



KEMENTERIAN TENAGA, SAINS, TEKNOLOGI,  
ALAM SEKITAR DAN PERUBAHAN IKLIM  
MINISTRY OF ENERGY, SCIENCE, TECHNOLOGY, ENVIRONMENT & CLIMATE CHANGE

# NATIONAL SURVEY OF RESEARCH AND DEVELOPMENT (R&D) IN MALAYSIA 2017





**NATIONAL SURVEY OF  
RESEARCH AND DEVELOPMENT (R&D)  
IN MALAYSIA 2017**

**MALAYSIAN SCIENCE AND TECHNOLOGY INFORMATION  
CENTRE  
MINISTRY OF ENERGY, SCIENCE, TECHNOLOGY,  
ENVIRONMENT AND CLIMATE CHANGE**



**Published by**

Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC)

Malaysian Science and Technology Information Centre (MASTIC)

Level 1-7, Block C4 & C5, Complex C

Federal Government Administrative Centre

62662, WP Putrajaya Malaysia

Tel : 603 – 8000 8000

Fax : 603 – 8888 9070

Email : enquiry@mestecc.gov.my

URL : <http://www.mestecc.gov.my>

**Frequency of publication: Annual**

Copyright@MESTECC (2018)

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any other means either electronic, mechanical, photocopying, recording and/or otherwise without prior permission of publisher (MESTECC).



@mestecc



@mestecc



@MyMESTECC



onemosti



## TABLE OF CONTENTS

TABLE OF CONTENTS.....	v
PREFACE.....	vii
ACKNOWLEDGEMENT .....	viii
RESEARCH TEAM.....	ix
EXECUTIVE SUMMARY .....	x
SUMMARY OF FINDINGS .....	xiii
KEY INDICATORS OF R&D ACTIVITIES IN MALAYSIA.....	xix
LIST OF FIGURES .....	xxvi
LIST OF TABLES .....	xxviii
LIST OF BOX ARTICLES.....	xxviii
CHAPTER 1 : INTRODUCTION .....	3
1.1 Objectives of the Study .....	3
1.2 Scope of Work.....	3
1.3 Outline of the Report.....	4
CHAPTER 2 : APPROACH AND METHODOLOGY.....	7
2.1 Approach of the R&D Survey .....	7
2.2 Concepts and Definitions .....	7
2.3 Questionnaire Design.....	9
CHAPTER 3 : DATA COLLECTION .....	15
3.1 Survey Procedures .....	15
3.1.1 Data Collection Approach and Methodology.....	15
3.2 Quality Control .....	15
3.3 Data Analysis.....	15
3.4 Survey Responses .....	16
CHAPTER 4 : OVERVIEW OF RESEARCH AND DEVELOPMENT (R&D) ACTIVITIES IN MALAYSIA.....	21
4.1 Gross Expenditure on Research and Development (GERD) .....	21
4.2 Expenditure by Sector.....	21
4.2.1 Expenditure by Type of Research.....	22
4.2.2 Expenditure by Field of Research and Socio-economic Objectives.....	23
4.3 Source of Funds .....	25

<b>4.4 Human Resources</b> .....	<b>26</b>
4.4.1 Research and Development Personnel and Researchers per 10,000 Labour Force (2008-2016) .....	26
4.4.2 Distribution of Researchers by Qualifications (2008-2016) .....	27
4.4.3 Researchers Headcount by Gender (2008-2016) .....	28
4.4.4 Full-Time Equivalent (FTE) .....	28
<b>4.5 Research Output</b> .....	<b>29</b>
4.5.1 Publications.....	29
4.5.2 Intellectual Property.....	30
<b>CHAPTER 5 : INTERNATIONAL COMPARISONS</b> .....	<b>35</b>
<b>5.1 R&amp;D Expenditure in 2016</b> .....	<b>35</b>
5.1.1 R&D Expenditure as Percentage of GDP in 2016.....	37
5.1.2 Business Enterprise R&D Expenditure as Percentage of Total R&D Expenditure in 2016 .....	39
5.1.3 Government R&D Expenditure as Percentage of Total R&D Expenditure in 2016 .....	41
5.1.4 Higher Education R&D Expenditure as Percentage of Total R&D Expenditure in 2016 .....	43
<b>5.2 Number of Patents Filed at National Patent Office in 2016</b> .....	<b>45</b>
<b>5.3 Number of Patents Granted at National Patent Office in 2016</b> .....	<b>47</b>
<b>5.4 Number of Patents Granted at the EPO in 2016</b> .....	<b>49</b>
<b>5.5 Number of Patents Granted at the USPTO in 2016</b> .....	<b>51</b>
<b>5.6 Trade Mark Applications in 2016</b> .....	<b>53</b>
<b>5.7 Total R&amp;D Personnel (FTE) in 2016</b> .....	<b>55</b>
<b>5.8 Total Researchers (Headcount) in 2016</b> .....	<b>57</b>
<b>CHAPTER 6 : RESEARCH LIMITATIONS</b> .....	<b>61</b>
<b>6.1 Caveats and Limitations</b> .....	<b>61</b>
<b>6.2 Way Forward in Minimising Limitations in R&amp;D Surveys</b> .....	<b>62</b>
<b>CHAPTER 7 : CONCLUSION AND RECOMMENDATIONS</b> .....	<b>65</b>
<b>7.1 Recommendations to Improve Future R&amp;D Surveys</b> .....	<b>67</b>
<b>7.2 Recommendations to Improve R&amp;D Strategy</b> .....	<b>68</b>
<b>REFERENCES</b> .....	<b>71</b>
<b>ACRONYMS</b> .....	<b>73</b>

## **PREFACE**

R&D and innovation has a pivotal role in laying the foundation of economic growth and development, and in improving the people's wellbeing. The 11<sup>th</sup> Malaysia Plan (11MP) has outlined an innovation strategy that is targeted at the enterprise and societal level, which is a shift from the previously practised, conventional top down approach.

Malaysia plans to strengthen and improve the collaboration between the key stakeholders of the Quadruple Helix: Government, Academia, Industry and People. The policy shift will see greater collaboration aimed at systemic, open and user-centric innovation initiative and away from the national approach.

One of the measures of a developed country is the ability to produce high quality research that can provide critical information about the performance and status as well as identify the critical challenges and issues. This is what the National Survey of R&D seeks to measure. The Malaysian Science and Technology Information Centre (MASTIC) has been conducting R&D surveys since 1994. In 2018, the entire component of the Ministry of Science, Technology and Innovation (MOSTI), green technology and energy components from the Ministry of Energy, Green Technology and Water (KeTTHA) and related components of climate change and environment from the Ministry of Natural Resources and Environment (NRE) has been restructured and formed the Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC).

The 2017 National R&D Survey reports on R&D activities for the year 2016. The survey covers Business Enterprises (BEs), Government Research Institutes (GRIs), Higher Learning Institutions (HLIs) and Non-Governmental Organisations (NGOs). The data comprise both primary and secondary data, and was collected between 2017 and 2018.

## **ACKNOWLEDGEMENT**

We wish to thank the Technical and Steering Committees for their guidance and unrelenting support towards the 2017 National Survey of Research and Development (R&D) in Malaysia. Their much-needed advice and guidance as well as comments to the draft and final reports are greatly appreciated.

We take this opportunity to thank the Department of Statistics Malaysia (DOSM) for their contribution in this project.

We also acknowledge the contribution of consultant team from PE Research Sdn. Bhd. for their commendable efforts in the survey and their involvement in the preparation of this report.

Under-Secretary,  
MASTIC, Ministry of Energy, Science, Technology, Environment and Climate Change

## **RESEARCH TEAM**

### **MASTIC**

<b>Project Leader</b>	:	Kamaruhzaman bin Mat Zin
<b>Project Manager/ Logistics &amp; Technical</b>	:	Nordiyana binti Mohd Ridzwan Shahzari bin Hussin
<b>Support</b>	:	Mohamad Khairol bin Khalid Noor Fairuz binti Shamsudin Nabilah binti Mohd Taha @ Talhah Nazeera binti Mohamad Dzarifa binti Ahmad

### **CONSULTANT (PE Research Sdn. Bhd.)**

<b>Lead Consultant</b>	:	Chang Yii Tan
<b>Senior Consultants</b>	:	Lim Ai Lee Ng Man San Kate Van Kit Yee Dr. Yong Chen Chen
<b>Consultants</b>	:	Jamilah Jawahir binti Mohd Bakeri Chin Lijin
<b>Research Officers</b>	:	Tan Say Wan Liw Teck Leong Nasyira binti Mohamad Nashuki Faten Nabila binti Rustam Affandy Hamka bin Mohd Noor
<b>Research Assistants</b>	:	Nuratiqah binti Mohd Nor Rohaiza binti Salamon

## EXECUTIVE SUMMARY

The National Survey of Research and Development (R&D) 2017 reports on the performance of R&D activities in Malaysia for the financial year 2016. The 2017 R&D Survey covered Business Enterprises (BEs), Government Research Institutes (GRIs), Higher Learning Institutions (HLIs) and Non-Governmental Organisations (NGOs). Canvassing was conducted through e-form, face-to-face interviews and telephone interviews.

The overview comprises R&D indicators compiled from R&D surveys over the years with respect to Gross Expenditure on R&D (GERD), Field of Research (FOR), Socio-Economic Objectives (SEO), Source of Funds, Human Research Development and Research Output. In addition, the 2017 R&D Survey also solicited feedback from the BEs, GRIs, HLIs and NGOs on the location of their R&D activities, outsourced R&D expenditure within and outside Malaysia as well as internal and external factors limiting their R&D activities. This survey serves as an important review of R&D activities that is useful for informed decision-making, particularly in policies, action plans and implementation strategies to address challenges for R&D in Malaysia.

The GERD for Malaysia is estimated at RM17,685 million in 2016. Current expenditure account for 81.0% of GERD whereas 19.0% is due to capital expenditure. Business Enterprises (BEs) is the main driver for R&D activities in Malaysia since 2008, except for 2014 where HLI took the lead. Both BEs and HLIs increased their GERD in 2016 compared to 2015. The GERD for BE increased from RM7,824 million to RM10,006 million thereby increasing its share of GERD from 52.0% to 56.6%. The HLIs increased their gross R&D expenditure from RM4,289 million in 2015 to RM6,041 million in 2016. For GRIs, their gross R&D expenditure fell from RM2,946 million to RM1,627 million, resulting in a decline in GERD of 19.6% to 9.2%. NGOs recorded a GERD of only RM11.6 million in 2016, accounting for only 0.1% of GERD.

In terms of R&D activities, there was an increase in expenditure shares noted for both Basic Research and Experimental Development in 2016 when compared to the previous two years. Basic Research increased its share of R&D expenditure from 20.9% to 28.9% while Experimental Development increased its share from 8.6% to 14.6%. A large proportion of the R&D expenditure in Basic Research came from the HLIs (70.4%) whereas the BEs focused its R&D activities on Applied Research.

Information, Computer and Communication Technology, and Engineering and Technology are the most researched fields in 2016, contributing to 42.2% and 15.2% respectively. Apart from Defence and Security, the main R&D is found in four SEOs, namely Sustainable Economic Development (28.8%), Advanced Experimental and Applied Science (20.6%), Advancement of Knowledge (19.9%), and Society (18.1%).

R&D funding came mainly from the Business Enterprises at 59.8%. Government, and other sources contributed another 34.2% and 6.0% respectively. Researchers form the largest group of the R&D labour force in 2016. The ratio of researchers to 10,000 labour force rose from 61.9 in 2015 to 74.0 in 2016. The majority of researchers have a Masters' degree (35.6%) followed by PhD holders (31.9%). Bachelor's degree holders account for 19.4% and other qualifications at 13.1% in 2016. Female participation in R&D still lags behind the males with a sex ratio of 93 female researchers to every 100 male researchers.

Overall, the total full-time equivalent (FTE) of R&D personnel increased from 22,287 (in 2008) to 89,178 (in 2016). FTE for researchers increased from 69,864 (in 2015) to 73,537 (in 2016) whilst technicians doubled from 4,007 in 2015 to 8,078 in 2016. FTE for support staff dropped slightly in 2016.

In 2016, publications are mostly produced by HLIs. This is not surprising as one of the key performance indicators (KPIs) for lecturers in institutes of higher learning is research papers.

Among the 11 selected Asian countries, China dominates the R&D expenditure, spending USD225 billion in 2016. In terms of R&D expenditure ratio to GDP, China ranked fifth at 2.0% surpassed by Singapore (2.1%), Taiwan (3.1%), Japan (3.5%) and South Korea (4.2%) in 2016. Malaysia ranked after China with 1.4% of R&D expenditure per GDP up from 1.0% in 2011.

The number of patents granted at the national office for Malaysia has increased from 2,353 in 2011 to 3,337 in 2016. The percentage of number of patents granted to patents filed at the national patent office rose from 36.0% in 2011 to 42.2% in 2016. The number of patents granted received by Malaysia at both the EPO and USPTO reached 24 and 77 respectively in 2016. These numbers still small as compared to Singapore with number of patents granted at both the EPO and USPTO reached 193 and 920 respectively in 2016.

Malaysia's R&D activity was strongly supported by the Business Enterprises, accounting for 56.6% of total R&D expenditure. In terms of researcher intensity<sup>1</sup>, Malaysia's intensity was 7.4, eclipsed by Japan (almost 1.8 times of Malaysia) and Iceland (almost 2.5 times higher than Malaysia).

Six recommendations were made to improve future R&D surveys. They include: using the Frascati Manual's definition of R&D in developing the sample frame; using a higher cut-off to increase the efficiency of R&D survey; making available past years' data at the firm level so that discrepancies can be checked; providing multiple channels for respondents to submit their survey data; including specific questions on shortfalls and shortages of R&D personnel to improve knowledge of R&D personnel in firms/institutions; and undertaking a combined innovation and R&D survey so that the dynamics between the two can be differentiated.

Seven recommendations were proposed to enhance R&D activities. They include: an assessment of the R&D incentive schemes (across all agencies) to get behind the issues of why they are not appropriate or suitable; provide allocation for publication in open access journals for research findings to get wider recognition; a case study to examine ways to improve R&D collaboration across the key organisations and institutions and to escalate good examples such as CREST; study how to strengthen intellectual property rights; revisit the programmes to develop R&D skills and talent as this problem seems intractable over the years; improve R&D communications to get better public attention on important policies and to accelerate the formation of the Research Management Agency that would coordinate efforts to achieve R&D goals for Malaysia.

In conclusion, the 2017 R&D Survey finds overall increase in the expenditures, total headcount of R&D personnel and research output. Malaysia has already reached its internal goal of 70 researchers per 10,000 labour force. While showing improvements in these aspects, maximum efforts are still needed in order to maintain its international competitiveness whilst at the same time achieving its target of 2.0% GERD per GDP by 2020.

---

<sup>1</sup> International reporting standards for researcher intensity (Section 5.8) is per thousand labour force. In Malaysia, R&D personnel and researchers (Section 4.4.1) is reported by per 10,000 labour force following the convention set in the National Policy on Science, Technology & Innovation (NPSTI).



# **SUMMARY OF FINDINGS**



R&D comprises creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge.

“Frascati Manual 2015 (OECD, 2015)”

### 5 criteria for identifying R&D



## R&D Expenditure of Malaysia, 2008-2016



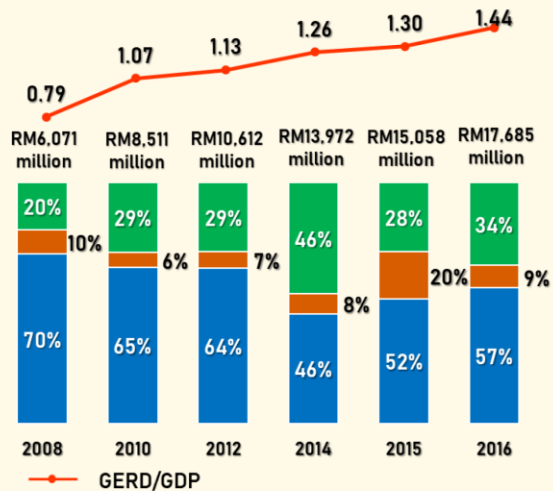
### Gross R&D Expenditure (GERD)

All expenditures spent on R&D in a country during a reference period



### Gross R&D Expenditure per Gross Domestic Product (GERD/GDP)

Percentage of a country's GDP spent on R&D



Business Enterprises



Government Research Institutes



Higher Learning Institutions

## R&D Expenditure by Sector, 2016



Business Enterprises

RM 10,006 million



Government Research Institutes

RM 1,627 million



Higher Learning Institutions

RM 6,041 million



Non-Governmental Organisations

RM 12 million

# OVERVIEW

(CHAPTER 4: OVERVIEW OF RESEARCH AND DEVELOPMENT (R&D) ACTIVITIES IN MALAYSIA, Page 21-32)

National Survey of Research and Development (R&D) in Malaysia 2017

## R&D Expenditure by Type of Research, 2016

28.9%

### Basic Research

Experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena & observable facts, without any particular application or use in view.



56.5%

### Applied Research

Original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective.



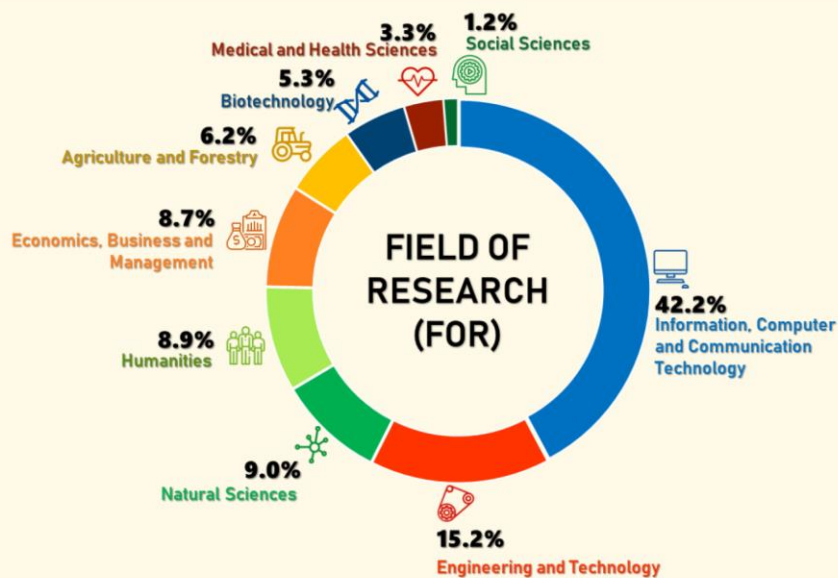
14.6%

### Experimental Development

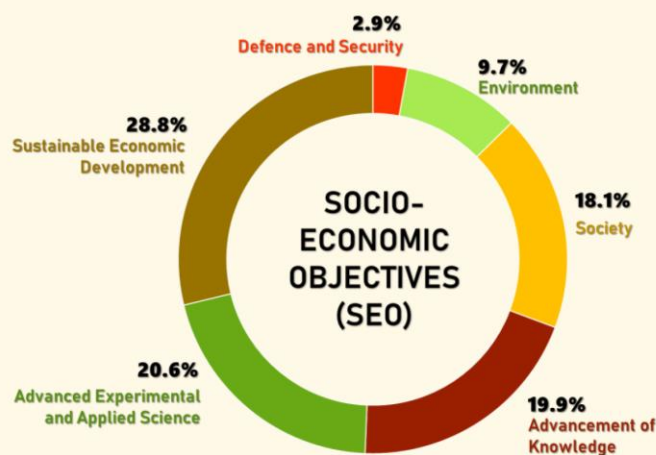
Systematic work, drawing on knowledge gained from research & practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes



## R&D Expenditure by Field of Research, 2016



## R&D Expenditure by Socio-economic Objectives, 2016

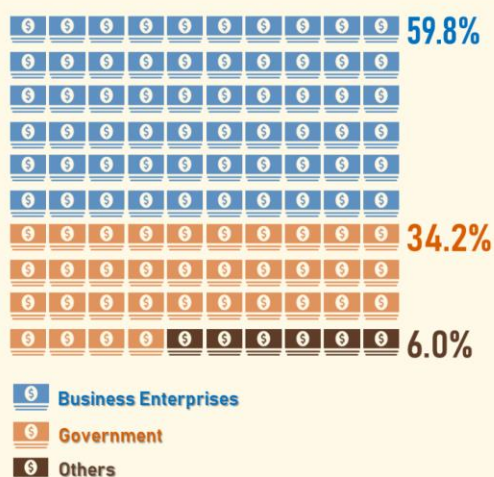


**OVERVIEW**

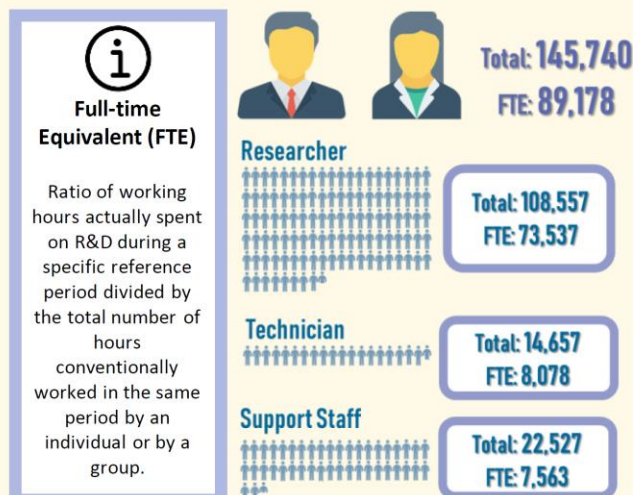
(CHAPTER 4: OVERVIEW OF RESEARCH AND DEVELOPMENT (R&D) ACTIVITIES IN MALAYSIA, Page 21-32)

National Survey of  
Research and Development (R&D)  
in Malaysia 2017

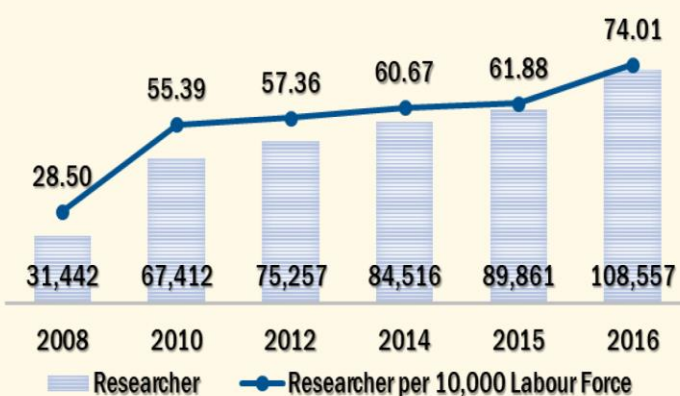
## Source of Funds, 2016



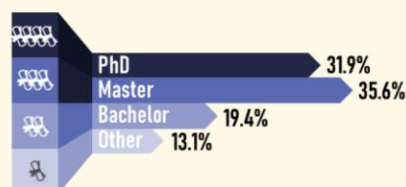
## R&D Personnel, 2016



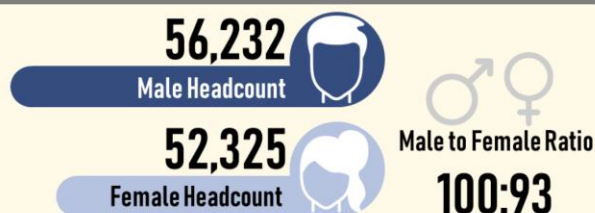
## Researchers and Researchers per 10,000 Labour Force, 2008-2016



## Researchers by Qualification, 2016



## Researchers by Gender, 2016



## Research Output, 2016

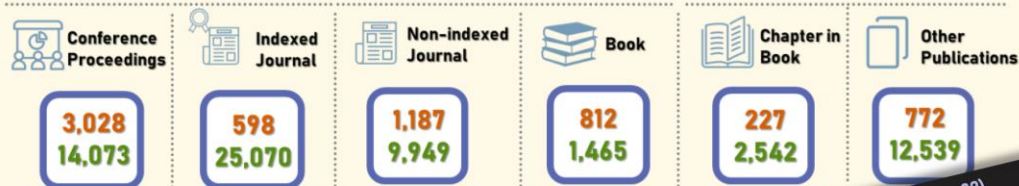
### Intellectual Property



Note: BE | GRI | HLI | NGO

Unit: Number

### Publications



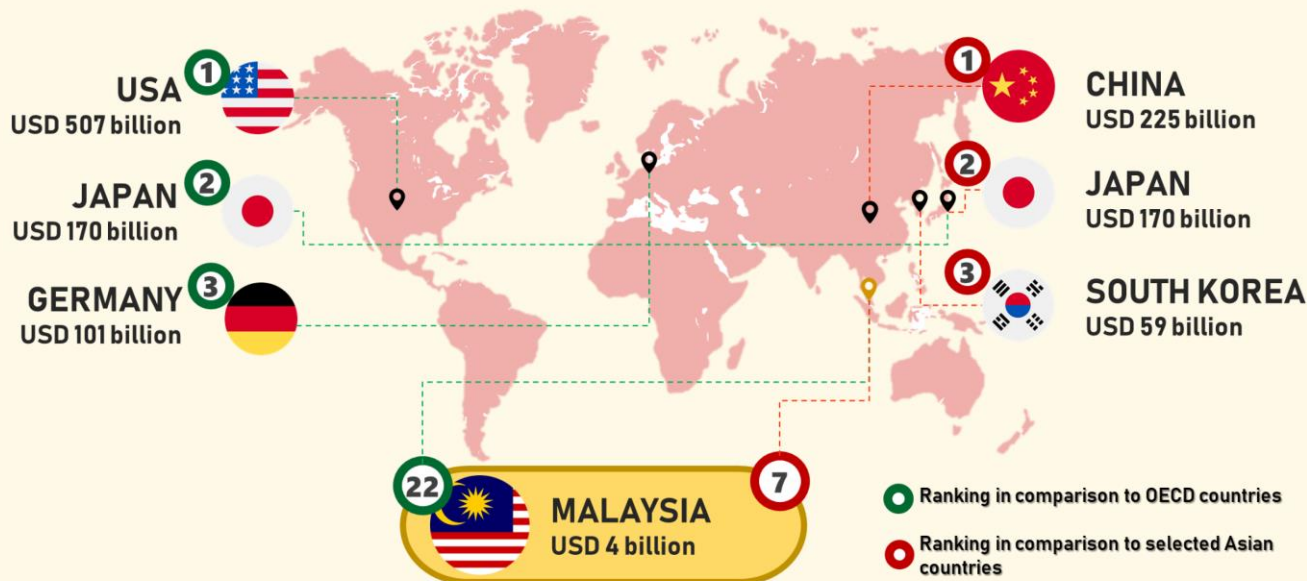
# OVERVIEW

National Survey of Research and Development (R&D) Activities in Malaysia, Page 21-32

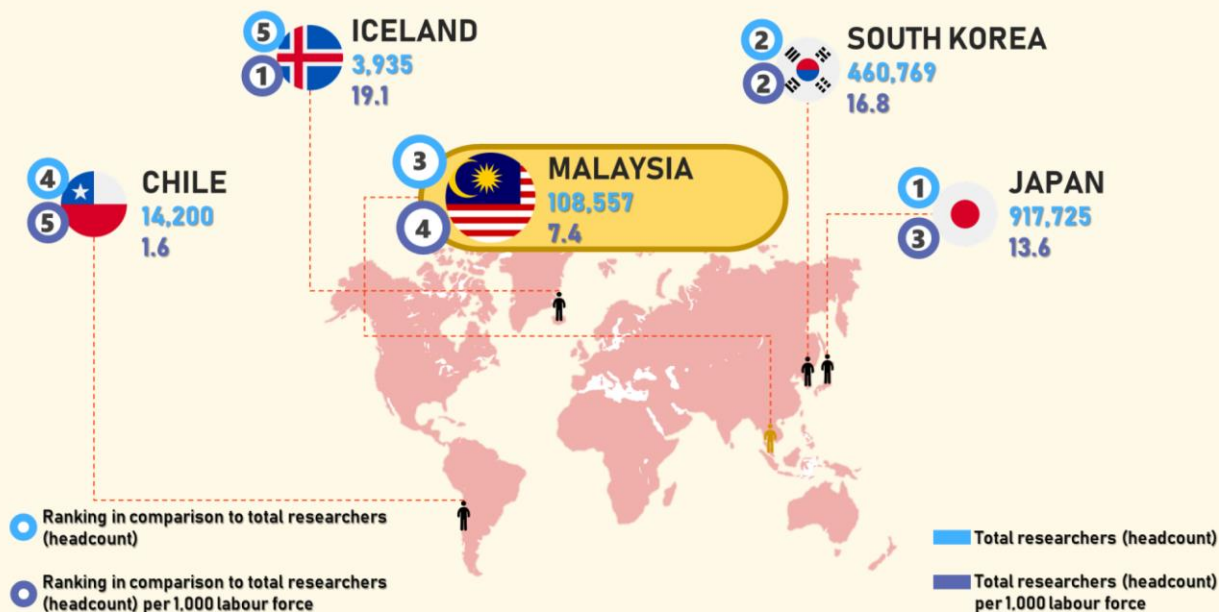
CHAPTER 4: OVERVIEW OF RESEARCH AND DEVELOPMENT (R&D) ACTIVITIES IN MALAYSIA, 2017

## GERD for Malaysia and OECD Countries, 2016

## GERD for Malaysia and Selected Asian Countries, 2016



## Total Researchers (Headcount), 2016 and Total Researchers (Headcount) per 1,000 Labour Force, 2016



**INTERNATIONAL COMPARISONS**

(CHAPTER 9: INTERNATIONAL COMPARISONS, Page 35-57)

National Survey of  
Research and Development (R&D)  
in Malaysia 2017

**KEY INDICATORS OF R&D ACTIVITIES IN MALAYSIA**

<b>Item \ Year</b>	<b>2008</b>	<b>2010</b>	<b>2012</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>
Labour Force (Million)	11.03	12.17	13.12	13.93	14.52	14.67
Total Population (Million)	27.58	28.59	29.30	30.60	31.19	31.63
GDP (RM) Million – Based on Current Price	769,949	795,037	941,237	1,106,580	1,157,139	1,230,120
<b>OVERVIEW OF NATIONAL SURVEY OF R&amp;D</b>						
<b>ORGANISATIONS SURVEYED WITH R&amp;D</b>						
Business Enterprise (BEs) (Number)	944	1,171	1,234	1,338	1,407	3,659*
Government Research Institutes (GRIs) (Number)	52	34	44	62	78	73
Higher Learning Institutions (HLIs) (Number)	37	39	49	58	74	64
Non-Governmental Organisations (NGOs) (Number)	N/A	N/A	1	0	0	8
<b>TOTAL</b>	<b>1,033</b>	<b>1,244</b>	<b>1,328</b>	<b>1,458</b>	<b>1,559</b>	<b>3,804</b>
Gross Expenditure on R&D (GERD) RM (Million)	6,070.80	8,510.70	10,612.81	13,971.56	15,058.34	17,685.39
Current Expenditure RM (Million)	5,134.10	6,732.50	8,559.48	10,265.06	12,340.15	14,323.34
Capital Expenditure RM (Million)	936.70	1,778.20	2,053.33	3,706.50	2,718.19	3,362.05
Percentage of GERD/GDP (%)	0.79	1.07	1.13	1.26	1.30	1.44
Percentage of BERD (%)	70.49	64.99	64.45	45.66	51.95	56.58
<b>HUMAN RESOURCE IN R&amp;D</b>						
Total Headcount of R&D Personnel	40,840	88,314	103,986	114,539	136,683	145,740
Total Headcount of Researchers	31,442	67,412	75,257	84,516	89,861	108,557

## National Survey of Research and Development (R&amp;D) in Malaysia 2017

Item \ Year	2008	2010	2012	2014	2015	2016	
Total Headcount of Technicians and Support Staff	9,398	20,902	28,729	30,023	46,822	37,184	
Total FTE of R&D Personnel	22,287	50,484	62,807	75,062	82,360	89,178	
Total FTE of Researchers	16,345	41,253	52,052	61,351	69,864	73,537	
FTE per R&D Personnel	0.55	0.57	0.60	0.66	0.60	0.61	
FTE per Researcher	0.52	0.61	0.69	0.73	0.77	0.68	
Headcount of Researchers per 10,000 Labour Force	28.50	55.39	57.40	60.66	61.88	74.01	
<b>FIELD OF RESEARCH AND SOCIO-ECONOMIC OBJECTIVES</b>							
Three Main Fields of Research (FOR)	1	-	ICT (45.50%)	Engineering & Technology (33.65%)	ICT (39.04%)	ICT (42.43%)	ICT (42.24%)
	2	-	Engineering & Technology (27.60%)	Natural Sciences (25.63%)	Engineering & Technology (24.48%)	Engineering & Technology (19.84%)	Engineering & Technology (15.23%)
	3	-	Biotechnology (6.60%)	ICT (10.79%)	Natural Sciences (8.19%)	Natural Sciences (10.87%)	Natural Sciences (9.00%)
Three Main Fields Socio-Economic Objectives (SEO)	1	-	Sustainable Economic Development (36.20%)	Sustainable Economic Development (49.61%)	Sustainable Economic Development (31.35%)	Sustainable Economic Development (35.58%)	Sustainable Economic Development (28.80%)
	2	-	Advanced Experimental & Applied Science (18.80%)	Advanced Experimental & Applied Science (17.68%)	Advanced Experimental & Applied Science (29.41%)	Society (19.94%)	Advanced Experimental & Applied Science (20.59%)
	3	-	Advancement of Knowledge (18.10%)	Advancement of Knowledge (16.79%)	Society (20.49%)	Advanced Experimental & Applied Science (19.06%)	Advancement of Knowledge (19.95%)

Note:

N/A - Not Available

\*weighted data

Source:

i. National Survey of Research and Development (R&amp;D) in Malaysia

ii. Department of Statistics, Malaysia

**R&D IN BUSINESS ENTERPRISES**

Item \ Year	2008	2010	2012	2014	2015	2016	
Total R&D Expenditure RM (Million)	4,279.40	5,531.50	6,839.67	6,379.10	7,823.54	10,006.06	
Current Expenditure RM (Million)	3,586.80	4,304.00	5,416.60	5,405.47	6,234.68	7,912.51	
Capital Expenditure RM (Million)	692.60	1,227.50	1,423.07	973.63	1,588.86	2,093.55	
<b>HUMAN RESOURCE IN R&amp;D</b>							
Headcount of R&D Personnel	6,166	9,858	11,724	10,952	14,621	26,926	
Headcount of Researchers	3,661	5,741	6,247	6,581	9,849	19,117	
Headcount of Technicians and Support Staff	2,505	4,117	5,477	4,371	4,772	7,809	
FTE of R&D Personnel	5,576	9,118	10,171	9,793	11,015	20,174	
FTE of Researchers	3,321	5,478	5,596	6,290	8,614	16,134	
FTE per R&D Personnel	0.90	0.92	0.87	0.89	0.75	0.75	
FTE per Researcher	0.91	0.95	0.90	0.96	0.87	0.84	
<b>FIELD OF RESEARCH AND SOCIO-ECONOMIC OBJECTIVES</b>							
Three Main Fields of Research (FOR)	1	-	ICT (66.60%)	Engineering & Technology (34.88%)	ICT (75.18%)	ICT (76.61%)	ICT (62.42%)
	2	-	Engineering & Technology (23.40%)	Natural Sciences (29.07%)	Engineering & Technology (16.49%)	Engineering & Technology (17.38%)	Engineering & Technology (14.70%)
	3	-	Bio-technology (6.70%)	ICT (12.79%)	Bio-technology (6.26%)	Bio-technology (2.92%)	Natural Sciences (12.17%)
Three Main Fields Socio-Economic Objectives (SEO)	1	-	Sustainable Economic Development (36.10%)	Sustainable Economic Development (62.30%)	Sustainable Economic Development (43.70%)	Sustainable Economic Development (43.07%)	Sustainable Economic Development (36.52%)
	2	-	Advanced Experimental & Applied Science (23.50%)	Advancement of Knowledge (13.20%)	Society (18.96%)	Society (18.17%)	Advancement of Knowledge (22.28%)
	3	-	Environment (15.00%)	Environment (13.20%)	Advanced Experimental & Applied Science (15.49%)	Advancement of Knowledge (16.70%)	Advanced Experimental & Applied Science (17.70%)

**R&D IN GOVERNMENT RESEARCH INSTITUTES**

<b>Item \ Year</b>	<b>2008</b>	<b>2010</b>	<b>2012</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	
Total R&D Expenditure RM (Million)	603.10	514.80	729.96	1,146.99	2,945.97	1,626.54	
Current Expenditure RM (Million)	469.50	334.70	597.95	916.33	2,622.12	1,532.19	
Capital Expenditure RM (Million)	133.60	180.10	132.01	230.66	323.84	94.35	
<b>HUMAN RESOURCE IN R&amp;D</b>							
Headcount of R&D Personnel	5,899	6,877	8,339	10,612	19,017	Research agency	8,900
						Non-research agency	9,045
						Total	17,945
Headcount of Researchers	3,650	2,972	4,045	4,550	6,721	Research agency	4,214
						Non-research agency	7,505
						Total	11,719
Headcount of Technicians and Support Staff	2,249	3,905	4,294	6,062	12,296	Research agency	4,686
						Non-research agency	1,540
						Total	6,226
FTE of R&D Personnel	3,009.09	4,114.96	5,932.19	8,362.16	9,180.10	Research agency	6,830.69
						Non-research agency	2,081.01
						Total	8,911.70
FTE of Researchers	1,566.23	2,403.00	3,533.49	3,964.12	6,721.00	Research agency	3,611.45
						Non-research agency	1,265.29
						Total	4,876.74
FTE per R&D Personnel	0.51	0.60	0.71	0.79	0.48	Research agency	0.77
						Non-research agency	0.23
						Total	0.50
FTE per Researcher	0.43	0.81	0.87	0.87	1.00	Research agency	0.86
						Non-research agency	0.17
						Total	0.42

Item	Year	2008	2010	2012	2014	2015	2016
<b>FIELD OF RESEARCH AND SOCIO-ECONOMIC OBJECTIVES</b>							
Three Main Fields of Research (FOR)	1	-	Agriculture & Forestry (44.90%)	Natural Sciences (28.15%)	Agriculture & Forestry (39.33%)	Agriculture & Forestry (25.00%)	Social Sciences (22.35%)
	2	-	Natural Sciences (15.70%)	Bio-technology (27.39%)	Engineering & Technology (21.39%)	Natural Sciences (23.97%)	Agriculture & Forestry (19.17%)
	3	-	Biotechnology (14.30%)	Agriculture & Forestry (26.31%)	ICT (13.76%)	Medical & Health Sciences (20.00%)	Natural Sciences (16.75%)
Three Main Fields Socio-Economic Objectives (SEO)	1	-	Sustainable Economic Development (69.70%)	Sustainable Economic Development (27.98%)	Sustainable Economic Development (36.56%)	Sustainable Economic Development (41.84%)	Society (24.53%)
	2	-	Society (13.90%)	Advanced Experimental & Applied Science (25.08%)	Advanced Experimental & Applied Science (26.56%)	Society (22.31%)	Advanced Experimental & Applied Science (23.67%)
	3	-	Advancement of Knowledge (7.50%)	Environment (19.12%)	Environment (16.73%)	Environment (11.60%)	Sustainable Economic Development (19.10%)

**R&D IN HIGHER LEARNING INSTITUTIONS**

Item	Year	2008	2010	2012	2014	2015	2016
Total R&D Expenditure RM (Million)		1,188.30	2,464.40	3,042.28	6,445.48	4,288.84	6,041.23
Current Expenditure RM (Million)		1,077.80	2,093.80	2,544.12	3,943.27	3,483.35	4,867.55
Capital Expenditure RM (Million)		110.50	370.60	498.16	2,502.21	805.49	1,173.68
<b>HUMAN RESOURCE IN R&amp;D</b>							
Headcount of R&D Personnel		28,775	71,579	83,919	92,975	103,045	100,817
Headcount of Researchers		24,131	58,699	64,962	73,385	73,291	77,674
Headcount of Technicians and Support Staff		4,644	12,880	18,957	19,590	29,754	23,143
FTE of R&D Personnel		13,702.50	37,251.45	46,700.09	56,906.56	62,164.79	60,048.39
FTE of Researchers		11,457.60	33,357.75	42,919.60	51,097.26	54,529.29	52,483.51
FTE per R&D Personnel		0.39	0.52	0.56	0.61	0.60	0.60
FTE per Researcher		0.47	0.57	0.66	0.70	0.74	0.68
<b>FIELD OF RESEARCH AND SOCIO-ECONOMIC OBJECTIVES</b>							
Three Main Fields of Research (FOR)	1	-	Engineering & Technology (40.70%)	Engineering & Technology (37.38%)	Engineering & Technology (32.94%)	Engineering & Technology (29.74%)	Engineering & Technology (32.48%)
	2	-	Natural Sciences (15.20%)	Natural Sciences (17.29%)	Natural Sciences (16.12%)	Natural Sciences (17.34%)	Medical & Health Sciences (19.73%)
	3	-	Medical & Health Sciences (11.90%)	Social Science (9.58%)	Social Science (11.45%)	Medical & Health Sciences (13.86%)	Natural Sciences (14.25%)
Three Main Fields Socio-Economic Objectives (SEO)	1	-	Sustainable Economic Development (29.40%)	Sustainable Economic Development (26.28%)	Advanced Experimental & Applied Science (43.71%)	Advanced Experimental & Applied Science (34.39%)	Advanced Experimental & Applied Science (26.92%)
	2	-	Advanced Experimental & Applied Science (28.80%)	Advanced Experimental & Applied Science (25.94%)	Society (24.13%)	Society (21.53%)	Society (24.31%)
	3	-	Society (23.90%)	Advancement of Knowledge (25.26%)	Sustainable Economic Development (18.20%)	Sustainable Economic Development (17.64%)	Advancement of Knowledge (23.64%)

**R&D IN NON-GOVERNMENTAL ORGANISATIONS, 2016**

Total R&D Expenditure RM (Million)		11.56
Current Expenditure RM (Million)		11.09
Capital Expenditure RM (Million)		0.47
<b>HUMAN RESOURCE IN R&amp;D</b>		
Headcount of R&D Personnel		52
Headcount of Researchers		46
Headcount of Technicians and Support Staff		6
FTE of R&D Personnel		43.8
FTE of Researchers		42.4
FTE per R&D Personnel		0.84
FTE per Researcher		0.92
<b>FIELD OF RESEARCH AND SOCIOECONOMIC OBJECTIVE</b>		
Three Main Fields of Research (FOR)	1	Medical & Health Sciences (57.49%)
	2	Natural Sciences (15.86%)
	3	Engineering & Technology (6.92%)
Three Main Fields Socio-Economic Objectives (SEO)	1	Environment (49.38%)
	2	Society (18.13%)
	3	Advancement of Knowledge (12.50%)  Advanced Experimental & Applied Science (12.50%)

## LIST OF FIGURES

- Figure 2.1: Definition for the Five Core Criteria
- Figure 2.2: Types of R&D
- Figure 4.1: GERD by Type of Cost, 2008-2016
- Figure 4.2: GERD by Sector, 2008-2016 (RM Million)
- Figure 4.3: GERD by Sector, 2008-2016 (Percentage)
- Figure 4.4: GERD by Type of Research, 2014-2016 (Percentage)
- Figure 4.5: Type of Research by Sectors, 2016 (RM Million)
- Figure 4.6: GERD by Field of Research, 2016 (Percentage)
- Figure 4.7: GERD by Field of Research, 2015-2016 (Percentage)
- Figure 4.8: GERD by Socio-Economic Objectives, 2016 (Percentage)
- Figure 4.9: GERD by Socio-Economic Objectives, 2015-2016 (Percentage)
- Figure 4.10: Source of R&D Funds, 2016 (Percentage)
- Figure 4.11: Source of R&D Funds Comparison, 2015-2016 (Percentage)
- Figure 4.12: R&D Personnel and Researchers per 10,000 Labour Force, 2008-2016
- Figure 4.13: Headcount of Researchers, 2008-2016
- Figure 4.14: Researchers by Qualification, 2008-2016 (Percentage)
- Figure 4.15: Headcount of Researchers by Gender, 2008-2016
- Figure 4.16: Full-Time Equivalent of R&D Personnel, 2008-2016
- Figure 4.17: Publication Output Comparison, 2015-2016
- Figure 5.1: Expenditure on R&D for Malaysia and Selected Asian Countries in 2016 (USD Million)
- Figure 5.2: Expenditure on R&D for Malaysia and OECD Countries in 2016 (USD Million)
- Figure 5.3: Expenditure on R&D as Percentage of GDP for Malaysia and Selected Asian Countries in 2016
- Figure 5.4: Expenditure on R&D as Percentage of GDP for Malaysia and OECD Countries in 2016
- Figure 5.5: Business Enterprise R&D Expenditure as Percentage of Total R&D Expenditure for Malaysia and Selected Asian Countries in 2016
- Figure 5.6: Business Enterprise Expenditure on R&D as Percentage of Total R&D Expenditure for Malaysia and OECD countries in 2016
- Figure 5.7: Government R&D Expenditure as Percentage of Total R&D Expenditure for Malaysia and selected Asian countries in 2016
- Figure 5.8: Government R&D Expenditure as Percentage of Total R&D Expenditure for Malaysia and OECD countries in 2016
- Figure 5.9: Higher Education Expenditure on R&D as Percentage of Total R&D Expenditure for Malaysia and selected Asian countries in 2016
- Figure 5.10: Higher Education Expenditure on R&D as Percentage of Expenditure on R&D for Malaysia and OECD countries in 2016
- Figure 5.11: Number of Patents Filed at National Patent Office for Malaysia and selected Asian countries in 2016
- Figure 5.12: Number of Patents Filed at National Patent Office for Malaysia and OECD countries in 2016
- Figure 5.13: Number of Patents Granted at National Patent Office for Malaysia and other Asian countries in 2016

- Figure 5.14: Number of Patents Granted at National Patent Office for Malaysia and OECD countries in 2016
- Figure 5.15: Number of Patents Granted at EPO for Malaysia and selected Asian countries in 2016
- Figure 5.16: Number of Patents Granted at EPO for Malaysia and OECD countries in 2016
- Figure 5.17: Number of Patents Granted at the USPTO for Malaysia and selected Asian countries in 2016
- Figure 5.18: Number of Patents Granted at the USPTO for Malaysia and OECD countries in 2016
- Figure 5.19: Trade Mark Applications for Malaysia and selected Asian countries in 2016
- Figure 5.20: Trade Mark Applications for Malaysia and OECD countries in 2016
- Figure 5.21: Total R&D Personnel (FTE) for Malaysia and other countries in 2016
- Figure 5.22: Total R&D Personnel per thousand labour force (FTE) for Malaysia and other countries in 2016
- Figure 5.23: Total Researchers (Headcount) for Malaysia and other countries in 2016
- Figure 5.24: Total Researchers (Headcount) per thousand labour force for Malaysia and other countries in 2016

## **LIST OF TABLES**

- Table 2.1: Contents of Questionnaires for 2017 R&D Survey  
Table 3.1: Number of Responses from Surveyed Institutions by Sectors, 2016  
Table 3.2: Number of Responses from BEs in the National R&D Surveys, 2010-2016  
Table 3.3: Number of Responses from GRIs in the National R&D Surveys, 2010-2016  
Table 3.4: Number of Responses from HLIs in the National R&D Surveys, 2010-2016  
Table 4.1: Number of Publications in HLIs and GRIs, 2015-2016  
Table 4.2: Number of Intellectual Property, 2015-2016  
Table 7.1: Summary of Key R&D Indicators for All Sectors

## **LIST OF BOX ARTICLES**

- Box 4.1: The Fourth Industrial Revolution and Challenges on R&D

# **CHAPTER 1: INTRODUCTION**



## CHAPTER 1: INTRODUCTION

The *Pusat Maklumat Sains & Teknologi Malaysia* (MASTIC), Ministry of Energy, Science, Technology, Environment and Climate Change commissioned the *Kajian Penyelidikan Dan Pembangunan (R&D) Kebangsaan 2017* or the National Research and Development (R&D) Survey 2017 with 2016 as the reference period for the survey.

MASTIC has commissioned biennial national R&D surveys since 1994. The first annual survey was conducted in 2008. The objective of the R&D survey is to find out the status, trends and statistics of the national R&D for a financial year, i.e. January to December. The findings of the R&D study have been used to measure the performance of national R&D activities against the targets set by Government and also used for international comparison.

This 2017 R&D Survey is a continuation of these activities and will be used to assess the nature of R&D inputs to the landscape of creative and innovative activities in Malaysia.

### 1.1 Objectives of the Study

The objectives of the study are:

- a) To obtain comprehensive information and statistics on the nation's status, progress and the flow of activities in R&D;
- b) To analyse R&D expenditure trends, sources of financing of R&D activities, human resources involved in R&D, output from the R&D activities such as the number of publications and intellectual property indicators until 2016, in investigating the level of achievement and progress of the nation's R&D;
- c) To compare the nation's R&D achievements and progress with other countries based on the findings of this study;
- d) To run diagnosis analysis on issues involving gross expenditure on R&D per GDP, minimum ratio of 30:70 in R&D expenditure between the public and private sectors as well as number of researchers per 10,000 labour force, based on factors such as economics, human resources, policy, social, political and others; and
- e) To conclude and recommend on improvements in R&D activities and further research that can be done through the outcome of National Survey of Research and Development (R&D) in Malaysia 2017.

### 1.2 Scope of Work

The first scope of work for the 2017 R&D Survey is to conduct international comparisons using the Frascati Manual guidelines published by the Organisation of Economic Cooperation and Development (OECD, 2015) as reference. Meanwhile, classification of national R&D fields uses the Malaysian Research and Development Classification System (MRDCS), 6<sup>th</sup> Edition as reference.

The survey would identify respondents that undertake R&D in addition to the list of respondents provided by the Department of Statistics Malaysia (DOSM), Malaysia Digital Economy Corporation (MDeC), and Bioeconomy Corporation. Furthermore, Business Enterprises (BEs) would include Government-Linked Companies (GLC), Multi-National

Companies (MNCs) and private companies whilst NGO sector would be established separately (if necessary).

Additionally, improvement to the existing (2015) questionnaire would be made to conform to meet the specific objectives of the study. The improved questionnaire would be used for data collection. The data collection would be carried out manually (by post, fax, e-mail, interviews in person or by telephone) and/or using e-Survey System. The data from manual collection needs to be entered into the e-Survey System for inventory and online purposes. Enumerators would be trained to make follow-up calls, field work visits, and conduct quality assurance to receive feedback from all respondents within the prescribed time. To ensure a high response rate, initiatives such as the collection of data in bulk according to the organisation, top-down approach, workshops, working visits or other appropriate methods would be used.

A detailed data analysis would be conducted on the primary research data and/or data from other sources in accordance with the research objectives using SPSS application software or any appropriate application. Validation and verification processes would be run continuously to maintain the quality of the data reported by the respondents in order to meet the standards and the requirements.

### **1.3 Outline of the Report**

This report contains eleven (7) chapters: Chapter 1 provides details of the objectives and scope of work for the R&D survey. Chapter 2 discusses the approach and methodology for the project. Chapter 3 details the data collection methodology proposed for the project. Chapter 4 discusses the overview of R&D in Malaysia. Chapter 5 compares R&D activities of Malaysia against other countries. Chapter 6 discusses the research limitations of the project. Lastly, Chapter 7 discusses the conclusion and recommendations for the project.

**CHAPTER 2:  
APPROACH AND  
METHODOLOGY**



## CHAPTER 2: APPROACH AND METHODOLOGY

The coverage of the 2017 R&D Survey includes both public and private organisations, and data collected from organisations that conducted R&D activities in the 2016 financial year (i.e. calendar year). The public sector comprises Higher Learning Institutions (**HLI**) and Government Research Institutes (**GRI**), while the Business Enterprise sector (**BE**) comprises private companies/industries but also includes government-linked companies. Non-Governmental Organisations (**NGO**) are another category of organisations included in the survey.

### 2.1 Approach of the R&D Survey

The approach for the study comprises the following tasks:

Task 1: Literature review

Task 2: Define concepts and definitions

Task 3: Questionnaire design

Task 4: Survey design and sampling

Task 5: Data collection

Task 6: Quality checking

Task 7: Data entry, data editing and data processing

Task 8: Benchmarking with other countries

Task 9: Detailed analysis of R&D survey data

Task 10: Report writing

### 2.2 Concepts and Definitions

In order to produce internationally comparable R&D statistics, it is essential to use standard R&D definitions as per the Frascati Manual 2015 (OECD, 2015). In reality, respondents may use a variety of definitions, hence, applying a standard definition will be a practical challenge<sup>2</sup> for all R&D surveys.

Based on the Frascati Manual 2015, **R&D comprises creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge.**

---

<sup>2</sup> In any survey, it would be important to expect problems relating to understanding, over or under-exaggeration, or even disinterest in the survey itself. This is particularly the case for surveys that require respondents to apply concepts and definitions that they may not be familiar with, use or understand in their daily work. Some may have preconceived notions of R&D, which may not fit with the standard definitions. To complicate matters, R&D may also be regulated and regulatory definitions may also add to the complexity of data collection. See discussion in Chapter 6 for other challenges in collecting R&D data.

R&D includes the design, construction and testing of prototypes; a pilot plant as the primary objective is R&D; industrial design is R&D, but it excludes design for production process. “Feedback” R&D and tooling up industrial engineering in innovation processes is R&D, but it excludes for tooling for production. Trial production that involves full-scale testing and subsequent further design and engineering is R&D, but all other associated activities, e.g. patent application for R&D are excluded.

The following are excluded from R&D: pre-production development, after-sales service and trouble-shooting, patent and licence work (all administrative and legal work), routine tests, data collection and routine compliance with public inspection control, enforcement of standard and regulations, scientific and technical information services, feasibility studies, specialised health care (routine investigation and normal application of specialised medical knowledge), policy-related studies and programmatic evaluations.

**Figure 2.1** shows the definition and inclusion/exclusion of R&D types. There are **five core criteria that R&D activities must satisfy, at least in principle: novel, creative, uncertain, systematic, and transferable and/or reproducible** (see **Figure 2.1** for definition).

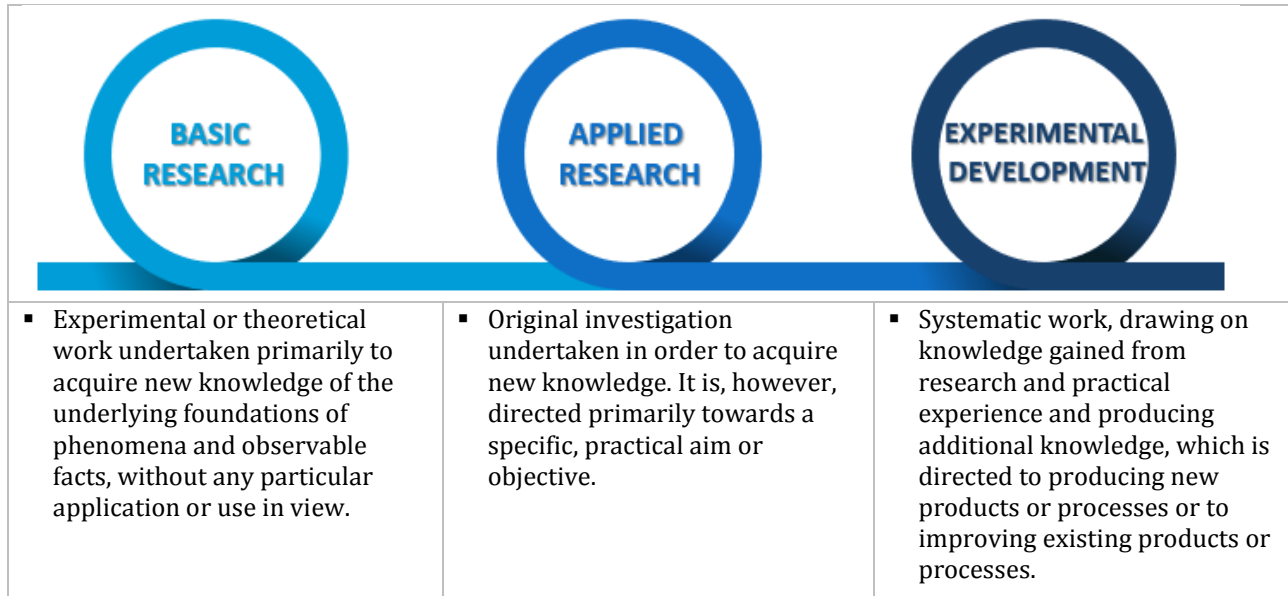
**Figure 2.1: Definition for the Five Core Criteria**

	<b>Novel</b>	<b>Creative</b>	<b>Uncertain</b>	<b>Systematic</b>	<b>Transferable and/or reproducible</b>
<b>Definition</b>	<b>Aimed at new findings</b>	<b>Based on original, not obvious, concepts &amp; hypotheses</b>	<b>Uncertain about the final outcome</b>	<b>Planned &amp; budgeted</b>	<b>Lead to results that could be possibly reproduced</b>
<b>Inclusion</b>	<ul style="list-style-type: none"> <li>▪ <b>New findings</b> &amp; not yet in use in industry</li> <li>▪ <b>New knowledge</b> &amp; not on new or significantly improved products or processes</li> </ul>	<ul style="list-style-type: none"> <li>▪ <b>New concepts or ideas that improve on existing knowledge</b></li> </ul>	<ul style="list-style-type: none"> <li>▪ <b>Possibility of not achieving the intended results.</b> E.g., uncertainty about the costs &amp; time needed to achieve the expected results</li> </ul>	<ul style="list-style-type: none"> <li>▪ <b>R&amp;D conducted in a planned manner</b></li> </ul>	<ul style="list-style-type: none"> <li>▪ <b>Transfer of the new knowledge &amp; allowing other researchers to reproduce the results</b> as part of their own R&amp;D activities</li> </ul>
<b>Exclusion</b>	<ul style="list-style-type: none"> <li>▪ <b>Activities such as copy, imitate or reverse engineer as a means of gaining knowledge</b></li> </ul>	<ul style="list-style-type: none"> <li>▪ <b>Routine work, data processing, vocational training</b></li> </ul>	<ul style="list-style-type: none"> <li>▪ <b>Non-R&amp;D prototyping, i.e., pre-production units used to obtain technical or legal certification</b></li> </ul>		<ul style="list-style-type: none"> <li>▪ <b>Tacit knowledge</b></li> </ul>

Source : Frascati Manual 2015

R&D activities are classified as Basic Research, Applied Research and Experimental Development<sup>3</sup> and they can also be grouped to form “R&D projects” as shown in **Figure 2.2**. Hence, an R&D project comprises a set of R&D activities which is not likely to be applied in the same way in all sectors (i.e., Business Enterprises, Government, Higher Education Learning and Private Non-Profit sectors).

<sup>3</sup> The term “Experimental Development” is used interchangeably with “Experimental Research” for the purpose of providing an easier-to-understand term.

**Figure 2.2: Types of R&D**

Source : Frascati Manual 2015

The four (4) main aspects of the survey are as follows:

1. R&D activities (i.e., Basic Research, Applied Research and Experimental Development) of R&D performers (i.e., the Business Enterprise, the Government, the Higher Education and the Private Non-Profit sectors) in specific sectors;
2. Financial allocation based on i) intramural R&D expenditures<sup>4</sup> of R&D performers in specific sectors (performer-based approach) and ii) source of funds/funding of R&D activities (funder-based approaches);
3. Human resource allocated to R&D activities; and
4. Government budget for R&D funding.

### 2.3 Questionnaire Design

Similar to previous R&D surveys, this 2017 R&D Survey uses four sets of questionnaires, specifically designed for BEs, NGOs, GRIs and HLLs. Questionnaires used in previous surveys were reviewed and improved. **Table 2.1** summarises the contents of the 2017 questionnaire.

<sup>4</sup> Intramural R&D expenditures are all current expenditures plus gross fixed capital expenditures for R&D performed within a statistical unit during a specific reference period, whatever the source of funds. Intramural R&D expenditure is synonymous with the performance of R&D within a statistical unit. The aggregation of intramural R&D for all units within a sector is synonymous with the performance of R&D within a sector of the economy; the summation of intramural R&D for all sectors is synonymous with the performance of R&D for the entire economy (GERD) (Frascati Manual, 2015).

**Table 2.1: Contents of Questionnaires for 2017 R&D Survey**

Section	Type of Data	GRI/HLI	BE/NGO
Section 1: Company Profile	<b>Company / Organisation Profile:</b> Collects general information on the firm, contact details, the person responsible for survey, main economic activity etc	√	√
Section 2: R&D Activities Conducted	<b>Field of Research (FOR):</b> <ul style="list-style-type: none"> <li>▪ Natural Sciences (<i>Mathematical Sciences, Physical Sciences, Chemical Sciences, Biological Sciences, Bioinformatics, Nuclear Sciences, Earth Sciences, Environmental Sciences, Material Sciences, Marine Sciences</i>)</li> <li>▪ Biotechnology</li> <li>▪ Engineering and Technology (<i>Engineering and Technology, Applied Sciences and Technologies</i>)</li> <li>▪ Information, Computer and Communication Technology</li> <li>▪ Medical and Health Sciences</li> <li>▪ Agriculture and Forestry (<i>Agricultural Sciences and Technology, Forestry Sciences and Technology</i>)</li> <li>▪ Social Sciences</li> <li>▪ Humanities</li> <li>▪ Economics, Business and Management</li> </ul>	√	√
	<b>Socio-economic Objective (SEO):</b> <ul style="list-style-type: none"> <li>▪ Defence and Security</li> <li>▪ Sustainable Economic Development</li> <li>▪ Society</li> <li>▪ Environment</li> <li>▪ Advancement of Knowledge</li> <li>▪ Advanced Experimental and Applied Science</li> </ul>	√	√
	<b>Types of R&amp;D activities:</b> <ul style="list-style-type: none"> <li>▪ Basic Research</li> <li>▪ Applied Research</li> <li>▪ Experimental Development</li> </ul>	√	√
Section 3: R&D Personnel	<b>Headcount/ Full-time equivalent (FTE)/ Total Yearly Salary &amp; Emoluments:</b>		
	<b>i) Internal R&amp;D Personnel</b>	√	√
	<ul style="list-style-type: none"> <li>▪ Researchers (Malaysian/Non-Malaysian) by Gender and Highest Qualifications</li> </ul>	√	√
	<ul style="list-style-type: none"> <li>▪ Technicians &amp; equivalent staff by Gender</li> </ul>	√	√
	<ul style="list-style-type: none"> <li>▪ Other supporting staff by Gender</li> </ul>	√	√
	<b>ii) External R&amp;D Personnel (or contributors) by Gender</b>	√	√
Section 4: R&D Expenditure & Source of Funds	<b>Current Expenditure:</b> <ul style="list-style-type: none"> <li>▪ Labour Costs</li> <li>▪ Operating Costs</li> <li>▪ Other Recurrent Costs</li> </ul>	√	√

Section	Type of Data	GRI/HLI	BE/NGO
	<b>Capital Expenditure:</b> <ul style="list-style-type: none"> <li>▪ Land, building &amp; other structures</li> <li>▪ Vehicles, plants, software, machinery &amp; equipment</li> </ul>	√	√
	<b>Source of Funds:</b> <ul style="list-style-type: none"> <li>▪ Company/Organisation-owned fund</li> <li>▪ Business Enterprises (<i>Public &amp; Private</i>)</li> <li>▪ Government (<i>Federal Government R&amp;D funds, State or local government funds, Other government funds</i>)</li> <li>▪ Other funds</li> <li>▪ Foreign funds</li> </ul>	√	√
	<b>Location of R&amp;D Projects by States</b>	√	√
Section 5: R&D Outsourced	<b>i) R&amp;D Projects being outsourced to company / organisation:</b>		
	<ul style="list-style-type: none"> <li>▪ Within Malaysia</li> <li>▪ Outside Malaysia</li> </ul>	√	√
	<ul style="list-style-type: none"> <li>▪ From Business Enterprise and NGO</li> </ul>	√	√
	<ul style="list-style-type: none"> <li>▪ From Higher Learning Institution (public / private)</li> </ul>	x	√
	<ul style="list-style-type: none"> <li>▪ From Government Research Institute</li> </ul>	√	√
	<b>ii) Reasons for outsourcing</b>	√	√
	<b>iii) Number of projects in collaboration with others</b>	√	√
	<b>iv) R&amp;D Projects being outsourced by your organisation</b>		
	<ul style="list-style-type: none"> <li>▪ Within Malaysia</li> <li>▪ Outside Malaysia</li> </ul>	√	x
	<ul style="list-style-type: none"> <li>▪ To Business Enterprise and NGO</li> <li>▪ To Government Research Institute</li> </ul>	√	x
Section 6: R&D Output	<b>Publications:</b> <ul style="list-style-type: none"> <li>▪ Book</li> <li>▪ Chapter in Book</li> <li>▪ Journal Article</li> <li>▪ Conference Proceedings</li> <li>▪ Other Publications</li> </ul>	√	x
	<b>Intellectual Property (IP) and Revenue:</b> <ul style="list-style-type: none"> <li>▪ Patents Filed</li> <li>▪ Patents Granted (Granted in 2016)</li> <li>▪ Copyright</li> <li>▪ Trademark</li> <li>▪ Industrial Design</li> <li>▪ Patents licensing and technology know-how licensing</li> <li>▪ Total number of commercialised product</li> <li>▪ Licensing Revenue from Patents and New Technologies Developed</li> <li>▪ Commercialised product revenue</li> </ul>	√	√

Section	Type of Data	GRI/HLI	BE/NGO
	<b>Human Capital:</b> <ul style="list-style-type: none"> <li>▪ Doctoral</li> <li>▪ Master (by research)</li> </ul>	For HLI only	x
Section 7: R&D Incentives	<b>Types of R&amp;D incentives</b>	x	√
	<b>Problems faced when applying for R&amp;D incentives</b>	x	√
	<b>Benefits obtained from carrying out R&amp;D activities</b>	x	√
	<b>Reasons for not taking up of R&amp;D incentives</b>	x	√
Section 8: Factors Limiting R&D Activities	<b>Internal factors</b>	√	√
	<b>External factors</b>	√	√
Section 9: Suggestion to Enhance R&D Activities in Malaysia		√	√

# **CHAPTER 3: DATA COLLECTION**



## CHAPTER 3: DATA COLLECTION

This chapter discusses the data collection methodology and survey instruments used for the National Research and Development (R&D) Survey 2017.

### 3.1 Survey Procedures

#### 3.1.1 Data Collection Approach and Methodology

Three (3) methods of data collection were used for this survey. Firms can choose to fill-in an e-form, have face-to-face interviews or telephone interviews. The e-form is distributed to firms via email with guidelines on how to fill up the survey.

### 3.2 Quality Control

A Quality Control (QC) system is set up to check for incomplete, ambiguous, inconsistent or contradictory responses. Quality checks is also conducted when survey forms are returned or received. Initial checks are for completeness, logical and range checks as well as for consistency of information. Data entry is made after the QC process was completed.

### 3.3 Data Analysis

After the dataset is thoroughly checked, analysis is carried out according to the requirements of the study. The reliability of the data is validated through data quality checking.

The study also specified the main R&D indicators to be analysed are as follows:

1. Current R&D Expenditure
2. Capital R&D Expenditure
3. Gross R&D Expenditure (GERD)
4. Gross R&D Expenditure per Gross Domestic Product (GERD/GDP)
5. R&D Expenditure by Sectors
6. R&D Expenditure in Business Enterprises
7. Source of Funds
8. Number of R&D Personnel
9. Number of Researchers
10. Number of Technicians
11. Number of Support Staff
12. Full-time Equivalent of Research Personnel (FTE)
13. Number of Researchers for every 10,000 labour force
14. Researchers by Gender
15. R&D expenditure by Field of Research (FOR)
16. R&D expenditure by Socio-economic Objectives (SEO)
17. Type of R&D activities
18. Number of IP and Publications

### 3.4 Survey Responses

**Table 3.1** shows the survey responses by sectors. A total of 1,627 BEs, 92 GRIs, 128 HLIs and 23 NGOs responded to 2017 R&D Survey. From the survey, a total of 239 (8.3%) out of the sample of 2,891 BEs were found to be ineligible due to the reasons stated in **Table 3.1** i.e. closed down, dormant and unable to locate. Thus, the total eligible sample is 2,652 firms.

**Table 3.1: Number of Responses from Surveyed Institutions by Sectors, 2016**

		BEs	GRIs	HLIs	NGOs
A	Number of sampled establishments	2,891	92	166	30
B	Ineligible ( <i>Closed down, dormant and unable to locate</i> )	239	0	21	0
C	Total eligible firms/institutions	2,652	92	145	30
D	Total number of responses	1,627	92	128	23
	<i>Institution responded with R&amp;D</i>	239	73	64	8
	<i>Institution responded without R&amp;D</i>	1,388	19	64	15
	Response rate = D/C x 100%	61.3%	100.0%	88.3%	76.7%

Out of the 2,891 establishments selected for the 2017 R&D Survey, 239 establishments or 8.3% were classified as ineligible. As a result, the response rate for the BE sector in the 2017 R&D Survey was 61.3% after removing the ineligible cases. The response status is shown in **Table 3.2**.

**Table 3.2: Number of Responses from BEs in the National R&D Surveys, 2010-2016**

		2010	2012	2014	2015	2016
A	Number of BEs that participated	2,038	2,142	3,552	7,854	2,891
B	Number of BEs that responded (primary)	1,313	1,437	1,399	2,021	1,627
C	Number of BEs that responded with R&D (primary)	1,171	1,234	134	1,407	239
D	Number of BEs that responded without R&D (primary)	142	203	132	614	1,388
E	Ineligible ( <i>Closed down, dormant and unable to locate</i> )	-	-	-	-	239
F	Total eligible firms	-	-	-	-	2,652
	Response rate = B/F x 100%	64.4%	67.1%	39.4%	25.7%	61.3%
	Number of BEs in database (secondary)	-	-	2,425	-	2,549
	Number of BEs that conducted R&D (secondary)	-	-	1,204	-	1,310
	Number of BEs that did not conduct R&D (secondary)	-	-	1,221	-	1,239

Note : Primary refers to data collected through National R&D survey; Secondary refers to data from other sources

The total number of GRIs participated in survey was reduced from 269 in 2015 to 92 in 2016 as shown in **Table 3.3**. Out of the 92 firms that responded to the 2017 R&D Survey, 79.3% were involved in R&D activities.

**Table 3.3: Number of Responses from GRIs in the National R&D Surveys, 2010-2016**

		2010	2012	2014	2015	2016
A	Number of GRIs that participated	202	63	287	269	92
B	Number of GRIs that responded	196	63	161	269	92
C	Number of GRIs that responded with R&D	34	44	62	78	73
D	Number of GRIs that responded without R&D	162	19	99	191	19
	Response rate = B/A x 100%	97.0%	100.0%	56.1%	100.0%	100.0%

For the HLI sector, the number of institutions surveyed increased from 109 in 2015 to 166 in 2016 (see **Table 3.4**). Out of the 128 institutions that responded to the 2017 R&D Survey, 50.0% of the HLIs were involved in R&D activities.

**Table 3.4: Number of Responses from HLIs in the National R&D Surveys, 2010-2016**

		2010	2012	2014	2015	2016
A	Number of HLIs that participated	42	462	64	109	166
B	Number of HLIs that eligible	42	462	64	109	145
C	Number of HLIs that responded	40	444	64	109	128
D	Number of HLIs that responded with R&D	39	49	58	74	64
E	Number of HLIs that responded without R&D	1	395	6	35	64
	Response rate = C/B x 100%	95.2%	96.1%	100.0%	100.0%	88.3%



**CHAPTER 4:  
OVERVIEW OF RESEARCH  
AND DEVELOPMENT (R&D)  
ACTIVITIES IN MALAYSIA**



## CHAPTER 4: OVERVIEW OF RESEARCH AND DEVELOPMENT (R&D) ACTIVITIES IN MALAYSIA

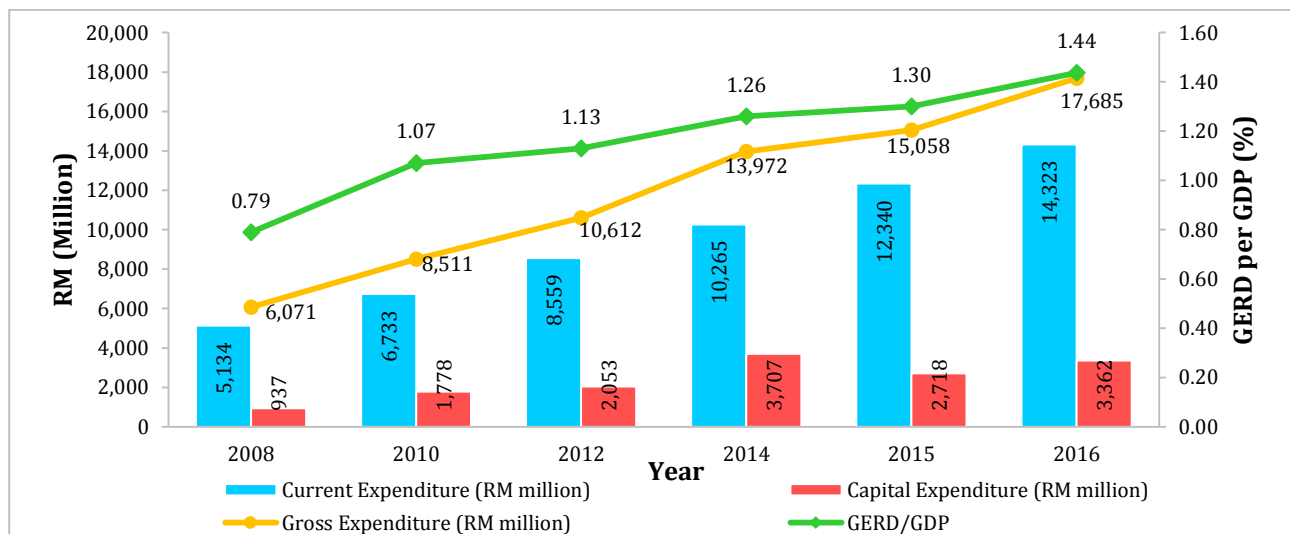
This chapter presents an overview of research and development (R&D) activities of the public and private organisations – Higher Learning Institutions (HLIs), Government Research Institutes (GRIs), Business Enterprises (BEs) and Non-Governmental Organisations (NGOs) – in Malaysia for the 2016 financial year. This overview focuses on developments in Malaysia’s national R&D activities in 2016 with respect to gross expenditure trends, sources of R&D financing, human resources involved, and research outputs in terms of the number of publications and intellectual property indicators.

### 4.1 Gross Expenditure on Research and Development (GERD)

Gross Expenditure on Research and Development (GERD) is the primary indicator for the R&D activities of a country. It covers all R&D expenditures in a country during a reference period. It measures both current and capital expenditures in R&D and includes foreign funded R&D activities but excludes R&D activities that take place overseas (Frascati Manual, 2015).

Malaysia’s GERD has increased since 2008. At RM17,685 million, GERD in 2016 is three times that in 2008 (see **Figure 4.1**). In addition, GERD per Gross Domestic Product (GDP) has improved from 0.79% in 2008 to 1.44% in 2016, closing in on the National Policy on Science, Technology & Innovation (NPSTI) target of 2.0%<sup>5</sup>.

**Figure 4.1: GERD by Type of Cost, 2008-2016**



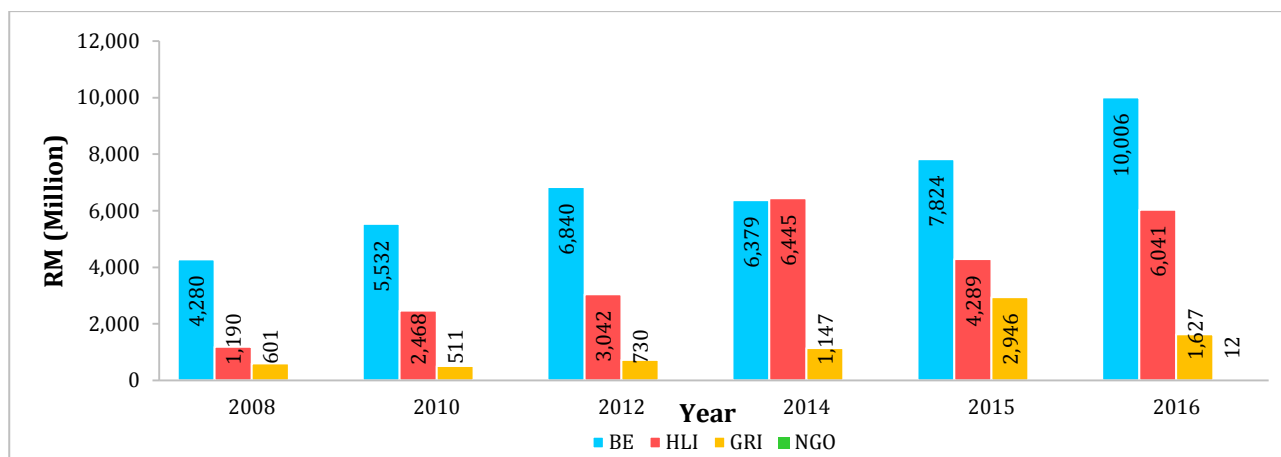
Source : National Survey of Research and Development (R&D) in Malaysia

### 4.2 Expenditure by Sector

BEs and HLIs recorded increases in R&D expenditures between 2015 and 2016 but GRI’s share of GERD declined from RM2,946 million (GERD 19.6%) to RM1,627 million (GERD 9.2%) due to a cut back in public sector funding (see **Figures 4.2** and **4.3**).

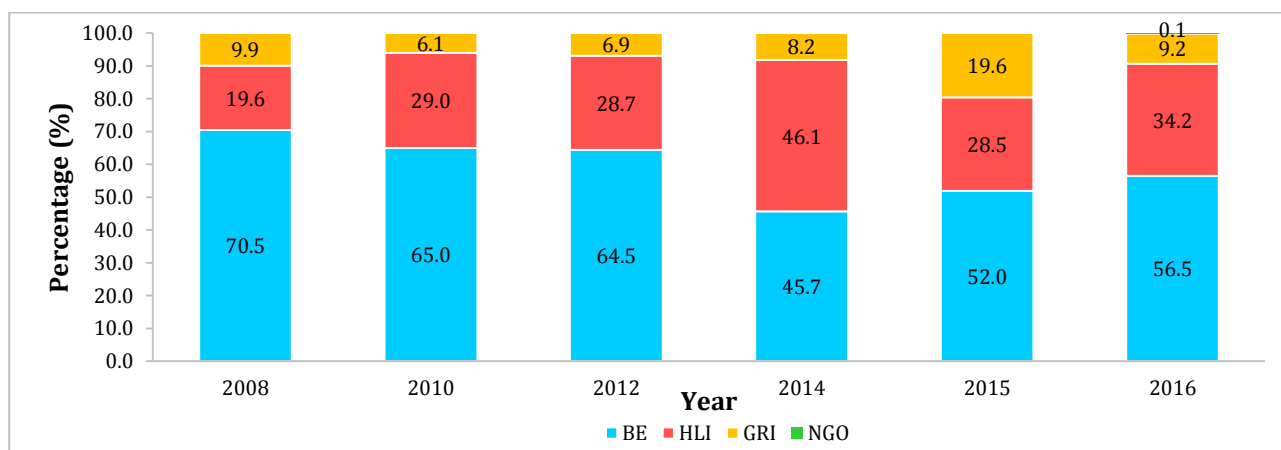
<sup>5</sup> Kementerian Sains, Teknologi dan Inovasi (MOSTI) (2016). The National Policy on Science, Technology & Innovation (NPSTI). Retrieved from <https://mastic.mestec.gov.my/ms/sti/kandungan-sti/row/dasar-sti/dasar-sains-teknologi-dan-inovasi-negara>, (Page 9)

**Figure 4.2: GERD by Sector, 2008-2016 (RM Million)**



Source : National Survey of Research and Development (R&D) in Malaysia

**Figure 4.3: GERD by Sector, 2008-2016 (Percentage)**

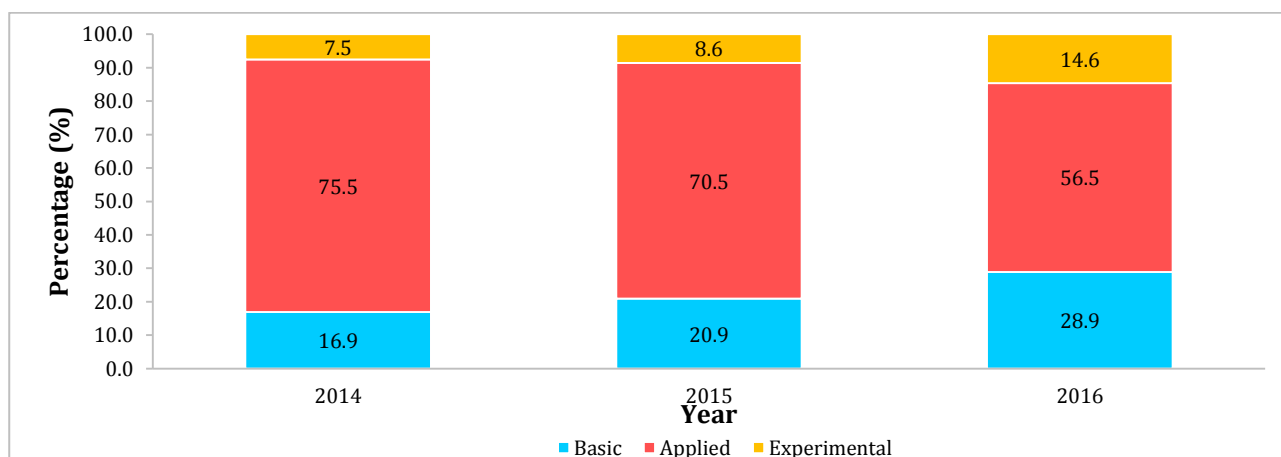


Source : National Survey of Research and Development (R&D) in Malaysia

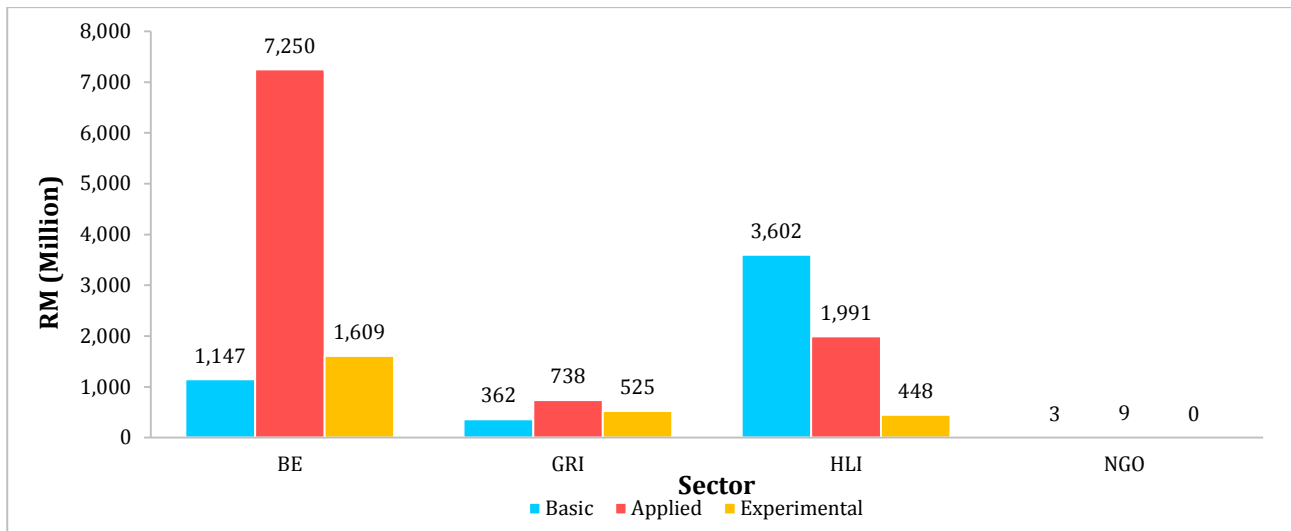
#### 4.2.1 Expenditure by Type of Research

While Applied Research has contributed the most to GERD in 2014 and 2015, its share has decreased in 2016, that is, from 70.5% in 2015 to 56.5% in 2016. Meanwhile, the contributions of both Basic and Experimental Development had continued to increase from 2014 to 2016, reaching 28.9% and 14.6% respectively (see **Figure 4.4**).

**Figure 4.4: GERD by Type of Research, 2014-2016 (Percentage)**



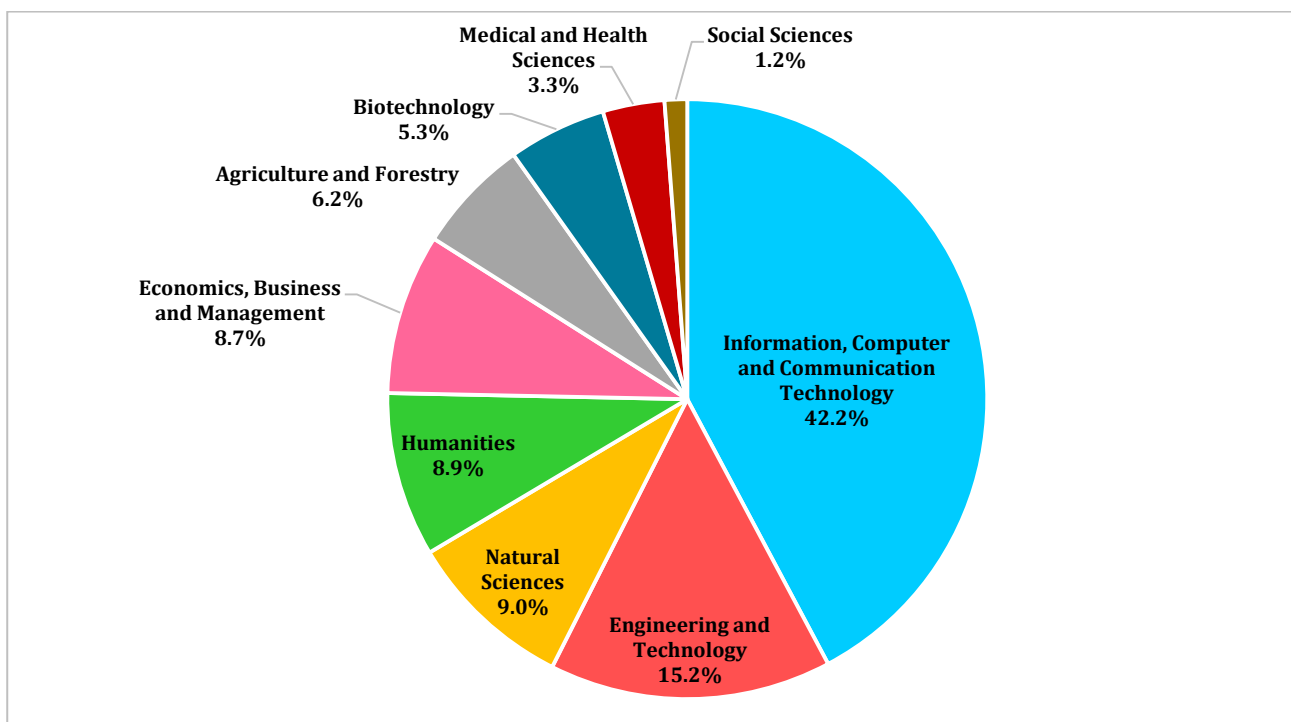
Source : National Survey of Research and Development (R&D) in Malaysia

**Figure 4.5: Type of Research by Sectors, 2016 (RM Million)**

It can be seen from **Figure 4.5**, HLIs focused on Basic Research and Applied Research in 2016. Meanwhile, the BE sector mostly on Applied Research.

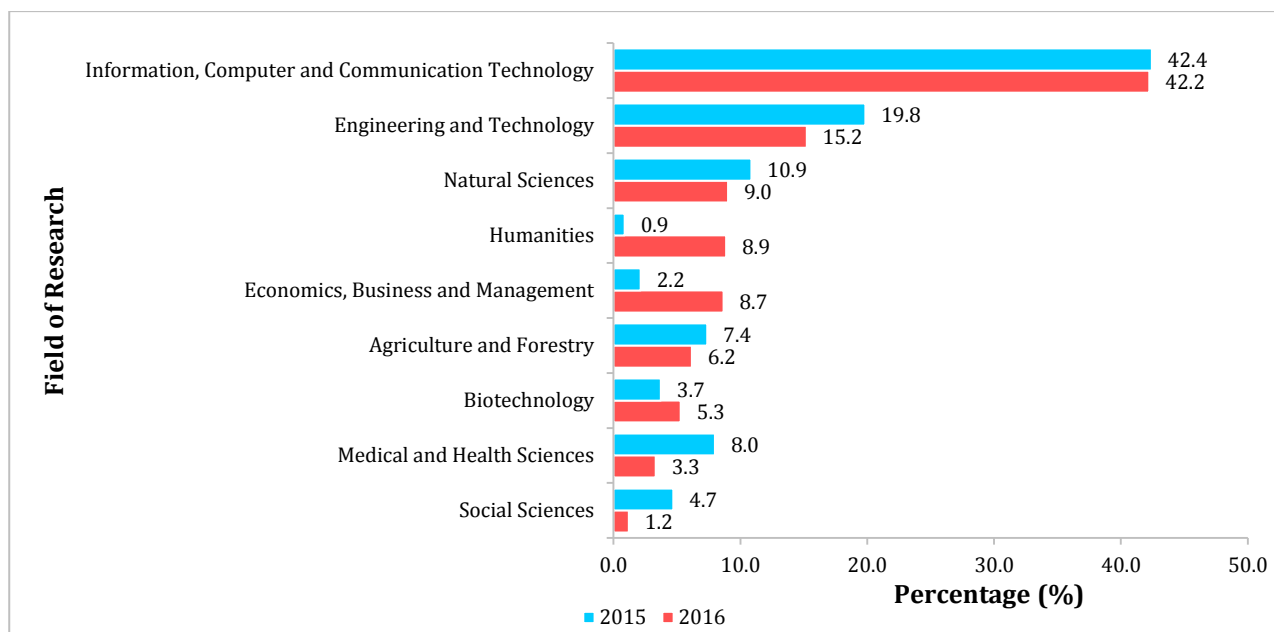
#### 4.2.2 Expenditure by Field of Research and Socio-economic Objectives

R&D expenditure is categorised according to knowledge domains using the Field of Research (FOR) and Socio-economic Objectives (SEO) based on the 6<sup>th</sup> Edition of the Malaysia Research and Development Classification System (MRDCS). There are nine main Fields of Research and six main Socio-economic Objectives as shown in **Figure 4.6** and **Figure 4.7** respectively.

**Figure 4.6: GERD by Field of Research, 2016 (Percentage)**

In 2016, the FOR with the highest GERD is Information, Computer and Communication Technology, covering 42.2% of the total GERD. This is followed by Engineering and Technology at 15.2%. The FOR with the least GERD is Social Sciences with 1.2% (see **Figure 4.6**).

**Figure 4.7: GERD by Field of Research, 2015-2016 (Percentage)**



Source : National Survey of Research and Development (R&D) in Malaysia

Figure 4.7 shows the percentage contribution of GERD by each Field of Research for 2015-2016. The top contributors remained the same between 2015 and 2016 with only a slight drop in terms of its percentage in 2016 relative to 2015.

Apart from Defence and Security, the main expenditure of R&D is found in four SEOs, namely Sustainable Economic Development (28.8%), Advanced Experimental and Applied Science (20.6%), Advancement of Knowledge (19.9%), and Society (18.1%) (see Figure 4.8).

**Figure 4.8: GERD by Socio-Economic Objectives, 2016 (Percentage)**

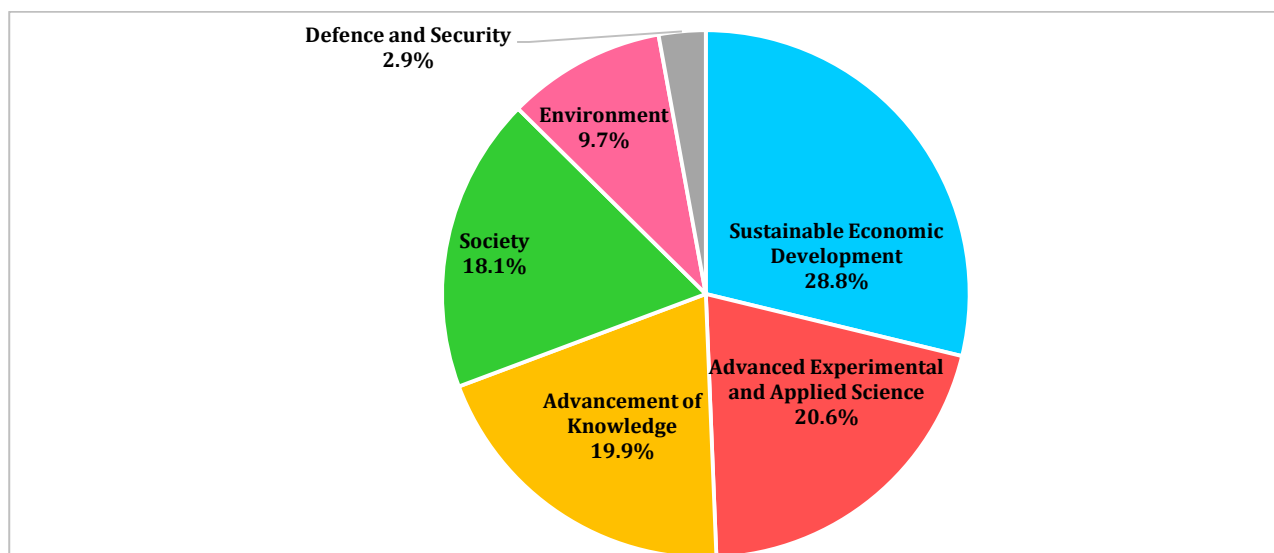
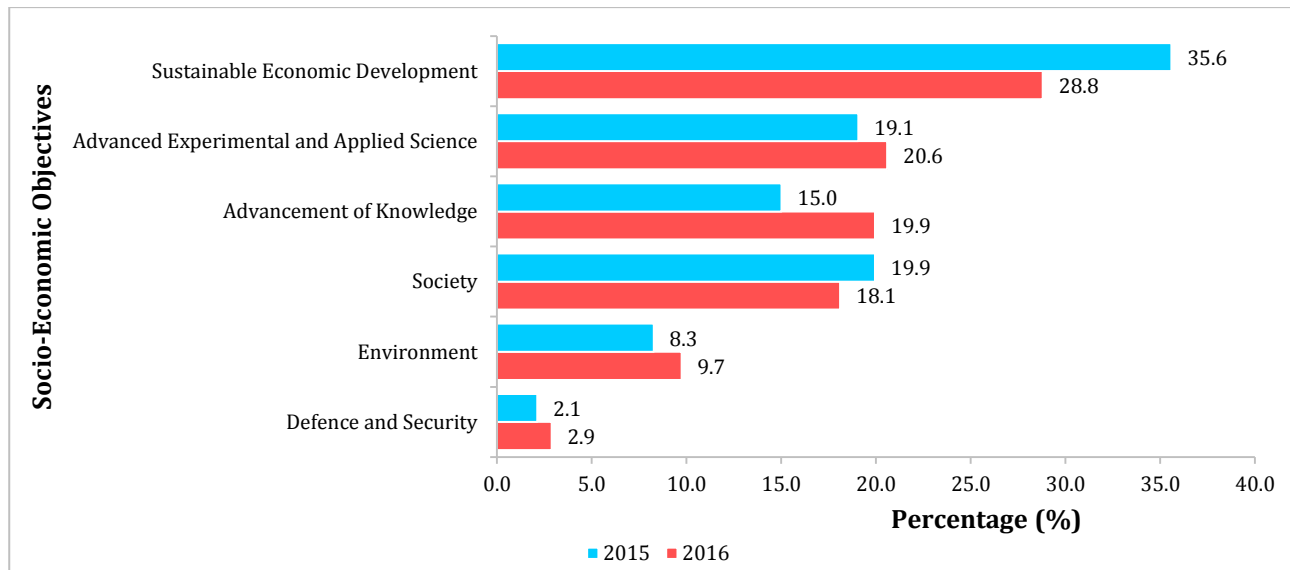


Figure 4.9 shows that Sustainable Economic Development had the largest GERD by SEO in 2015 (35.6%) but its share of GERD dropped to 28.8% in 2016. Advanced Experimental and Applied Science and Advancement of Knowledge increased its share of GERD from 19.1% and 15.0% in 2015 to 20.6% and 19.9% in 2016 respectively. Defence and Security maintained its low percentage out of total GERD with 2.9% in 2016.

**Figure 4.9: GERD by Socio-Economic Objectives, 2015-2016 (Percentage)**

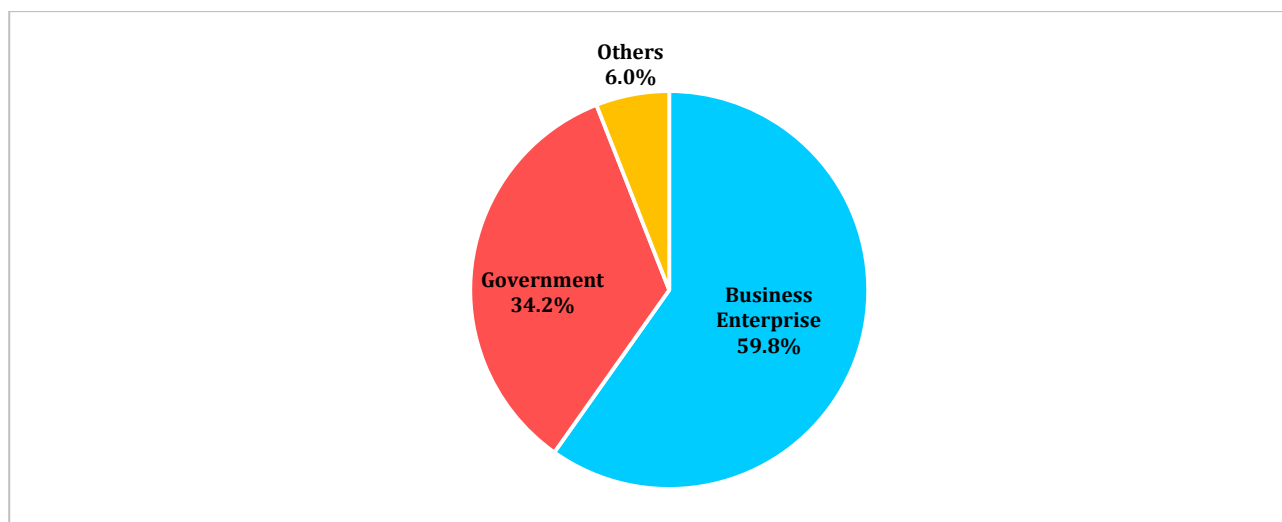
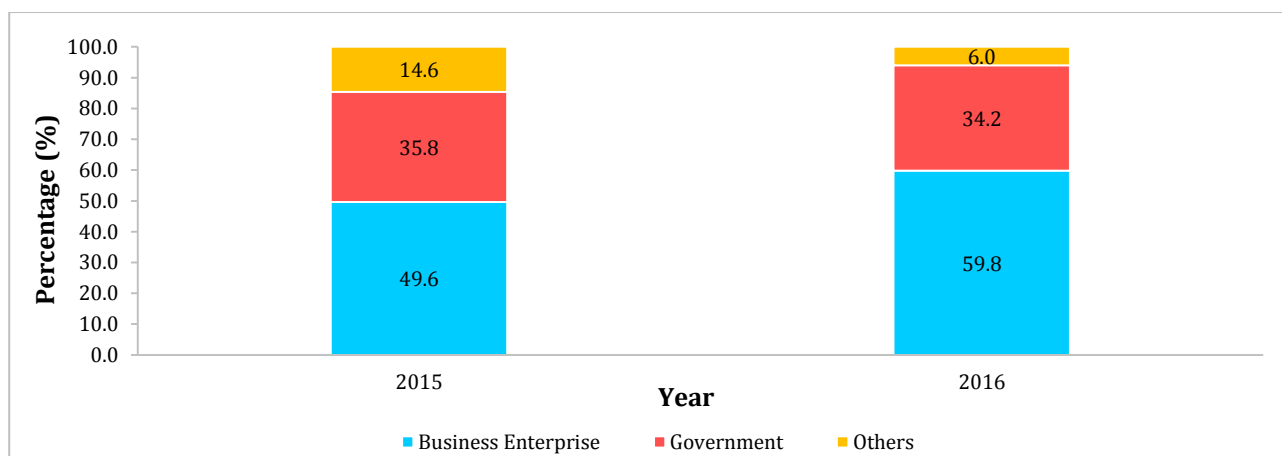
### 4.3 Source of Funds

This section examines the source of R&D funds, i.e. the sources supporting the R&D activities. The fund comes in all forms such as grants, contracts, salaries, commission and donations to finance the R&D activities. It comes from Business Enterprises, Governments, and other sources including Higher Education or institution-owned, foreign and unspecified sources.

According to NPSTI 2013-2020, “... a private sector is to be energised to rejuvenate investments, create high value jobs and position Malaysia in global market to propel sustained high income growth. To spur innovation and commercialisation, industry is the key player by which ideas are transformed into jobs and wealth for the nation. Despite the innovation imperative, many firms in Malaysia remain deficient in this essential ingredient for success due to a variety of reasons. Part of the reason is due to the heavy dependence of private sector on government to develop their innovative capacity. Since the outbreak of the global financial crisis, private sector’s R&D spending began to fall sharply from a high of 84.9% achieved in 2006 to a level of 70.5% in 2008. The declining trend private R&D expenditures hit the bottom at 56.7% in 2011, thus further impacted the private sector innovative capability and capacity... To elevate innovative capacity among industries, the following policy measure will be undertaken: Maintains a minimum R&D expenditure ratio of 30:70 between public and private sector”<sup>6</sup>. However, the ratio of GERD between the public and private sectors for 2016 is 43:57, where at 57.0% Malaysia is still further behind the target of 70.0% GERD of private sector.

While funds from BEs contributed the most at 59.8%, Government also contributed 34.2%, a significant amount. Other sources constitute 6.0% (see **Figure 4.10**). **Figure 4.11** shows the comparison of the R&D funding between 2015 and 2016. There was an increase in the share of funding from the BE sector (49.6% in 2015 to 59.8% in 2016). On the other hand, although by percentage the share of funding from the Government decreased from 35.8% to 34.2%, the amount has increased from in 2015 in 2016.

<sup>6</sup>Kementerian Sains, Teknologi dan Inovasi (MOSTI) (2016). The National Policy on Science, Technology & Innovation. Retrieved from <https://mastic.mestec.gov.my/ms/sti/kandungan-sti/row/dasar-sti/dasar-sains-teknologi-dan-inovasi-negara>. (Page 12-13)

**Figure 4.10: Source of R&D Funds, 2016 (Percentage)****Figure 4.11: Source of R&D Funds Comparison, 2015-2016 (Percentage)**

Source : National Survey of Research and Development (R&D) in Malaysia

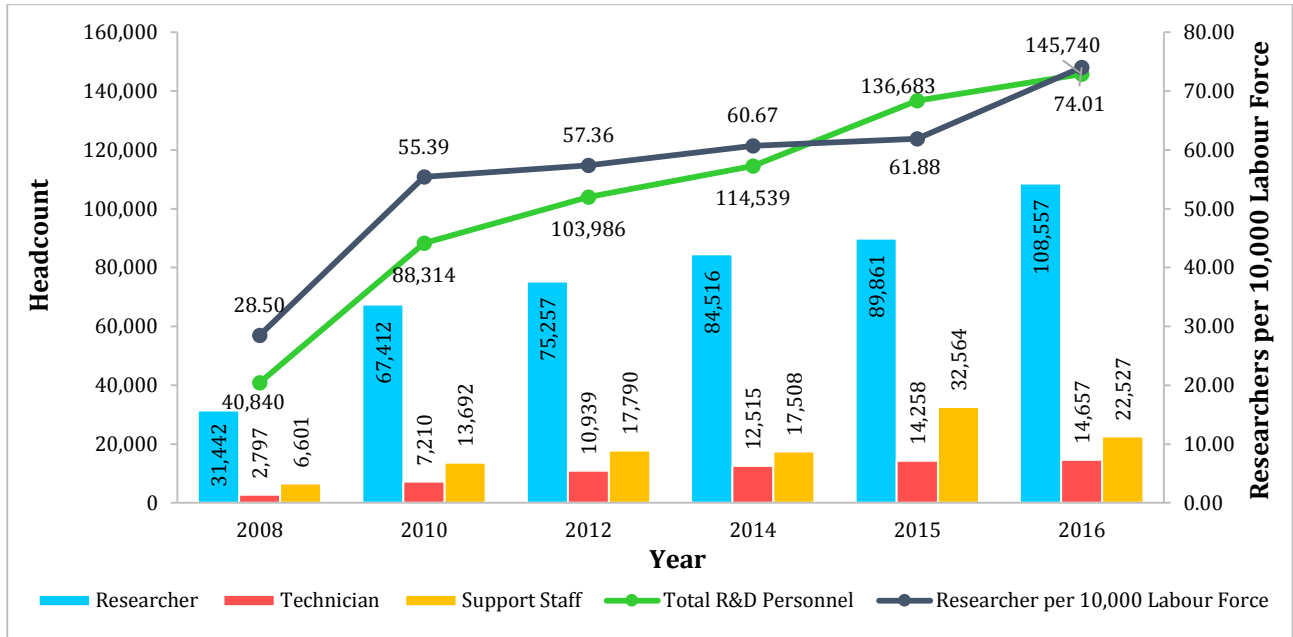
## 4.4 Human Resources

### 4.4.1 Research and Development Personnel and Researchers per 10,000 Labour Force (2008-2016)

The largest proportion of the R&D labour force are researchers, followed by support staff and technicians. After almost doubling its share (28.5 to 55.4) between 2008 and 2010, the R&D personnel and researchers per 10,000 labour force has steadily increased to 74.0 in 2016 (see **Figure 4.12**). **The NPSTI policy target of 70 researchers per 10,000 labour force by 2020<sup>7</sup> was already exceeded in 2016.** Thus, Malaysia has achieved this target four years ahead of schedule. According to the NPSTI, the talent pool is needed to create and transform ideas into products, processes and solutions to improve the quality of lives. At the same time, it is the basis for building a vibrant innovation ecosystem and economy.

<sup>7</sup> Kementerian Sains, Teknologi dan Inovasi (MOSTI) (2016). The National Policy on Science, Technology & Innovation. Retrieved from <https://mastic.mestecc.gov.my/ms/sti/kandungan-sti/row/dasar-sti/dasar-sains-teknologi-dan-inovasi-negara>. (Page 10-11)

**Figure 4.12: R&D Personnel and Researchers per 10,000 Labour Force, 2008-2016**

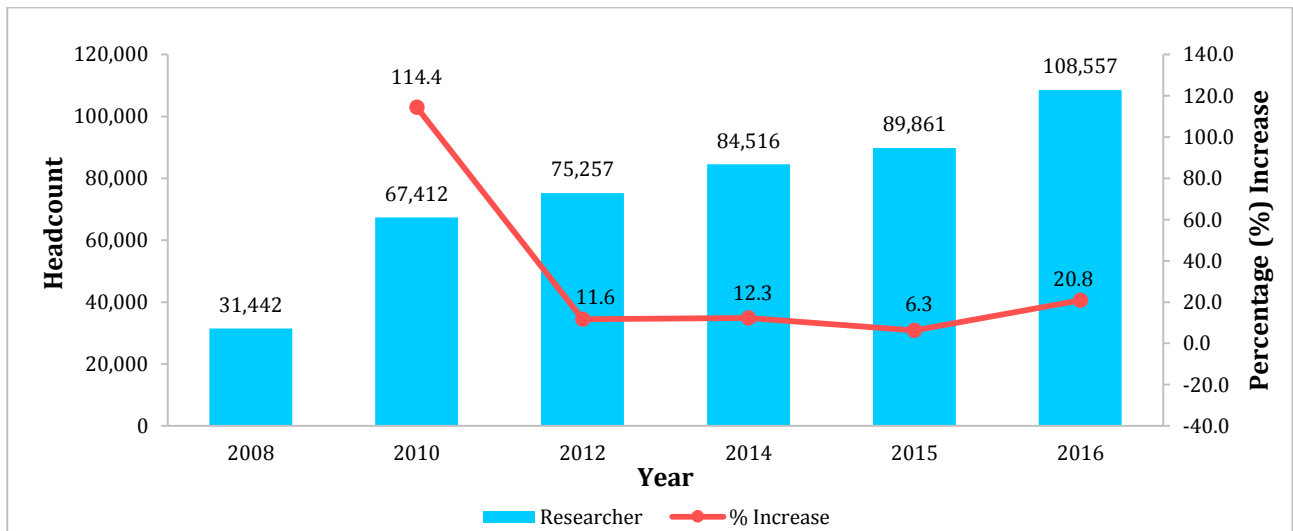


Source : National Survey of Research and Development (R&D) in Malaysia

#### 4.4.2 Distribution of Researchers by Qualifications (2008-2016)

**Figure 4.13** shows the total headcount of researchers from 2008 to 2016. Over the period, there was a steady increase in the headcount of researchers in R&D although the percentage fluctuates. The lowest increment was in 2015 (6.3%) while 2016 recorded the highest percentage of increment since 2010 with 20.8%.

**Figure 4.13: Headcount of Researchers, 2008-2016**

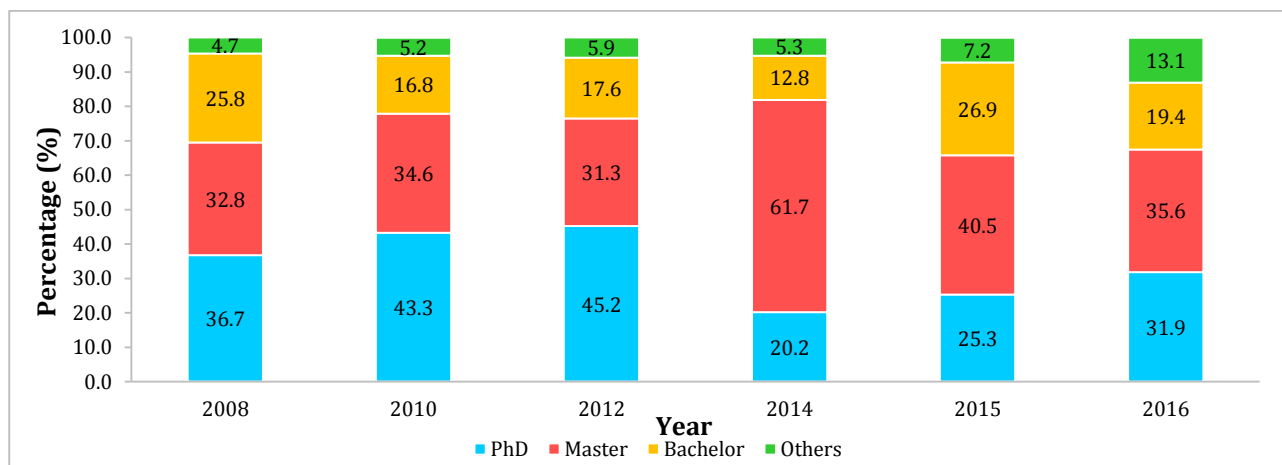


Source : National Survey of Research and Development (R&D) in Malaysia

R&D researchers were categorised into four groups – PhD, Masters, Bachelors and others for the 2008-2016 surveys. **Figure 4.14** shows that between 2015 and 2016, there were significant changes in the composition of PhD, Master’s degree and Bachelor’s degree holders. The proportion of PhD increased from 25.3% in 2015 to 31.9% in 2016. Conversely Masters’ and Bachelor’s degree holders dropped its share from 40.5% and 26.9% in 2015 to 35.6% and 19.4% respectively in 2016. However, it is worth noting that the share of researchers with other

qualifications (other than PhD, Master and Bachelor) increased significantly from 7.2% in 2015 to 13.1% in 2016.

**Figure 4.14: Researchers by Qualification, 2008-2016 (Percentage)**

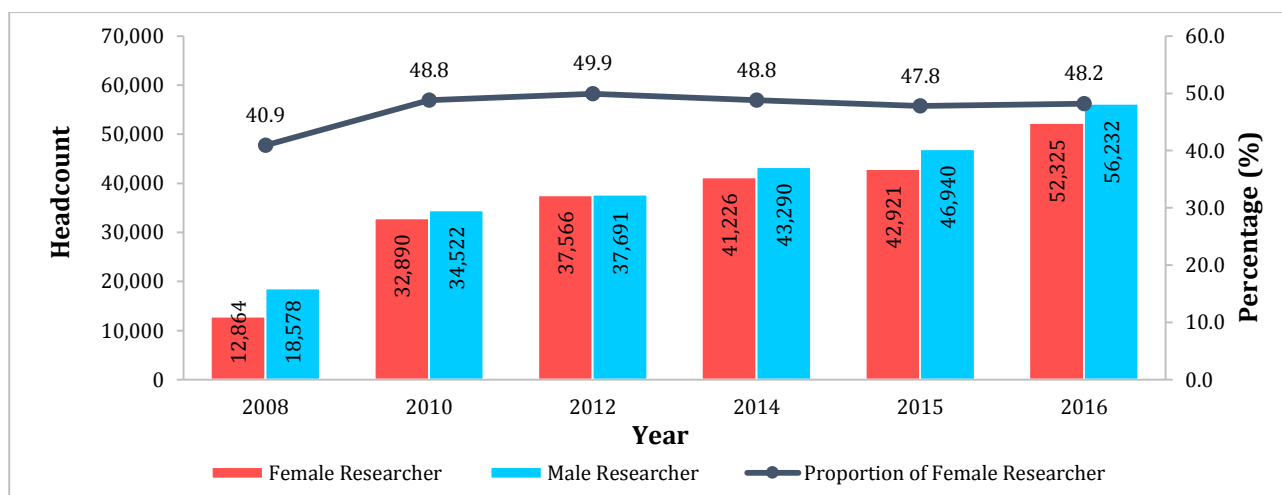


Source : National Survey of Research and Development (R&D) in Malaysia

#### 4.4.3 Researchers Headcount by Gender (2008-2016)

In the second strategic thrust (ST2), one of the policies to develop, harness and intensify STI talents set by NPSTI is to promote and enhance meaningful, effective and equitable female participation in STI at all levels and in all sectors<sup>8</sup>. The 2017 R&D Survey shows that the total number of female researchers in R&D had increased between 2008 and 2016 (**Figure 4.15**). The big jump in terms of gender ratio of female researchers was between 2008 and 2010. After 2010, the ratio has remained rather steady, i.e. between 48.2% (2016) and 49.9% (2012). Overall, it can be said that there is gender parity in the researcher community.

**Figure 4.15: Headcount of Researchers by Gender, 2008-2016**



Source : National Survey of Research and Development (R&D) in Malaysia

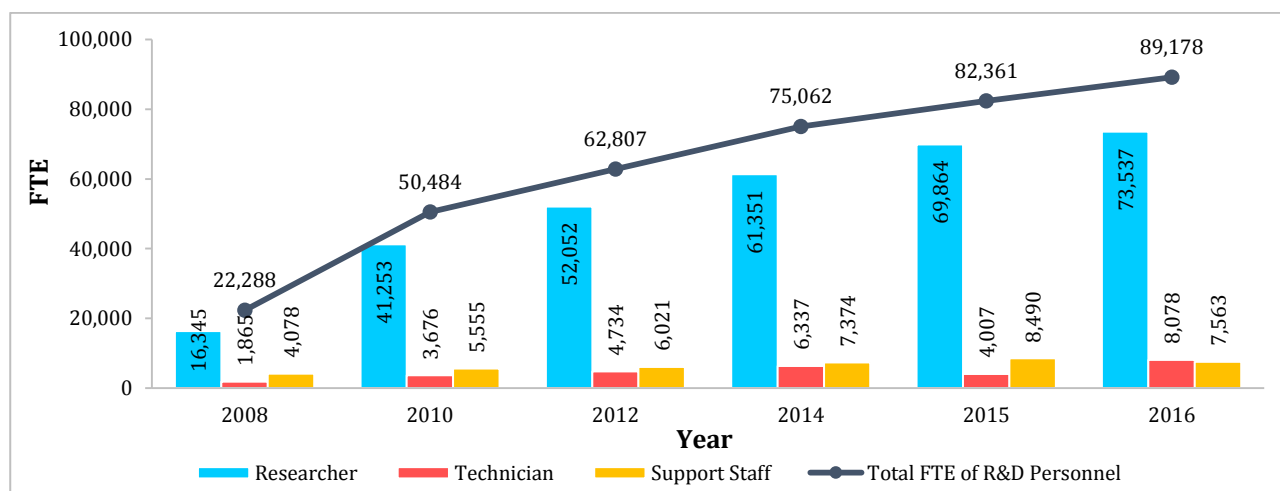
#### 4.4.4 Full-Time Equivalent (FTE)

Full-Time Equivalent (FTE) is the amount of time in a year that researchers, whether full or part time, devote to R&D projects. **Figure 4.16** shows that the total FTE has increased for researcher

<sup>8</sup> Kementerian Sains, Teknologi dan Inovasi (MOSTI) (2016). The National Policy on Science, Technology & Innovation. Retrieved from <https://mastic.mestec.gov.my/ms/sti/kandungan-sti/row/dasar-sti/dasar-sains-teknologi-dan-inovasi-negara>. (Page 10-11)

and technician but dropped for support staff. At the overall level, total FTE increased gradually from 2008 (22,288) to 2016 (89,178).

**Figure 4.16: Full-Time Equivalent of R&D Personnel, 2008-2016**



Source : National Survey of Research and Development (R&D) in Malaysia

## 4.5 Research Output

This section presents the analysis of research outputs, i.e., publications and intellectual property indicators (IP).

### 4.5.1 Publications

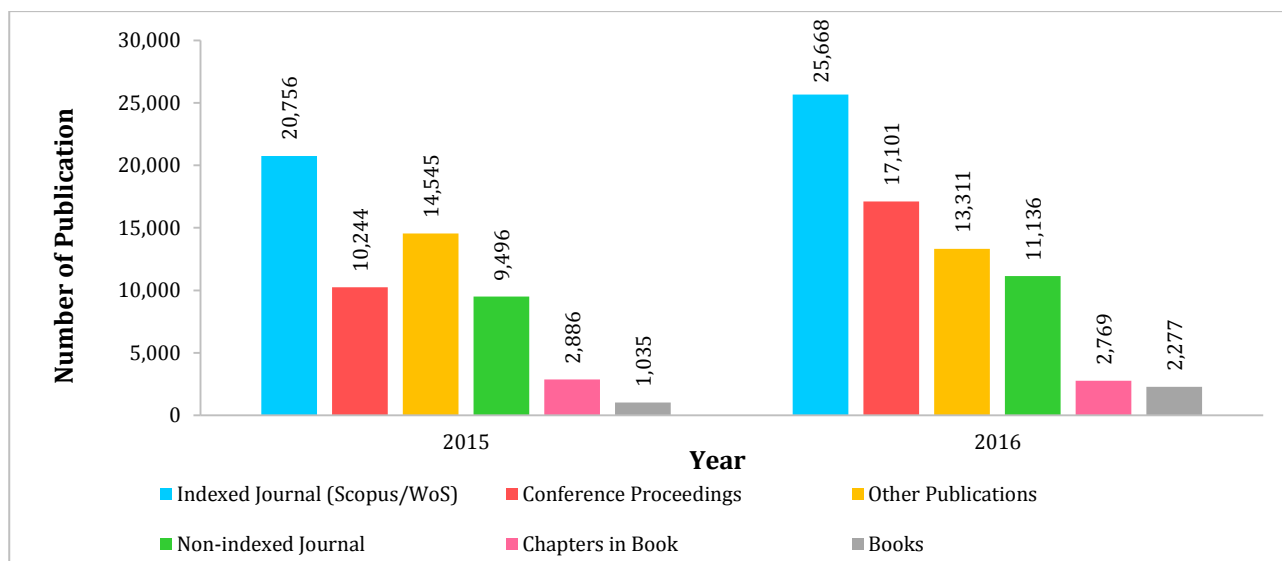
**Table 4.1** and **Figure 4.17** show the types and number of publications from HLIs and GRIs for 2015-2016. Most of the published materials are produced by HLIs. No BEs and NGOs reported any publications or IP.

**Table 4.1: Number of Publications in HLIs and GRIs, 2015-2016**

Publication	HLI		GRI		Total	
	2015	2016	2015	2016	2015	2016
Indexed Journal (Scopus/WoS)	20,239	25,070	517	598	20,756	25,668
Conference Proceedings	8,760	14,073	1,484	3,028	10,244	17,101
Other Publications	11,811	12,539	2,734	772	14,545	13,311
Non-indexed Journal	8,529	9,949	967	1,187	9,496	11,136
Chapters in Book	2,785	2,542	101	227	2,886	2,769
Books	924	1,465	111	812	1,035	2,277

Source : National Survey of Research and Development (R&D) in Malaysia

For HLIs, the output of all publications has increased from 2015 to 2016 except for chapters in book. For GRIs, the number of all publications have also increased from 2015 to 2016 except for other types of publications. In total, the changes in number of publications for both HLIs and GRIs from 2015 to 2016 are more nuanced – other publications and chapters in book have seen decreases in output, however indexed journal, conference proceedings, non-indexed journal and book have all seen increment in output (see **Figure 4.17**).

**Figure 4.17: Publication Output Comparison, 2015-2016**

Source : National Survey of Research and Development (R&D) in Malaysia

#### 4.5.2 Intellectual Property

A summary of the intellectual property indicators in 2015-2016 is shown in **Table 4.2**. For HLIs, only patents granted and copyright increased between 2015 and 2016. As for GRIs, patents filed decreased in 2016. All intellectual property indicators for BEs increased in number as compared to 2015. All R&D outputs improved in 2016 over 2015. As for the number of patents granted, it is more than the number of patents filed for a particular year (e.g. GRI in 2016) mainly because for the patents granted they were filed much earlier. These two indicators are thus independently determined.

**Table 4.2: Number of Intellectual Property, 2015-2016**

Intellectual Property	HLI		GRI		BE		NGO	Total	
	2015	2016	2015	2016	2015	2016	2016	2015	2016
Patents Filed	521	392	88	53	592	662	6	1,201	1,113
Patents Granted	129	148	39	61	220	326	1	388	536
Copyright	1,545	1,859	72	493	159	445	0	1,776	2,797
Trademark	137	84	25	62	228	956	1	390	1,103
Industrial Design	90	30	6	6	47	2,493	1	143	2,530

Source : National Survey of Research and Development (R&D) in Malaysia

**Box 4.1: The Fourth Industrial Revolution and Challenges on R&D**

The First Industrial Revolution focused on mechanisation, the Second on mass production and the Third on automated production. The digital revolution (Fourth) is revolutionising cross-industry business. Technology is fuelling the transformation of production system which in turn will change the trend of R&D activities.

The current R&D model has three features: crowdsourcing, digitisation in R&D and accelerated R&D. Crowdsourcing looks beyond internally developed solutions. Digitisation provide insights on user behaviour while big data allows for automated identification and continuous updating of user requirements for timely and appropriate solutions. Fast solutions with accelerated iteration cycles has increased the efficiency in R&D process. The potential disruption of these approaches will reduce product and technology life-cycles. Open source development has made ideas easier to share. Other potential disruption includes outsourcing of activities to external R&D service providers.

Under the Fourth Industrial Revolution, cross-industry collaborations are envisaged. The R&D network, for instance, will involve competitors, suppliers, distributors and so on. Patents will play a pivotal role in encouraging firms to invest in R&D as exclusive rights accrue to the owners of patented technology. Patents filed and granted are thus increasing in Malaysia with 3,300 patents granted at National Patent Office in 2016. One of the main challenges is data theft. Technical expertise is needed to manage electronic records with greater demand for expensive hardware and software, system maintenance and upgrading. It is not surprisingly that the demand for job related support is being created at the infancy stage of this digital age.

The Fourth Industrial Revolution has pushed Malaysia to increase R&D investment for broader and deeper reach into external markets, to optimise its value-chain and productivity. Although the short-term costs are high and current pay-off not yet economic, the benefits lie in delivering effective products, simplification of research, the ease of complex data navigation which would have long lasting effects.

**References:**

Ubell, R. (1997), The changing R&D Information Economy in the Digital Age. CENDI.97-3.

Nobelius, D. (2004). Towards the Sixth Generation of R&D Management. *International Journal of Project Management*, 22, 369-375.

Schimpf, S. (2016). Crowdsourcing, Digitisation and Acceleration: Is Corporate R&D Disrupting Itself?, R&D Management Conference 2016 "From Science to Society: Innovation and Value Creation" 3-6 July 2016, Cambridge, UK.



# **CHAPTER 5: INTERNATIONAL COMPARISONS**



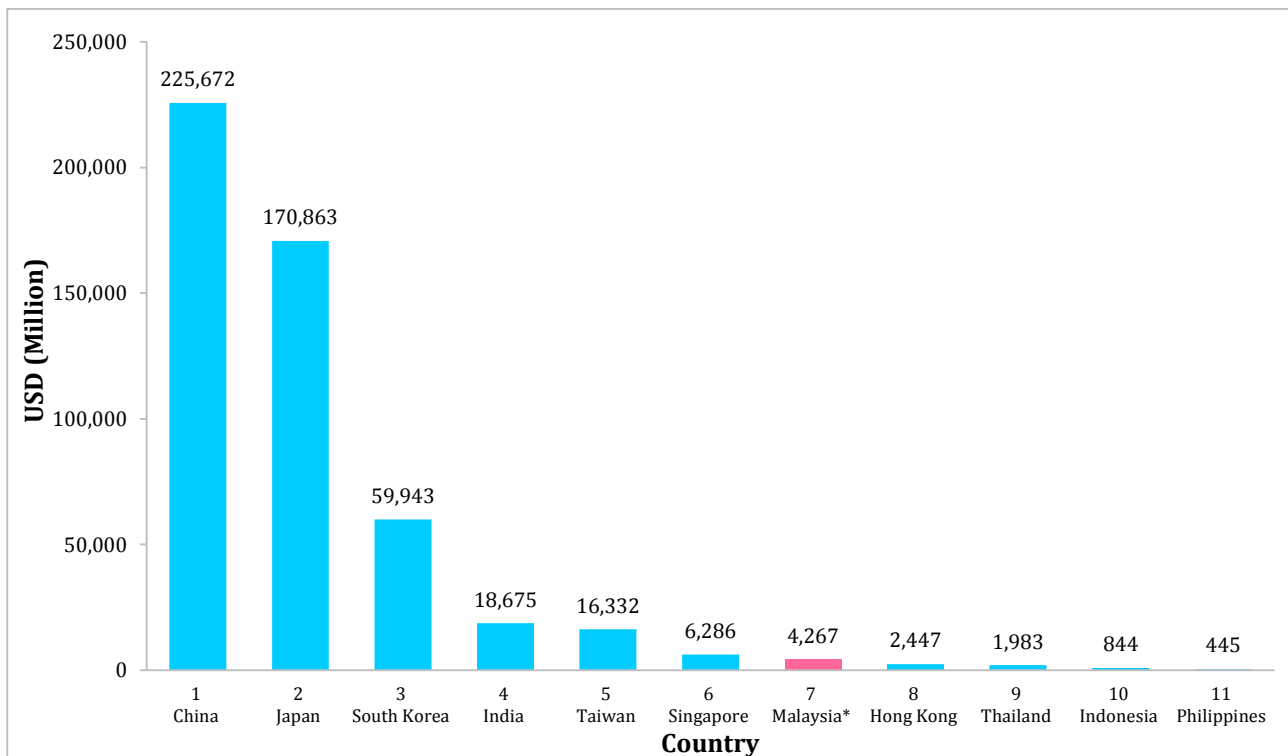
## CHAPTER 5: INTERNATIONAL COMPARISONS

This chapter presents Malaysia's performance on R&D as compared to selected Asian and OECD countries for the year 2016, which is intended to be a benchmarking exercise. The R&D benchmarking indicators for the selected countries were compiled from the Euromonitor International database. Malaysia's data is derived from the survey of this study. The selected Asian countries include the Philippines, Indonesia, Thailand, Hong Kong, Singapore, Taiwan, India, South Korea, Japan and China.

### 5.1 R&D Expenditure in 2016

China, with USD225 billion of R&D expenditure, ranked first among selected Asian countries (see **Figure 5.1**) followed by Japan with USD170 billion. Singapore ranked 6<sup>th</sup> with USD6.28 billion and Malaysia ranked 7<sup>th</sup> with USD4.27 billion. In terms of R&D expenditure, Singapore spent USD2.02 billion more than Malaysia.

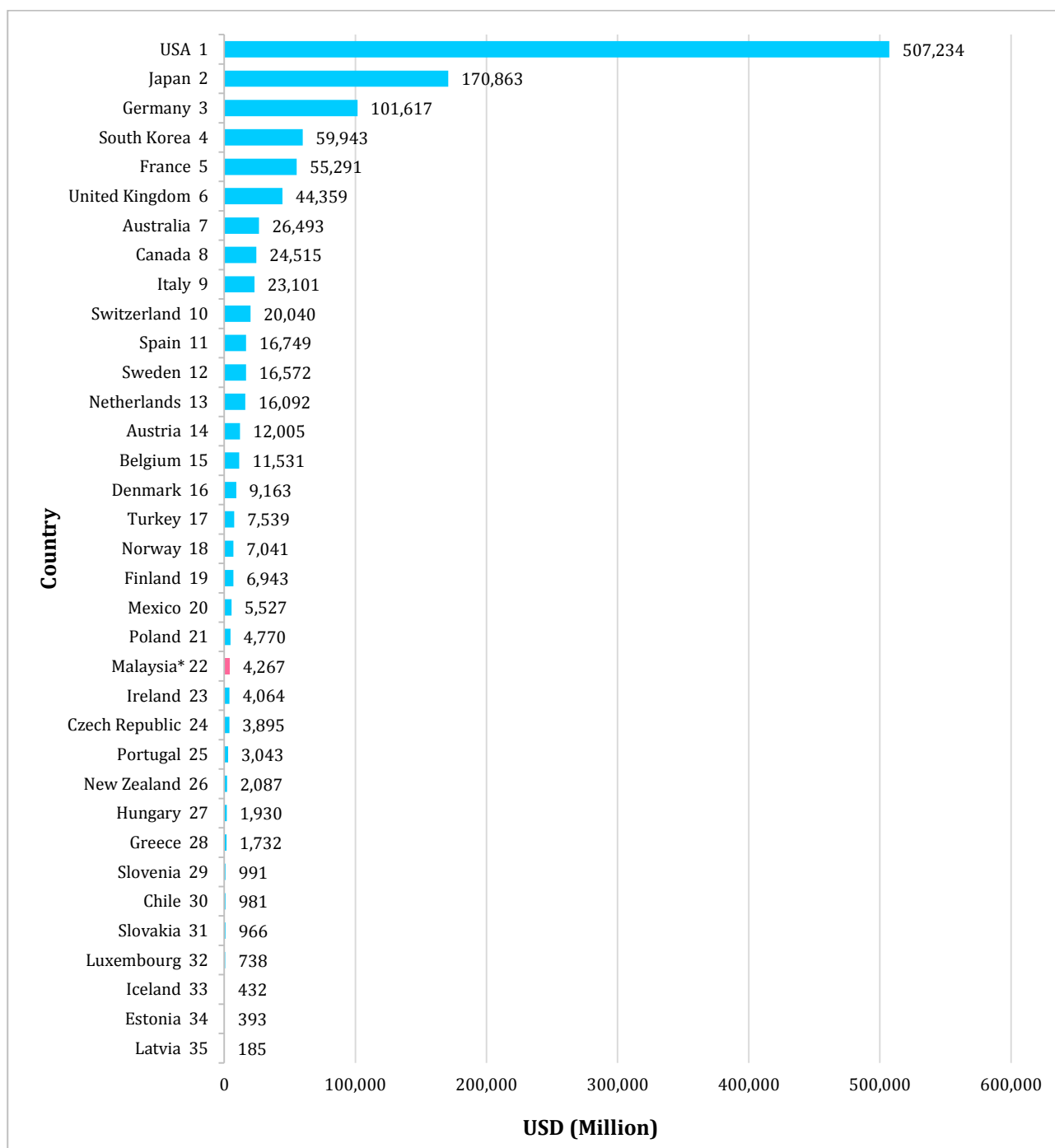
**Figure 5.1: Expenditure on R&D for Malaysia and Selected Asian Countries in 2016 (USD Million)**



Source : Euromonitor International from UNESCO/Eurostat  
 \*National Survey of Research and Development (R&D) in Malaysia 2017

Among the OECD countries, the USA ranked 1<sup>st</sup> with USD507 billion in R&D expenditure, followed by Japan with USD170 billion and Germany with USD101 billion (see **Figure 5.2**). The top five OECD countries with highest R&D expenditure were the USA, Japan, Germany, South Korea and France. Malaysia ranked 22<sup>nd</sup> in R&D expenditure, higher than other OECD countries, such as New Zealand, Hungary and Greece. Poland ranked 21<sup>st</sup>, with USD4.77 billion was one rank higher than Malaysia.

**Figure 5.2: Expenditure on R&D for Malaysia and OECD Countries in 2016 (USD Million)**



Source : Euromonitor International from UNESCO/Eurostat  
 \*National Survey of Research and Development (R&D) in Malaysia 2017

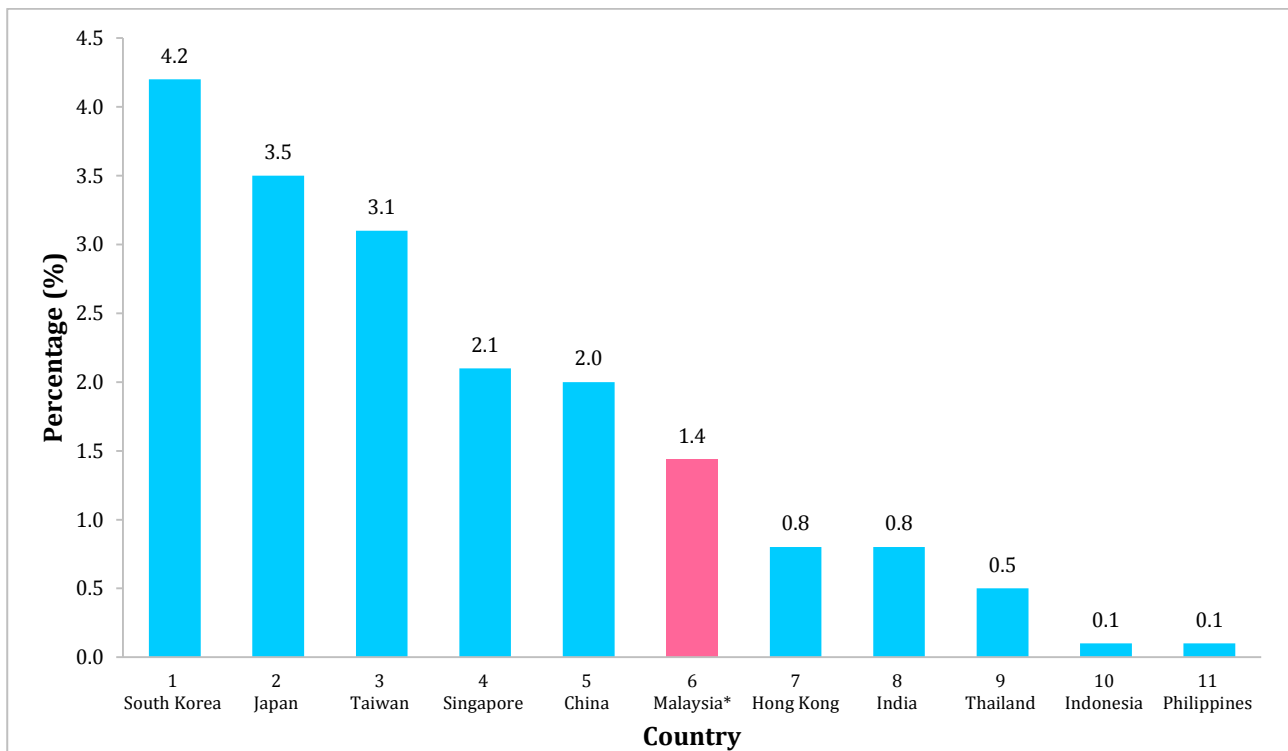
**Key Highlights:**

1. Among the 11 selected Asian countries, Malaysia ranked 7<sup>th</sup> with USD4.27 billion in R&D expenditure.
2. Compared with OECD countries, Malaysia ranked 22<sup>nd</sup>.
3. The R&D expenditure of Malaysia constituted 0.8%, 1.9% and 67.9% of the R&D expenditure of the USA, China and Singapore respectively.

### 5.1.1 R&D Expenditure as Percentage of GDP in 2016

South Korea ranked 1<sup>st</sup> among the list of selected countries with 4.2% of R&D expenditure in GDP (see **Figure 5.3**) followed by Japan (3.5%), Taiwan (3.1%), Singapore (2.1%) and China (2.0%). Malaysia ranked 6<sup>th</sup> with 1.4% which was higher than India and Hong Kong at 0.8%. The R&D expenditure contributed 0.1% of GDP for Philippines and Indonesia, and for Thailand it was 0.5% in 2016.

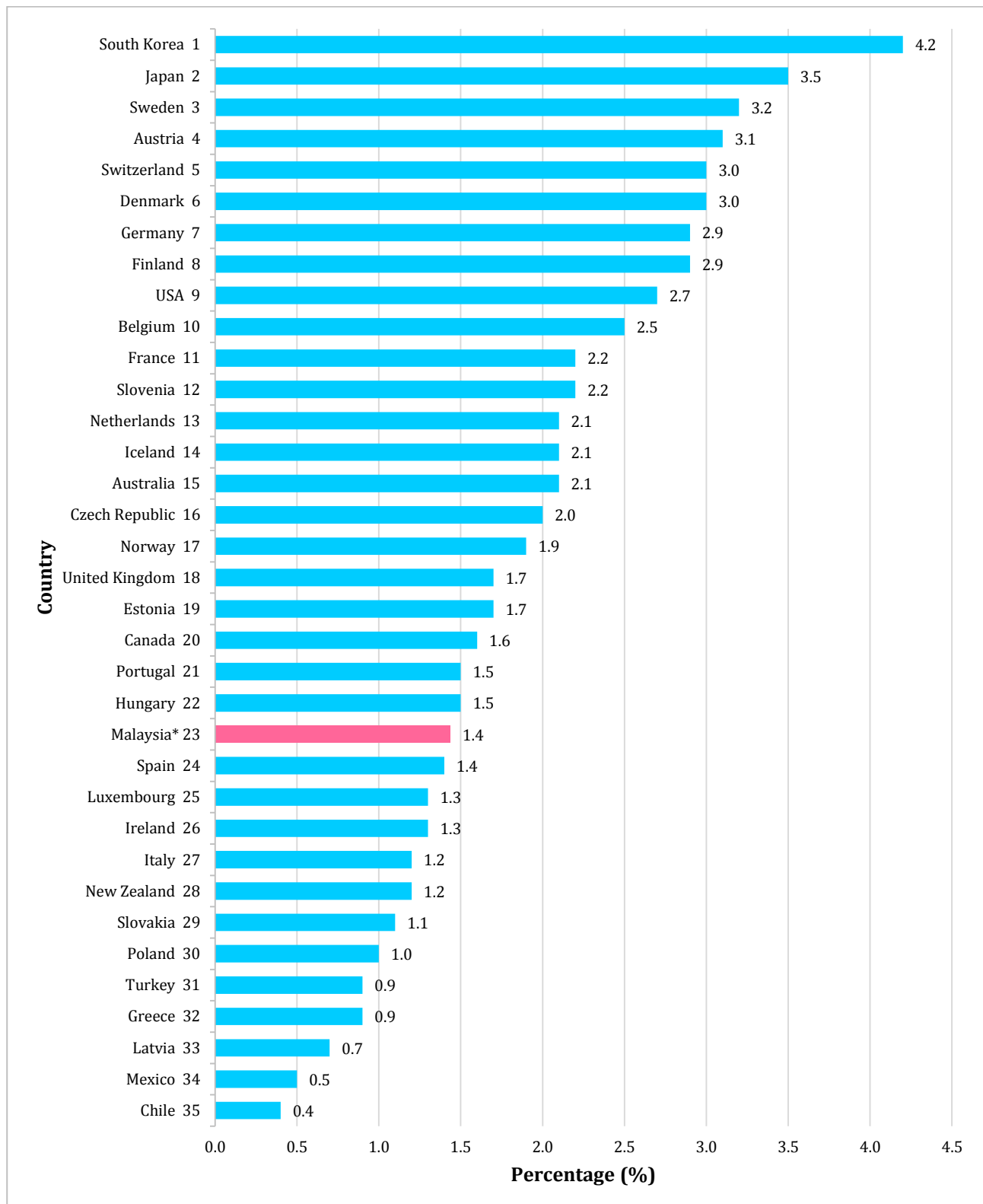
**Figure 5.3: Expenditure on R&D as Percentage of GDP for Malaysia and Selected Asian Countries in 2016**



Source : Euromonitor International from UNESCO/Eurostat  
 \*National Survey of Research and Development (R&D) in Malaysia 2017

In terms of R&D expenditure per GDP, South Korea ranked 1<sup>st</sup> with 4.2% (**Figure 5.4**). The second highest was Japan with 3.5%. Compared with all OECD countries, Malaysia ranked 23<sup>rd</sup>. It had the same ranking as Spain with 1.4% of R&D expenditure per GDP. Malaysia's ratio was higher than Poland, Slovakia, New Zealand, Italy, Ireland, Luxembourg, Turkey, Greece, Latvia, Mexico and Chile.

**Figure 5.4: Expenditure on R&D as Percentage of GDP for Malaysia and OECD Countries in 2016**



Source : Euromonitor International from UNESCO/Eurostat  
 \*National Survey of Research and Development (R&D) in Malaysia 2017

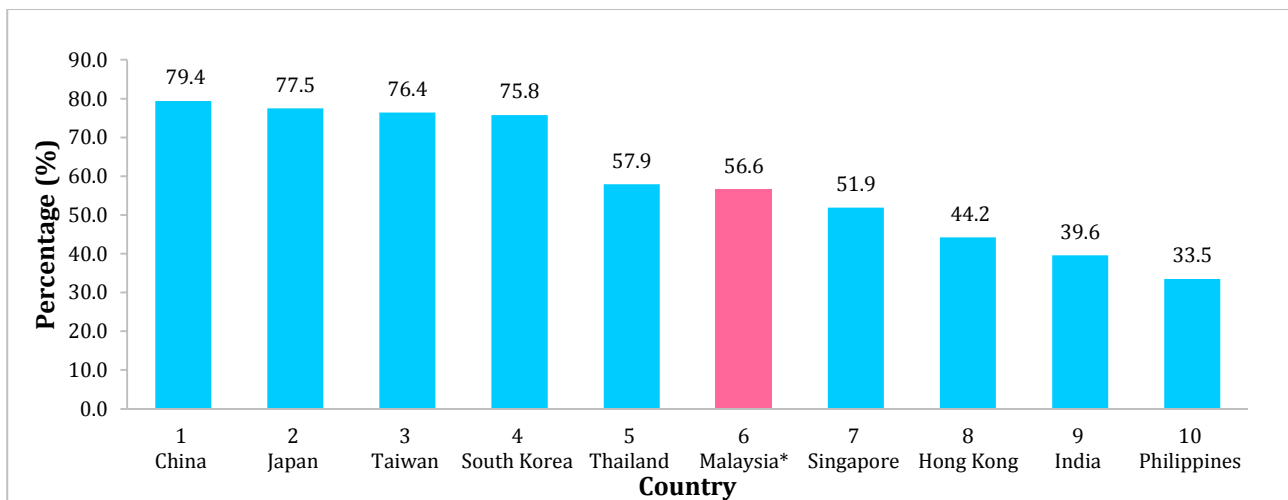
**Key Highlights:**

1. Among the 11 selected Asian countries, Malaysia ranked 6<sup>th</sup> with 1.4% of R&D expenditure per GDP. Singapore ranked 4<sup>th</sup> with 2.1%. Malaysia was higher than Indonesia, Philippines, Thailand, Hong Kong and India in terms of the ratio of R&D expenditure per GDP.
2. The ratio for South Korea, Japan, Sweden, Austria, Switzerland and Denmark was 3.0% and above. For the next group, i.e., between 2.5% and 2.9%, the countries include Belgium, the USA, Finland and Germany.
3. Between 2.0% to 2.4%, the countries were: Czech Republic, Australia, Iceland, Netherlands, Slovenia and France;
4. Between 1.5% and 1.9%, they include: Hungary, Portugal, Canada, Estonia, United Kingdom and Norway; and
5. Between 1.0% and 1.4%, they include Poland, Slovakia, New Zealand, Italy, Ireland, Luxembourg, Spain and Malaysia.

### 5.1.2 Business Enterprise R&D Expenditure as Percentage of Total R&D Expenditure in 2016

In Malaysia, Business Enterprises accounted for 56.6% of total R&D expenditure spent in 2016. China ranked top the list of selected Asian countries with 79.4% while Singapore was ranked 7<sup>th</sup> (see **Figure 5.5**).

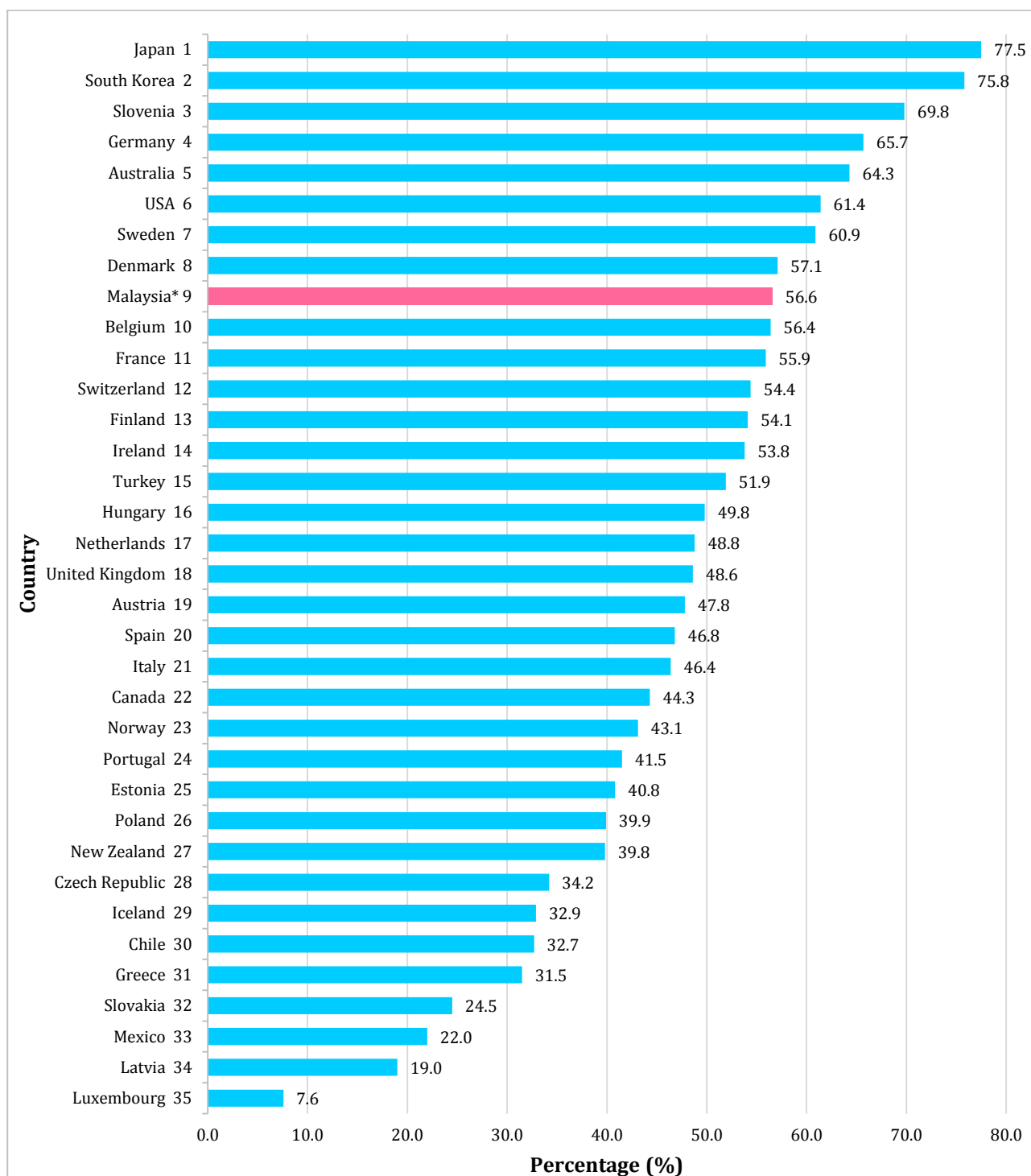
**Figure 5.5: Business Enterprise R&D Expenditure as Percentage of Total R&D Expenditure for Malaysia and Selected Asian Countries in 2016**



Source : Euromonitor International from UNESCO/Eurostat  
\*National Survey of Research and Development (R&D) in Malaysia 2017

Japan topped the list of OECD countries with the 77.5% of its total R&D expenditure from business funding. Malaysia rank 9<sup>th</sup> compared with all OECD countries. Among the OECD countries, the USA ranked 6<sup>th</sup> with 61.4% of Business Enterprise funds as percentage of total R&D expenditure followed by UK with 48.6% (see **Figure 5.6**).

**Figure 5.6: Business Enterprise Expenditure on R&D as Percentage of Total R&D Expenditure for Malaysia and OECD countries in 2016**



Source : Euromonitor International from UNESCO/Eurostat  
 \*National Survey of Research and Development (R&D) in Malaysia 2017

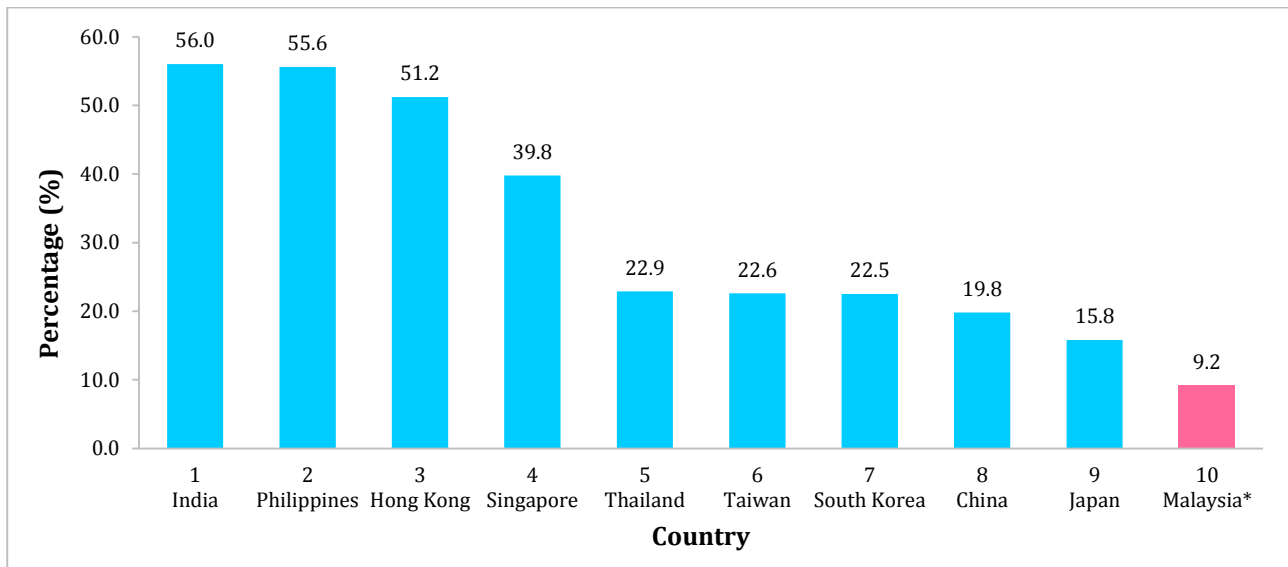
**Key Highlights:**

1. Japan’s Business Enterprises topped the selected country’s list compared to Asian and OECD countries of R&D expenditure as a percentage of total R&D expenditure.
2. Creating a conducive business environment is crucial for ensuring that Malaysia becomes a regional innovation hub.

### 5.1.3 Government R&D Expenditure as Percentage of Total R&D Expenditure in 2016

India ranked 1<sup>st</sup> among the 10 selected Asian countries in terms of Government's share of total R&D expenditure (see **Figure 5.7**). India's share was 56.0% followed closely by the Philippines with 55.6% and Hong Kong with 51.2%. Whereas, Singapore ranked 4<sup>th</sup> with 39.8%. Meanwhile, the Malaysia's government funding of R&D activities was 9.2% of total R&D expenditure.

**Figure 5.7: Government R&D Expenditure as Percentage of Total R&D Expenditure for Malaysia and selected Asian countries in 2016**

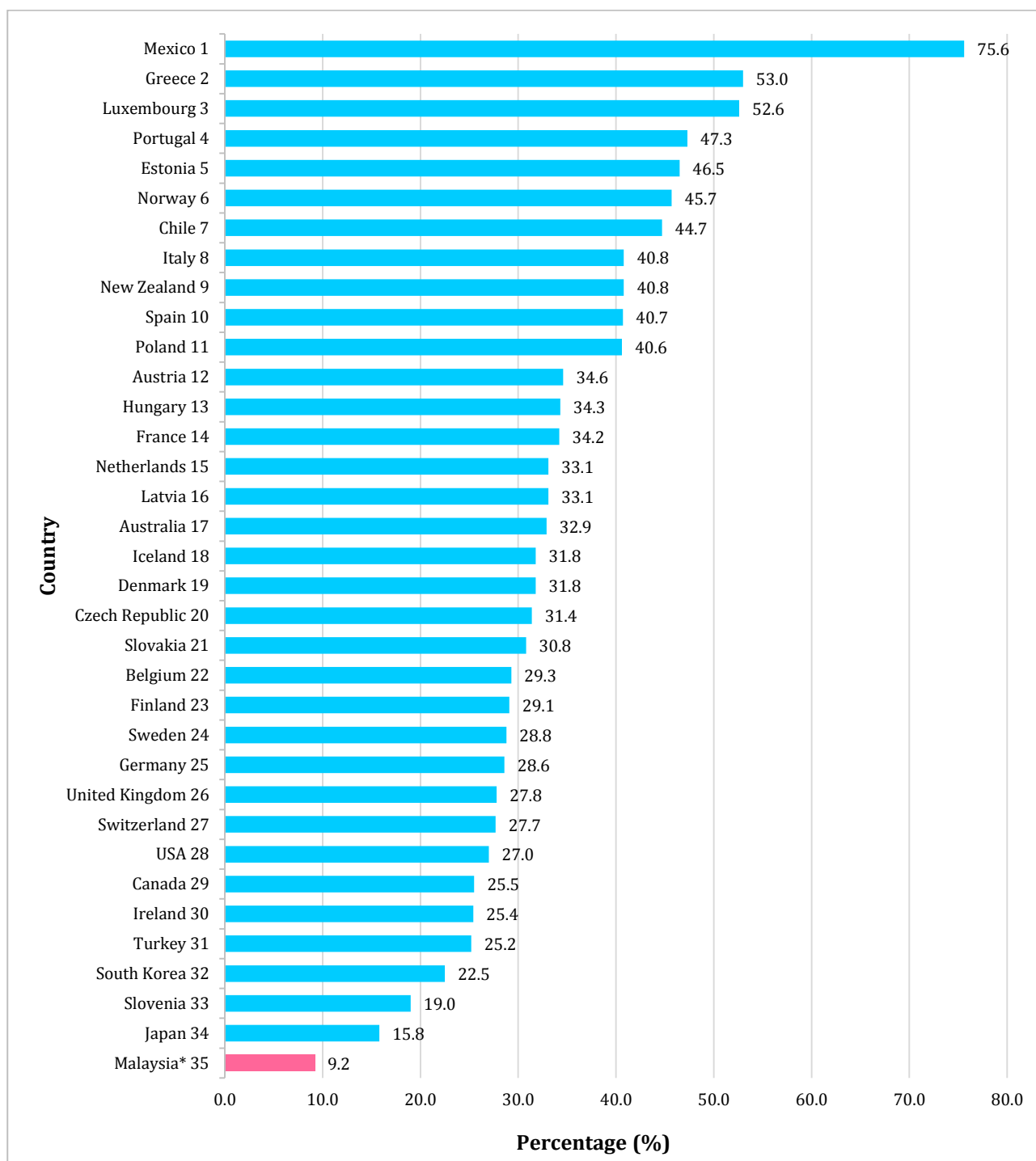


Source : Euromonitor International from UNESCO/Eurostat

\*National Survey of Research and Development (R&D) in Malaysia 2017

The top five OECD countries with highest percentage of Government R&D expenditure were Mexico (75.6%), Greece (53.0%), Luxembourg (52.6%), Portugal (47.3%) and Estonia with 46.5%. As compared with OECD countries, Malaysia ranked at the bottom with only 9.2% of government funding of total R&D expenditure (see **Figure 5.8**).

**Figure 5.8: Government R&D Expenditure as Percentage of Total R&D Expenditure for Malaysia and OECD countries in 2016**



Source : Euromonitor International from UNESCO/Eurostat  
 \*National Survey of Research and Development (R&D) in Malaysia 2017

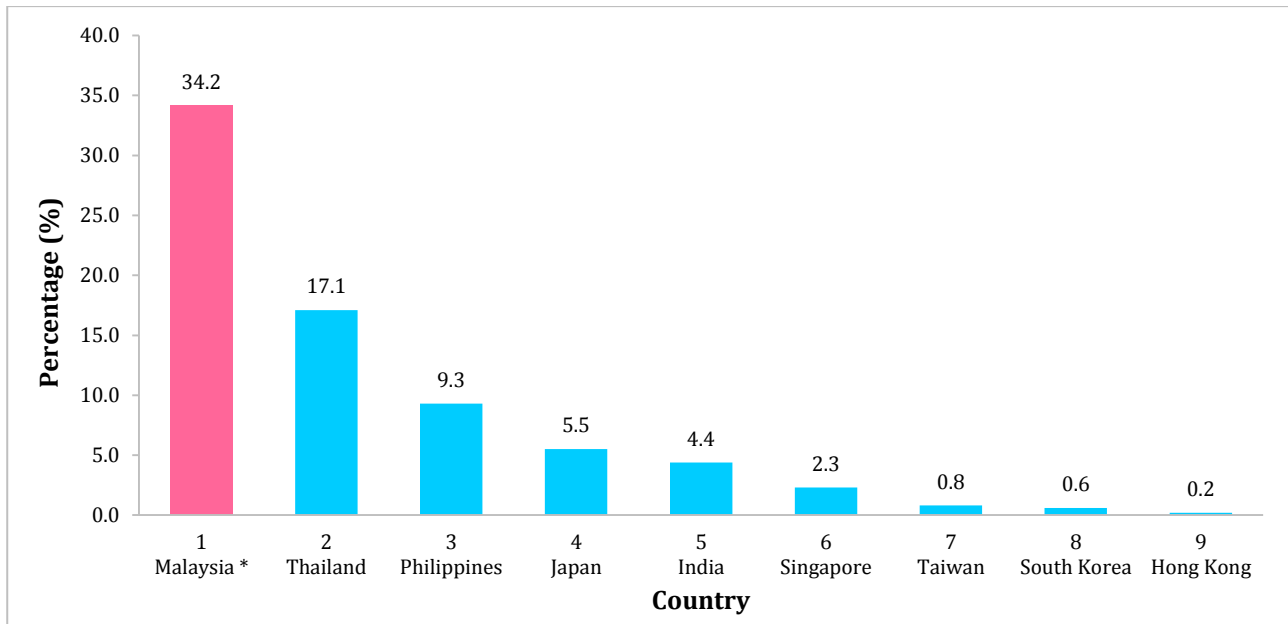
**Key Highlights:**

1. Malaysia’s government funding for R&D activities comprised only 9.2% of total R&D expenditure which was comparable to other Asian and OECD countries.
2. The Indian Government has been financing R&D activities through tax incentives and fund allocations.

### 5.1.4 Higher Education R&D Expenditure as Percentage of Total R&D Expenditure in 2016

Among the three major sources of R&D funds (i.e., Business Enterprise, Government and Higher Education) as proportion of total R&D expenditure, Malaysia recorded the highest ratio at 34.2% (see **Figure 5.9**) followed by the Thailand (17.1%), Philippines (9.3%), Japan (5.5%), India (4.4%) and Singapore (2.3%). The lowest share of Higher Education funding was found in Hong Kong.

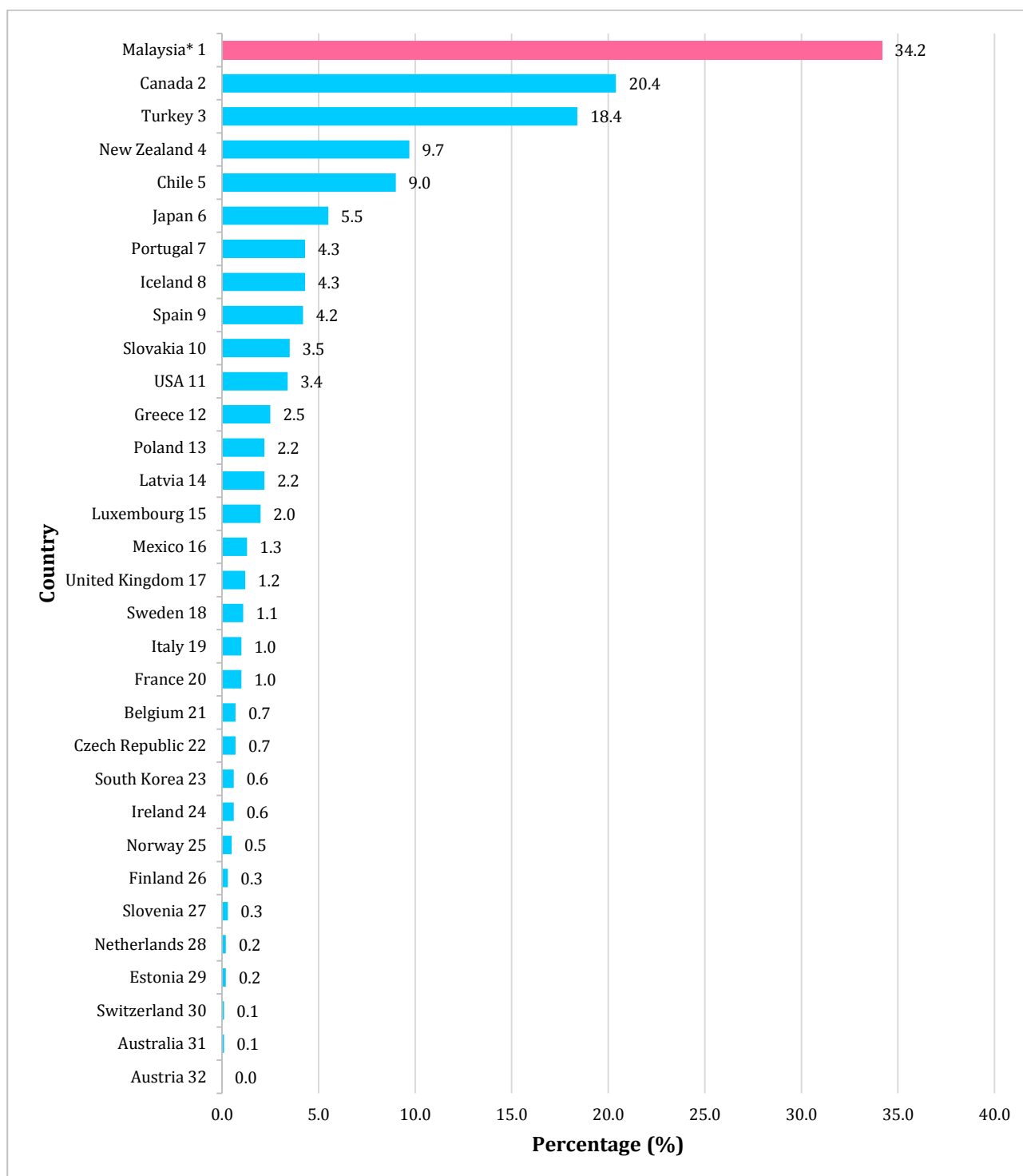
**Figure 5.9: Higher Education Expenditure on R&D as Percentage of Total R&D Expenditure for Malaysia and selected Asian countries in 2016**



Source : Euromonitor International from UNESCO/Eurostat  
\*National Survey of Research and Development (R&D) in Malaysia 2017

Malaysia was the top of selected countries based on the ratio of Higher Education R&D expenditure as a percentage of total R&D expenditure (see **Figure 5.10**). Canada and Turkey achieved more than 18.0% with New Zealand at 9.7% and Chile at 9.0%. Portugal and Iceland recorded the same percentage of 4.3% followed by Spain (4.2%), Slovakia (3.5%) and the USA (3.4%).

**Figure 5.10: Higher Education Expenditure on R&D as Percentage of Expenditure on R&D for Malaysia and OECD countries in 2016**



Source : Euromonitor International from UNESCO/Eurostat  
 \*National Survey of Research and Development (R&D) in Malaysia 2017

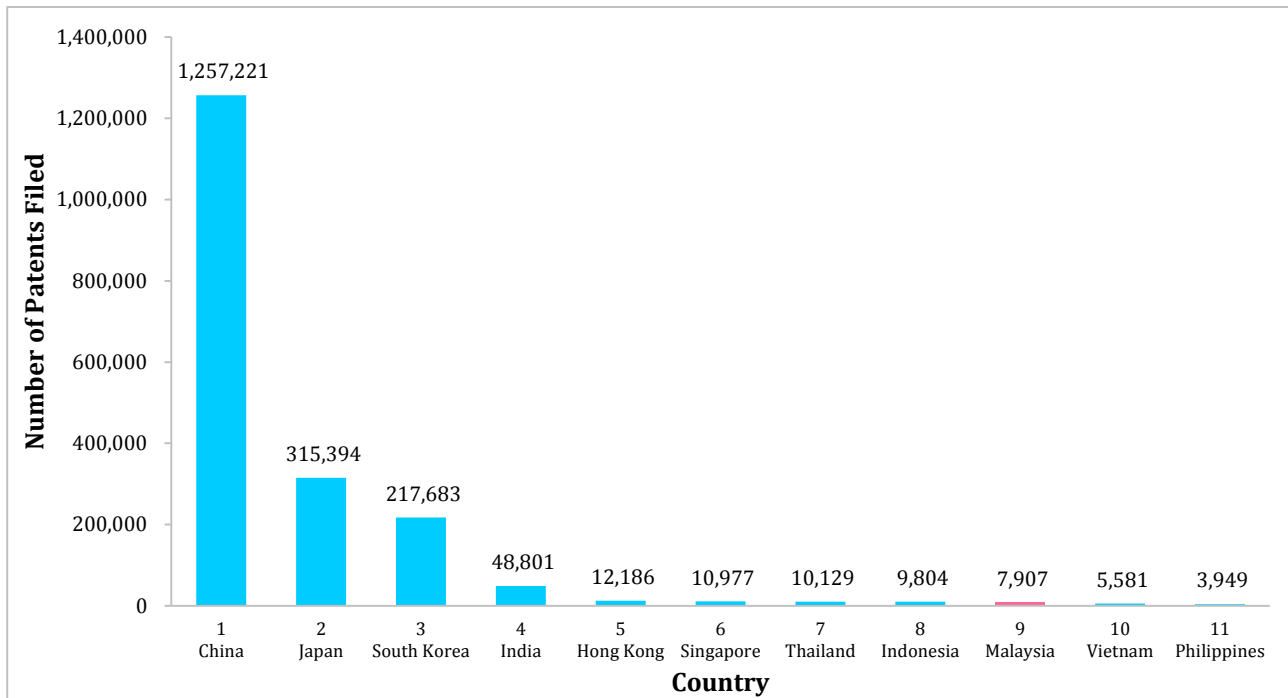
**Key Highlights:**

1. Malaysia’s Higher Education R&D expenditure at 34.2% of total R&D expenditure was ranked highest among nine selected Asian countries.
2. The share of the Higher Education sector was less than 10.0% of total R&D expenditure for all OECD countries except Malaysia (34.2%), Canada (20.4%) and Turkey (18.4%).

## 5.2 Number of Patents Filed at National Patent Office in 2016

China's 1.2 million patents filed at the National Patent Office was the top of 11 selected Asia countries (see **Figure 5.11**). This was followed by Japan, which recorded nearly 315 thousand of patents filed. South Korea ranked third with 217 thousand of patents filed. India was fourth, with approximately 48 thousand of patents filed. Singapore ranked 6<sup>th</sup> with more than 10 thousand patents filed. Meanwhile, Malaysia ranked 9<sup>th</sup> with 7.9 thousand patents filed.

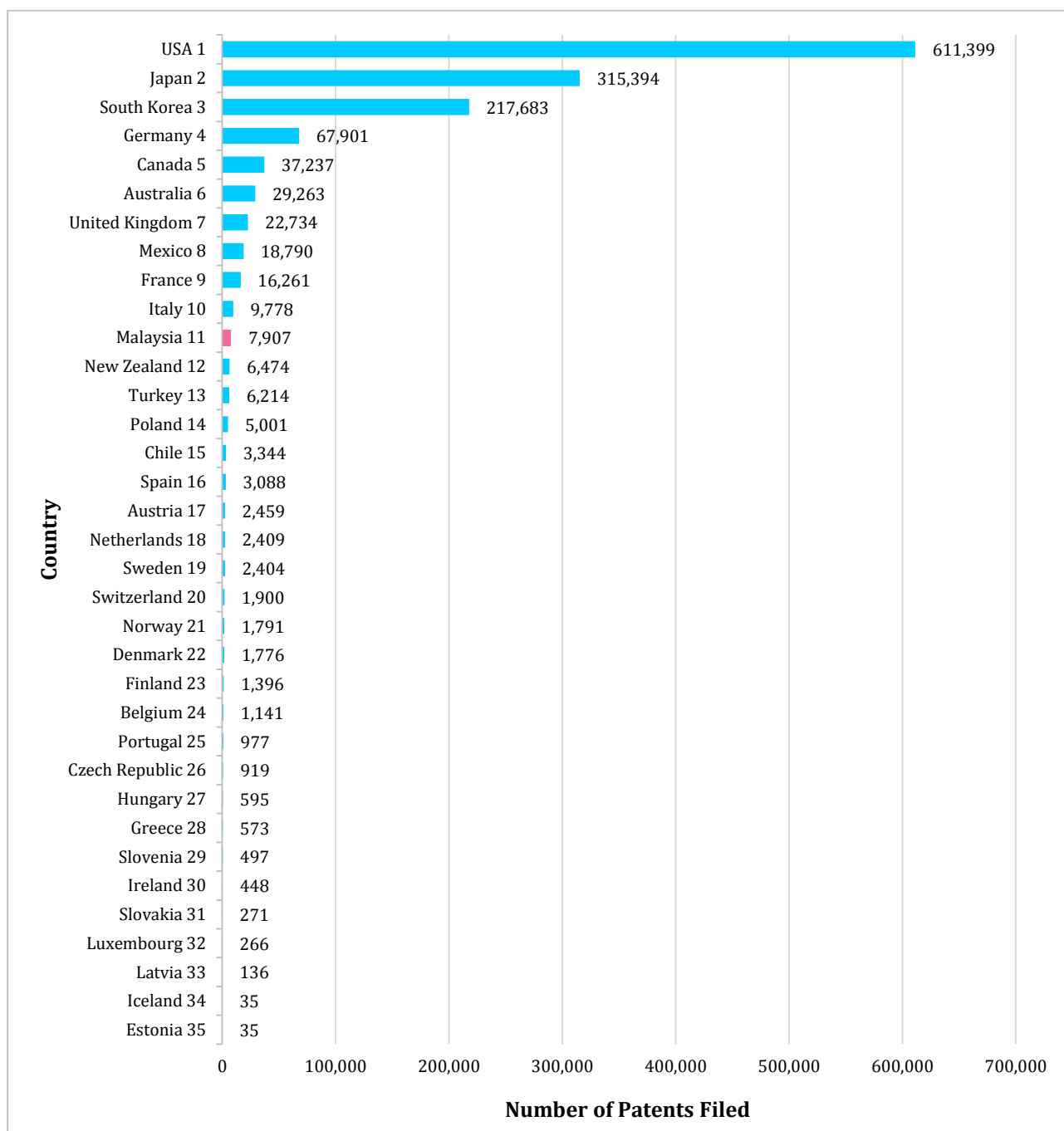
**Figure 5.11: Number of Patents Filed at National Patent Office for Malaysia and selected Asian countries in 2016**



Source : Euromonitor International from World Intellectual Property Organization (WIPO)

The USA has the highest patents filed among OECD countries (see **Figure 5.12**), at 611 thousand in 2016 followed by Japan (315,394), South Korea (217,683), Germany (67,901), Canada (37,237) and Australia (29,263). Malaysia ranked 11<sup>th</sup> with only 7.9 thousand patents filed, after France and Italy with 16,261 and 9,778 patents filed respectively.

**Figure 5.12: Number of Patents Filed at National Patent Office for Malaysia and OECD countries in 2016**



Source : Euromonitor International from World Intellectual Property Organization (WIPO)

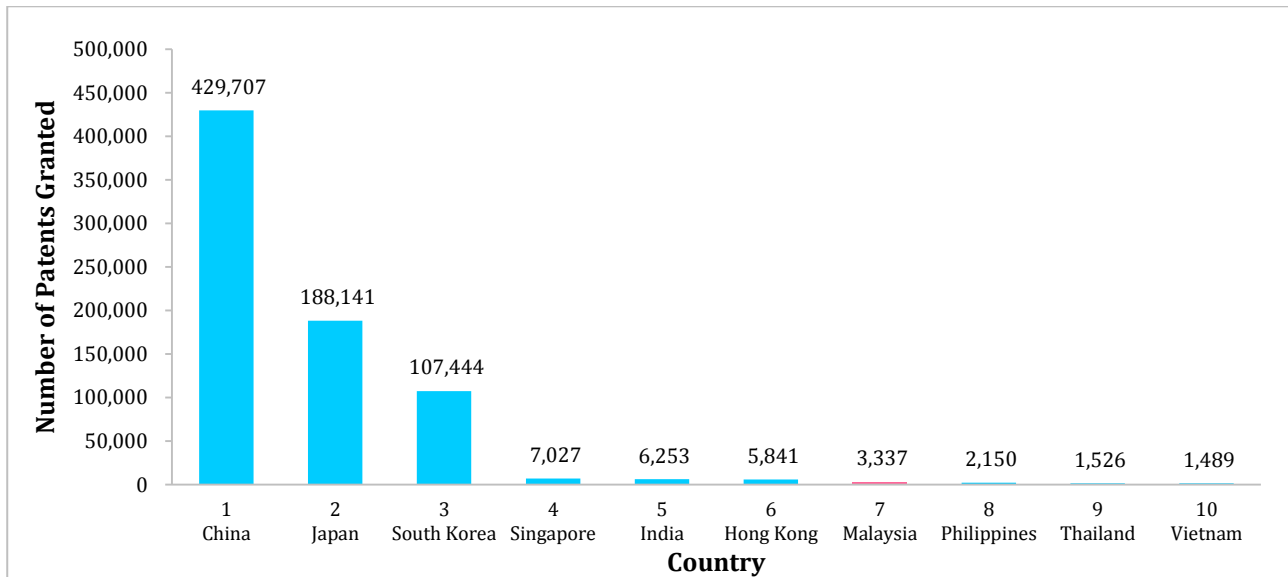
**Key Highlights:**

1. Malaysia recorded 7.9 thousand of patents filed and ranked 9<sup>th</sup> among the 11 selected Asian countries.
2. Malaysia ranked 11<sup>th</sup> in terms of number of patents filed among all OECD countries. The USA topped the list with 611 thousand followed by Japan (315,394), South Korea (217,683), Germany (67,901), Canada (37,237) and Australia (29,263).

### 5.3 Number of Patents Granted at National Patent Office in 2016

Malaysia ranked 7<sup>th</sup> among the ten selected Asian countries with 3.3 thousand patents granted filed at the National Patent Office (see **Figure 5.13**). China ranked 1<sup>st</sup> with 429 thousand of patents granted followed by Japan with 188 thousand of patents granted. Meanwhile, South Korea ranked 3<sup>rd</sup> with 107 thousand of patents granted and Singapore 4<sup>th</sup> with approximately 7 thousand patents granted. Malaysia's patents granted more than 2 times lower than Singapore.

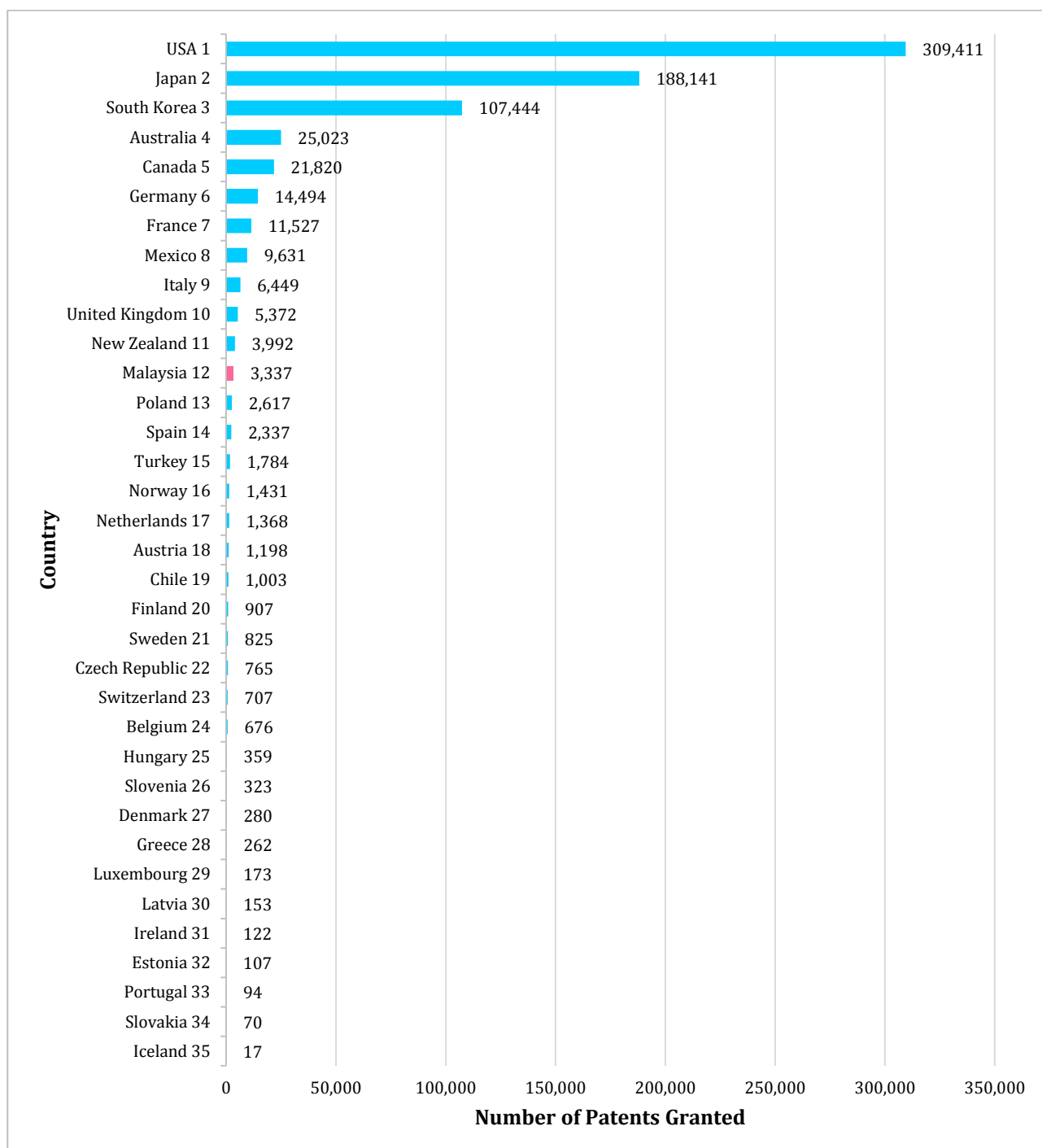
**Figure 5.13: Number of Patents Granted at National Patent Office for Malaysia and other Asian countries in 2016**



Source : Euromonitor International from World Intellectual Property Organization (WIPO)

Malaysia ranked 12<sup>th</sup> in terms of patents granted compared with OECD countries (see **Figure 5.14**). The USA ranked 1<sup>st</sup> with 309 thousand of patents granted followed by Japan with more than 188 thousand patents granted. South Korea ranked 3<sup>rd</sup> with nearly 107 thousand patents granted. Besides, the number of patents granted of Malaysia was higher than many developed countries, such as the Poland (2.6 thousand), Spain (2.3 thousand), Turkey (1.8 thousand), Norway (1.4 thousand) and Netherlands (1.4 thousand). Based on **Figure 5.14**, the number of patents granted of Malaysia obtained in 2016 one of the top fifteen countries as compared with other OECD countries.

**Figure 5.14: Number of Patents Granted at National Patent Office for Malaysia and OECD countries in 2016**



Source : Euromonitor International from World Intellectual Property Organization (WIPO)

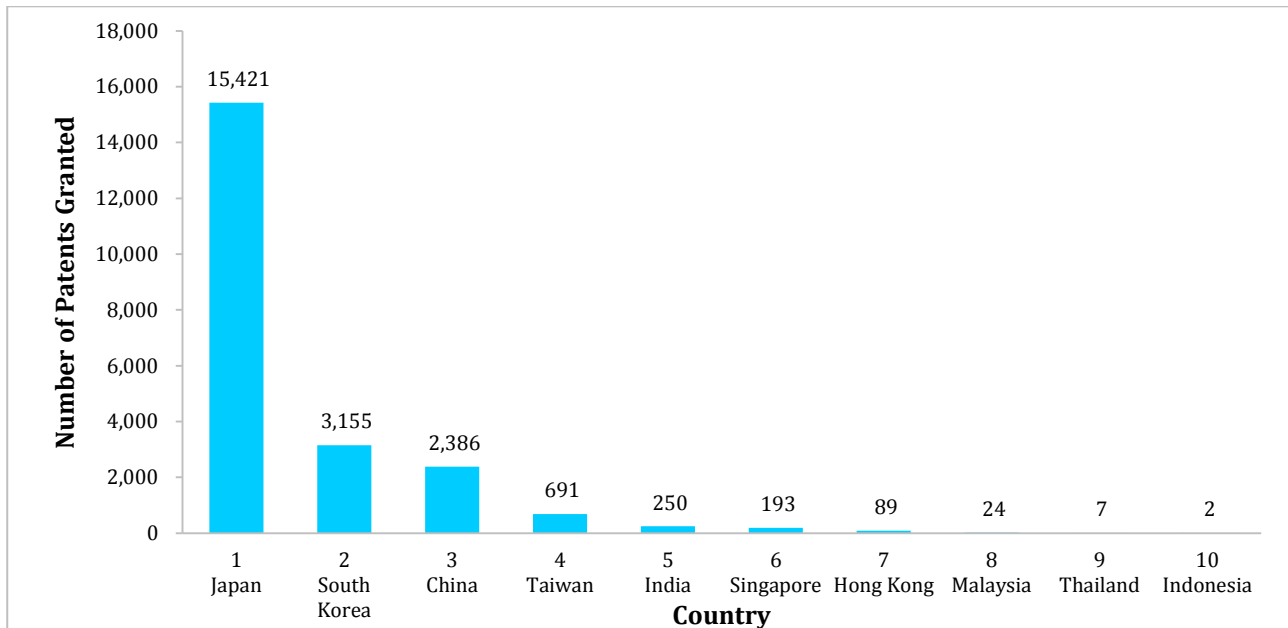
**Key Highlights:**

1. Malaysia ranked 7<sup>th</sup> among selected Asian countries with 3.3 thousand patents granted filed at the National Patent Office in 2016.
2. Malaysia ranked at 12<sup>th</sup> as compared with the OECD countries.
3. The number of patents granted for Malaysia was more than 2 times lower than Singapore.

#### 5.4 Number of Patents Granted at the EPO in 2016

The top five countries with the highest patents granted at European Patent Office (EPO) were Japan, South Korea, China, Taiwan, and India (see **Figure 5.15**). Japan had approximately 15 thousand patents granted at EPO in 2016. South Korea obtained 3.1 thousand patents granted at EPO. Singapore ranked 6<sup>th</sup> with 193 patents granted at EPO. Malaysia ranked 8<sup>th</sup> with 24 patents granted at EPO. The number of patents granted at EPO for Malaysia was 8 times lower than Singapore.

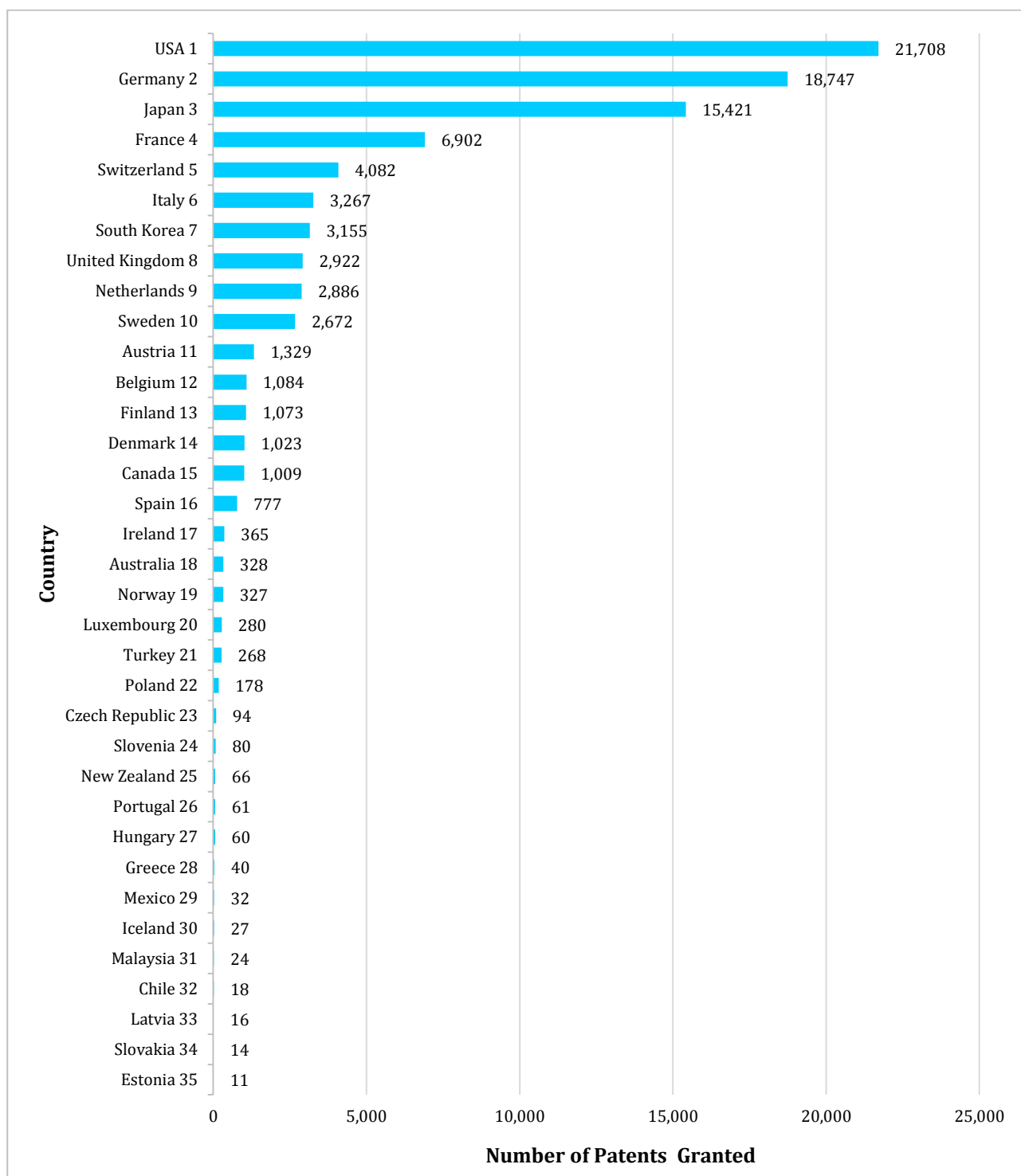
**Figure 5.15: Number of Patents Granted at EPO for Malaysia and selected Asian countries in 2016**



Source : Euromonitor International from OECD/USPTO/EPO

The top five countries with highest number of patents granted at EPO were the USA, Germany, Japan, France and Switzerland as compared with other OECD countries (see **Figure 5.16**). USA obtained 21.7 thousand patents granted, while Germany obtained 18.7 thousand patents granted at EPO. Malaysia ranked 31<sup>st</sup> after Iceland. The number of patents granted obtained by Malaysia (24) was higher than Chile (18), Latvia (16), Slovakia (14) and Estonia (11).

**Figure 5.16: Number of Patents Granted at EPO for Malaysia and OECD countries in 2016**



Source : Euromonitor International from OECD/USPTO/EPO

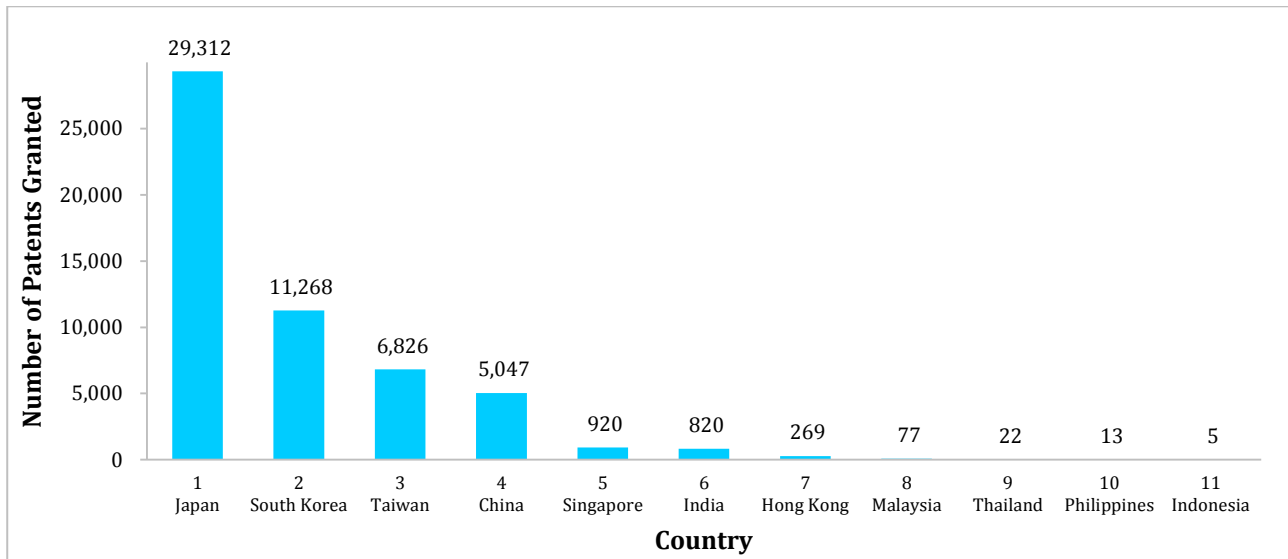
**Key Highlights:**

1. Among 10 selected Asian countries, Malaysia ranked 8<sup>th</sup> with 24 patents granted at EPO.
2. Malaysia ranked 31<sup>st</sup> among OECD countries in terms of patents granted at EPOs.
3. The number of patents granted at EPO for Malaysia was 8 times lower than Singapore.

## 5.5 Number of Patents Granted at the USPTO in 2016

The top five countries with the highest number of patents granted at United States Patent and Trademark Office (USPTO) were Japan, South Korea, Taiwan, China and Singapore (see **Figure 5.17**). Japan obtained approximately 29 thousand patents granted at USPTO. China ranked 4<sup>th</sup> with 5 thousand patents granted at USPTO. Singapore ranked 5<sup>th</sup> with 920 patents granted. Malaysia ranked 8<sup>th</sup> with 77 patents granted at USPTO. The number of patents granted in USPTO for Singapore was approximately 12 times higher than Malaysia.

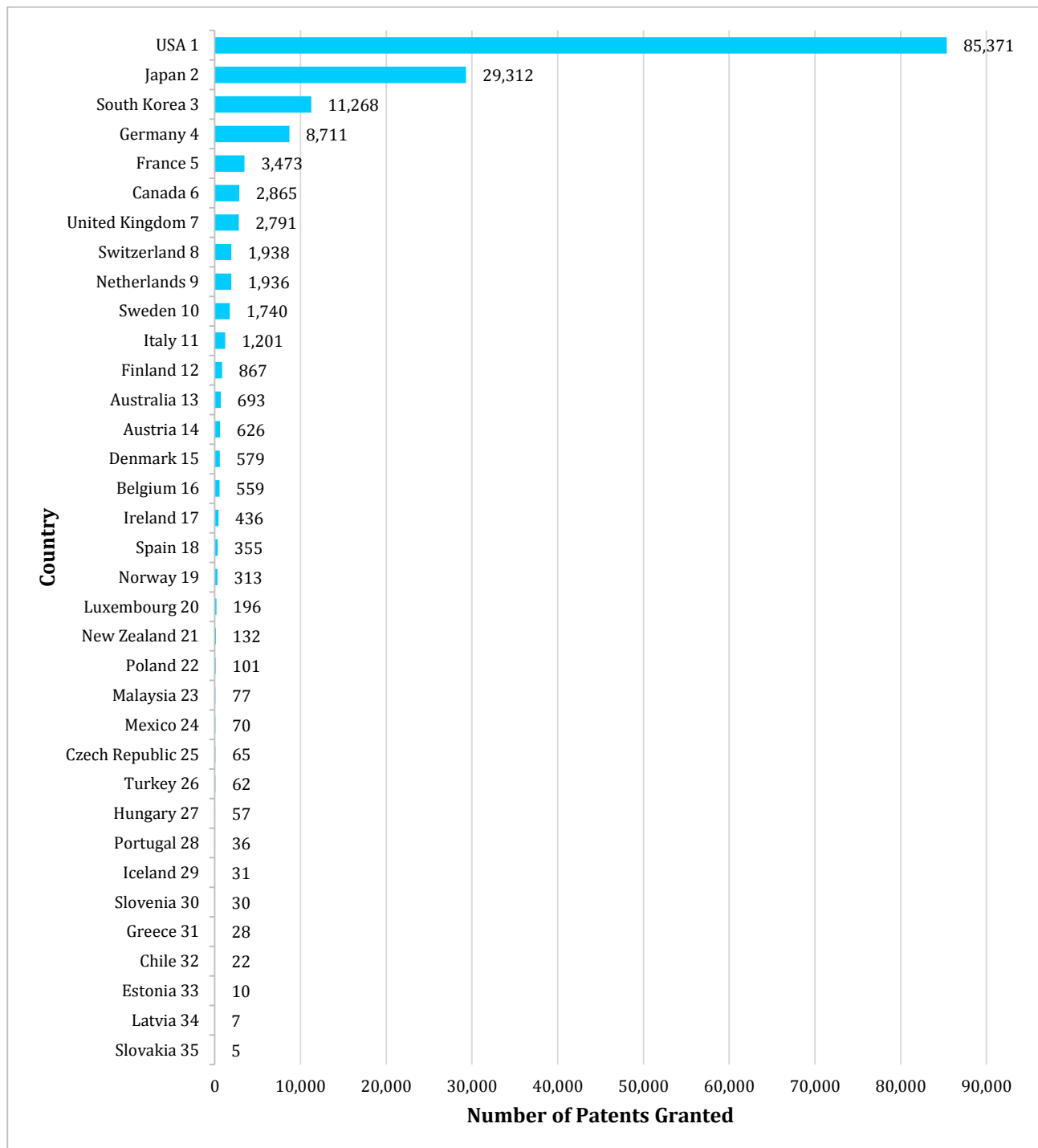
**Figure 5.17: Number of Patents Granted at the USPTO for Malaysia and selected Asian countries in 2016**



Source : Euromonitor International from OECD/USPTO/EPO

Compared with OECD countries, the top five countries with highest number of patents granted at the USPTO were the USA, Japan, South Korea, Germany and France (see **Figure 5.18**). The USA obtained more than 85 thousand patents granted at USPTO. Malaysia ranked 23<sup>rd</sup> after Poland. The number of patents granted for Malaysia (77) was higher than Mexico (70), Czech Republic (65), Turkey (62), Hungary (57), Portugal (36), Iceland (31), Slovenia (30), Greece (28), Chile (22), Estonia (10), Latvia (7) and Slovakia (5).

**Figure 5.18: Number of Patents Granted at the USPTO for Malaysia and OECD countries in 2016**



Source : Euromonitor International from OECD/USPTO/EPO

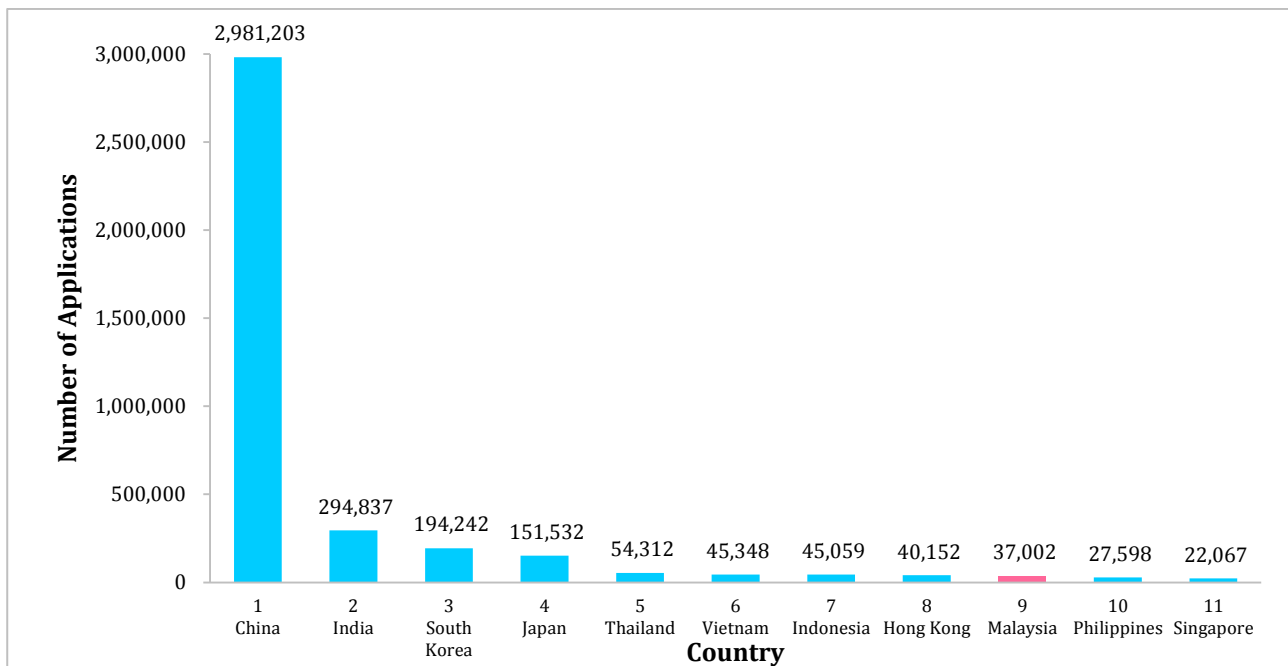
**Key Highlights:**

1. Malaysia obtained 77 patents granted at the USPTO in 2016.
2. Malaysia ranked 23<sup>rd</sup> as compared with OECD countries in terms of the number of patents granted obtained from the USPTO.
3. The number of patents granted in USPTO for Singapore was approximately 12 times higher than Malaysia.

## 5.6 Trade Mark Applications in 2016

**Figure 5.19** compared the trade mark applications between Malaysia and other selected ten Asian countries. The top five countries were China, India, South Korea, Japan and Thailand. China achieved nearly 3 million trade mark applications in 2016 followed by India with approximately 300 thousand of trade mark applications. Malaysia ranked 9<sup>th</sup> with 37 thousand trade mark applications. Singapore ranked 11<sup>th</sup> with 22 thousand trade mark applications.

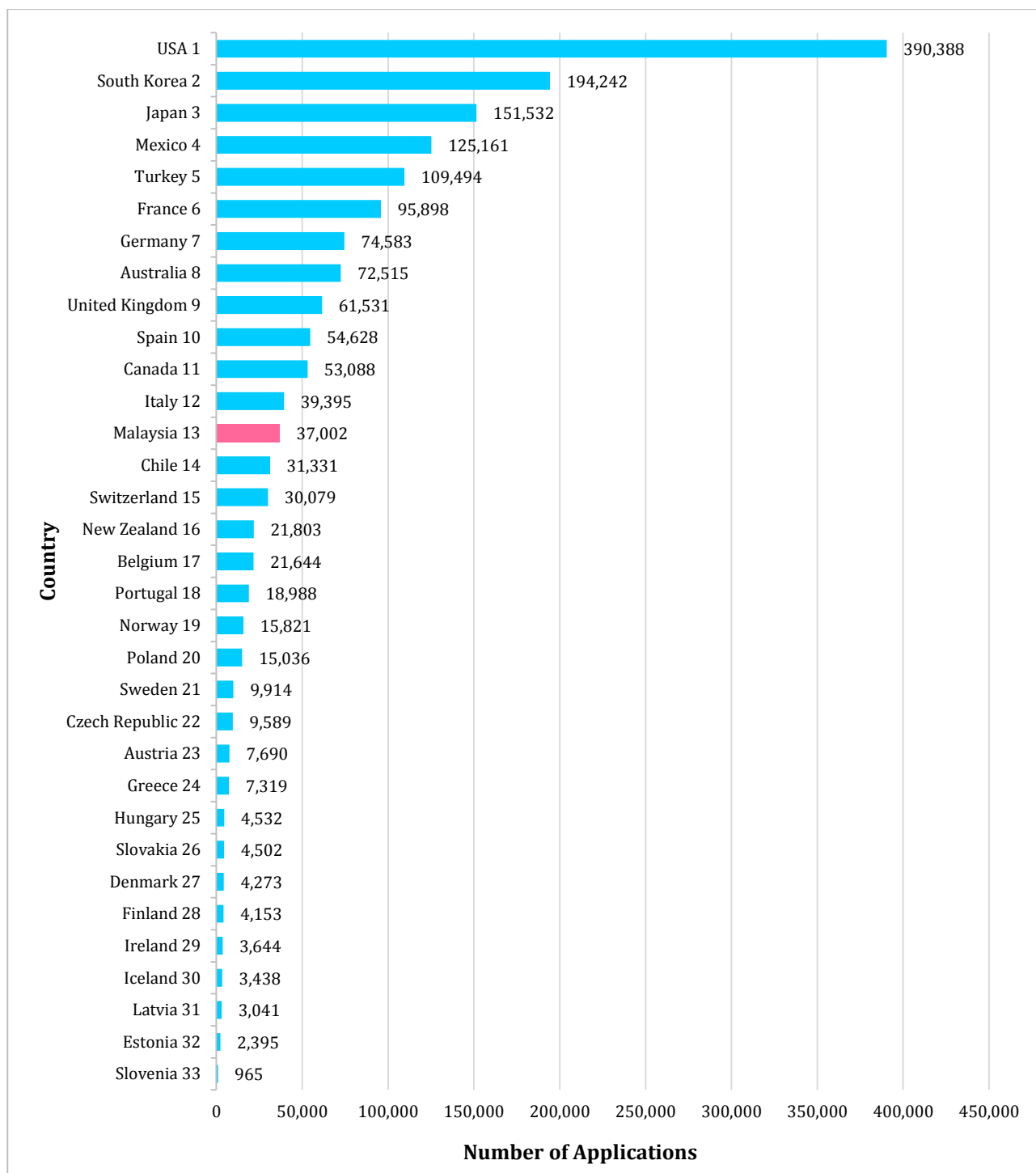
**Figure 5.19: Trade Mark Applications for Malaysia and selected Asian countries in 2016**



Source : Euromonitor International from World Bank/World Intellectual Property Organization (WIPO)

**Figure 5.20** shows the trade mark applications for Malaysia and other OECD countries. Malaysia ranked 13<sup>th</sup> with 37 thousand of trade mark applications in 2016. The top five OECD countries with highest number of trade mark applications were the USA (390 thousand), South Korea (194 thousands), Japan (151 thousands), Mexico (125 thousands) and Turkey (109 thousands). The number of trade mark applications for Malaysia was higher than some of the developed countries such as Chile (31 thousand), Switzerland (30 thousand), New Zealand (21.8 thousand), Belgium (21.6 thousand) and Portugal (18.9 thousand).

**Figure 5.20: Trade Mark Applications for Malaysia and OECD countries in 2016**



Source : Euromonitor International from World Bank/World Intellectual Property Organization (WIPO)

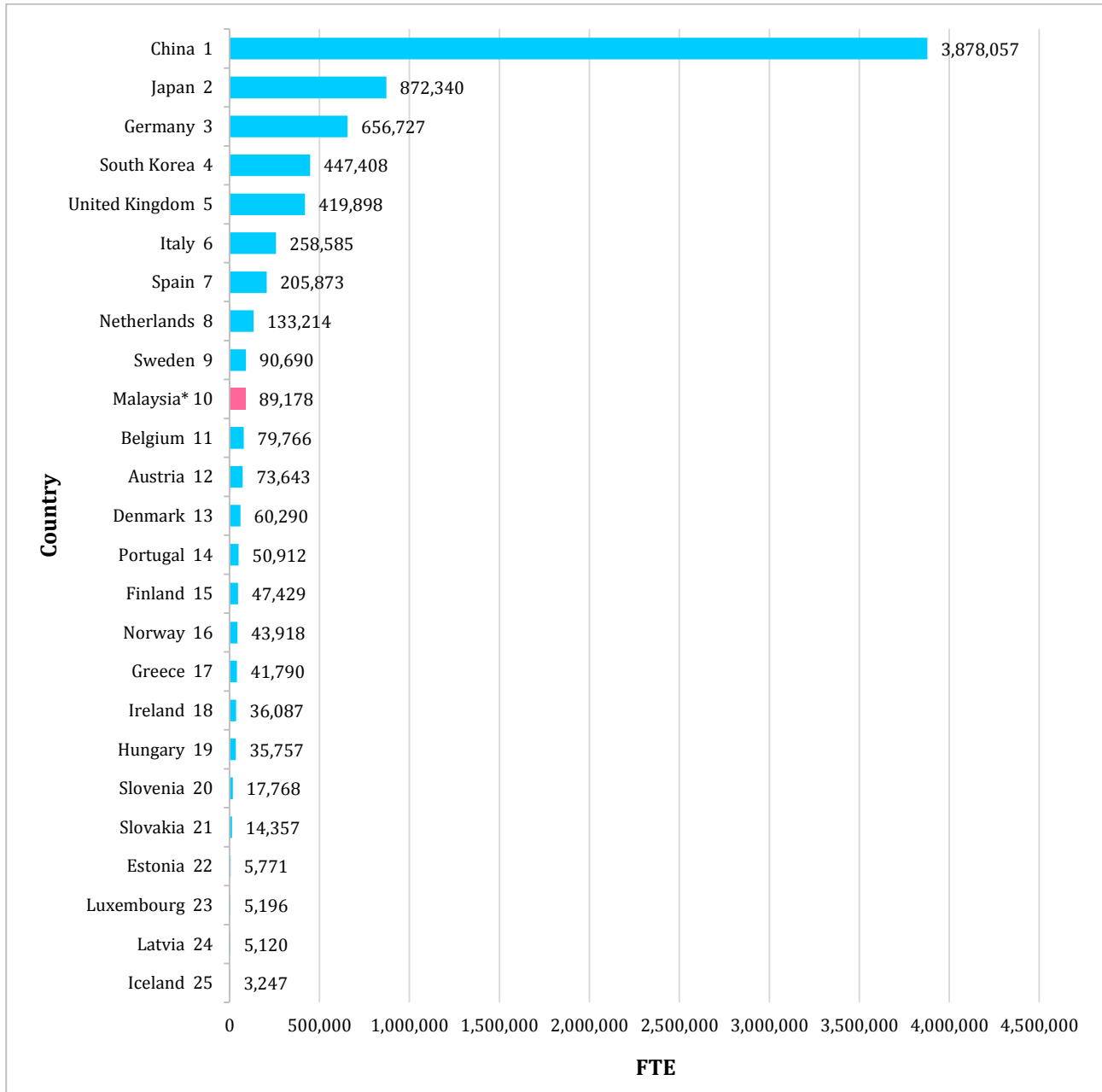
**Key Highlights:**

1. Malaysia achieved 37 thousand trade mark applications in 2016.
2. Malaysia ranked 13<sup>th</sup> in terms of number of trade mark applications as compared with OECD countries.
3. The number of trade mark applications for Malaysia was higher than Singapore in 2016.

## 5.7 Total R&D Personnel (FTE) in 2016

Although the R&D Personnel (FTE) for Malaysia surpassed Belgium, Austria, Denmark, Greece, Finland, Luxembourg, Ireland, Slovakia, Slovenia, Hungary and Iceland (see **Figure 5.21**), their R&D personnel intensity is farther ahead than Malaysia's (see **Figure 5.22**).

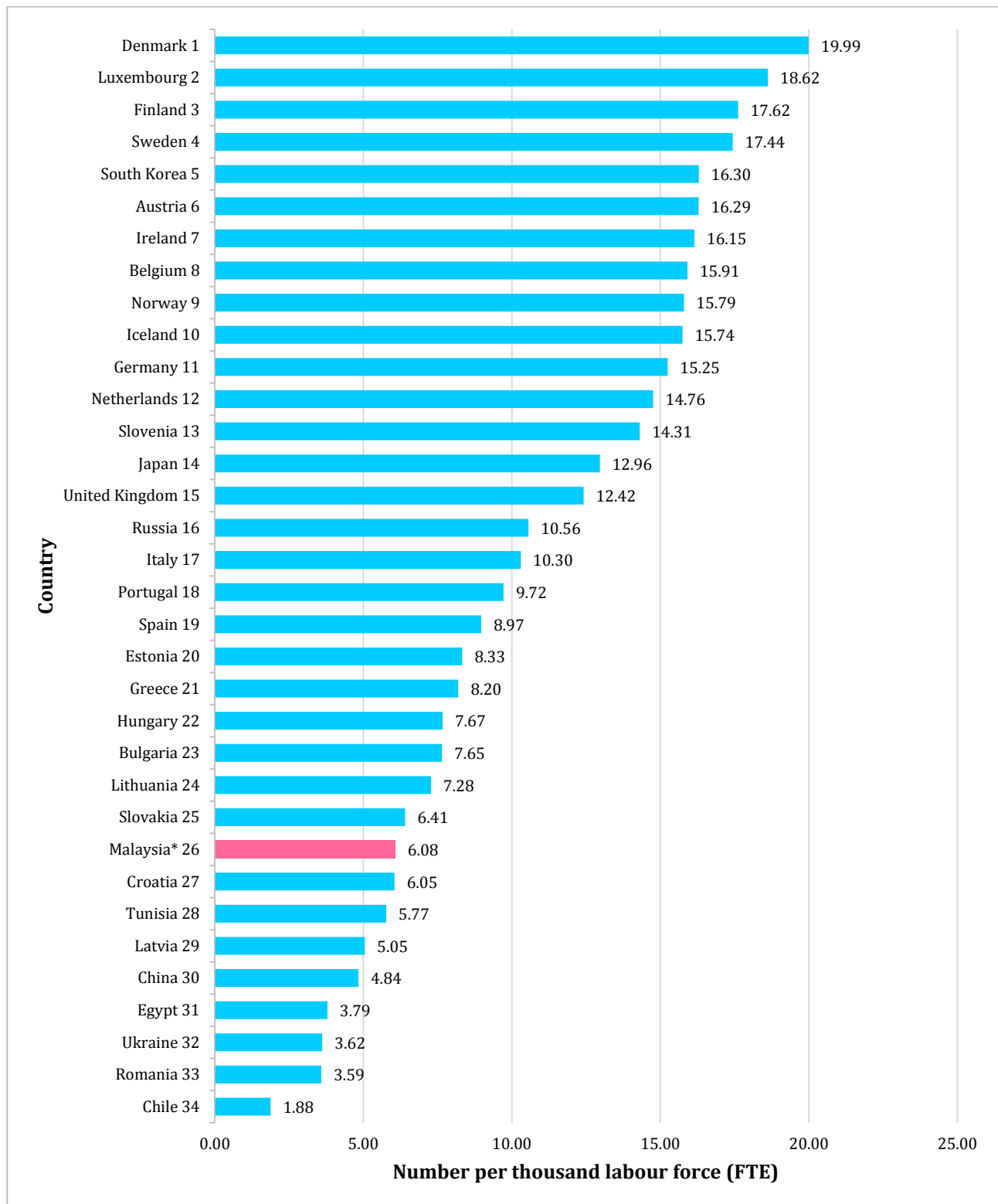
**Figure 5.21: Total R&D Personnel (FTE) for Malaysia and other countries in 2016**



Source : UNESCO database

\*National Survey of Research and Development (R&D) in Malaysia, 2017

**Figure 5.22: Total R&D Personnel per thousand labour force (FTE) for Malaysia and other countries in 2016**



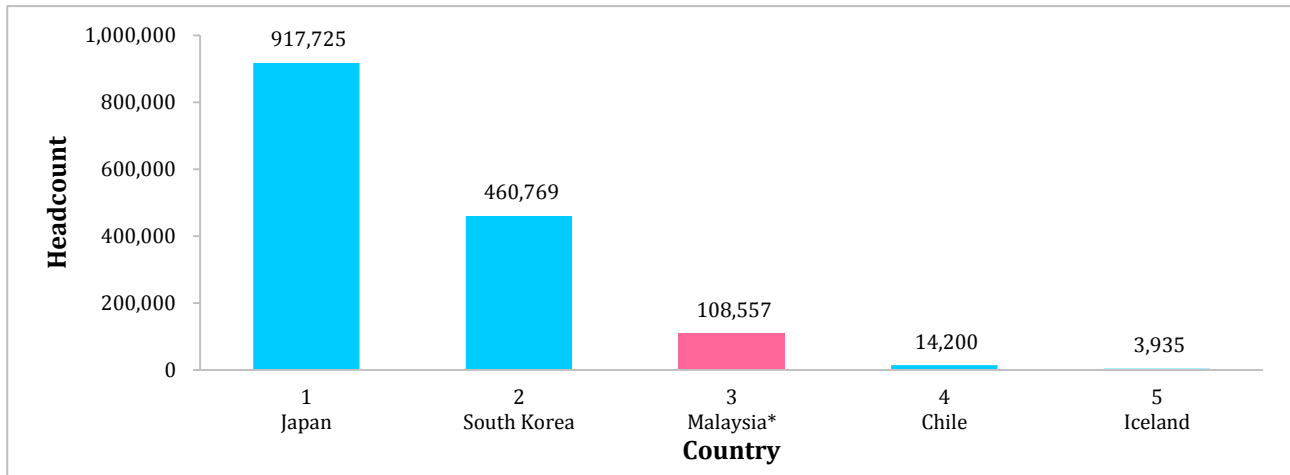
Source : UNESCO database.

\*National Survey of Research and Development (R&D) in Malaysia, 2017

## 5.8 Total Researchers (Headcount) in 2016

**Figure 5.23** shows the total headcount of researchers in 2016. Japan ranked 1<sup>st</sup> with 918 thousand researchers. The second position was South Korea with more than 460 thousand researchers in 2016. Malaysia ranked third with 108 thousand researchers, higher than Chile (14 thousand) and Iceland (3.9 thousand).

**Figure 5.23: Total Researchers (Headcount) for Malaysia and other countries in 2016**

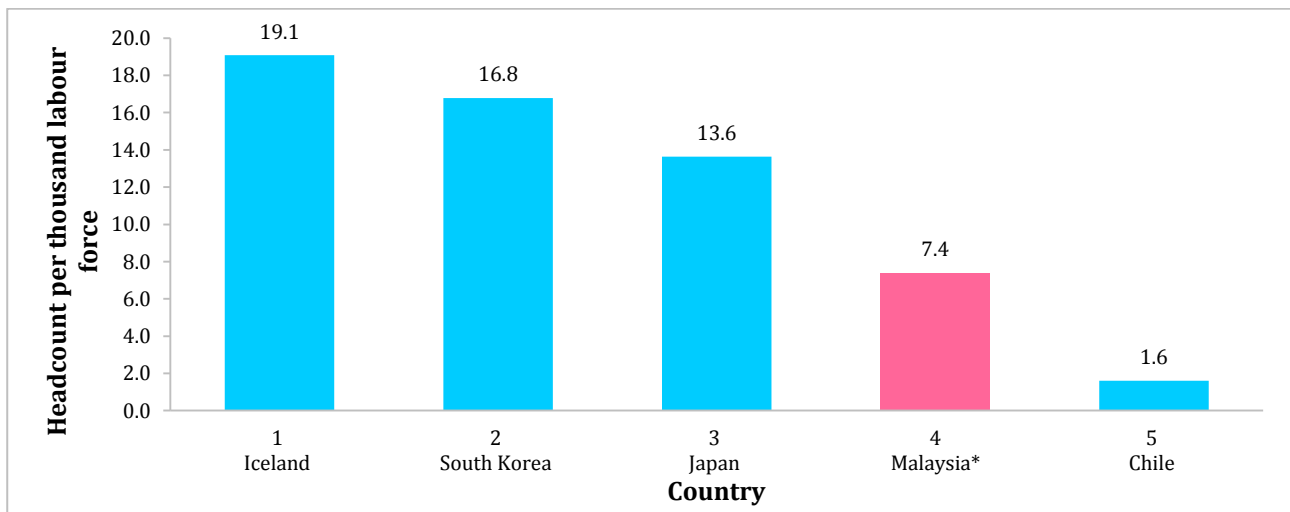


Source : UNESCO database.

\*National Survey of Research and Development (R&D) in Malaysia, 2017

In terms of researcher intensity, i.e. researchers per thousand labour force, Malaysia's intensity was 7.4, much lower than Japan's (almost 1.8 times higher) or Iceland (almost 2.5 times higher).

**Figure 5.24: Total Researchers (Headcount) per thousand labour force for Malaysia and other countries in 2016**



Source : UNESCO database.

\*National Survey of Research and Development (R&D) in Malaysia, 2017



# **CHAPTER 6: RESEARCH LIMITATIONS**



## CHAPTER 6: RESEARCH LIMITATIONS

### 6.1 Caveats and Limitations

This section discusses the caveats and limitations in carrying out R&D surveys based on lessons learned and insights from R&D surveys in Malaysia and other countries. Limitations are found mainly in two areas, i.e. methodology and operational aspects.

Based on the Frascati Manual 2015, the main **limitations of methodology** are as follows:

#### 1. Terminology used

- It is important that all respondents have the same and correct understanding of the terms used in the survey. For instance, differentiating between innovation and R&D is a practical difficulty for respondents who may not have training and exposure in these concepts. Administrative data included in the study must also be validated and comply with the definitions and terminologies used.
- The sample selected from the sub-frame of 10,393 establishments from the EE Frame, comprising establishments with R&D expenditure above RM1,000. Related to the above, it is important to have a clean frame so that there is little need to adjust for ineligible and non-response cases.

**2. Financial reporting:** There is no standard R&D expenditure in financial reporting across all business firms due to the compliance of rules and regulations as well as the coverage of R&D activities and its definition. The distinction between innovation and R&D may not be fully appreciated by journalists and writers or who may other intentions, e.g., wanting to show ever rising investments in technologies, research or development.

From an **operational aspect**, the **main challenges in carrying out an R&D survey** are as follows:

1. **Difficulty in getting a high response rate and timeliness issue.** R&D organisations could have multiple units undertaking R&D where each unit has the autonomy to manage the funds for R&D activities, and oversight of the entire operations is weak. Thus, respondents will require a longer time to complete the survey. The reference year for the survey may differ from the financial year in the firms' financial reporting. Firms might need time to update or provide required information such as type of research personnel by age criteria.
2. **The use of information for policy.** Information from surveys cannot be used for impact analysis due to complex interaction among multiple actors and the absence of knowledge distribution and use in the economy. Information on R&D activities by the management and governance are limited. More detailed information is required and special case studies could be initiated to obtain a better understanding of the R&D related policy issues.
3. **Incomplete or inaccurate information due to inconsistent definitions and the breakdown of disaggregated criteria in classifying the R&D statistical unit.** For example, R&D data for multiple product enterprises could lie across several lines of business or in different faculties or departments within HLIs or GRIs.

To overcome the difficulty of collecting R&D data, countries such as Taiwan and Thailand conducted joint R&D survey with the national science and technology surveys.

## 6.2 Way Forward in Minimising Limitations in R&D Surveys

To facilitate R&D data collection through surveys, the following way forward is proposed:

1. Continue with the four institutional sectors in future R&D surveys: i.e. Business Enterprises, Government, Higher Education and Private Non-Profit sectors. Institutions have a common set of economic objectives, principal functions and guides all the R&D units within it. Use the strata approach as it produces reliable national estimates, enables data collection and estimation efforts of R&D activities of the reporting units. If the reporting unit performs more than one economic activity, classification should be based on the principal activity.
2. Apply the R&D definition in the Frascati Manual 2015 where R&D comprises creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge. Terms must be well-understood by respondents, e.g. intramural R&D expenditure which is synonymous with the performance of R&D within a reporting unit, while extramural R&D refers to R&D performed outside it.
3. The relevant authorities should have a clear picture of the R&D transformation strategy, future R&D landscape and opportunity for R&D development in order to collect the relevant data for evaluation and monitoring purposes.
4. Correctly identify the reporting unit of the organisation in completing the survey. It is vital to find out whether it is the establishment or the enterprise level that collects R&D data so that data collection can not only be efficient but also remove any overlapping coverage, i.e. reduce double counting.
5. Quality check where administrative data and national data are required for data comparison and imputation purposes. In the case of administrative data, it is important to make sure that the correct definitions with the survey are used.

**CHAPTER 7:  
CONCLUSION AND  
RECOMMENDATIONS**



## CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

Malaysia has been running R&D surveys since 1994 and have used standard definitions as part of its efforts to measure accurately the level of R&D activities and understand its performance in Malaysia. This survey is the latest in that series.

The 2017 R&D Survey is based on the Frascati Manual and the Malaysia Research and Development Classification System (6<sup>th</sup> edition). The survey was managed in two parts that may be described as private and public. For the private component, a probability survey was carried out for Business Enterprises. For the public component, a full census was carried out to canvass for R&D information from Government Research Institutes, Higher Learning Institutions, and Non-Governmental Organisations. The targeted response rate of 60.0% was reached for the private sector, and more than 88.0% for the public sector. Detailed 2015 data was also provided, and it facilitated a different level of analysis that enabled a better understanding of the collected data (i.e. quality assurance across surveys was undertaken). The summary of the key indicators for all sectors is exhibited in **Table 7.1**.

**Table 7.1: Summary of Key R&D Indicators for All Sectors**

Key R&D Indicator		Overview	BEs	GRI	HLI	NGOs
Current R&D Expenditure RM (Million)		14,323.34	7,912.51	1,532.19	4,867.55	11.09
Capital R&D Expenditure RM (Million)		3,362.05	2,093.55	94.35	1,173.68	0.47
R&D Expenditure by Sectors RM (Million)		-	10,006.06	1,626.54	6,041.23	11.56
Gross R&D Expenditure (GERD) RM (Million)		17,685.39	-	-	-	-
Gross R&D expenditure per Gross Domestic Product (GERD/GDP)		1.44	-	-	-	-
R&D Expenditure in Business Enterprises RM (Million)		-	10,006.06	-	-	-
Source of Funds	BE	59.8%	97.8%	12.7%	1.0%	36.0%
	Government	34.2%	1.0%	86.9%	59.0%	53.0%
	HLI	-	-	-	37.4%	-
	Foreign	-	-	-	0.6%	-
	Others	6.0%	1.2%	0.4%	2.0%	11.0%
R&D Personnel	Total	145,740	26,926	17,945	100,817	52
	Researchers	108,557	19,117	11,719	77,674	46
	Technicians	14,657	4,690	3,286	6,680	1
	Support Staff	22,527	3,119	2,940	16,463	5

Key R&D Indicator		Overview	BEs	GRI	HLI	NGOs
Full-time Equivalent of Research Personnel (FTE)		89,178	20,174	8,912	60,048.39	44
Number of Researchers for Every 10,000 Labour Force		74.01	-	-	-	-
Researchers by Gender	Male	56,232	12,238	5,855	38,127	12
	Female	52,325	6,880	5,864	39,547	34
R&D Expenditure by Field of Research (FOR)	Engineering and Technology	15.2%	14.7%	11.3%	32.5%	6.9%
	Natural Sciences	9.0%	12.2%	16.8%	14.2%	15.9%
	Information, Computer and Communication Technology	42.2%	62.4%	5.9%	7.3%	3.5%
	Economics, Business and Management	8.7%	3.2%	1.9%	5.2%	0.0%
	Agriculture and Forestry	6.2%	2.7%	19.2%	3.3%	3.5%
	Medical and Health Sciences	3.3%	1.1%	8.4%	19.7%	57.5%
	Biotechnology	5.3%	3.5%	5.2%	3.9%	3.5%
	Humanities	8.9%	0.2%	9.0%	2.2%	3.5%
	Social Sciences	1.2%	0.1%	22.3%	11.7%	5.9%
R&D Expenditure by Socio-economic Objectives (SEO)	Advancement of Knowledge	19.9%	22.3%	15.1%	23.6%	12.5%
	Sustainable Economic Development	28.8%	36.5%	19.1%	16.9%	4.4%
	Advanced Experimental and Applied Science	20.6%	17.7%	23.7%	26.9%	12.5%
	Environment	9.7%	7.5%	13.9%	7.6%	49.4%
	Society	18.1%	13.2%	24.5%	24.3%	18.1%
	Defence and Security	2.9%	2.8%	3.7%	0.7%	3.1%
Type of R&D Activities	Basic	5,114	1,147	362	3,602	3
	Applied	9,988	7,250	738	1,991	9
	Experimental Development	2,582	1,609	524	448	0

Key R&D Indicator	Overview	BEs	GRI	HLI	NGOs	
Number of IP and Publications	<b>Intellectual Property</b>					
	Patents Filed	1,113	662	53	392	6
	Patents Granted	536	326	61	148	1
	Copyright	2,797	445	493	1,859	0
	Trademark	1,103	956	62	84	1
	Industrial Design	2,530	2,493	6	30	1
	<b>Publication</b>					
	Indexed Journal (Scopus/WoS)	25,668	-	598 (9.0%)	25,070	-
	Conference Proceedings	17,101	-	3,028 (45.7%)	14,073	-
	Non-indexed Journal	11,136	-	1,187 (17.9%)	9,949	-
	Chapters in Book	2,769	-	227 (3.4%)	2,542	-
	Books	2,277	-	812 (12.3%)	1,465	-
	Other Publications	13,311	-	772 (11.7%)	12,539	-

The 2017 R&D Survey used the standard formats and definitions as in previous surveys. The main difference in this survey was the availability of firm level data from earlier surveys as well as data from administrative sources. With this data, conflicting information between the years can be checked. For instance, information on the R&D cycle, the variability of R&D funding from year to year, the ability to quantify the impact of using different frames and sources of data, as well as the ability to separate these influences from the issue of outliers. It is important to note that all these lessons were possible only if accurate data are collected, due essentially to a quality control and quality assurance system being in place.

In that regard, the following recommendations are made so that future surveys can be managed more effectively and efficiently to achieve the study objectives.

### 7.1 Recommendations to Improve Future R&D Surveys

1. **Sampling Frame.** It is recommended that discussions are held with DOSM to resolve the following issues related to the R&D BE Sampling Frame on matters related to having a standardised definition for R&D as well as on the sampling frame. If administrative data is added to the survey data, it should be provided at the firm level, so that disaggregated analysis can be undertaken. A consolidated sampling frame will contribute to higher reliability and accuracy of the sample and will improve on the efficiency of the survey.
2. **R&D BE Sampling Frame cut-off.** The BE R&D sampling frame for the 2017 R&D Survey was based on the cut-off R&D expenditure of RM1,000 and above. Findings from the survey however, uncovered that many small establishments did not have R&D activities, and this affected the efficiency of data collection. It follows that there is a need to increase the cut off to a higher level for defining the BE population coverage.

It is recommended that the threshold of RM1,000 be increased to a higher level. The 2017 R&D Survey results show that most of the R&D funding start with at least RM50,000 (firm

level). Although RM1,000 will provide a great sweep of firms, in essence, more firms may be included in the sample, but they are unlikely to have R&D activities. A higher threshold will contribute to future surveys being more efficient and effective.

3. **Firm Level Data.** It is recommended that future surveys be given access to firm level data from previous surveys to enable a second layer of checks (especially quality assurance) to be conducted. In any survey, one can surely find data that does not fit in with expectations, e.g. strata jumpers. Thus, it is important to ask questions that did not fit in with the assumptions, e.g. why R&D funding or expenditure increased in some firms but decreased in others or why amounts varied from year to year, etc. Without firm level data, detailed analysis cannot be undertaken and trends or characteristics covered. The condition that must accompany this access is a non-disclosure agreement.
4. **Survey Channels.** It is recommended that future surveys allow for multiple survey channels to be provided for respondents to complete the questionnaire. This survey has found that the respondents capacity for online survey is high, but some respondents are less familiar with an online approach and may want more traditional methods, such as telephone or face-to-face interviews. The latter would have greater demand in the less urban areas. Over-time, it is anticipated that the online approach would see greater usage.
5. **Improving future R&D surveys.** It is recommended that future surveys ask specific questions on shortfalls and shortages of R&D personnel. While the Frascati Manual may have provided the basic questions on human resources, more detailed questions of the Malaysian context will help inform on the demand and supply plus quality of the R&D personnel. Again, the issue is to have better knowledge of R&D in future surveys in order to better inform on the formulation of R&D as well as HRD policies. In addition, all data to be included in the R&D survey must conform strictly to the Frascati Manual's definition in order to get an accurate situational profile and analysis.
6. **Differentiating between R&D and Innovation.** Taking caution from the UNESCO study, it is vital to separate innovation from R&D, given the importance of innovation in the Malaysian context. The EE frame and the sub-frame created for this R&D Survey have full and complete documentation of the characteristics and definitions for R&D, which is an important element in the 2017 R&D Survey. Although data from administrative sources is important to include in any R&D survey, it is vital to ensure that they adhere to the criteria in order to give a true impression of the state and condition of R&D in the country.

## 7.2 Recommendations to Improve R&D Strategy

1. **R&D incentives.** It is recommended that the R&D incentive scheme undergo an evaluation as many firms have commented that the application process is burdensome and decisions take too long while others say that it was not suitable for their needs. While these may be general comments, a closer assessment will provide better grasp of the gap between the goals (more R&D) and the means (incentives). It should also be noted that some of the R&D incentives also allow non-R&D activities to enjoy the incentives. For example, the Science and Techno Fund (MOSTI) allow patents filed to be included as activities to receive funding. Clearly, this kind of activity is not within the Frascati Manual's definition of R&D. It is proposed that a more detailed study of the R&D incentive scheme be undertaken to get behind the issues raised in this survey, which is not peculiar to the 2017 R&D Survey but also mentioned in earlier R&D surveys.
2. **Allocation for open access journal publications.** To get wider recognition, research articles need to be published in open access journals. By making available research findings

in the open access domain, the impact of research can be maximised. However, publication fees or article processing charge (APC) are expensive. The APC for high impact journals can be as high as over USD5,000<sup>9</sup>. It is recommended for Malaysian research grants to include APC allocation in open access journals to boost recognition of Malaysian R&D.

3. **Foster R&D collaboration.** This R&D survey has also highlighted the matter that most of the R&D takes place within the same organisation, whether it is BE, GRI, HLI and also NGO. The trend in the R&D world is collaboration and building of research networks mainly due to the fact that fewer and fewer research institutions have all the requisite skills to apply to their research projects. The findings of this R&D survey show the lack of collaboration by all the organisations, whether BE, GRI or HLI. They also mention difficulties in collaboration but as this is a survey it was not possible to go into details. It is proposed that a special study be undertaken to examine this issue. The supply and demand for collaborative efforts in R&D need to be brought closer together. The example of CREST (Collaborative Research in Engineering, Science and Technology) should be highlighted as this represents an excellent example of tripartite entities (Government, private sector and universities) focussing R&D activities on specific industrial problems and issues. An evaluation of CREST should be done, and the shortcomings addressed and then escalated in other sectors (beyond E&E).
4. **Strengthen Intellectual Property Rights.** Some firms have called for stronger protection of intellectual property. As IPR is about the commercial value of the IP and the market that it is lodged in, this matter needs further study. It is unclear whether the problem is about the cost of obtain IP (i.e. incentives are provided by the Government but firms do not know of its existence) or something more serious, e.g. inability to file good patent applications (the problem of legal firms and institutions providing good IP services) resulting in a lack of proper protection. As with other issues, a detailed study is necessary with experts designing specific surveys to unravel the problem.
5. **Deepen R&D skills and talent.** A common theme that emerged in both the internal and external limitations has been the lack of skills and personnel. Firms and institutions in all the four sectors, BEs, GRIs, HLIs and also NGOs, all cite this problem. Currently, HLIs hire R&D staff through contracts that are based solely on R&D funding. When the funding stops, R&D staff are let go. Hence, R&D funding can help support temporary R&D staff but without long term security and tenure. It is vital that the current situation of human resource in R&D be revisited in a holistic manner (perhaps with funding obligations) in order to create a more conducive environment for recruiting, retaining and building the capacity of R&D staff. This is not a new issue but no long-lasting solution has been found to address this issue, and to develop R&D skills and talent in a systematic and comprehensive manner.
6. **Better R&D Communications.** It is recommended that a strategy is developed for better R&D communications in order to ensure that journalists, writers, and even the public is able to appreciate the differences between R&D, innovation, technological advancement, and other terminologies. Better communications would be able to foster better understanding and it would enable the public to understand the rationale and reasons for better policy formulation and implementation. The communications strategy should be aimed not only at the public, but also industry as they provide data for this effort, and the expectation is that it will lead to better data collection in the future. The Government and their officers should also be a target as they formulate policies and programmes to advance the policies that would enable Malaysia to compete more effectively.

---

<sup>9</sup> Elsevier (2018). Open Access Price List. Retrieved from [https://www.elsevier.com/\\_data/promis\\_misc/j.custom97.pdf](https://www.elsevier.com/_data/promis_misc/j.custom97.pdf)

- 7. More Effective R&D Governance.** It is recommended that the 11MP strategy for a Research Management Agency be implemented soon. This recommendation was made earlier in the National R&D 2016 Survey report. This Agency can review the recommendations made in this report and if considered appropriate, set up implementation plans to achieve the R&D goals for Malaysia.

In conclusion, the 2017 R&D Survey achieved its objectives, which are to collect comprehensive data and statistics on the nation's R&D activities, analyse the characteristics and trends and level of its achievement, and situate that within the context of the nation's development, compare Malaysia's R&D performance with the same in other countries, conduct diagnostic analysis of the data, and make recommendations for future R&D surveys based on the experience and outcome of this survey.

**REFERENCES**

Elsevier (2018). Open Access Price List. Retrieved from [https://www.elsevier.com/\\_data/promis\\_misc/j.custom97.pdf](https://www.elsevier.com/_data/promis_misc/j.custom97.pdf)

Kementerian Sains, Teknologi dan Inovasi (MOSTI) (2016). The National Policy on Science, Technology & Innovation (NPSTI). Retrieved from <https://mastic.mestecc.gov.my/ms/sti/kandungan-sti/row/dasar-sti/dasar-sains-teknologi-dan-inovasi-negara>.

National Survey of Research and Development (R&D) in Malaysia, various years

Nobelius, D. (2004). Towards the Sixth Generation of R&D Management. *International Journal of Project Management*, 22, 369-375.

Schimpf, S. (2016). Crowdsourcing, Digitisation and Acceleration: Is Corporate R&D Disrupting Itself?, R&D Management Conference 2016 "From Science to Society: Innovation and Value Creation" 3-6 July 2016, Cambridge, UK.

Ubell, R. (1997), The changing R&D Information Economy in the Digital Age. CENDI.97-3.



**ACRONYMS**

<b>11MP</b>	Eleventh Malaysia Plan 2016-2020
<b>APC</b>	Article Processing Charge
<b>BEs</b>	Business Enterprises
<b>BERD</b>	Business Expenditure on R&D
<b>CREST</b>	Collaborative Research in Engineering, Science and Technology
<b>DOSM</b>	Department of Statistics Malaysia
<b>EE Frame</b>	Establishment and Enterprise Frame
<b>EPO</b>	European Patent Office
<b>FOR</b>	Field of Research
<b>FTE</b>	Full-time Equivalent
<b>GERD</b>	Gross Domestic Expenditure on R&D
<b>GDP</b>	Gross Domestic Product
<b>GLC</b>	Government-Linked Company
<b>GRI</b> s	Government Research Institutes
<b>HLI</b> s	Higher Learning Institutions
<b>HRD</b>	Human Resources Development
<b>ICT</b>	Information, Computer and Communication Technology
<b>IP</b>	Intellectual Property
<b>IPR</b>	Intellectual Property Rights
<b>KPI</b>	Key Performance Indicator
<b>MASTIC</b>	Malaysian Science and Technology Information Centre
<b>MDEC</b>	Malaysia Digital Economy Corporation
<b>MESTECC</b>	Ministry of Energy, Science, Technology, Environment and Climate Change
<b>MNC</b>	Multi-National Company
<b>MOSTI</b>	Ministry of Science, Technology & Innovation
<b>MRDCS</b>	Malaysian Research and Development Classification System
<b>NGOs</b>	Non-Governmental Organisations
<b>NPSTI</b>	National Policy on Science, Technology and Innovation
<b>OECD</b>	Organisation for Economic Co-operation and Development
<b>PhD</b>	Doctor of Philosophy
<b>QC</b>	Quality Control
<b>R&amp;D</b>	Research and Development
<b>2017 R&amp;D Survey</b>	National Survey of Research and Development (R&D) in Malaysia 2017
<b>SEO</b>	Socio-economic Objective

<b>ST</b>	Strategic Thrust
<b>STI</b>	Science, technology and innovation
<b>UK</b>	United Kingdom
<b>UNESCO</b>	United Nations Educational, Scientific and Cultural Organization
<b>USA</b>	United States of America
<b>USPTO</b>	United States Patent and Trademark Office
<b>WIPO</b>	World Intellectual Property Organisation
<b>WoS</b>	Web of Science



**KEMENTERIAN TENAGA, SAINS, TEKNOLOGI,  
ALAM SEKITAR DAN PERUBAHAN IKLIM**  
MINISTRY OF ENERGY, SCIENCE, TECHNOLOGY, ENVIRONMENT & CLIMATE CHANGE

Ministry of Energy, Science, Technology, Environment & Climate Change (MESTECC)  
Malaysian Science and Technology Information Centre (MASTIC)  
Level 1 - 7, Block C4 & C5, Complex C  
Federal Government Administrative Centre,  
62662 WP Putrajaya, Malaysia.

Telephone : 603-8000 8000  
Fax : 603-8888 9070  
Email : [enquiry@mestecc.gov.my](mailto:enquiry@mestecc.gov.my)  
URL : [www.mestecc.gov.my](http://www.mestecc.gov.my)



@mestecc



@mestecc



@MyMESTECC



One Mestec