and China, which registered outstanding growth in HT exports. The EU's exports increased from US$433.5 billion to US$809.6 billion, while China's exports expanded four-fold from US$142.5 billion to US$662.3 billion. Malaysia was the eighth largest exporter of HT products in the world in 2010.

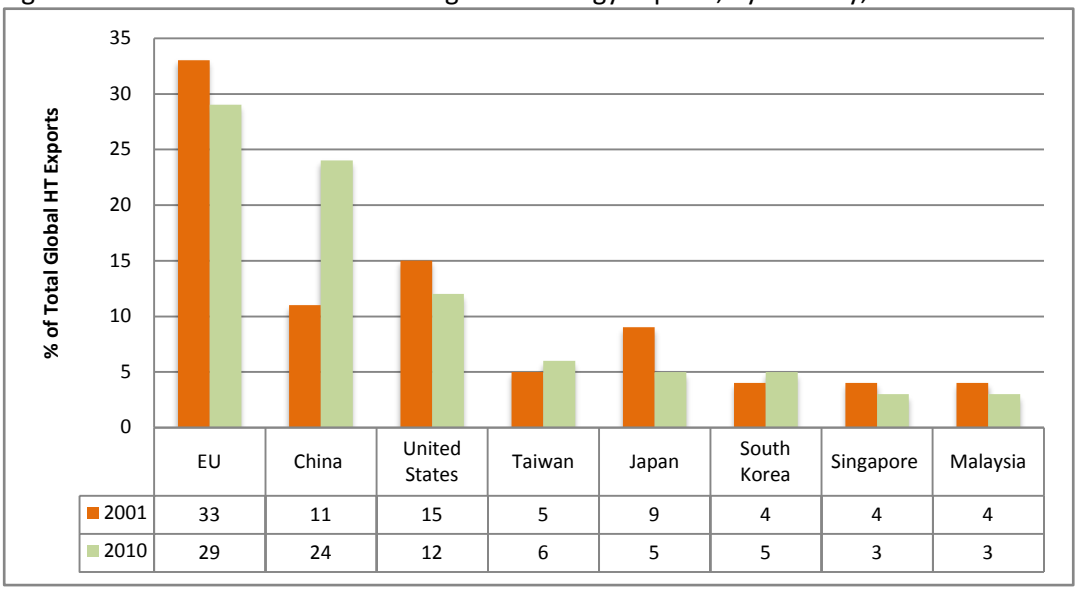
Figure 11.29: Key Exporters of High-Technology Products in the World, 2001-2010



Source: Data extracted from US Science and Engineering Indicators, 2012

Figure 11.30 shows that China's share in the HT global trade rose notably from 11% in 2001 to 24% in 2010. As a result of this, the market share of other key exporters gradually shrank. The most drastic drop was experienced by Japan, where its market share dwindled from 9% to 5% between 2001 and 2010. The EU's export share fell from 33% to 29%, while the contribution by the United States dropped from 15% to 12%. Similarly, Malaysia's share declined from 4% to 3%. Nevertheless, Taiwan and South Korea experienced an expansion in the global export share.

Figure 11.30: Share of Total Global High-Technology Exports, by Country, 2001 and 2010

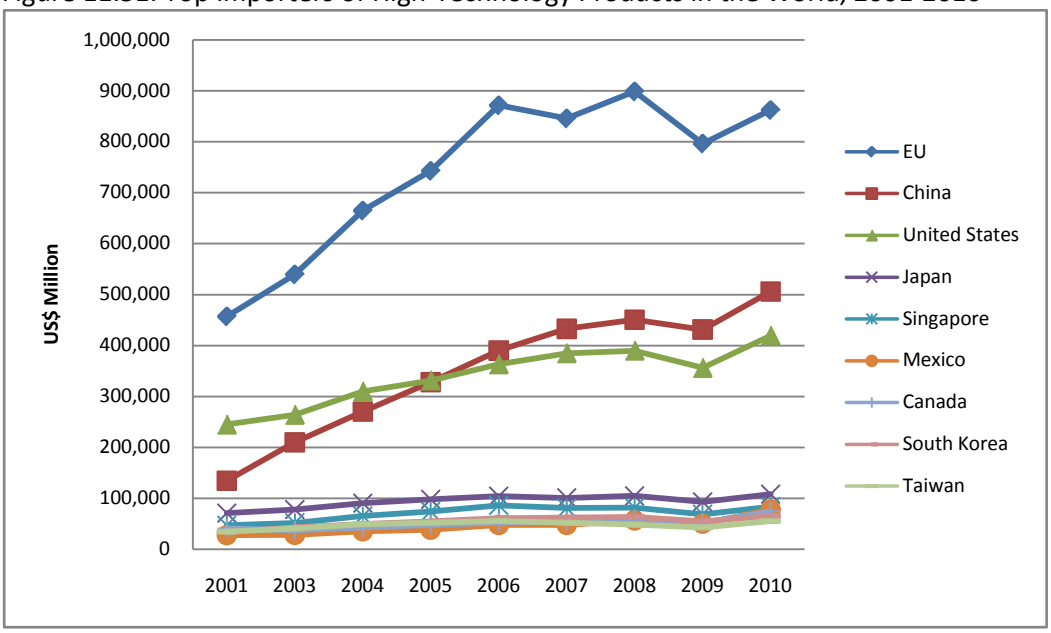


	EU	China	United States	Taiwan	Japan	South Korea	Singapore	Malaysia
2001	33	11	15	5	9	4	4	4
2010	29	24	12	6	5	5	3	3

Source: Data extracted from US Science and Engineering Indicators, 2012

The largest importers of HT products in the world were the EU, China and the US **(see Figure 11.31)**. The total HT imports by the EU doubled from US$456.9 billion in 2001 to US$862.2 billion in 2010. A similar trend is noted for the United States. China's import increased four-fold; from US$134.4 billion to US$505.6 billion.

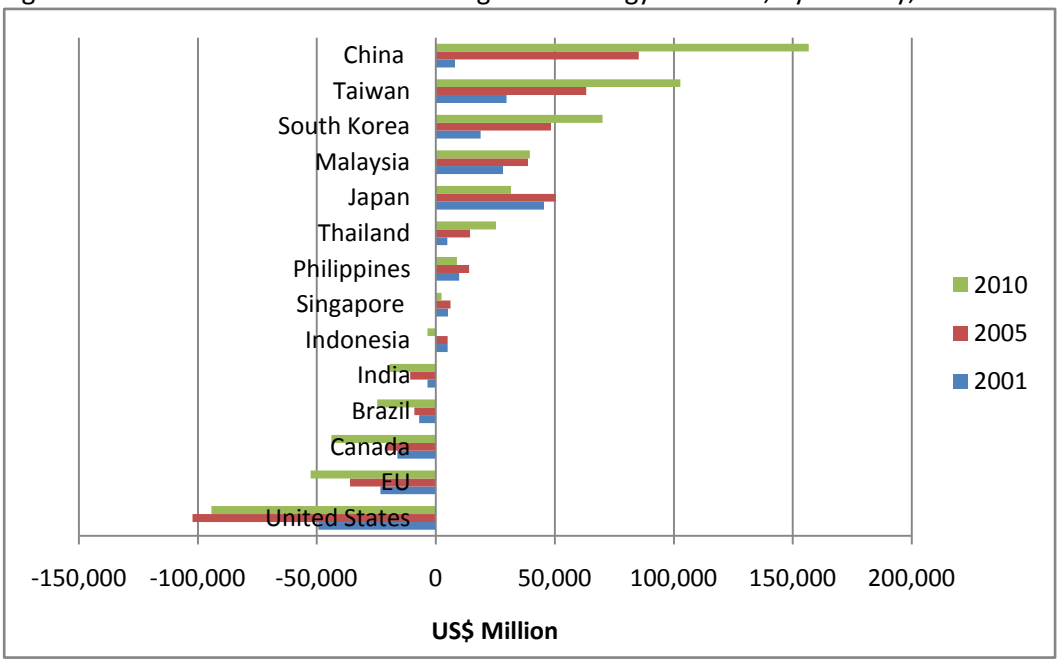
Figure 11.31: Top Importers of High-Technology Products in the World, 2001-2010



Source: Data extracted from US Science and Engineering Indicators, 2012

Southeast and East Asian countries registered a surplus in HT trade between 2001 and 2010 **(see Figure 11.32)**. China recorded the largest trade surplus, registering a ten-fold increase from US$8.1 billion to US$85.2 billion between 2001 and 2005. By 2010, the surplus expanded to US$156.7 billion.

Figure 11.32: Global Trade Balance in High-Technology Products, by Country, 2001-2010



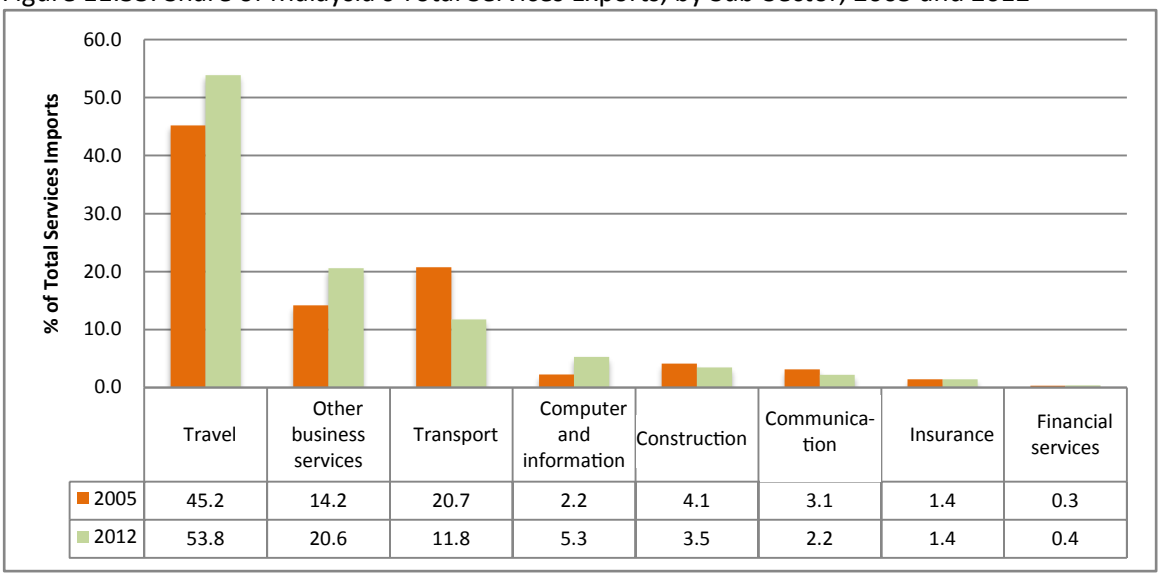
Source: Data extracted from US Science and Engineering Indicators, 2012

In contrast, the United States recorded the largest deficit in high-technology trade in 2010, totaling US$94.3 billion. The trade deficit in the EU, Brazil, Canada and India widened during the period between 2001 and 2010.

11.8 MALAYSIA'S TRADE AND TRADE BALANCE IN KNOWLEDGE-INTENSIVE SERVICES

Malaysia's total services exports increased from RM52.9 billion in 2000 to RM115.9 billion in 2012. The expansion in services exports is mainly contributed by travel services, which accounted for 53.8% of the total services exports in 2012 **(Figure 11.33)**. Travel services increased three fold between 2000 and 2012, rising from RM19.0 billion to RM62.4 billion during the period.

Figure 11.33: Share of Malaysia's Total Services Exports, by Sub-Sector, 2005 and 2012

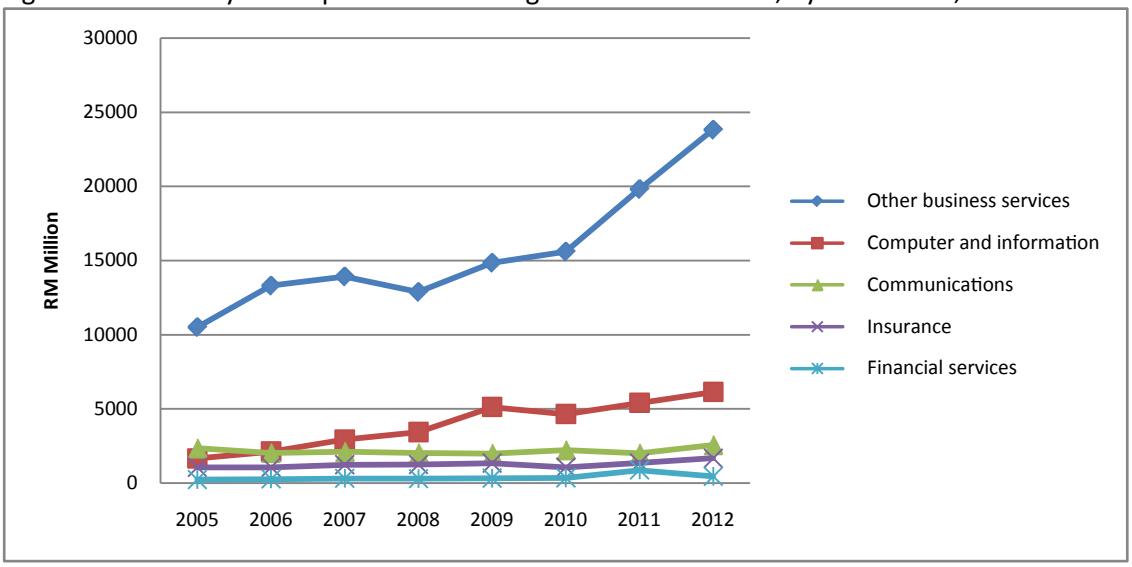


	Travel	Other business services	Transport	Computer and information	Construction	Communica-tion	Insurance	Financial services
2005	45.2	14.2	20.7	2.2	4.1	3.1	1.4	0.3
2012	53.8	20.6	11.8	5.3	3.5	2.2	1.4	0.4

Source: Data extracted from UNCTADStats

All the KI services sectors experienced positive export growth between 2005 and 2012. In particular, other business services had the highest contribution to services exports, accounting for 20.6% of total services exports in 2012 **(see Figure 11.33)**. Its total exports rose gradually from RM10.5 billion in 2005 to RM14.8 billion in 2009, and then rose sharply to RM19.8 billion and RM23.8 billion in 2011 and 2012 respectively **(see Figure 11.34)**.

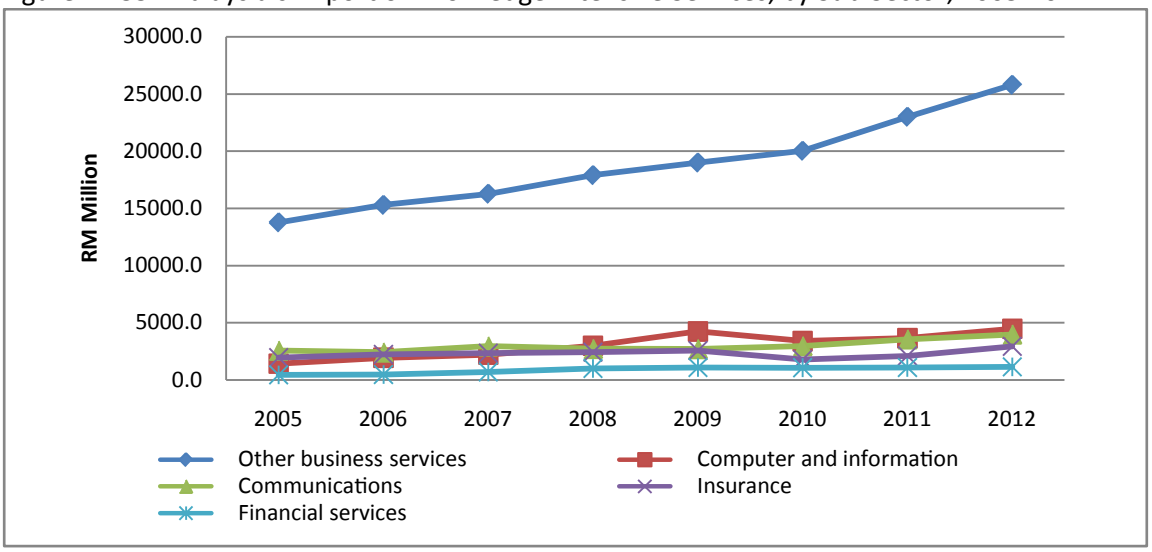
Figure 11.34: Malaysia's Exports of Knowledge-Intensive Services, by Sub-Sector, 2005-2012



Source: Data extracted from UNCTADStats

The import of knowledge-intensive services grew steadily over the years between 2005 and 2012. The largest import of KI services in Malaysia is that of other business services, accounting for 61.2% in 2012. Total import of other business services grew at 9.4% annually between 2005 and 2012, thereby doubling the value of import from RM13.8 billion to RM25.8 billion during the period **(Figure 11.35)**. The imports of other KI services grew at a slower pace.

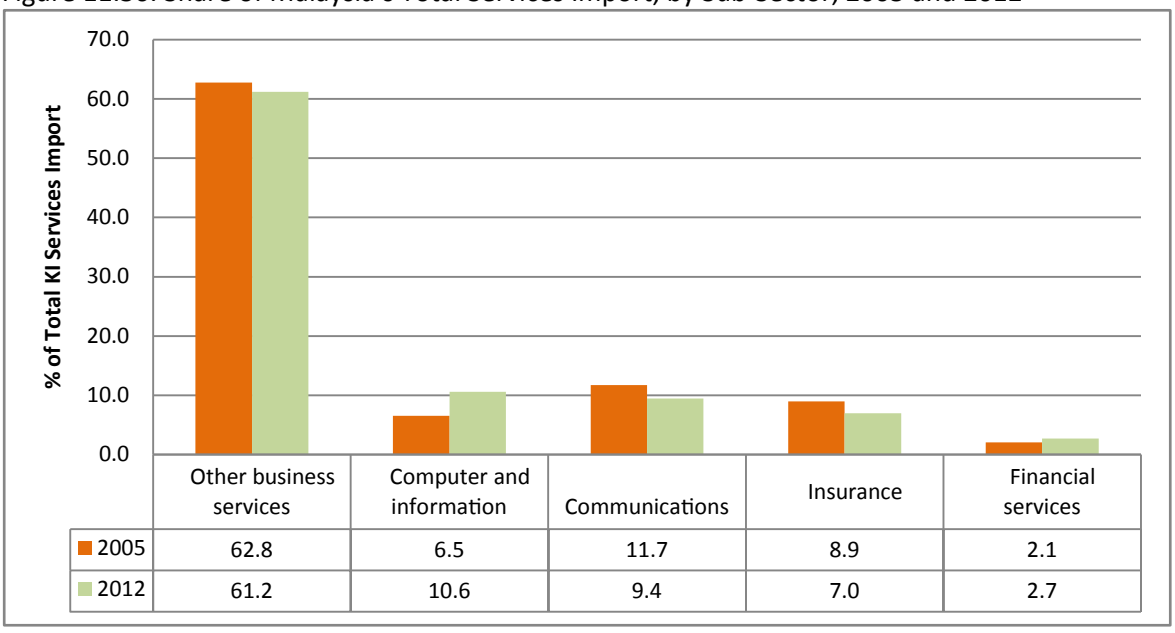
Figure 11.35: Malaysia's Import of Knowledge-Intensive Services, by Sub-Sector, 2005-2012



Source: Data extracted from UNCTADStats

Figure 11.36 demonstrates that between 2005 and 2012 the share of computer and information services and financial services in total services import registered an increase. The computer and information services import share increased from 6.5% in 2005 to 10.6% in 2012, while financial services' share rose slightly from 2.1% to 2.7%. The other three KI sub-sectors experienced a decline in their share. The communications services' share in total services import fell from 11.7% to 9.4%; other business services (from 62.8% to 61.2%) and insurance (from 8.9% to 7.0%).

Figure 11.36: Share of Malaysia's Total Services Import, by Sub-Sector, 2005 and 2012

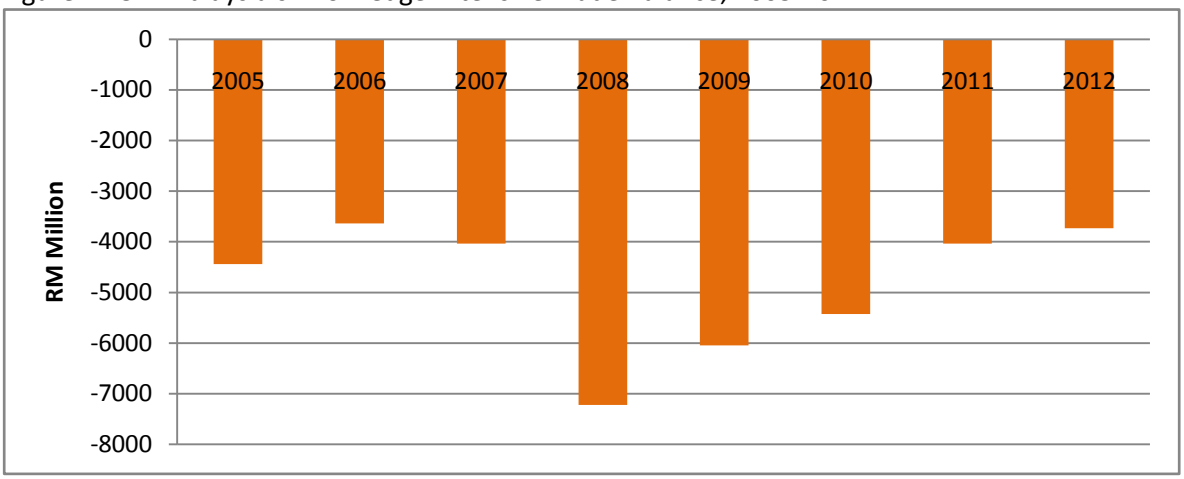


	Other business services	Computer and information	Communications	Insurance	Financial services
2005	62.8	6.5	11.7	8.9	2.1
2012	61.2	10.6	9.4	7.0	2.7

Source: Data extracted from UNCTADStats

The KI services trade balance has recorded a persistent deficit since 2005. In 2005, the trade deficit was RM4.4 billion, which then widened to RM7.2 billion in 2008 **(See Figure 11.37)**. Since then, the trade deficit gradually declined, and by 2012, it totaled RM3.7 billion.

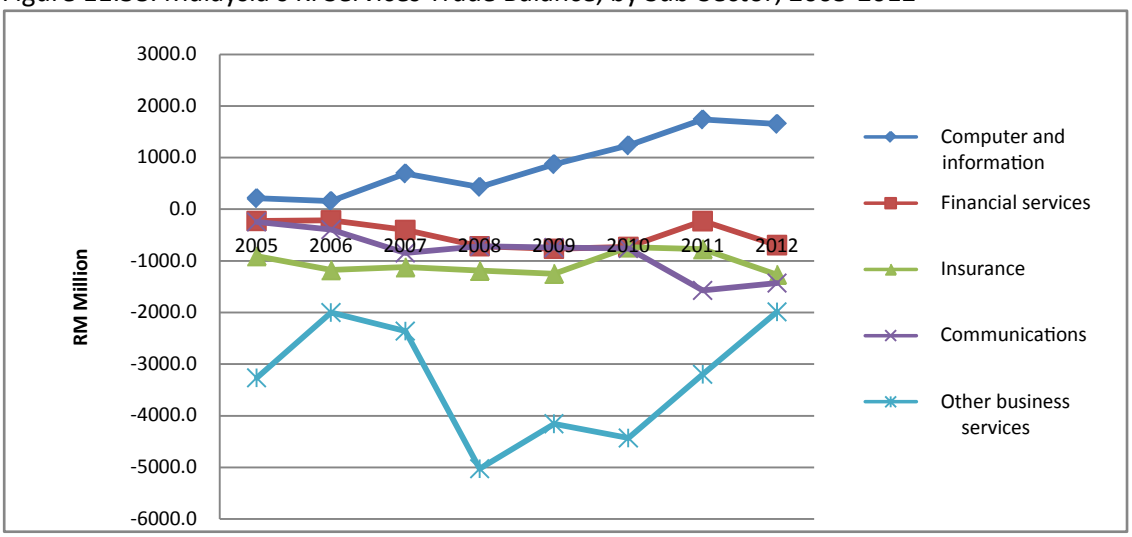
Figure 11.37: Malaysia's Knowledge-Intensive Trade Balance, 2005-2012



Source: Data extracted from UNCTADStats

The only sector that has registered a trade surplus is computer and information services. The trade surplus of this sector improved from RM212.1 million in 2005 to RM1.7 billion in 2012 **(see Figure 11.38)**. Other KI services sectors have recorded a continuous trade deficit. The largest deficit was in other business services that worsened from RM3.3 billion in 2005 to RM5.0 billion in 2008. However, the sector has experienced an improved trade balance since 2009, and registered a relatively smaller deficit of RM3.7 billion in 2012.

Figure 11.38: Malaysia's KI Services Trade Balance, by Sub-Sector, 2005-2012



Source: Data extracted from UNCTADStats

11.9 TRADE AND TRADE BALANCE IN KNOWLEDGE-INTENSIVE SERVICES IN THE DEVELOPED AND EMERGING ECONOMIES

Global KI services exports expanded from US$1.5 trillion in 2000 to US$4.4 trillion in 2012. Two-thirds of the total global KI services exports was contributed by the developed countries, while developing countries accounted for only 30.4% **(see Table 11.6)**. Other business services accounted for 25.5% of total global KI services exports in 2012, followed by travel services (25.1%), transport services (20.2%), financial services (6.8%), computer and information services (5.9%), communications services (2.5%) and insurance (2.3%).

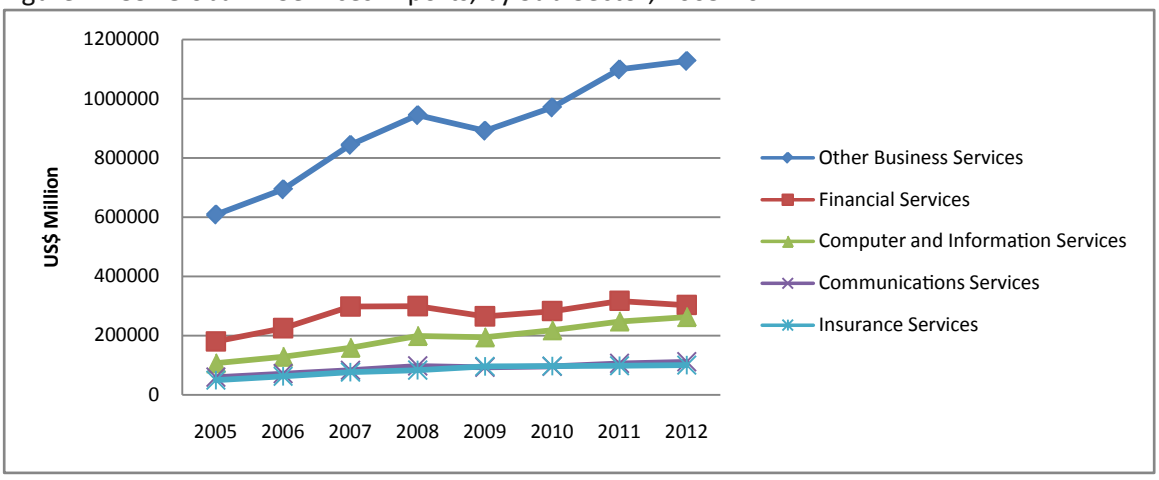
Table 11.6: Global KI Services Exports, by Sub-Sector and Level of Development, 2012

KI Services Sectors	Developing Economy		Transition Economy		Developed Economy		Total World Services Exports	
	US$ Million	% of World Total	US$ Million	% of World Total	US$ Million	% of World Total	US$ Million	% of World Total
Total Services	1,345,900	30.4	129,400	2.9	2,950,500	66.7	4,425,800	-
Other Business Services	330,400	29.3	26,400	2.3	770,500	68.4	1,127,200	25.5
Financial Services	51,800	17.1	2,000	0.7	249,300	82.3	303,100	6.8
Computer and Information Services	78,300	29.8	4,400	1.7	180,000	68.5	262,700	5.9
Communications Services	27,500	24.7	4,000	3.6	80,000	71.7	111,500	2.5
Insurance Services	20,100	20.0	700	0.7	79,500	79.3	100,300	2.3

Source: Data extracted from UNCTADStats

Other business services exports grew at an annual growth rate of 9.2% between 2005 and 2012, expanding from US$608.2 billion to US $1.1 trillion in the 7-year period **(see Figure 11.39)**, while global financial services exports increased from US$180.2 billion to US$303.1 billion (CAGR: 7.7%). Exports in computer and information services also expanded during the period, at an annual growth rate of 13.8%, growing from US$106.3 billion to US$262.7 billion, while communications services exports grew at 9.4% annually recording total exports of US$111.5 billion in 2012. The total export of insurance services in 2012 was US$100.3 billion.

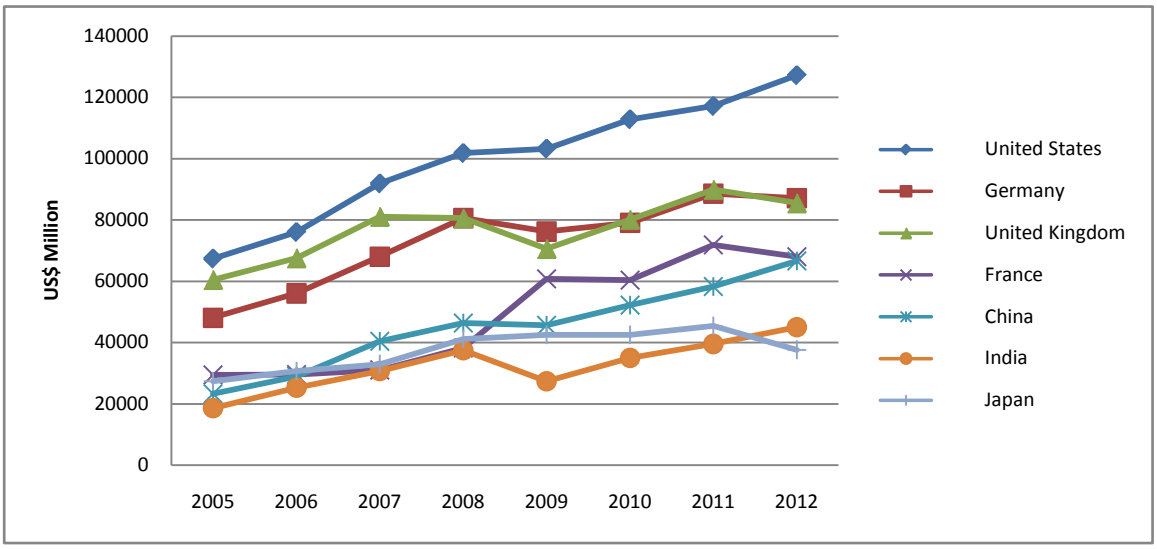
Figure 11.39: Global KI Services Exports, by Sub-Sector, 2005-2012



Source: Data extracted from UNCTADStats

The largest producer of other business services in the world in 2012 was the United States **(see Figure 11.40)**. Its exports accounted for about 11% of the total global exports of other business services, and the value of exports doubled from US$67.4 billion in 2005 to RM127.4 billion in 2012. Other key exporters in 2012 were Germany (7.9%), the United Kingdom (7.6%), France (6.0%), China (5.9%), India (4.0%) and Japan (3.3%).

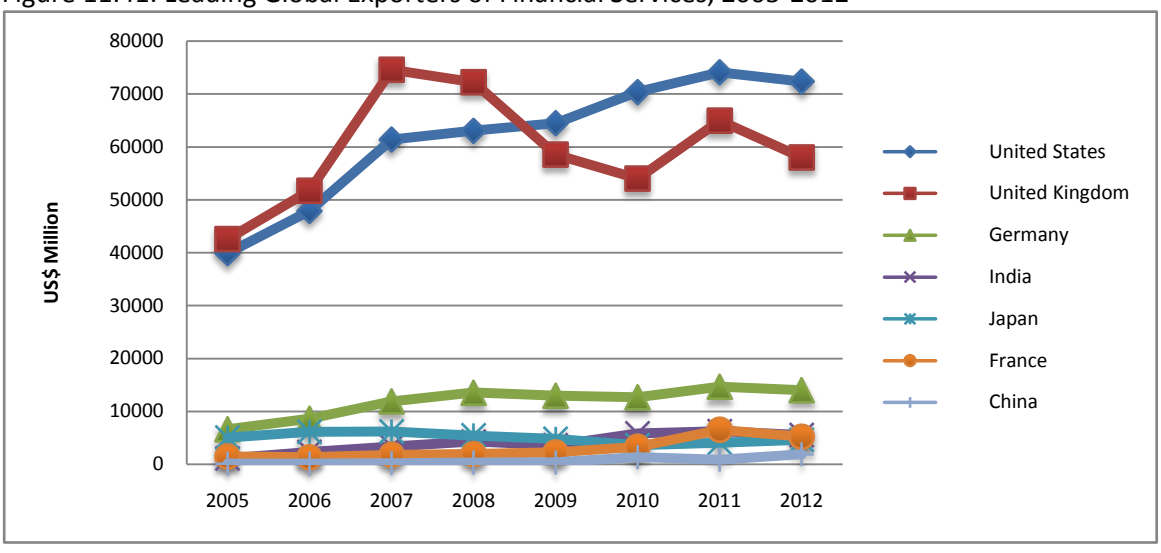
Figure 11.40: Leading Global Exporters of Other Business Services, 2005-2012



Source: Data extracted from UNCTADStats

In the financial services sector, the United States and the United Kingdom were the leading exporters, accounting for 23.9% and 19.1% respectively of the total global financial services exports in 2012 **(Figure 11.41)**. Other key exporters were Germany (4.6%), India (1.8%), Japan (1.5%), France (1.7%) and China (0.8%). The United Kingdom was the leading financial services exporter until 2008. However, the UK experienced a gradual decline in the financial services exports since 2007 while the exports from the United States recorded a steady expansion since 2005. As a result of this, the United States became the top exporter of financial services in 2009.

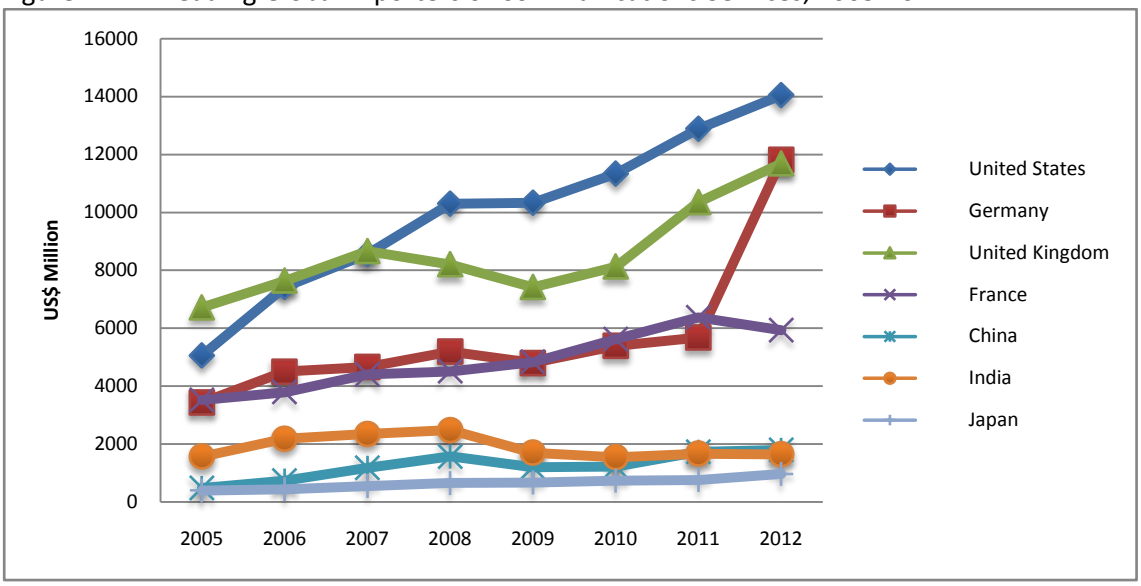
Figure 11.41: Leading Global Exporters of Financial Services, 2005-2012



Source: Data extracted from UNCTADStats

The leading global exporters of communications services in 2012 were the United States, Germany and the United Kingdom **(see Figure 11.42)**. Their shares in global communications services exports were 12.6%, 10.6% and 10.5% respectively. **Figure 11.42** shows that Germany's exports doubled from US$5.7 billion in 2011 to US$10.5 billion in 2012, improving Germany's global ranking for top exporters of communications services from the 4th to the 2nd position.

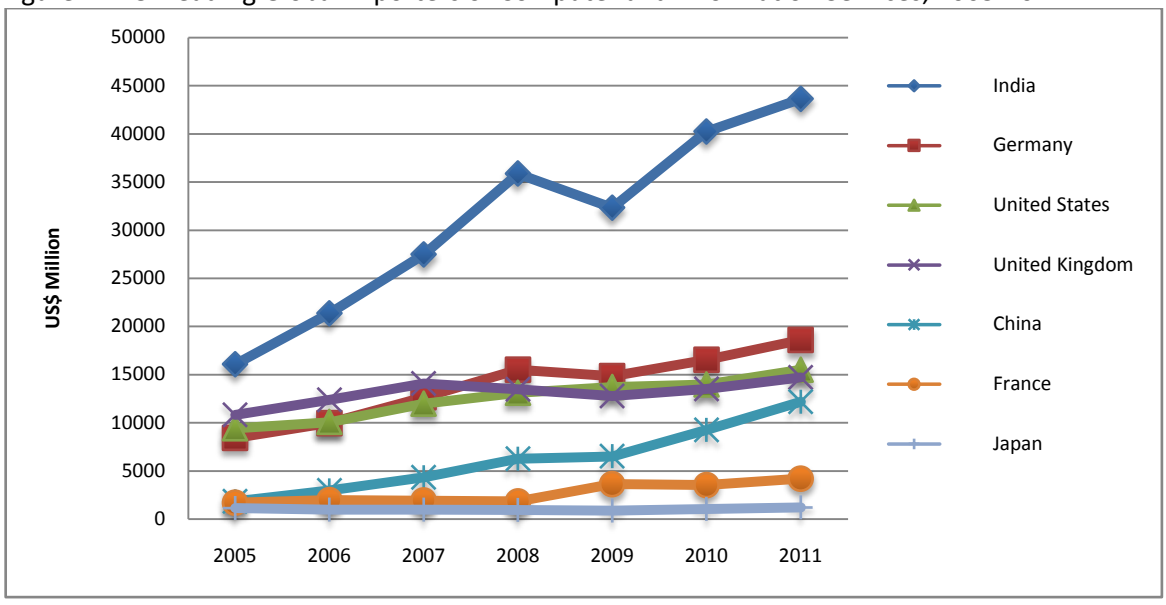
Figure 11.42: Leading Global Exporters of Communications Services, 2005-2012



Source: Data extracted from UNCTADStats

India is the leading exporter of computer and information services in the world **(see Figure 11.43)**. It experienced an outstanding annual growth of 42.3% between 2000 and 2012, recording an expansion of exports from US$16.1 billion in 2000 to US$43.6 billion in 2012. Consequently, its share in the global computer and information services exports increased from 12.5% in 2005 to 18.0% in 2012. China's exports also expanded notably from US$1.8 billion in 2000 to US$14.5 billion in 2012. Hence, its share in the global exports of computer and information services jumped from 0.8% to 5.5% during the period.

Figure 11.43: Leading Global Exporters of Computer and Information Services, 2005-2012



Source: Data extracted from UNCTADStats

Despite positive growth in exports, Germany, United States, UK, France and Japan held diminishing shares in the total global KI services exports. The largest decline in the share is registered by the United States, where it fell from 15.2% to 6.3% between 2000 and 2011[81].

11.10 CONCLUSIONS AND RECOMMENDATIONS

The high-technology and knowledge-intensive services industries play an important role in the Malaysian economy. However, the contribution of high-technology industries toward the nation's GDP and manufacturing exports has diminished over the years. In contrast, the knowledge-intensive services grew in importance. The KI services value added expanded at 9.6% annually between 2000 and 2010; hence doubling the value added from RM53.1 billion to RM117.4 billion. In terms of exports, there is an apparent difference in the performance of high-technology products and knowledge-intensive services, where the total exports of high-technology products experienced a downward trend between 2007 and 2012, while that of KI services exports registered a notable expansion.

Among the high-technology manufacturing sub-sectors, the aircraft and spacecraft, pharmaceuticals, and scientific equipment sectors have performed impressively in terms of value added and exports, although their share in the total manufacturing value added and exports is relatively small. The expansion in these sectors is a direct outcome of the government's policy emphasis in promoting investment in high-technology and high-value added sectors, with the objective of moving up the value chain and achieving a high-income nation status by 2020. As result of this policy shift, there has been a significant increase in FDIs in new growth areas, such as renewable energy, aerospace, pharmaceuticals, and medical equipment (Bank Negara Malaysia Annual Report, 2011). A similar trend is also found in the KI services that have benefited from a large inflow of foreign investments into the knowledge-intensive services sectors, such as financial services, education services, health and social services and shared services operations.

It would be useful to note that Malaysia's ranking in the Economic Complexity Index[82] list has gradually declined since year 2000. Malaysia ranked 27th in the ECI list in 2000, and by 2008[83], Malaysia's position went down to 34th. It implies that Malaysia's export diversity and sophistication relative to other countries in the world has worsened in the last decade.

[81] There is no data available for the United States for 2012. Therefore, data for 2005 to 2011 are used in Figure 11.43.

[82] The Economic Complexity Index (ECI) combines metrics of the diversity of countries and the ubiquity of products to create measures of the relative complexity of a country's exports.

[83] ECI list is available only up to 2008.

CHAPTER 12:
ENERGY AND GREEN TECHNOLOGY

CHAPTER 12

ENERGY AND GREEN TECHNOLOGY

12.0 INTRODUCTION

The energy sector continues to play a critical role in supporting the Malaysian economy and currently is estimated to contribute approximately 20% to the country's Gross Domestic Product (GDP). The sector is expected to play an even more important role in the near future, as the objective to achieve the developed economy status would increase the country's energy requirements to fuel the increasing economic activities. The sector is listed as one of the 12 National Key Economic Areas (NKEAs) to be given special attention due to its critical role in supporting the economy. Specifically, under the Economic Transformation Programme (ETP), 13 Entry Point Projects (EPPs) for the oil, gas, and energy industries are being categorized under four main thrusts, namely (i) sustaining oil and gas production, (ii) enhancing downstream growth, (iii) making Malaysia the number one Asian hub for oilfield services, and (iv) building a sustainable energy platform for growth. Consequently, the energy sector is expected to remain significant and to play a bigger role—parallel with our economic advancement—by contributing approximately RM273 billion to the country's targeted Gross National Income of RM1.7 trillion in 2020.

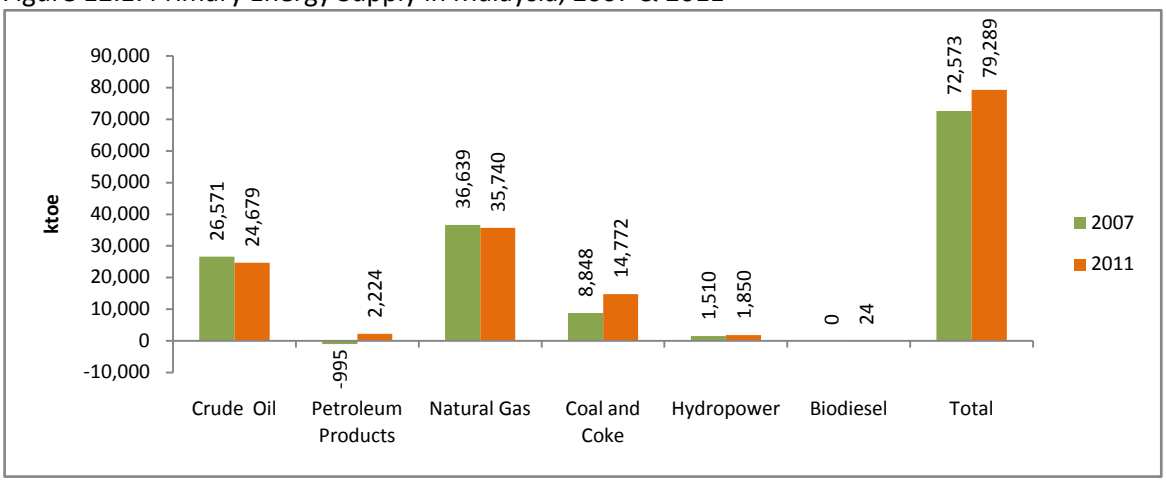
In view of the increasing energy demand but depleting natural energy resources and volatile energy prices, a major challenge posted before Malaysia and other countries today is the adoption of efficient energy management. Energy efficiency efforts have become a central issue in the energy sector in many countries. In Malaysia, the commitment to promote energy efficiency continues in the various development plans and policies aimed at achieving the objective. Long term strategies to address the issues of energy security, global warming and climate change are also being crafted in the national energy efficiency masterplan.

This chapter focuses on the recent developments in the energy sector in Malaysia. The chapter provides an overview of the energy sector in the country and discusses the country's continuous efforts to adopt efficient energy management. Updates on the development of renewable energy sources are provided along with the promotion of green technology in the country. The chapter ends with the prospects of the energy sector and concluding remarks.

12.1 ENERGY SUPPLY AND UTILISATION

In 2011, Malaysia produced a total of 79,289 kilo tonnes of oil equivalent (ktoe) of primary energy products compared to 72,573 ktoe in 2007, a growth of 9.2% over the five-year period **(Figure 12.1)**. The primary energy supply in Malaysia has been traditionally contributed by two major sources, namely natural gas (contributing 35,740 ktoe or 45.1% of the total supply in 2011) and crude oil (contributing 24,679 ktoe or 31.1%). Contributions from other sources of energy supply have been relatively small, with coal and coke at 18.6%, petroleum products at 2.8%, hydropower at 2.3% and biodiesel at only 0.03%. The growth in the primary energy supply during the 2007-2011 period has been contributed by the increase in all energy sources except crude oil, which recorded a decline of 7.1% from 26,571 ktoe in 2007 to 24,679 ktoe in 2011.

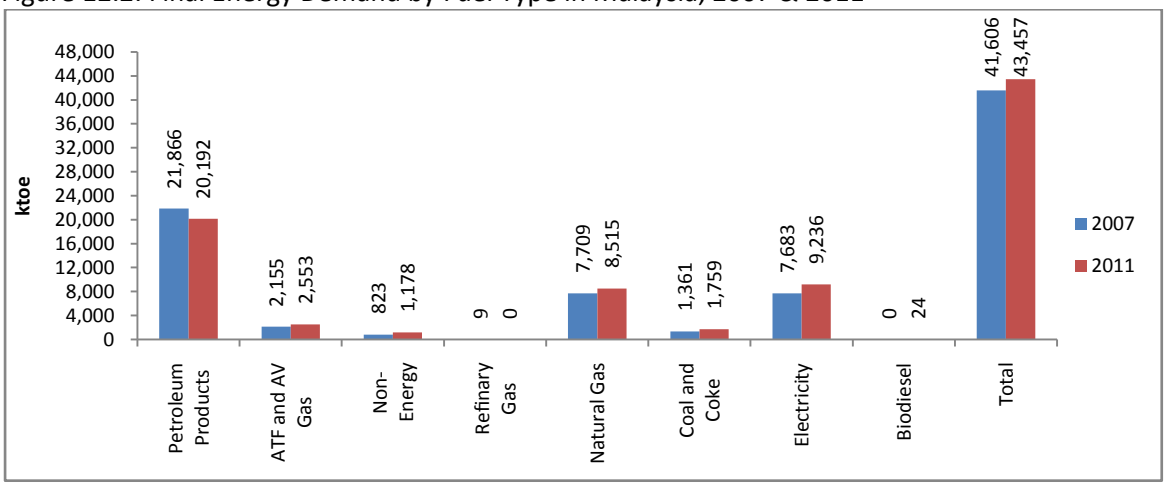
Figure 12.1: Primary Energy Supply in Malaysia, 2007 & 2011



Source: Energy Commission, Malaysia

Meanwhile, final energy demand reached 43,457 ktoe in 2011 from 41,606 ktoe in 2007, recording a growth of about 4.4% over the five-year period **(Figure 12.2)**. Demand largely comes in the form of petroleum products (accounting for 55.1% of the total energy demand), followed by electricity at 21.3%, natural gas at 19.6%, and coal and coke at 4.0%**.** In terms of growth, while the demand for diesel, fuel oil and motor petrol showed a decline over the 2007-2011 period, the demand for electricity has increased by 20.2% from 7,683 ktoe in 2007 to 9,236 ktoe in 2011 and natural gas by 10.5% from 7,709 ktoe in 2007 to 8,515 ktoe in 2011. The latest data show that total energy demand is expected to remain stable at 4.5% in 2013 on the back of sustained economic performance in the year.

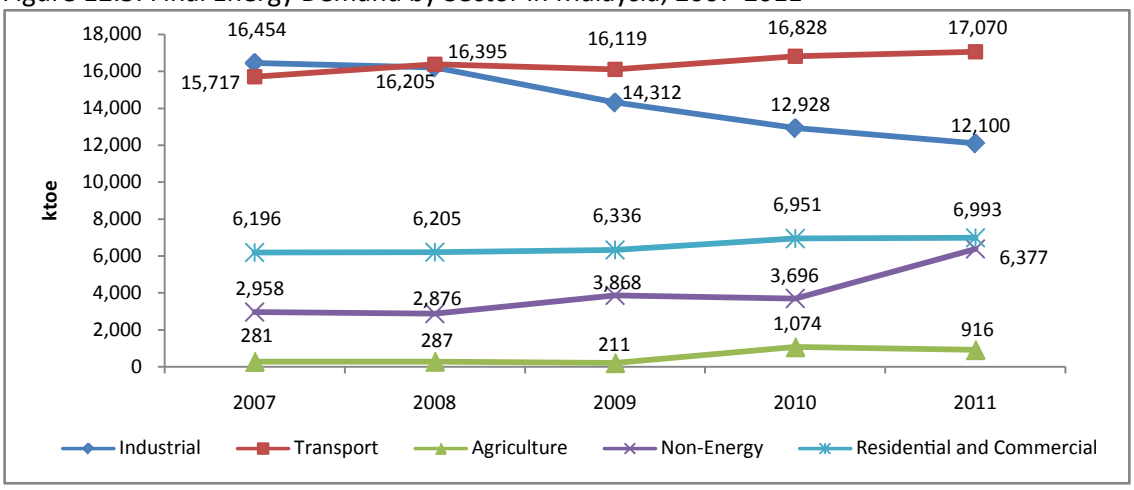
Figure 12.2: Final Energy Demand by Fuel Type in Malaysia, 2007 & 2011



Source: Energy Commission, Malaysia

During the period under review, the transport sector has been the leading sector in energy consumption surpassing the industrial sector since 2008 **(Figure 12.3)**. In 2011, the transport sector contributed nearly 40% of total energy demand in Malaysia, followed by the industrial sector at 27.8%, residential and commercial at 16.1%, non-energy use at 14.7% and agricultural sector at 2.1%. Over the five-year period, energy demand by the transport sector has grown steadily by 8.6%, while demand from the industrial sector has declined by 26.5%, reflecting the improvements in the sector's technical energy efficiency as well as the its shift towards a structure that is less energy intensive.

Figure 12.3: Final Energy Demand by Sector in Malaysia, 2007-2011

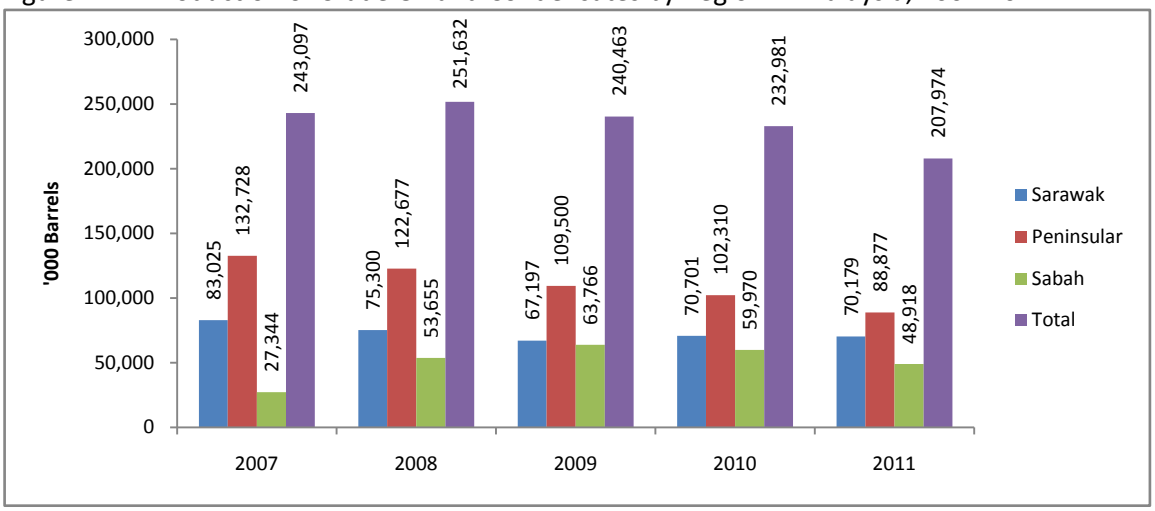


Source: Energy Commission, Malaysia

12.1.1 Crude Oil and Petroleum Products

The country's crude oil production dropped to 207.97 million barrels in 2011 from 243.10 million barrels in 2007 **(Figure 12.4)**. The 16.9% decline in crude oil production over the same period was mainly due to declining production in the oil fields in Peninsular Malaysia by 33.04% as well as in Sarawak by 15.5%. These declines, however, are offset, to a certain extent, by higher production in the oil fields in Sabah, which grew by nearly 80% during the same period. In terms of contribution to the country's total crude oil production, Peninsular Malaysia contributed 42.7%, Sarawak 33.7% and Sabah 23.5%.

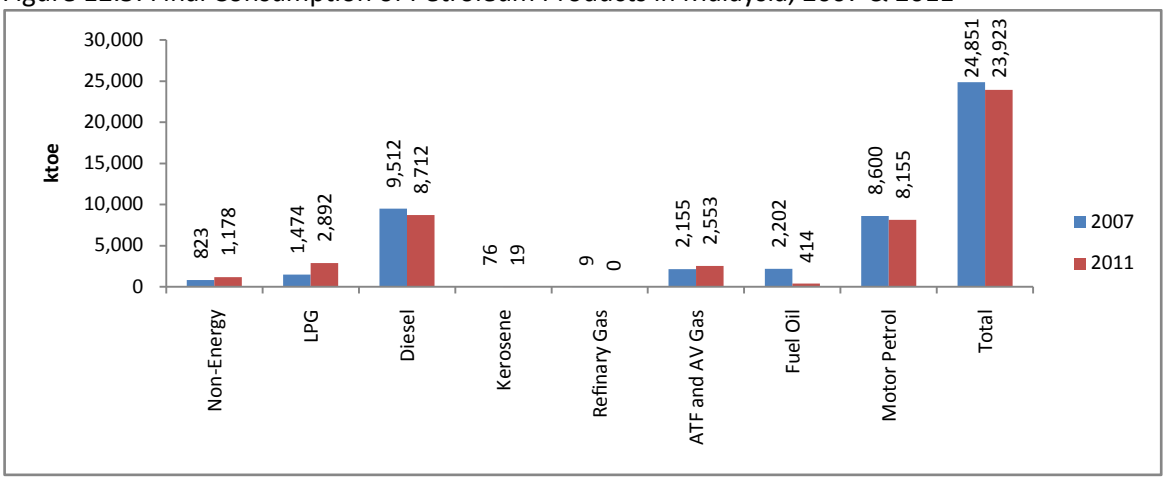
Figure 12.4: Production of Crude Oil and Condensates by Region in Malaysia, 2007-2011



Source: Energy Commission, Malaysia

Total demand for petroleum products declined to 23,923 ktoe in 2011 from 24,851 ktoe in 2007, recording a decline of 3.7% over the five-year period **(Figure 12.5)**. Final consumption of petroleum products in 2011 are largely in diesel, accounting for 36.42% of total consumption at 8,712 ktoe; motor petrol, which accounts for 34.09% at 8,155 ktoe; and LPG, which accounts for 12.09% at 2,892 ktoe. While demand in diesel and motor petrol declined by 8.41% and 5.17% respectively, the demand for LPG nearly doubled during the same period.

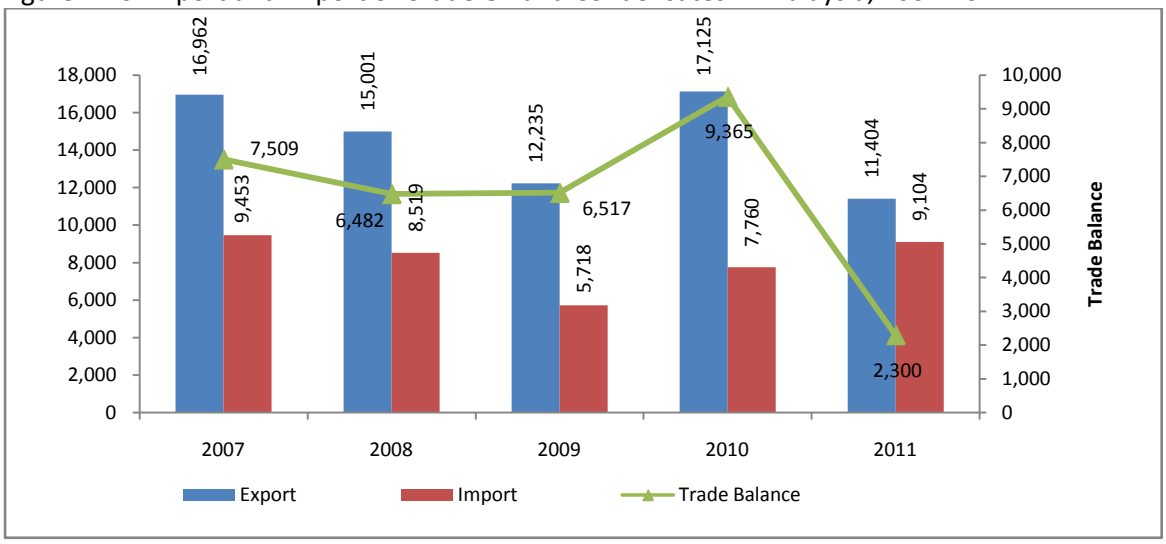
Figure 12.5: Final Consumption of Petroleum Products in Malaysia, 2007 & 2011



Source: Energy Commission, Malaysia

In 2011, a total of 11,404 ktoe of crude oil and condensates were exported compared to 16,962 ktoe in 2007, reflecting a decline of 32.8%; while imports were relatively stable at 9,104 ktoe in 2011 (2007: 9,453 ktoe) **(Figure 12.6)**. As for petroleum products, exports declined by 3.7% to 9,421 ktoe in 2011 (2007: 9,780 ktoe); while imports surged by 37.0% to 11,579 ktoe in 2011 (2007: 8,452 ktoe). In this regard, there is a large trade deficit in two specific types of the petroleum products, namely motor petrol and fuel oil.

Figure 12.6: Export and Import of Crude Oil and Condensates in Malaysia, 2007-2011



Source: Energy Commission, Malaysia

Currently, Malaysia's oil and condensates reserves level is estimated at around 5.86 billion barrels, higher than that recorded for 2007 at 4.32 billion barrels. Approximately 40.5% of the total reserves are in Peninsular Malaysia, while Sabah and Sarawak contributed 34% and 25.5%, respectively. For comparison purposes, the oil reserve levels for Saudi Arabia stood at 266 billion barrels, Iran at 157 billion barrels, and Iraq at 150 billion barrels at end-2012[84].

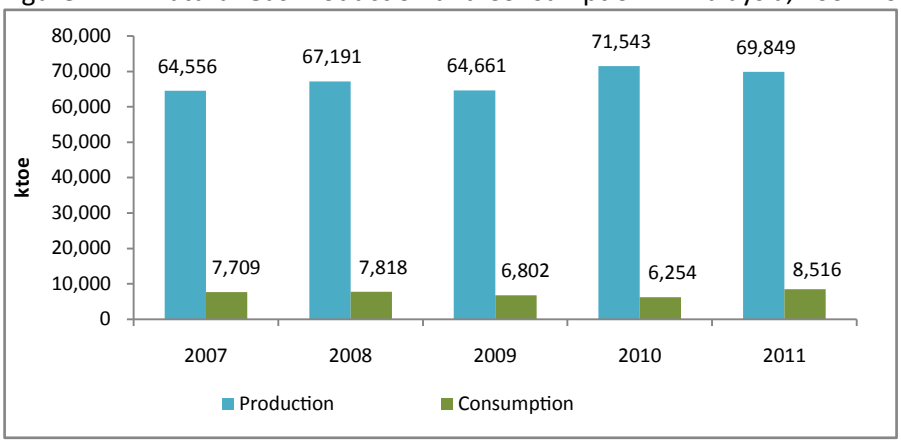
[84] Based on estimates by *BP Statistical Review of World Energy*, June 2013.

12.1.2 Natural Gas

Malaysia's proven natural gas reserves as at January 2013 is estimated at around 83 trillion cubic feet[85] (tcf), making it the third country having the largest proven natural gas reserves in the Asia Pacific after China (estimated at 109 tcf) and Indonesia (estimated at 103.3 tcf). Countries with the highest natural gas reserves are Iran at 1,187.3 tcf, Russia at 1,162.5 tcf, and Qatar at 885.1 tcf[86]. Natural gas reserves in Malaysia are largely found in Sarawak and Sabah, which collectively account for about 61.0% of the total reserves, while the remaining 39% are in Peninsula Malaysia's offshore.

Production of natural gas has been quite stable at around the 70,000 ktoe in 2011 **(Figure 12.7)**. Compared to the production level in 2007, natural gas production rose by 8.2%. On the other hand, final consumption of natural gas has increased at a higher rate of 10.5% to 8,516 ktoe during the same period, largely contributed by a large increase in consumption by the non-energy sector by 84.9% to 3,906 ktoe in 2011 from 2,112 ktoe in 2007. Consumption by other sectors such as commercial, transport, and residential has remained relatively stable, while consumption by the industrial sector has continued to decline further to 4,300 ktoe in 2011 from 5,416 ktoe in 2007.

Figure 12.7: Natural Gas Production and Consumption in Malaysia, 2007-2011

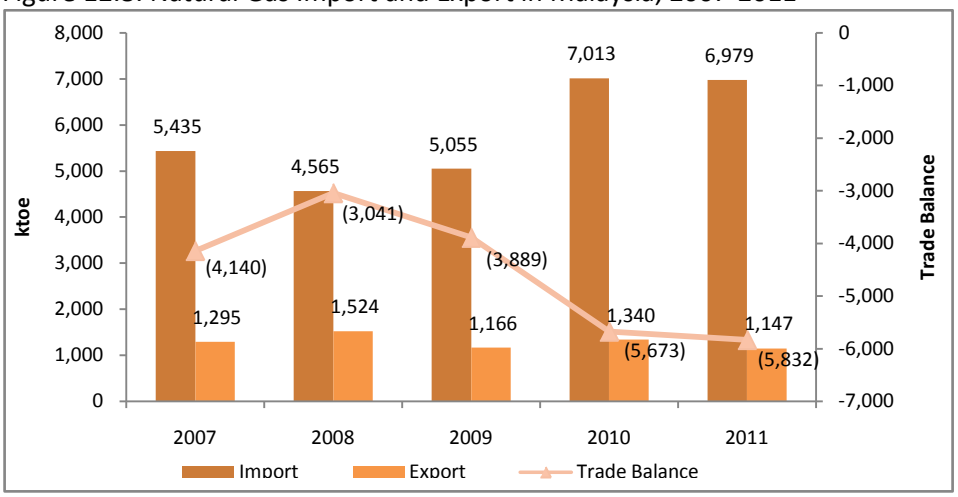


Source: Energy Commission, Malaysia

On the external trade front, over the five-year period from 2007 to 2011, Malaysia's exports of natural gas declined by 11.4% to 1,147 ktoe in 2011 (2007: 1,295 ktoe), while imports recorded a double digit growth of 28.4% to 6,979 ktoe (2007: 5,435 ktoe) **(Figure 12.8).** In view of the decline in exports and strong growth in imports of natural gas, trade deficit continued to widen to 5,832 ktoe in 2011 compared to 4,140 ktoe in 2007. About 25.0% of natural gas supplied in the domestic market is imported.

[85] Based on estimates by the *Oil and Gas Journal* as quoted in the US Energy Information Administration's *Country Update: Malaysia*, September 3, 2013.
[86] Based on estimates by *BP Statistical Review of World Energy*, June 2013.

Figure 12.8: Natural Gas Import and Export in Malaysia, 2007-2011

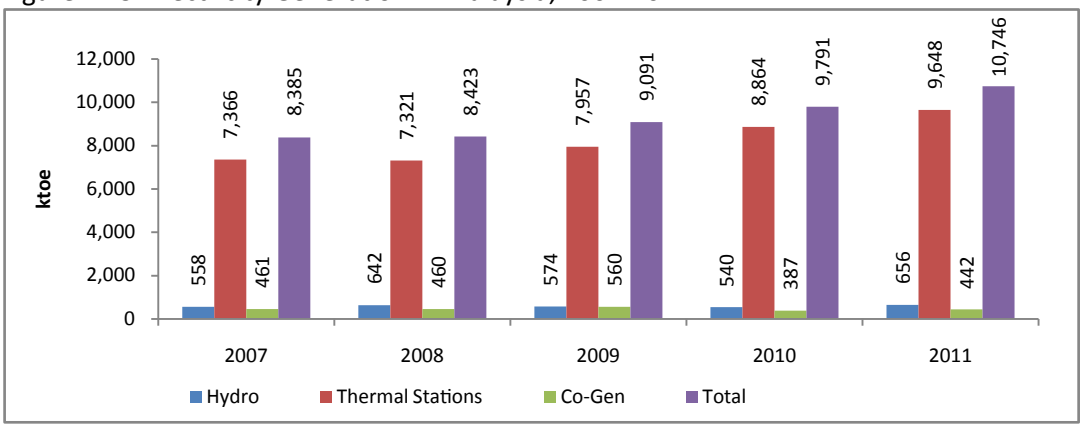


Source: Energy Commission, Malaysia

12.1.3 Electricity

Total electricity generation for 2011 was 10,746 ktoe in 2011, an increase of 28.2% compared to 8,385 ktoe in 2007 **(Figure 12.9)**. Thermal stations have been the main prime mover, contributing about 90% of the total electricity generation during the year. Indeed, electricity generation from thermal stations increased substantially—by 31.0%—during the period 2007-1,011 compared to power generation from hydro stations which increased by 17.6% during the same period.

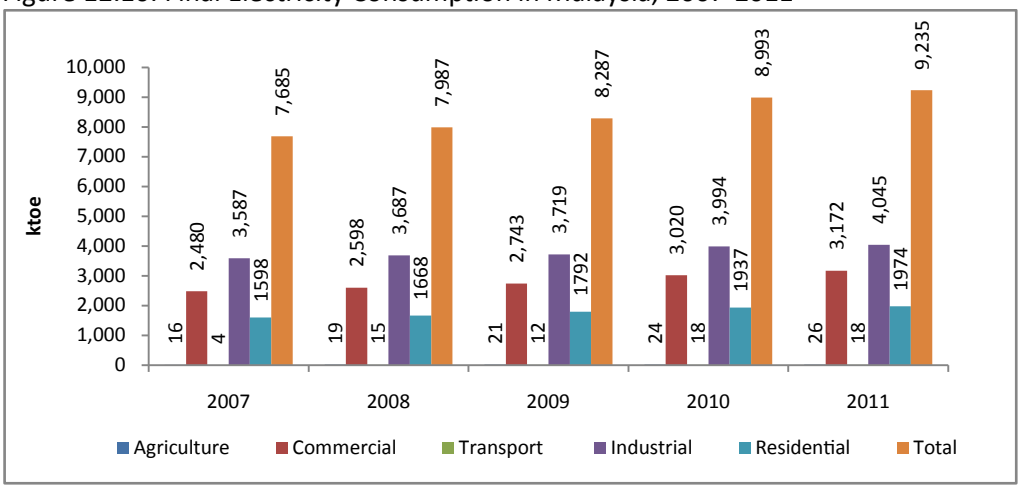
Figure 12.9: Electricity Generation in Malaysia, 2007-2011



Source: Energy Commission, Malaysia

Final electricity consumption increased by 20.2% in 2011 to 9,235 ktoe compared to 7685 ktoe in 2007 **(Figure 12.10)**. The double digit growth in the final energy consumption was attributed to the increase in all sectors, namely the industrial sector, which contributes 43.8% of the total energy consumption, registering an increase of 12.8% during the 2007-2011 period; the commercial sector (contributing 34.4% of total energy consumption) increasing at 27.9%; and the residential sector (contributing 21.4%), increasing at 23.5%. It is important to note that the transport sector, while its contribution to total final electricity consumption is small at 0.2%, recorded a significant increase of 350% as modern public transport infrastructure development continues to take center-stage attention in the country.

Figure 12.10: Final Electricity Consumption in Malaysia, 2007-2011

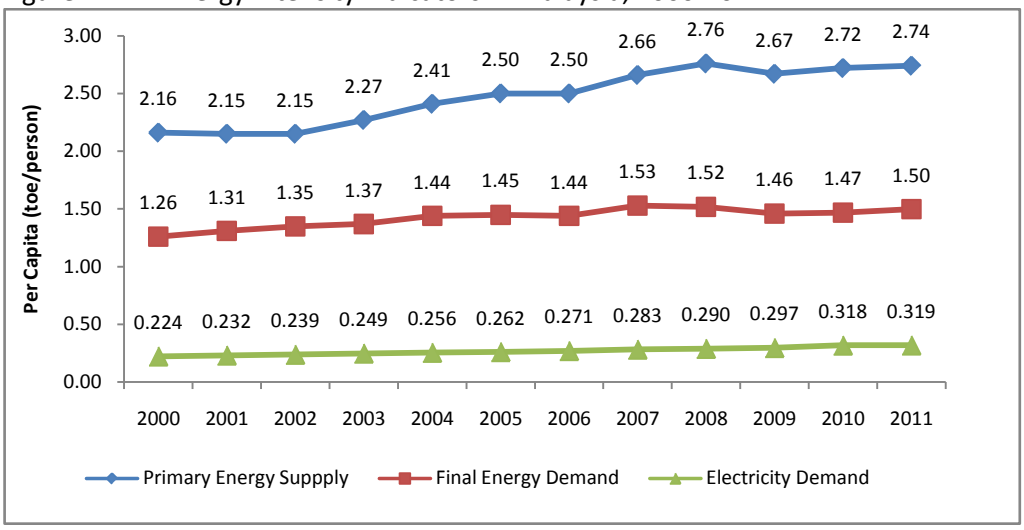


Source: Energy Commission, Malaysia

12.2 ENERGY INTENSITY AND EFFICIENCY INDICATORS

The energy intensity indicator as shown by the per capita primary energy supply has increased gradually to 2.74 toe/person in 2011 from 2.66 toe/person in 2007 **(Figure 12.11)**. When compared to the level recorded in 2000 at 2.16 toe/person, per capita energy supply actually showed an increase. Meanwhile, per capita final energy demand has been rather stable, at 1.5 toe/person in 2011 (2007: 1.53 toe/person), but has edged up marginally compared to 1.26 toe/person in 2000. For electricity, per capita electricity demand has increased steadily to 0.319 toe/person in 2011 from 0.283 toe/person and 0.224 toe/person in 2000. Similarly, it increased by 12% to 3,706 kWh/person in 2011 from 3,285kWh/person in 2007, and 42.37% if compared to the 2,603 kWh/person in 2000. The sustained increase in per capita electricity demand has been a cause of concern by the authorities with various efforts being pursued to address this concern.

Figure 12.11: Energy Intensity Indicators in Malaysia, 2000-2011

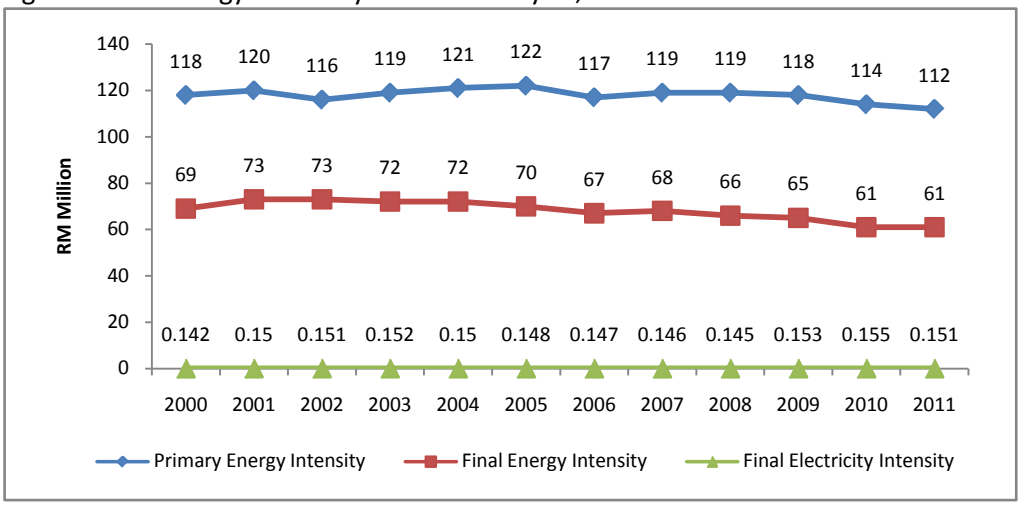


Source: Energy Commission, Malaysia

Amid the ongoing efforts to promote energy efficiency, several indicators point towards improving energy efficiency in the country. The final energy intensity ratio (as measured by final

energy demand divided by GDP at 2005 prices) has showed a gradual declining trend to reach a low of 61% compared to 68% in 2007 and 73% in 2001 **(Figure 12.12)**. This is in line with the proposed final energy intensity ratio of around 88% by 2010 indicated in the 9th Malaysia Plan. Meanwhile, the final electricity intensity ratio has remained relatively stable at 0.151 in 2011 (2007: 0.146 and 2000: 0.142). The industrial energy intensity ratio (as measured by industrial energy demand divided by industrial GDP at 2000 prices) declined to 68% in 2010 from 90% in 2007, partly reflecting the weaker economic situation due to the global financial crisis which started in the US in 2007/2008.

Figure 12.12: Energy Efficiency Ratio in Malaysia, 2000-2011



Source: Energy Commission, Malaysia

12.3 ENERGY EFFICIENCY INITIATIVES

The commitment to ensure energy security in Malaysia is well reflected by the continuous efforts to promote energy efficiency through the implementation of specific policies and initiatives. In fact, energy efficiency has been an important element in the national development agenda. Initiatives for energy efficiency have been implemented since the Seventh Malaysia Plan (1996-2000) and continue to be emphasised in other development plans, namely the Eighth Malaysia Plan (2001-2005 period), Ninth Malaysia Plan (2006-2010), and Tenth Malaysia Plan (2011-2015). In the current Tenth Malaysia Plan, specific efforts covering the residential and industrial sectors, and township and building are being highlighted to meet the objective of energy efficiency as outlined in the National Energy Efficiency Master Plan, 2010. These initiatives are complementing the Efficient Management of Electricity Regulation 2008, which aims at promoting the efficient usage of electrical energy through better energy planning and management system in the industry and commercial sectors.

Specific energy efficiency programmes have been embarked on to achieve the objectives of energy efficiency **(Table 12.1)**. Among others, the Energy Efficient Building Showcase Models programme, which includes the Low Energy Office (LEO) building, Green Energy Office (GEO) building, and Diamond building is meant to encourage the private sector to build energy efficient and green buildings in support of the energy efficiency efforts, which the government intends to lead by example. In particular, the GEO building that houses the Malaysian Green Tech Corporation and Energy Commission's Diamond Building have substantially low energy consumption as indicated by the low Building Energy Index at 65kWh/m^2 and 85 kWh/m^2 respectively.

Table 12.1: Energy Efficiency Programmes in Malaysia

No.	Programme	Descriptions
1	Energy Efficient Building Showcase Models	This model programme serves as a demonstration project to encourage the building of energy efficient and green buildings to be built in the future, particularly by the private sector. The model programme includes the LEO building, the GEO building and the Diamond building.
2	Auditing and Retrofitting Existing Buildings into Energy Efficient Buildings	The government is auditing and retrofitting some of the existing complexes to turn them from normal buildings to energy efficient and green buildings. Thorough energy audits were carried out in these complexes and it shows that a minimum of 20% reduction in electricity consumption could be achieved through simple retrofitting.
3	Green Building Certification (Green Building Index, GBI)	Launched in 2009, this is a green building rating system undertaken by the Building Professional Bodies rank commercial and residential buildings according to six criteria namely energy efficiency; indoor environment quality; sustainable site planning; materials & resources; water efficiency; and innovation. Buildings that met the minimum "greenness" level will be awarded with GBI Certified. Higher levels of award are GBI Silver, GBI Gold and GBI Platinum with GBI Platinum as the highest rank. The awards will expire in three (3) years to ensure that building owners maintained their buildings in a proper manner.
4	Malaysia Industrial Energy Efficiency Improvement Project (MIEEIP)	This project was developed to improve energy efficiency in Malaysia's industrial sector by removing barriers to efficient industrial energy use and creating institutional capacity in policy development, planning, research and implementation of sustainable energy projects. It covers a wide-ranging area of energy efficiency that includes space conditioning, water heating, building envelope, motor improvements, control improvements, refrigeration, lighting improvements, process improvements and ventilation improvements.
5	Electrical Equipment Labeling Programme	This programme was introduced in 2005 covering items such as refrigerator, air-conditioner, television, motor, lamp and fan. The programme was later expanded to cover more electrical appliances. Appliances are labeled in a scale of five stars with three stars as the average. The more stars an appliance gets, the higher its efficiency is.
6	Energy Efficiency Awareness Campaign	Awareness campaigns are carried out to educate the public on the benefits of energy efficiency and its practices. Besides the continuous awareness programmes organised, a compilation handbook on energy efficiency practices in the household was published and distributed to the public in 2008.

Source: APEC Energy Working Group (2011). *Peer Review on Energy Efficiency in Malaysia*

Another major programme specifically designed to promote industrial and commercial energy efficiency is the Malaysian Industrial Energy Efficiency Improvement Project (MIEEIP), which was launched in 2000. The positive impact from this project is now evident after more than 10 years following its implementation as indicated by the decline in the industrial energy intensity ratio from 90% in 2007 to around 70% in the recent period. With the aims of removing barriers to efficient industrial energy use and creating institutional capacity in policy development, planning, research and implementation of sustainable energy projects, the implementation of the MIEEIP has great potential energy savings. It is estimated that the implementation of the

MIEEIP would reduce energy consumption of the industrial sector of approximately 2.58 million gigajoule (GJ) per year and financial savings of RM85 million a year, resulting in an equivalent of CO_2 emission reduction of 761,000 tonnes/year **(Table 12.2)**.

Table 12.2: Potential Energy and Cost Savings Identified from the Factories Audited under the MIEEIP, 2004

Sectors		Food	Wood	Ceramic	Cement	Glass	Rubber	Pulp & Paper	Iron & Steel	Total
Annual Energy Consumption (GJ/year)		1,835,430	1,031,528	774,061	21,556,595	4,000,370	611,307	5,080,208	4,223,247	39,112,746
Annual Energy Costs (Th. RM/year)		42,233	13,512	24,061	204,149	97,830	16,908	84,201	160,131	643,026
Measures	No Cost Energy Savings (GJ/year)	24,361	7,996	38,566	1,375	31,449	57,010	51,559	64,194	276,510
	Low Cost Energy Savings (GJ/year)	111,087	131,702	75,229	6,866	13,732	21,171	69,100	56,985	485,872
	High Cost Energy Savings (GJ/year)	238,139	220,863	41,561	337,266	58,913	84,292	690,889	148,874	1,820,796
	Total Energy Savings (Total GJ/year)	373,587	360,561	155,356	345,508	104,095	162,472	811,547	270,053	2,583,178
Total Cost Saving (Th. RM/year)		8,515	5,201	5,992	33,752	2,485	4,313	19,767	5,247	85,272
CO_2 Emissions Reduction Potential (Tons/year)		27,988	30,378	14,463	444,667	8,069	18,931	194,403	22,836	761,734

Source: Malaysia Energy Centre. Findings of the Energy Audits as quoted in *Achieving Industrial Energy Efficiency in Malaysia*

Additionally, in an effort to steer the business sector towards being more energy-efficient, particularly in electricity consumption, the awareness of the importance of energy efficiency and ISO 50001 Standard to businesses are being promoted. The ISO 50001 Standard assists businesses in improving operational efficiencies and maintenance practices and, ultimately, to reduce energy costs through a structured approach to manage energy consumption effectively. With the ISO 50001 international certification status, business entities would benefit from an improved energy performance, including energy efficiency, use and consumption. Other specific programmes to support energy efficiency includes; (i) banning the use of incandescent lamps by 2014, which would reduce energy consumption by 1,074 gigawatts per year, while simultaneously reducing CO_2 emissions by an estimated 732,000 tonnes, (ii) widening the coverage for the Electrical Equipment Labeling Programme to enable consumers to make informed decisions regarding the energy efficiency of the products that they purchased, (iii) intensifying the Energy Efficiency Awareness Campaign to educate the public on the benefits of energy efficiency and its practices, and (iv) implementing the Sustainability Achieved Via Energy Efficiency (SAVE) programme launched in 2011, which gives rebates to promote energy efficient electrical appliances.

Despite the various efforts and continuous commitment to promote energy efficiency in Malaysia, there remain several challenges involved in the adoption of efficient energy practices. Currently, limited knowledge and general lack of awareness of energy issues, particularly with regard to energy efficiency techniques and their economic benefits are evident at all levels of the business organisation, particularly among the medium and small companies. Businesses also fail to recognise the importance of realising opportunities for energy efficiency and as such, are unwilling to venture into relatively higher-cost energy efficient transactions, and would rather continue to focus on investments in production rather than on efficiency. Energy users are often reluctant to try out innovative solutions unless they are confident that claimed benefits are achievable. They may also have little need to use less energy if they can easily pass energy costs to their customers. Awareness from the financial sector in supporting energy efficient projects is also minimal. Similarly, at the moment, there are insufficient stringent regulations in ensuring the adoption of energy efficient standards at all levels. Coupled with the inadequate local energy support services and lack of trained industry and financial sector personnel in energy management, the energy efficiency drive by the government could remain untapped by the private sector.

12.4 RENEWABLE ENERGY: POLICY AND INITIATIVES

In Malaysia, efforts to support the development of renewable energy were initiated in 1999 with the introduction of the 5th Fuel Diversification Policy, which essentially addressed the concern of imbalance energy mix due to over-reliance on fossil fuel resources in the country. Five major sources of energy were identified, namely gas, coal, hydro, oil and renewable energy. Subsequently, as envisaged in the 10th Malaysia Plan, efforts are being intensified to increase the contribution of renewable energy to 5.5% of total generated electricity in 2015 from less than 1% in 2009. Specifically, by 2015, renewable energy is expected to generate 985 MW electricity with the contribution coming from biomass (330 MW or 33.5% to total), hydro (290 MW or 29.4%), solid waste (200 MW or 20.3%), biogas (100 MW or 10.2%), and solar PV (65 MW or 6.6%).

Renewable energy received a huge support particularly in 2010 following the implementation of the National Renewable Energy Policy and Action Plan (NERP). Comprising five strategic thrusts **(Table 12.3)**, the NERP is expected to pave the way for more rapid development of renewable energy such that its contribution is targeted to increase from the current 0.5% of the electricity fuel mix to 6% in 2015, and a further 11% and 17% in 2020 and 2030 respectively **(Table 12.4)**. The increase in the contribution of renewable energy of the electricity fuel mix would simultaneously reduce the cumulative CO_2 emissions by 42.2 million tonnes by 2020 and a significant 145.1 million tonnes by 2030.

Table 12.3: Strategic Thrusts of the National Renewable Energy Policy and Action Plan 2010

Malaysian National Renewable Energy Policy and Action Plan

THRUST 1	THRUST 2	THRUST 3	THRUST 4	THRUST 5
•**Introduce Appopriate Legal Framework** •Feed-in Tariff (FiT) •RE Fund •SEDA Malaysia-FiT Implementing Agency	•**Create Conducive Business Environment For RE** •Promote RE business-SME and manufacturing •Long term low interest financing •Fiscal incentive •Special incentives for locally developed R&D •Incentives to promote local content •RE centre for SMEs	•**Intensify Human Capital Development** •RE in technical and Tertiary Curricular •RE Training Institutes •Centre of Excellence •Experts to fulfil local and overseas market •Fiscal relief for RE courses •Financial incentives for training programmes	•**Enhance RE R&D** •Focus R&D - reduce cost of technology & promote wider application •Coordination & co-operation in technology & economic research between Government and private sector •Strong linkages between local & international research institutes •Development of RE innovatios	•**Increase Public and Stakeholder Awareness & RE Policy Advocacy** •Effective & continuous information dissemination •Relationship with media, NGOs & private entities •Demonstration & awareness programmes in primary & secondary schools •Periodic monitoring & evaluation of RE

Source: Sustainable Energy Development Authority Malaysia (2012)

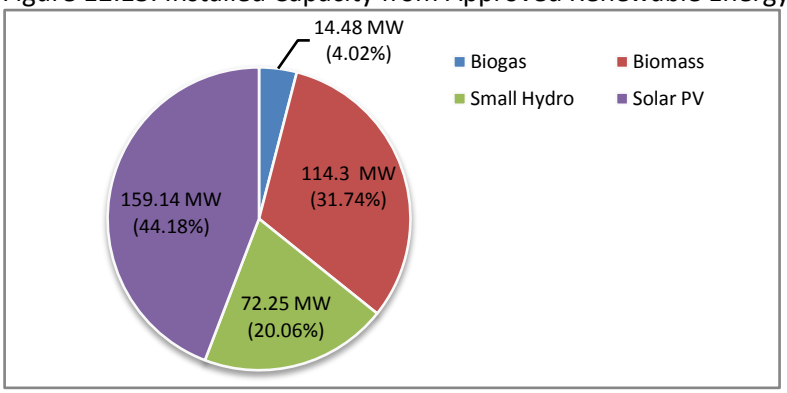
Table 12.4: Malaysia's National Renewable Energy Targets

Year	Cumulative RE Capacity (MW)	RE Power Mix (%)	Cumulative Co_2 Avoided (mt)
2011	68.48 MW	0.47	0.29
2015	9,85 MW	6.0	11.1
2020	2,080 MW	11.0	42.2
2030	4,000 MW	17.0	145.1

Source: Sustainable Energy Development Authority Malaysia (2012)
Note: RE capacity achievements are dependent on the size of RE fund

The main element of the NERP that acts as a catalyst for the development of renewable energy in Malaysia is the introduction of the Renewable Energy Act 2011, which entails the implementation of the Feed-in Tariff (FiT) as an incentive system for investments in renewable energy. According to Sustainable Energy Development Authority (SEDA), as at end-March 2012, a total of 788 applications for FiT were received, of which 433 applications were approved and 268 were in the process of approval, while 87 applications were rejected. Total installed capacity from the 433 approved projects is estimated at 360.17 MW of electricity generation, of which solar PV is contributing 44.2%, biomass 31.7%, small hydro 20.0% and biogas 4.0% **(Figure 12.13)**.

Figure 12.13: Installed Capacity from Approved Renewable Energy Projects, March 2012



Source: Sustainable Energy Development Authority Malaysia (2012).

In addition, renewable energy has started to emerge as a contributing sector to the Malaysian economy, apart from bringing in benefits to the environment. As shown in **Table 12.5**, while the approved FiT projects have resulted in 2,504.6 MW generation of renewable energy with a total installed capacity of 360.17 MW, they have also created a total of 8,853 jobs as at end-March 2012, and have resulted in the reduction of CO_2 emission of 2,171.175 thousand tonnes[87]. With continuous government support and commitment, renewable energy is expected to expand rapidly and increase its contribution to the economy and the environment. Indeed, by the year 2020, it is estimated that there are several positive impacts of the National Renewable Policy, namely (i) a minimum of RM2.1 billion in terms of external cost savings to mitigate CO_2 emissions; (ii) a minimum RM19 billion of loan values created for the renewable energy projects, thus providing new sources of revenue for the local banks; (iii) a minimum RM70 billion of renewable energy business revenues generated from the renewable power plant operations, generating a potential income tax revenue of RM1.7 billion to the government; and (iv) more than 50,000 jobs created from the operations of the RE power plants (SEDA, 2012).

Table 12.5: Estimated Outcomes of the Renewable Energy Projects, March 2012

	No. of Jobs Created	RE Generation (MWh)	Installed Capacity (MW)	CO2 Reduction / tonnes
Biogas (palm oil waste, agro based, farming)	362	113.6	14.48	60,494
Biomass (palm oil, agro based)	3,429	419.0	114.3	1,209,399
Mini Hydro	1,083	1,789.1	72.25	568,662
Solar PV	3,978	182.8	159.14	332,623
Total	8,853	2,504.6	360.17	2,171,179

Source: Sustainable Energy Development Authority Malaysia (2012).

[87] Based on information provided in presentation by Sustainable Energy Development Authority Malaysia entitled "Renewable Energy Development and Feed-in Tariff (FiT) Implementation in Malaysia" during the Information and Training Session on European Union Framework Programme 7 for Research and Technological Development in Kuala Lumpur on 16 May 2012. Information accessed on 10 December 2013 at:http://eeas.europa.eu/delegations/malaysia/documents/press_corner/all_news/2012/160512_fp7seda_en.pdf

12.5 GREEN TECHNOLOGY IN MALAYSIA

Green technology, also known as "environmentally sound technology" can be defined as technology that has the potential to significantly improve environmental performance relative to other technology[88]. This definition is in line with that of Malaysia's National Green Technology Policy as "…the development and application of products, equipment, and systems used to conserve the natural environment and resources, which minimises and reduces the negative impact of human activities". Malaysia's efforts in promoting a low carbon green growth is well reflected by the scores of policies and initiatives geared towards sustainable development and green living, whilst recognizing the role of green technology in powering the economy through new value creations. Ultimately, Malaysia is committed to achieving the reduction in carbon emission of up to 40% of the GDP compared to its 2005 level by the year 2020.

In this regard, the National Green Technology Policy was established in 2009 with the aims to reduce the energy usage rate and at the same time increase economic growth, facilitate the growth of the Green Technology industry and enhance its contribution to the national economy, increase national capability and capacity for innovation in Green Technology development and enhance Malaysia's competitiveness in Green Technology in the global arena, ensure sustainable development and conserve the environment for future generations and enhance public education and awareness on Green Technology and encourage its widespread use **(Table 12.6).** Ultimately, the goal is to provide a conducive environment for the development of green technology to become the economic driver in the country. In an effort to achieve these objectives, the Policy is supported by four primary pillars; namely energy, environment, economy and social perspective. Through these four pillars, the government has embarked on various specific initiatives to expedite the development of green technology by strengthening the institutional frameworks, providing a conducive environment for green technology development, intensifying human capital development in green technology, intensifying research and innovation, and increasing promotion and public awareness.

[88] United Nations Economic and Social Commission for Asia and the Pacific. *Low Carbon Green Growth Roadmap for Asia and the Pacific: Fact Sheet – Green Technology.*

Table 12.6: National Green Technology Policy

Reduce the energy usage rate and at the same time increase economic growth	Facilitate the growth of the Green Technology industry and enhance its contribution to the national economy	Increase national capacity and capacity for innovation in GT development and enhance Malaysia in Green Technology globally	Ensure sustainable development and conserve the environment for future generations	Enhance public education and awareness of Green Technology and encourage its widespread use	**Policy Objective**
Energy	**Environment**	**Economy**	**Social**		
Seek to attain energy independence and promote efficient utilization	Conserve and minimize the impact on the environment	Enhance the national economic development through the use of technology	Improve the quality of life for all		**Policy Pillars**
Short-Term Goals	**Mid-Term Goals**	**Long-Term Goals**			
10th Malaysia Plan	11th Malaysia Plan	12th Malaysia Plan and beyond			**Policy Goals**
Strengthen the Institutional Frameworks	Provide a Conducive Environment for Green Technology Development	Intensifying Human Capital Development in Green Technology	Intensifying Green Technology Research and Innovations	Promotion and Public Awareness	**Policy Strategic Thrusts**

Source: Ministry of Energy, Green Technology and Water, Malaysia.

Several initiatives have been undertaken to develop and support the development of green technology in Malaysia. The establishment of the National Green Technology and Climate Change Council under the National Green Technology Policy is aimed at enhancing the cohesion between the different agencies for the implementation of green technology initiatives. The National Renewable Energy Policy and Action Plan launched in 2010 is also part of the efforts to support the development of green technology in the country. Additionally, the Green Technology Roadmap is currently crafted to pave the way for green technology development in Malaysia.

In providing a conducive environment for green technology development through eco-business projects, the Green Technology Financing Scheme (GTFS) was set up with an initial fund allocation of RM1.5 billion and an additional RM2.0 billion allocation was announced during the 2013 Budget. The GTFS was established to provide soft loan facilities for the purpose of financing green technology projects. Under the GTFS, the government would provide a 2% interest subsidy and 30% guarantee on the loan. Approximately RM1.58 billion in funds have been disbursed to 120 projects/companies till December 2013.

Efforts are also being promoted towards the development of green townships with Putrajaya and Cyberjaya as the pioneers utilizing the Low Carbon City Framework (LCCF) and Assessment Systems that takes into account the framework and assessment of a green township that can be adopted by the local councils and private entities. Additionally, the LCCF would provide a comprehensive guide towards measuring carbon emissions based on sectors that enable the setting of a baseline and reduction of greenhouse gas targets.

Another initiative reflecting the government's full commitment towards the development of green technology is to develop green Information and Communications Technology (ICT). The

Green IT Guideline for the public sector has been introduced by the government in the designing, manufacturing, using and disposing of computers, servers and associated subsystems such as monitors, printers, storage devices and networking and communications systems in an efficient and effective manner with minimal or no impact on the environment. A Green Data Centre has been established as the government's first initiative towards Green ICT. A Global Computing Initiative (GCI) is also underway, through the creation of a Green Data Center rating system to support this initiative.

12.6 CONCLUSION

With the final energy demand projected to grow at 3.4 percent per year, reaching 92.9 million tonnes of oil equivalent (mtoe) in 2030, which is more than double the 2010 level, efficient energy management is critically important for Malaysia. The higher energy requirement, coupled with the depleting natural energy resources and volatile energy prices further pose a challenge for Malaysia and other countries to expedite the development of renewable energy sources. Malaysia has shown its full commitment to develop the renewable energy sector; and more efforts and initiatives are currently planned to further develop the sector.

To spur Malaysia towards a greener economy, it is imperative that efficient energy management is practiced at all levels of society and in all social and economic activities. Greater understanding, support, co-operation and willingness from all sectors of the economy are needed to ensure the success of the green technology development in the country. Promoting a low carbon green growth would help to promote sustainable development and green living while simultaneously empowering the Malaysian economy through new value creation. Through the various green technology policies and initiatives, Malaysia is committed to achieving the reduction target of up to 40% of the GDP in terms of emissions intensity by the year 2020.

CHAPTER 13:
NEW INITIATIVES IN MALAYSIA'S STI

CHAPTER 13

NEW INITIATIVES IN MALAYSIA'S STI

13.0 INTRODUCTION

Nanotechnology and oceanography are two fields that have been identified as among the National Key Economic Areas (or NKEAs) that have the potential of generating high income as well as contributing to Malaysia's economy. This is why one of the priorities of the 10th Malaysia Plan is to further drive the development of oceanography and nanotechnology. In achieving this aim, specific policies have been introduced, such as the National Ocean Policy 2011-2020, the New Energy Policy, the Renewable Energy Policy and Action Plan 2010, as well as the National Nanotechnology Policy and Strategy. The allotment of funds for these two areas has been quite significant in providing the necessary monetary assistance to ensure that projects under these initiatives are successful.

To highlight the significance of oceanography and nanotechnology for Malaysia's economy, this chapter discusses the recent advancements made in these two sectors. The following section presents an overview of nanotechnology and its potential for growth in Malaysia and a brief description of research in nanotechnology and its development indicators. This is followed by a brief description of oceanography, the governmental efforts to preserve this important resource, the amount of funds allocated for oceanography projects, as well as a brief discussion on harnessing the ocean as a source of renewable energy.

13.1 NANOTECHNOLOGY

The Malaysian government has identified nanotechnology as the new driver of growth and high income. It has been targeted that nanotechnology's contribution will correspond to 1% of the gross national income (GNI) by 2020.

Towards this end, the national nanotechnology initiative was launched in 2005, which paved the way for the establishment of the National Nanotechnology Directorate under the Ministry of Science, Technology and Innovation in 2010. Malaysia is set to leverage on its existing strength as the leading exporter of oil and gas products, electronics and semiconductors, halal food, and ICT components. At the same time Malaysia has an advantage in bio-science due to its natural biodiversity. These are among the two areas that have been targeted for nanotechnology. Four key economic clusters have been identified as the Jumpstart Nanotechnology: (i) food and agriculture, (ii) energy and environment, (iii) wellness, medical and healthcare, and (iv) electronic devices and systems. Among the high-impact products that have been identified from Jumpstart Sectors are: bio-security products, nano diagnostic systems, nano nutrition water treatment systems, nano delivery systems, bio-fuels food nano coatings, anti corrosion nano coatings solar panels (and photovoltaic), hydrogen reactors, oil & gas drilling fluids.

Nanotechnology is defined as "the science of materials and systems with structures and components which display improved novel physical, chemical and biological properties; phenomena that exist in the nanosizescale (1-100nm)[89]". One nanometre is one billionth of a meter; hence nanotechnology is essentially the engineering of matter even to the level of individual atoms. *Nanotechnology is the understanding and control of matter and processes at the nanoscale, typically, but not exclusively, below 100 nanometers in one or more dimensions where the onset of size dependant phenomena usually enables novel applications"* [90].

National Nanotechnology Policy Malaysia is a comprehensive roadmap that will classify, define and navigate through a welter of strategies, elements, programmes, and legislative enactments needed to promote nanotechnology as Malaysia's primary, new growth engine. The NanoMalaysia Roadmap has three main phases: Phase 1 (up to 2014), Phase 2 (2015-2017), and phase 3 (ending 2020).

13.1.1 R&D Indicators

R&D in nanotechnology has been described as the most rapid in terms of its growth in comparison to other fields of technology.[91] The market forecast on the growth of the industry is very promising; with the estimated government annual average R&D in Malaysia amounting to 10 million USD from 2006 to 2010. Compared to the USA, this amounts to less than one tenth of the estimated average annual US R&D at 1,080 million USD during the same period. The second top champion in nanotechnology is Japan; with its estimated government average R&D slightly behind the US by 40 million USD. Korea, which has been ascribed as a newcomer, has rapid growth in nanotechnology, with an estimated government average R&D per year amounting to 146 million USD in the 5-year period.

In coming up with this forecast, Malaysia has chosen the most optimistic market forecasts that refer to the total market value of all end products that embody a nanotechnology component, rather than the value of end-products that can be directly attributed to this component. This is in line with international trends.[92] As the total estimated expenditure on R&D in nanotechnology is modest, the estimated impact to our GDP is 1.4% and impact to GNI is 1.2% **(Table 13.1)**.

[89] MOSTI, National Nanotechnology Policy and Strategy, p.16

[90] Working definition of the International Organisation for Standardisation (ISO), cited in Christopher Palmberg, Hélène Dernis and Claire Miguet, Nanotechnology: An Overview Based on Indicators and Statistics, STI Working Paper 2009/7, available online at http://www.oecd.org/sti/working-papers, last accessed 5 Nov 2013, at p.12

[91] Christopher Palmberg, Hélène Dernis and Claire Miguet, Nanotechnology: An Overview Based on Indicators and Statistics, STI Working Paper 2009/7, available online at http://www.oecd.org/sti/working-papers, last accessed 5 Nov 2013, at p.12

[92] The STI Working Paper also adopted the same methodology. STI Working Paper 2009/7, available online at http://www.oecd.org/sti/inno/43179651.pdf last accessed 5 Nov 2013.

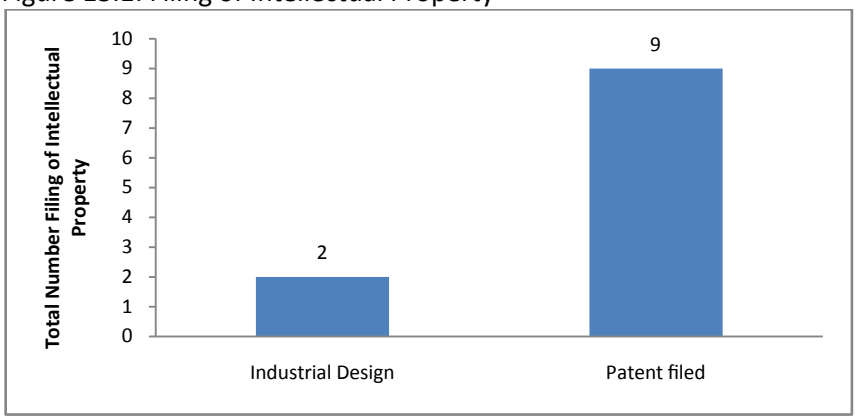
Table 13.1: Assessing the Potential Impact of Nanotechnology on the Economy (2006-2010)

Country	Est. Govt Average R&D per year (USD millions)	Est. Total R&D Exp. In Nanotech per year (USD millions)	GERD/GDP Ratio	Est. Impact of Nanotechnology to GDP (USD millions)	Est. Impact to GDP (%)	Est. Impact to GNI (%)
USA	1,080	2,812.4	0.0288	97,656.3	0.6	0.6
UK	94	171.2	0.0185	9,255.2	0.4	0.4
Korea	146	517.7	0.0336	15,407.7	1.4	1.3
Japan	1,040	4,250.1	0.0333	127,630.7	2.2	2.1
Malaysia	10	25.0	0.0064	3,906.3	1.4	1.2

Sources: MOSTI
GERD/GDP – National Science Foundation –USA
Private to Public Sector R&D Expenditure – UNESCO Database
GDP and GNI – World Bank
Nanotechnology Govt. Expenditure–INIC, Nanspots
National Nanotechnology Directorate, Malaysia
Public-Private Sector R&D Expenditure for Malaysia – MASTIC

As nanotechnology involves a broad range of sub areas and application fields, their research outcome can be patented in a wide range of fields. Globally, most patents on nanotechnology are filed in nanoelectronics and nanomaterials[93]. In Malaysia, there has not been much filing of patents and registration of industrial design; only 9 patents and 2 industrial designs were filed.

Figure 13.1: Filing of Intellectual Property

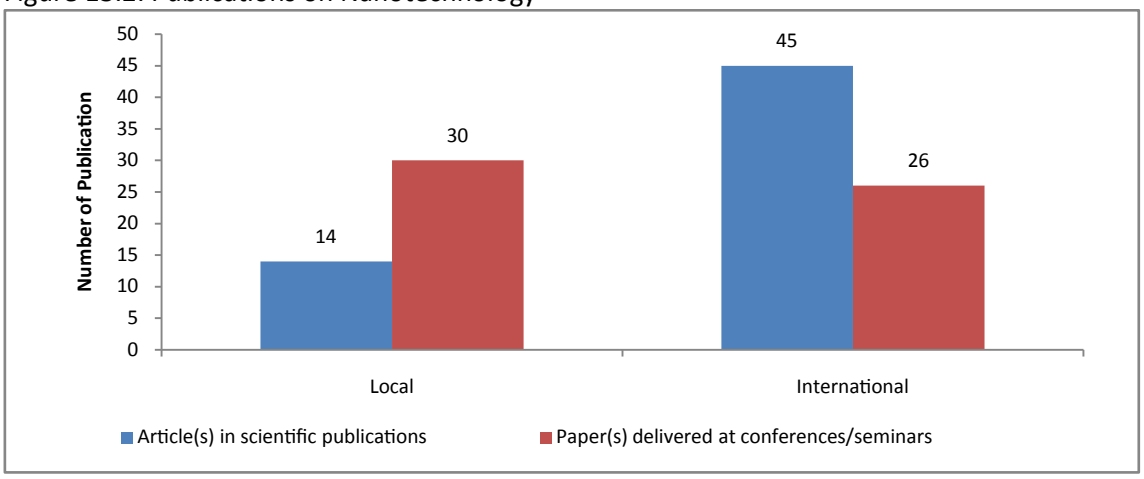


Source: MOSTI

Publication count is another form of measurement of the level of research activity. Globally, nanotechnology-related publications are increasing at rates that clearly exceed those of all publications contained in the database[94]. This trend can be seen in the US, Japan, EU and OECD, with rapid growth witnessed in China. In Malaysia the total number of publications has been quite encouraging, with 14 articles published in local scientific publications and 45 in international journals **(Figure 13.2)**.

[93] STI Working Paper 2009/7, available online at http://www.oecd.org/sti/inno/43179651.pdf last accessed 5 Nov 2013 at p.4
[94] STI Working Paper 2009/7, available online at http://www.oecd.org/sti/inno/43179651.pdf last accessed 5 Nov 2013, at p.35

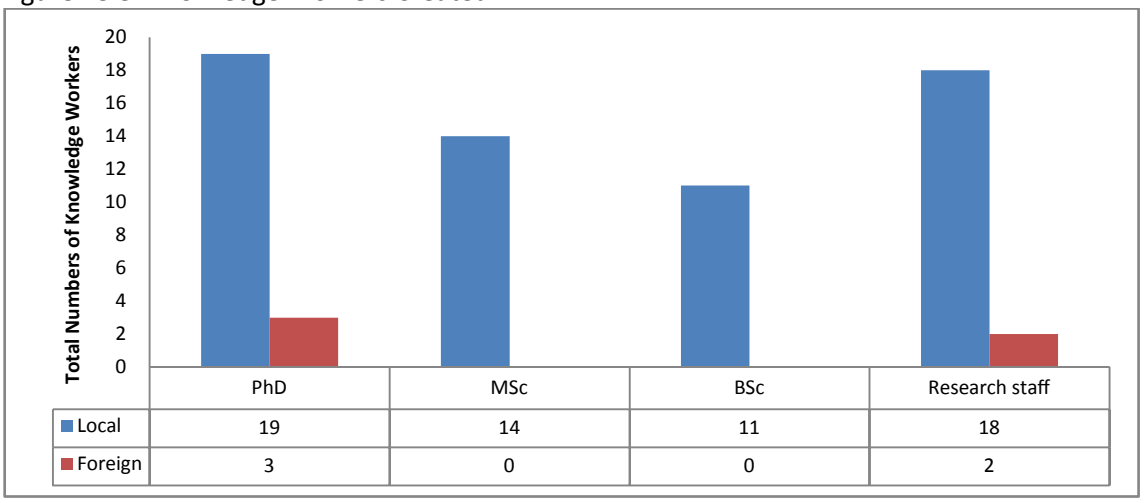
Figure 13.2: Publications on Nanotechnology



Source: MOSTI

Some insights can also be gained from the number of knowledge workers involved in a particular industry. **Figure 13.3** demonstrates the number of knowledge workers created in the nanotechnology industry.

Figure 13.3: Knowledge Workers Created



	PhD	MSc	BSc	Research staff
Local	19	14	11	18
Foreign	3	0	0	2

Source: MOSTI

13.2 OCEANOGRAPHY

The vast part of the earth is covered by water (more than 70%), which makes the study of oceanography very important and increasingly relevant. This is due to the fact that there is a wealth of marine life and energy that is yet to be harnessed. Oceanography concerns all of the following and more: ocean currents, waves, geophysical fluid dynamics, plate tectonics and the geology of the sea bed, the study of marine life, and ecosystem dynamics. Due to the wide range of fields that oceanography covers, twelve government ministries are needed to govern this sector.

13.2.1 Preservation of the Ocean and Marine Life

The increasingly complex ways in which the sea is being used necessitates changes in the care of the sea in order to balance the benefits that human beings are able to get from the sea whilst caring for and preserving the environment at the same time. Caring for the environment has become an important goal for the nation to strive towards as this allows for the proper utilisation of the benefits of the sea while taking steps to ensure the safe and secure management of the earth's very important resource.

As such, the government of Malaysia has come up with several policies and initiatives that were introduced to achieve this aim. Currently, the National Ocean Policy 2011-2020 (as part of Malaysia's 10th Rolling Plan) is in the process of being carefully drafted. The new policy is an interpretation of the six National Key Results Areas, which have been underlined in the Government Transformation Programme, the National Key Economic Areas of the Economic Transformation Programme, and economic reforms in the New Economic Model—as they all relate to ocean governance, the marine and coastal geographic area, and marine industries. There are four important goals under the proposed National Ocean Policy; which are, firstly, to understand, conserve & restore the ocean environment; secondly to support a sustainable economic growth and opportunities that are derived from ocean related activities, thirdly to encourage the practice of good ocean governance, and lastly, to achieve a participatory, responsible and sustainable development of islands.

13.2.2 Coral Triangle Initiative

Among the initiatives aimed at conserving and sustaining coastal and marine resources was the Coral Triangle Initiative (CTI), introduced in 2009—a joint cooperation between six countries: Malaysia, Indonesia, the Philippines, Timor Leste, the Solomon Islands and Papua New Guinea. Among the purposes of this initiative is by achieving the 5 CTI goals which are to firstly to designate and effectively manage priority seascapes, secondly to fully apply the ecosystem approach to management of fisheries and other marine resources, thirdly to establish and effectively manage marine protected areas, fourthly to achieve the climate change adaptation measures and lastly to improve the status of threatened species.

Malaysia's National Plan of Action (NPOA) under the CTI is to develop priority actions consistent with national aspirations and policies. It emphasizes on the development and implementation of new management approaches to tackle and solve problems related to climate change risks and overutilization of marine resources that are necessary for sustaining the lives of our future generation. Under the NPOA, there will be monitoring and evaluation of the 133 projects or priority actions in relation to the CTI to ensure their timely completion. The number of priority

actions that have been developed are very encouraging and reflects the commitment of not only government agencies, but also non-government partners to help achieve the 5 CTI goals. With the proper execution of these projects, it is hoped that the management of ocean resources and preservation of marine life would not only be preserved, but developed responsibly and equitably so as to meet the needs of the people without compromising on or upsetting the equilibrium of the ocean environment.

13.2.3 Application and Approval of Oceanography Related Grants and Projects

In order to encourage further developments in the oceanography sector, the government has allocated more funds, through the National Oceanography Directorate (NOD), under the Ministry of Science and Technology (MOSTI), for marine-related projects. The awards for oceanography-related projects are encouraging and can be seen in **Table 13.2**.

Table 13.2: Approval of Oceanography Related Grants and Projects

8th Malaysia Plan (RMK-8)							
No	**Items**	**Year**					**RM (million)**
		2001	**2002**	**2003**	**2004**	**2005**	
1	Intensification of Research in Priority Areas (IRPA)			2	3		1.45
						Total Amount	**1.45**
9th Malaysia Plan (RMK-9)							
No	**Items**	**Year**					**RM (million)**
		2006	**2007**	**2008**	**2009**	**2010**	
1	ScienceFund (MOSTI) – monitored by NOD	19	29	6	14	2	15.89
2	TechnoFund – monitored by NOD				2		6.00
3	ScienceFund NOD		2	6	2		12.25
						Total Amount	**34.14**
10th Malaysia Plan (RMK-10)							
No	**Items**	**Year**					**RM (million)**
		2011	**2012**	**2013**	**2014**	**2015**	
1	ScienceFund (MOSTI) – monitored by NOD	7	42	5*			15.21
2	Preliminary study on Mussel Disease Evaluation and Diagnosis Program	1					0.02
3	*Kajian Strategik Penubuhan Institut Oseanografi Negara*			1			0.25
4	Coastal erosion studies of the east coast and vulnerable small island regions of Peninsular Malaysia		1				0.19
5	Malaysian (Oceanographic) Data Aggregation/Archive System (MyDAS)			1			3.80
6	Community Projects, Coral Triangle initiative (CTI)			7			0.99
						Total Amount	**20.66**

Source: MOSTI
*Updated October 2013

In the 8th Malaysia Plan (from 2001 to 2005), government funds awarded for projects related to oceanography amounted to RM1.4 million. In the 9th (2006-2010) and 10th (2011-2015) Malaysia Plans, not only did the amount of funds increase, but so did the number of projects. However, it should be mentioned that although there were more projects awarded and monitored by NOD

during the 9th Malaysia Plan than the 10th, this does not reflect a decline in interest in oceanography. The fact that there seems to be less projects in the 10th Malaysia Plan could be attributed to the fact that under the CTI, numerous projects have been undertaken amounting to thousands of ringgit. Not all of the CTI projects are reflected specifically under the 10th Malaysia Plan, but under a separate initiative.

13.2.4 The Ocean as a Source for Renewable Energy

The ocean is one of the most vital sources of energy, particularly when it comes to renewable energy—as traditional forms of energy are slowly but surely being depleted over time. In order to avoid the exploitation and possible drying out of oil and gas resources, the Malaysian government has acknowledged the importance of finding alternative sources of energy. Hence, the government has taken many steps to promote the study of this field and encourage the development of this technology by coming up with policies that facilitate marine renewable energy projects. The National Renewable Energy Policy and Action Plan (2009) was introduced with the purpose of enhancing the utilisation of renewable energy resources to contribute towards the electricity supply security of the country and to provide for sustainable socioeconomic growth. Laws such as the Renewable Energy Act 2011 and the Sustainable Energy Development Authority (SEDA) Act 2011 were also passed to facilitate the implementation of the policy.

The government also provided for the allocation of sufficient funds to carry out projects for the purpose of deriving renewable energy to generate electricity, particularly those that are marine related. The national aim was to have at least 5% of our electricity needs coming from renewable energy—and by 2011, 1% was already achieved.

Table 13.3 shows the number of renewable energy projects as of December 2011, and the capacity of energy generated in megawatt (MW)**.** The number of projects for developing and generating renewable energy is encouraging, and it is expected that the number of projects will only increase in the coming years, especially considering the heightened awareness of environmental issues and the need for alternative yet sustainable energy resources. **Table 13.4** shows the projection of renewable energy generated in the next 40 years, while **Table 13.5** shows specifically the projection of renewable energy generated in the next 40 years according to the specific sub-sectors. The government has set a high aim for achieving the target of renewable energy to be generated in the coming years to stress the importance and benefits of renewable energy for the environment, ensure a lasting resource for future generations as well as contribute to the economy through the reduction of costly energy imports, as renewable energy projects are locally built and maintained.

Table 13.3: Number of Renewable Energy Projects and Capacity of Energy Generated (MW), December 2011

RE	Number	Installed capacity (MW)
Biomass	20	180
Biogas	10	29
Mini Hydro	13	87.7
Geothermal	1	50
Total	44	354.7

Source: MOSTI

Table 13.4: Projection of Renewable Energy Generated in the Next 40 Years

Year	Cumulative RE Capacity (MW)	RE Contribution
2010	73	0.5
2015	985	6
2020	2,080	11
2030	4,000	17
2050	21,400	73

Source: MOSTI

Table 13.5: Projection of Renewable Energy Generated in the Next 40 Years According to Sub-sectors

Projected RE Growth					
Year	**Cumulative Biomass (MW)**	**Cumulative Biogas (MW)**	**Cumulative Mini Hydro (MW)**	**Cumulative Solar PV (MW)**	**Cumulative Total RE (MW)**
2011	110	20	60	9	219
2015	330	100	290	65	985
2020	800	240	490	190	2,080
2030	1,340	410	490	1,370	4,000
2040	1,340	410	490	3,690	6,340
2050	1,340	410	490	18,700	21,370

Source: MOSTI

Deriving renewable energy from the ocean is a green and sustainable way of meeting the needs of the Malaysian people without impacting much on the environment and draining other natural resources. To ensure that these efforts are effectively carried out, the government works hand in hand with public universities, companies from the private sector, and other relevant agencies by sharing expertise, facilities, equipment, and infrastructure. The participation and cooperation by the government and other bodies, coupled with the rising awareness of the Malaysian people of the importance of coming up with renewable energy for the preservation of our environment is very encouraging. With such commitment, the developments in marine renewable energy will continue to improve in the years to come.

13.3 CONCLUSION

The recent advancements that Malaysia has made in the field of oceanography and nanotechnology is commendable; particularly considering the fact that Malaysia is a developing country. Due to the government's emphasis on and support for oceanography and nanotechnology development through the creation of national policies, Malaysia is fast catching up with other developed nations in these two fields. R&D and innovation in oceanography as well as nanotechnology are integral to the economic growth of Malaysia. However, economic growth should not be achieved at the expense of the environment. The drive behind developing these fields is and should be focused on the positive effects it would have on the preservation of the environment. Nanotechnology can help to achieve this aim in many ways, for example, by the better use of resources to reduce the hazardous waste produced and to contribute to environmental cleanup through the application of absorptive remediation technologies.

Oceanography helps significantly in meeting the needs of developing a clean, alternative energy source that can be sustained for the future generations. In striving to become a country that is ranked highly in terms or scientific and technological achievements, one must not neglect environmental concerns, but instead should make this as one of the most important objectives of developing new technologies. It is hoped that with the implementation of national policies that place proper emphasis on environmental preservation, Malaysia would not only advance in the field of S&T, maintain steady economic growth, and progress as a high-income country; but most importantly, become a cleaner, more environmentally conscious nation.

CHAPTER 14:
CONCLUSION AND THE WAY FORWARD

CHAPTER 14

CONCLUSION & THE WAY FORWARD

14.0 INTRODUCTION

The aim of this report is to describe "where we are" with regard to science, technology, and innovation (STI), and in other areas that are deemed crucial for the progress of the nation and the growth of its economy. Specifically, it aims to assess, through STI indicators, how we fare in these areas so that we may chart the future directions for R&D activities and S&T development in Malaysia. With the increased importance of S&T for a knowledge-based economy, STI Indicators have been developed to map the national system of innovation so that competitive advantages for the country could be identified and promoted, and policy makers provided with an indication of the status of the national S&T system. This chapter presents a summary of how we have fared in these indicators. It also discusses the areas in which we have made advancements in STI as well as those in which further improvement is necessary.

14.1 MALAYSIA'S PERFORMANCE IN SCIENCE, TECHNOLOGY AND INNOVATION

14.1.1 Education in S&T

Enrolment in science and mathematics at the SPM level has generally increased every year. From 2008-2012, mathematics is the subject that most students registered for followed by science and additional mathematics, where the enrolments have remained relatively constant. However, at the STPM level, registrations for science, mathematics and technology subjects have generally declined. The trends also show that enrolments for non-science courses at the undergraduate and postgraduate levels are always higher than that of science courses. With regard to examination results in mathematics and science at the SPM and STPM levels, however, the trends show an increase in the number of A's for the subjects.

14.1.2 Expenditure on R&D

Malaysia's gross expenditure on R&D (GERD) has steadily increased since 2000. A sharp increase in GERD is particularly notable between 2006 and 2009, reaching close to an estimated RM7.2 billion in 2009, and RM9.4 billion in 2011. Malaysia's research intensity (GERD/GDP) has also charted a consistent increase since 2004; rising to 0.79% in 2008 and further to 1.01% in 2009, meeting the target of 1.0% set in the RMKe 10 to be achieved by 2015. Our research intensity continued to improve, and in 2010 and 2011, Malaysia recorded a GERD/GDP of 1.07%.

Malaysia's business expenditure on R&D has also improved over the years. In 2011, Malaysia's BERD/GDP (the percentage of the GDP that is spent on R&D by the business sector) was 0.61. Although this is an improvement over our previous BERD/GDP values, it is still low when

compared to that of a developed South East Asian country such as Singapore (1.27) and developed East Asian countries such as South Korea (2.8) and Taiwan (2.08).

14.1.3 Human Resource in R&D

Malaysia has also made improvements in terms of the number of research personnel, which has increased markedly since 2006. 2011 recorded the highest headcount (96,961) for R&D personnel, which includes researchers, technicians, and support staff. The highest number of researchers (73,752) was also recorded in 2011, with an estimated 58.2 researchers per 10,000 labour force, topping the target set by the Ninth Malaysia Plan of 50 researchers per 10,000 labour force by 2010.

The trends also show a marked increase in researchers with Masters and PhDs. The headcount of researchers with PhDs increased from 7,001 in 2006 to 33,272 in 2011; while those with masters degrees increased from 5,337 in 2006 to 24,691 in 2011.

Female participation in R&D has also steadily increased over the years. In 2008, women accounted for 40.9% of Malaysia's researchers, while in 2009, 50.9% were women, the highest recorded since 2000, outnumbering their male counterparts by a small margin. Female researcher participation declined only slightly in 2010 and 2011 to 48.8% and 48.7% respectively. The percentage of female relative to male researchers is much higher than that of many advanced economies such as Denmark (31.9%), Finland (31.4%), Singapore (28.5%), Germany (24.9%), South Korea (16.7%), and Japan (13.6%).

14.1.4 Public's Awareness and Understanding of and Attitude Towards S&T

The results of the National Public Awareness Surveys conducted from 1998-2008 show that Malaysians have consistently shown a positive attitude towards S&T. More than 60% of Malaysians viewed S&T as having a positive impact on *individual enjoyment of life, public health, standard of living* and *working conditions*. In the 2008 survey, 73.8 % of the respondents believed that S&T research does more good than harm. On the other hand, not many Malaysians answered correctly to more specialized S&T issues such as *"All radioactivity is man-made"* (14.0%), *"Lasers work by focusing sound waves"* (5.5%) and *"Milk contaminated by radioactivity is safe to drink after it is boiled"* (28.9%); although they seem to have a good understanding of the more general S&T issues taught in school such as, *"Plants produce the oxygen that we use for breathing"* (76.4% answered correctly), *"The earth travels around the sun"* (72.6%), *"The centre of the earth is very hot"* (66.0%) and *"Light travels faster than sound"* (58.9%). The highest number of correct answers were given to the statement, *"Smoking causes lung cancer"* (81.8%). In general, Malaysia falls behind some international countries such as America, Europe and South Korea on their understanding of certain S&T issues, suggesting that a lot more needs to be done to enable Malaysians to have the specialized knowledge that is necessary for research and development and for the advancement of S&T.

14.1.5 Innovation

On the GCI 2011-2012, Malaysia has been ranked 23rd on innovation and 25th on competitiveness out of 144 countries. Malaysia has been consistently at the top quartile of the overall rankings for the past few years. She has a well-developed financial market (ranked 6th) and an efficient

goods market (ranked 11th). Malaysia was also judged as having done relatively well in the more complex categories, namely business sophistication (20th) and innovation (25th), which, according to the report, matter the most for advanced economies, as this augurs well for the future. On the WCY 2013, on the innovative capacity of firms in generating new products and processes, Malaysia was ranked 13th, behind developed countries such as Israel (ranked 1st), the USA (ranked 2nd), Switzerland (3rd), Germany (4th), and Denmark (5th). Malaysia is ranked higher than Japan (14th), Norway (15th), Singapore (17th), and Korea (19th).

14.1.6 Knowledge Infrastructure and Diffusion

ICT access in Malaysia has also improved significantly over the years, reflecting continuous improvement in ICT technology adoption among the Malaysian population. Our penetration rate for cellular telephones reached 143.4 at end-June 2013 compared to 105.4 at end-2009, while households' broadband penetration rate has increased to 66.8 per 100 households at end-June 2013 compared to only 31.7 per 100 households at end-2009.

14.1.7 Scholarly Publications

The emphasis on academic publications has resulted in the positive growth of scholarly publications as well as citations as captured in the Thomson Reuters (ISI) Index. The annual growth rate, however, is on the decline for both publications as well as citations. This resulted in Malaysia's being behind Singapore and Thailand in terms of publications and citations but ahead of Indonesia and Philippines. Nevertheless, Malaysia has accelerated her growth in scientific publications in the last five years to double her share of publications within the ASEAN 5 during the period 2001-2011.

14.1.8 Patents

With regard to patents, Malaysia has made significant inroads into international patenting as evidenced from the promising growth in the application of PCT patents by the IHLs and RIs. To that extent, Malaysia has been successful in building its technological base, enough to vie for international patents and compete with foreign technologies. Malaysia is among the top five middle-income countries in the application of PCT patents; behind Turkey, India and China. A notable achievement for Malaysia is that Universiti Sains Malaysia has emerged as among the top 45 university applicants for university patents in the world, one rank behind Duke University of the United States of America and 6 ranks higher than the renowned University of Cambridge; while MIMOS emerged as the sixth among the top 30 applicants from government and research institutes, higher than some of the institutes from France, Australia, United States, Germany, Japan, and Korea. The domestic filing of patents, trade marks and industrial designs continue to show strong growth of varying degrees among the different intellectual property rights (IPRs). A significant portion of the local patents are produced by the IHLs and RIs, with the total share of around 60% of the total patent applications filed by Malaysians from 2010 onwards. In terms of balance of trade in intellectual property, however, Malaysia continues to record a deficit of around USD1 billion since 2005 as Malaysia pays more for foreign technology in comparison to the payment she received for the usage of her technology.

14.1.9 Knowledge- and Technology-Intensive Industries

Finally, Malaysia's knowledge- and technology-intensive (KTI) industries have recorded a steady increase in production over the years; from RM87.1 billion in 2000 to RM141.0 billion in 2010. A significant portion of the increase is contributed by the knowledge-intensive (KI) services sector. The value added of KI services expanded from RM53.1 billion to RM117.4 billion, increasing the sector's share in the total KTI value added from 61% to 83% during the same period. The high-technology manufacturing sector, however, recorded a declining trend in the production levels from RM43.1 billion to RM23.6 billion. Hence, its total exports also declined from RM218.4 billion in 2007 to RM186.4 billion in 2012. Consequently, the share of KTI industries in Malaysia's gross domestic product (GDP) declined from 24% to 18% between 2000 and 2010, mainly due to the smaller share of high-technology industries in the GDP that reduced from 10% to 3%. At the global level, Malaysia's KTI value added accounted for only 0.2% of the world's KTI value added in 2010. In comparison, the US share is (32%), the EU (27.8%), Japan (8.9%) and China (6.8%). The structural change in the economic activities in Malaysia is the direct outcome of the shift in the industrial policy emphasis from that based on manufacturing to that of services.

14.2 CONCLUSION AND THE WAY FORWARD

The marked increase in the GERD, GERD/GDP, headcount of researchers and research personnel, researcher intensity, scholarly publications, and number of patents filed, point to the fact that Malaysia has made notable achievements in the area of science, technology, and innovation. In addition, ICT access in Malaysia has also improved significantly over the years, reflecting continuous improvement in ICT technology adoption among the Malaysian population. Production by the knowledge- and technology-intensive (KTI) industries has also recorded a steady increase, largely contributed by the knowledge-intensive (KI) services sector. While we have charted many improvements in various areas as assessed by our national S&T indicators, there are also areas that need our attention and in which we need to make improvements. Based on the trends observed in the STIs over the last decade, we put forward the following suggestions as the way forward to improve the state of STI in the country.

14.2.1 Education in S&T

The PISA scores of Malaysian students on mathematics and science show that there is a need to improve the standard of mathematics and science education in our schools. Firstly, we need to ensure that science is effectively taught in schools such that students appreciate the *value* of science and so that they would see the relevance of science to everyday life. In-service and pre-service courses should focus not only on the effective delivery of content, but also on helping teachers to develop an *appreciation* for mathematics and science among their students, as this would motivate them to seek knowledge of mathematics and science and to be creative in their approach to problems.

To improve the standard of science education it is also essential that a curricular review be conducted periodically. We need to look at whether the *need* for mathematics and science has been adequately addressed in the teaching of these two subjects in schools and whether it is reflected in the syllabus as well as textbooks. This is crucial, because unless a student sees and understands the need for mathematics and science, he or she is less likely to be interested in learning these subjects and in pursuing them at the degree level.

Finally, with regard to mathematics and science education in schools, we suggest that research studies be carried out to find out:

- the effectiveness of mathematics and science instruction in our schools
- the attitudes of Malaysian students towards mathematics and science
- the perceptions of Malaysian students toward the mathematics and science curriculum, textbooks, and lessons.
- teachers' questioning and teaching styles when teaching mathematics and science in schools

At the degree level, more efforts should be undertaken to attract students to enroll in S&T courses and also to pursue postgraduate degrees in S&T. These could include the provision of research grants and graduate assistantships to enable students to pursue degrees in S&T so that more R&D and innovation activities, particularly in the NKRAs, can be conducted.

14.2.2 Research and Development (R&D) in Malaysia

Malaysia needs to continue to undertake measures to enhance her national capacity in R&D and her national capability in S&T to drive the economy towards higher value added activities. To achieve this goal, we need to increase our expenditure in R&D further as this will lead to greater economic growth. We have met our GERD/GDP target of 1.0% by 2015 with our GERD/GDP of 1.07% in 2011. Similarly, our target of 50 researchers per 10,000 labour force by 2010 was also met, in 2011, with our 58.2 researchers per labour force. However, these achievements are still below that of advanced economies and also many emerging economies. We also need to improve our business expenditure on R&D as it plays a significant role in propelling developed nations well ahead of developed nations. In this regard, a reasonable target would have to be set for our business R&D expenditure while new targets set for our GERD/GDP and researchers per labour force. Given our present performance in R&D, it would be reasonable to set our BERD/GERD close to the OECD average of 70%, GERD/GDP close to the OECD average of 2.3, and our researcher per 10,000 labour force close to the OECD average of 70. Finally, there has to be a close cooperation between the business, academic, and government sectors in R&D, innovation, and commercialisation to further stimulate national development and sustain long-term economic growth.

14.2.3 Public Sector Support for R&D in Science, Technology and Innovation (STI)

The monitoring mechanism in the provision of various government grants can be enhanced to ensure that there is no misappropriation of funds or unauthorised outsourcing of projects to unqualified third parties so as to ensure that the maximum outcome is achieved in terms of the quantity and quality of R&D output.

Briefing programs on the requirements of various grant schemes should be conducted periodically so as to ensure that applications meet the specific criteria of the grants, hence reducing the probability of applications being rejected for non-fulfilment of requirements.

14.2.4 Public Awareness of S&T

In order to improve public awareness on S&T, it is essential that the concept of scientific literacy be clearly defined. This will determine the direction that the country will take in terms of the national science curriculum for schools as well as the intervention strategies for S&T.

It is also important to ensure that science is effectively taught in schools and that textbooks are written in such a manner that they help to foster, among students, an interest in and appreciation for science.

In raising the public's awareness of S&T and in implementing strategies and programmes, we need to use different approaches. For example, since a big segment of the Malaysian population are those living in rural areas and those who come from the lower income group, the government should come up with S&T activities that would provide additional income for rural families such as using the right fertilizers for optimum crop yield, etc. These activities and programmes should create a sense of ownership and participation among the rural folk to help them achieve a higher level of S&T literacy. Rural folk should also be encouraged to participate in educational tours on the applications of S&T in farming, aquaculture, pest-control, etc., and of the benefits of S&T.

Finally, the private sector should also be encouraged to play its role as a good corporate citizen by involving themselves in government S&T programmes and initiatives or by designing their own programmes in support of the government initiatives. Special tax exemptions should be given to these companies for participating in and promoting the S&T programmes.

14.2.5 Bibliometrics: Publications and Citations

Malaysian scientists have proven their intellectual prowess and academic abilities through the strong growth in the total number of publications in the Thomson Reuters' Web of Science. Nevertheless, a better understanding of the dynamism of scientific pursuit can be achieved through a thorough study of the total publications of Malaysian scientists, including those published under SCOPUS, Open Access journals and local journals. With regard to citations, however, there is a need to increase national and international institutional collaboration in research projects as articles co-authored under collaboration attract more citations.

14.2.6 Innovation in Malaysian Manufacturing and Services Sector

In order to further promote innovation, human resource in science, technology and innovation needs to be continuously developed, and complemented by cross-ministry and agency consultations to align policies and prioritise reform measures that are supported by an effective monitoring process.

14.2.7 Intellectual Property

Malaysia can further improve its global ranking in intellectual property if the existing policies and strategies are revisited. Of top concern is the lower proportion of resident filings to non-resident filings, due to the under-utilisation of utility innovations. As the number of utility innovation filings is included in the patent total count, a good way to accelerate the total patent

count is by increasing the number of utility innovation filings, where the threshold of registrability of utility innovations is lower than patents and the period of examination shorter. Hence, more SMEs should be persuaded to be file for utility innovations, as utility innovations are easier for them to achieve.

As for the delivery system, to further shorten the pendency period in the examination of patent applications, an expedited examination has been introduced in 2011. Unfortunately, the expedited examination process has been largely underutilised. One way of popularising the expedited examination process is by revising its fee structure to make it more attractive to local patent applicants and SMEs that have to show patent grants as key performance indicators.

Strategies that have been introduced to augment the commercialisation of intellectual property such as those devised by Agensi Inovasi Malaysia by auditing the IHLs' and GRIs' intellectual property and matching them with the industry need to be sustained. The orientation of some research grants such as Bio-Science, which requires collaboration between IHLs and the industry, should be further supported as this mandates that the research projects are aligned to the industry's interests. Similar measures that increase collaboration between the IHLs and RIs, which are the major recipients of government research funding, and the industry must be augmented to produce patents with commercial potential.

Malaysia has shown its potential in the international patent system, as illustrated by the high ranking received by some of the top IHLs and GRIs. Such growth must be sustained so that Malaysia continues to produce patents with global standards that would attract international licensing. This will assist in reducing the trade deficit in intellectual property.

Malaysia should also seriously consider other international IP systems such as the Madrid Protocol for the international filing of trade marks and the Hague Convention for the international filing of industrial designs to elevate our local trade marks and industrial designs to the international level.

14.2.8 Information and Communications Technology in Malaysia

In line with the global trend in incorporating the usage of ICT in all walks of life, major indicators point towards ICT advancement at all levels in Malaysia. The sector is expected to play a bigger role as the enabler to a more rapid growth of the Malaysian economy, with its contribution expected to increase nearly threefold to RM57.7 billion by 2020 (2009: RM22 billion). Moving forward, there are several challenges that need to be addressed in our efforts to sustain the rapid growth of the sector. In particular, there is a pressing need to further strengthen the sector's infrastructure towards higher-value added and more advanced areas such as in e-services, wireless intelligence and ubiquitous connectivity, which is in line with the country's requirements to be a developed nation by 2020 and to move away from hardware-based technologies to IT services and software. There is also a need to address the issue of talent and human resource development, which includes the mismatch in the supply of and demand for workforce in ICT as well the skill gaps that could hinder the healthy growth of the industry. Last but not least, amid the increasing concern with regard to improving the environmental aspects of ICT, continuous efforts and support need to be accorded to the development of green ICT in Malaysia. With the local ICT sector expected to incur electricity expenditure by approximately 400% more compared to the level in 2011, and carbon footprint to increase by 55% by 2020, serious and collaborative efforts are needed towards the development of green ICT and de-

carbonizing the ICT sector, which, at the same time, would positively contribute to the Malaysian economy.

14.2.9 Biotechnology

As one of the 12th mega-diverse countries in the world, Malaysia is blessed with the biological resources needed to support its biotechnology initiatives. However, as the majority of the BioNexus companies are SMEs, there is a need to develop more manpower training and financial incentives to upgrade them into stable companies that generate higher income.

The other major players in the biotechnology industry are the IHLs and GRIs. There is a need to capture the contributions of the IHLs and GRIs to the biotechnology sector through their research expenditure and by tracking their research outputs in the form of patents and scientific publications. Close collaborations between the IHLs and GRIs must be forged in order to align these institutions' research initiatives with the interests of the industry.

14.2.10 Knowledge- and Technology-Intensive Industries

The production and trade trends in the electrical and electronics industrial sectors show that there is premature de-industrialisation in these industrial sectors. Hence, there is a need for the sector to be pushed to move up the value chain, and complementary policies are necessary to ensure that the industries are supported by competitive and efficient services and resource-based industries. There has also been greater policy emphasis in developing a new class of high-technology industries, namely aerospace, pharmaceutical and medical equipment. These industries are largely MNC-led; and therefore, reliance on imported inputs and technology tends to be high. It is important that we do not repeat the same mistake made in the E&E sectors. Developing domestic technological capabilities is crucial to ensure sustainability and competitiveness of the industry.

The knowledge-intensive services are still a very small segment of Malaysian trade and GDP. Financial services, for example, have expanded significantly over the years; but the sector is still domestic-oriented. On the other hand, trade deficit in the business services and communication services sectors has worsened over the years, indicating increased reliance on imported services. The growth and development of the knowledge-intensive services sectors are hindered by restrictive domestic regulations and serious shortage of skilled manpower. Each service sub-sector is very unique and complex, and therefore there is a need for specific strategies for each sub-sector.

There is a paucity of data on the high-technology manufacturing and knowledge-intensive services sectors. We propose that the Department of Statistics compile and categorize these data according to the OECD classification for value added and trade. The availability of such data would be useful for evaluating Malaysia's performance in these industries and is also important for effective policy formulation.

14.2.11 Energy and Green Technology

The energy sector will continue to fuel Malaysia's economic growth as the country strives towards developed nation status by 2020. The more rapid economic activity would naturally result in greater energy requirements, with the country's final energy demand projected to grow at 3.4 percent per year, reaching 92.9 million tonnes of oil equivalent (mtoe) by 2030. As the projected energy requirement is approximately more than double that of the current level, efficient energy management is critically important for Malaysia. The current efforts to promote energy efficiency in the various development plans and policies bode well with efficient energy management. Despite this, however, and while the commitment of the authorities is well reflected in the various policies and plans, a more critical issue in the adoption of efficient energy practices is to ensure the full participation and cooperation of all segments of the society. There is also the need to increase the awareness of the financial sector in supporting energy efficient projects. Additionally, there is also a pressing need to expedite the development of renewable energy. To achieve the aim of increasing the contribution of renewable energy to 17% of the total electricity fuel mix by 2030 (2012: around 1%), Malaysia needs to both intensify its efforts and diversify the sources for renewable energy. In this regard, greater understanding, support, co-operation and willingness from all sectors of the economy are needed to ensure the success of green technology development in the country.