# 2017

# SCIENCE OUTLOOK

Academy of Sciences Malaysia

# SCIENCE OUTLOOK

## Converging Towards Progressive Malaysia 2050

Version 2

AKADEMI SAINS MALAYSIA

**SCIENCE OUTLOOK 2017**
Research and Policy Recommendations Document



**Academy of Sciences Malaysia**
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# FOREWORD

by **President,**
Academy of Sciences Malaysia

The Academy of Sciences Malaysia (ASM) carries a mandate to address the needs of the nation by providing the best scientific advice and advocacy that is independent, credible, relevant and timely. In order to effectively carry out this role, ASM undertakes strategic STI studies on sustainability science, emerging technologies, socio-economics and Malaysia 2050 among others to facilitate evidence-based, informed decision making. In recent years, ASM's championing of STI advancement for national development and global competitiveness has steadily gained momentum and influence as well as drawn various strategic partners.

The Science Outlook is one of the flagship studies of ASM that aims to present insights supported by relevant data on Malaysia's STI landscape. In addition, strategic interventions and investments concerning STI are also recommended for the short, medium and long term STI planning. These inputs reflect the views of the scientific community and complement key national initiatives.

In tracking Malaysia's progress in STI, the Science Outlook study by ASM also serves as a monitoring and evaluation exercise. This has paved the path for several key platforms of engagement and drawn opportunities for collaboration with government ministries and agencies, industry players, researchers and civil society. This has also enabled the spearheading of important national initiatives such as the formulation of the STI Master Plan, National STEM Action Plan (2018-2025), review of the current National Science, Technology and Innovation Policy (2013-2020) (NPSTI) along with the formulation of the new NPSTI (2020-2030) and establishment of the National STEM Centre.

Data is critical for an objective evaluation and analysis of our current STI position, capacity and capabilities towards realising desired outcomes. I am pleased to note that for the 2017 edition of the Science Outlook, ASM has seen an increase in data that can be accessed and analysed in particular through our strategic partners including government ministries and agencies. However, the challenge of obtaining comprehensive data in particular on specific aspects related to STI still remains. I hope moving forward, the science outlook can inspire a culture of trust and data sharing through transformative thinking and catalytic actions across all sectors and knowledge domains.

I wish to take this opportunity to thank all ministries, agencies, organisations, members of the scientific community and industry partners that have contributed in one way or another towards making this study possible. I wish to thank Professor Dr Halimaton Hamdan FASc., the Chairperson of the Science Outlook study for her leadership, all Working Group Chairs and members for your valuable contribution, the ASM Management team and all Analysts for your diligence and dedication towards carrying out this study and producing this report.

I hope this report would serve as a useful reference for national STI planning as well as effective monitoring and evaluation. The uptake and implementation of the proposed strategies calls for effective collaboration, coordination and commitment. I am confident that if all parties work together in the spirit of national interest, we can successfully mainstream STI in nation building and converge towards a Progressive Malaysia 2050.

**Professor Datuk Dr Asma Ismail FASc**

# PREFACE

by **Chairperson,**
Science Outlook 2017

Mainstreaming Science, Technology and Innovation (STI) at all levels and sectors is recognised as the key enabler to catalyse productivity, enhance competitiveness and promote inclusive growth. In order to realise Malaysia's aspiration of becoming one of the top innovation-led nations in the world, we have no choice but to increase STI proficiency and transform the way STI is coordinated and propelled in Malaysia. As such, the theme for this Science Outlook 2017 is 'Converging towards Progressive Malaysia 2050'.

The first edition of the Science Outlook report by ASM in 2015 has contributed to a reignited focus on STI governance and emphasis on science, technology, engineering and mathematics (STEM) education. Undoubtedly, there have been on-going efforts by the Government to enhance the STI landscape in Malaysia. These efforts are tracked in the Science Outlook 2017 based on the six thrusts of the National Policy on Science, Technology and Innovation 2013-2020 (NPSTI) namely STI Governance, Research, Development and Commercialisation, STI Talent, Energising Industries, STI Enculturation and Strategic International Alliances.

The Science Outlook 2017 upholds the principle of an evidence-based approach to ascertain where we are in STI as a nation, identifying gaps in relation to where we want to be in the future, s tudying best practices and transformation trajectories of other competitive nations as well as providing forward thinking prescriptions to ensure our aspirations can be realised.

Multiple forms of methodology for data collection and analysis have been employed in this study. These methods may not be exhaustive, but are sufficient to draw insights and perspectives on Malaysia's STI landscape. The views and opinions presented in this Science Outlook are substantiated with verified facts, figures, primary as well as secondary research findings, case studies and inferences. I hope that having all related input compiled in one strategic document offering timely insights would be a valuable reference for all stakeholders.

I cannot overemphasise the importance of data for the science outlook study considering that it is evidence-based. While we have seen improvement in terms of access to data, at the same time we found that obtaining comprehensive and specific data related to STI was a challenge. Data is power and we urgently need to address the way STI data is collected, stored, tracked, integrated, analysed and interpreted in Malaysia. It calls for collaborative efforts as we have pockets of data everywhere with multiple custodians but consolidated national level data is difficult to obtain.

On behalf of ASM, I would like to thank all Working Group Chairs and members, industry practitioners, researchers, analysts and writers for their tireless efforts in making this Science Outlook possible. We are hopeful that this document will go beyond just raising awareness amongst various stakeholders to taking requisite action to enhance the STI landscape in Malaysia.

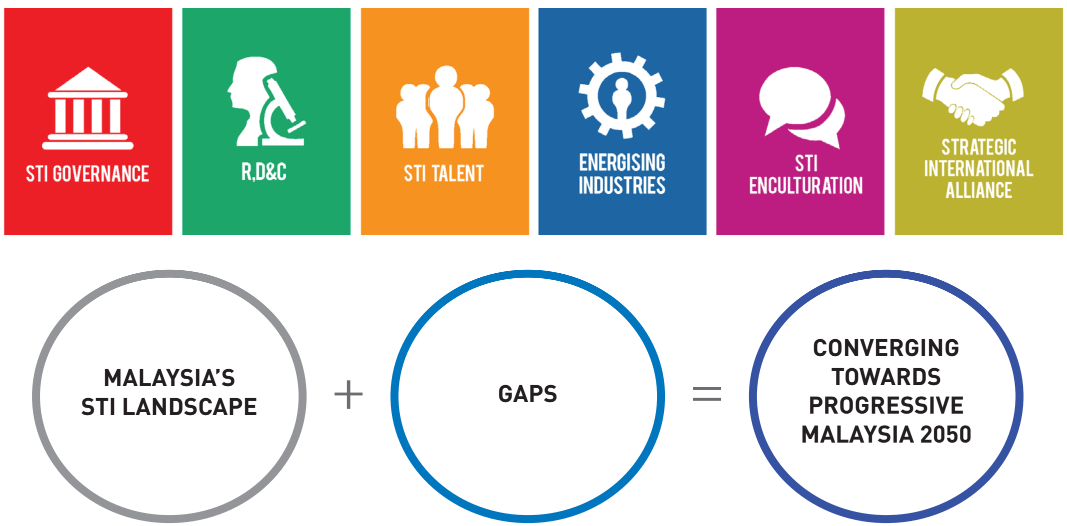
**Professor Datuk Dr Halimaton Hamdan FASc**

## Conduct of Study

The second edition of the Science Outlook, Science Outlook 2017 – Converging Towards Progressive Malaysia 2050, anchored by the Academy of Sciences Malaysia (ASM) continues to provide an independent analysis and consolidated review on the key Science, Technology and Innovation (STI) trends and developments in Malaysia. This study aimed at providing evidence-based insights and new perspectives on the Malaysian STI landscape based on the six strategic thrusts of the NPSTI believed to contribute to a robust STI ecosystem).

This biennial report goes by the philosophy of measuring and evaluating where Malaysia is in its science, technology and innovation landscape. The findings of the report was then benchmarked with other economies to identify the gaps, consider future implications and suggest way forward based on existing best practises in order to realise the nation's vision of converging towards a progressive Malaysia by 2050.

Methodology - The Science Outlook's methodology is based on a quantitative and qualitative approach towards providing evidence of the dynamics of STI and the impact of STI activities. The process includes review of the current status and the outlook through desktop research, stocktaking exercises to study key trends and challenges in STI, data gathering, stakeholder engagements and international peer reviews.




- Stocktaking
- Study key trends and challenges
- Data gathering
- International reviewers

- Identify indicators
- Benchmarking
- Evaluation
- Analysis

- Way forward
- Towards evidence based informed decision making
- Future implications
- Recommendations

The process of this report emphasizes on:

- Collection of both primary and secondary data based on the specific outline of each focus areas;
- Identification of trends, challenges and opportunities in global STI development through systematic horizon scanning;
- Modelling, mapping or systemic evaluation of the current state of science and scenarios
- Two-pronged stakeholder engagement exercises to extract relevant information and to encourage early buy-in
- Data analyses and compilation
- Independent review by local and international science policy experts for verification of the information.

Science Outlook emphasises on a practical approach, well grounded in reality and supported by evidence through research, feedbacks, global trends and best practices. It aims at informing stakeholders and policy-makers of STI on recent developments and anticipated changes in the trends, patterns as well as future implications for national STI development in view of the current national and global socio-political and economic climate. For an all-encompassing report we had a series of engagements with various members of the quadruple helix; government, academia, civil societies (NGO, business chambers etc.) and industry players.

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# Acronyms /Abbreviations

| | |
|---|---|
| AAC | ASEAN Coordinating Centre for Transboundary Haze Pollution Control |
| AASA | Association of Academies of Sciences in Asia |
| AATHP | ASEAN Agreement on Transboundary Haze Pollution |
| ACCF | ASEAN-China Cooperation Fund |
| ADF | ASEAN Development Fund |
| AERS | Agriculture, Environmental and Related Studies |
| AFEO | ASEAN Federation of Engineering Organization |
| AIF | ASEAN-India Fund |
| AIM | Agensi Inovasi Malaysia |
| AISTOF | ASEAN-India Science & Technology Development Fund |
| AMED | Asia-Middle East Dialogue |
| AMIC | Aerospace Malaysia Innovation Centre |
| AMMST | ASEAN Ministerial Meeting on Science and Technology |
| AMS | ASEAN Member States |
| APEC | Asia-Pacific Economic Cooperation |
| ARIC | ASEAN-Republic Korea Innovation Centre |
| ASEAN | Association of Southeast Asian Nations |
| ASEAN COST | ASEAN Committee on Science and Technology |
| ASEM | Asia-Europe Meeting |
| ASM | Academy of Sciences Malaysia |
| ASTC | Association of Science-Technology Centres |
| ASTIF | ASEAN Science and Technology Fund |
| ATCM | Antarctic Treaty Consultative Meeting |
| BE | Business Enterprise |
| BERD | Business Enterprise Expenditure Research and Development |
| BNM | Bank Negara Malaysia |
| BRICS | Brazil, Russia, India, China and South Africa |
| CARIF | Cancer Research Initiatives Foundation |
| CAV | Connected Autonomous Vehicles |
| CERN | European Organisation for Nuclear Research |
| CHOGM | Commonwealth Heads of Government Meeting |
| CIDB | Construction Industry Development Board |
| CNPSTI | Council for Science, Technology and Innovation |
| COL | Critical Occupation List |
| Conf/ Proc | Conference/Proceedings |
| CREST | Collaborative Research in Engineering, Science and Technology |
| CSA | Chief Scientific Advisers |
| CSPO | Certified Sustainable Palm Oil |
| CSR | Corporate Social Responsibility |
| DFTZ | Digital Free Trade Zone |
| DOSM | Department of Statistics Malaysia |
| E&E | Electrical and Electronics |
| EEV | Energy-Efficient Vehicle |
| ENGO | Environmental NGO |
| EPU | Economic Planning Unit |
| ERT | Engineering and Related Technologies |
| ETH | Swiss Federal Institutes of Technology |
| ETP | Economic Transformation Programme |
| Exco | Executive councillors |
| FDI | Foreign direct investment |
| FEALAC | The Forum for East Asia –Latin America Cooperation |
| FMM | Federation of Malaysian Manufacturers |
| FTA | Free Trade Agreement |
| FTE | Full-time equivalent |
| G2G | Government to Government |
| GAIN | Global Acceleration and Innovation Network |
| GBS | Global Business Services |
| GCSA | Government Chief Scientific Adviser |
| GDP | Gross domestic product |
| GERD | Gross Domestic Expenditure on Research and Development |
| GLC | Government-Linked Company |
| GSIAC | Global Science and Innovation Advisory Council |
| GVC | Global Value Chains |
| HCL | Healthier Choice Logo |
| HESA | Higher Education Statistics Agency |
| Hi-CoE | High-impact Centre of Excellence |
| HICOM | Heavy Industries Corporation of Malaysia |
| HIP | High Impact Programmes |
| HOTS | Higher Order Thinking Skills |
| IAEA | International Atomic Energy Agency |
| IAMP | Inter Academy Medical Panel |
| IAP | Inter Academy Partnership |
| IBSE | Inquiry-Based Science Education |
| ICGEB | International Centre for Genetic Engineering and Biotechnology |
| ICSU | International Council for Science |
| ICT | Information and Communications Technology |
| IDFR | Institute of Diplomacy and Foreign Relations |
| IGCSE | International General Certificate of Secondary Education |
| IHL | Institutions of Higher Learning |
| IIASA | International Institute for Applied Systems Analysis |
| IIUM | International Islamic University Malaysia |
| ILMIA | Institute of Labour Market Information and Analysis |
| IMP | Industrial Master Plans |
| INIR | Integrated Nuclear Infrastructure Review |
| IoT | Internet of Things |
| IPBES | Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services |
| IPG | Institute of Teacher Education / Institut Pendidikan Guru |
| IR4.0 | Industrial Revolution 4.0 |
| IRC | International Rice Commission |
| ISRAS | International Silk Road Academy of Sciences |
| ISTIC | Institute of Science, Technology and Innovation Centre for South-South Cooperation |
| IT | Information Technology |
| JAIF | Japan –ASEAN Integration Fund |
| JAIST | Japan Advanced Institute of S & T |
| JICA | Japan International Cooperation Agency |
| JKPDA | Jawatan Kuasa Pelaburan Dana Awam |
| JMM | Jabatan Muzium Malaysia |
| JPA | Public Service Department / Jabatan Perkhidmatan Awam |
| JST | Japan Science and Technology |
| KAST | Korean Academy of Science |
| KECV | Kenyir Elephant Conservation Village |
| KI | Knowledge Intensive |
| KIST | Korea's Institute of Science and Technology |
| KISTEP | Korean Institute of Science, Technology and Evaluation Planning |
| LCSMEPP | Large Cooperation-SME Partnership Programme |
| LRGS | Long Term Research Grant Scheme |
| M&E | Machinery and Equipment |
| M2M | Machine to Machine |
| MAHA | Malaysia Agriculture, Horticulture & Agrotourism festival |
| MARDI | Malaysian Agricultural Research and Development Institute |
| MASCO | Malaysia Standard Classification of Occupations |
| MASTIC | Malaysian Science and Technology Information Centre |
| MATRADE | Malaysia External Trade Development Corporation |
| MBOT | Malaysian Board of Technologists |
| MCMC | Malaysian Communications and Multimedia Commission |
| MCMM | Ministry of Communications and Multimedia Malaysia |
| MDEC | Malaysia Digital Economy Corporation |
| MDG | Market Development Grant |
| MEEPA | Malaysia-European Free Trade Association Economic Partnership Agreement |
| MEKAR | Persatuan Khazanah Rakyat Ma'Daerah |
| MIDA | Malaysian Investment Development Authority |
| MIDF | Malaysian Industrial Development Finance |
| MiGHT | Malaysian Industry-Government Group for High Technology |
| MIST | Mexico, Indonesia, South Korea and Turkey |

| | |
|---|---|
| MIT | Massachusetts Institute of Technology |
| MITI | Ministry of International Trade and Industry |
| MLS | Multilateral System |
| MNC | Multinational Corporation |
| MOE | Ministry of Education |
| MOH | Ministry of Health |
| MOHE | Ministry of Higher Education |
| MOSTI | Ministry of Science, Technology and Innovation |
| MRU | Malaysian Research Universities |
| MSC | Multimedia Super Corridor |
| MTCP | Malaysian Technical Cooperation Programme |
| MTDC | Malaysian Technology Development Corporation |
| MTUN | Malaysian Technical University Network |
| MyIPO | Intellectual Property Corporation of Malaysia |
| MyRA | Malaysian Research Universities Assessment |
| MyTIC | Malaysian Technological Innovation Capability |
| NADMA | National Disaster Management Agency Malaysia |
| NAM | Non-Aligned Movement |
| NANOCAT | Nanotechnology and Catalysis Research Centre |
| NANOMITE | Malaysia Institute for Innovative Nanotechnology |
| NBC | National Bioeconomy Council |
| NEM | New Economic Model |
| NetASA | Network of ASEAN Science Academies |
| NGO | Non-governmental organisation |
| NIC | National Innovation Council |
| NKEA | National Key Economic Areas |
| NPANM III | 3rd National Plan of Action for Nutrition of Malaysia, 2016-2025 |
| NPS | Natural and Physical Sciences |
| NRF | National Research Foundation |
| NSC | National Science Council |
| NSF | National Science Foundation |
| NSRC | National Science & Research Council |
| NSTC | National science and technology councils |
| NUOF | Newton-Ungku Omar Fund |
| NUS | National University of Singapore |
| NYAS | New York Academy of Sciences |
| ODA | Official Development Assistance |
| OECD | Organisation for Economic Co-operation and Development |
| OIC | Organisation of Islamic Cooperation |
| OSA | Office of the Science Advisor |
| PAJSK | Physical Activity, Sports and Co-curriculum Assessment / Penilaian Pentaksiran Aktiviti Jasmani Sukan & Kokurikulum |
| PBD | Classroom Assessment / Penilaian Bilik Darjah |
| PEKA | Practical Skill Assessment / Penilaian Kemahiran Amali |
| PhD | Doctor of Philosophy |
| PlaTCOM | Platform Technology Commercialisation |
| PMO | Prime Minister Office |
| PMR | Penilaian Menengah Rendah |
| Post-Doc | Post-doctoral |
| PPRN | Public Private Research Network |
| PPsi | Psychometric Assessment / Pentaksiran Psikometrik |
| PPSTI | Policy Partnership on Science, Technology & Innovation |
| PRI | Public Research Institute |
| PROTON | Perusahaan Otomobil Nasional Berhad |
| PSA | Pacific Science Association |
| PSC | Parliamentary Select Committee |
| PSDC | Penang Skills Development Centre |
| PSNCWU | Pusat Sains Cawangan Utara |
| PSNKL | Pusat Sains Negara Kuala Lumpur |
| PT3 | Penilaian Tahap Tiga |
| PTD | Diplomatic Service Officers |
| R&D | Research and development |
| R,D&C | Research, development, and commercialisation |
| RCNN, ITB | Research Center for Nanosciences and Nanotechnology, Institute of Technology Bandung |
| RIE | Research, Innovation and Enterprise |
| RIEC | Research, Innovation and Enterprise Council |
| RMA | Research Management Agency |
| RMK /MP | Malaysia Plan |
| RoI | Return on investment |
| RSPO | Roundtable on Sustainable Palm Oil |
| RU | Research Universities |
| S&T | Science and technology |
| S2A | Science to Action |
| SAB | Scientific Advisory Board |
| SAGE | Scientific Advisory Group for Emergencies |
| SATREPS | Japan Science and Technology Agency |
| SBC | Sarawak Biodiversity Centre |
| SCA | Science Council of Asia |
| SCAR | Scientific Committee on Antarctic Research |
| SCENIC | SME Central Incentives System |
| SCJ | Science Council Japan |
| SCMSAT | Sub-Committee on Marine Science and Technology |
| SEF | Services Export Fund |
| SL1M | Skim Latihan 1Malaysia |
| SLSAM | Soft Loan Scheme for Automation and Modernisation |
| SME | Small and Medium Enterprise |
| SMEIPA | SME Integrated Plan of Action |
| SOP | Standard operating procedure |
| SPM | Sijil Pelajaran Malaysia |
| SRI | Strategic Reform Initiatives |
| SSC | South-South Cooperation |
| STEM | Science, Technology, Engineering and Mathematics |
| STI | Science, technology and innovation |
| TCA | Technology Commercialisation Agency |
| TCDC | Technical Cooperation among Developing Countries |
| TERAJU | Unit Peneraju Agenda Bumiputera |
| TIMMS | Trends in International Mathematics and Science Study |
| TIV | Total Industry Volume |
| TLOs | Technology Licensing Offices |
| TPM | Technology Park Malaysia |
| TPP | Trans-Pacific Partnership |
| TTO | Technology Transfer Office |
| TVET | Technical and Vocational Education and Training |
| TWAS | The World Academy of Sciences |
| UIG | University-Industry-Government |
| UK | United Kingdom |
| UKM | Universiti Kebangsaan Malaysia |
| UM | Universiti Malaya |
| UN | United Nations |
| UNESCAP | United Nations Economic and Social Commission for Asia and the Pacific |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UPM | Universiti Putra Malaysia |
| UPSR | Ujian Penilaian Sekolah Rendah |
| USA | United States of America |
| USM | Universiti Sains Malaysia |
| USSR | Union of Soviet Socialist Republics |
| UTM | Universiti Teknologi Malaysia |
| WAITRO | The World Association of Industrial and Technological Research Organisation |
| WEF | World Economic Forum |
| WHO | World Health Organisation |
| WIPO | World Intellectual Property Organization |
| WTO | World Trade Organization |
| YPASM | Yayasan Penyelidikan Antartika Sultan Mizan |

# Executive Summary

## Converging towards Progressive Malaysia 2050

Over the past 50 years Malaysia has transcended from an economy that heavily relied on primary commodities to one which is now driven by high-tech manufacturing and Foreign Direct Investments (FDI). The economy now is geared towards global collaborations to tap on current knowledge and innovations. A sustainable and inclusive developed economy in the 21st century is driven by knowledge capital that fuels technological innovations that are the basis of high value-added enterprises. The various prosperity and development programmes introduced by the Government such as Economic Transformation Programme (ETP) and National Key Economic Areas (NKEA) are founded upon the utilisation of science, technology, and innovation (STI) as the engine of growth. In tandem, Malaysia's aspiration to become an advanced nation can only be realised if Malaysians are a progressive and innovative society.

Although Malaysia's growth has been steady, the STI development however has not shown much satisfactory trajectory in comparison to developed nations. In 1986, the First National Science and Technology Policy was formulated and included as a distinctive strand within the Fifth Malaysia Plan (1986–1990). This was followed by other similar action plans, culminating with the NPSTI (2013-2020) – all with the goal of leveraging on STI for inclusive socio-economic transformation. Is Malaysia still playing catch-up?

It is vital to examine the outcomes of these policies, what have been the most significant hurdles to date, what new challenges that are expected to crop up during the transformation period into becoming an advanced economy, and what possible course correct interventions will needed. The Science Outlook 2017 continues to present an objective independent review of the outcome of these policies in building Malaysia's STI capabilities and capacity against international benchmarks. The analyses provided in the Science Outlook 2017 Report are supported with new data collated from the various STI stakeholders in the country, from ministries and agencies, to corporate entities, researchers and policy makers. It also examines if and how the recommendations in Science Outlook 2015 have been implemented, and whether these actions have made an impact on the STI landscape in Malaysia.

Although Malaysia has only begun to make serious public investment in building an STI ecosystem for high technology industry and knowledge-based economy in the past three decades, the Government is committed to implement strategic policies to build the country's R,D&C capacity and capabilities in both the public and private sectors. This is done through establishing a competent and efficient STI governance, strengthening stakeholder network to facilitate resources and expertise sharing through dependable platforms, and building R,D&C infrastructure for strategic national, regional and international STI collaborations. Malaysia has the potential of developing world-class scientific innovations to benefit the country and global denizens; we just need to ensure that we deploy our ideas, talent, and resources effectively and efficiently.

# 01

## Is the STI Ecosystem Well-Coordinated?

Malaysia is one of Asia's remarkable success stories. Its economic and social development since independence has been impressive. As in many developing countries, in Malaysia the process of modernization is generally understood as to unleash the productive power of science and technology into society and to fuel economic growth for well-being.

STI Governance, the first focus area of this study is especially important in understanding the complexity of actors and entities in the STI landscape. Well informed and independent STI governance plays the primary role in STI development of a country. The actors in the STI Governance like any Governance comprises of the Government and its machinery.

The accountability of the Government is supported by responsive participation from the private sector, academia and civil societies in charting the STI future of the country through mutual sharing of information and exchange of experiences. A strong and stable STI Governance will have the competency and capacity to chart a sustainable orientation through a robust STI ecosystem for the future generation. Good STI Governance overseeing the entirety of the STI ecosystem is paramount as it deals with the public's money for good science to create wealth for its people.

Malaysia's STI landscape unlike countries like the UK and Singapore is multifaceted characterised by the variety of institutions ranging from ministries, agencies, to government-linked corporations. As of December 2017, there are 48 active national STI-related policies in place; and for most the implementation and monitoring is not measured. The national STI landscape overarches 23 Federal Ministries.

There are 26 STI-related national Councils; 10 of these Councils are chaired by the Prime Minister, while the other 16 are chaired by respective Ministers. Six intermediaries are in place to develop and intensify industry-academia collaboration are carried out through. A lot of initiatives are also mirrored under the Prime Minister's Department or Central Agency. There are more than 160 STI-related agencies, foundations, institutes, statutory bodies and companies under respective ministries of which at least 16 are under the Prime Minister's Department.

The plethora of entities engages in every facet of STI policy making and, funding and implementation. Each organisation in the STI landscape is with its own objectives, strategic framework and policy instruments. The multiple stakeholders and support instruments have led to fragmentation of resources, overlapping competencies, and the risk of redundancy resulting in ineffective wealth creation and decision making. The fragmented landscape of the STI ecosystem at present causes inefficiency and dysfunction in the service delivery to support a strong innovation ecosystem.

One of the key components of any STI management cycle is monitoring and evaluation. At present Malaysia's STI management cycle is a fragmented wheel. STI cross-cuts but monitoring activities are only conducted by the ministries for its respective policies. The gaps in the cycle are also caused by components placed under the domain of different agencies. Therefore, alignment of national STI actors through a rationalisation exercise is proposed to be carried for better coordination, monitoring and evaluation and a leaner, empowering and efficient STI Governance.

The National Science Council (NSC) established with the purpose of streamlining the various STI-related councils and act as the apex STI advisory body in the country is chaired by the Prime Minister. It is a step forward for STI Governance in Malaysia as for the first time 12 Ministers from relevant Ministries come together to discuss STI matters. The representation at the NSC however should be more holistic, comprising key public and private sectors players in order to have an all-inclusive view on implementation progress and issues, and to evaluate new development in the STI landscape. In order to remain sustainable the NSC ideally should be backed up by a legislative mandate and a dedicated and empowered secretariat. Such an entity is missing in our landscape.

At present in Malaysia, the NSC secretariat support comes largely from the Office of Science Advisor to the Prime Minister and the Policy and Strategic Planning Division of MOSTI which also has 14 other functions under its portfolio. A central council such as the NSC requires a more robust bureaucratic intelligentsia - perhaps an aptly named Science Planning Unit (SPU) - to effectively carry out all that has been outlined in its mandate.

A full-time role of the secretariat with often monitoring and evaluation of on-going programmes/projects and, deliberation on new proposals before presentations to the NSC will strengthen the apex body. For SPU to achieve its objectives, it must be granted a legitimate, legislative mandate that is supported with sustainable funding and strategic manpower. Roles and functions of relevant entities can be consolidated to function as a centralised SPU for coordination of planning, monitoring and evaluation of macro STIs as well as working as Secretariat of the NSC.

A National Science Agenda and a STI Masterplan (STIMP) will help in providing the direction for all the players in the ecosystem. At present, neither is in place. A specific national science agenda to serve as the consolidating guideline of the various STI-related policies and governance at present should be developed with an eye to harness STI to achieve Malaysia's aspirations beyond the year 2020. The agenda should nurture an STI ecosystem that supports technological innovations for knowledge-intensive productivity of a high-income nation.

The STIMP outlines the Government's development goals, strategies, parameters, and timeframe to implement the policy framework reflected in the national STI policy will serve as a crucial governance tool to harmonise, consolidate and focus all of the nation's STI-related initiatives and players in consonance with the national aspiration. The STIMP initiative is currently being undertaken by ASM and MOSTI.

Nearly all aspects of national and global development involve STI, underscoring the importance of a dedicated legal structure to facilitate STI governance. Legal instruments such as a Science Act are established to reinforce the Government's and stakeholders' commitment towards STI-related implementation and enforcement. A Science Act will also provide mandate and legislative clout for the NSC and other national STI actors.

A Parliamentary Select Committee (PSC) on STI, made up of a small number of parliamentary members that are appointed should be established. The establishment of PSC on STI is important to build political will and create legislative consensus towards promoting the STI agenda. It will become a formal platform in the parliament to discuss STI issues, supported with expert inputs. Thus, the establishment of the aforementioned committee is important to be included and mandated in the Science Act.

Effective delivery and coordination of STI governance should seamlessly cascade from Federal to State level and vice-versa. This however, requires concerted cooperation between the two. A formal structure with clearly delineated expectations, roles, and supporting network will benefit the development and implementation and coordination of STI Governance in each state.

The lack of effective STI governance in the nation in the last 15 years has caused the state of STI to become retrogressive. In addition, the lack of cross-cutting co-ordination of STI has failed to mainstream STI for socio-economic advancement. STI is usually associated with knowledge generation and technology development. However the direct impact of STI to economic growth has not been well translated in Malaysia.

## Recommendations

### 1. Strengthen Science Planning and Coordination through a Centralised Dedicated Body

Alignment of national STI actors through a rationalisation exercise is proposed to be carried out and a centralised STI body named as the Science Planning Unit (SPU) is proposed to be established under the purview of the Prime Minister's Department. SPU will be the enforcement arm of the NSC with a mandate that transcend all ministries to enable greater stakeholder participation and synchronised planning, coordination and monitoring of STI decisions.

### 2. Establish a Formal STI Platform between Federal and States Governments in West Malaysia as well as Sabah and Sarawak

Effective delivery and coordination of STI governance at federal and state level require concerted cooperation between the two. A formal structure with clearly delineated expectations, roles, and supporting network will benefit the development and implementation of STI policies in each state.



# 02

## How Impactful is RDC towards Socio-Economic Development?

A key element of a robust advanced economy of the 21$^{st}$ century is knowledge capital generated by scientific innovation. This is the underpinning of Malaysia's policies on STI and the Government's commitment to nurture the nation's research, development and commercialisation (R,D&C) ecosystem by synergising public and private stakeholders. A mature scientific innovation system does not happen overnight; intensive investment in research and development (R&D) in Malaysia only began little more than 20 years ago.

At present, R,D&C in Malaysia's public sector are led by public universities and public research institutions (PRIs). Business enterprises (BEs) – both local and foreign owned – also engage in R,D&C to make sure their products and services can command top dollar in the global market. Investment in R,D&C from both the public and private sector in 2015 amounted to RM15 billion (about USD3.54 billion), roughly 20 times higher than in 1996; the outcome of which are measured by the number of publications, patents filed and granted, as well as income generated from patents.

Malaysia's GERD has been on an upward trend over the years; the country's percentage of GERD/GDP is ranked 29$^{th}$ in the Global Innovation Index 2017 at 1.3%. To date, only 19 economies have achieved above the ideal ratio of 2% GERD/GDP. Although BEs are the largest contributing sector to Malaysia's GERD, it is still not comparable to the proportion of top innovative economies. At the moment, the biggest commitment for R,D&C in the private sector is from the multinational corporations (MNCs); very few small and medium enterprises (SMEs) engage in R,D&C.

Malaysia's percentage of GERD spent on basic research is similar to top innovative economies, but differs greatly in applied research and experimental development. Malaysia's high percentage of applied research and extreme low percentage of experimental development indicates the lack of potential for applied research to move to experimental development stage. As a result, only a handful of research can be developed into products and services for commercialisation. This could be caused by the lack of collaboration between university and industry.

The NPSTI (2013-2020) aims to increase the ratio of researchers per 10,000 workforce to at least 70 by 2020 to ensure Malaysia has sufficient R,D&C human resource. The number of researchers full-time equivalent (FTE) in the country has been growing steadily since 2008, reaching 69,864 in 2015. Malaysia is ranked 37th in the number of researchers (FTE) per million population in the Global Innovation Index 2017 report. However, the top 10 economies have 2.5 to 4 times more researchers (FTE) than that of Malaysia, indicating a need for Malaysia to increase the number of researchers to achieve greater R&D intensity.

The majority of Malaysia's researchers are found in universities, in contrast to the high performing economies whose researchers are mostly in BEs. This imbalance in the number of researchers versus funding allocated for their organisation may be another contributing factor to the inefficiency and ineffectiveness of GERD utilisation in Malaysia. Industry-led R,D&C is key to technological innovations that drive the nation's economic expansion. Malaysian industries are not innovating using R,D&C like the top economies, making the country vulnerable to technological seismic shifts that affect the global market.

With the notable exception of Republic of Korea, advanced economies tend to have a longer R,D&C history with entrenched ecosystem for experimental development and commercialisation. Therefore, they understand that investing money and time in experimental development is crucial in innovation-led growth. Lack of investment in experimental development and limited number of researchers in BEs may halt the progression of applied research to commercialisation stage. The innovation ecosystem should be reshaped to encourage BEs to conduct more experimental development and facilitate migration of researchers from IHLs into industry. Gap funds can be introduced as a financial enabler to support researchers in the development of prototypes, hence reducing the risks involved in commercialising technology.

Knowledge-based economy is driven by intellectual assets that provide economic returns. Malaysia is ranked 34th globally in terms of total publication from 1996-2016 based on the SCImago Database; our published documents per researcher average is similar to Japan, but still not comparable to other top innovative economies. The number of patent applied and granted in Malaysia remains low. The reason for this observation should be investigated in order to increase the number of successful patent application.

Although the average expenditure per patent application for Malaysia is on par with Singapore, Singapore's income from the use of intellectual property (USD 18.6 billion) is much higher compared to Malaysia (USD 1.2 billion). This may be because industry-driven R,D&C have a bigger push on productivity with a focus on return on investment. The existing national R,D&C ecosystem must be transformed to explicitly highlight national research priorities and the country's research agenda, as well as strengthening industry-driven R,D&C to produce more patents which can be translated into novel products and services.

Malaysia is hampered by the lack of a right advisory body that can advise on STI development strategies as well as identify focus areas and opportunities for research, training, and knowledge transfer. As a result, Umbrella terms are commonly used as priority areas in Malaysia, leading to difficulty in producing focused and solution-oriented research. The complexity of R&D processes in Malaysia which involve multiple agencies under the scope of different ministries makes it urgent for the proposed Research Management Agency (RMA) in the 11th Malaysian Plan to do more than just administering funds disbursement, proposal evaluation, and monitoring the progress of public funded research. The proposed RMA should play a larger role which includes coordinating research priorities across ministries and agencies.

Aligning national research priorities to industry's needs has the potential to help Malaysian industries to be more competitive globally. It is crucial for Malaysia to conduct foresight studies involving industry players periodically to identify focus areas which can then be incorporated into upcoming Malaysia Plans to ensure all ministries and agencies share the same focus. The Malaysian public also need to be engaged when identifying issues that require STI interventions. The synergy between industry, academia, government and civil society is needed to materialise the national quadruple helix innovation system.

Innovation clusters have worked very well in developed economies such as the Netherlands. Since creating clusters from scratch is extremely challenging, identifying and catalysing existing clusters 'hidden' in their respective regions should be prioritised. To optimise resource allocation for the country's admittedly limited R,D&C financial and talent, mapping out the industrial clusters within the economic development corridors to identify R&D needs is needed to increase the efficiency of R,D&C resource utilisation. When institutions of higher learning are involved, this strategy can lead to intensification of industry-academia collaboration as well as encourage knowledge diffusion and specialisation. As large firms move up the value chain, SMEs will also benefit from providing their services to these large firms in the cluster.

In essence, all stakeholders must move towards increasing the country's GERD in the direction that will stimulate profitable output in terms of publications, patents filed, and intellectual property monetisation. Malaysian private sectors, particularly the SMEs, should take advantage of the incentives and infrastructure available to enhance their innovative capacity and technological adoption.



Boosting R,D&C in Malaysia must be a cooperative effort among all the players – both the public and private sectors – to align their vision and share resources for mutual advantage. The SPU proposed in Chapter 1 and the RMA that was mooted in the 11th Malaysian Plan can be central coordinators to enhance Malaysia's STI R,D&C and harmonise the roles of all the stakeholders. Leveraging on existing industrial and research hubs to galvanise niche clusters through university-government-industry synergy can help to fire up the regional economic corridors and generate sustainable growth for all states holistically.

## Recommendations

### 1. Emphasis on Experimental Development

Increased funds for experimental development will encourage more collaboration between university and industry towards demand driven research which will consequently increase experimental development activities to produce more market ready products and/or services.

### 2. Expedite the Establishment of a Multifunctional Research Management Agency (RMA) and to Consider Establishing a Technology Commercialisation Agency (TCA)

It is important to expedite the establishment of a RMA to catalyse demand driven collaborative research with effective utilisation of funds and the TCA to complete the ready-to-market delivery cycle. Expediting the establishment of a RMA and TCA will assist in prioritisation of research and formation of symbiotic relationships with technology transfer offices and collaborative platforms.

### 3. Re-identify National RDC Priority Areas

Re-identifying national RDC priority areas by aligning and streamlining to Malaysia's research and economic strengths and needs will result in optimisation of available resources.

### 4. Development of Regional Innovation Clusters

Development of regional innovation clusters by enhancing collaboration between industry and knowledge institutions as the case in Malaysia's E&E sector must be considered.

# 03

## STEM Talent Development: Is Aspiration and Action Well-Aligned?

Malaysia's drive to become a developed nation in a sustainable and equitable manner means increasing the dynamic capabilities of the nation's workforce. It is a holistic endeavour that targets all levels of the population, from children in pre-school all the way to secondary and tertiary education, as well as making sure that the current labour force is ready for the inevitable transformation of the job and socio-economic landscape. The Science and Technology Human Capital report was established to map out the route to ensure that the quality and quantity of Malaysia's labour force in STI to fulfil the country's development up to the year 2020 is sufficient.

There are approximately 5 million students enrolled each year in both primary and secondary schools across Malaysia. About 100,000 enrol in Science Streams at upper secondary level. To ensure these valuable assets remain in the pipeline for Malaysia's continuous supply labour force the Ministry of Education (MOE) has set up a number of initiatives to improve STEM education delivery including and beyond what is outlined in the Malaysia Education Blueprint 2013-2025. One of them is inclusion of higher order thinking skills (HOTS) in the syllabus beginning in 2014.

The first year where 20% of the questions are set based on HOTs was in 2016 which saw a dramatic decline in the performance of *Ujian Penilaian Sekolah Rendah* (UPSR) Science and Mathematics which continued into 2017. This may indicate that the students are not prepared for HOTS-style evaluation or there is a need to review how HOTS is delivered. Performance in Science and Mathematics in *Penilaian Tahap Tiga* (PT3) in 2014 to 2016 has been rather alarming; less than a quarter passed Mathematics and Science with a minimum of C. Only 23% of the PT3 students were eligible for Form Four Science stream in 2017, the pattern over the last five years showed less than 30% were eligibility annually. This is low and insufficient to fulfil the desire of reaching 60% Science or Technical based students in our education system as outlined in the 60:40 Science/Technical: Arts Policy. The Technical steam recorded around 22.5% enrolment in 2017.

In the 2016 *Sijil Pelajaran Malaysia* (SPM) level examination 80% passes with a minimum C grade were recorded for Physics and Biology, while slightly above 50% were recorded for Additional Mathematics and Chemistry. Students without a sound Additional Mathematics qualification may not gain entry into critical courses such as engineering. As the nation moves towards joining the next industrial revolution bandwagon, we may face a possible shortage of technological competent talent. As it is, the trend of lesser candidates taking subjects offered in the Science Stream for SPM is shrinking the talent pool entering institutions of higher learning (IHLs) for subsequent STEM training. Approximately 50% of SPM leavers pursue tertiary studies. Data from MOE and MOHE shows that only about 80,000 enrolled in STEM-related tertiary courses.

Lack of awareness of opportunities in STEM careers, parents not favouring science education, STEM subjects are too difficult, learning science is boring and too theoretical, and lack of encouragement to take up STEM subjects in school were among the reasons on low popularity of STEM subjects among students. Our survey on secondary school STEM teachers resulted in 48% responding that they had never attended STEM related training, reciprocating the boring teaching and learning complaint made by the students.

The advent of Fourth Industrial Revolution means that Malaysia's talent must be adaptable to change, have a high degree of facility for life-long learning, good interpersonal and collaborative skills, and is trained in multi-sectoral thinking. Preparation for technological disruption is possible through training and education; Reskilling and upskilling must be the norm for Malaysian talent to stay relevant to the job market.

Therefore, the Ministry of Higher Education (MOHE) included a new strategy to enhance student experience in the industry through degree apprenticeship. The 2U2I programme is being rolled out by selected universities whereby the student will spend 2 years in the university and 2 years in the industry to enable them to have real world experience with the theoretical knowledge they have obtained in the university. A similar module can be started at an earlier stage – during secondary schools to expose both teachers and students to the expectation of the industry. The establishment of the National STEM Learning Centre is expected to address the mundane teaching and learning of STEM subjects by producing more passionate teachers as well as engaging public to be encultured to science.

Upon enrolment and graduation, students and generally their parents need to be assured that STEM jobs are as rewarding as non-STEM jobs. Besides curriculum that involves hands-on-trainings, the Government should conduct STEM career path review with emphasis on remuneration and career development. This is because the Government is considered as the benchmark for employment wage and benefits, as well as positioning post with matching qualifications (i.e. not utilising under-educated labour force to save cost).

STEM talent is the core of high-skill, knowledge-intensive economy for global competitiveness. Like most economies, Malaysia's demographic will be moving towards an ageing population by 2030 which makes lack of STI talent in critical sectors more acute. While Malaysia ranks 16 out of 118 economies in Vocational & Technical Skills pillar of the Global Talent Competitiveness Index 2017, we rank 41 for the Global Knowledge Skills. The Global Innovation Index places Malaysia at 46 out of 137 economies in terms of technological readiness. The average ranks of our talent are a concern that the present STEM talent pipeline may be less competent to helm the country's aspiration towards the Fourth Industrial Revolution bandwagon.

From the pipeline, we may not be producing sufficient number of talent needed to sustain the country's growth in 2020 and beyond. However, STEM talent utilisation in Malaysia is not a straight forward matter of demand and supply, but rather a shortage of the right proficiencies and unmet compensation expectations. Rather than continue to produce over qualified and underutilised workers, the upskilling, training and education pathway in the country should be strategized to produce talent with the right mindset for life-long learning, and the flexibility to explore new niches. It is also vital to make sure that the talent powering the economy is appropriately compensated to match the nation's aspiration to be a developed country.

## Recommendations

### 1. Attracting and Retaining STEM Talent through Improved Remuneration and Continuous Career Development

Engaging and attracting young people to first enrol in STEM-related degree programs and then to pursue careers in STEM remains a challenge. Therefore, revisiting of the entire education pathway to be in-line with current global demands, STEM pedagogy and curriculum is proposed. An improved remuneration scheme comparable to other nations and continuous career development is proposed to ensure sustainability and succession.

### 2. Prioritisation of Numerically and Technically Competent Talent Development

Numeracy skills are the foundation of most STEM courses at tertiary level and it is predicted to come in handy in most future jobs. Therefore numerically competent talent development must be prioritised to develop technical competency.

### 3. Development of Biennial National STEM Talent and Skill Gap Assessment

Development of a biennially nationwide STEM talent and skills gap assessment is proposed to gauge and identify the mismatch of our STEM talent - if there is either an oversupply or an under-demand of for especially critical jobs.

# 04

## Are Malaysian Industries Poised to be Innovators?

Over the years industries in Malaysia have transitioned from resource-based to one that is knowledge intensive. Malaysia has charted its course towards becoming an innovation-led economy by recognising the need to develop indigenous science, technology and innovation (STI) capacity and capability for competitiveness and sustainability to better leverage on market opportunities and elevate along the global value chain.

On the global front, Malaysia enjoys a reasonably competitive position in the overall global competitiveness. However, when it comes to specific innovation indices, Malaysia fares quite moderately. Malaysia ranked 17$^{th}$ among 40 countries in the 2016 Global Manufacturing Competitiveness Index; in the product innovation pillar of the Global Entrepreneurship Index (GEI) 2018 Malaysia ranked 130 out of 137 countries - lowest among most ASEAN countries. GEI measures a country's ability to develop new products and integrate new technology. The 2017 Global Innovation Index ranking saw Malaysia suffering a massive drop in Knowledge Workers from 35$^{th}$ to 93$^{rd}$ spot. This raises concerns about the competency of the Malaysian workforce to engage in high-value innovation.

Given that 98.5% (DOSM, 2016) of Malaysian business establishments are small and medium enterprises (SMEs), there is a need to elevate the capacities of our industries, infrastructure, workforce competency as well as technology utilisation to be on par with global players. In 2016, SMEs only contributed 36.6% to the country's GDP. It is clear that Malaysia needs to invigorate the industry landscape by enhancing innovation capacity as SMEs have low appetite for investment towards R&D (MyKE III, 2017).

Innovation requires integration of knowledge and competences from a number of different fields: technology, market intelligence, product design, economics, etc. Our findings show that most of our SMEs are unable to create value from R&D output - most of the business establishments are technology imitators rather than true innovators. Our national ecosystems primarily support absorptive capability; but are not able to enhance our adaptive and innovative capabilities. Only 6% of Malaysian companies are creators (MyTIC, MPC, 2012). Foreign firms and countries benefit from our strong absorptive capability while Malaysian firms remain stuck at this level, unable to move up the innovation value chain.

Novelty of new products from both manufacturing and services sector are fairly less than 1% – being imitators, market saturation has unable our products to compete globally. The SME Corp's Survey of the first quarter of 2017 states that firms often release products and services to the market without developing foundational and driver conditions of the ecosystem, leading to high failure rates due low novelty of products and services.

Realising this, the Government continues to formulate policy measures intended to nurture and establish conducive environment for technology development to spur investment in technology for more innovative output. The current IMP3 (2006-2020) outlines the industry's strategies and policies for the country's sustained efforts towards realising Malaysia's objective to be a developed nation. The Government has also mapped out numerous initiatives to assist especially SMEs to strengthen their competitiveness.

The SME Masterplan (2012-2020) targets contribution of 41% of the nation's GDP and 25% of the nation's total export value by 2020, by the SMEs. It also targets to reduce employment share to 62% from 65% in 2016, by reducing reliance on cheap foreign labour and adopting technology that will help increase productivity. High Impact Programme (HIPs) aims to help SMEs develop innovations from prototype to commercialisation stages. The Innovation Certification for Enterprise Rating and Transformation (1-InnoCERT), a programme facilitated by SME Corp awards certificates to innovative SMEs and facilitates fast-track access to funding or incentives (SME Corp., 2014) to encourage entrepreneurs to venture into high technology and innovation-driven industries.

Growth of industries is supported by strengthening the nation's ICT infrastructure such as the broadband strength and speed, and initiatives such as the Cloud First Strategy, the National Big Data Analytics Framework and Cyber Security Malaysia. The Digital Free Trade Zone (DFTZ) launched in 2017 is an initiative to capitalize on the confluence and exponential growth of the internet economy and cross-border e-Commerce activities. This setup facilitates seamless cross-border trade and enable local businesses especially SMEs to export their products globally with ease

The Malaysian Business Angel Network (MBAN) offer opportunities for project owners to book investments - MBAN's Accredited Angel Investors are eligible to enjoy a tax benefit amounting to RM 500,000 under the Angel Tax Incentive Programme. Securities Commission Malaysia has introduced six equity crowd funding (ECF) platforms in 2015 to provide alternative venue for capital-raising for SMEs and innovative new businesses (start-ups).

Strategic partnerships models to spur technology development, commercialisation and to accelerate the productivity growth of SMEs have been identified through innovation intermediaries such as SIRIM-Fraunhofer, Steinbeis Malaysia Foundation and PlaTCOM Ventures. The Public-Private Research Network (PPRN) was established to strengthen university-industry linkages to facilitate knowledge-transfer and catalyse R&D. However, these intermediaries are limited by nature of partnerships – they are not industry-led to foster demand-driven research and to effectively bridge the innovation chasm as well as to encourage open innovation. Hence establishing collaborative networks co-ordinated by industry-led trusted neutral entity for growth-potential key sectors should be the way forward.

Multiple actors and multiple industry-related knowledge dissemination channels with weak connections between them are diluting efforts of creating a successful innovation ecosystem. A centralised virtual knowledge repository to integrate, synergise and coordinate access to STI-related information must be considered. The virtual platform should be built upon intelligent systems encompassing research and market analytics frameworks and also capture information about teaching, training, facilities, business partnerships, and existing international engagement across scientific and non-scientific disciplines, and it should be accessible to all. This platform should also track and monitor STI-based BEs and SMEs to have targeted intervention.

A strong and robust STI-based industry would pave the path to enhanced productivity, job creation, innovation capacity and high-skilled talent pool. Therefore, Malaysia should strategically invest in selected niche STI based industries based on our current strengths and future projections to leapfrog from being immitators to innovators of technology.

## Recommendations

### 1. Establish Industry-Led Collaborative Networks to Enhance Demand Driven Research and Private Sector Participation

An initiative to stimulate the uptake of R&D and innovation among industries should be facilitated by industry-led ollaborative networks that shall guarantee the rise of knowledge clusters, leading to organically formed talent hubs (thus enhancing knowledge workers) and disruptive innovations.

### 2. Facilitate Dissemination and Monitoring of Industry Related Information through a Virtual Centralised Knowledge Repository and Data Centre

In order to enhance the development of STI-based SMEs and innovative start-ups, it is essential to provide sufficient industry related STI resources. Therefore a virtual centralised knowledge repository and data centre to make the full range of STI-based resources as well as market intelligence information known to all, is pertinent to energise the industries.

# 05

## Scientifically Encultured Society: Where Are We?

Culture is the collective manifestation of human intellectual achievement. Enculturation is the acquisition of one's own culture, including its values, behaviours, beliefs, understandings, social norms, customs, rituals, and languages.

STI enculturation is the process through which science culture become integrated in the mind and habits of the people, similar to how national and ethnic identity are internalised. STI culture includes scientific literacy, public understanding, acceptance and awareness of science and scientific methods, as well as the applications of science in day-to-day life engagements.

Various government institutions and universities conduct programmes to promote STI literacy and enculturation to the public. The Ministry of Health (MoH) for instance conducts various awareness programmes, ranging from promoting disease prevention to healthy living. MOSTI has a dedicated unit for STI related awareness programmes; with the latest being the NICE'17. Universities are also venues and promoters of disseminating scientific information to the public in their vicinity through activities such as faculty specific campaigns, public service programmes, scientific societies, film screenings, public forums, inaugural lectures, etc.

Informal science enculturation appears to have greater impact in nurturing a scientifically literate society; these out-of-school experiences are life-long, and enjoyment for it can be inculcated from young. Malaysians are fortunate that there are various designated environments that serve as STI enculturation spaces such as science centres, museums, zoos, nature preserves, botanical gardens, and aquariums offer a variety of permanent and temporary exhibitions to enrich STI immersion throughout the country. There are also new entertainment spaces or commercial theme parks that offer fun activities with STI elements incorporated such as Kidzania and Legoland. Continuous efforts to keep these spaces current, exciting, and attractive to new and recurrent visitors must be in place.

The Malaysian media – print, broadcast, and electronic – remain the most important means for most Malaysian adults to keep updated on science information. Study of publicly available broadcast over a three month period showed that Government television channels offer the most of in terms of STI content; private television channels had little to none. In Malaysia, newspapers have dedicated sections for science coverage apart from regular news with science content but have lesser content in comparison to Political and Sports coverage. YouTube channels that appeal to Malaysians are entertainment and comedy channels; similar to global YouTube viewing patterns and not a single STI-related YouTube channel made it to Malaysia's top favourites.

A virtual Science Media Centre for STI content resource can improve the quality of STI content across platforms in Malaysia. This centre will focus on communicating science concepts in layman encouraging translation and creation of STI content.

Civic scientific literacy in Malaysia is supported by STI grassroots movement and non-governmental organisations (NGOs) alongside professional associations; most of them utilise social media as a platform for STI activism. These grassroots movements debunk pseudoscience, give information on nutraceutical, and health products on the market, share relevant media content, invite knowledgeable speakers to give talks, and many more. Environmental NGOs in Malaysia such as the Persatuan Khazanah Ma' of Terengganu are instrumental in mainstreaming nature conservation and campaigning for wildlife preservation, important civil elements in STI enculturation.

Science education in the classroom is the most important formal method of science enculturation; large amount of research and investment goes into strengthening science education in Malaysia from primary to tertiary level. However, the strongest agency of science literacy is through informal approaches that incites curiosity and encourages knowledge-seeking habits, supported by the availability and accessibility of designed environments (e.g. science centres, museums, zoos, galleries). Casual discussion with peers and family on STI matters, using information gleaned from attending public forums and expositions, as well as media and popular culture also promote habits of the mind for STI enculturation.

Benchmarking the Malaysian public's STI literacy against other countries, to assess scientific knowledge illustrated that science and mathematics literacy among young people in Malaysia are below the international average. STI enculturation survey showed that Malaysian adults generally scored below the international average; lower than the adults in most developed countries. Science culture is highly influenced by level of education, mass media coverage and cultural mentality. It is clear that more is needed to make science mainstream in Malaysia's culture.

It is evident that STI enculturation is a complex interplay of formal and informal learning, in and out of dedicated enrichment spaces as well as developing life-long habits of the mind to satisfy scientific curiosity. Even though Malaysians has yet to achieve the STI literacy of citizens in advanced countries; the good news is that there are plenty of avenues for Malaysians to enjoy STI enrichment, particularly for the benefit of the younger generation. Support for STI enculturation are not just from the Government and profit-driven private entities with STI agenda, but also by ordinary Malaysians who are determined to highlight the importance of science in our everyday lives. We can be optimistic that every effort is being expanded to make Malaysia a scientifically literate society for the 21st century.

## Recommendations

### 1. Public-Private Partnership to Update and Upgrade STI Enculturation Spaces

Encourage Public-Private partnership to update and upgrade STI enculturation spaces to attract more visitors. STI places should also leverage on local scientists, scientific associations and social innovators such as content providers giving input on STI.

### 2. Virtual Science Media Centre to Strengthen STI Content in Various Media Platforms

A virtual resource centre that focuses on communicating science in laymen Bahasa Melayu and English and encouraging translation and creation of STI content needs to be in place.

### 3. Prioritise Development of STI-based Creative Content

The trend shows Malaysians are inclined towards entertainment-based programmes hence creative edutainment-based STI content must be considered. This will likely increase interest in STI.

# 06

## How Do STI International Alliances (Science Diplomacy) Stir Malaysia's Competitiveness?

Globalisation has transformed not just the economy of the world, but also how scientific resources, personnel, and research funding are no longer restricted by geographical borders in advancing scientific knowledge and finding solutions to global challenges. One of the ways to fully harness the potential of globalisation of STI is by understanding science diplomacy.

Science diplomacy is defined by the use of scientific collaboration among nations to address common problems and to build international cooperation. It is further segregated into three distinct types that differ according to the objective of the diplomacy required;

- **Science in Diplomacy**
- **Diplomacy for Science**
- **Science for diplomacy**

Malaysia's international alliances leverages on diplomacy and science through international agreements, membership in international STI-related organisations, joint research collaborations of IHLs and industries.

As of the end of 2016, the Malaysian Government has signed 964 bilateral agreements with countries all over the world of which 187 of them are directly STI-related, mostly to promote cooperation in scientific research and development. 112 of these were signed with Asian countries due to the geographical factor, trade partnership, as well as common diplomatic agenda.

Malaysia has also signed 107 multilateral agreements to safeguard its international interest. 58 of these are STI-related; such treaties present platforms where Malaysia can attract knowledge, talent and resources for STI advancement. Majority of STI-related multilateral agreements signed by Malaysia are efforts to monitor, regulate and standardise procedures where science is an important element for an agreement to achieve its objective.

By being part of the signatory members, Malaysia can retain its voice in the formulation of the monitoring, regulation and procedures as well as leverage on the advancement of technology of first world countries to boost our STI capacity and capability. These multilateral agreements are vital in promoting Malaysia's security, international law advancement as well as active participation in the international fora.

Malaysia also is a member of many international organisations. As a member of ASEAN and APEC, Malaysia has been holding significant posts in spearheading important missions such as the ASEAN Economic Community which was launched during Malaysia's chairmanship of ASEAN. Malaysia also leverages upon its membership in various international organisations to secure international funding for ambitious and impactful STI projects.

There are also many Malaysians having key roles in international organisations. This is an added advantage for Malaysia to lobby and secure important key ositions in international organisations to improve Malaysia's visibility in the global STI arena. This is especially important in fighting for Malaysia's stand in vital issues that could affect Malaysia's position and sovereignty.

The international networking of STI researchers and experts is unique; crossing national boundaries with partnership traditions that open many doors and support crucial frameworks for joint efforts to address a wide array of problems of broad interest. There has been substantial amount of strategic international agreements signed by Malaysian Research Universities (MRUs) from years 2012 to 2016 resulting in an increase of projects funded under these agreements. These MRUs performed well when compared to some other neighbouring countries except with Singapore. Most collaborations are done with the United States of America (USA), the United Kingdom (UK), Bangladesh and Nigeria. Malaysia both learn from developed nations and help developing nations. In terms of publications, Malaysia is the top among ASEAN countries since 2010.

Strategic STI international alliances increases access to research funding and knowledge transfers. In 2016 approximately RM21.7 million worth of international research funds were pledged. Besides funds, strategic alliances also increase opportunities through expert engagements. At times, capacity building, technical assistance, knowledge transfer, sharing of facilities and resources adds to the success of important scientific discoveries.

Malaysia actively trades with economies around the globe. The number of trading nations bring along opportunities for further developing our STI capacity and capabilities especially in technology transfers. There are also opportunities to leverage onto the abundance of trade data and intelligence to predict trends and fore-sighting for emerging technologies.

Malaysia and its people need to continue to take the lead in strategising and positioning Malaysia's standing at global platforms. Hiring diplomats with technical know-hows will help ministries to make informed decisions on matters related to STI.

It is evident through this study that national policies plays large role in determining the direction of foreign policies initiatives. Therefore, it is important for Malaysia to strategise on its international alliance internally with important stakeholders to craft the right strategies in the Nation's best interest.

## Recommendations

### 1. Leadership in Positioning Malaysia's Strategic STI International Alliances

To further strengthen the strategic STI international alliances, the various international platforms where Malaysia is a member must be fully utilized by our STI key opinion leaders to add to global competitiveness and increase the visibility of Malaysia's STI capacity and capabilities.

### 2. Enhance Roles of Science Attaché in Malaysian Embassies

The roles of Science Attaché in Malaysian embassies should be enhanced and expanded to include strategising, monitoring and evaluating STI-related issues pertinent to the nation's interest.

### 3. Strengthen Linkages Between Ministry of Foreign Affairs (MOFA) and Malaysian Scientific Community

The linkages between the Ministry of Foreign Affairs (MOFA) and Malaysian scientific community should be strengthen to include scientific evidences as an avenue for diplomatic decision makings.

### 4. Leverage Malaysia's Trade Platforms Globally to Facilitate Market Intelligence in STI-based Industries

Malaysia's should also leverage on its global trade platforms and trade missions for gathering STI-related intelligence to develop the right STI-related strategies for the Nation.

## Conclusion

Malaysia's aspiration to be an advanced nation requires all sectors to have the capacity for developing knowledge capital to fuel Malaysia's drive to be an advanced economy. STI has underpinned the pillars of our economic growth for the last six decades since independence and should be seen as a catalyst to spur the new economy.

The Science Outlook 2015 outlined 18 recommendations to mainstream STI. 11 were taken up through 16 initiatives and programmes by the relevant stakeholders. The Fourth Industrial Revolution has made it more urgent for all stakeholders to collaborate in making sure that the country is capable of coping with potential socio-economic uncertainties brought about by STI upheavals to the global economy. Malaysia's progressive and innovative society must have the necessary STI robustness for the country to navigate the deep waters of knowledge-based economy for our sustained growth and inclusive development. Besides putting forth new ideas on how Malaysia's STI landscape can be further strengthened, the Science Outlook 2017 proposes that the remaining recommendations be revisited by these stakeholders.

But first some cross-cutting issues must be addressed. The multitude of actors in the national STI landscape has to be revisited. Too many actors and funding agencies become self-competing hence diluting available funding and resources. The weak link between the Federal and State Governments on the STI issues also must be bridged to cascade policies and decision for effective transformation of the nation towards joining the paradigm shift towards knowledge economy. Malaysia aspires to be an innovation-led nation. However, little emphasis is being put on experimental development. Hence we are going to see much less prototyping and product testing and even lesser commercialisation. The R&D done in Malaysia is also not industry-led as most of our researchers are concentrated in IHLs.

To ride on the knowledge economy, the country relies on knowledge-workers. However, there is a decline in interest of young people in enrolling in STEM-fields. The quality based on major national level examination is about average. Is STEM-field unattractive or is the pedagogy losing touch with the learning style of millennials? Our survey showed almost 47% STEM teachers from secondary school had not received any STEM-related training. The future jobs will be technology based. There are also critical STEM related jobs which may not be filled by national talent since the numbers are declining over the years. But then again, is our industry ready to hire STEM talent?

With 98.5% of our industry being the SMEs; most do not adopt technology and do not invest in R&D while only 6% are creators. The productivity of our SMEs is low; the contribution to the GDP is less than 40% and most SMEs do not have the capacity to hire knowledge workers. There is also no national data on the number of S&T based business enterprises in Malaysia. Overall global indices show competitiveness level is strong but innovation output is not realised through our industries.

Malaysians STI literacy and awareness is low although engagement is quite satisfactory based on visits to STI spaces. But the content of exhibits can be further updated to follow global trends to increase STI literacy of Malaysians. The STI content in media and the avenue for science communication can be further improved. Globally, Malaysia and some prominent Malaysians have stamped their mark in various international platforms. However, output through collaborations show that these avenues are not fully leveraged and internal strategizing between international divisions of various Ministries needs strengthening for better planning to capitalize on opportunities to form collaborations. Tying these loose ends should propel Malaysia's STI ecosystem and innovation to greater heights.

# 01
## STI Governance

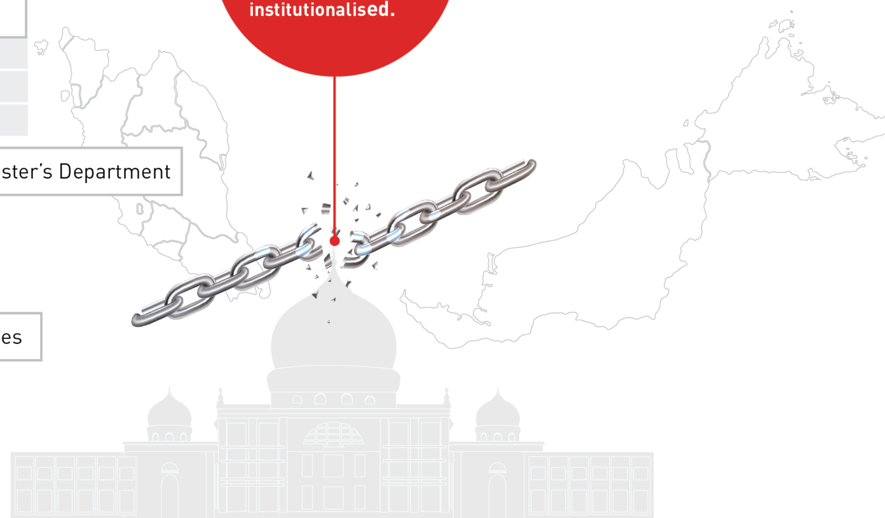
## 1 NATIONAL STI LANDSCAPE

# 268 Actors

Too many entities, resources spread too thin and weak follow through.

- **23** ministries
- **157** STI-related entities under respective ministries
- **27** STI-related councils
  - 1 international council
  - 10 councils chaired by Prime Minister
  - 16 national councils
- **16** STI-related entities under Prime Minister's Department
- **20** Public universities
- **6** Intermediaries
- **14** State governments & federal territories
- **5** Economic corridors
- **48** Active, STI-related national policies

Formal dedicated platform between Federal & State Government on STI-related matters is **not institutionalised.**



**MEMBERS***

- 12 STI-related Ministries
- 2 State representatives
- 5 representatives from public sector
- 4 representatives from Industry/GLC
- 3 Academics

**JOINT SECRETARIAT**

- Secretary General of MOSTI
- Science Advisor to the PM

## 2 NATIONAL SCIENCE COUNCIL

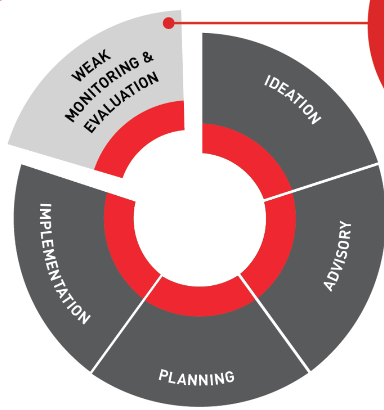
Apex STI advisory body in Malaysia

Chaired by Prime Minister

Has brought closer Ministers and key scientists to discuss STI-related matters.

* Membership as of 1st meeting in January 2016

## 3 STI MANAGEMENT CYCLE




**Crosscutting monitoring and evaluation entity** across ministries for STI- related matters is **not in place**.

## Malaysia's Achievements – An Overview

Malaysia is one of Asia's remarkable success stories. Its economic and social development since independence has been impressive. Over an extended period of time, Malaysia has achieved robust growth in gross domestic product (GDP), exceeding 7% per year. As in many developing country, in Malaysia the process of modernisation is generally understood as to unleash the productive power of science and technology into society and to fuel economic growth for well-being (EPU, 2015a; EPU, 2015b).

However, while Malaysia has greatly gained from a close integration in global value chains (GVCs), it has not fully reaped the benefits of participating in such GVCs. Upgrading in value chains turned out to be slower in some areas, especially when compared to the best performing economies in Asia such as Republic of Korea and Taiwan.

To respond to such challenges, the Malaysian economy will have to rely more on innovation-driven productivity gains. As the examples of Korea and others have shown, continuous improvements in domestic innovation capabilities can be translated into sustained growth in productivity and GDP, even in a high-income context.

Malaysia acknowledges that science and technological innovation generates qualitative improvements in products and processes, and through this it produces output and productivity growth. In return, real incomes generation and economic welfare are affected by the ways science and technological innovation shapes levels of technology. Therefore, to establish and maintain competitive trade positions that both accompany and enable domestic growth strategies, a good Science, Technology and Innovation (STI) governance has to be in place.

## HINDSIGHT

Science Outlook 2015, STI Governance Chapter highlighted **four** recommendations.

| 2015 Recommendation | | Development |
|---|---|---|
| The need to strengthen the STI Management Cycle by focusing on continuous Monitoring and Evaluation, as well as Ideation, in keeping with global best practices. | STRENGTHEN STI MANAGEMENT CYCLE | • Ministerial level check and balance on STI matters should be cross-cutting. Mechanism for such cross-ministerial dialogue and discourse must be in place.<br>• Dedicated monitoring mechanism to eliminate lapses, duplication and obsolete element in STI landscape is to be considered.<br>• Institutional review conducted by EPU which lead to the uptake of establishment of Research Management Agency (RMA). |
| Empowerment of a centralised STI coordination and monitoring body that transcend across all ministries is needed to ensure harmonisation of efforts, collaboration of resources, exchange of information between various stakeholders, and a seamless progression across various stages of the STI Management Cycle. | ESTABLISH A CENTRALISED STI BODY | • Establishment of the National Science Council (NSC) as the apex STI council chaired by YAB Prime Minister; first meeting was in January 2016.<br>• A dedicated centralised STI coordination and monitoring body should be established. |
| The establishment of a Parliamentary Select Committee on STI will build the necessary political will and create legislative consensus towards promoting STI agenda. | ESTABLISH A PARLIAMENTARY SELECT COMMITTEE | • Minister of MOSTI wrote to the Parliament of Malaysia for this issue to be considered, however, no Select Committee on STI was established under recent Parliament reorganisation and restructuring.<br>• A subcommittee on Technology and Innovation was established in the Youth Parliament. However, Youth Parliament does not affect the decision making at the Parliament.<br>• This suggestion must be revisited. |
| The proposed Science Act (of Malaysia) will be instrumental in setting up a robust institutional framework on science governance. The Act will serve as an overarching Master Plan for unified execution strategy. | ENACTMENT OF A SCIENCE ACT | • No enactment of Science Act till date.<br>• The initiative to draft a Science Act dated back in 2012 by the then National Science and Research Council and MOSTI is proposed to be revived.<br>• The earlier initiative must be continued. |

# 1.0 MALAYSIA'S STI GOVERNANCE LANDSCAPE

Science and technology (S&T) are important enablers to catalyse productivity, enhance competitiveness and promote inclusive growth of the nation. S&T cuts across economic sectors, ministries, agencies as well as knowledge domains and cannot be viewed in isolation. Therefore, efficient national level coordination, planning, monitoring and evaluation are vital. Good leadership and governance serves as a driving factor to enable continuous high economic growth and societal progress.

Malaysia's STI governance is characterised by plethora of institutions; ministries, agencies, and government-linked corporations that engage in STI policy making, funding and implementation, each with its own strategic framework and policy instruments (Omar, 2011). Our first attempt to map the institutions and actors at multiple levels shows the complexity of Malaysia's STI landscape (Refer spread on the following page).

The STI landscape comprises 23 Ministries and 26 STI-related national councils. The Prime Minister chairs 10 of these councils while the other 16 are chaired by respective Ministers. Initiatives such as the development and intensification of industry-academia collaboration are carried out through six intermediaries. It is also observed that a lot of initiatives are also mirrored under the Prime Minister's Department or Central Agency. There are also more than 160 STI-related agencies, foundations, institutes, statutory bodies and companies under respective ministries of which at least 16 are under the Prime Minister's Department. Through the stock-taking process, this study also identified 48 active STI-related national policies by the 23 Ministries (Refer list Appendix 1.1). Mapping these policies showed some overlapping policy measures.

This unwieldy governance landscape appears to mirror the multi-faceted nature of innovation; but the multiple stakeholders and support instruments lead to fragmentation of resources, overlapping competencies, and the risk of redundancies. This is made worse by lack of co-operation and information exchange across 'overnance silos' (Saad & Zawdie, 2011), leading to ineffective decision making.

Malaysia's primary development instrument has always been the Malaysia Plans (MP), the five year plan scheme that details out national goals, strategicpapers, policies and funding programmes (Figure 1.1). The 5$^{th}$ MP is the first plan to have a dedicated chapter on S&T and this continued up until the 9$^{th}$ MP. Since the publication of the 10$^{th}$ MP, it is observed that there is an absence of a dedicated chapter on S&T (or STI). Considering that effective planning of technology development is difficult due to the cost, complexity, and pace of technological change in the global market, technology development planning for socio-economic transformation should be embedded in instruments such as Malaysia Plans in order to develop and deploy technologies in a systematic manner with proper follow through (ASM, 2017).

ASM's Science & Technology Foresight Malaysia 2050 report highlighted that entities in the national STI landscape are often guided by their own policy instruments and strategic plans leading to a lack of synergy with other policy measures, strategic initiatives and in many cases duplication of efforts with diluted impact. Hence, there is an urgent need to establish one coordinating body to lead the planning, implementation, monitoring and evaluating of the nation's STI agenda across these institutions.

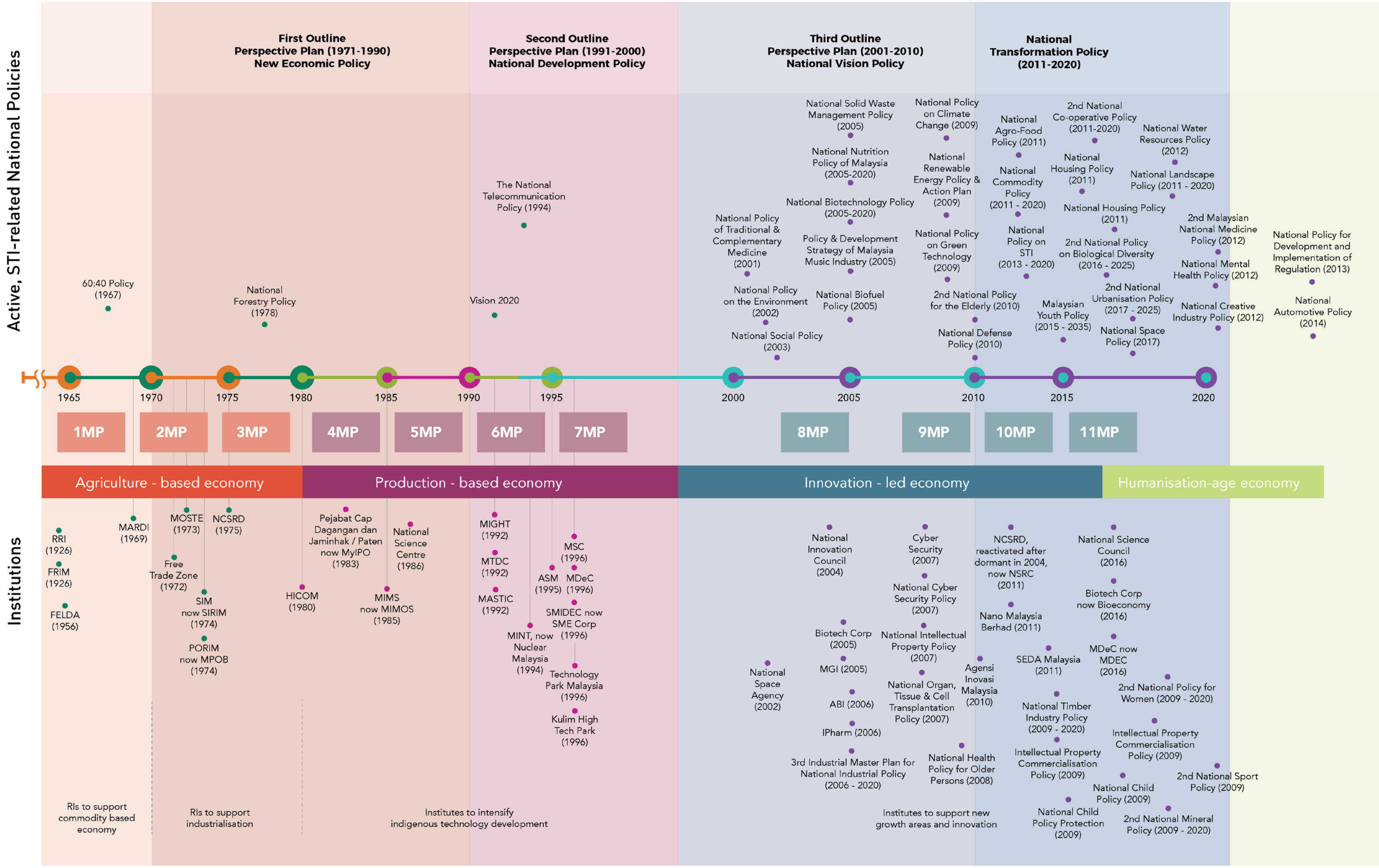
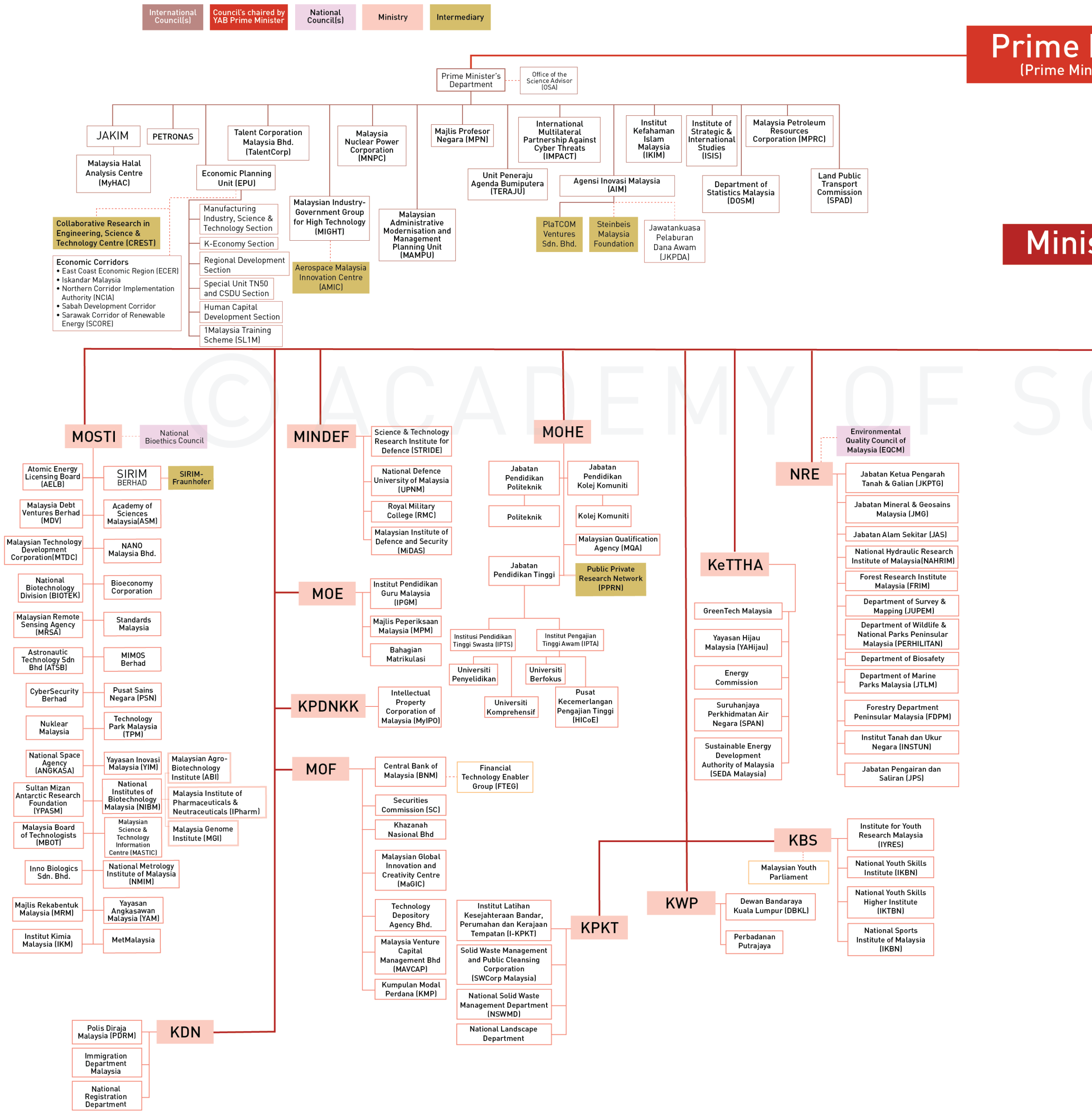


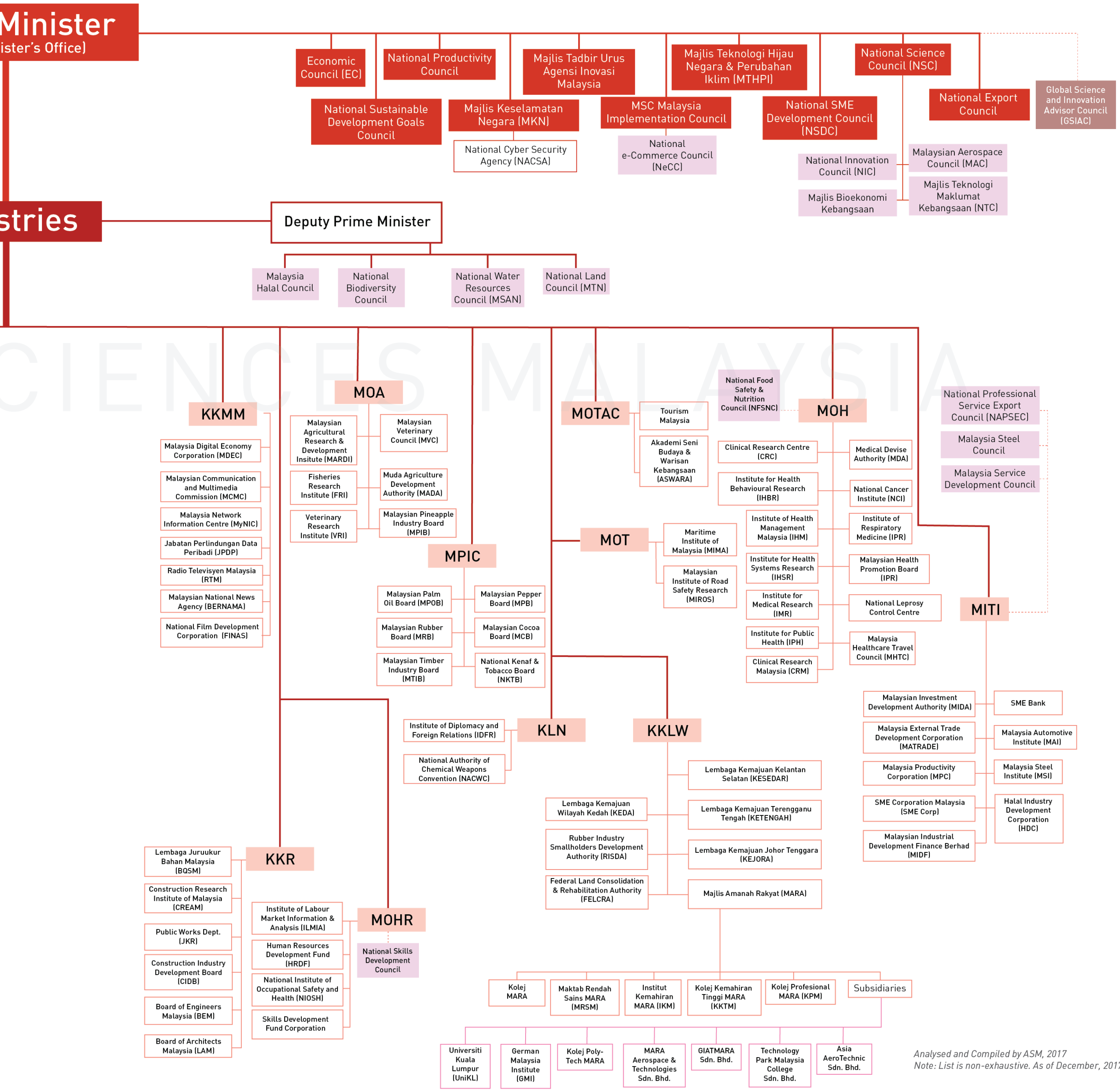

**Figure 1.1**

**Malaysia's development plans from 1st MP to 11th MP**

Source: Science Outlook 2015 and Science & Technology Foresight Malaysia 2050, ASM

# Malaysia's STI Landscape






*Analysed and Compiled by ASM, 2017*
*Note: List is non-exhaustive. As of December, 2017*

## Malaysia's STI Management Cycle

One of the key components of any STI management cycle is monitoring and evaluation. At present, Malaysia's STI management cycle is a fragmented wheel that lacks cohesion among its components (Figure 1.3).

On the advisory side, the National Science Council (NSC) was established with the purpose of streamlining the various STI-related councils and act as the apex STI advisory body in the country. The NSC is chaired by the Prime Minister and held its first meeting in early 2016.

However, based on engagement sessions with representatives from the quadruple helix i.e. Ministries, academia, industries and civil societies, this study observed that monitoring and evaluation remains a challenge. STI cross-cuts but monitoring activities are only conducted by the ministries for its respective policies.

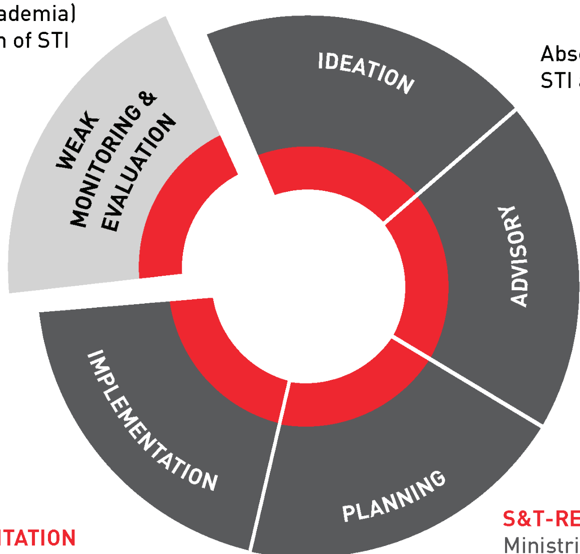
The gaps in the cycle are also caused by components placed under the domain of different agencies.

A National Science Agenda and an STI Masterplan will help in providing the direction for all the players in the ecosystem. There is also a need for STI monitoring and evaluation at the national level similar to the monitoring role played by the Economic Planning Unit (EPU) for economic planning and projects. Therefore, a centralised STI body to perform the coordinating function, to formulate and implement national STI strategies and to harmonise the roles and objectives of all involved must be in place.

- Crosscutting monitoring and evaluation entity across ministries for STI matters is not in place
- STI data is scattered; indicators must be streamlined among sectors (public sector, industry, and academia) for more holistic representation of STI status for the country

**PUBLIC FUND MONITORING FOR R,D,C,I ACTIVITIES**
JKPDA
**PROJECT MONITORING**
Intra ministries, EPU & ICU
**DATA & INFORMATION GATHERING**
DOSM & MASTIC

**HORIZON SCANNING**
Technology Foresight Division, MOSTI, ASM & MIGHT




Absence of an overarching STI agenda for the country

**S&T ADVISORY**
National Science Council (NSC), National Innovation Council (NIC), Science Advisor to the Prime Minister, ASM, National Science and Research Council (NSRC)-*now defunct*

**S&T-RELATED PLANNING**
Ministries and Agencies

No STI Master Plan to harmonise, consolidate and focus all national STI-related initiatives and players

**S&T-RELATED IMPLEMENTATION**
Ministries & Agencies, Research Management Agency (RMA)-*yet to be established* and Technology Commercialisation Agency (TCA)-*proposed*

**Figure 1.3**
**STI Management Cycle**

## National STI Council

A national STI council is responsible for setting priorities, policy and strategic direction, STI agenda formulation and its implementation and coordination. Positioning the NSC under the top leadership of the country i.e. the Prime Minister, gives the organisation a greater clout in implementing the STI directives for the country.

STI councils are the most common mechanism for more effective STI governance through priorities setting and advising, but also policy co-ordination and strategic planning in many countries (Table 1.1). However, translating these priorities into action through the various programmes and policy instruments available is problematic when the links between research priorities and key sectors are not clear (Omar, 2013).

In terms of composition, some national STI councils in other countries consist of experts appointed in their personal capacity while others consist of policy makers and high-level representatives of ministries, sometimes also including academia and industry (Serger, S.S., Wise, E., & Arnold, E., 2015). In the context of Malaysia, the establishment of the current NSC is a welcomed move. The representation at the NSC however should be more holistic, comprising key public and private sectors players in order to have an all-inclusive view on implementation progress and issues, and to evaluate new development in the STI landscape.

To strengthen the NSC, it is proposed to be supported by advisory bodies made up of science, corporate and academic representatives, both at national and international level (OECD, 2015a; Omar, 2013). In Singapore, the advisory body exists in a form of an advisory board called the Scientific Advisory Board (SAB) which comprised eminent international scientists and technology leaders. It has a hands-on approach and work in a synergised way with the country's STI council i.e. Research, Innovation and Enterprise Council (RIEC) through its secretariat, National Research Foundation (NRF). SAB roles include:

- Highlighting critical issues and emerging global trends where Singapore could fill a gap or meet a need;
- Identify, together with the NRF, new areas of research where Singapore can reap the benefits of cutting edge science and build the foundation for enterprise and industry growth;
- Review and advise on the proposals and plans prepared by the NRF; and
- Assist and advise the NRF on the management of R&D, including the allocation of funding and the assessment of research outcomes.

The NSC of Malaysia has the advantage to leverage on the Global Science and Innovation Advisory Council (GSIAC) which is also chaired by the Prime Minister. Established in 2011, the main role of GSIAC is to provide strategic advice to support Malaysia's development through science and innovation. Members of GSIAC include selected Malaysian ministers, national and global corporate leaders, Nobel Laureates, global academicians and researchers.

**Table 1.1**

## National STI Councils in Selected Advanced Economies

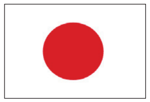
Republic of Korea

STI Council: ***National Science and Technology Council**
Chair: *Co-chairman of Prime Minister and Private Sector

**As of April 17, 2018, Republic of Korea's National Science and Technology Council will be restructured and called the Presidential Advisory Council on Science and Technology (PACST), chaired by the President (http://english.pacst.go.kr/).*

Mandate:

- Co-ordination of major policies and a plan for science and technology promotion
- Establishment of a Basic Science and Technology Plan
- Distribution and co-ordination of the national R,D&C budget
- Investigation, analysis and evaluation of national R,D&C programmes



Japan

STI Council: **Council for Science, Technology and Innovation (CNPSTI)**
Chair: **Prime Minister**

Mandate:

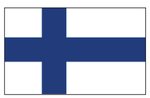
- Investigates and discusses basic policies concerning science and technology
- Investigates and discusses science and technology budgets and the allocation of human resources
- Assesses Japan's key research and development
- Decision making and coordination for other key issues surrounding the promotion of science and technology

Singapore

STI Council: **Research, Innovation and Enterprise Council (RIEC)**
Chair: **Prime Minister**

Mandate:

- Advise the Singapore Cabinet on national research and innovation policies and strategies
- Lead the national drive to promote research, innovation and enterprise by encouraging new initiatives in knowledge creation in science and technology, and to catalyse new areas of long-term economic growth



Finland

STI Council: **Research and Innovation Council (RIC)**
Chair: **Prime Minister**

Mandate:

- Advise the government and its ministries on strategic issues (such as policy priorities and budget allocations, as well as on the evaluation and development of national innovation system as whole) and coordinates science wand innovation policies across ministries

# Box 1-1

## The National Science Council (NSC) of Malaysia

A Cabinet meeting in September 2015 agreed for the NSC to be established as the apex STI Council in Malaysia to discuss the STI agenda. The NSC was also established under a rationalisation exercise to consolidate the various STI-related councils that were chaired by The Honorable Prime Minister (Figure 1.4).

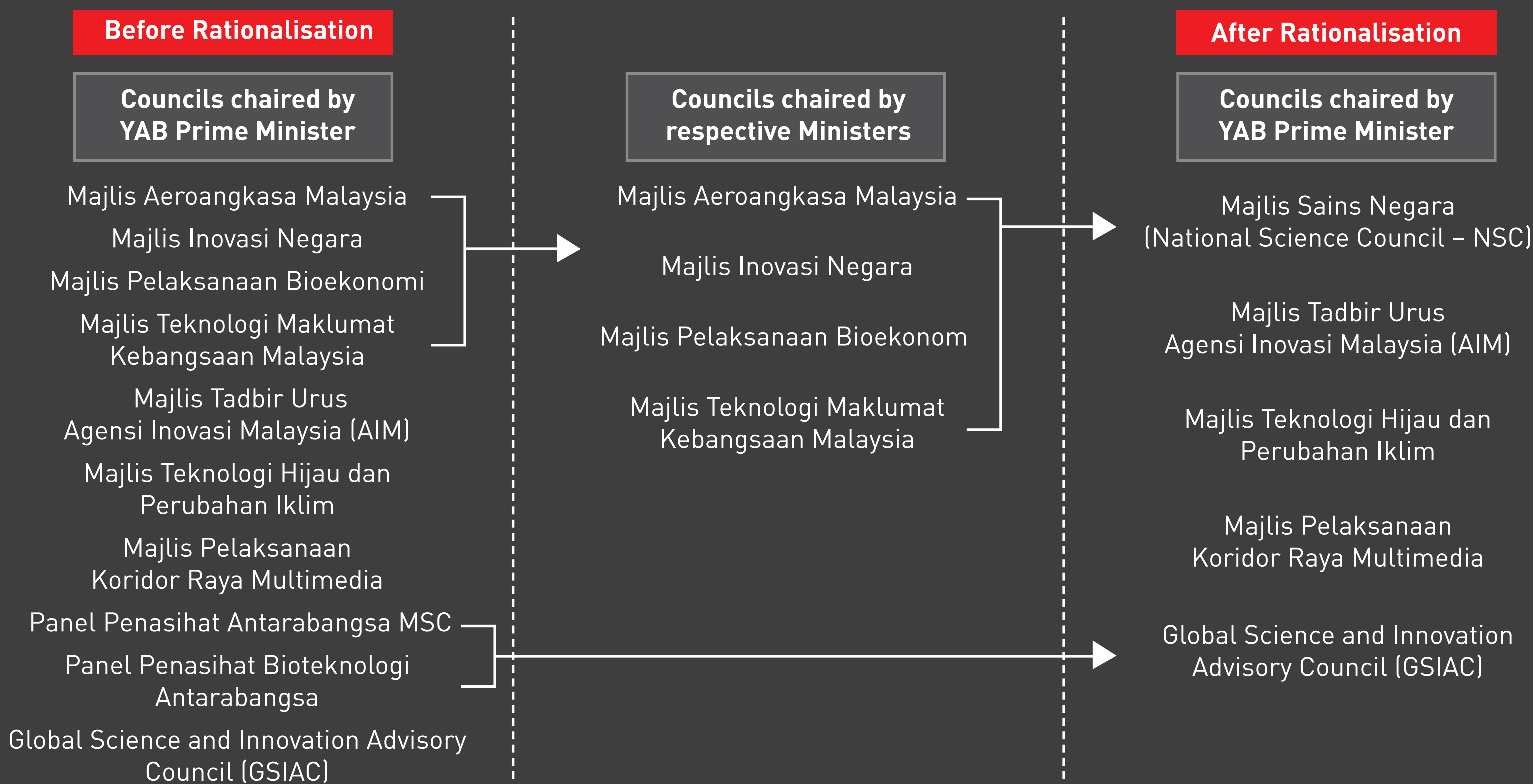



**Figure 1.4**
**Rationalisation to consolidate STI-related councils**

Source: NSC, 2016

The establishment of NSC is a step forward for STI Governance in Malaysia as for the first time 12 Ministers from relevant Ministries come together to discuss STI matters. The NSC is expected to serve as an overarching council to reduce duplication and promote collaboration in addressing cross-cutting issues. Till date, the NSC has made several key decisions on advancing STI in the nation.

Among other functions of the NSC are as follows:

- To monitor all activities related to STI;
- To review and propose a comprehensive plan for R,D&C across the public and private sectors;
- To provide advice on the formulation of policies, laws and programs related to STI;
- To identify R&D investments in STI (New emerging S&T);
- To monitor performance, achievement and STI-related action plans;
- To promote R,D&C programmes and innovations that will boost Malaysia at global level;
- To ensure and support the provision of adequate resources for R,D&C of the country;
- To support enculturation programmes to nurture a conducive STI ecosystem;
- To foster supportive measures to enable women's talents and capabilities in STI to be maximised; and
- To address the talent requirements to drive the country's STI agenda.

As of the first meeting of the NSC in January 2016, the council chaired by the Prime Minister was also represented by selected academics and private sector representatives (Figure 1.5). The council is scheduled to meet four times a year. The joint-secretariat for NSC is MOSTI and the Science Advisor's Office. However, in order to enhance the sustainability of the NSC and the national science agenda, the NSC ideally should be backed up by a legislative mandate and a dedicated and empowered secretariat. Such an entity is missing in our landscape.

**National Science Council (NSC)**
Chaired by: Prime Minister
(Minister of Finance)

**Joint-Secretariat**
- Secretary General of MOSTI
- Science Advisor to the Prime Minister

*Other councils chaired by respective Ministers, reporting to the Prime Minister*

- **Malaysian Aerospace Council**
- **National Bioeconomy Council**
- **National Information Technology Council**
- **National Innovation Council**

**Cabinet Ministers**
- Deputy Prime Minister / Ministry of Home Affairs
- Ministry of Science, Technology and Innovation (MOSTI)
- Ministry of Health (MOH)
- Mininistry of Energy, Green Technology and Water (Malaysia) (KeTTHA)
- Ministry of Plantation Industries and Commodities (MPIC)
- Ministry of Agriculture and Agro-based Industry (MOA)
- Ministry of Higher Education (MOHE)
- Ministry of Natural Resources and Environment (NRE)
- Ministry of Education (MOE)
- Ministry of International Trade and Industry (MITI)
- Ministry of Communication and Multimedia (KKMM)
- Ministry at Prime Minister's Department – Portfolio Economic Planning Unit (EPU, JPM)

**Representatives from Public Sector**
- Chief Secretary of the Government of Malaysia (KSN)
- Secretary General, Ministry of Finance (KSP)
- Director General, EPU
- President, Academy of Sciences Malaysia (ASM)
- CEO, Malaysia Digital Economy Corporation (MDEC)

**Representatives from Industry/GLC**
- Managing Director, Khazanah Nasional
- President, Federation of Malaysian Manufacturers (FMM)
- Managing Director, Westports Malaysia
- Managing Director, Binapuri Holdings

**Academics**
- Expert on Social Sciences
- Expert on Life Sciences
- Expert on Physical Sciences

**State Representatives**
- Deputy Chief Minister, Sarawak
- Science and Technology Advisor to the Chief Minister of Sabah

**Figure 1.5**
**Structure of the National Science Council**

Source: NSC, 2016

## National STI Council Secretariat

The national STI council that formulates the country's STI strategic direction in advanced economies are supported by strong secretariat which is also empowered to be its implementer (Table 1.2). At present in Malaysia, the NSC secretariat support comes largely from the Office of Science Advisor to the Prime Minister (OSA) and the Policy and Strategic Planning Division of MOSTI which also has 14 other functions under its portfolio.

A central council such as the NSC requires a more robust bureaucratic intelligentsia assistance to effectively carry out all that has been outlined in its mandate. A full-time role of the secretariat with often monitoring and evaluation of on-going programmes/ projects and, deliberation on new proposals before presentations to the NSC will strengthen the apex body.

Other proposed roles of the bureaucratic intelligentsia which ideally is suggested to be called a centralised Science Planning Unit (SPU) are as below:

- To follow-through NSC decisions with relevant stakeholders
- To monitor implementation of strategies and action plans of all STI based councils, boards and/or committees
- To ensure a mandated allocation for national research and development as determined in the National STI policy

**Table 1.2**

**Secretariat of National STI Council in Selected Advanced Economies**

### South Korea

*Science and Technology Council

**Secretariat**

- The Steering Committee of the Council
- *Chaired by the Vice Minister of Science, ICT and Future Planning
- Members:

- Government officers from 19 departments
- Professors and researchers from universities and R&D institutions

**Role**

- Providing practical counsel on STI policy
- Reviewing and coordinating the R&D budget
- Advising on the investment direction for major R&D businesses
- Connecting and coordinating between businesses

** As of April 17, 2018, South Korea's National Science and Technology Council will be restructured and called the Presidential Advisory Council on Science and Technology (PACST), chaired by the President. The PACST Secretariat will be By Secretary-General and supported by S&T Infrastructure Management Team, S&T Innovation Team and, S&T Society Team. The Secretariat services the operation and, supports the activities of members of the PACST. (http://english.pacst.go.kr/).*

### Japan

Council for Science, Technology & Innovation

**Secretariat**

- Headed by the Director General for STI under the supervision of the Minister of State for Science and Technology Policy
- Members:

- Three Deputy Directors-General
- 100 staff members

**Role**

- Planning and overall coordination related to STI and organisation of meetings

### Singapore

Research, Innovation and Enterprise Council

**Secretariat**

- National Research Foundation
- Formed under the Prime Minister's Office chaired by the Deputy Prime Minister
- Members:

- Relevant ministers and permanent secretaries
- University presidents
- Chairs of the Economic Development Board and A*STAR, the Campus for Research Excellence and Technological Enterprise (CREATE), and corporate R&D laboratories

**Role**

- Funding agency and a national policy agency
- Developing and coordinating national policies to grow Singapore's research capability, support economic growth and meet Singapore's future national challenges
- Setting the national R&D direction

- To ensure mandatory research and development funds to be allocated for basic and applied sciences on a yearly basis to universities, public research institutes, STI- based government agencies and centres of excellence
- To advise on formulating national STI policies related to emerging sciences and technologies
- To propose national priority areas to NSC
- To audit Research Institutions and STI enculturation efforts
- To strategise STI talent supply and demand
- To advice industries on emerging technologies and trends based on market intelligence STI data
- To strategise with Ministry of Foreign Affairs (MOFA) on international STI strategic alliances

The SPU is envisioned to function as a coordinating body to manage STI resources, ideation and horizon scanning, and implementing strategic STI strategies in the country. This centralised co-ordination unit is proposed to be put under the Prime Minister Department's purview and will also serve as the secretariat and executive arm of the NSC with the task of harmonising the roles and deliverables of all the STI players in the country.

The SPU is also proposed to be mandated to carry out monitoring and evaluating implementation of strategies and action plans of all STI-based councils, boards and committees in Malaysia. With this, SPU will act as a focal point for matters related to STI for other national councils such as Economic Council, National SDG Council, National Export Council, and National SME Development Council and this will further promote commercialisation and innovation through public-private partnerships and international collaboration. It is also a positive step to have a learn STI Governance ecosystem.

As secretariat of the NSC, the SPU will also monitor and review national research and development performance as determined in the national STI policy. The Science Outlook study proposes for RMA and TCA to be placed under SPU to streamline public R,D,C&I funds and initiatives. RMA will coordinate and reduce duplication of proposals and increase collaboration among related stakeholders for implementation. Funding is expected to be channelled into research for knowledge creation, solving national issues, and developing new and existing industries by creating new value. Evaluation of the research grants should be through a neutral and transparent peer review process.

It is important for the institution playing the role of clearing house for research to be given the mandate as described in the 'Haldane principle'. Named after Richard Burdon Haldane, the principle describes that that decisions on individual research proposals are best taken following an evaluation of the quality and likely impact of the proposals (such as a peer review process). As understood by most people, it states that decisions about the specific research topics to be pursued using public funding should be made by researchers and not by politicians.

For SPU to achieve its objectives, it must be granted a legitimate, legislative mandate that is supported with sustainable funding and strategic manpower. The Unit must be manned by qualified and competent professionals from various disciplines who are capable of using tools and techniques of measurement, mapping and analysis of STI input to facilitate informed decision making by the Council. SPU must also have access to all data and information collected by all STI policy instruments; these data will provide evidence-based inputs to the NSC, and monitoring intelligence to evaluate the effectiveness of the policies. In short, SPU will be the enforcement arm of the NSC with a mandate that transcend all ministries to enable greater stakeholder participation and synchronised implementation.

Roles and functions of relevant entities can be consolidated to function as a this centralised SPU for coordination of planning, monitoring and evaluation of macro STIs as well as working as Secretariat of the National Science Council (NSC) similar to the role played by the Economic Planning Unit (EPU) for economic planning and as Secretariat to the Economic Council (EC) (Figure 1.6). This will create a lean ecosystem that allows direct contact between research and industry activities.

Research Management Agency (RMA) - An institutional review related to national STI actors was already conducted by the Economic Planning Unit (EPU) through the idea of establishing an agency to manage public R,D,C&I fund . The 11th Malaysian Plan document included the establishment of the RMA to manage public R,D,C&I initiatives in order to increase return on investment (Figure 1.6). The Agency, which yet to be created (as of December 2017), will undertake planning, coordination, and monitoring of public-funded Research, Development, Commercialisation and Innovation (R,D,C&I) projects.

However, the RMA cannot be expected to co-ordinate and implement funding mechanism for the R,D,C & I as well as realise value from R&D in STI through commercialisation. There is a need to establish a Technology Commercialisation Agency (TCA) alongside the RMA to function as a national one-stop agency empowered by experts for a focused commercialisation process working together in a consolidated institutional framework. This will involve market intelligence analysis, technology brokers, technopreneurs, and intellectual property experts, marketing and branding experts. Relevant agencies can be integrated to play the role as a TCA.

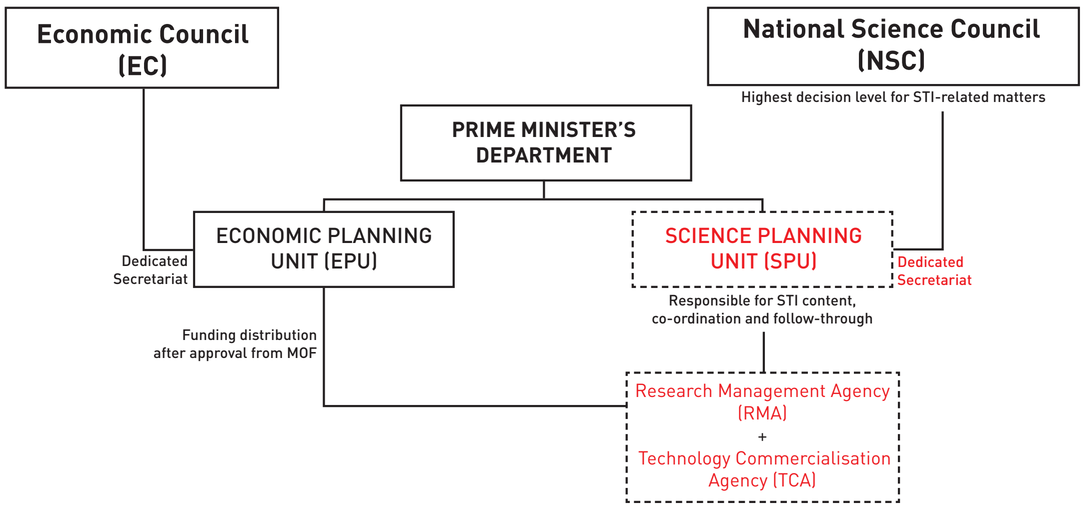



**Figure 1.6**
**Proposed Structure of the centralised Science Planning Unit (SPU)**

## 1.2 NATIONAL SCIENCE AGENDA AND NATIONAL STI POLICY

National STI-related policies must be driven by a robust science agenda based on global best practices adapted to Malaysian context. Malaysia currently does not have a specific national science agenda to serve as the consolidating guideline of the various STI-related policies and governance at present.

The agenda must outline the supporting components of the STI policies such as funding and resource sharing, talent development, collaboration, knowledge sharing, and governance. Ways to achieve the vision and strategic policy framework laid out in the science agenda will then be reflected through the national STI policy. The national STI policy also helps to structure the nation's medium- and long-term STI goals by establishing the platform through which these goals are to be achieved.

We can learn from the successes of others e.g. Australia (Box 1.2) in developing our own science agenda that will address our economic and knowledge growth needs, to build on our strengths and shore up any weaknesses.

## Formulating Malaysia's Science Agenda

The national science agenda should be developed with an eye to harness STI to achieve Malaysia's aspirations beyond the year 2020. The agenda should nurture an STI ecosystem that supportstechnological innovations for knowledge-intensive productivity of a high-income nation. It should contain recommendations for research and development (R&D) targets that will support the nation's sustainable economic development, anticipate societal challenges Malaysia will need to address, and ensure inclusive participation in the country's STI strategy.

The agenda will be evidence of the Government's commitment to provide a comprehensive STI infrastructure, nourishing an ethical and competent scientific community, and support collaboration with the private sector for wealth creation through technology and innovation in all sectors. It should include building a creative, entrepreneurial, and scientifically literate society in its goals. While the agenda aims for higher goals, basic needs such as food, water, shelter and healthcare should always remain sustainable and as priority. The agenda must be subject to periodical reviews to keep it current and relevant.



## Box 1-2

### Australia's National Science Statement 2017

The Statement articulates the importance the Australian Government places on having a strong and stable science system and its recognition of the long term nature of science. It sets out a vision and strategic policy framework for science in Australia, and establishes whole of government principles that are intended to guide decision making and provide a secure, stable and enduring foundation for Australian science. The Statement will continue to provide guidance for the government's other science related policies and initiatives into the future.

The government's vision is for an Australian society engaged in and enriched by science.

The following four objectives are described in the Statement:

- engaging all Australians with science;
- building Australia's scientific capability and skills;
- producing new research, knowledge and technologies; and
- improving and enriching Australians' lives through science and research.

To realise its vision, the government will act in three leadership roles:

- supporting science by providing funding and other resources for the spectrum of basic to applied scientific research, critical scientific infrastructure and equipment, and science and mathematics education, directly investing in Australia's future;
- participating in science by producing, using and sharing research, data and information, operating scientific research infrastructure and engaging with science internationally; and
- enabling science by setting institutional arrangements that shape the science system and its interactions with business and the community, including the translation of research into economic and other benefits.

## 1.3 STI MASTER PLAN

The STI Master Plan outlines the Government's development goals, strategies, parameters, and timeframe to implement the policy framework reflected in the national STI policy. Not just limited to ministries' related STI issues, the master plan should also cover other essential socio-economic sectors in order to implement a holistic science agenda. The Masterplan will serve as a crucial governance tool to harmonise, consolidate and focus all of the nation's STI-related initiatives and players in consonance with the national aspiration. A summary of STI Master Plan's (or its equivalent) in other countries are shown in Table 1.3.

**Table 1.3**

**STI Master Plan in other Countries**

| 5th Science and Technology Basic Plan Japan 2016-2020 | The new High-Tech Strategy Innovations for Germany | Research, Innovation and Enterprise 2020 Plan (RIE2020 Plan) of Singapore | Science & Technology Master Plan of Mongolia 2007-2020 |
|---|---|---|---|
| In order to ensure sustainable development for Japan and the world into the future, the following goals have been defined as the National Targets:<br>• Sustainable growth and self-sustaining regional development;<br>• Ensure safety and security for the nation and its citizens and a high-quality, prosperous way of life;<br>• Address global challenges and contribute to global development; and<br>• Sustainable creation of intellectual assets. | The Strategy aims of moving Germany forward on becoming a worldwide innovation leader. The goal is for good ideas to be translated quickly into innovative products and services as innovative solutions are the factors that drive prosperity and support quality of life. They also strengthen Germany's position as a leading industrial and exporting nation.<br><br>The new High-Tech Strategy driven by the Federal Government is based on five pillars:<br>• Priority task areas: establish priorities for research and innovation in areas with enormously dynamic innovation;<br>• Better transfer: create new instruments for improved regional, national and international networking between science and industry;<br>• Greater dynamism in innovation: provide special support for SMEs and technology-oriented start-ups;<br>• Improved framework: optimise key framework conditions of the German innovation system; and<br>• Intensified dialogue: enhance active participation by society as a central player. | To build on the progress achieved under the RIE2015 Plan and to create greater value from their investment in research, innovation and enterprise, Singapore is implementing four major shifts under the RIE2020 Plan:<br>• Closer Integration of Strategies: Encourage multi-disciplinary, multi-stakeholder collaboration for greater coordination of efforts nationally and, to invest strategically in curiosity-driven and mission-oriented research;<br>• Stronger Dynamic for Renewal: Continued shift towards more competitive funding (from 20% of public funding for research in RIE2015 to 40% in RIE2020);<br>• Sharper Focus on Value Creation: Strengthen flow-through from research to its impact in society and economy, through additional budget allocation towards public-private research collaborations and increased efforts in helping companies expand their absorptive capacities for new technologies; and<br>• Better Optimised RIE Manpower: Sustain a strong research and innovation workforce in the private and public sector; strengthen their team with international talent. | This plan serves as a key document to guide government, business, and public organizations' efforts toward intensive and comprehensive development of science and technology of Mongolia for 2020.<br><br>As mentioned in the document, the vision for Mongolian S&T sector is *to practice the national innovation system as a driving force for social and economic development for 2020, and to ensure secure and quality living of the people by creating and producing advanced knowledge and by continuously supporting the science and technology progress and development.*<br><br>The Master Plan implementation goal consists of developing advanced technology, using science capacity and resources as a source for economic growth, establishing effective innovation system, and promoting sustainable development of R&D sector. |

The NSC in its inaugural meeting in January 2016 decided that there is a need to formulate a STI Master Plan for the country and MOSTI with its agency ASM, is currently in the process of drafting the document.

## 1.4 SCIENCE ACT

Nearly all aspects of national and global development involve STI, underscoring the importance of a dedicated legal structure to facilitate STI governance. In countries such as Republic of Korea and Japan (Table 1.4), legal instruments such as act are established to reinforce the Government's and stakeholders' commitment towards STI-related implementation and enforcement.

Legislating in a form of act gives rise to a structured system in which the governing body, in this case the NSC will be mandated and authorised with specific authority which confer its legal status as a legal entity. Formulation of an act, will allow for any shortcomings caused by different sources and authorities to be eliminated i.e. decision decided by various bodies and ministries/agencies in which there are uncertainties whether these decisions will be acted upon or be binding upon the organisations. An act also will state a clear mechanism of coordination and monitoring to all related parties especially on compliance, imposing standards and legal sanctions (adapted from Bidin, A et al., unpublished).

The Science Act also indicates the Government's financial commitment in implementing the policy instruments; a vital component to ensure continuous and sustainable funding to support STI advancement in the country.

The proposed Science Act of Malaysia is expected to provide mandate and mechanism to the national STI management by incorporating the following thematic areas, among others:

- National STI governance structure e.g. board, council, management
  - Selection, membership, appointment of above
  - Role and function of above
- Establishment and execution of National STI Master Plan
- R&D-related fund to be made available e.g. grant for research, operational, developmental/capital
- Public-private partnership
- Clauses on conflict of interest, accounts, reporting, monitoring, auditing, etc.

Note: The initiative to draft a Science Act by the National Science and Research Council (NSCR) and MOSTI started back in 2012. However, after many revisions of the draft Act, this initiative was later dropped. Ironically, one of the policy measures of the NPSTI (2013-2020) requires the establishment of a Science Act. Therefore, Malaysia ought to emulate practices of developed nations on having a legal framework as structural guidance for STI governance over infrastructure, talent, resource allocation and linkages. It is also a way to ensure transparency and accountability of the government's expenditure to support the national STI agenda, as well as improving service delivery.



## Box 1-3

### Science & Technology Promotion Act 1967

**Transformation of Republic of Korea**

Republic of Korea transformed itself from a war-torn hinterland in the middle of the 20th century into an economic powerhouse in less than 50 years through heavy investment in Government research institutes to support industrial expansion. Unlike most Asian economic tigers like Malaysia, Republic of Korea had little foreign direct investment to support the country's technological capacity building. This nation's STI progress was directed by the Science and Technology Promotion Act, and the Science Education Act which came into force in 1967. The country then launched the National R&D Programme in 1982 to promote and facilitate public-private R&D enterprises under the same legal framework. Currently, the Framework Act on Science and Technology of Republic of Korea is the overarching legislation governing STI development in the country [Chung, 2011]. This demonstrates that STI growth can be propelled with appropriate legal guidelines in place to support the policy implementation.

**Table 1.4**

## Science Act in Republic of Korea and Japan Act

### Framework Act on Science & Technology


| Governance | Policy Document | S&T Funding | Other provision(s) |
|---|---|---|---|
| The State shall formulate a comprehensive policy for S&T innovations and, through such innovations, the advancement of the economy and society, and shall execute the policy<br><br>Local governments shall establish policies and measures to promote science and technology in provincial areas, taking into accou the State's policy and local features, and shall execute them | Formulation and execution of the basic plan for science and technology every five years | Establishment of a Fund for the promotion of science and to efficiently support the S&T advancement and the diffusion of S&T culture | *Establishment of National Science and Technology Council to coordinate major policies of science and technology, R&D plans and projects, industrial and manpower policies related to S&T innovation<br><br>** This section will be obsolete with the establishment and operationalisation of PACST by 17 April 2018.* |

### The Science and Technology Basic Law 1995


| Governance | Policy Document | S&T Funding | Other provision(s) |
|---|---|---|---|
| The nation is responsible for formulating and implementing comprehensive policies with regard to the promotion of S&T<br><br>The local governments are responsible for formulating and implementing policies with regard to the promotion of S&T corresponding to national policies and policies of their own initiatives in accordance with the characteristics of their jurisdictions | Establishment of a basic plan for the promotion of S&T in order to comprehensively and systematically implement policies with regard to the promotion of S&T | For every fiscal year, the Government shall take the necessary measures for the smooth implementation of the Basic Plan such as including the necessary fund in the budget within the limits of national financial status<br><br>Necessary policy measures should be implemented to use R&D funds effectively corresponding to the progress of R&D in order to promote R&D smoothly | The nation should implement necessary policy measures to improve research facilities of R&D Institutions and to upgrade supporting R&D functions such as supplying research materials smoothly in order to promote R&D effectively |

## Parliamentary Select Committee on STI

A Parliamentary Select Committee (PSC) is a committee made up of a small number of parliamentary members that are appointed to deal with a particular issue or area of issues. These Select Committees reports back to the Parliament. PSCs are an integral part of a Parliament structure to investigate in detail issues at large or proposed laws so that the Parliament can be well-informed before making decisions of national significance. PSCs originate in the Westminster system of parliamentary democracy. Committee members can be appointed from the lower house (*Dewan Rakyat*) or upper house (*Dewan Negara*) of the parliament. Members can be drawn from the same House, or have members from both the Houses, making them a Joint Committee (CPPS, 2011). A select committee may be permanent or temporary.

The establishment of PSC on STI is important to build political will and create legislative consensus towards promoting the STI agenda. It will become a formal platform in the parliament to discuss STI issues, supported with expert inputs. Thus, the establishment of the aforementioned committee is important to be included and mandated in the Science Act.

In the United Kingdom, the Science and Technology Committee (Lords) have a broad remit "to consider science and technology". It scrutinises Government policy by undertaking cross-departmental inquiries into a range of different activities. These include:

- public policy areas which ought to be informed by scientific research (for example, health effects of air travel);
- technological challenges and opportunities (for example, genomic medicine); and
- public policy towards science itself (for example, setting priorities for publicly funded research)

In addition, the Committee undertakes from time to time shorter inquiries, either taking evidence from Ministers and officials on topical issues, or following up previous work.

There are other S&T-related committee in the UK namely the Select Committee on Artificial Intelligence (Lords) which was appointed in 2017 to consider the economic, ethical and social implications of advances in artificial intelligence, and to make recommendations. There is also a Committee in the House of Commons (equivalent to lower house; i.e. *Dewan Rakyat*) namely Science and Technology Committee (Commons) which scrutinises the Government Office for Science, which is a "semi-autonomous organisation" based within the Department for Business, Energy and Industrial Strategy.

This Committee ensures that government policy and decision-making is based on good scientific and engineering advice and evidence.

### S&T-related Select Committee or Panel in other countries

**Parliament of New Zealand**

- Select Committee on Economic Development, Science and Innovation

**Parliament of Australia**

- Standing Committee on Industry, Innovation, Science and Resources

**Parliament of Canada**

- Standing Senate Committee on Social Affairs, Science and Technology
- House of Commons Standing Committee on Industry, Science and Technology

**European Parliament**

- Science and Technology Options Assessment

**Netherlands**

- Committee on Education, Culture and Science

**Switzerland**

- Science, Education and Culture Committee

As a comparison, the current Committees of the Parliament of Malaysia are as follows:

- Committee of Selection
- House Committee
- Committee of Privileges
- Standing Orders Committee
- Public Accounts Committee

## 1.5 STI GOVERNANCE AT STATE LEVEL

Unlike water- and land- related issues which fall directly under the jurisdiction of the State Governments but is coordinated between both governance through MSAN [*Majlis Sumber Air Negara*; (National Water Resources Council)] and MTN [*Majlis Tanah Negara*; (National Land Council)] respectively, STI related matters fall directly under the purview of the Federal Ministry – MOSTI.

In April 2017, the Minister of MOSTI chaired a meeting involving Federal Ministries and STI actors from State Governments to discuss on STI-related matters. Besides this meeting, currently there is no dedicated platform between the Federal Government and State Governments to discuss matters related to STI. If this platform is formalised, it could be an apt federal-state platform for effective delivery and coordination of STI governance.

The stocktaking process (summarised in Figure 1.7) found that there are no dedicated STI state executive councillors (Exco) for most of the states; existing post include responsibilities beyond just STI at present. Out of 11 states in the Peninsular Malaysia, three states do not have an Exco that looks into STI development.

Sabah is the only state with a Science Advisor to the Chief Minister. While in Sarawak, the closest STI-related Ministry is the Ministry of Education, Science and Technological Research.

**Perlis**
Natural Resources and Environment; Science, Technology and Innovation; Information and Communication Technology Development (ICT), Corporate Communications Affairs & Public Complaints; Special Duties

**Kedah**
**Science, Innovation and Information Technology**; Communication and High-Technology; Human Resources

**Kelantan**
Agriculture, Bio Technology and Green Technology

**Penang**
State Economic Planning, Education & Human Resources, Science, Technology and Innovation

**Perak**
Education; Science, Environment and Green Technology

**Terengganu**
*Exco Pendidikan, Sains, Teknologi dan Transformasi Kerajaan Negeri*

**Pahang**
Health, Human Resources and State-related Special Tasks

**Selangor**
Education; Human Capital Development; Science, Technology and Innovation

**Negeri Sembilan**
Education and Health

**Malacca**
Education; Higher Education; Science and Technology; Green Technology and Innovation

**Johor**
Health and Environment; Education and Information

**Sarawak**
Minister of Education, Science and Technological Research

**Sabah** * **Science Advisor to Chief Minister of Sabah**
Ministry of Resource Development and Information Technology Advancement

**Figure 1.7**
**STI-related Exco in the States of Malaysia** *(as of December 2017)*

It is suggested that state governments in Malaysia should emphasise on the following undertakings concerning STI:

- To increase STI support for economic corridors;
- To ensure R&D activities for economic corridors' focus areas to be conducted by regional researchers/universities; and
- To strategically locate STI-related agencies in the state/region to support economic corridors activities.

In terms of STI governance at state level, it is imperative for state governments to consider the following:

- State plan/objective/blueprint to be translated into STI actionable item and goals;
- State governments to have a dedicated committee on STI that deliberates issues related to STI;
- Committee to be chaired by Chief Minister of the respective state; and
- Appointment of a Science Advisor to provide independent advice to the *Menteri Besar*/Chief Minister and committee

The Economic Corridor Initiatives play a vital role in linking state and federal government agendas through identifying key enabling technologies critical for ensuring efficiency, productivity and competitiveness of the economic sectors. The STI Committee under the purview of respective Chief Ministers/ *Menteri Besar* should then coordinate and monitor state STI development initiatives empowered by the economic corridors. Having State-level STI Committees will also assist in coordinating R,D&C linkages between the industries promoted by the economic corridors with the various institutions of higher learning and research institutes in the state. This can create the desired synergy to ramp up R,D&C activities with direct on-the-ground benefit and optimising the use of financial capital as well as talent in STI-led knowledge and wealth creation.

## **Economic Corridors in Malaysia** (adapted from the 9th Malaysia Plan)

**Iskandar Malaysia (2006-2025)**
*"A Strong and Sustainable Metropolis of International Standing"*

Corridor Authority:
**Iskandar Region Development Authority (IRDA)**

Area:
**2,216 km²**
**(Johor Bahru district and part of Pontian)**

Focus Sector / Industry:
**Education, Electrical & Electronics, Tourism, Petrochemical, Healthcare, Food Manufacturing, Financial, Logistics, ICT & Creative Industries**

Investment Target:
**RM382 billion**

Employment Target:
**1.4 million**

**Northern Corridor Economic Region (NCER) (2007-2025)**
*"World-Class Economic Region by 2025"*

Corridor Authority:
**Northern Corridor Implementation Agency (NCIA)**

Area:
**17,816 km²**
**(Pulau Pinang, Kedah, Perlis and Northern Perak)**

Focus Sector / Industry:
**Talent, Tourism, Manufacturing, Logistic & Agriculture**

Investment Target:
**RM178 billion**

Employment Target:
**3.1 million**

**East Coast Economic Region (ECER)** (2007-2020)
*"A Developed Region-Distinctive, Dynamic and Competitive"*

Corridor Authority:
**East Coast Economic Region Development Council (ECERDC)**

Area:
**66,736 km²**
**(Pahang, Kelantan, Terengganu & Johor-Mersing)**

Focus Sector / Industry:
**Agriculture, Tourism, Manufacturing, Oil, Gas and Petrochemical & Talent Development**

Investment Target:
**RM112 billion**

Employment Target:
**1.9 million**

## STI-related initiatives by selected state governments'

*(states selected based available information)*

SABAH
DEVELOPMENT CORRIDOR

**Sabah Development Corridor (SDC)** (2008-2025)
*"Harnessing Unity in Diversity for Wealth Creation and Social Well Being"*

Corridor Authority:
**Sabah Economic Development & Investment Authority (SEDIA)**

Area:
**73,997 km²**
(Sabah)

Focus Sector / Industry:
**Agriculture, Talent, Manufacturing, Infrastructure, Tourism & Environment**

Investment Target:
**RM113 billion**

Employment Target:
**2.1 million**

SARAWAK SCORE
CORRIDOR OF RENEWABLE ENERGY

**Sarawak Corridor of Renewable (SDC)** (2008-2030)
*"Development and Industrialised State"*

Corridor Authority:
**Regional Corridor Development Authority (RECODA)**

Area:
**70,708 km²**
(Tanjung Manis-Similajau and inland region)

Focus Sector / Industry:
**Aluminium, Glass, Marine Engineering, Metal based Industries, Petroleum based Industries, Aquaculture, Livestock, Palm Oil & Tourism**

Investment Target:
**RM113 billion**

Employment Target:
**2.1 million**

- The **Penang Science Council (PSC)** is a state government's initiative to collaborate with industry to advance science education and encourage innovation & creativity in science was announced in 2009. To foster and develop a dynamic and innovative society, five key pillars, all led by industry captains were established: Sustainable Education and Learning, Cultivating Innovation & Research, Mentoring Young Scientific Entrepreneurs, Life Science & Medical Health and the Penang Tech Center.

- The **Penang State Secretariat Office** includes several STI initiatives in their Strategic Plan 2016-2020. One of the Strategic Initiatives is to establish a hub for ICT, technology learning and idea exchange. While several programmes to be executed under this Strategic Initiative are:
  - To establish Penang Science Café in every district of the state;
  - To establish ESTEEM (Engaging Science, Technology, Engineering, English, Maths) Learning Center in every district of the state; and
  - To establish Penang Tech Dome equipped with astronomy facilities and equipment.

- The **Penang Paradigm**, a 10-year development framework for the state was unveiled in 2013. Developed by the state's think tank, Penang Institute, the framework and among others proposed strategies and initiatives to enhance the state's economic growth potential by:
  - Addressing shortage of knowledge workers by 2018. 20% of knowledge workers will be made available in total workforce and Penang to have one additional comprehensive university.
  - Enhancing local innovative capacity- Interest in S&T to be instilled among the young and diffusion of new development in S&T to be accelerated through intensified and expanded programmes under Penang Science Cluster & Tech Dome Penang.
  - Improving synergy between industry-government-university-consulting relationships will be enhanced.
  - Establishing Penang as a regional education hub. Penang aims to attract foreign universities to set up campuses in the state.
  - Establishment of new professional training institutes in also in the pipeline.

- **Invest Selangor Berhad** is a one-stop investment solution agency that provides information, advisory services, as well as start-up or expansion assistance to potential and existing investors. Through Invest Selangor, the State Government has set-up three councils to push industries forward.
- **Selangor Information Technology and E-Commerce Council (SITEC)** is an entity under the secretariat of Invest Selangor to develop Selangor as the regional trading hub for e-commerce, and to uplift the startup ecosystem. Established by the Selangor State Government, SITEC chaired by Selangor State Exco in charge of investment.
- **Selangor Bio Council** was established in March 2016 by Invest Selangor to generate thriving environment for biotechnology companies to advance. Under the Bio Council, Selangor Bio Bay will be developed and set to be a centre for research institutes, laboratories and biotech-related manufacturing activities.
- The **Selangor Aerospace Council**, is an initiative to drive the development of the aerospace sector in Selangor. Chaired by the Selangor *Menteri Besar,* its inaugural council meeting in was held in August 2016.

The state of Sarawak, has several STI-related organisations to leverage on its natural resources and biodiversity.

- **Sarawak Diversity Centre (SDC)** established as a State Statutory Agency under the Ministry of Education Science and Technological Research is entrusted to initiate intensive biotech-based R&D activities on the State's biological resources.
- **CRAUN Research**, an agency of the State's Ministry of Education, Science and Technological Research and Biotechnological Council pursues R&D strategies that ensure the sago industry is globally competitive and sustainable.
- **Agriculture Research Centre** provides the necessary technological support to guide the development of agriculture and food industries in Sarawak.
- **Tropical Peat Research Institute** undertakes cutting edge R&D and advisory support on tropical peatland management.
- **Forest Research Centre (FRC)** provides information necessary for formulating a sound management policy on the utilisation of forest resources.
- **Sarawak Information Systems Sdn. Bhd. (SAINS)** spearheads development and implementation of IT within the State Government to better integrate and utilize its resources.
- **Planetarium Sultan Iskandar** was established to raise awareness on astronomy to public.

**Terengganu Science & Creativity Centre (PSKT)** was established in March 2005 to create the awareness of science and technology among community. It is one of the state subsidiaries under The State Executive Council of Education, Science Technology and Special Task Committee with the long term goal of becoming the comprehensive learning centre of science, technology, and innovation in Malaysia. PSKT collaborates with the State Education Department of Terengganu, state agencies and private sectors to provide friendly and informative science galleries, activities and programmes. Selected STI based programmes organised by PSKT is as follows:

- Science Journey, workshops and exhibitions to promote STI
- *Cakap-cakap Sains*, a series of talk show to promote science, creativity, astronomy to local communities and students
- Meet The Scienster, a science awareness programme regarding career related to science
- Astronomy Programme
- Terengganu Setiu Wetland Camp, an awareness programme related to environment and biology
- Terengganu Turtle Camp
- Monsoon Science Camp
- *Festival Sains Teknologi Inovasi (FeSTI)*

## WAY FORWARD ELEVATE STI GOVERNANCE FOR STI ADVANCEMENT

STI is critical to fuel economic advancement and societal progress. STI also cuts across economic sectors, ministries and knowledge domains and cannot be viewed in isolation. As such, the governance of STI in the nation is crucial. A paradigm shift is required to transform the current complex, fragmented and ineffective STI governance to become one that is lean, empowering and efficient.

1

**Strengthen Science Planning and Coordination through a Centralised Dedicated Body**

The fragmented STI governance landscape at present causes inefficiency and dysfunction in the service delivery to support a strong innovation ecosystem. Alignment of national STI actors through a rationalisation exercise is proposed to be carried out and a centralised STI body is proposed to be established under the purview of the Prime Minister's Department aptly named as the Science Planning Unit (SPU).

The SPU will serve as the secretariat and executive arm of the NSC with the task of harmonising the roles and deliverables of all the STI players in the country. The core business of this body would be to follow through and facilitate implementations of decisions made by the NSC.

Through this institutional arrangement, science planning, co-ordination and monitoring across quadruple helix actors can be carried out in a structured manner. The proposed SPU is expected to complement EPU as the principal government agency responsible for the STI development of the nation.

For SPU to achieve its objectives, it must be granted a legitimate mandate that is supported with sustainable funding and strategic manpower. In short, SPU will be the enforcement arm of the NSC with a mandate that transcend all ministries to enable greater stakeholder participation and synchronised implementation. With SPU in place, a leaner ecosystem that allows direct contact between research and industry activities can be created.

2

**Establish a formal STI platform between Federal and States governments in West Malaysia as well as Sabah and Sarawak**

Effective delivery and coordination of STI governance at federal and state level require concerted cooperation between the two. A formal structure with clearly delineated expectations, roles, and supporting network will benefit the development and implementation of STI policies in each state.

A linear and formalised structure between Federal Government and states in West Malaysia is needed for information related to STI direction, initiatives and goals to be cascaded effectively to the states and vice-versa. The state of Sabah and Sarawak shall be further empowered in terms of mandate and resources to harness its natural resources and biodiversity through STI.

Once the structure between Federal Government and West Malaysia is established and formalised, STI ecosystem in Sabah and Sarawak can be further enhanced by adopting a parallel STI Governance structure with the Federal Government.

# FURTHER READING

**Appendix 1.1**

## Active STI-Related National Policies in Malaysia

**Ministry of Science, Technology & Innovation (MOSTI)**

1. National Biotechnology Policy 2005 - 2020
2. National Cyber Security Policy 2007
3. National Policy on Science, Technology & Innovation 2013 - 2020
4. National Space Policy 2017-2030

**Ministry of Natural Resources & Environment (NRE)**

5. National Forestry Policy 1978
6. National Policy on the Environment 2002
7. Second National Mineral Policy 2009 - 2020
8. National Policy on Climate Change 2010
9. National Water Resources Policy 2012
10. Second National Policy on Biological Diversity 2016-2025
11. National Wetland Policy 2004

**Ministry of Energy, Green Technology and Water (KeTHHA)**

12. National Biofuel Policy 2005
13. National Renewable Energy Policy and Action Plan 2009
14. National Green Technology Policy 2009

**Ministry of Health (MOH)**

15. National Policy of Traditional and Complementary Medicine 2001
16. National Nutrition Policy of Malaysia 2005 - 2020
17. National Organ, Tissue and Cell Transplantation Policy 2007
18. National Health Policy For Older Persons 2008 - 2020
19. Second Malaysian National Medicines Policy 2012
20. National Mental Health Policy 2012

**Ministry of Education (MOE) & Ministry of Higher Education (MOHE)**

21. 60:40 Policy 1967
22. Third National Education Policy 2012

**Ministry of Agriculture (MOA)**

23. National Agro-Food Policy 2011-2020

**Ministry of International Trade and Industry (MITI)**

24. Third Industrial Master Plan for National Industrial Policy 2006 - 2020
25. National Automotive Policy 2014

**Ministry of Defence**

26. National Defence Policy 2010

**Ministry of Plantation Industries and Commodities (MPIC)**

27. National Timber Industry Policy (NATIP) 2009 – 2020
28. National Commodity Policy 2011-2020

**Ministry of Youth And Sports (KBS)**

29. Second National Sports Policy 2009
30. Malaysian Youth Policy 2015-2035

**Ministry of Domestic Trade, Co-Operatives and Consumerism (KPDNKK)**

31. National Intellectual Property Policy 2007
32. Intellectual Property Commercialisation Policy 2009
33. Second National Co-operative Policy 2011-2020

**Ministry of Communications and Multimedia (KKMM)**

34. The National Telecommunication Policy 1994 - 2020
35. Policy and Development Strategy of Malaysia Music Industry 2005
36. National Creative Industry Policy 2012

**Ministry of Urban Wellbeing, Housing and Local Government (KPKT)**

37. National Solid Waste Management Policy 2005-2020
38. Second National Urbanization Policy 2017 -2025
39. National Housing Policy 2011
40. National Landscape Policy 2011 – 2020

**Ministry of Women, Family and Community Development (KPWKM)**

41. National Social Policy 2003
42. National Child Policy 2009
43. National Child Protection Policy 2009
44. Second National Policy for Women 2009 - 2020
45. Second National Policy for the Elderly 2010

**Prime Minister Department (JPM)**

46. Vision 2020
47. New Transformation Policy 2011-2020
48. The National Policy for Development and Implementation of Regulations 2013

*Note: This list is non-exhaustive*
*Active policy is defined as policy that is still in its implementation period as of 2017 or policy that is still being referred to by the respective ministry.*

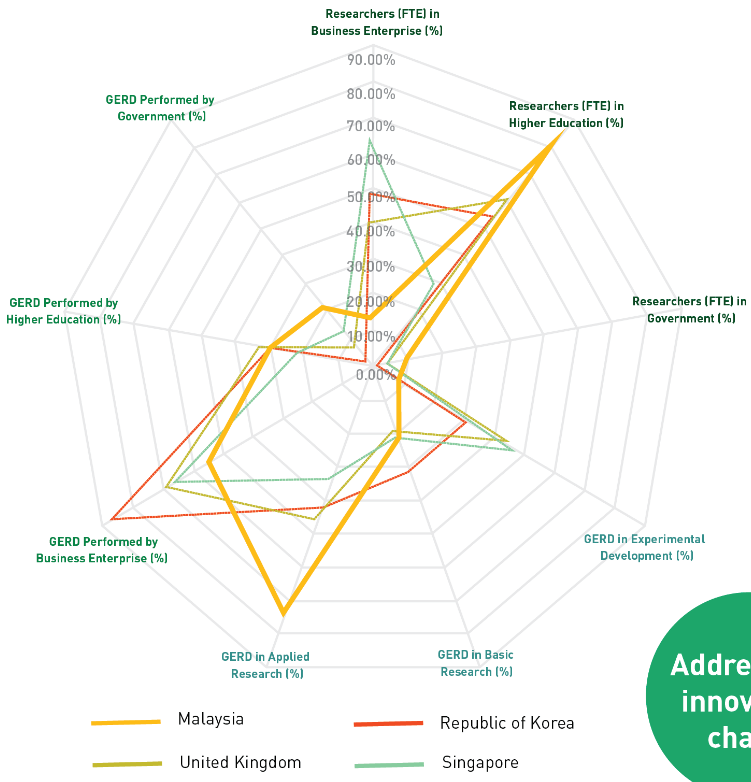
The above national policies were studied through text mining and cross checked by a research officer. A policy is deemed STI-related if it covers the use of STI to achieve the objective of the policy, the presence of research and development component in the policy or proposes research and development to achieve policy goals. Alternatively, a policy is also deemed as STI-related when statements regarding STI as a vague or general goal of the policy. The keywords used in the search are both in English and Bahasa Melayu with selected samples.

| Malay | English |
|---|---|
| penyelidikan, selidik, kajian, tinjauan,teknologi, pengetahuan, sains, saintifik, pemindahan teknologi, pemindahan pengetahuan, pembangunan komunikasi, perhubungan, inovasi | research, study, survey, R&D, technology, knowledge, science, scientific, technology transfer, knowledge transfer, development, communication, innovation |

# 02

# Research, Development & Commercialisation

## 1 RESOURCE ALLOCATION AND DISTRIBUTION




**Address the innovation chasm**

## 2 TRANSLATION OF COMMERCIALISATION

**Malaysia :** USD1.2 billion

**Singapore:** USD18.6 billion

**Thailand:** USD4.1 billion

**Indonesia:** USD1.6 billion

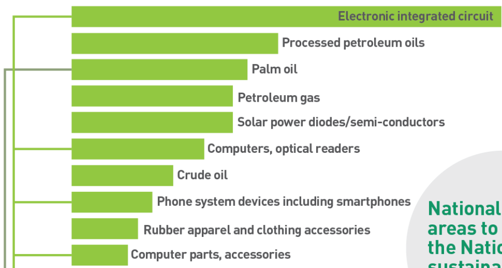
**Philippines:** USD0.6 billion

Our IP generates low income in comparison to ASIAN neighbours

More industry-led R&D initiatives needed

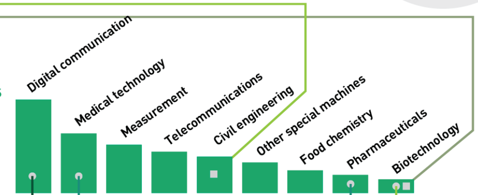
## 3 NATIONAL PRIORITY AREAS FOR R&D

Top 10 Highest Value Exports




National priority areas to address the Nation's sustainability and economic growth

Top 10 Resident Patent Filings in Malaysia by Field of Technology, 2015




National Priority Areas for Research and Development

## National R, D & C Investment and Productivity

Research, development, and commercialisation (R,D&C) has been on-going in Malaysia since before the Independence. The British colonial government had set up a number of public research institutes (PRIs) – mostly to support primary commodity sectors such as palm oil, rubber, and minerals – others focussing on health research and industrial support. Since then, R,D&C activities in Malaysia include the 20 public institutions of higher learning (IHLs) and private universities with research focus in the country, as well as sundry private research institutions.

The nation's R,D&C efforts beyond the commodities, agriculture, and health sector were low until the 1990s. The surge of foreign direct investment (FDI) in manufacturing generated a demand for domestic technical skills and expertise for maintaining and adapting manufacturing equipment, as well as master industrial processes. Malaysia's economic growth trajectory was slowed down by the Asian financial crisis in 1997, necessitating Malaysia to search for new sources of growth and increasing investments in intangible assets through R,D&C. In 2015, the R,D&C expenditures of IHLs, PRIs, and business enterprises were approximately RM15 billion (about USD3.54 billion), roughly 20 times higher than in 1996.

Investment in R,D&C from both the public and private sector amount to millions of ringgit annually in the form of gross expenditure on research and development (GERD); the outcome of which are measured by the number of publications, patents filed and granted, as well as income generated from patents. Examining these parameters periodically is important to assess whether the policies supporting them are performing as expected, or require adjustments to support Malaysia's move to become an advanced economy through technological innovation.

## HINDSIGHT.

Science Outlook 2015, R,D&C Chapter highlighted **two** recommendations.

| 2015 Recommendations | | Development |
|---|---|---|
| Empowering a body will help oversee, manage and evaluate all R,D,C & I budgets for a seamless and smooth transition from the Pre-R&D stage to subsequent stages of R,D,C&I, Early Stage Commercialisation and Commercialisation. Additionally, it will be possible to evaluate beyond the ROI by integrating intellectual property (IP), industry set-up, role of solution-providers, interest of researchers and project managers for sustainable R,D,C&I, with socio- economic benefits. | **EMPOWER CENTRALISED COORDINATION BODY** | As indicated by the 11th Malaysia Plan, the cabinet has approved for a RMA; however, the establishment plans are not clear. |
| For better planning and targeted results, empowerment of existing organisation/s for centralised funding mechanism or management is crucial. An introduction of a special purpose Ideation Fund may help evidence-based decision making, when choosing the areas of R,D,C&I as well as towards efficient allocation of resources to achieve optimum capacity. | **EFFECTIVE USE OF GERD** | No identified mechanisms in place on the recommendation to improve the effectiveness of the nation's GERD utilisation. |

## 2.1 GROSS EXPENDITURE IN RESEARCH & DEVELOPMENT (GERD)

Malaysia's GERD observed an upward trend over the years (Figure 2.1). The National Science, Technology and Innovation Policy (2013-2020) (NPSTI) aims to achieve 2% GERD/GDP by 2020. However, the GERD/GDP in 2015 was 1.3%, indicating the need for Malaysia to consistently maintain an average growth rate of 0.14% of GERD/GDP per year for R&D investment from business enterprises and the Government.

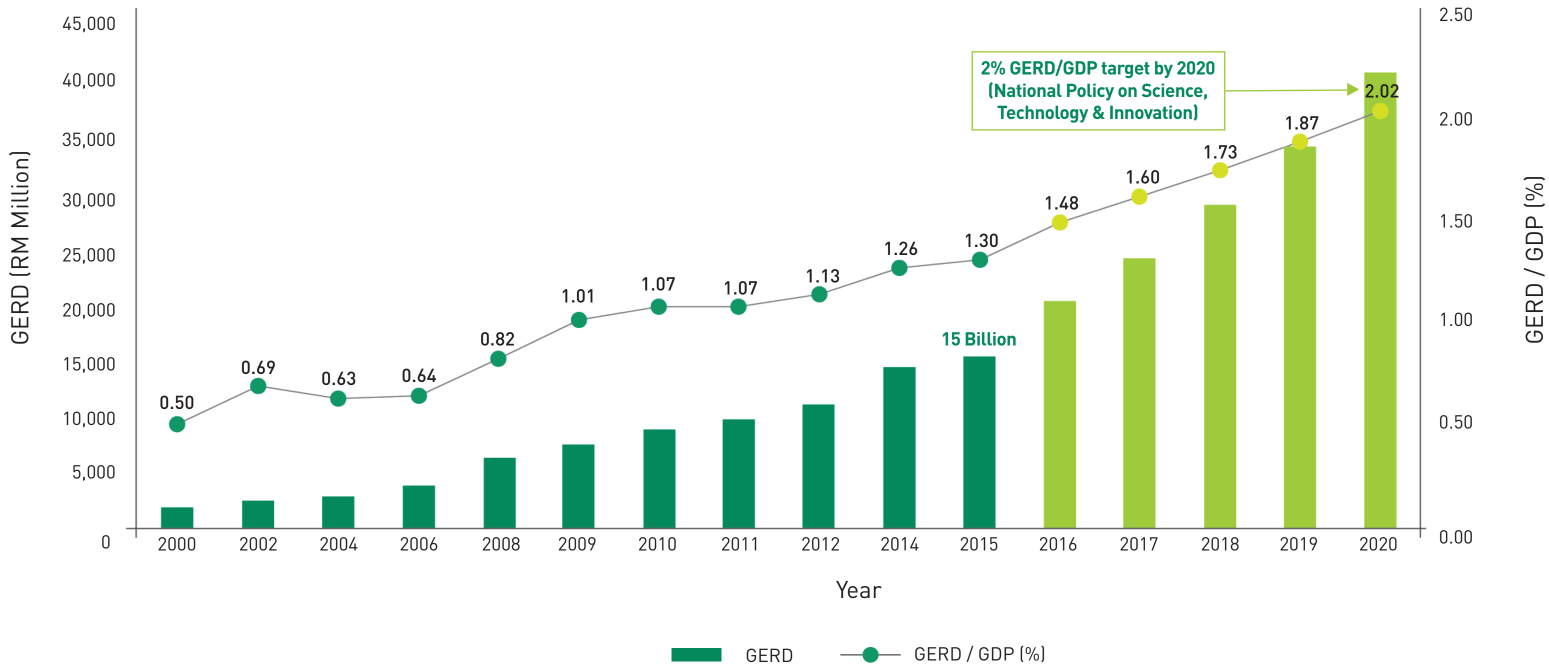



**Figure 2.1**

**Malaysia's Gross Expenditure on R&D (GERD) and Percentage of GERD/GDP**

Data Source: UNESCO Institute of Statistics Database, 2017 (Retrieved on 9 August 2017)

The country's percentage of GERD/GDP is ranked 29 out of 127 economies in the Global Innovation Index 2017; at 1.3% GERD/GDP, Malaysia is above European countries like Luxembourg, Portugal, Spain, Slovakia, and Greece. To date, only 19 economies have achieved 2% GERD/GDP, with Israel and Republic of Korea at the top with 4.3% and 4.2% GERD/GDP, respectively (Figure 2.2). The Europe 2020 strategy adopted by the European Council in 2010 aims to achieve 3% GERD/GDP by year 2020, but till now only three member countries (Sweden, Austria and Denmark) have achieved that target.

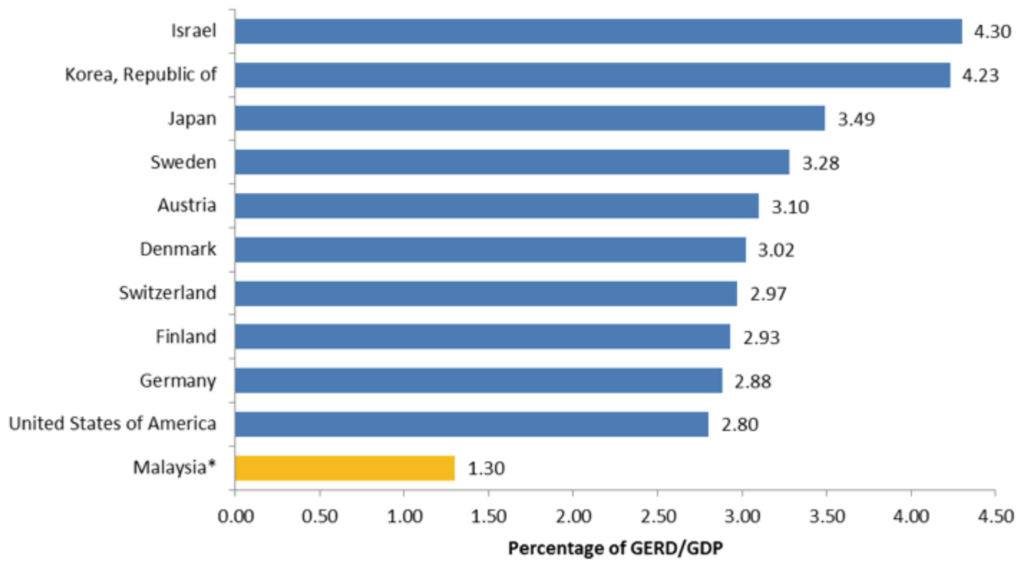



**Figure 2.2**

**Malaysia and Top 10 Economies with Highest GERD/GDP (%), 2015**

*Based on data from MASTIC's National R&D Survey 2016
Source: The Global Innovation Index 2017

## GERD by Sector of Performance

Business enterprises (BEs) are the largest contributing sector to the Malaysian GERD (Figure 2.3 & 2.4), similar to top innovative economies (Figure 2.5). Overall, the impressive increase in GERD from 2008 to 2015 was led almost exclusively by BEs even though there was a slight decline in 2011 and 2014. However, the GERD for BEs are not reflective in terms of percentage of GERD (Figure 2.4); the GERD percentage for BEs have decreased since 2008 and has been overtaken by IHLs in 2014, attributing to a spike from RM3 billion (28.7%) to RM6 billion (46.1%) (Figure 2.3). However, the GERD increase for IHLs declined to RM4 billion (28.5%) in the following year.

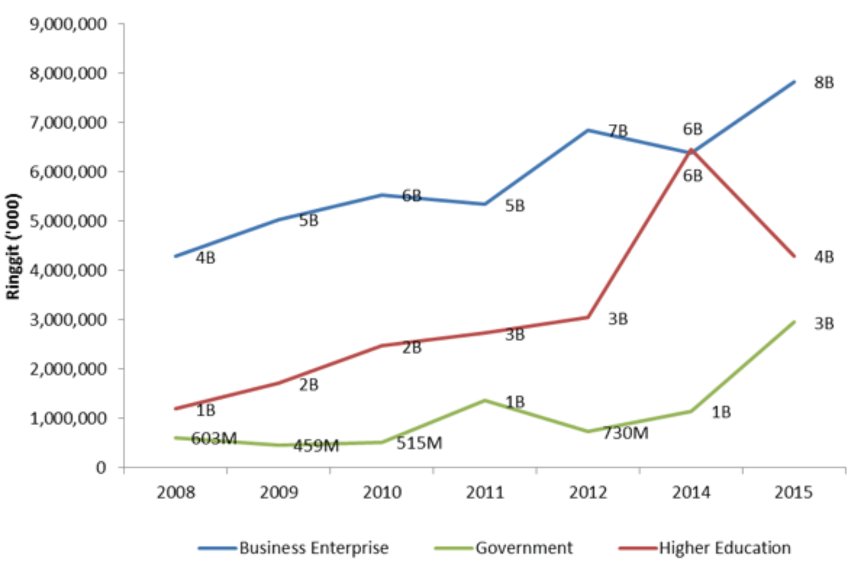



**Figure 2.3**
**Malaysian GERD by Sector of Performance, 2008-2015**

Data Source: UNESCO Institute of Statistics Database, 2017 (Retrieved on 9 August 2017)

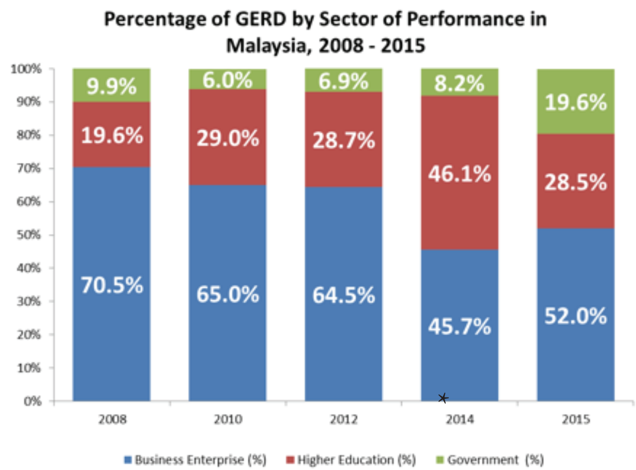



**Figure 2.4**
**Percentage of GERD by Sector of Performance in Malaysia, 2008-2015**

Data Source: UNESCO Institute of Statistics Database, 2017 (Retrieved on 9 August 2017)

**Note: The Science Outlook 2017 could not identify the cause of the sudden jump of R&D expenditure of Higher Education in 2014 and Government Research Institutes in 2015. It may be due to a change of methodology in data collection and interpretation. The annual National R&D Survey published by MASTIC is conducted by different consultants each year.*

GERD contribution by BEs in Malaysia is still low compared to top innovative economies, most of them achieving more than 60% than Malaysia's 52% (Figure 2.4). This shows that BEs in Malaysia are not pushing R,D&C as part of their business agenda as hard as advanced economies that rely on innovation-driven growth.

The funding for R,D&C in IHLs in Malaysia is comparable to most advanced economies (Figure 2.5) with the notable exception for Luxembourg, Republic of Korea and Japan. Luxembourg made up for the lack with greater investment in their PRIs; R,D&C investment in Republic of Korea is concentrated in the industry although driven by the government's STI agenda (Gupta et al., 2013).

To achieve 70% expenditure from BEs, the Government needs to spur growth of R,D&C in the private sector. At the moment, the biggest commitment for R,D&C in the private sector is from the multinational corporations (MNCs); very few small and medium enterprises (SMEs) engage in R,D&C (MyTIC, 2012). These MNCs still conduct R,D&C in Malaysia although their manufacturing plants are in countries with lower labour costs than Malaysia; this means that Malaysia is unable to fully enjoy the financial benefits of these MNC's innovations.

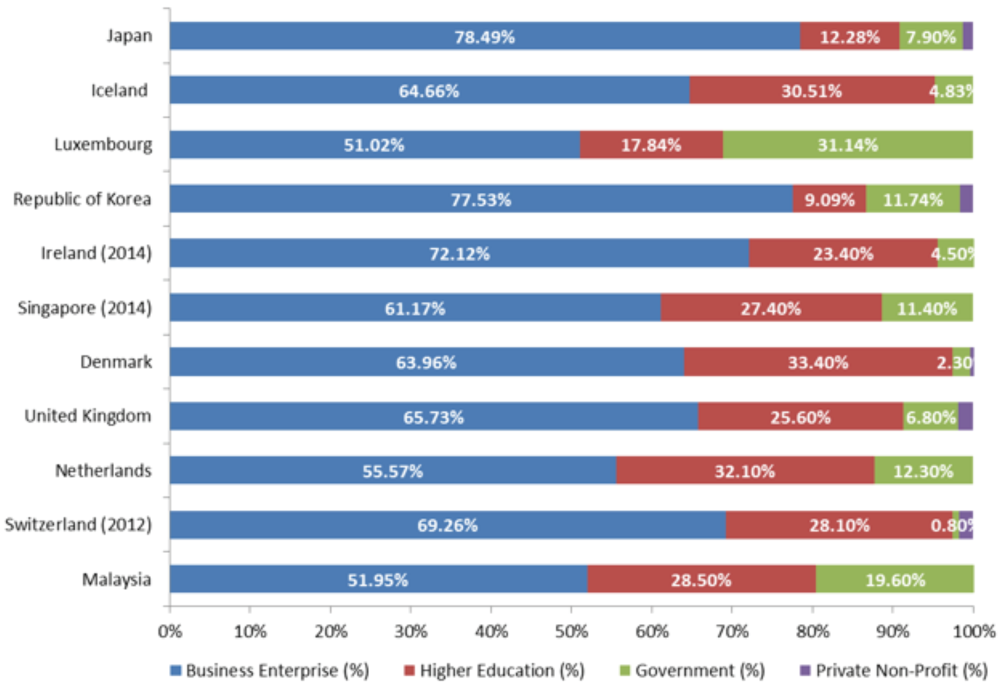



**Figure 2.5**

**GERD by Sector of Performance for Malaysia and Top Innovative Economies, 2015**

Data Source: UNESCO Institute of Statistics Database, 2017 (Retrieved on 9 August 2017)

## GERD by Type of R&D Activities

The rule of thumb is that basic research drives applied research; however in Malaysia, applied research has greater funding with an average of 68.07% from 2008 to 2015, followed by basic research (20.51%) and experimental development (11.42%) (Figure 2.6). There was a spike of greater funding in basic research in 2012, but the percentage has dropped since then.

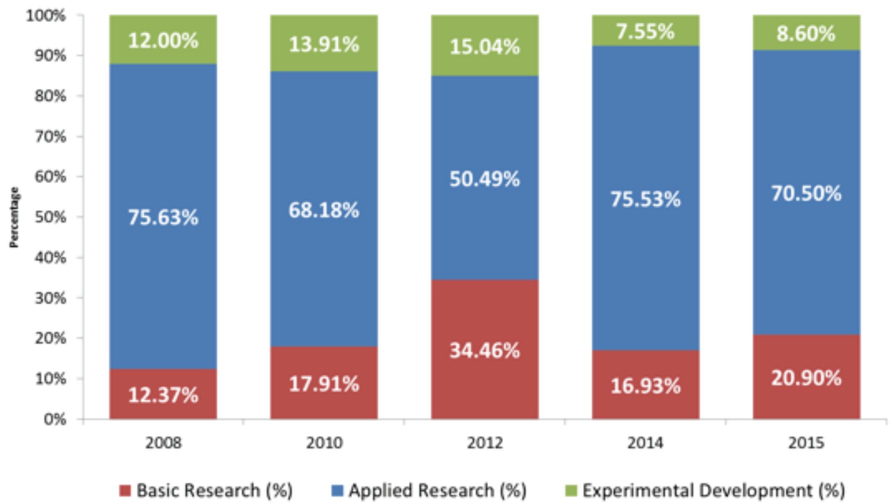


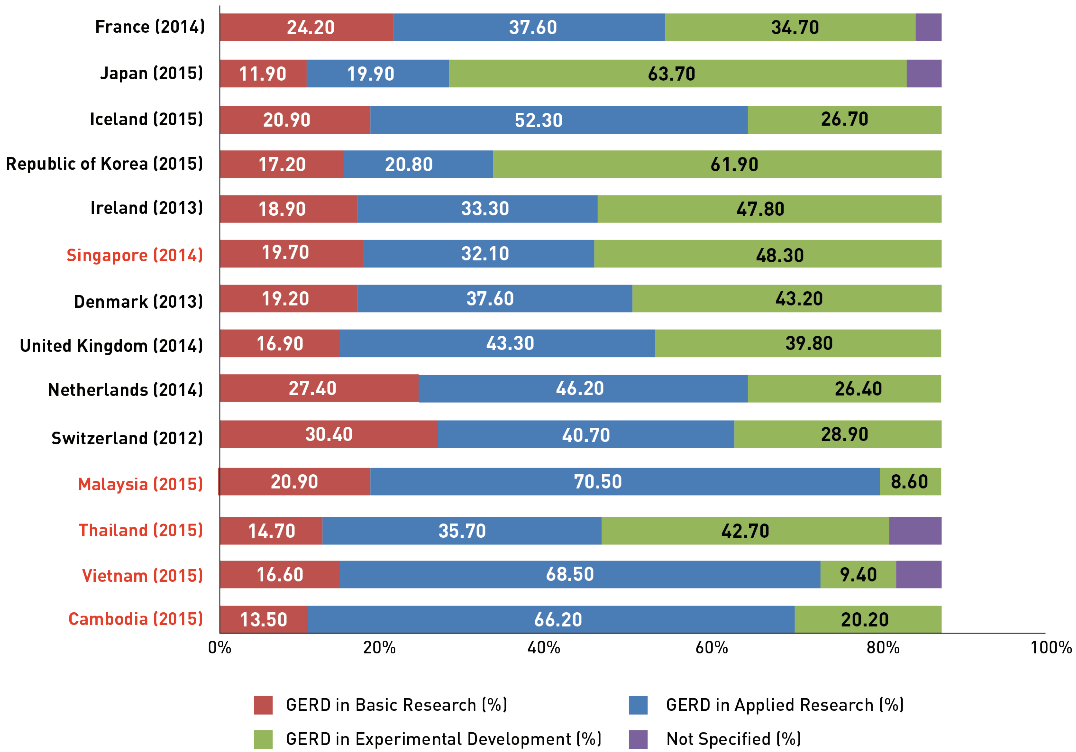

**Figure 2.6**

**Percentage of GERD by Type of R&D Activities in Malaysia, 2008-2015**

Data Source: UNESCO Institute of Statistics Database, 2017 (Retrieved on 9 August 2017)

Malaysia's GERD for experimental development has remained low over the years while majority of the GERD is spent on applied research. This could be attributed to the research funding focus trend in Malaysia; the highest amounts of research grants are channelled into applied research. The allocation for basic research shows a similar pattern to developed economies (Figure 2.7).

When benchmarked against top innovative economies, Malaysia has significantly less GERD in experimental development (8.6%) in 2015, which may indicate a bulk of the applied research did not progress to commercialisation stage (Figure 2.7). This is unlike the Republic of Korea which focus on experimental development (61.90%), followed by applied research (20.80%) and basic research (17.20%), leveraging on strong ties between industries, GRIs and PRIs to push the R,D&C cycle.

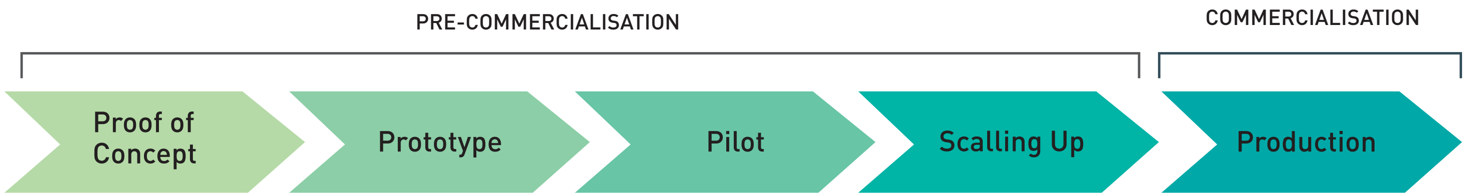


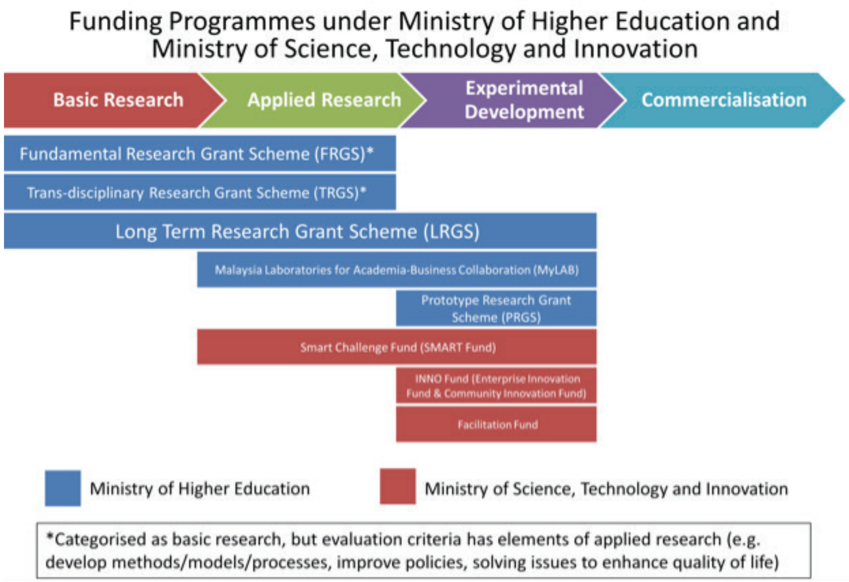

Even though Malaysia's percentage of basic research is similar to top innovative economies, the percentage of applied research and experimental development greatly differ. Malaysia's high percentage of applied research and extreme low percentage of experimental development could indicate the lack of potential for applied research to move to experimental development stage. As a result, only a handful of research can be developed into products and services for commercialization. This could be caused by the lack of collaboration between university and industry.

Activities in experimental development are similar to the ones in pre-commercialisation stage which covers proof of concept, prototype, pilot projects and the process of scaling up.

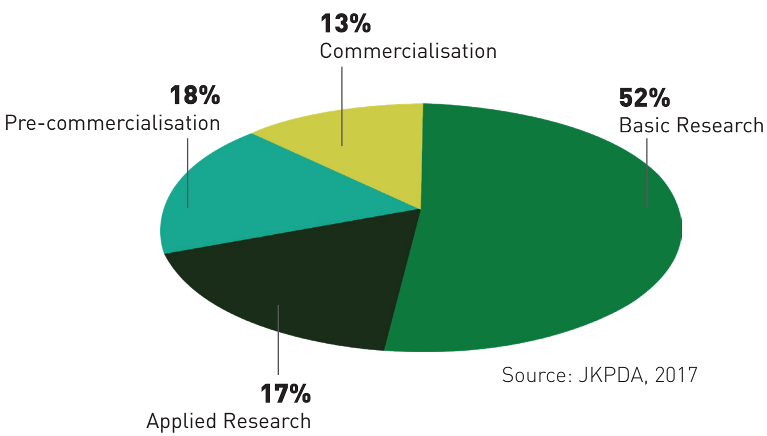
**Figure 2.7**
**GERD by Type of R&D Activities**

Data Source: UNESCO Institute of Statistics Database, 2017 (Retrieved on 9 August 2017)






**Programmes Funded by Malaysian Government, 2017**




Source: JKPDA, 2017

Most funding programmes under Ministry of Higher Education (MOHE) and Ministry of Science, Technology and Innovation (MOSTI) do cover the expenditure for experimental development. However, only 18% of the funding programmes (majority from MOHE and MOSTI) were utilised for pre-commercialisation (experimental development equivalent) in 2017. More financial allocation for experimental development is needed for research to translate into commercializable products or services.

## 2.2 RESEARCHERS (FULL-TIME EQUIVALENT)

The NPSTI aim to increase the ratio of researchers per 10,000 workforce to at least 70 by 2020. The number of full-time equivalent (FTE) researchers in the country has been growing steadily since 2008, reaching 69,864 in 2015 (Figure 2.8). Malaysia is ranked 37 out of 127 economies in the number of researchers (FTE) per million population in the Global Innovation Index 2017 report. Figure 2.8 includes researchers from social sciences, humanities and arts.

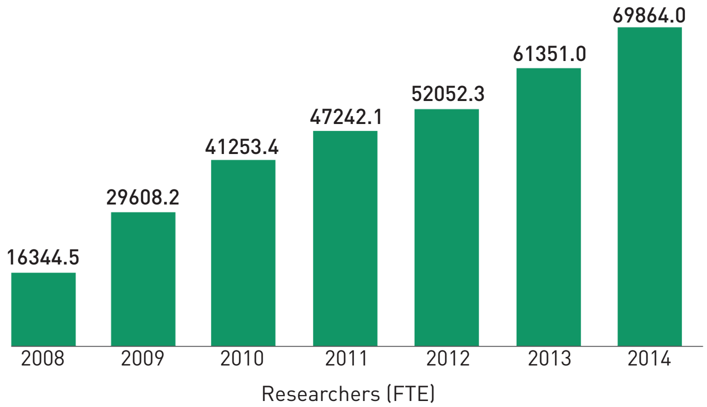



**Figure 2.8**
### Total Number of Researchers in Malaysia (FTE), 2008-2015

Data Source: UNESCO Institute of Statistics Database, 2017
(Retrieved on 8 August 2017)

However, the top 10 economies have 2.5 to 4 times more researchers (FTE) than that of Malaysia, indicating a need for Malaysia to increase the number of researchers to achieve greater R&D intensity (Figure 2.9). The difficulty for Malaysia to achieve parity with other advanced economies for this particular parameter is discussed at length in Chapter 3.

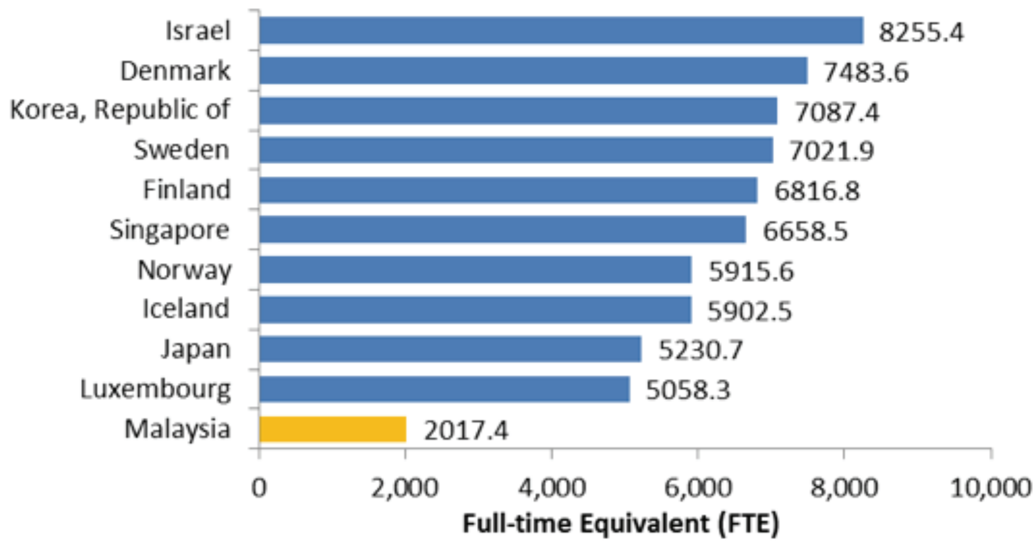



**Figure 2.9**
### Malaysia and Top 10 Economies with Highest Number of Researchers (FTE) per Million Population

Source: The Global Innovation Index, 2017

## Researchers (FTE) by Sector

Majority of the researchers (FTE) in Malaysia are in IHLs (averaging 81.40% between 2010 -2015) with the rest in BEs (11.82%) and PRIs (6.82%) (Figure 2.10). This is an interesting trend considering that most of Malaysia's GERD expenditure is supported by the private sector (Figure 2.4). This imbalance in the number of researchers versus funding allocated for their organisation may be another contributing factor to the inefficiency and ineffectiveness of GERD utilisation in Malaysia.

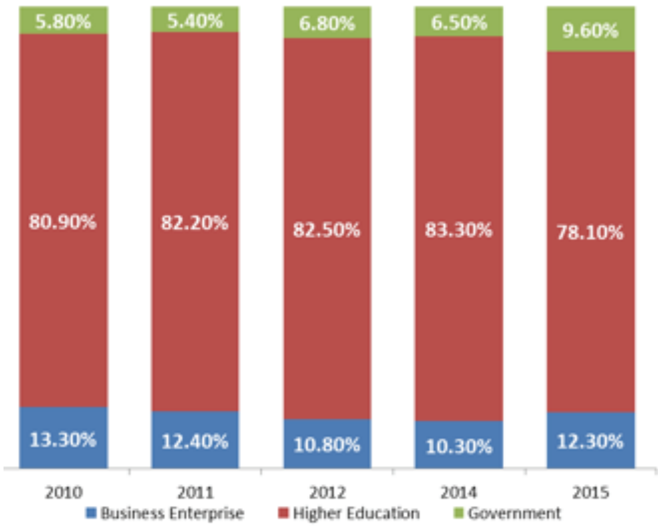



**Figure 2.10**

**Percentage of Researchers (FTE) in Malaysia by Sector of Performance, 2010-2015.**

Data Source: UNESCO Institute of Statistics Database, 2017 (Retrieved on 8 August 2017)

In stark contrast to Malaysia, more than 50% of the researchers in top innovative economies work for the industry, indicating that the greatest proportion of research is done by the private sector (Figure 2.11). Industry-led R,D&C is key to technological innovations that drive the nation's economic expansion. Malaysian industries are not innovating using R,D&C like the top economies in Figure 2.12, which makes the country vulnerable to technological seismic shifts that affect the global financial system. This may also be an indicator of Malaysia's readiness (or lack of it) for Fourth Industrial Revolution which is expected to be a game changer in the 21st century interconnected economy.

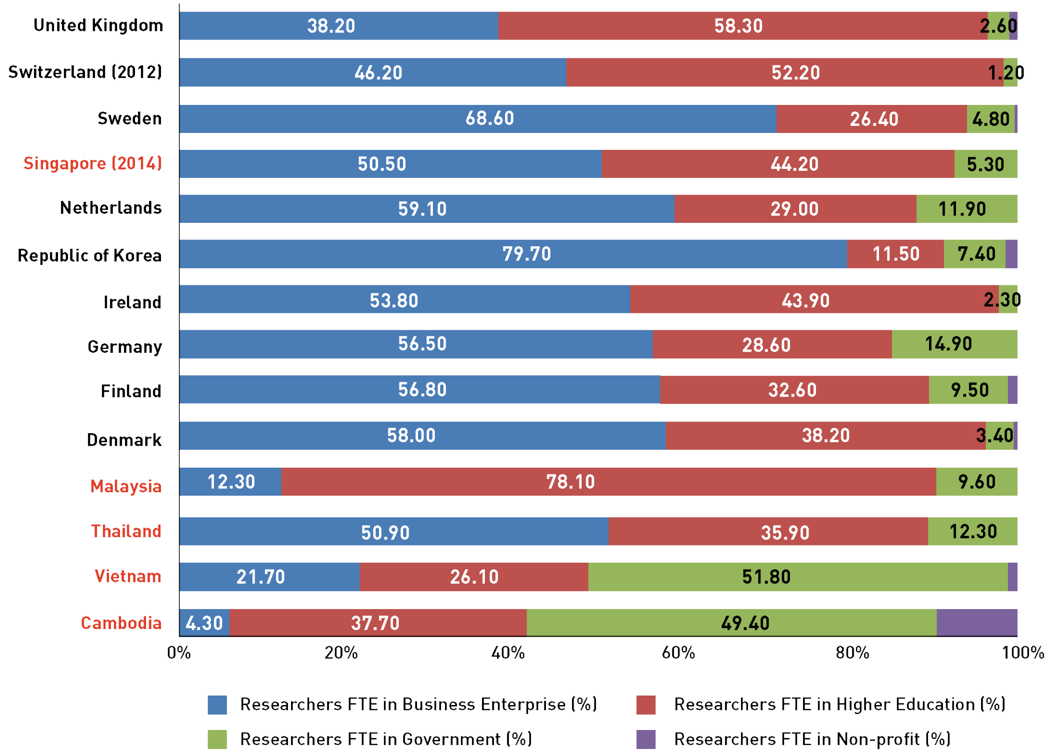



**Figure 2.11**

**Percentage of Researchers (FTE) by Sectors for Malaysia and Top Innovative Economies, 2015.**

Data Source: UNESCO Institute of Statistics Database, 2017
(Retrieved on 11 August 2017)

One way of addressing this imbalance between research talent and financial capital is by increasing R,D&C collaboration between BEs and IHLs. The Public-Private Research Network (PPRN) initiated by Ministry of Higher Education (MOHE) is one of the strategies to work on this issue (see Chapter 4). Most universities also have a Technology Transfer Office (TTO) responsible for coordinating the commercialisation aspect of the institution's R,D&C; the TTO should lead the university's R&D marketing strategy in tandem with their researchers.

For government research institutions, more effort should be directed towards R&D. Based on an internal study by EPU in 2017 on the National Public Research Institutes, researchers in government research institutions are more focused on administrative tasks rather than research. Setting the right KPI to ensure 70% of a researcher's time is utilised on research should be the way forward.

## 2.3 THREE-INDICATOR COMBINED BENCHMARKING

Benchmarking GERD source, type of research, and researchers of selected top performing economies can give us an idea of the best practices in GERD utilisation (see Appendix 2.1). The profile of these economies are placed against Malaysia's to compare the pattern and see if the country is on the right track (Figure 2.12). In terms of GERD source, Malaysia is comparable to the selected economies with the greatest GERD source from the BEs, followed by IHLs and PRIs.

The 2017 Global Innovation Index categorised research talent in business enterprise as a weakness for Malaysia; Malaysia is ranked 66th, far behind other ASEAN economies like the Philippines (8th), Thailand (21st), Singapore (23rd), Indonesia (39th) and Viet Nam (54th). This could be because the highest percentage of researchers (FTE) in Malaysia is skewed toward IHLs whereby majority of the researchers in the selected economies are within the BEs. BEs should be encouraged to take advantage of this scientific talent by setting up more collaboration with IHLs for their R&D services. SMEs with lower R,D&C capital can leverage on this association for profitable resource sharing without the need to invest in R,D&C physical set up or manpower to add value to their products and/or services.

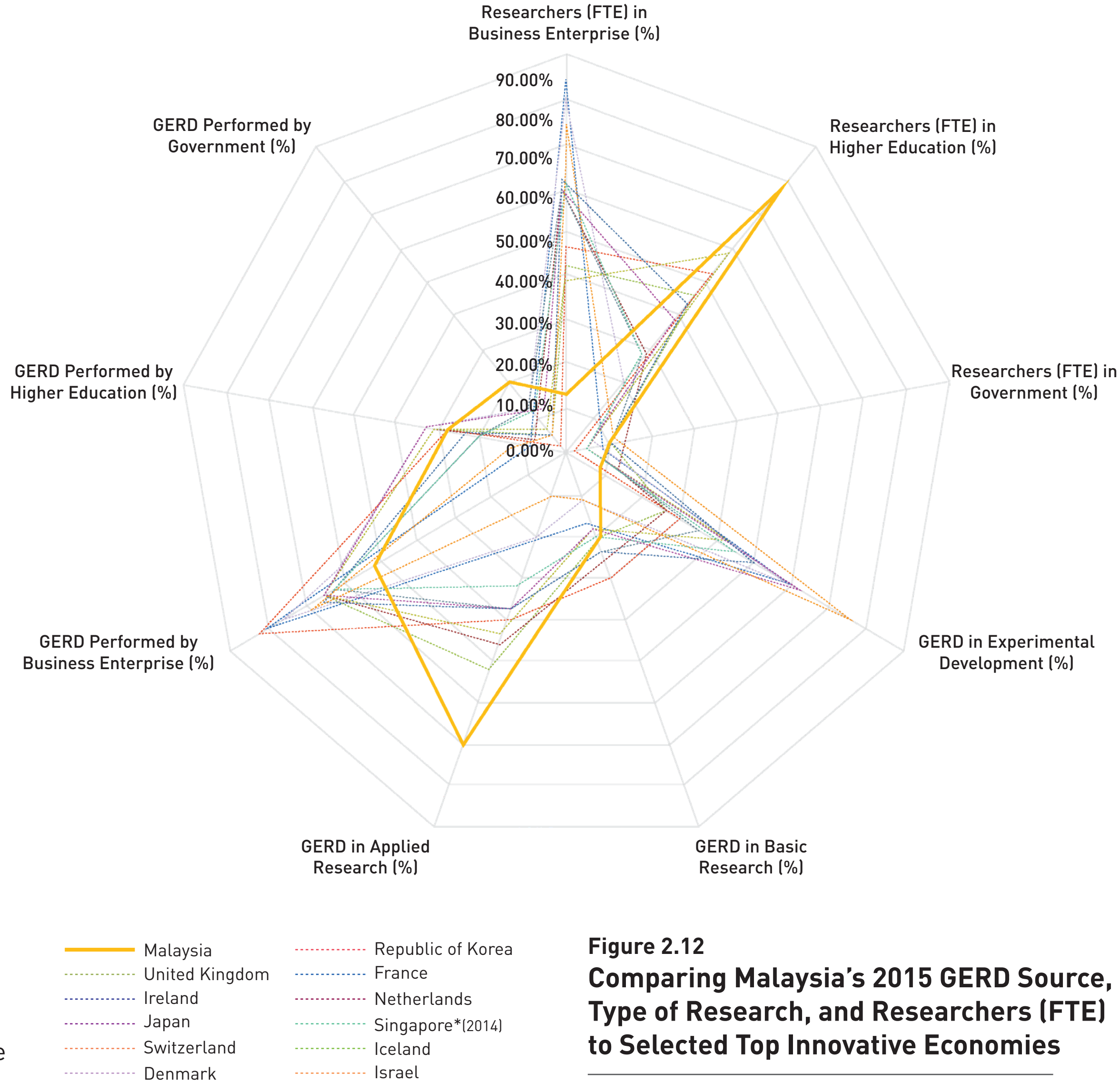



**Figure 2.12**
**Comparing Malaysia's 2015 GERD Source, Type of Research, and Researchers (FTE) to Selected Top Innovative Economies**

Data Source: UNESCO Institute of Statistics Database, 2017 (Retrieved on 8 August 2017)

Malaysia invests a huge amount in applied research but its outcome did not seem to move on to the experimental development stage (indicated by the low investment in this research type), which is the critical precursor to commercialisation; unlike top performing economies that invest more in basic and experimental development research, rather than applied research. Founding President of the Academy of Sciences Malaysia, Academician Emeritus Professor Tan Sri Datuk Dr Omar Abdul Rahman FASc, highlighted a crucial stage between invention and innovation known as "Prenovation" where critical enablers such as finance, talent and institutions are needed to determine its success (Figure 2.13). Advanced economies tend to have a longer R,D&C history with entrenched ecosystem for experimental development and commercialisation, with the notable exception of Republic of Korea. Therefore, they understand that investing money and time in basic and experimental development is a crucial component in innovation-led growth.

Incentivising experimental development research by BEs and IHLs should be made top priorities. Gap funds can be introduced as a financial enabler to support researchers in the development of prototypes hence reducing the risks involved in commercialising technology. Strengthening institutional capacity of pre-existing Technology Transfer Offices (TTOs) / Technology Licensing Offices (TLOs) in universities by installing permanent staff with appropriate career progression and training in commercialisation strategies should be the way forward.

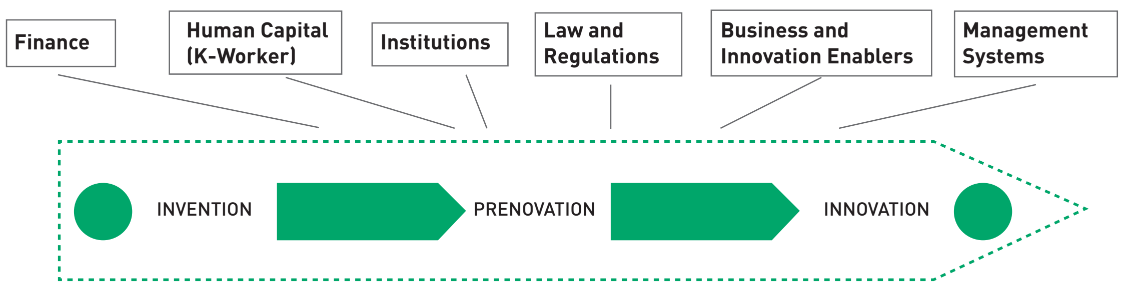



**Figure 2.13**
**From Invention to Innovation - The Critical Enablers**

Source: Omar Abdul Rahman, 2017

## 2.4 AVERAGE R&D EXPENDITURE PER RESEARCHER

Benchmarking the average R&D Expenditure per Researcher against top innovative economies indicate that Malaysian researchers received less funding for R&D (Table 2.1); Malaysia's average is PPP$118,379, while the average value of top innovative economies combined is 36% higher at PPP$160,540.

Malaysia can choose to increase funding for researchers to bring this average closer to advanced economies, which may not always be possible as the greatest number of Malaysia's researchers is in IHLs. This would incur more GERD from the Government (the goal is for BEs to increase their GERD share); unless BEs would increase their resource sharing with IHLs for R,D&C. We can consider trying to improve resource efficiency by doing more with less like the case of United Kingdom (whose expenditure per researcher is only PPP$90,361) which indicates good management of R&D productivity. However, Malaysia's R,D&C ecosystem is still rather new compared to the United Kingdom that has been conducting industry- and academic-led research since the Industrial Revolution in the 18th century; we have not reached that level of research efficiency.

**Table 2.1**
### Average R&D Expenditure per Researcher

Source: Global Innovation Index, 2017

| Country | Global Innovation Index 2017 Ranking | Gross Expenditure in R&D (GERD), PPP$ | Researcher Headcount (HC) | Average R&D Expenditure per Researcher, PPP$ |
|---|---|---|---|---|
| Switzerland (2012) | 1 | 13,669,878,710 | 60,278 | 226,781 |
| Sweden (2013) | 2 | 14,509,455,040 | 101,820 | 142,501 |
| Netherlands (2014) | 3 | 16,555,996,870 | 111,795 | 148,092 |
| United Kingdom (2014) | 5 | 44,202,850,400 | 489,181 | 90,361 |
| Denmark (2014) | 6 | 7,884,331,720 | 59,287 | 132,986 |
| Singapore (2014) | 7 | 10,068,169,990 | 40,730 | 247,193 |
| Finland (2014) | 8 | 7,191,709,340 | 55,515 | 129,545 |
| Germany (2013) | 9 | 102,998,522,120 | 549,283 | 187,514 |
| Ireland (2013) | 10 | 3,470,886,960 | 25,393 | 136,687 |
| Republic of Korea (2015) | 11 | 74,217,713,070 | 453,262 | 163,741 |
| **Malaysia (2015)** | **37** | **10,637,622,890** | **89,861** | **118,379** |

## 2.5 PUBLICATION

Publication in reputable journals that uses rigorous peer-review process is considered an important outcome in research. It signifies that the research output attains the standard set by the international scientific community as well as a contribution to the scientific body of knowledge.

Malaysia is ranked 34th globally in terms of total publication from 1996-2016 (SCImago, 2017). Although this performance is still far behind the top 10 economies with highest published documents (Figure 2.14), it is still a notable accomplishment considering these economies have a significantly higher amount of GERD and number of researchers.

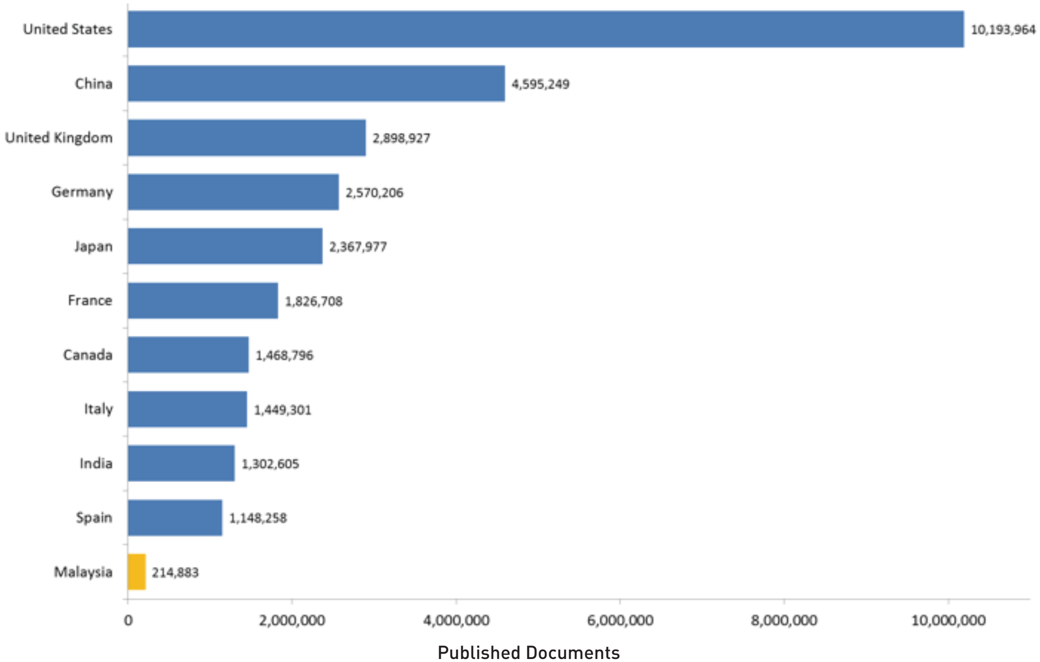



**Figure 2.14**
**Malaysia in comparison to the Top 10 Economies with Highest Published Documents from 1996-2016**

Data Source: SCImago (Retrieved on 14 August 2017)

When benchmarked against ASEAN economies, Malaysia has boosted its publication since the appointment of UM, USM, UKM and UPM as research universities (MRUs) in 2006, UTM following suit in 2010. Based on the Malaysian Research Assessment (MyRA) data, MRUs contributed 70% of the total publications; recording a quantum leap of publication since 2007 (Figure 2.15). Malaysia surpassed Thailand in 2008, Singapore in 2010, and topped the publication number in ASEAN economies in 2011. Since then, Malaysian scientific publication generation has entered the maturity stage with a steady growth, attributed to the emergence of new public and private universities in R&D and publication.

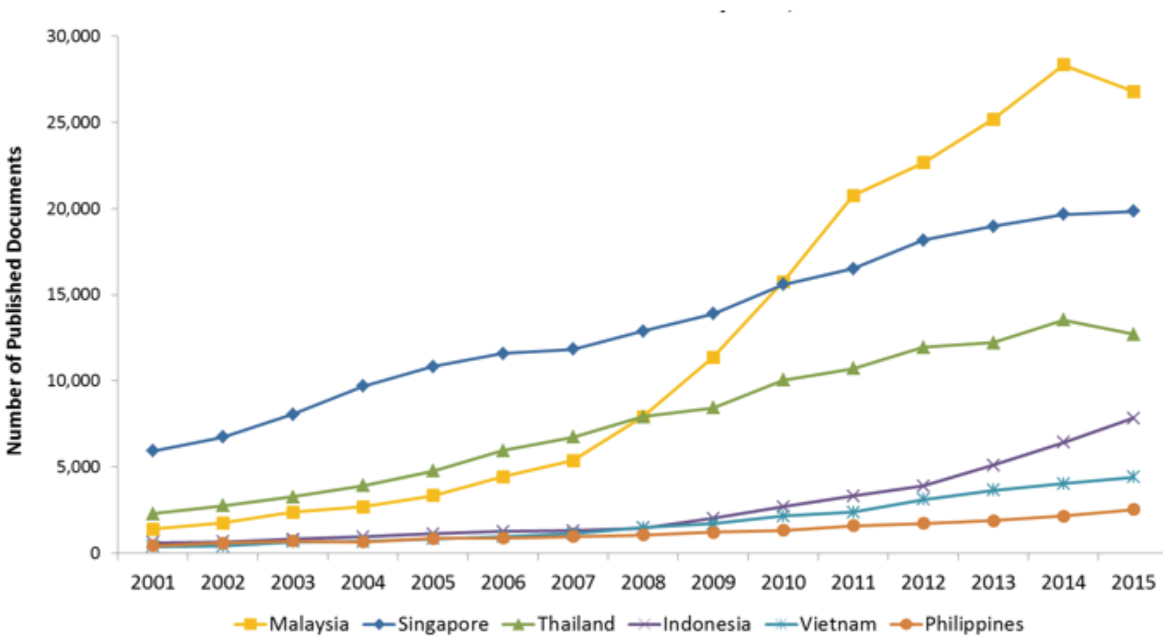



**Figure 2.15**
**ASEAN Countries: Published Documents by Year, 2001-2015**

Data Source: SCImago (Retrieved on 14 August 2017)

Malaysian average of published documents per researcher is 0.37, which is on par with Japan (0.38) (Table 2.2). However, when benchmarked against other top innovative economies like United Kingdom (0.55) and Germany (0.62), Malaysia's researchers' productivity can still be improved. This needs to take into account the funding provided for each researcher in those economies compared to Malaysia as well; as shown in Table 2.1, Malaysia's researchers for instance received 36% less funding compared to Germany which may affect their research output. Funding amount may also differ according to research areas; greater and/or lesser competition for financing can also influence researchers' productivity.

**Table 2.2**
## Average Published Documents per Researcher

Data Source: SCImago, 2017 & UNESCO Institute for Statistics, 2015

| Country | Published Documents, 2015 | Researcher Headcount in Higher Education, 2015 | Average Published Documents per Researcher |
|---|---|---|---|
| Luxembourg (2013) | 1,861 | 828 | 2.25 |
| Netherlands (2014) | 56,256 | 25,396 | 2.22 |
| Hong Kong (2014) | 16,393 | 14,311 | 1.15 |
| Singapore (2014) | 19,835 | 18,210 | 1.09 |
| Switzerland (2012) | 43,640 | 41,395 | 1.05 |
| France (2014) | 115,687 | 113,217 | 1.02 |
| Denmark (2014) | 25,697 | 28,113 | 0.91 |
| Sweden (2013) | 38,579 | 42,894 | 0.90 |
| Finland (2014) | 19,462 | 22,274 | 0.87 |
| Norway (2014) | 20,097 | 23,404 | 0.86 |
| Republic of Korea (2015) | 79,633 | 99,870 | 0.80 |
| Ireland (2014) | 12,752 | 17,022 | 0.75 |
| Iceland (2015) | 1,510 | 2,058 | 0.73 |
| Austria (2013) | 24,057 | 33,781 | 0.71 |
| Germany (2014) | 165,845 | 265,910 | 0.62 |
| United Kingdom (2014) | 188,882 | 342,696 | 0.55 |
| Japan (2015) | 121,840 | 322,100 | 0.38 |
| **Malaysia (2015)** | **26,796** | **73,291** | **0.37** |

## 2.6 INTELLECTUAL PROPERTY

Knowledge-based economy is driven by intellectual assets that provide economic returns. Malaysia is still far behind the top 10 economies in terms of patent applications (see Figure 2.16). China is leading the way with close to a million patents filed in 2015 alone, demonstrating China's determination to be an advanced economy driven by R,D&C innovation. It should be investigated on whether applied research performed in Malaysia is directed towards production of intellectual assets and value for patenting.

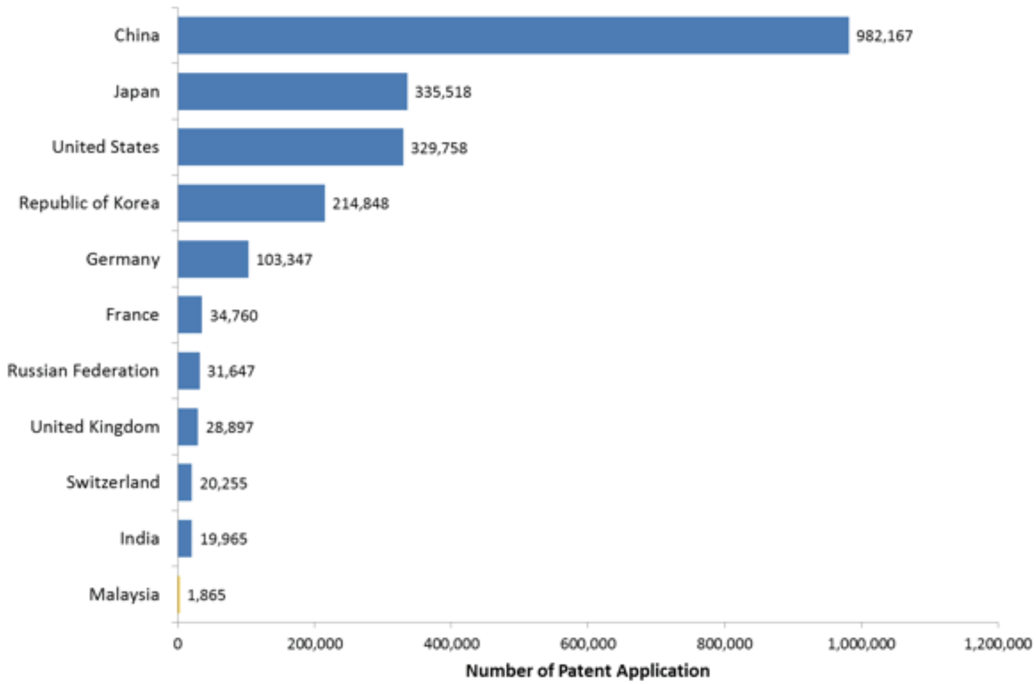



**Figure 2.16**
**Malaysia in comparison to the Top 10 Economies with Highest Patent Applications, 2015**

Data Source: World Intellectual Property Organization (WIPO) Statistics Data Centre (Retrieved on 15 August 2017)

The number of patents granted in Malaysia has been slowly increasing from the time it was first monitored in 1986; a significant jump was observed since 2005 (Figure 2.17). This is attributed to the appointment of research universities in 2006 where incentives were given to patent the research done in their laboratories. The number of patent applications and granted patents in Malaysia remained low. The reason for this observation should be investigated in order to support patent applicants to be more successful in their application.

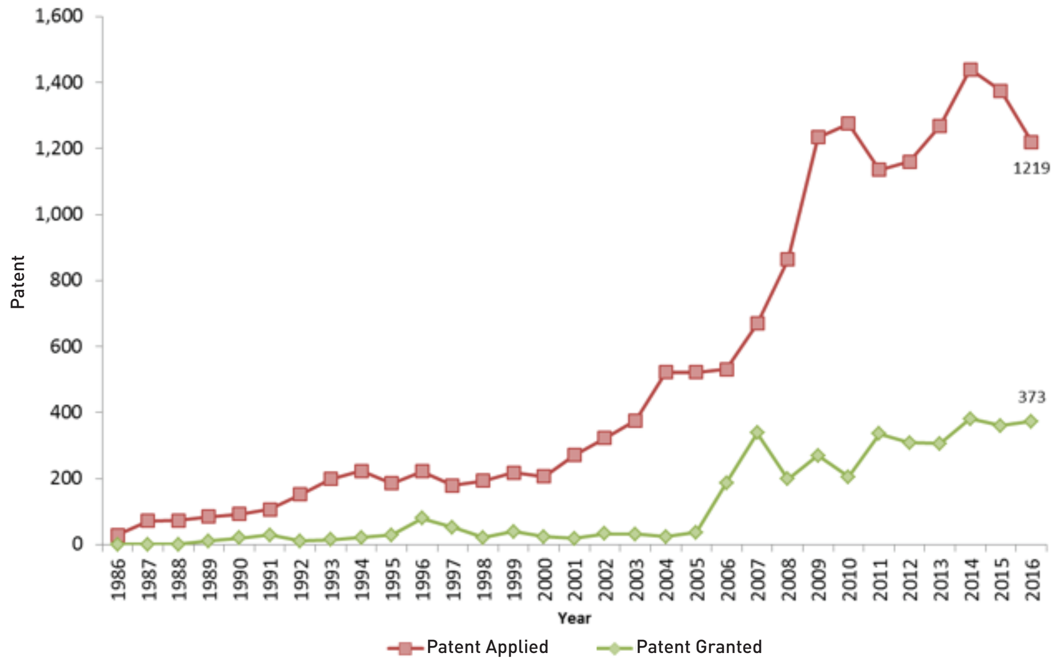



**Figure 2.17**

**Malaysia: Patent Applied and Patent Granted, 1986-2016**

Data Source: MyIPO Statistics (Retrieved on 14 August 2017)

The average expenditure per patent application for Malaysia is PPP$4,345,000 (Table 2.3), which is on par with Singapore, Sweden, and Netherlands. United Kingdom, Germany, and Republic of Korea are notable for spending less than PPP$2 million per patent application. This efficiency could be because their R,D&C are industry driven with a large amount of GERD from their BEs; the industry are also big on productivity with a focus on return on investment (RoI).

**Table 2.3**

## Average Expenditure per Patent Application

Data Source: World Intellectual Property Organization (WIPO) Statistics Data Centre (Retrieved on 15 August 2017)

| Country | R&D Expenditure Performed by Business Enterprise ('000 current PPP$), 2015 | Patent Filed, 2015 | Average Expenditure per Patent Application ('000 current PPP$) |
|---|---|---|---|
| Ireland (2013) | 2,494,645.3 | 250 | 9,979 |
| Switzerland (2012) | 9,467,738.8 | 1,477 | 6,410 |
| Sweden (2013) | 10,004,055.9 | 2,038 | 4,909 |
| Malaysia (2015) | 5,526,760.6 | 1,272 | 4,345 |
| Netherlands (2014) | 9,275,630.1 | 2,207 | 4,203 |
| Singapore (2014) | 6,158,725.9 | 1,469 | 4,192 |
| Finland (2014) | 4,869,679.9 | 1,289 | 3,778 |
| Denmark (2013) | 4,941,030.5 | 1,462 | 3,380 |
| United Kingdom (2014) | 28,797,088.9 | 14,867 | 1,937 |
| Germany (2013) | 69,199,466.7 | 47,384 | 1,460 |
| Republic of Korea (2015) | 57,538,877.1 | 167,275 | 344 |

When looking at income generation from the use of intellectual property among ASEAN countries, Singapore leads the way with USD18.6 billion incurred from knowledge assets nearly nine times as much when compared to Malaysia (USD1.2 billion) (Figure 2.18). Clearly, Malaysia needs transformation strategies to strengthen industry-driven research and development that will lead to more patents with potential commercial value that can be translated into lucrative products and services.

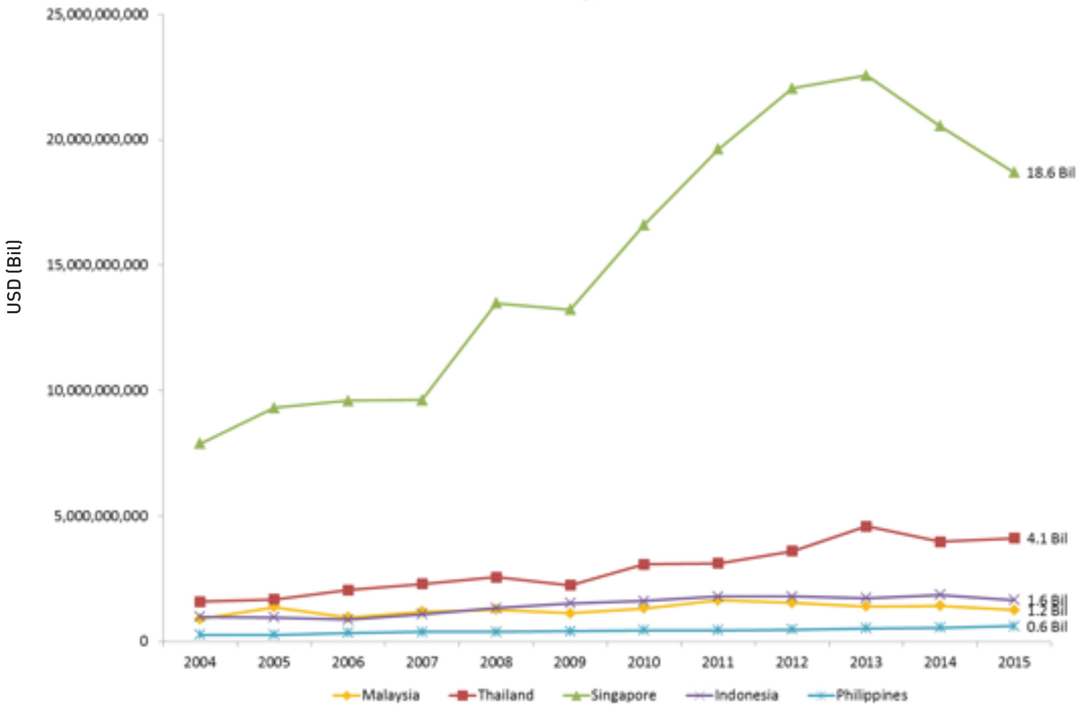



**Figure 2.18**

**Selected ASEAN Countries: Charges for the Use of Intellectual Property, Payments (BoP, Current USD), 2015**

Data Source: World Bank Database
(Retrieved on 14 August 2017)

## 2.7 RESEARCH, DEVELOPMENT AND COMMERCIALISATION ECOSYSTEM

The R,D&C ecosystem of any country is a complex interplay among government and private entities; some countries involve cross cutting with civil society and the general public. Malaysia's R,D&C ecosystem is much larger and more convoluted compared to Singapore (Figure 2.19), United Kingdom (Figure 2.20) and Switzerland (Figure 2.21). Malaysia has many councils at national level that determine the trajectory of different facets of R&D; policies which may be implemented by other institutions without a clear engagement with the policy makers (Figure 2.22).

| Prime Minister's Office | Research, Innovation and Enterprise Council<br>Scientific Advisory Board<br>Supported by NRF | | | | | | |
|---|---|---|---|---|---|---|---|
| Ministries | Trade & Industry | | | Education | Health | Other Ministries & Agencies + NRF | Defence |
| R&D Funding Bodies | Economic Development Board | SPRING | A*STAR | Academic Research Council | National Medical Research Council | | Defence Science and Technology Agency |
| R&D Performers | MNCs Corp Labs | SMEs | Research Institutes | Universities | Hospitals | Other Government Labs | Defence Science Labs |

**Figure 2.19**
**Research, Innovation and Enterprise Ecosystem in Singapore**

Source: National Research Foundation Singapore, 2017

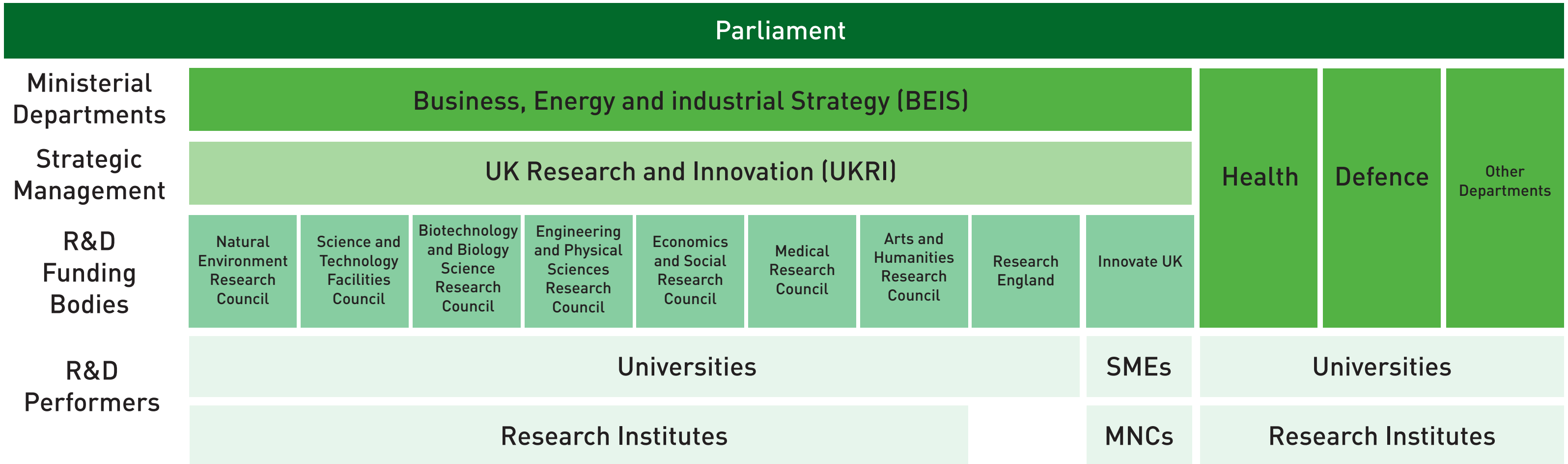



**Figure 2.20**
**Research and Innovation Ecosystem in United Kingdom**

(Compilation by ASM for Science Outlook 2017 from analysis of the ecosystem in United Kingdom)

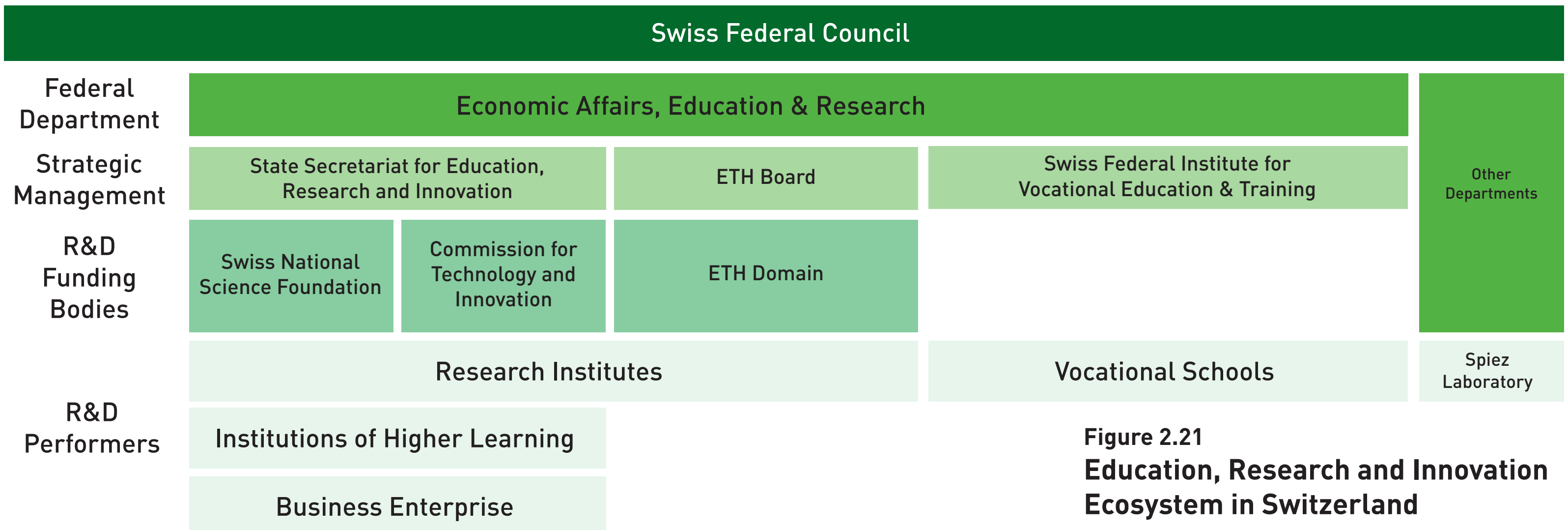



**Figure 2.21**
**Education, Research and Innovation Ecosystem in Switzerland**

(Compilation by ASM for Science Outlook 2017 from analysis of the ecosystem in Switzerland)

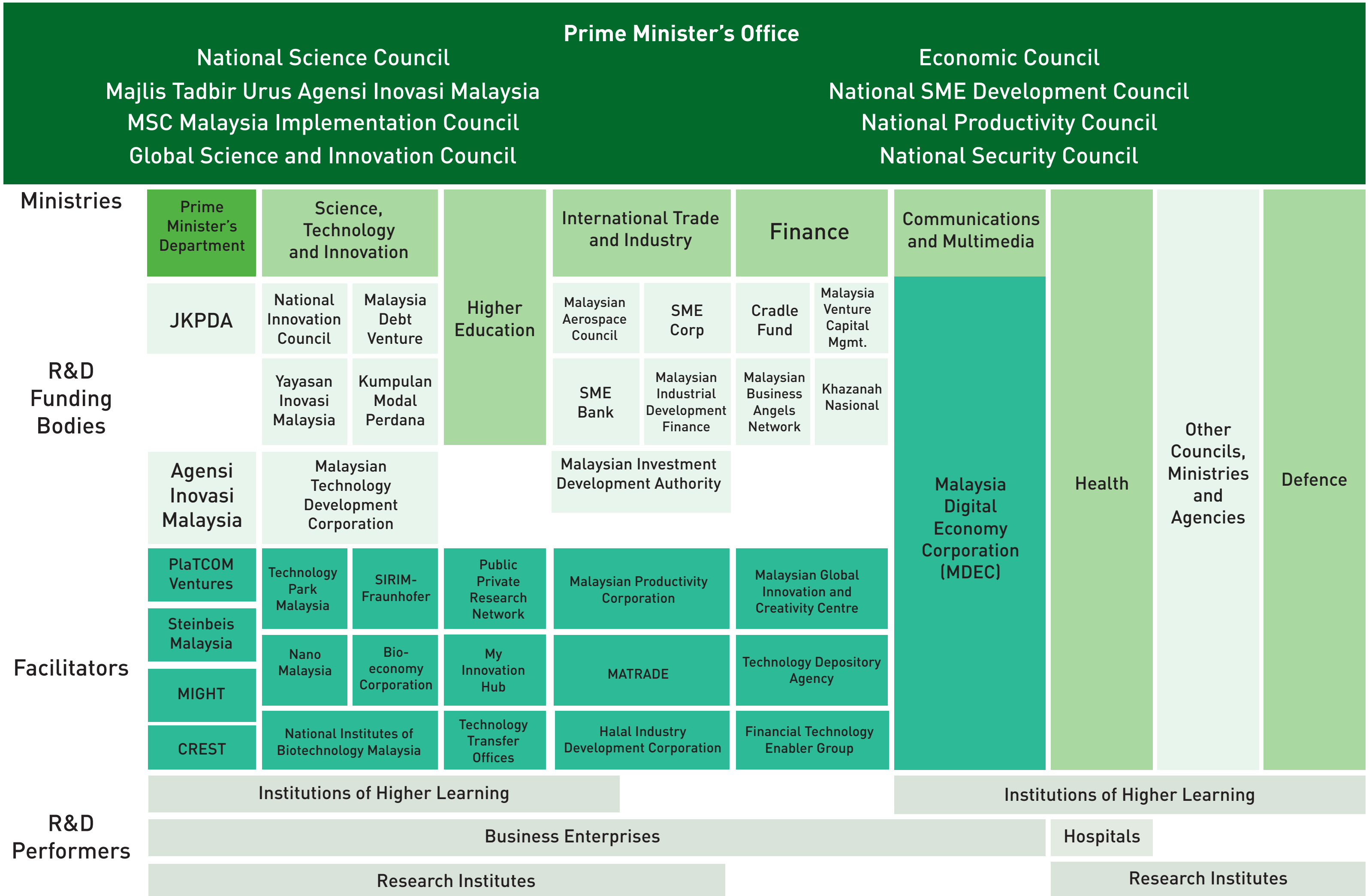



**Figure 2.22**

**Research, Development and Commercialisation Ecosystem in Malaysia**

(Compilation by ASM for Science Outlook 2017 from analysis of the ecosystem in Malaysia)

National level blueprints for monetary allocation – like the Malaysia Plans prepared by the Economic Planning Unit (EPU) – do not explicitly highlight national research priorities and agenda. This results in weak coordination of research prioritisation as ministries and agencies were given the freedom to set their own priorities, performing in silos which can also lead to redundancy and poor optimisation of resources.

Unlike Singapore and the United Kingdom, Malaysian ministries do not have research councils that identify R,D&C niches and advice on training, and knowledge transfer in developing strategies and policies. As a result, Umbrella terms are commonly used as priority areas in Malaysia, leading to difficulty in producing focused and solution-oriented research.

Multiple R&D funding bodies and facilitators that serve as interface between funding bodies and R,D&C performers for niche development (e.g. pre-commercialisation, collaboration, acceleration, incubation and technology penetration) in the ecosystem by respective ministries may result in redundancy. There is a need to examine how this system can be streamlined in order to optimise resources as well as maximise the potential output; there is no facilitator layer in the R,D&C ecosystem in Singapore, Switzerland and United Kingdom.

One of the mechanisms to simplify the R,D&C processes in Malaysia is to have the RMA that is documented in the 11$^{th}$ MP to take the leadership in this matter. The RMA can do more than just manage the fund distribution, evaluate the research proposals, and monitoring the progress of public funded research; the agency can play a larger role which includes coordinating the research priorities across ministries and agencies.

The RMA should also support intellectual property generation through R,D&C by investigating how the number of successful patent applications can be increased. The agency should analyse the gap between the intensity of applied science investigation in the country and the number of patents filed, which can be a sign of disconnect between market demand and research. This would help to accelerate production of intellectual asset with high economic value needed to propel Malaysia's transformation into a knowledge-based economy.

## 2.8 NATIONAL PRIORITY AREAS FOR R&D

In 2012, the National Science Research Council (NSRC) identified nine National Priority Areas of R&D to optimise the distribution of government funding in hopes of standardising research priorities across ministries and agencies. These nine areas were adopted by the Jawatan Kuasa Pelaburan Dana Awam (JKPDA), the secretariat directing the restructuring and strengthening of public innovation funding mechanism under the Agensi Inovasi Malaysia (AIM) Governance Council.

Analyses on the linkages between National Research Priority Areas, Patent Filings and Exports in Malaysia (Figure 2.23) shows that the nine priority areas identified are not aligned with the Malaysia's economic strength. For example, electronic integrated circuit is Malaysia's top export in 2016, but it is not included in any of the National Research Priority Area. The number of patents filed for it is also low, indicating that not much R,D&C is done to elevate electronic integrated circuit industry domestically.

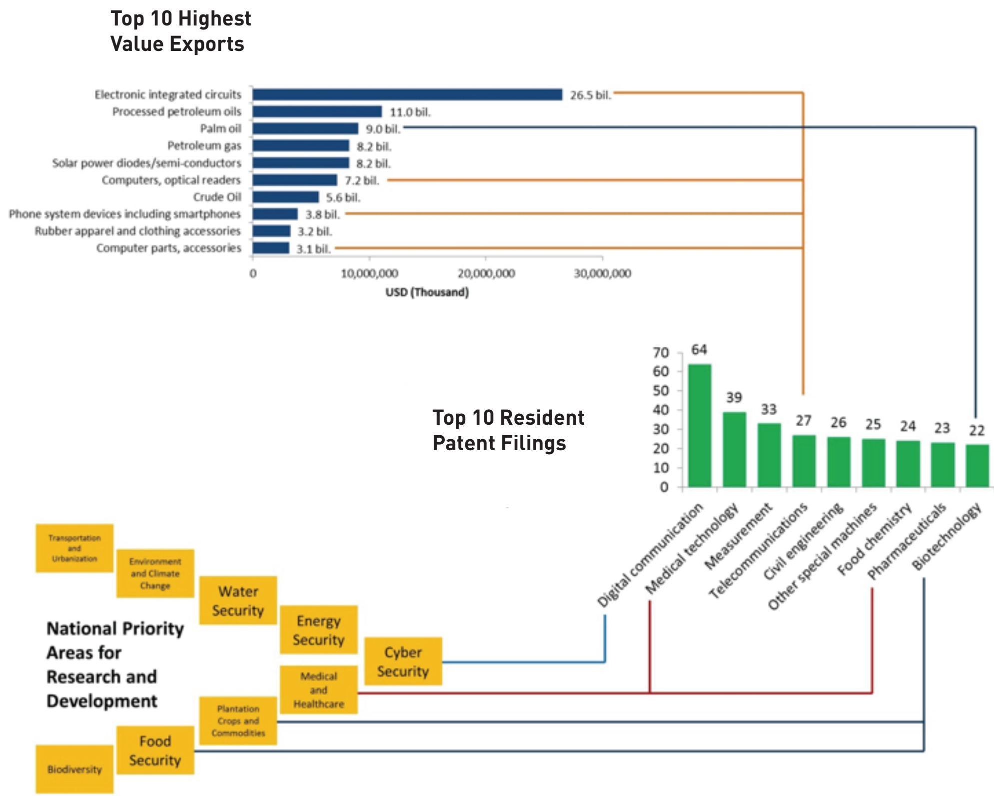



**Figure 2.23**
**Linkages between National Research Priority Areas, Patent Filings and Exports in Malaysia**

**National Priority Areas for Research and Development**
Source: NSRC, 2012

**Top 10 Resident Patent Filings in Malaysia by Field of Technology, 2015**
Data Source: WIPO Statistics Data Centre (Retrieved on 20 October 2017)

**Top 10 Highest Value Exports of Malaysia, 2016**
Data Source: Trade Map, International Trade Centre (Retrieved on 29 August 2017)

The proposed RMA could play a role in addressing this misalignment of industrial needs, and R&D priority and resource management. It can begin by mapping out Malaysia's industrial strength and overlapping it with the R&D resources available. However, there is a need to establish a Technology Commercialisation Agency (TCA) alongside the RMA to function as a national one-stop agency comprising the whole gamut of expertise required for the commercialization process working together in a consolidated institutional framework. This will involve market intelligence analysis, technology brokers, technopreneurs, intellectual property experts, marketing and branding experts etc. which could further strengthen the regional economic corridors in the country and augmenting R,D&C cross fertilisation.

Malaysia could learn from the Netherlands on how national research priority areas can be leveraged to support innovation-led economy. The Dutch Government implemented the Top Sector Policy in 2010 to support the nine key economic areas (known as Top Sectors) in Netherlands through the triple helix approach (industry-academia-government collaboration). Each Top Sector is supported by a Top Consortia for Knowledge and Innovation (TKI) to encourage and coordinate public-private partnerships (PPP) within the Top Sectors. This has led to high level of innovation in the Netherlands, making it the 3rd most innovative economy in the Global Innovation Index 2017 Report. Figure 2.24 shows that Netherlands have better linkages compared to Malaysia; the priority areas for research are aligned to Dutch exports while associated patent filings by residents are also significantly higher than Malaysia.

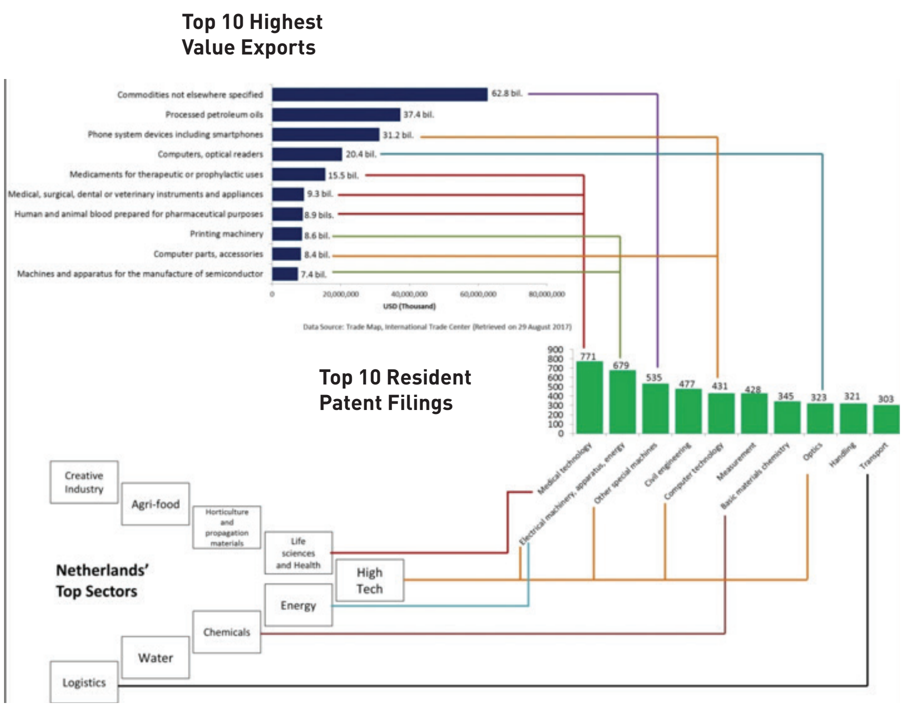



**Figure 2.24**

## Linkages between Top Sectors, Patent Filings and Exports in Netherlands

**Netherlands' Top Sectors**

**Top 10 Resident Patent Filings in Netherlands by Field of Technology, 2015**

Data Source: WIPO Statistics Data Centre (Retrieved on 20 October 2017)

**Top 10 Highest Value Exports of Netherlands, 2016**

Data Source: Trade Map, International Trade Centre (Retrieved on 29 August 2017)

The Principal Statistics of Manufacturing Industries by the Department of Statistics Malaysia in 2015 (Tables 2.4 and 2.5) also indicate that the amount of R&D expenditure per export value by the top manufacturing industries in Malaysia is low. The same applies for both Malaysian-owned and non-Malaysian owned companies. This illustrates the importance of supporting industry-academia linkages to produce research output that can push Malaysia up the value chain in manufacturing.

**Table 2.4**

**Export Value and R&D Expenditure of Malaysia's Top 10 Manufacturing Industries Owned by Malaysian Residents, 2015**

Data Source: Department of Statistics Malaysia, 2017

| Industry (Malaysian) | Export Value (RM '000) | R&D (RM '000) | % R&D/ Export Value |
|---|---|---|---|
| Refined petroleum products | 78,852,527 | 495,686 | 0.63% |
| Vegetable & animal oils and fats | 38,279,595 | 734,822 | 1.92% |
| Electronic components & boards | 19,578,773 | 213,957 | 1.09% |
| Rubber products | 16,149,706 | 116,280 | 0.72% |
| Basic chemicals, fertilizer and nitrogen compounds, plastic & synthetic rubber in primary forms | 11,175,869 | 237,650 | 2.13% |
| Products of wood, cork, straw and plaiting materials | 8,560,363 | 50,538 | 0.59% |
| Plastics products | 7,481,818 | 97,596 | 1.30% |
| Other fabricated metal products; metal working service activities | 6,339,717 | 32,479 | 0.51% |
| Other food products | 5,460,784 | 63,408 | 1.16% |
| Non-metallic mineral products n.e.c. | 4,597,504 | 126,475 | 2.75% |
| | | Average | 1.28% |

**Table 2.5**

**Export Value and R&D Expenditure of Malaysia's Top 10 Manufacturing Industries Owned by Non-Malaysian Residents, 2015**

Data Source: Department of Statistics Malaysia, 2017

| Industry (Non-Malaysian) | Export Value (RM '000) | R&D (RM '000) | % R&D/ Export Value |
|---|---|---|---|
| Electronic components and boards | 88,439,202 | 2,394,820 | 2.71% |
| Consumer electronics | 38,831,240 | 191,511 | 0.49% |
| Computers and peripheral equipment | 28,464,989 | 316,952 | 1.11% |
| Refined petroleum products | 18,627,280 | 148,316 | 0.80% |
| Basic chemicals, fertilizer and nitrogen compounds, plastic & synthetic rubber in primary forms | 16,003,771 | 373,841 | 2.34% |
| Communication equipment | 12,177,212 | 202,782 | 1.67% |
| Vegetable and animal oils and fats | 9,823,727 | 139,243 | 1.42% |
| General-purpose machinery | 7,338,775 | 190,711 | 2.60% |
| Electric motors, generators, transformers and electricity distribution and control apparatus; batteries and accumulators | 6,707,376 | 44,593 | 0.66% |
| Rubber products | 5,994,202 | 69,983 | 1.17% |
| | | Average | 1.50% |

Non-Malaysian BEs tend to spend greater percentage of R&D over export value to increase their export value. This could be because non-Malaysian BEs have already penetrated the international market more comprehensively and thus, making the R&D investment more profitable. Encouraging Malaysian BEs to go further in the export market with R,D&C support has been the priority of agencies such as Malaysian International Trade and Industry; however, not many Malaysian BEs are taking up the challenge to bring their goods and services beyond our shores.

Aligning the national research priorities to our industries' needs has the potential to help our industries to be more competitive at the global arena. It is crucial for Malaysia to conduct foresight studies involving industry players every five years to identify the relevant focus areas. These findings can then be incorporated into the future Malaysia Plans to ensure all ministries and agencies share the same focus. The community can also be engaged to identify issues needing STI interventions as well as tackle potential ethical considerations that arise from it. All of these are the parameters needed for the country to "weave" a quadruple helix innovation ecosystem (Figure 2.25).


**Figure 2.25**
**"Weaving" of a Quadruple Helix Innovation Ecosystem**

## 2.9 INNOVATION CLUSTERS

Harvard Business School defines clusters as geographic concentrations of interconnected companies, specialised suppliers, service providers, and associated institutions in a particular field present in a nation or region. Some clusters are formed by networks of SMEs; some are organised around key anchor firms, and others developed around universities (European Commission Enterprise and Industry Directorate-General, 2013). Many innovative economies claimed that aside from direct economic impacts, cluster strategy strengthens industry-academia collaboration, increases innovation of SMEs, and promotes market-driven research (see Appendix 2.2).

Cluster policies were implemented in Malaysia since the 6th MP. The Multimedia Super Corridor (MSC) Malaysia in 1995 and Technology Park Malaysia (TPM) in 1996 are examples of cluster development that utilise technology to strengthen the country's innovation strategies (Evers & Gerke, 2015). The 9th Malaysia Plan formed five regional economic corridors to fixuneven development in the country through public-private partnerships (PPP) (Figure 2.26).

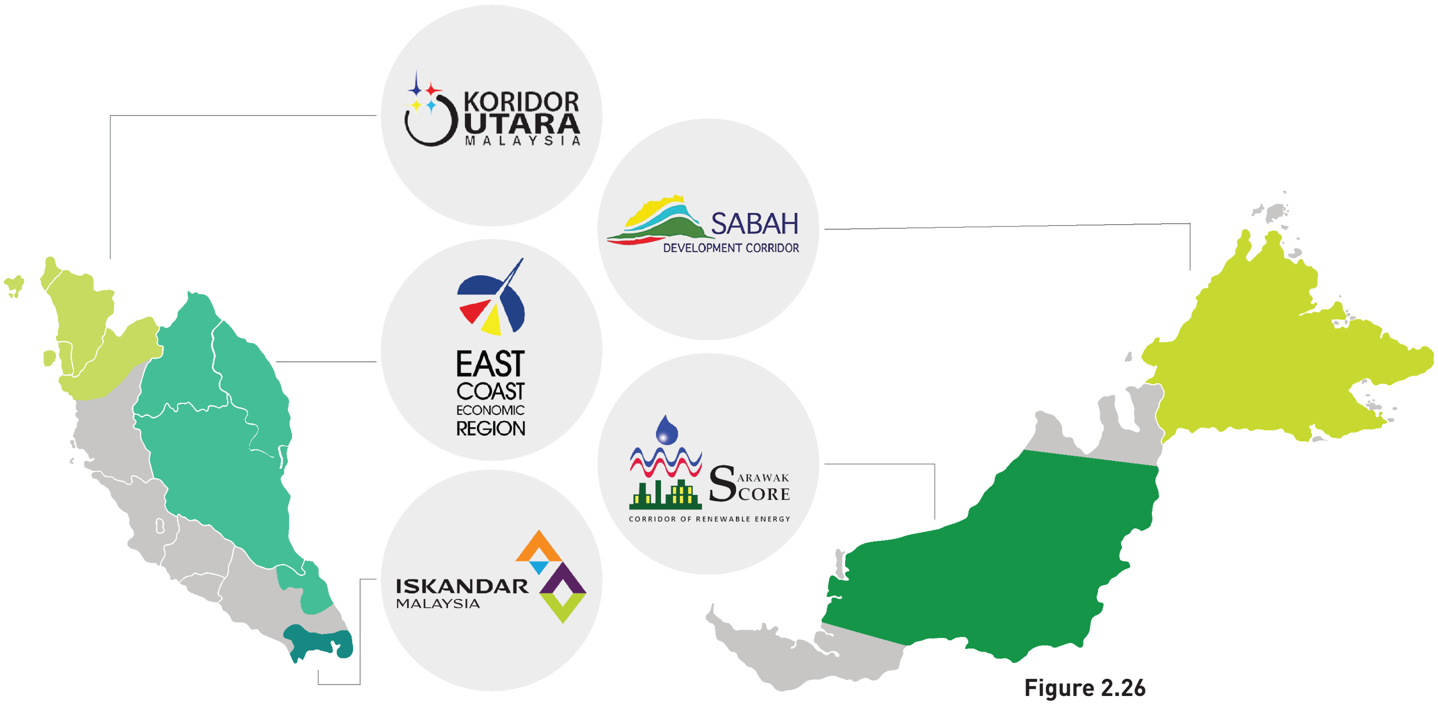



**Figure 2.26**
**Regional Economic Corridors**

The Executive Opinion Survey 2016–2017 conducted at the World Economic Forum had Malaysia ranked 13 out of 138 economies for the indicator on state of cluster development, indicating the strong perception on cluster development in the country by Malaysian executives. However, in terms of performance [Patent Coorporation Treaty (PCT) filings] by clusters, Kuala Lumpur is the only region in Malaysia that made it in the Top 100 Clusters Ranking in the Global Innovation Index 2017 at the 92nd position (Table 2.6). This shows a mismatch between perception and reality, making it urgent for us to strengthen our cluster strategy.

## Top 100 Clusters Ranking and Number of PCT Filings

Source: Global Innovation Index, 2017

- 1 **Tokyo-Yokohama** — Japan — 94,079
- 2 **Shenzhen-Hong Kong** — China — 41,218
- 3 **San Jose-San Francisco, CA** — USA — 34,324
- 4 **Seoul** — Republic of Korea — 34,187
- 5 **Osaka-Kobe-Kyoto** — Japan — 23,512
- 6 **San Diego,CA** — USA — 16,908
- 7 **Beijing** — China — 15,185
- 8 **Boston-Cambridge, MA** — USA — 34,187
- 9 **Nagoya** — Japan — 13,515
- 10 **Paris** — France — 13,461

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- 90 **Daegu** — Republic of Korea — 1,085
- 91 **Amsterdam** — Netherlands — 1,063
- 92 **Kuala Lumpur** — Malaysia — 1,049
- 93 **Clermont-Ferrand** — France — 1,041
- 94 **Nanjing** — China — 1,030
- 95 **Mumbai** — India — 1,012
- 96 **Pune** — India — 1,006
- 97 **Shikokuchuo** — Japan — 995
- 98 **Toulouse** — France — 991
- 99 **Hannover** — Germany — 979
- 100 **Suzhou** — China — 956

Building clusters from scratch is extremely challenging, as shown by MSC and Technology Park Malaysia. However, identify areas of the economy in regions with comparative advantages and to develop short and long-term strategies is important for growing the regional economy. Identifying and catalysing existing clusters 'hidden' in their regions or localities rather than building new ones is also a better way of optimising resource usage and increasing the buy-in factor from the private sector (NESTA, 2010).

Netherlands mapped out their sectoral and cross-sectoral regional industry and R&D data based on geographical concentration before formulating their Top Sector Policy. Some of the indicators they look out for are the presence of critical mass depending on the cluster's size, the degree to which it is specialised, and how productive it is including cross-sectoral cluster categories.

Figure 2.27 illustrates the cluster mapping of the Dutch agriculture and food business to support the process of scaling up based on location, concentration of production process, and presence of numerous cooperatives between suppliers and processors within the region. The Dutch employ internationalisation as a growth strategy, expanding into foreign markets when the home market is saturated; a vital measure since the Dutch market is relatively small (Schouten and Heijman, 2012).

Malaysia can emulate Netherlands by conducting a detailed cluster mapping in Malaysia to identify location, density and specialisation of clusters to spot specific locations for government intervention. This can be further reinforced through a comprehensive cluster policy.

We can identify and support specific economic areas with the greatest growth potential by aligning the national research priorities with them, leveraging on existing economic corridors infrastructure. These clusters should be supported by IHLs and PRIs within the cluster to intensify industry-academia collaboration, encourage knowledge diffusion, specialisation. As large firms move up the value chain, SMEs will also benefit from providing their services to these large firms in the cluster. Furthermore, having a specific geographic location would ease the development of digital infrastructure to help the industry prepare for Industry 4.0.

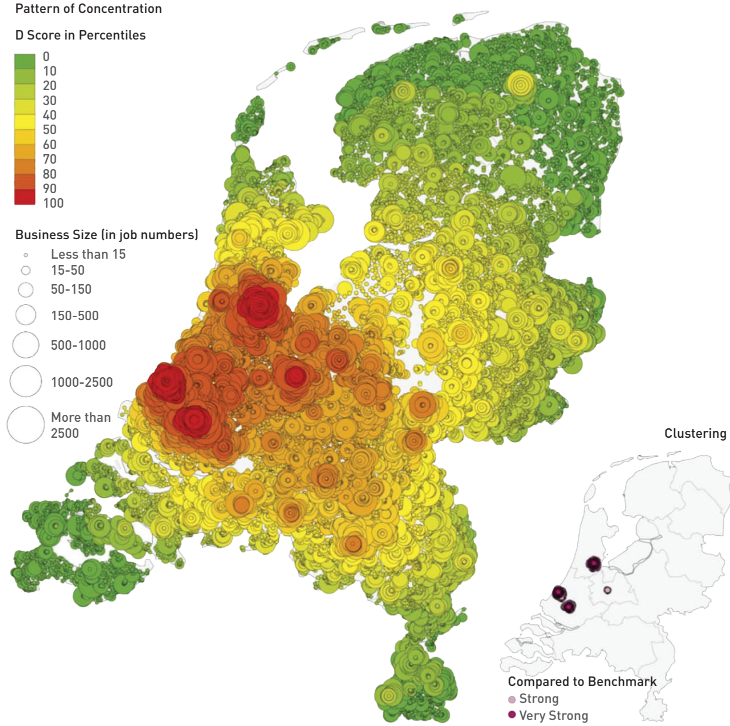



**Figure 2.27**
**Cluster Mapping of Netherlands' Agro and Food Sector Before (Top) and After (Bottom) the Formulation of the Top Sectors Policy (Cluster Policy)**

Source: PBL Netherlands Environmental Assessment Agency, 2012 - The rationale of spatial economic top sector policy

## WAY FORWARD IN MANAGING, PRIORITISING AND COMMERCIALISING R&D

In order to bridge the innovation chasm, experimental development must be given emphasis. The entire R,D&C chain also must be seamlessly managed and priority areas revisited to align to the strength of our country.

1

### Emphasis on Experimental Development

Experimental development translates research and discoveries to a stage suitable for attracting commercial investment and market uptake. In the context of Malaysia, the GERD analysis shows that research (basic and applied) has a greater intensity compared to experimental development resulting in only a handful of research actually developing into products and services for commercialisation.

Therefore, increased funds for experimental development will encourage more collaboration between university and industry towards demand driven research. This will consequently increase experimental development activities such as proof of concept, prototyping, pilot projects and the process of scaling up into producing more market ready products and/or services.

2

### Expedite the establishment of a Research Management Agency and to consider establishing a Technology Commercialisation Agency (TCA)

The cabinet in principle has approved to have a RMA in place. However, the detail of establishment has not been ironed-out. This study also proposes that to complement RMA's function, a TCA should be in place.

The proposed functions of the RMA includes to implement national research priorities, management of R,D,C&I funds, public-private facilitation and non-financial resource optimisation (subject matter experts, public R&D facilities and information). While facilitating the formation of innovation clusters by providing specialised funds to knowledge institutions in close proximity to high potential industries and, to establish symbiotic relationships with technology transfer offices and collaborative platforms is envisioned to be the role of TCA.

Hence, it is important to expedite the establishment of a RMA to catalyse demand driven collaborative research with effective utilisation of funds and TCA to complete the ready-to-market delivery cycle.

3

### Re-identify National RDC priority areas

National priority areas for R&D are important for financial resource optimisation. Nine national priority areas have been formally adopted by the NSRC. However, these priority areas have not been implemented across all ministries and agencies. Furthermore, these priority areas are not aligned to our economic strengths.

Therefore, it is urgent to re-identify national RDC priority areas by aligning and streamlining to Malaysia's research and economic strengths and needs.

4

### Development of regional innovation clusters

Even though cluster strategy has been implemented in the country and we have been building our clusters since 1995, our clusters have not achieved the desired innovation maturity.

Development of regional innovation clusters by enhancing collaboration between industry and knowledge institutions as the case in Malaysia's E&E sector must be considered.

# FURTHER READING

*Frascati Manual 2015*
**Basic research** is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.

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

**Experimental development** is systematicwork, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes.

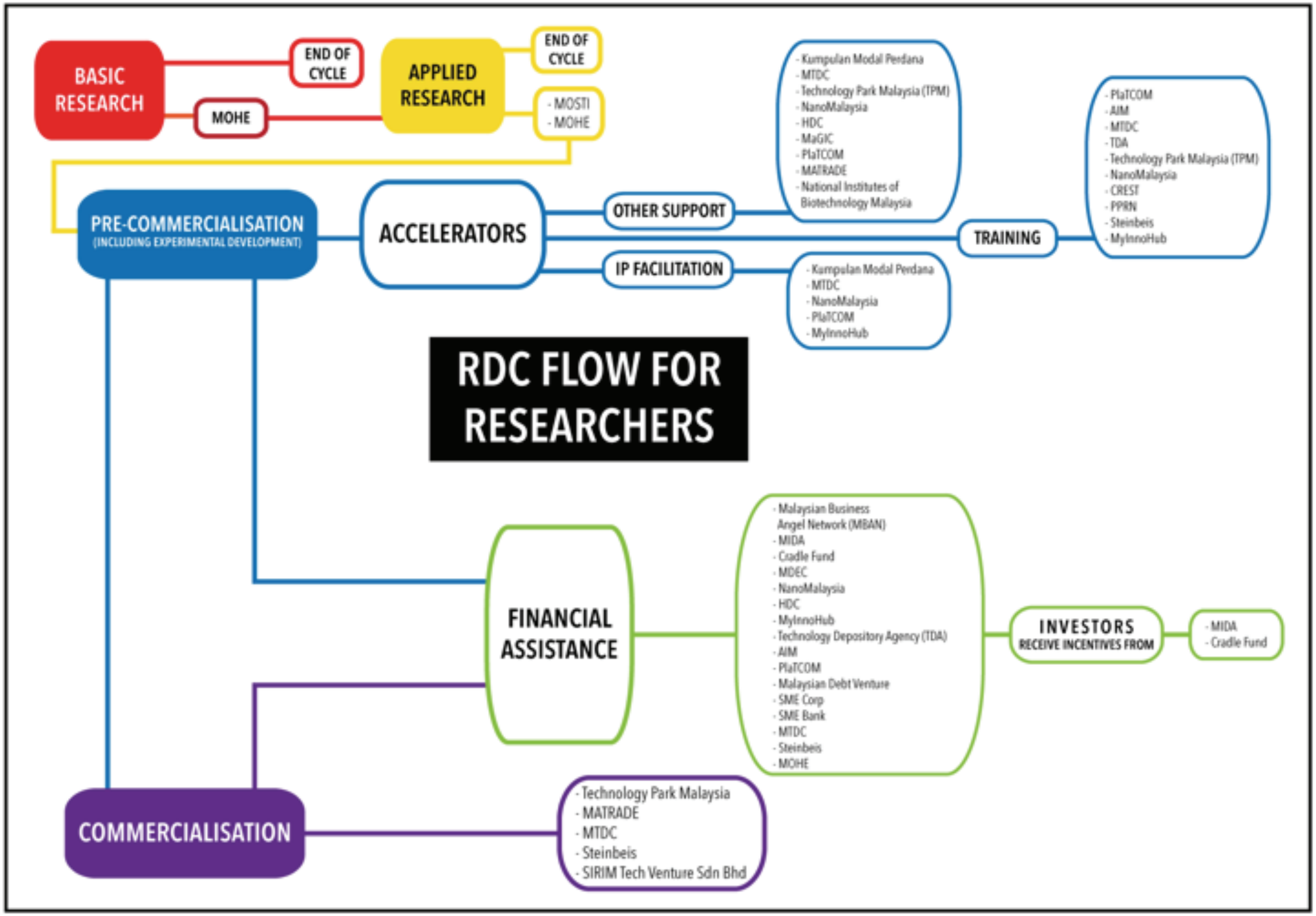
*General example:*
The study of a given class of polymerisation reactions under various conditions is basic research. The attempt to optimise one of these reactions with respect to the production of polymers with given physical or mechanical properties (making it of particular utility) is applied research. Experimental development then consists of “scaling up” the process that has been optimised at the laboratory level and investigating and evaluating possible methods of producing the polymer as well as products to be made from it.

*Example in nanotechnology:*
**Basic research**
Researchers study the electrical properties of graphene by using a scanning tunnelling microscope to investigate how electrons move in the material in response to voltage changes.

**Applied research**
Researchers study microwaves and thermal coupling with nanoparticles to properly align and sort carbon nanotubes.

**Experimental development**
Researchers use researches in micro-manufacturing to develop a portable and modular micro-factory system with components that are each a key part of an assembly line.

## Research, Development and Commercialisation Flow for Researchers

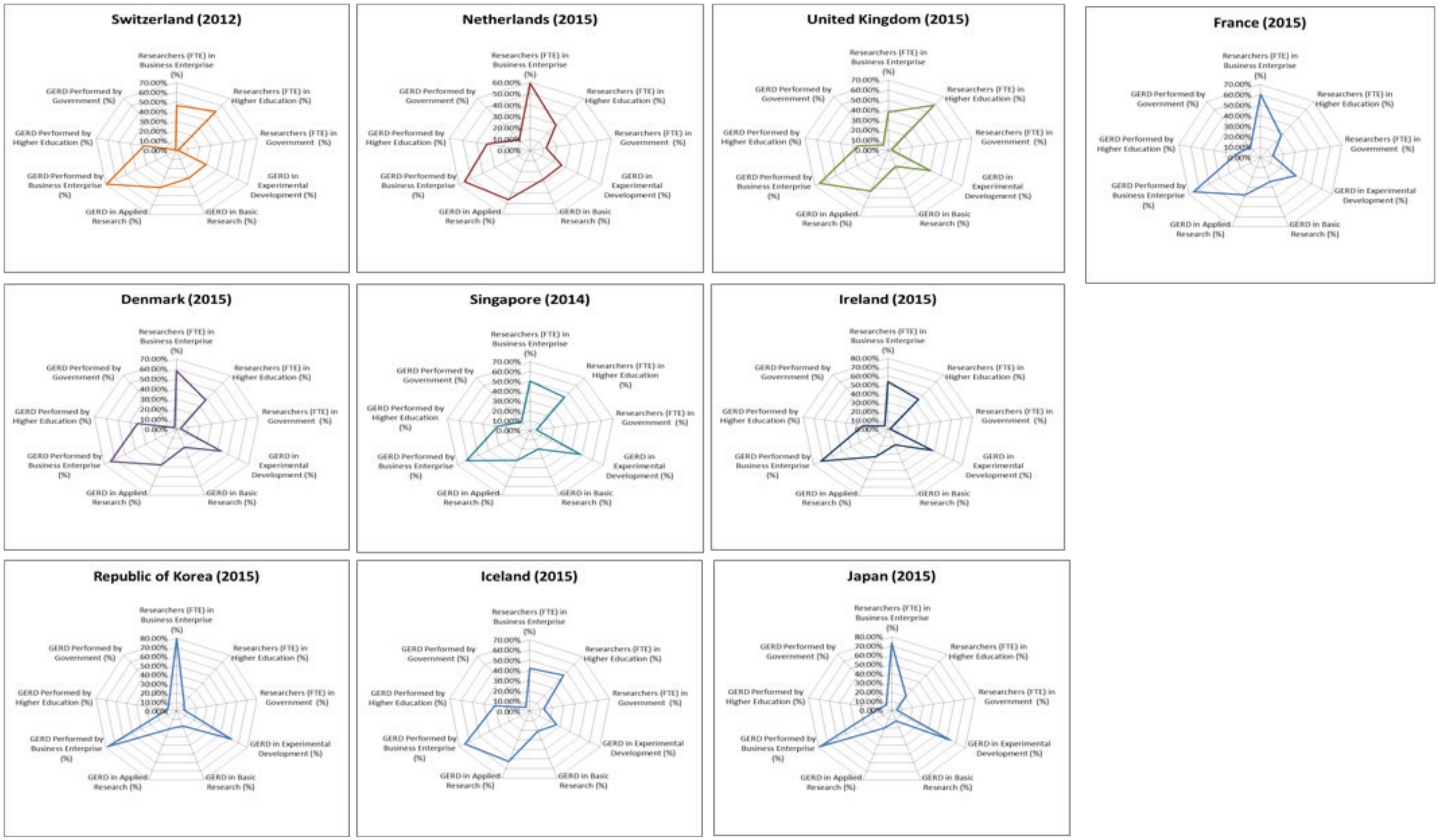


# APPENDICES

**Appendix 2.1**

## GERD, Type of Research, and Researchers FTE Comparison of Selected Top Innovative Economies

UNESCO Institute of Statistics Database, 2017



Appendix 2.2

## Support for Cluster Strategy in Synergising R,D&C and Industry

### Europe

Economic prosperity among the regions of Europe is linked to the degree of cluster strength. Regions with a higher share of employment in industries that belong to strong clusters are generally more prosperous.

Source:
Europe INNOVA, 2008

### Denmark

Statistics show that the most significant Danish clusters reach more than 13,000 enterprises per year and foster innovation in around 1,600 enterprises. The vast majority of these enterprises are small and medium-sized. Furthermore, enterprises that participate in clusters are four times more likely to be innovative than enterprises that do not.

Source:
Danish Agency for Science, technology and Innovation, 2016.

### Germany

Cluster-oriented policy increased the likelihood of innovation in targeted industries by 4.6 to 5.7 percent. At the same time, R&D expenditures decreased by 19.4% on average for firms in targeted industries, while access to external know-how, cooperation with public scientific institutes, and the availability of suitable R&D personnel increased.

Source:
Falck, O., Heblich, S. & Kipar, S., 2010.

### Republic of Korea

Republic of Korea was among poorest countries in the world following the devastating Korean War (1950-1953). The per capita GNP of Republic of Korea was less than USD100 in 1960, but it increased to USD20,000 in 2007. Such a remarkable achievement in the economic growth is closely related to the government's successful implementation of industrial development strategies, innovation and cluster policies, as well human resource development.

Source:
Park, Sam Ock and Koo, Yangmi, 2013

### Norway

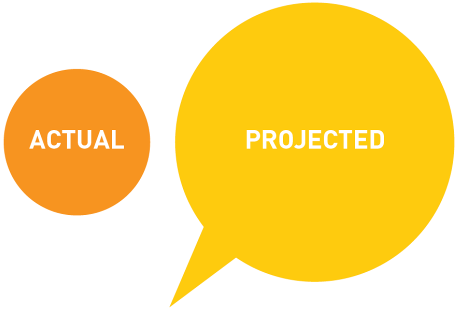
Innovation research demonstrates that the Norwegian economy is benefiting from a range of strong industry clusters where customers, suppliers and relevant educational institutions are linked through longstanding and binding partnership.

Source:
Norwegian Innovation Cluster, 2015

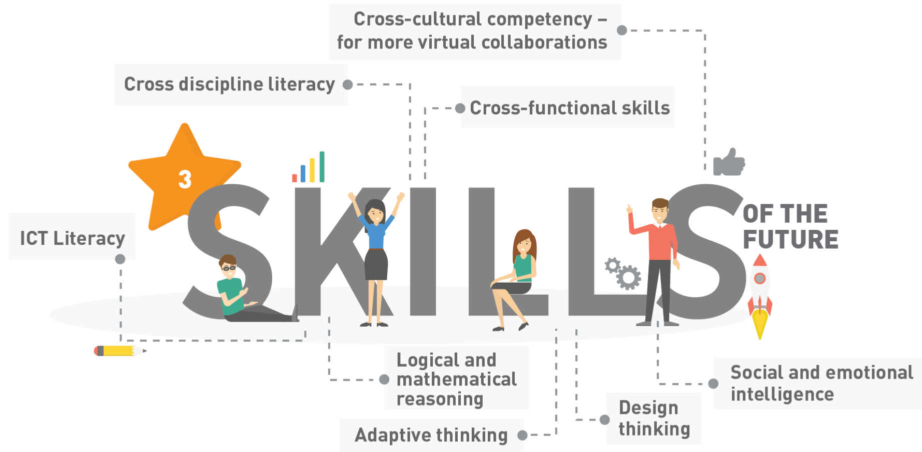
# 03

STI TALENT

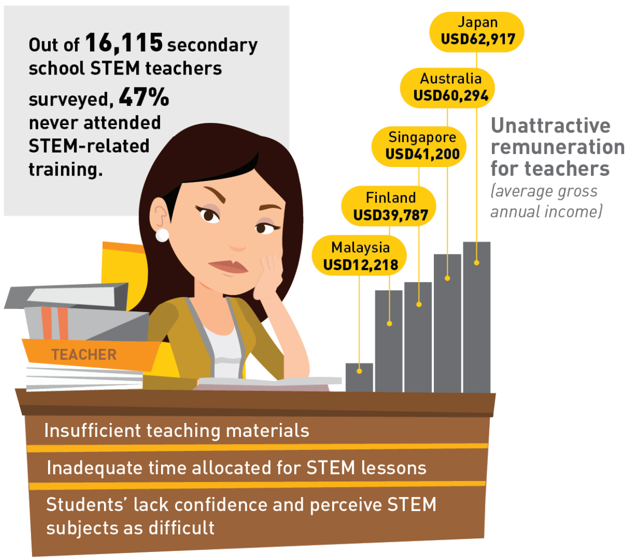
## 1 Enrolment of Students in Science Stream – *Actual, and Forecast*

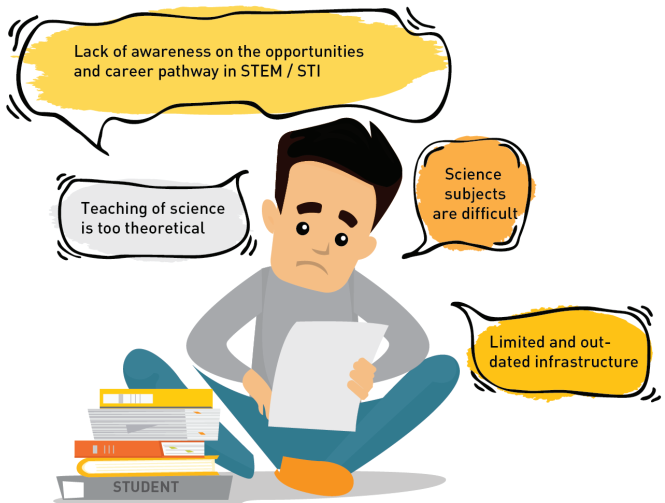



*The desired target of 270,000 students ready to enter STEM courses at tertiary level by 2020 will not be achieved.*




## 2 STEM CHALLENGES



## Developing STI Talent Today for Tomorrow

Novel technology is the catalyst for the remarkable changes in human productivity and prosperity. Spinning Jenny birthed the first industrial revolution in the 18th century; today the Internet of things, artificial intelligence, and data analytics augur the dawn of Fourth Industrial Revolution. Digitisation, automation, and technology-led horizontal integration of the value chain means that jobs for tomorrow and beyond evidently require STEM knowledge and training.

Industries and countries will embrace Industry 4.0 at different rates and in different ways, depending on their tech savviness and capital readiness. Moving up the value chain means that all jobs would require some sort of information and computer technology (ICT) knowledge. Automation will remove the need for large numbers of low-skilled labourers who perform simple, repetitive tasks. Skilled and semi-skilled workers who can deal with the growing complexity of the tasks which require continuous knowledge and skills development are in demand. Cross discipline competencies are in greater demand as technologies for various fields intersect; e.g. the use of augmented reality in medical diagnostics require health workers with ICT skills (Ras et al., 2017).

Malaysia's drive to become a developed nation in a sustainable and equitable manner requires investment to increase the dynamic capabilities of the nation's workforce. It is a holistic endeavour that targets all levels of the population, from children in pre-school all the way to secondary and tertiary education, as well as making sure that the current labour force is ready for the inevitable transformation of the job and socio-economic landscape. The skills of the current workforce is ranked at the 33 out of 130 economies by The Global Human Capital Index 2017 trailing other East Asian economies such as Singapore (11$^{th}$), Japan (17$^{th}$), and Republic of Korea (27$^{th}$) (WEF, 2016). The index measures individuals' ability to acquire, develop and deploy skills throughout their working life. If we look into the sub-pillar of Skills gap as major constraint in the pillar under Vocational and Technical Skills in the Global Talent Competiveness Index 2017, we are 53 out of 118 economies (Human Capital Leadership Inst.-INSEAD, 2017). Looking into the Knowledge workers sub-pillar in the Global Innovation Index 2017 Malaysia is at 93 spot out of 127 economies (WIPO-INSEAD, 2017). The indices may have different measuring parameters but at globally level, there is much to be done to bring our talent to be competitive and ready for challenges of the Fourth Industrial Revolution.

## HINDSIGHT.

Science Outlook 2015, STI Talent Chapter highlighted **three** recommendations.

| 2015 Recommendation | | Development |
|---|---|---|
| • Having a strategic framework that will guide human capital development in S&T services and delivery is essential. The Human Capital Roadmap for Science and Technology 2012 – 2020 (HCRST) which includes a review of the current status of people, processes, technology and culture and the identification of S&T human capital goals and priorities, measurable success factors that will drive the development of an actionable roadmap has already been strategised and documented. | **SYSTEMIC PLANNING & DEVELOPMENT** | **National STEM Action Plan (2018-2025)**<br>• A collaborative effort among MOSTI, MOE and MOHE. It is expected to be tabled at NSC meeting in 2018<br>**National STEM Movement**<br>• Formed in 2015 with members from MOSTI, MOE, MOHE, institutions, agencies, industry, and private individuals. The Movement's main objective is to instil passion for STEM in the next generation through various activities |
| • Drastic intervention measures need to be taken at each domain of the human capital value chain in order to reach the targeted number of 500,000 skilled S&T workforce. | **BRIDGE GAP BETWEEN POLICY & REALITY** | **Visioning Malaysia's Future of Work: A Framework for Action (TalentCorp, 2017**<br>• It provides recommendations to achieve the nation's talents goals as aspired by 2020<br>**Embracing Industry 4.0: A Malaysian Technology Strategic Outlook (MiGHT, 2018)**<br>• The report focuses on Industry 4.0 initiatives by government to prepare for the digital revolution<br>**Malaysia Productivity Blueprint 2017 – 2020 (EPU, 2017)**<br>• The blueprint is a guide to achieve the nation's labour productivity growth target of 3.7% per annum<br>**Digital Talent Report 2018 (MDEC, 2018)**<br>• The report comprises analysis of the existing available talent and requirement by digital industry<br>**TVET Malaysia Master Plan (on going)**<br>• The Master Plan will have a long-term action plan until 2050 for demand and supply of TVET-based talent<br>**National Industry 4.0 Policy Framework**<br>• The policy outlines strategies, initiatives and action plans to achieve the targets and vision of Malaysia's Industry 4.0 |
| There is a need to devise a 'sustainable' action plan for retaining STI Talent, especially to fuel the high-priority sectors of the economy. Such a plan could outline methodologies and criterion to identify the right talent, with the right skills and expertise, who can be incentivised with a career roadmap in the country, with opportunities created through public-private partnerships. | **RETAIN STI TALENT** | **National STEM Centre**<br>• A professional development centre for STEM teachers and lab technicians to enhance their skills, capabilities as well as confidence in teaching science and mathematics in addition to handling lab practical using the enquiry based learning method<br>**Penang Skills Development Centre (PSDC)**<br>• To upskill the workforce for industry in areas of Design and Development, Manufacturing and Services<br>**• Malaysian Board of Technologists (MBOT)**<br>Recognizes technologists and technicians as professionals by assuring all courses for technologists at diploma and certificate levels are accredited according to international standards |

## 3.1 CHALLENGES: STREAMLINING DEFINITION OF STEM EDUCATION TO OPTIMISE TALENT PATHWAY

STEM is the acronym for Science, Technology, Engineering and Mathematics. However,the definition of STEM can be rather subjective depending on the perspective of the stakeholder, which makes harmonisation of relevant policies difficult. For example, the word technology; teachers would define technology as something presently used like computers while industry players would include innovations that have not materialised as technology (Gerlach, 2012).

### Various Definitions of STEM in Education in Malaysia's context

#### Ministry of Education, Malaysia

STEM education is life-long learning which involves an education that integrates science, technology, engineering and mathematics in a formal manner based on a curriculum; informally through co-academic and co-curricular activities; and indirectly through all ages from early childhood, primary education, lower and upper secondary education; tertiary and at industrial/community level that leads toward generating a STEM literate society and to supply highly skilled STEM workforce that can contribute towards new innovations.

#### National STEM Action Plan (2018-2025)

Integrated learning of science, technology, engineering and mathematics disciplines that is applied in real world context by connecting the institutions of education, community and industry to produce STEM literate talents and society to drive the nation's economic growth.

#### Ministry of Higher Education, Malaysia

Disciplines of knowledge consisting of Science (physics, chemistry and biology) and Mathematics with the integration of various Technologies and Engineering. STEM incorporates all the technologies that engage science and mathematics.

#### Southeast Asian Ministers of Education (SEAMEO)

... a curriculum based on the idea of educating students in four specific disciplines science, technology, engineering, and mathematics in an interdisciplinary and applied approach. Rather than teach the four disciplines as separate and discrete subjects. STEM integrates them into a cohesive learning paradigm based on real-world applications.

STEM is an accepted terminology worldwide; nevertheless, when discussing educational policies, the emphasis differs from country to country. Different agencies have different focus, which influence the interpretation, similar to how it is in Malaysia. Some of these countries and their STEM definition and focus are as follows:

## STEM Definition in Selected Countries

### United States of America

- **National policy**

COMPETES Act of 2010 defines the term STEM as "the academic and professional disciplines of science, technology, engineering, and mathematics." *(Source: America Competes Reauthorization Act of 2010)*

- **National research directive**

National Science Foundation (NSF), the STEM fields include the so-called core sciences (e.g., mathematics and physical sciences) and engineering as well as psychology and the social sciences. *(Source: Gonzalez & Kuenzi, 2012)*

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### United Kingdom

- **National policy**

STEM is the acronym for science, technology, engineering and mathematics. The UK government's STEM programme aims to increase young people's STEM skills in order to provide employers with the skills needed for a 21st century workforce and ensure the UK's place as a leader of science-based research and development. *(Source: Department of Education UK, 2010)*

- **Higher education directive**

STEM subject areas as classified by The Higher Education Statistics Agency (HESA) are: Medicine and dentistry; Subjects allied to medicine; Biological sciences; Veterinary science; Agriculture and related subjects; Physical sciences; Mathematical sciences; Computer science; Engineering and technology; Architecture, building and planning. *(Source: Higher Education in Science, Technology, Engineering and Mathematics (STEM) subjects Report, 2012)*

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### Australia

- Defined by Australia's Chief Scientist STEM, or science, technology, engineering and mathematics, refers collectively to a broad field of distinct and complementary approaches to knowledge. *(Source: Office of the Chief Scientist Australia, 2016)*

- STEM qualifications refer to any non-school qualifications at the postgraduate degree level, Master degree level, graduate diploma and graduate certificate level, bachelor degree level, advanced diploma and diploma level, and certificates III and IV levels in any of the following fields; Natural and Physical Sciences (NPS), Information Technology (IT), Engineering and Related Technologies (ERT) and Agriculture, Environmental and Related Studies (AERS). *(Source: Australian Bureau of Statistics, 2014)*

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### UNESCO

The concept of STEM is defined from three perspectives: STEM field, STEM stream and STEM approach.

- STEM as a field covers traditional disciplines such as Medicine, Engineering, Chemistry, Biology, Mathematics and Statistics, as well as the more specialized disciplines such as Astrophysics, Biochemistry and Genetic Engineering.
- STEM Stream refers to enrolling of students in upper secondary school to a stream of their choice and inclination.
- STEM approach refers to a pedagogical strategy that emphasizes application of knowledge, skills and values from the disciplines of Science, Technology, Engineering and Mathematics, in an integrated manner to help students solve problems encountered in the real world.

*(Source: UNESCO International Bureau of Education (IBE), 2016)*

From all the above, it is obvious that although there are similarities in the definitions however there is no single agreed upon definition for STEM. Harmonisation of these definitions and intentions will clarify the parameters when discussing the cultivation of STEM talent. For the purpose of this chapter, a comprehensive working definition is derived from the National STEM Action Plan (2018-2025) and MOHE; *STEM is the disciplines of knowledge consisting of Science (Physics, Chemistry and Biology) and Mathematics with the integration of various Technologies and Engineering. STEM is applied in real world context by connecting the institutions of education, community and industry to produce STEM literate talents and society to drive the nation's economic growth.*

As for STEM talents, the National Science Foundation (NSF) USA defines these talents as individuals with a degree in computers, statistics, engineering, life- or physical- sciences as well as social sciences like psychology, economics and anthropology (UC Davis); while Australia does not include social sciences as part of its STEM workforce (Office of the Chief Scientist Australia, 2016). Similar to Australia, STEM talents in the context of this chapter do not include those from social sciences.

## 3.2 WHERE ARE WE TODAY WITH THE STEM TALENT SUPPLY?

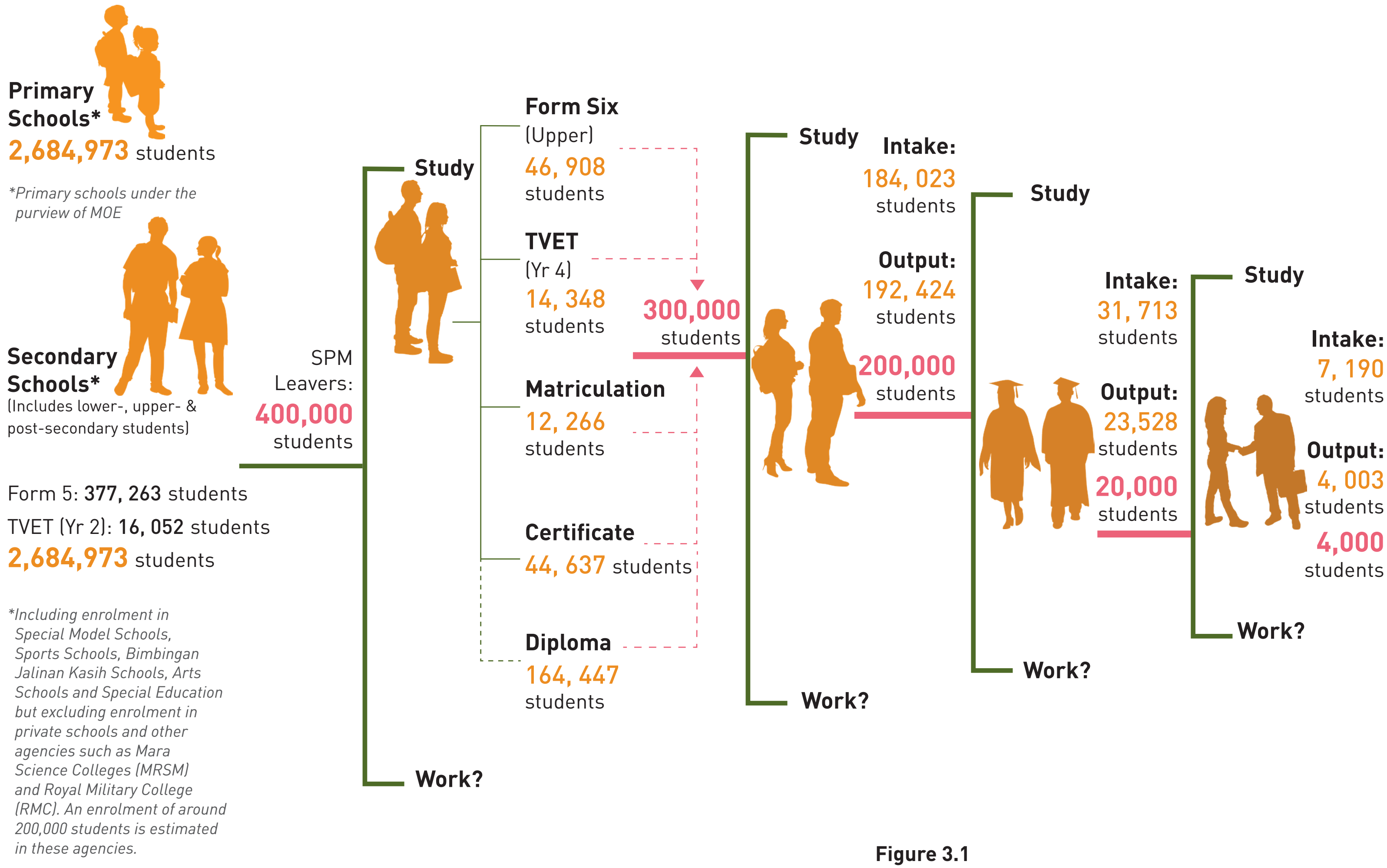
There is a variety of educational choices for primary and secondary education in Malaysia. Annually, there are approximately 2.7 million students enrolled in Government and Government-supported primary schools (i.e. vernacular schools and religious schools) while around 2 million are in secondary schools. Annual intake of private schools for both primary and secondary level at present is approximately 37,000 and 110,000 respectively (MOE, 2017).
This data, however, excludes figures from other government agencies such as MARA (data not available). Figure 3.1 illustrates the flow of talent development in the country from secondary level through tertiary education.

Malaysia spent an average of 7.7% of the national budget to support higher education to power the nation's growth, more than Hong Kong, Singapore, Republic of Korea and Japan. However, the tertiary enrolment in Malaysia has further declined from 85 (previous year report) to 89 out of 137 economies according to the Global Competitiveness Report 2017-2018 (WEF, 2017). Singapore and Finland are ranked 4$^{th}$ and 8$^{th}$ respectively in this report. In terms of literacy and numeracy among 15 -24 year olds, Finland tops the charts while Singapore ranked 23$^{rd}$ and Malaysia at 76.

Based on the available statistics (Figure 3.1), approximately 50% of our school leavers pursue tertiary education; 12% of these undergraduates go on to further their post-graduate studies. The representation of STEM students at tertiary level is still lower than non-STEM.

Growth in STEM talent is a priority where knowledge intensive productivity is concerned. The Malaysia Education Blueprint 2013-2025 indicates that STEM education will be instilled from pre-school onwards. The most common education pathway for STEM talent starts from Form Four onward, when streaming into the various vocations (i.e. Arts, Sciences, and Vocational courses) begin.

The Malaysian Government formulated the National Key Economic Areas (NKEA) in 2010 as part of the Economic Transformation Programme (ETP) to strategise Malaysia's move up the value chain through knowledge intensive productivity. The NKEA is the driver of the various economic corridors established to spur growth in an equitable manner all over the nation. The S&T Human Capital report was established to map out the route to ensure that the quality and quantity of Malaysia's labour force to fulfil the country's development up to the year 2020 is sufficient (ASM, 2012 *unpublished*).




*As of 31st Jan 2017*

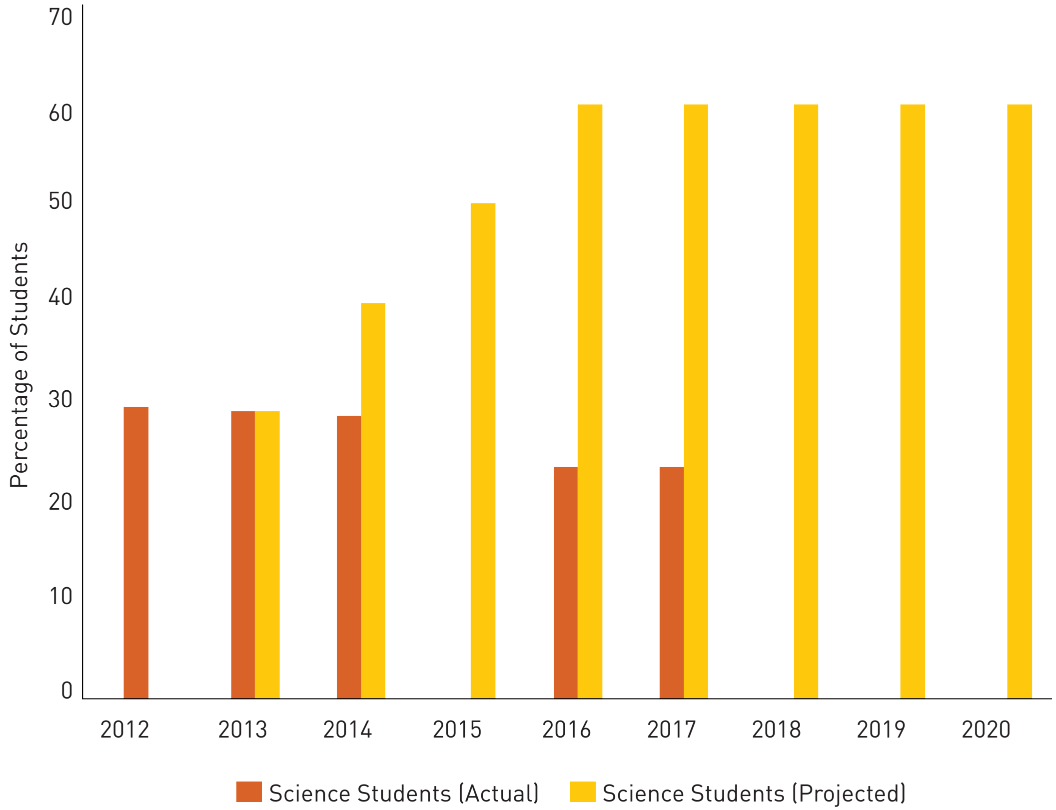
**Figure 3.1**
**Overall Talent Pipeline in Malaysia (2016)**

Data Source: National Higher Education Statistics, MOHE 2017
Malaysia Educational Statistics, MOE 2017

*Annually, approximately 400,000 Malaysian students complete the mandatory secondary school education; out of which 50% pursue their undergraduate degrees. On average, 10% of these graduates opt to pursue a Masters Degree while the rest join the workforce. The pathway continues with one fifth of these Masters Degree holders joining PhD courses (For easy of illustration, all figures have been rounded-up). Number of students pursuing STEM courses at tertiary level is only around 40%.*

The first step in the roadmap is to increase the supply of school students to enter STEM training at upper secondary all the way to doctorate level. The report forecasted that to accommodate the demand for STI talent at the country's current growth rate, intervention is needed to increase the number of students entering STEM stream in Forms Four and Five by 10% every year from 2014 onwards. Figure 3.2 illustrates that we have not achieved the desired increase to date.

The performance to date made it clear that we will not achieve the desired target of 270,000 students ready to enter STEM courses at tertiary level by 2020 (ASM, 2012 *Unpublished*). Higher education (at least diploma level) has been indicated as one of the drivers of talent development for a flourishing and innovative knowledge economy. Semi-skilled and skilled jobs moving up the value chain are needed to increase Malaysia's income/capita so that the aspiration to become a sustainable advanced nation with equitable wealth can be realised.




***Science students:***
*Students taking Physics, Chemistry, Add. Maths. and Biology*

**Figure 3.2**
**Enrolment of Form Five Students in Science Stream – Actual, and Forecast**

Source: Modified from S&T Human Capital (ASM, 2012 *Unpublished*)
*(Data for 2015 is not available)*
Data Source: MOE, 2012-2017

## Education Level and Performance

The Higher Education Planning Committee Report (1967) recommended a target of STEM to Arts stream student ratio of 60% to 40% as a guide towards becoming a developed nation by 2020. The 60:40 Science/Technical: Arts Policy in education was implemented in 1970 and is still active till date (Other policies on education can be found at section A3.1). The policy advocates for a ratio of 30:30:40 of science to technical to arts students distribution. The reality on the ground evidently shows a reverse trend where the arts stream continues to dominate even above combined Science and, Technical and Vocational Education and Training (TVET) stream.

Data collected by MOE over the years show that less than half of Form Four students enter Science or TVET stream. STEM stream enrolment has been declining from 48.15% in 2012 to 45.74% in 2017 (Table 3.1) despite efforts of introducing new learning approaches and an enhanced curriculum to sharpening skills and abilities of teachers (MOE, 2013). The 2017 National Budget allocated of RM570 million to reconstruct 120 destitute schools and to upgrade 1,800 schools laboratories (PMO, 2017). A number of reasons have been put forth to rationalise this decline, among them being, perceived difficulty of STEM subjects (MOE, 2013b).

**Table 3.1**
**Number of students enrolled in Form 4 and 5, in STEM and Non-STEM Streams in Government Schools (2012 – 2017)**

Data Source: Extracted and analysed by ASM, 2017 from various MOE statistical reports

| Year | Total no. of students | STEM (%) Science/Technical/Vocational | Non-STEM (%) Arts/Religious Studies/Special Edu. |
|---|---|---|---|
| 2012 | 844,821 | 48.15<br>Science: 29.35 | 51.85 |
| 2013 | 845,712 | 46.96<br>Science: 28.90 | 53.04 |
| 2014 | 823,129 | 46.33<br>Science: 28.69 | 53.67 |
| 2016 | 800,575 | 47.82<br>Science: 23.15 | 52.18 |
| 2017 | 785,612 | 45.74<br>Science: 23.19 | 54.26 |

**Data for 2015 is not available*

Red font denotes students in the Science Stream

## Performances of students at the National Level Examinations

The *Ujian Penilaian Sekolah Rendah* (UPSR) Science and Mathematics result analysis showed that the students performed well in Science and Mathematics and it can be assumed students are keen on STEM subjects, at least while they were in primary school (Figure 3.3).

However, there was a dramatic decline in the UPSR Mathematics performance in 2016 and 2017 (Figure 3.3). 2016 was the first year where 20% of the questions were set based on the higher order thinking skills (HOTS), which was incorporated in the syllabus in 2014. This may indicate that the students are not prepared for HOTS-based evaluation and it also bears investigation of the teachers' efficacy in HOTS delivery also bears investigation. HOTS for Science and Mathematics are a good addition to complement the traditional rote-learning methods; however, the lack of hands-on/practical activities in learning especially in science limits the students' ability to comprehend HOTS.

It should be noted that students are no longer evaluated solely on the performances in the UPSR exams but also based on Classroom Assessment (PBD), Physical Activity, Sports and Co-curriculum Assessment (PAJSK), and Psychometric Assessment (PPSI) beginning assessment year 2017. This is deemed a more just and holistic way to monitor the development of our future talent.

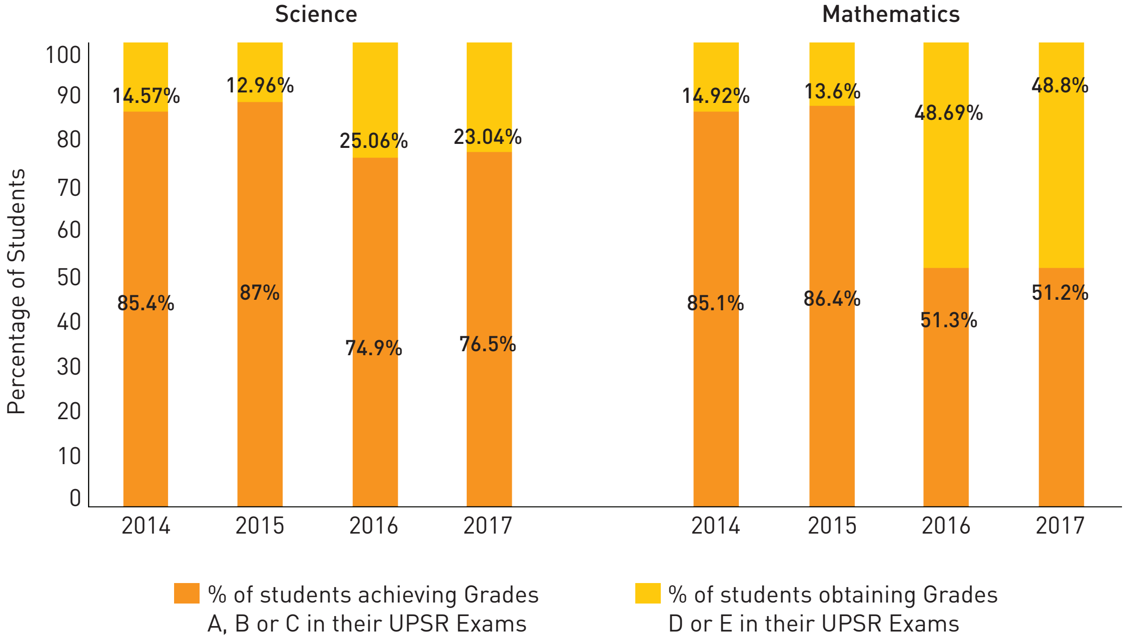



**Figure 3.3**
**Students' performances in the UPSR exams in Science and Mathematics subjects (2014 - 2017)**

Data Source: MOE, 2017

Students' interest and performance in Science and Mathematics in lower secondary was evaluated based on the *Penilaian Tahap Tiga* (PT3) result. As seen in Figure 3.4, the number of students passing the two subjects in 2015 and 2016 is unsatisfactory. Less than a quarter passed Mathematics with a minimum of C, and the numbers are even lower for Science. Although there was a slight improvement in the 2016 results, there is no denying that based on the grades the eligibility for Form Four Science stream is low and insufficient to fulfil the recommendations of the 60:40 Science/Technical: Arts Policy (30% Science, 30% TVET, 40% Arts).

Although the number of students eligible to join the Science stream in Form Four is low, their performance at the *Sijil Pelajaran Malaysia* (SPM) level is heartening. As seen in Figure 3.5, the number of students who passed Additional Mathematics, Biology, Chemistry, and Physics with a minimum of C grade are above 50%, with Physics and Biology attaining 80% passes in 2016. The average to poor performances in Additional Mathematics is a cause of concern. Is there a possibility of universities enrolling students without a sound Additional Mathematics qualification into critical courses such as engineering?

As the nation moves towards joining the next industrial revolution bandwagon, are we compromising on quality as we face a possible shortage of technological competent talent?

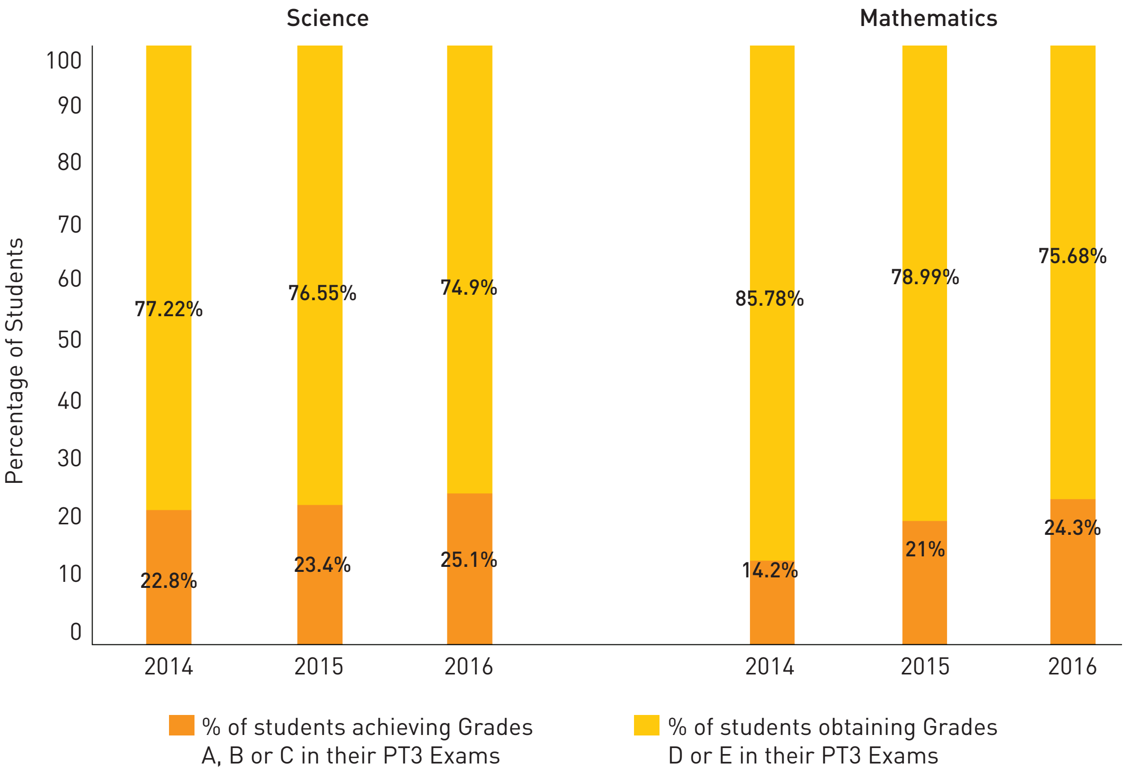



**Figure 3.4**

**Students' performances in PT3 for Science and Mathematics subjects (2014 - 2016)**

Data Source: MOE, 2017

Overall, performances at national level examinations likely demonstrate that students have poor comprehension of Science and Mathematics taught using the HOTS method of teaching at the lower secondary level, and to some extent, at the upper secondary level too.

SPM qualification is the gateway into pre-university programmes such as Form Six, MOE matriculation, and Foundation Studies in Science (limited to selected universities) in Malaysia *(note: foreign students are allowed to enrol with other qualifications such as A levels)*. A pass in SPM Bahasa Melayu is also a requirement to enter Malaysian civil service. Therefore, based on a cohort study involving students who sat for UPSR in 2010 and in 2011 (Cohorts A and B respectively, Box 3.1) it is worrying that the number taking the PMR/PT3 and subsequently the SPM examinations is on a decline. This trend should be analysed and understood as it affects the STI talent supply for Malaysia.

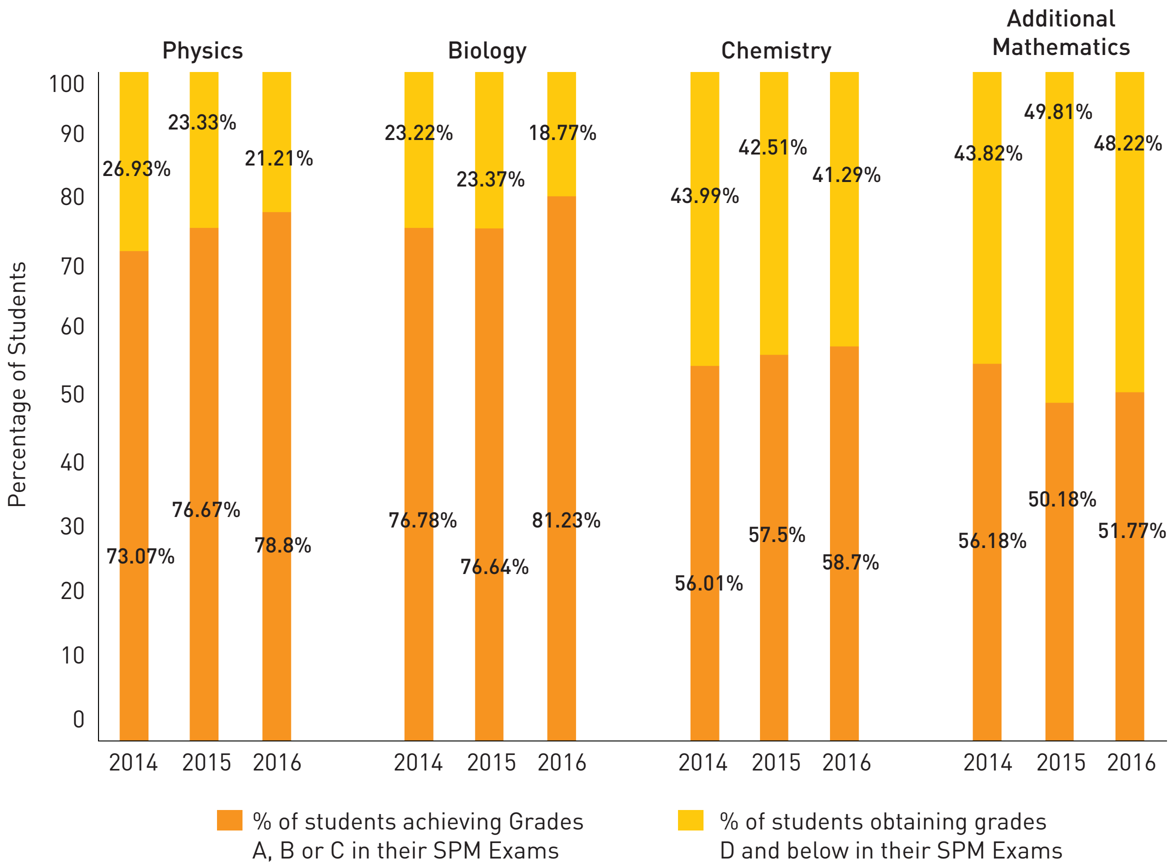



**Figure 3.5**

**Students' performances in SPM for Physics, Biology, Chemistry and Additional Mathematics subjects (2014 - 2016)**

Data Source: MOE, 2017

Box 3-1

## Decline in Students' Enrolment in a cohort study

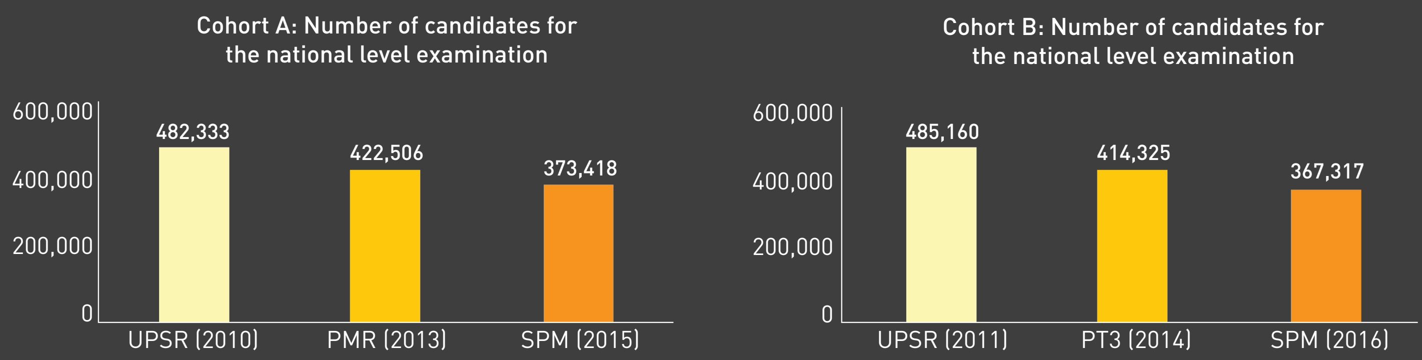



**Figure 3.6**
**Number of candidates for the national level examination**

Data Source: MOE, 2010-2017

Figure 3.6 shows the attrition of SPM candidates in a cohort study. Cohort A lost 22.58% students while Cohort B lost 24.29% over the years from UPSR onwards. The lower number could be due to several reasons, such as:

1. Students in Chinese independent secondary schools who opt for the Unified Examination Certificate
2. Students in private, international, or private religious schools who opt for international high school examinations (e.g. International General Certificate of Secondary Education or IGCSE)
3. Students in vocational schools who sit for *Sijil Vokasional Malaysia*
4. Students who drop out to enter training and apprenticeships (hard to trace as some training are unconventional or informal)
5. Students who drop out to enter the workforce

## Is STEM Stream Unpopular?

Performance in Science and Mathematics at PT3 level indicated that the lower secondary is where the STEM education crisis began. Secondary school students who are eligible to enrol into the Science stream after the *Penilaian Menengah Rendah* (PMR, now known as *Penilaian Tahap Tiga*, or PT3) but chose not to do so increased to approximately 15% in 2013 (MOE, 2013).

In addition, the uptake of subjects offered in the Science stream is also on a decline over the years (Figure 3.7); shrinking the talent pool enrolling into institutions of higher learning (IHLs) for subsequent Science/STEM- related training over the years.

The undesirability of science stream as an educational choice must be examined as it affects the country's talent planning and management. A number of studies have looked into why science continue to be marginalised even by the students who are eligible for it and their findings are condensed as follows:

### Reasons Why Students Avoid Taking Science Stream

- Lack of awareness on the opportunities and career pathway in STEM/ STI
- More difficult to enrol for tertiary education in science
- Teaching of science is too theoretical
- Students' attitude and interest are positive but lack of confidence and perceived STEM subjects as difficult
- Inconsistent quality of teaching and learning
- Lack of encouragement by teachers or counsellors
- Peers or parents do not favour science education
- Popularisation of STEM (media)
- High investment in STEM (reference book, laboratory and equipment)
- Teaching & learning process and infrastructure that is not interesting and not conducive
- Limited and out-dated infrastructure
- Science subjects are difficult

*Condensed from MOE, 2012; MASTIC, 2014; National STEM Movement, 2016; ASM, 2017*

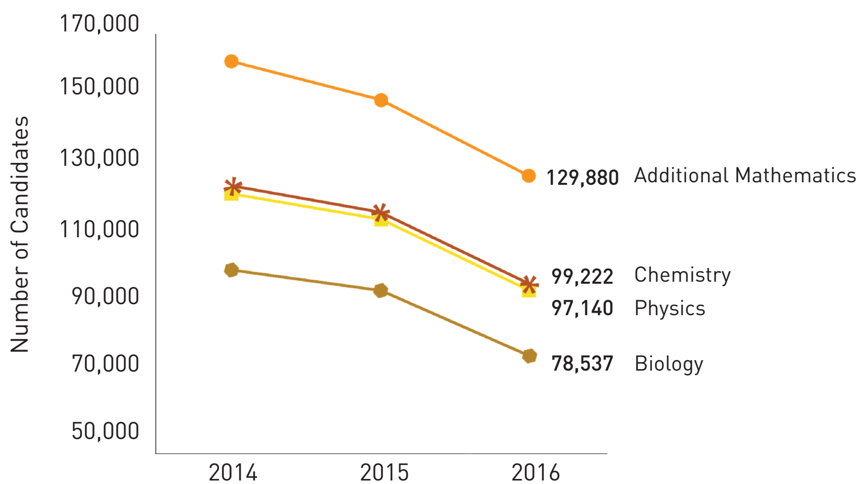



**Figure 3.7**
**Number of SPM Candidates in Science Stream**

Data Source: MOE, 2016

## STEM Curriculum and Education Delivery

The Ministry of Education (MOE) is continuously working with various stakeholders to keep the STEM curriculum and education delivery up to date. The Malaysia Education Blueprint 2013-2025 is MOE's commitment to redesign the Malaysian curriculum to align with international standards and to upgrade the assessment frameworks to monitor the student not just academically, but also their holistic development (MOE, 2016). Inquiry-based science education (IBSE) was introduced by ASM as a Pilot Study from 2012 to 2013 to develop active and independent learning in science beyond formulas and memorisation. Nationwide science practical curriculum would have been perfect to complement IBSE methods; however, implementation is delayed to 2019 while the laboratory infrastructure undergo phase-wise upgrades to the accepted standard.

Data showed that the majority of the teachers in service are in the 30-34 age bracket; i.e. they were students when *Penilaian Kemahiran Amali* (PEKA) was introduced. These teachers are highly likely to have experienced reduced science practical engagements in schools which may affect their effectiveness in teaching hands-on science practical (Ng, 2014). In preparation for the SPM Science Practical paper rollout in 2018, 2,681 Science teachers sat for the STEM Skill Competency Assessment in 2016. Results showed that 2,545 (94.9%) teachers achieved moderate to high competency levels (MOE, 2017).

Improving STEM teaching talents is an on-going effort by the MOE. At the moment, the available ratio of STEM teachers to students is 1:39 (Table 3.2), which is less than ideal. STEM education delivery is linked to the teacher's qualification, necessitating the drive to increase the number of graduate teachers specialising in STEM subjects. Fortunately, the majority of STEM teachers in Malaysian secondary schools hold a minimum of Bachelor's degree as their qualification.

Teachers in the present scheme should be supported to engage in research and upskilling activities to enhance their pedagogical skills. The National STEM Learning Centre which was announced in the 2018 National Budget for training STEM specialist teachers is a good move to boost STEM instruction in schools. It is envisioned that the National STEM Learning Centre will update STEM teachers on the latest development in STEM and its pedagogy, as well as conduct continuous professional development modules for career-long training, similar to doctors and engineers. STEM teachers also receive support from the National STEM Movement in terms of training and subject matter enrichment programmes.

**Table 3.2**
**Academic Qualification of Science and Mathematics Teachers, 2017**

Data Source: MOE, 2017

| | | TRAINED | | NO-TRAINING | TOTAL |
|---|---|---|---|---|---|
| | | Graduate | Non-Graduate | | |
| Primary School | Science, Mathematics, Technical Design Teachers | 47,836 | 34,981 | 386 | 83,203 |
| | All Teachers | 145,293 | 85,729 | 634 | 231,656 |
| | No. of Students | | | | 2,683,753 |
| | Ratio of Science, Mathematics, Technical Design Teachers to Students | | | | 1:32 |
| Secondary School | STEM Teachers | 53,200 | 1,752 | 175 | 55,127 |
| | All Teachers | 173,350 | 6,536 | 1,833 | 181,719 |
| | No. of Students | | | | 2,175,967 |
| | Ratio of STEM Teachers to Students | | | | 1:39 |

At the moment, there is no clear career path for STEM teachers to further incentivise them. Teaching profession in Malaysia does not offer the most attractive remuneration although there are other excellent benefits; remuneration for a primary school teacher in Malaysia is lower than other developed economies. To put into perspective, the average gross annual income including supplements such as bonuses for teachers in Malaysia is only USD12,218 while it is USD41,200, USD60,294, USD62,917 and USD39,787 in Singapore, Australia, Japan and Finland respectively (IMD, 2016). To make teaching STEM stream attractive and incentivising teachers to upgrade their performance, the existing pay scale of these teachers should be revised.

ASM conducted a survey among STEM teachers in secondary schools to assess the current STEM teaching landscape in Malaysia. 29% of the 55,127 STEM teachers in secondary schools responded to the online survey – the result of which is summarised in Box 3.2. One of the key recommendations from the review is raising the bar of entry to the teaching profession; i.e. choosing the crème de la crème as teachers and they should be paid according to their qualifications (similar to lecturers or science officers).

# Box 3-2

## STEM Teachers' Perception Survey (ASM, 2017)

ASM conducted a survey to get a snapshot of STEM education by the front liners. 16,115 (29.2%) secondary school STEM teachers responded to the online questionnaire and the results are as follows:

- Majority of the teachers (mean of 76%) agree that:
  - STEM subject exposure is important;
  - TVET training is important as part of STEM education
  - They encourage their students to take up STEM subjects;
  - Their students enjoy STEM subjects; and
  - It is difficult for their students to pass STEM subjects with distinction.

**48%** respondents said they have never attended STEM-related training; the rest acknowledged having attended training at least once (Figure 3.8).

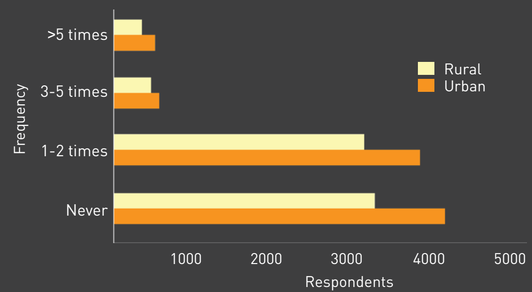



**Figure 3.8**
**Number of STEM Teachers Attended Training**

**34%** indicated that they did not receive enough exposure on STEM teaching and learning skills.

Among the difficulties they faced in teaching STEM:

- Students interest
- Inadequate facilities / Poorly equipped laboratory
- Insufficient teaching materials / resources;
- Not enough time for lesson plan preparation
- STEM curriculum has too much content to cover
- Time allocated for STEM teaching is inadequate
- Class size is too big for effective teaching

- In general, the respondents were happy that their schools placed emphasis on STEM education but they also feel that the STEM subject curriculum has too much content.
- The respondents were also concerned that many of their students find STEM subjects being too difficult.
- The STEM teachers acknowledge that jobs of the future will require basic understanding of Mathematics and Science.
- The respondents agree that STEM is important to ensure Malaysia's global competitiveness.

Efforts by MOE through collaborations with MOSTI, MOHE and other partners to expand STEM enculturation beyond academic programmes are on-going, e.g. Universiti Sains Malaysia and MOE innovated the STEM with Multiple Intelligence (STEMMI 1.0) programme that provides hands on activities for rural students to experience STEM learning in their own preferred learning styles.

Private-public partnership to increase access to STEM enrichment programmes such as National Science Camp can be further encouraged. Corporate social responsibility (CSR) projects for STEM engagement for schoolchildren should also be promoted. The levelling of the playing ground through the Internet and social media can be exploited by increasing STEM content appropriate for school children to be disseminated through these means.

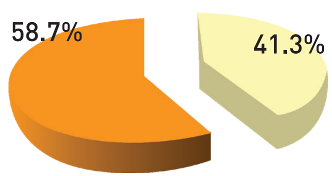
## Tertiary Education Level

Annually, non-STEM courses have larger intake regardless of public or private IHLs. For instance, the intake for STEM related courses for the year 2015 was only 46% in public IHLs and 30% in private IHLs (MOHE, 2016b). Non-STEM courses have lower capital and infrastructure requirement (i.e. no need for laboratories, specialised equipment, and technical support manpower) making them more lucrative to private universities and colleges. Hence, private IHLs usually offer more placements for non-STEM courses.

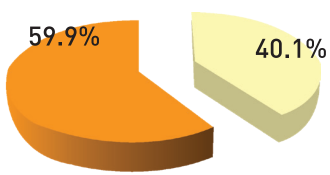
Public IHL can offer more STEM-related placements because they have been established longer with the requisite infrastructure in place. However, the declining pool of students interested in STEM is of concern as shown in sections above resulting in lesser uptake of STEM courses as opposed to non-STEM courses (also in Figure 3.9). This imbalance is a matter of concern as reports on the future of jobs in Fourth Industrial Revolution indicated that STEM knowledge will be core in high-skilled employment of the future (Ras et al., 2017).

It is interesting to note that the intake trend in higher education favour women. Nearly all field of studies have twice as many women enrolled compared to men, except for engineering, manufacturing and construction as well as agriculture and veterinary; even for these two areas, the enrolment numbers are almost evenly matched (MOHE, 2016). While this means that women are given equal educational opportunities in Malaysia, women's labour participation in the country is still relatively low at 54.3% (DOSM 2017a). The loss of these qualified women in the job market should be investigated as it impacts the country's plan for growth through knowledge economy.

**a) Enrolment in 2015 for Tertiary Education**




**b) Enrolment in 2016 for Tertiary Education**




Non-STEM STEM

Courses:
**STEM:** Science, Mathematics & Computer, Engineering, Manufacturing & Construction, Agriculture & Veterinary, Health & Welfare
**Non-STEM:** Education, Arts & Humanities, Social Science, Business and Law, Services, General Programmes
**Tertiary Education:** Public Universities, Private Institute of Higher Learning, Polytechnics and Community Colleges

*Intake: First time registered students for the programme*
*Enrolment: Registered local students as of October of the evaluation Year*

**Figure 3.9**
**Distribution of enrolment between STEM and non-STEM courses for Tertiary Education in Malaysia**
Courses includes Diploma, Undergraduate Degrees and Post-graduate degrees

Data Source: MOHE, 2017

## Employability of STEM Graduates

The youth unemployment rate is at 10.5% (DOSM, 2017a) and employability of Malaysian graduates is a perennial issue. More than one in five graduates have yet to be employed six months after they finished their studies (MOHE, 2016a). However, surprisingly there is little difference between unemployed STEM and non-STEM graduates although more non-STEM graduates are employed than STEM graduates. This is because a significant number of STEM graduates are either waiting for placement or chose to further their study (see Figure 3.10).

TalentCorp conducted a survey in 2014 to assess trends in graduate employability and found that employers and universities do not always cooperate to produce and utilise the best talents available (World Bank-TalentCorp, 2014). The survey also found that most employers are unhappy with the soft skills of Malaysian graduates; it is not known whether these issues are particularly harder for STEM graduates versus non-STEM graduates.

The Government introduced a number of soft skills training programmes to address this lack of competencies, primarily the Skim Latihan 1Malaysia (SL1M) which target fresh IHL graduates. The graduates are given soft skills training prior to placement in selected companies. This public-private partnership allows companies to participate in the programme as a corporate social responsibility (CSR) activity as well as a way to recruit fresh talent.

The Malaysia Education Blueprint for 2015-2025 (Higher Education) includes a new strategy to enhance student experience in the industry through degree apprenticeship. The 2U2I programme is being rolled out by select universities whereby the student will spend 2 years in the university and 2 years in the industry to enable them to have real world experience with the theoretical knowledge they have obtained in the university. This new education partnership is a way for higher education to meet the need of employers for skilled and trained workers in niche areas with the potential of promoting growth and development of local talent.

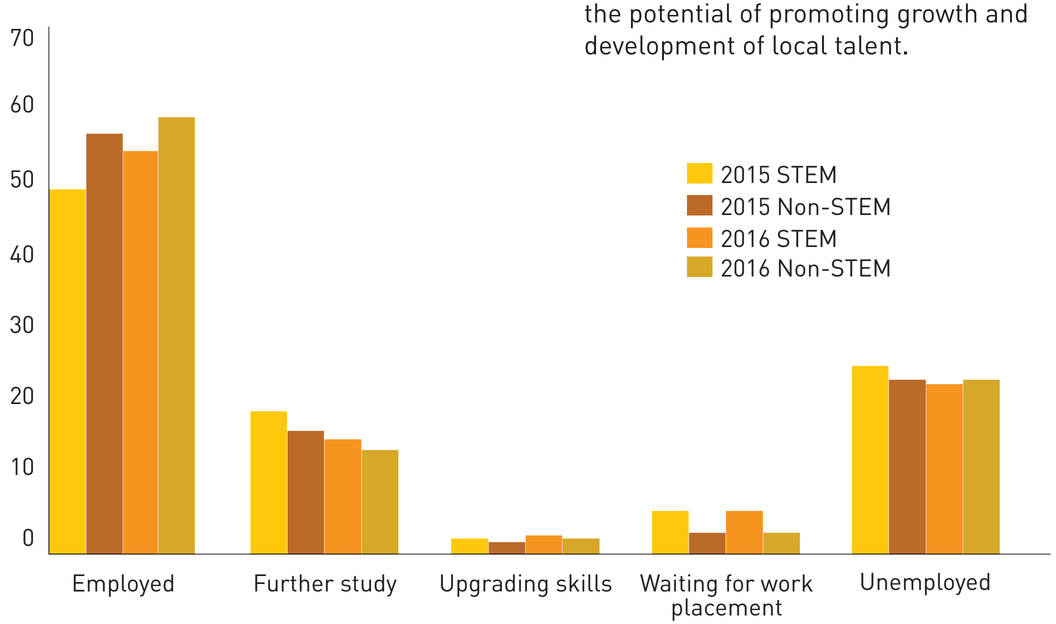


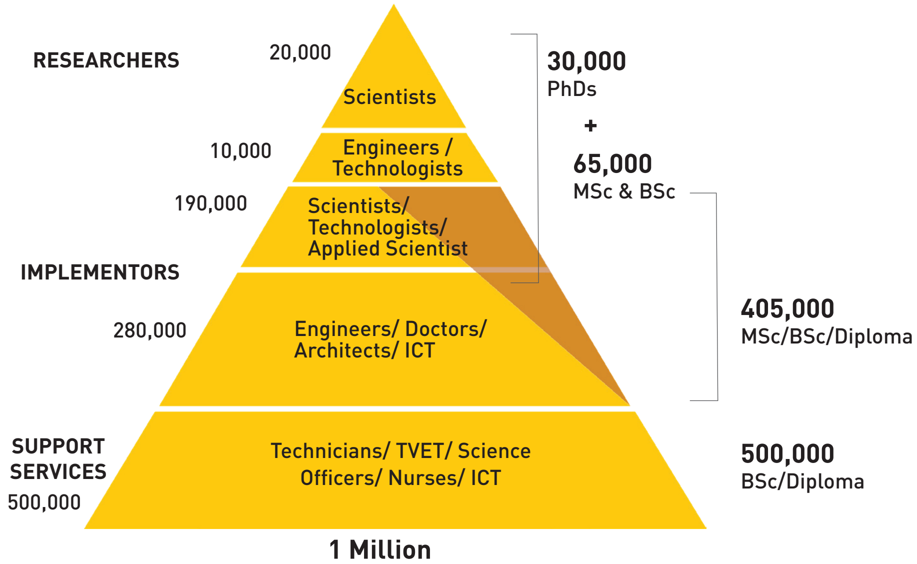

**Figure 3.10**
**Employment Status of Malaysian Graduates**

Data Source: MOHE, 2017

## 3.3 DEMAND FOR STEM WORKFORCE

Commodities-intensive economic system of post-Independence Malaysia did not require highly educated workforce but the nation's shift toward high value added, knowledge intensive economy demand a more sophisticated talent. STEM workforce market share is roughly around 15% of the labour market at the moment. This market share is expected to grow by 2020 and beyond as the national key economic areas (NKEA) and regional economic corridor planning began to bear fruit. Ten out of the twelve NKEA focuses on STEM to drive the transformation; It is expected that by the year 2020, over 1.0 million STEM workforce is needed to drive the national economic programmes as well as the regional economic corridors (Figure 3.11). These jobs require a minimum of diploma or a bachelor's degree as the most basic qualification; an essential ingredient for increasing the income per capita of the nation. With the current pool of STEM graduates, this target will not be met by 2020.

Although the labour market share appears to be small, STEM talent is the core of high skill, knowledge intensive economy for global competitiveness. The current breakdown of employment by skills shows that the industry only has 27.3% high skilled talent; semi-skilled at 59.7% makes the biggest part of the pie and the remaining are low-skilled labour (DOSM, 2017a). From R&D, production and quality control, to data management and analysis, the STEM workforce is a vital feature of Malaysia's future economy.




**Current number of researchers:**

**13,034** researchers in Public Universities (MyRA, 2016)

Out of which **270** are in HiCOE

**3,394** researchers in Public Research Institutions (EPU, 2017, *unpublished*)

Number in business enterprises and Private IHLs is not known

**Figure 3.11**
**STEM Talent Quantitative Distribution**

Data Source: ASM[b], 2012

An Economic Planning Unit (EPU) study shows that the top 10 jobs demanded by 2020 are as shown in Tables 3.3 and 3.4.

**Table 3.3 (top)**
**Top 10 Jobs Created in the Coming Five years for MASCO 2**

**Table 3.4 (bottom)**
**Top 10 Jobs Created in the Coming Five years for MASCO 3**

Source: EPU, 2016

| MASCO 4-Digit | Description | No. of Jobs Created |
|---|---|---|
| 2142 | Civil Engineers | 7,009 |
| 2425 | Administrative Professionals | 6,065 |
| 2152 | Electronic Engineers | 5,130 |
| 2522 | Systems Administrators | 5,032 |
| 2514 | Applications Programmers | 4,471 |
| 2165 | Cartographers and Surveyors | 3,282 |
| 2144 | Mechanical Engineers | 2,792 |
| 2161 | Building Architects | 2,163 |
| 2511 | System Analysts | 1,938 |
| 2432 | Public Relations Professionals | 1,625 |

| MASCO 4-Digit | Description | No. of Jobs Created |
|---|---|---|
| 3123 | Construction Supervisors | 19,148 |
| 3322 | Commercial Sales Representatives | 16,313 |
| 3115 | Mechanical Engineering Technicians | 7,447 |
| 3113 | Electrical Engineering Technicians | 6,480 |
| 3122 | Manufacturing Supervisors | 6,355 |
| 3341 | Office Supervisors | 4,767 |
| 3522 | Telecommunications Engineering Technicians | 4,221 |
| 3112 | Civil Engineering Technicians | 4,089 |
| 3118 | Draughtspersons | 3,846 |
| 3313 | Accounting Associate Professionals | 3,765 |

Note:
MASCO-Malaysia Standard Classification of Occupations 2008

**M2: Professionals**
Education Level: Tertiary education leading to a university or postgraduate university degree; Malaysian Skills Advanced Diploma (DLKM) Level 5-8

**M3: Technical and Associate Professionals**
Education Level: Tertiary education leading to an award not equivalent to a first University Level; Malaysian Skills Certificate (SKM) Level 4, or Malaysian Skills Diploma (DKM) Level 4

Many of the focus area to be developed in the five regional economic corridors require TVET and STEM talents. Enhancing TVET and STEM training to encourage cross fertilisation of ideas will help promote creative cross platform solutions. For example, tourism is not a traditional STEM field but application of STEM knowledge can be used to enhance tourism services delivery, e.g. developing online booking portals and using smart devices to enhance communication and customer experience.

The Critical Occupation List (COL) co-developed by ILMIA and TalentCorp is the primary instrument to facilitate effective coordination of talent policies for upskilling the workforce; guiding TVET and higher education teaching programs; retaining skilled Malaysians while also enticing returning Malaysians; and attracting foreign talent (CSMS, 2017). The current list is the 2$^{nd}$ publication (after the 2015/2016 list); 31 occupations continue to remain on the list for the second straight year.

The current COL sets forth 48 jobs most in demand in key sectors of the economy in the year 2016/2017. Below are some selected STEM related jobs from that list:

- Research and Development Managers
- Information and Communications Technology (ICT) Managers
- Geologists and Geophysicists
- Mathematicians, Actuaries and Statisticians
- Industrial and Production Engineers
- Mechanical Engineers
- Mining Engineers, Metallurgists and Related Professionals
- Electrical Engineers
- Electronic Engineers
- Telecommunications Engineers
- Systems Analysts
- Software Developers
- Databases and Administrators
- Computer Network Professionals

The Global Human Capital Report 2017 published Malaysia's high skill employment ranks at 48$^{th}$ while Singapore is 2$^{nd}$ and Finland 12$^{th}$. In terms of knowledge intensive jobs, Malaysia needs to create more opportunities. At present, Malaysia ranks at 53$^{rd}$ place in the Global Technology report while Singapore is at the 2$^{nd}$ spot and Finland at 12$^{th}$. The Global Innovation Index place Malaysia at the 46$^{th}$ spot out of 137 economies in terms of technological readiness. In Global Competitiveness Index (GCI) 2016–2017, Malaysia ranked 25$^{th}$.

All this indicate that our talent is still unsatisfactory to keep the country on the trajectory for a sustainable knowledge-based economy. The situation is worsened when it is clear that our STI talent supply at all levels will not be meeting the demand at the present rate.

## Box 3-3

### Demand and supply in the Transportation Sector – MRT/ High Speed Rail (Engineering Services)

The mass rapid transit (MRT) projects and upcoming High Speed Rail system connecting Kuala Lumpur to Singapore creates a demand for skilled and semi-skilled technical talents in engineering services. It is projected that by 2017, 16,000 technical manpower is needed from approximately 5,500 in 2013. While the supply of skilled engineering fresh graduates is projected to be able to meet industry demand, the supply of semi-skilled fresh graduates may not be met with the projected demand by 2020.

Source: Ipsos Business Consulting, 2014

# Box 3-4

## Demand and supply of MDEC's Digital Talent

In 2017, the estimated employees in Malaysia's Digital Industry were 355,119. It is projected to grow at an exceptional rate of 15% over the next three years to 540,562 employees in 2020. The growth will be driven by business expansion and improving business outlook, particularly the key focus areas in the Digital Industry such as Cloud/Data Centre (28%), Global Business Services (21%), Fintech (21%), Creative Content Technologies (20%), IoT (19%), eCommerce (18%) and others.

However, the talent supply scenario highlights that out of 119,000 graduates in 2017, only 37% have relevant qualifications in digital technology, with the majority in E&E, IT and creative technology/arts. The forecasted trend would show that we are expecting a shortage of talent supply, especially in the fields of IT and Engineering, who are willing to join the Digital Industry.

The challenge therefore is for all parties to leverage on the positives - that there are many job opportunities in the Digital Industry, hence, there must be a continuing effort to create awareness and encourage our young talent to enrol in the field of study that is relevant to the Digital Industry.

Source: Ipsos Business Consulting, 2014

# Box 3-5

## Demand and supply in Petronas's RAPID Project

The Refinery and Petrochemical Integrated Development Project (RAPID) project by Petronas in Pengerang is expected to be operational by 2019 and is projected to produce 300,000 barrels of crude oil per day (bpd). It aims to make Pengerang the regional oil & gas hub by 2035 with approximately 54,000 new jobs expected to be generated. However, participants of a focus group conducted on the 26 May 2016 with 22 sub-contractors of the RAPID project unanimously agreed that there is a shortage of skilled and semi-skilled workers to fill the vacancies created by the project.

Source: EPU, 2016

## Is there a STEM Talent Gap?

Malaysia's aspiration to become a high-income nation requires talent reflective of the talents in advanced economies. Feedback from industry indicated that a talent gap exists that is affecting the nation's progress. The Critical Skills Monitoring Committee was established to investigate this claim and the data obtained were consolidated in the Pilot Critical Occupations List (COL) Report in 2015. The COL report identified the following sectors with high growth and expansion potential, currying income in the billions of ringgit with staffing issues:

1. Electrical & Electronics (includes Machinery /Equipment and Advanced Engineering)
2. Oil & Gas
3. Information and Communication Technology & Global Business Services (ICT & GBS)
4. Telecommunications & Multimedia
5. Financial Services
6. Accounting
7. Education
8. Aerospace
9. Medical Devices
10. Petrochemicals

Employers in some of these sectors outlined the reasons why they have difficulty obtaining the talents they need to fulfil these vacancies as shown in Table 3.5.

**Table 3.5**

## Reasons for Hard-to-Fill by Sectors

Source: CSMC, 2015

| Sectors | Oil & Gas | E&E | ICT & GBS | Telco & Media | Accounting | Financial Services |
|---|---|---|---|---|---|---|
| None or insufficient applicants | 14% | 18% | 21% | 16% | 21% | 17% |
| Applicants did not have the required educational qualifications | 10% | 5% | 14% | 5% | 14% | 10% |
| Applicants did not meet the required skills / experience | 39% | 38% | 28% | 34% | 25% | 40% |
| Applicants did not possess required soft, interpersonal skills (e.g. attitude or communication skills) | 22% | 20% | 18% | 17% | 14% | 14% |
| Applicants are qualified for the job, but company unable to meet the salary / benefits requested | 15% | 19% | 19% | 25% | 25% | 19% |

The greatest grouse seem to be applicants lacking the desired skills / experience. This indicated a need for more dialogues between employers and talent development institutions to identify the training the kind of training employers are seeking in their talent pool. Employers should also be willing to get someone who may not tick all the right boxes, and invest in training them to raise candidates who fit their needs.

The report also indicated that 15 to 25 percent of the employers are unwilling to match the salary and benefit requested by their candidates. Some employers may believe the labour market gives them time to shop around for candidates who will take below-market wages, or they may actually not be able to pay the market wage. This mindset needs to be addressed because unskilled labour cannot fulfil the rigours for Malaysia to engage in knowledge intensive economy.

Like most economies, Malaysia's demographic will be moving towards ageing population after 2030 which makes lack of STI talent in critical sectors more acute. Moving the optional retirement age up to 70 years for selective STEM fields may be a needed stopgap measure to fill the talent gap.

Although the country is producing even more educated labour force in the past two decades, it seems that there is a gap between the talent supplied and the demand by employers. Department of Statistics Labour Force Survey Report

2015 indicated that the labour size with tertiary education was about four million but only 3.6 million of the jobs available require tertiary qualification. This is an indicator that the industry is not producing enough skilled jobs that would help drive Malaysia up the value chain.

STEM talent utilisation in Malaysia is not a straight forward matter of demand and supply, but rather a shortage of the right proficiencies and unmet compensation expectations. Rather than continue to produce over qualified and under-utilised workers, the upskilling, training and education pathway in the country should be strategised to optimise the production of the desired talent.

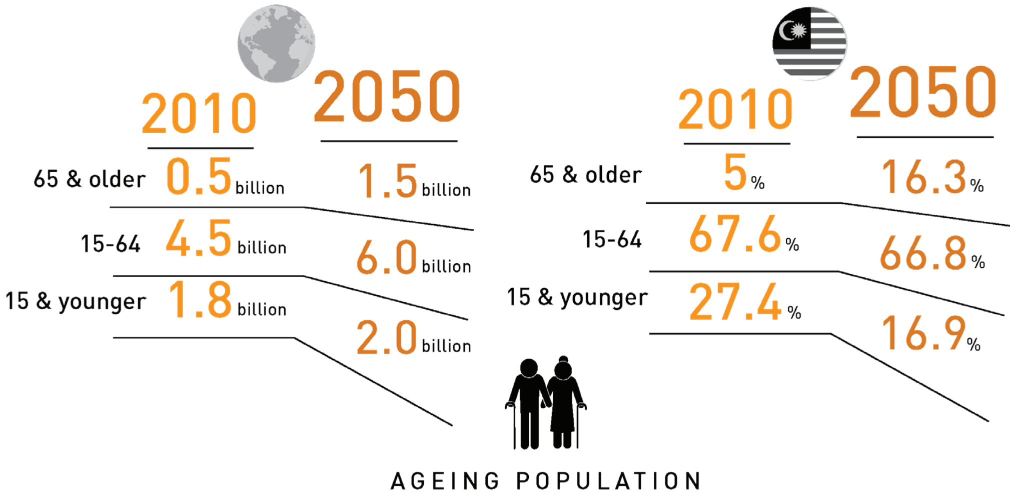



**Figure 3.12**
**Demographic Projection for Malaysia**

Data Source: DOSM, 2017b

## Initiatives for STEM Workforce

Every time the economy shifts from one system to another, there will be jobs sacrificed to the altar of obsolescence. This is why a number of advanced economies see a rising number of adults who change their career midway to enter STEM areas by reskilling and upskilling themselves in areas that they previously would not have thought about (WEF, 2016).

Individuals interested to expand their marketability in STEM areas can explore upskilling training programmes provided by various agencies and private entities. A number of the qualifications are accredited internationally. Employer can participate in the Human Resource Development Fund (HRDF) in various upskilling training by qualified providers to advance their staff. The upskilling training offered by HRDF include soft skills as well as technical training.

The Human Capital Development (HCD) Strategic Reform Initiatives (SRI) implemented strategies for the upskilling and reskilling of Malaysia's workforce, particularly for NKEA specific talent. One of the most successful activities is the MyProCert programme (MyProCert) for international certification in software and IT networking skills. TalentCorp offers Talent ProCertification, a double tax incentive for employers to defray training expenses and enable their employees to obtain various industry-recognised professional certifications.

The National Talent Enhancement Programme (NTEP) provides on-the-job and industry-relevant training for the electrical and electronics sector in a 12-month attachment programme tailored for each of Malaysia's regional economic corridors. TalentCorp initiated the FasTrack Apprenticeship Programme for University Engineering Graduates to experience complete industrial immersion through coaching and mentoring by Host Companies.

HRDF is currently funding training programmes in ICT Adoption and Big Data for employees and prospective employees until 2020 to develop local digital talent for the industry. The agency has allocated RM203 million for data and data professional training, empowering women through ICT and leadership data science, and development programme on critical ICT skills.

HRDF is collaborating with KnowledgeCom and Penang Skills Development Centre (PSDC) for the National Empowerment in Certification, and Training for Next Generation Workers (NECT-Gen-Industry 4.0) programmes. Five courses have been approved to deliver high-end technology certification programmes that are of Industry 4.0 standards through their partnerships with PSDC, SAP, Microsoft, Oracle and many others.

Sustainable Energy Development Authority Malaysia (SEDA) offers continuous development programmes (CDP) for those interested in the sustainable energy business. This serves a dual purpose of elevating renewable energy usage in Malaysia as well as providing the skilled workers needed in the arena. The Institute of Labour Market Information and Analysis (ILMIA) is also looking into other upskilling and reskilling programmes for jobs in green technology industry.

There is a rapidly growing demand for data professionals around the world. Malaysia aims to produce 20,000 data professionals by 2020, out of which 10% are data scientists (Priyanka, 2017). Malaysia Digital Economy Corporation Sdn. Bhd. (MDEC) launched ASEAN Data Analytics Exchange (ADAX) in March 2017. ADAX is set to be the resources hub for big data analytics in Malaysia and ASEAN region and to foster collaboration amongst these players and build up a talent pool in the area of data analytics.

# Box 3-6

## Skillful Partnership

Penang Skills Development Centre (PSDC) is a non-profit organisation for vocational education and training (VET) established in 1989. The self-sustaining talent development organisation is administered by representatives from industry, government, and academia. Among PSDC industry collaborators are Intel, Motorola, Hitachi, HP, AMD, National Instruments Malaysia and Philips. PSDC leverages on its industrial partners to produce highly skilled VET workers trained in the latest technology for manufacturing, electronics, and engineering companies.

Upon its establishment, PSDC offered 32 courses. By 2015, it conducts up to 375 courses, and has trained over 203,000 participants in its programmes. PSDC also offers consultancy services; i.e. training needs analysis and instructional systems design to prepare for the Fourth Industrial Revolution.

Programmes offered by PSDC:

- The German Dual Vocational Training (GDVT) programme
- Mechatronics programme
- STEM education for secondary students keen on the engineering track
- Breaking Boundaries initiative for upskilling of senior employees to take on new functions or tasks

## 3.4 JOBS FOR THE FUTURE

Can we prepare Malaysia for jobs of the future that does not even exist yet?

The Fourth Industrial Revolution is at our doorstep. Futurists predict that technological innovation in automation, 3D printing, genetics, AI,advanced materials, the IoT, big data, to name a few, will dominate the global economic landscape. The turbulence from technology's seismic waves mean that a number of highly sought-after skills today did not exist 10 or even five years ago; as in the skills for tomorrow has not yet been invented.

Automation and machine learning are expected to take out the most dangerous and tedious jobs out of the market; what will be left are jobs that require the human touch and ingenuity. Machines cannot replace human inspiration for novelty and creativity for problem solving. There will be new cross-functional roles that require technical, analytical and social skills to navigate taking us to the next industrial revolution.

For Malaysia to continue to prosper in the face of such challenges, the country needs talent qualified in STEM that is adaptable to change, have high facility for life-long learning, good interpersonal and collaborative skills, and trained in multi-sectoral thinking. This require more than just a shift in how formal education is structured and delivered, but also reframing thought processes to embrace the inevitable complexity that jobs of the future will be. Preparation for technological disruption demands talent with enhanced skill in STEM education and training.

### Skills needed for the Future

- ICT Literacy
- Cross discipline literacy
- Cross-functional skills
- Cross-cultural competency – for more virtual collaborations
- Logical and mathematical reasoning
- Adaptive thinking
- Design thinking
- Social and emotional intelligence

### STI Jobs of the near future

- Data analysts
- Software and applications developers
- Information security analysts
- Health IT engineers
- Database and network professionals
- 3D designers
- Digital designers
- Commercial and industrial designers
- Digital marketers
- Professional gamers
- Virtual teacher
- Regulatory and government relations specialists materials in bio-chemicals, nanotech and robotics
- Geospatial information systems experts
- Genetic counsellors
- Alternative energy developers

**Table 3.6**
**Global Talent Competitiveness Index (GTCI), 2017**

| Country ( n=118) | Vocational & Global Knowledge Skills | Technical Skills |
|---|---|---|
| Malaysia | 16 | 41 |
| South Korea | 35 | 19 |
| Japan | 32 | 23 |
| Singapore | 8 | 1 |
| Germany | 1 | 26 |
| Australia | 25 | 5 |

*The Vocational and Technical Skills (or VT Skills) and the Global Knowledge Skills (GK Skills) pillars of this index aim to describe and measure the quality of talent in a country. Mid-level skills or VT Skills describes skills that have a technical or professional base acquired through vocational or professional training and experience. High-level skills or GK Skills deal with knowledge workers in professional, managerial, or leadership roles that require creativity and problem solving.*

## 3.5 WAY FORWARD TO ENHANCE STEM TALENTS IN MALAYSIA

Skilled, knowledgeable, and creative STEM talents are important drivers for sector growth and productivity in any knowledge-based economy. It is not possible to have a single comprehensive STEM talent pipeline, much less depend only on the Government to provide top down support for such an endeavour. Therefore, promotion of collaboration among all sectors is the key in cultivating STEM talents successfully to fulfil the talent needs.

1

### Attracting and Retaining Stem Talent Through Improved Remuneration and Continuous Career Development

STEM education is a crucial element in producing knowledge workers. However, the challenge lies in engaging and attracting young people to first enrol in STEM-related degree programmes and then to pursue careers in STEM. This worrisome trend of low enrolment will lead to a loss in competitiveness of Malaysia in a technologically inclined world. Therefore, the entire education pathway, the STEM curriculum and STEM pedagogy has to be revisited to take away the perception of STEM subjects being tough and to make STEM stream an interesting choice.

Also, a predictable approach to attract and retain STEM talent is with improved remuneration schemes. While we acknowledge that compensation between STEM and non-STEM talent should not be valued one over the other, however, at present there is a need to reverse the decline of STEM talent. At present, at entry level a Science Officer (C41) earns RM 3,217/month (with allowances) while in the USA the lowest paying STEM occupation wage is USD3,265/month (U.S. Bureau of Labour Statistics, 2018).

The establishment of the National STEM Learning Centre by the end of 2018 is a quick win to serve as a platform for a structured continuous professional development to re-skill the STEM teachers nationwide with the aim to produce competent and passionate STEM teachers. Such a structured plan may also work to ensure sustainability of STEM talent elsewhere besides in teaching profession. Career development and alternative career pathway both in public and private services must be given a serious thought to have well place succession plan.

2

### Prioritisation of Numerically and Technically Competent Talent Development

Numeracy skill is the foundation of most STEM courses at tertiary level. However, the results of Mathematics in the UPSR and PMR/PT3 exams and Additional Mathematics in the SPM exams showed an average performance. Hence, this calls for a revised methodology of teaching and learning of Mathematics-based subjects. Future of Jobs report by WEF predicts Computer and Mathematical job families to have strong employment growth in the near future. Therefore numerically competent talent development must be prioritised to develop technical competency.

3

### Development of Biennial National STEM Talent and Skill Gap Assessment

To have more industry ready talent supply, it is important for industry and academia to work together. However, the problem identified is a mismatch of the talent supplied by IHLs and those with the right skillsets needed by the industry. Therefore, the development of a biennial nationwide STEM talent and skills gap assessment is proposed to gauge and identify the mismatch of our STEM talent- if there is either an oversupply or an under-demand especially of critical jobs. This effort must involve the quadruple helix in order to have holistic and accurate results.

## FURTHER READING.

**Appendix 3.1**

### Development of STI Talent Timeline

| 1966 -1970 | 1971-1975 | 1976 - 1980 | 1981 - 1985 | 1986 - 1990 | 1991 - 1995 |
|---|---|---|---|---|---|
| 60:40 Higher Education Planning Committee Report policy (1967)<br><br>Technical and Vocational Education consolidated by MOE (1964) | Science Secondary Schools and MARA Junior Science College were established (1970s) | | | | MOSTI spent RM34.5 million into S&T awareness projects (1994-1999)<br><br>Technical Human Resource Output Action Plan (1995) |

## 1996 - 2000

School-based science practical assessment, Penilaian Kerja Amali (PEKA) (1999)

Increasing Science & Technical Students in Secondary Schools Policy (1997)

Mandatory for students achieving C6 and above in SRP and PMR into science stream (2000)

## 2001 - 2005

Professional Circular (SPI) Bil. 1/2001: Upper Secondary Science & Technology Specialisation Choices Package (2001)

Teaching and Learning of Science and Mathematics in English (PPSMI) (2003)

National Education Policy suggested increasing number of pure science labs (2004)

## 2006 - 2010

National Education Development Master Plan 2006–2010 (2006)

National Higher Education Strategic Plan (NHESP) (2007)

PPSMI system phased out in stages (2010 - 2012)

## 2011 - 2015

TalentCorp establishment under the Prime Minister's Department (2011)

60:40 Policy Review Committee (2012) MOE agree to implement 15 of 61 recommendations School Improvement Specialist Coaches (SISC+) for Mathematics (2013)

Malaysia Education Blueprint 2013-2025 (Preschool to Post-Secondary Education) Revised KSSR and KSSM curriculum (2015)

Higher Order Thinking Skills (HOTS)

## 2016 - 2020

National Science Council requested a National STEM Action Plan to be drafted (2016)

School Improvement Specialist Coaches (SISC+) for Science (2016) Dual Language Programme introduction in selected pilot schools (2016)

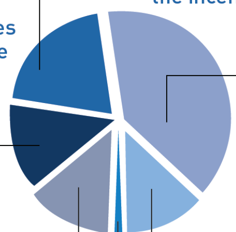
# 04
# STI Energising Industries

## 1 MALAYSIA'S GLOBAL COMPETITIVENESS 2017-2018

| Index | Ranking |
|---|---|
| **Global Competitiveness Index**<br>Technological Readiness: | 35/137 |
| **Global Innovation Index**<br>Knowledge Workers: | 93/127 |
| **Global Entrepreneurship Index**<br>Product Innovation: | 130/137 |
| **Bloomberg**<br>Overall Ranking: | 26/80 |

## 2 ENERGISING THE INDUSTRIES THROUGH STI

**Reasons for not taking advantage of Government R&D Incentives**




MOSTI, 2016

## 3 MALAYSIA'S INDUSTRY LANDSCPAE

**98.5%** **(907, 065)** of Business Establishments are SME

**Performance of SMEs (2016)**

- **36.6%** Contribution to GDP
- **17.8%** Exports

**18.0%** **High skilled** workers in manufacturing sector

Many SMEs are merely **ADAPTERS & IMITATORS** (EPU, 2017)

Only **6%** of Malaysian companies are **CREATORS,** whilst majority are **ADAPTERS** (MPC, 2012)

**Innovative capacity & capability is still LOW**

**42%** of companies allocate less than 10% of their revenue for technology

**3962** Industry Associations

**42** Industry Parks

## Transformation of Malaysian Industries To Be Globally Competitive And Sustainable

Malaysia has transitioned from a resource-based economy to one that is knowledge-intensive. As a result, a whole new playing field has emerged globally. Mass production and consumption is being taken over by mass customisation. Products no longer decide demand. In fact, demand is creating new products and services. Previously, scale mattered most but today speed and flexibility are key factors. Where once large enterprises led the way, today small and medium enterprises (SMEs), and innovative start-ups are taking the lead.

Recognising the need to develop indigenous science, technology and innovation (STI) capacity and capability for competitiveness and sustainability, Malaysia has charted its course towards becoming an innovation-led economy. Given that 98.5% (DOSM, 2016) of Malaysian business establishments are small and medium enterprises (SMEs), they would need to be agile and respond proactively to participate effectively in the industry value chain.

The Government of Malaysia offers many incentives (e.g. tax incentives, grants and soft loans) for industries to enhance knowledge intensity and innovation capacity. However, many industry players claim that they are unaware of the know-hows to leverage on these incentives. More members of the industry and STI-based business associations as representatives in the National Science Council (NSC) and the National Innovation Council (NIC) may help bridge this gap. Foresight is another key factor for industries to leverage dynamic opportunities towards wealth creation and moving up the innovation value chain.

Malaysia has the right ingredients to energise its STI based industries – English speaking talent, abundant natural resources, supportive regulations and financing, socio-political stability as well as access to technology, expertise and knowledge. What is missing is the knowledge intensity of industries to leapfrog from being imitators to innovators. The key success factors to be inculcated by local industries in order to successfully capitalise disruptive innovations and enhance their competitiveness includes leadership, knowledge intensiveness and collaborative strategies (ASM, 2017). Local industries will continue to lag behind unless they optimise these factors. There is a need to elevate from merely being consumers to prosumers of technology in the long run.

## HINDSIGHT

Science Outlook 2015, STI Energising Industries highlighted **three** recommendations.

| 2015 Recommendation | | Development |
|---|---|---|
| An "STI Stakeholder Engagement Model" will not only define "critical stakeholder universe" essential for STI policy implementation success but will also define the nature and extent of collaborations between the industry and other STI proponents (including academia). | **FORMAL + REGULATED LINKAGES FOR PUBLIC-PRIVATE PARTNERSHIP** | Several intermediaries and platforms to enhance collaborations between industry and the other STI proponents have been established but these intermediaries are not industry-led. (e.g.: PPRN, SIRIM-Fraunhofer, Steinbeis Malaysia and PlaTCOM).<br><br>The NSC in 2017 decided for the collaborative network model to be implemented in four potential focus areas (Fintech in Islamic Banking, Virtual Health, Industry 4.0 and Halal value chain) to enable demand driven research and enhance innovation capacity.<br><br>Collaborative efforts by various government ministries and agencies concerning STI and industry advancement are being carried out [e.g. The National Industry 4.0 Policy Framework was led by the MITI and involved five other ministries (namely, the MoF, KKMM, MOHE, MOHR and MOSTI)]. |
| An awareness and enculturation campaign for the industry using appropriate and innovative ICT channels will help enhance the level of understanding as well as involvement in promoting STI agenda. The industry associations, with measurable KPIs, can educate and mobilise the industry towards creating a better STI ecosystem. This should encompass nominating industry associations as well as successful companies to represent on various policy-making committees, R&D review panels, and consultation clinics of ministries. | **TO DISSEMINATE STI AGENDA AMONGST INDUSTRY PLAYERS** | Selected industry captains have been appointed as members of the NSC and the NIC. However, membership in both Councils can be further enhanced to be more inclusive of all key sectors of the industries. |
| A centralised knowledge repository will provide access to critical and credible Malaysian STI information. Such a centre can also help synergise and coordinate all STI funds, plans, policies and programmes across sectors, to avoid duplication of efforts and maximise output. | **STI DATA CENTRE** | A centralised knowledge repository to integrate, synergise and co-ordinate various industry-related information and intelligence has not been formed. |

## 4.1 TRANSITION OF THE MALAYSIAN ECONOMY

STI has underpinned the pillars of our economic growth for the last five decades. It drives the generation of new knowledge and translation of ideas into cutting-edge technologies, products and services which will lead to the growth of knowledge-based enterprises for wealth creation, economic development and societal well-being. STI proficiency will enable Malaysian industries to climb up the global value chain by enhancing innovation capacity. Strong and robust STI-based industries would then pave the path to enhanced productivity, job creation, innovation capacity, high-skilled talent pool and ultimately economic prosperity and societal well-being.

Malaysia has strategised and moved to enhance competitiveness through STI in frontier industries, especially where Malaysia already has a niche. In efforts to transform the commodity-based industries to become innovative and market-oriented, R&D is vital. Successful transformation through adoption of R&D by some of Malaysia's thriving industry players is narrated in paragraphs below.

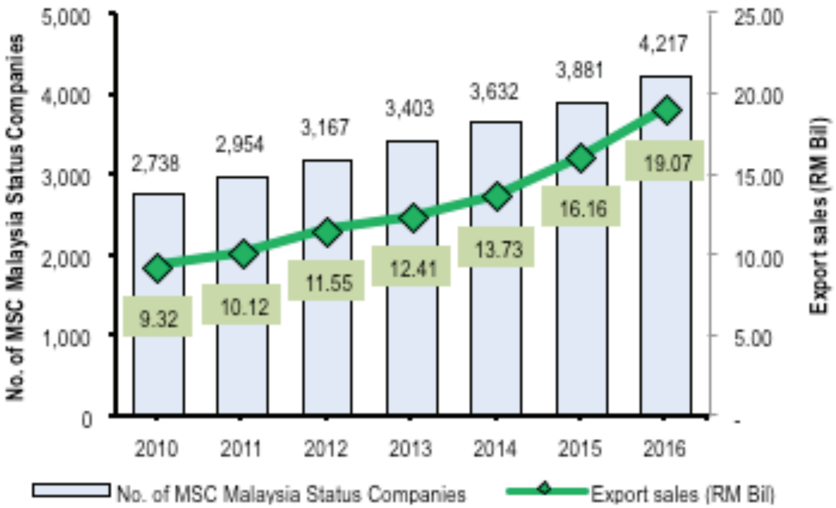
**RUBBER:** In the late 1990s, production of natural rubber was on the decline. However, sufficient and timely R&D activities have brought upon advancement to the rubber sector. In 2016, rubber gloves were the largest section of the Malaysian rubber products industry, amounting to RM13.2 billion. Malaysia produces 60% of the total global supply of rubber gloves.

**PALM OIL:** Total exports of palm oil products declined in 2016 (down to RM23.29 million tonnes from RM25.37 million tonnes in 2015), attributed to the El-Niño phenomenon. Oil palm biotechnology has the potential to increase oil extraction rate as well as produce oil palms that are more resilient. Another downside in palm oil production is the heavy reliance on foreign labour for the harvesting process; 77% of the 431,357 workers in oil palm estates are foreigners (The Star, 2017). Changes in foreign labour policy directly affect palm oil production. To address this, the Malaysian Palm Oil Board set up an Oil Palm Mechanisation Fund in January 2017 with an initial investment of RM30 million to acquire suitable technology to reduce the dependency on foreign labour.

**ICT:** The setting up of the Multimedia Super Corridor (MSC) strived to create an ideal Information Technology (IT) and multimedia environment to enable Malaysia to be in the mainstream of activities necessary to attract knowledge workers, technopreneurs and high-technology industries through its technology-led companies and R&D investments. In 1996, MSC Malaysia designated several areas as cyber cities and cyber centres including Cyberjaya, Kuala Lumpur City Centre, Technology Park Malaysia, KL Tower, and Universiti Putra Malaysia-Malaysian Technology Development Corporation. In 2005, MSC Malaysia further expanded its footprint to other states like Penang, Kedah, Melaka, Johor, Perak and Pahang. In 2016, 336 new MSC-Status companies (Figure 4.1a) and RM6.43 billion worth of investments were approved of by MDEC resulting in 18,171 employments opportunities (Figure 4.1b), and RM2.91 billion in export sales. At present, approximately 88% (1,413 firms) of IT companies currently earn an average annual revenue of RM1.4 million while 10% (170 firms) earn RM26 million and 2% (24 firms) managed to surpass RM100 million earnings and an average revenue of RM267 million (The Star, 2016).

**BIOECONOMY:** The global market for industrial biotechnology is projected to approximately 300 billion euros by 2030 (OECD, 2011). In relation to this, Malaysia has invested in biotechnology areas in terms of utilising a national institutional framework, R&D incentives, and talent development.

*BioNexus is a special status awarded to qualified international and Malaysian biotechnology companies that demonstrate access or capability to undertake continuous R&D activities relevant to market needs. The status entitles them for fiscal incentives, funding and other guarantees that assist their operation and expansion opportunities.*



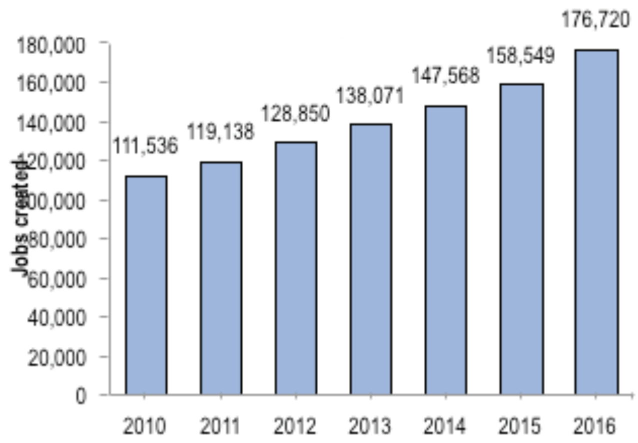




**Figure 4.1**

**(a) Number of MSC Malaysia Status Companies & Export Sales (Cumulative) and (b) Jobs Created, 2010-16**

Source: MDEC, 2015; MOSTI STI Indicators, 2016

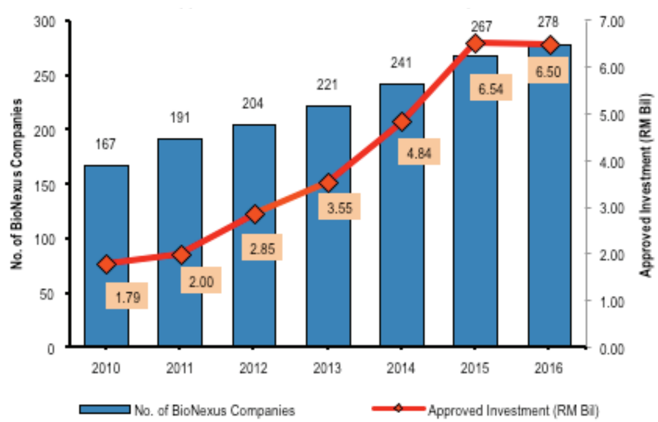



**Figure 4.2**

**Number of BioNexus companies and approved investments**

Source: MOSTI STI Indicators, 2016

As of 2016, there are a total of 278 BioNexus companies (Agri-Biotech: 152 companies, Bio-Industrial: 43 companies and Bio-Medical: 72 companies) with a total of RM6.5 billion in approved investments (Figure 4.2).

In line with transforming agro-based industries to be more market-oriented, inputs from R&D and market intelligence are essential. Research in plant biotechnology through genetic engineering addresses the demand for crops and vegetables that are more resilient to climate change.

## 4.2 GLOBAL TRENDS

The world has transitioned towards knowledge-driven economy enabled by fast-paced technology and digital connectivity, allowing radical sharing of ideas across borders. It is imperative that Malaysia strives to excel in the key competitiveness factors pertaining to innovation for socio-economic development and global competitiveness.

According to the Global Competitiveness Report 2017-2018, Malaysia is the most competitive economy among the 20 economies that is transitioning from efficiency-driven to innovation driven (WEF, 2017). Malaysia has moved up two spots in the GCI to 23rd spot (2017-2018) out of 137 economies. There is also an increase in the Technological Readiness Pillar while the Innovation pillar remained unchanged (Figure 4.3).

However, Malaysia needs to improve particularly on the GERD financed by businesses (BERD, from 11th to 75th). Malaysia's GERD/GDP value by proportion of Private to Public is still low, lagging behind other innovative countries (as discussed in Chapter 2). The 2017 GII ranking saw Malaysia suffer a massive drop in Sub Pillar Knowledge Workers from 35th to 93rd spot (Figure 4.4). Since one of the measures to ensure Industry 4.0 readiness is up-skilling and re-skilling of workforce, this drop is an indicator that Malaysian firms are not sufficiently investing in the preparation of their workforce for the systemic changes brought about by Fourth IR. This is of particular concern as to thrive in a knowledge economy, knowledgeable, skilled, and adaptable talent that can engage in high-value innovation is critical.


**Figure 4.3**
**Malaysia's ranking in the Global Competitiveness Index 2017 & 2018**

Source: World Economic Forum (WEF), 2016 & 2017

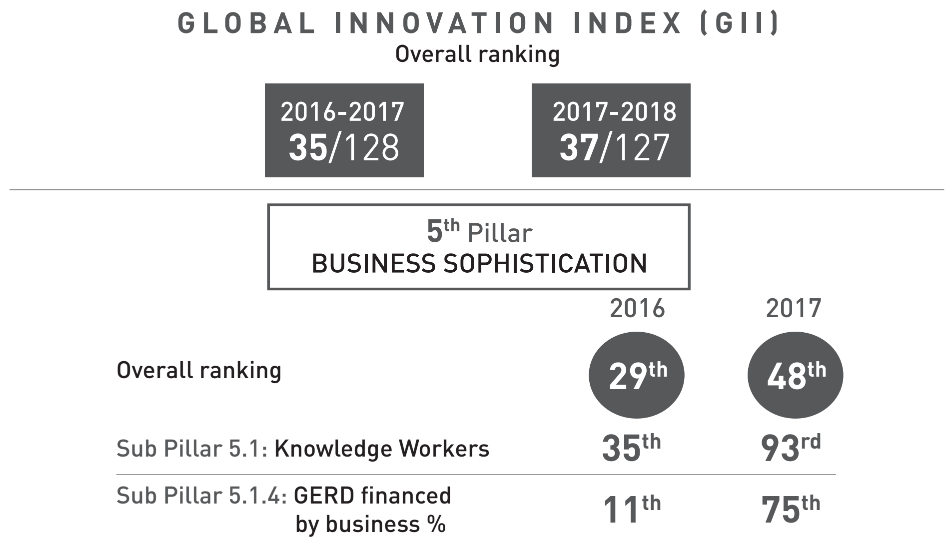



**Figure 4.4**
**Malaysia's ranking in the Global Innovation Index 2016 & 2017**

Source: World Intellectual Property Organisation (WIPO), 2016 & 2017

The Bloomberg's 2018 Innovation Index (Figure 4.5) measures the countries' efforts on research and development as well as attractiveness to technology firms. Malaysia's rankings fell by three places to 26th place and ranked 17th in manufacturing value added category. This is also reflected by Malaysia's reasonably strong position in the Global Manufacturing Competitiveness Index whereby Malaysia was ranked 17th out of 40 countries and is projected to rank 13th by 2020 (Deloitte, 2016).

**BLOOMBERG INNOVATION INDEX**

Overall ranking

| 2017 | 2018 |
|---|---|
| **23**/80 | **26**/80 |

5th Pillar
BUSINESS SOPHISTICATION

| | 2017 | 2018 |
|---|---|---|
| Manufacturing value-added | 12th | 17th |

**Figure 4.5**
**Malaysia's ranking in the Bloomberg Innovation Index 2017 & 2018**

Source: MASTIC, 2017

On the contrary, according to the Global Entrepreneurship Index 2018, Malaysia ranked overall 58th out of 137 countries but when it comes to product innovation, Malaysia was ranked at 130th, which is the lowest among most ASEAN economies (Table 4.1). Product innovation measures a country's ability to develop new products and integrate new technology, implying that our entrepreneurs have low innovation capability and capacity.

**Table 4.1**
**Malaysia's ranking in the Global Entrepreneurship Index 2018**

Data Source: Global Entrepreneurship and Development Institute (GEDI), 2018

| Country | Product Innovation |
|---|---|
| Philippines | 27th |
| Singapore | 32nd |
| Indonesia | 53rd |
| Thailand | 61st |
| Vietnam | 70th |
| Malaysia | 130th |

Malaysia enjoys a reasonably competitive position in the overall global competitiveness. However, when it comes to specific innovation indices, it is clear that there is a need to elevate the capacities of our industries, infrastructure, workforce competency as well as technology utilisation to be on par with global players. The parameters of these ranking should be used to revisit and revamp our innovation and industrial policies to ensure that Malaysia continues on an upward trajectory to become a developed country.

## 4.3 INDUSTRY LANDSCAPE IN MALAYSIA

### Malaysia's Industrial Development

The transformation of industries in Malaysia was primarily guided by the Industrial Master Plans (IMP) driven by the Ministry of International Trade and Industry (MITI), which elevated Malaysia from an agrarian industry to one that was heavy industries based in the 1970s. The IMP 1 (1986-1995) has laid the foundation for the manufacturing sector to become the leading growth sector of the Malaysian economy. The IMP2 (1996-2005) contributed further to the development of the manufacturing sector by strengthening industrial linkages, increasing value-added activities and enhancing productivity.

The development of clusters emphasised the growth of the manufacturing sector driven by market forces and linked the clusters to the global supply chain (Box 4.1). The current IMP3 (2006-2020) outlines the industrial strategies and policies which form part of the country's continuing efforts towards realiSing Malaysia's objective of becoming a fully developed nation by 2020.

Overall, Malaysia has had a good track record in development plans, infrastructure development, institutional frameworks (Figure 4.6) but we may not be faring very well in the integration of S&T into industries as well as the implementation of our plans.

## Box 4-1

### Cluster Development Strategy in Energising SMEs

Development of clusters has assisted in building the core competencies of industries, especially the SMEs, to be a part of the global production networks and supply chains. For instance, a number of SMEs in the Electrical and Electronics (E&E) Sector as well as in precision stamping, tooling and machining had progressed to become global suppliers to Multi-national Corporations (MNCs).

Clusters also help in forming collaboration as seen in the E&E semiconductors manufacturing cluster in Penang where R&D collaboration was established through collaborative research and access to resource centres. Also, with Subang, Selangor being designated as the current provider of maintenance, repair and overhaul services for the aerospace industry, along with the strategies of the Selangor Industrial Master Plan (Invest Selangor, 2017) aims to expand this industry further by forming the 3S (Serendah, Subang and Sepang) Aerospace Belt for Selangor, these indeed are opportunities to be leveraged to integrate our SMEs into the supply chain for wealth creation.

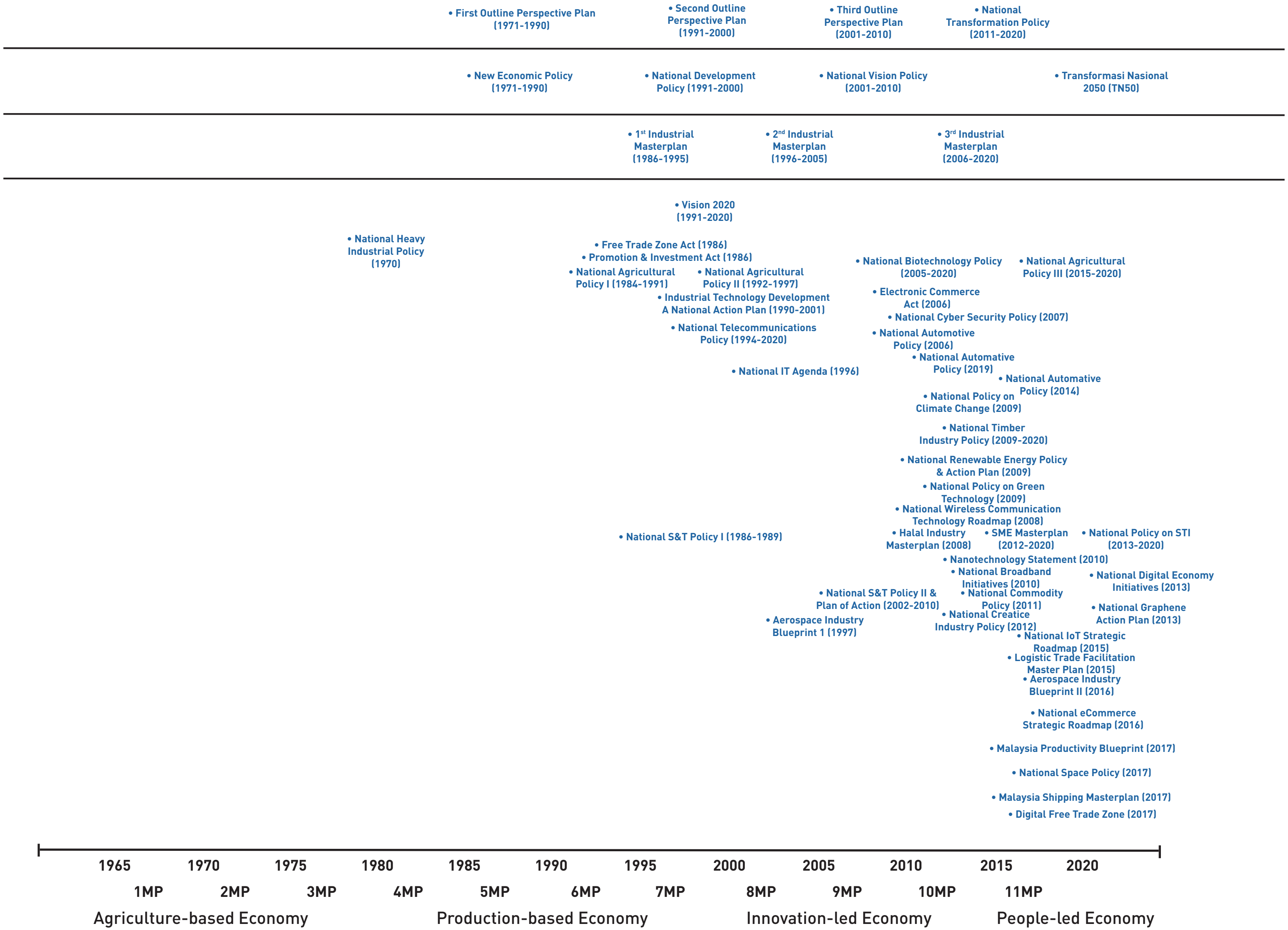



**Figure 4.6**

**Landscape of Malaysia's national initiatives in relation to industrial development**

Source: Compiled by ASM 2017, *list is non-exhaustive*

## Malaysia's Business Establishments

The largest proportion of business establishments (BEs) in Malaysia are made up of small and medium enterprises (SMEs) which account for 98.5% (907,065) of the total BEs; 76% are classified as micro enterprises, 21% are small enterprises, and the remaining 3% are categorised as medium-sized enterprises (Table 4.2). SMEs in the services sector accounts for the largest number of business establishments (89%), followed by manufacturing, construction, and agriculture. Services and manufacturing sectors, as the two prominent economic drivers of the country, contributing 54.5% and 23% of the GDP respectively in 2016 (DOSM, 2016). Both sectors have demonstrated a continuous increase over the last four years and are projected to contribute RM 791 and 314 billion respectively to the Nation's GDP by 2020 (11th MP).

Unfortunately, the capacity of our SMEs are mainly not realised due to low productivity (Figure 4.7) and as a result, less than 40% contribution to the GDP (Figure 4.8). Several reasons are summarised as follows:

- Limited resources and capacity for innovation
- Low knowledge intensity
- Low adoption of technology
- Low appetite for investment in R&D
- Profile of SMEs are largely from the Services-based sector, mostly in trading

**Table 4.2**

**Breakdown of Business Establishments by Main Economic Sector, 2016**

Data Source: DOSM, 2016

| Economic Sector | No. of SME Establishments | | | | Large Firms | Total BEs |
|---|---|---|---|---|---|---|
| | Micro | Small | Medium | Total SMEs | | |
| Services | 649,186 | 148,078 | 11,862 | 809,126 | 9,185 | 818,311 |
| Manufacturing | 22,083 | 23,096 | 2,519 | 47,698 | 1,403 | 49,101 |
| Construction | 17,231 | 17,008 | 4,829 | 39,158 | 1,400 | 40,558 |
| Agriculture | 4,863 | 4,143 | 1,212 | 10,218 | 1,410 | 11,628 |
| Mining & quarrying | 217 | 458 | 190 | 865 | 161 | 1,026 |
| Total | 693,670 | 192,783 | 20,612 | 907,065 | 13,559 | 920,624 |
| Percentage Proportion | 76.5% | 21.2% | 2.3% | 98.5% | 1.47% | 100% |

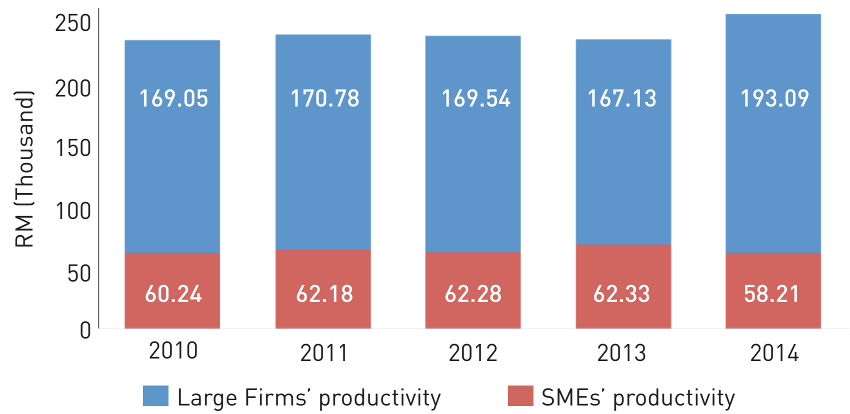



**Figure 4.7**

**Productivity of SMEs and large firms in Malaysia, 2010 - 2014**

Source: SME Corp Malaysia, 2015 & DOSM, 2016

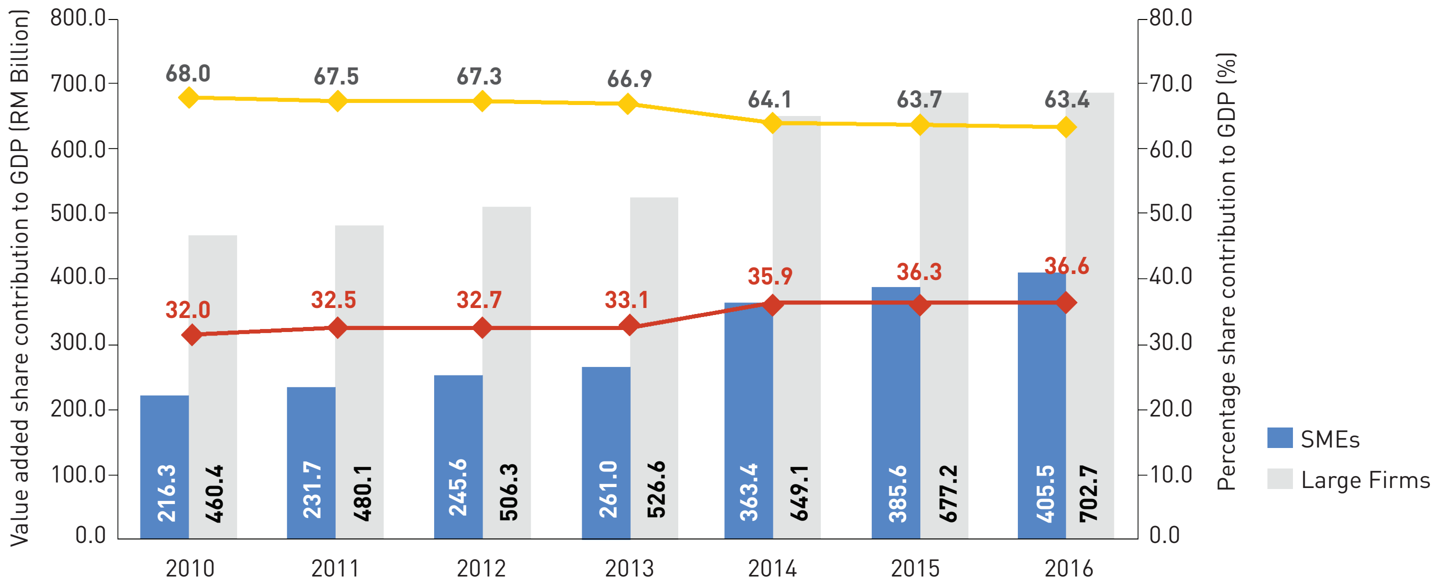



**Figure 4.8**
**Value-added and Share of SMEs and Large Firms to GDP, 2010-2016**

Source: DOSM, 2016

Due to the domestic firms mainly being classified as SMEs, the Government has outlined numerous initiatives to assist these companies to grow their productivity and size, as well as strengthen their competitiveness.

The SME Masterplan (2012-2020) targets Malaysia's SMEs to contribute to 41% of the nation's GDP and 25% of the nation's total export value by 2020. The SME Masterplan also targets reduction in the SME employment share to 62% from 65% in 2016, by reducing reliance on cheap foreign labour and adopting technology that will help increase productivity.

**Table 4.3**
**Current status and projection of the performance of SMEs**

Source: SME Corp Malaysia, 2012

| | 2015 | 2016 | Target 2020 |
|---|---|---|---|
| **Contribution to GDP** | 36.3% | 36.6% | 41.0% |
| **Employment** | 65.5% | 65.0% | 62.0% |
| **Exports** | 17.6% | 17.8% | 25.0% |

At the moment, only 13.8% of Malaysian SMEs have penetrated international markets; 17.2% of them are first time exporters (SME Corp., 2017). To compete in the international arena, Malaysia's SMEs must innovate to conceptualise new products through R&D and technology adoption, ensure compliance to the required international standards, and find ways to exploit profitable niche markets.

Most of the SMEs in Services sector are made of trading firms and vendor in nature. The National Services Blueprint launched in 2015 aims to reach 56.5% GDP by 2020 via knowledge-intensive and innovation-led transformed services. As of 2016, the top five service segments were Government Services (16.2%), Wholesale Trade (12.5%), Retail Trade (11.7%), Finance (9.3%) and ICT (10.9%) (MITI, 2016). The services sector managed to attract RM28.4 trillion of FDI in 2016 with 88,108 jobs created (MIDA, 2017).

Malaysia's export market for the manufacturing sector is diverse (Figure 4.9); (MATRADE, 2018). This indicates that Malaysia's manufacturers are dynamic and responsive to the global market. Moreover, the 11th MP) targeted for the manufacturing sectors to produce more high-value, diverse, and complex products in three catalytic sub-sectors; i.e. electrical and electronics (E&E), chemicals, as well as machinery and equipment (M&E) which contributed RM343 billion, RM68.58 billion, and RM40.21 billion respectively to the top ten major exports in 2017 (MATRADE, 2018).

In addition, potential growth areas such as aerospace and medical devices continued to evolve into higher value-added activities after having established a strong base in the country, thereby forming the 'Industry 3+2', as these five sectors are the key focus areas towards energising the manufacturing sector. In realisation that Malaysia has the capacity to be a significant player of the global supply chain in terms of high technology exports, manufacturing is identified as a core sector for sustainable growth under the 11MP and one of the key sectors to propel the country to achieve high-income nation status by 2020.

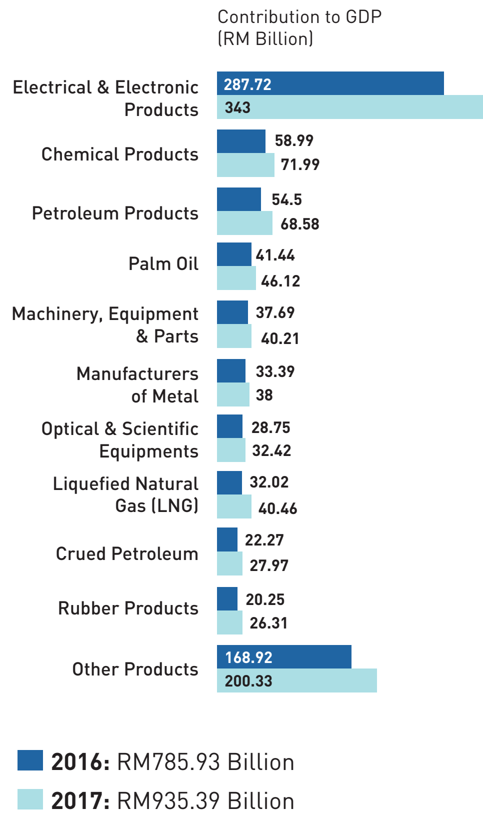



**Figure 4.9**

**Breakdown of Malaysia's Top Ten Major Exports in 2016 & 2017**

Source: MATRADE, 2018a

The largest employment in the manufacturing sector was semi-skilled workers (75%), with the smallest percentage requiring tertiary qualification (8%) (Figure 4.10),(DOSM, 2016). High skilled jobs require tertiary education qualifications and as more of the industrial sectors adopt automation and other technological innovation, this number is expected to increase. Coping with greater demand for skilled talent is not an easy task especially since this

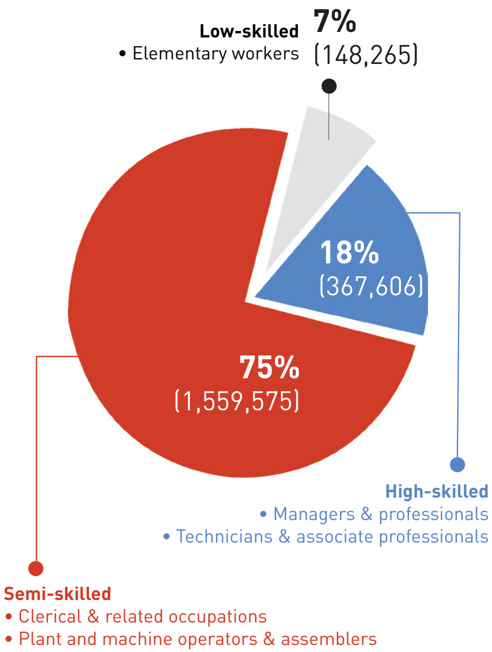



**Figure 4.10**
**Category of skilled workers in manufacturing sector**

Data Source: Economic Census, DOSM, 2016

sector demands STI training (see Chapter 3). High quality and quantity of skilled workforce are indeed responsible to facilitate the shift towards innovation and advanced manufacturing strategies (Dloitte, 2016).

Malaysia has yet to evolve from mere assembly, testing, design and development that are common in component parts and system production, suited to support high tech sectors. Despite the number of strategies introduced by the Government to raise the quantity and quality of talent development in the country, it is indicative that our local industries lags behind in terms of highly skilled workforce, especially those with tertiary, technical and research qualifications. Therefore, for Malaysia to move up the knowledge value chain, knowledge-based workers, equipped with tertiary education is critical.

On the whole, Malaysia is challenged by the shortage of high-skilled talent and fairly low productivity of our local industries. In the face of these challenges, the Malaysian government continues looking to stimulate growth, but whether this stimulus is enough to attract, support, and sustain a larger number of private sector commitments, remains to be seen. Hence, there is increasing concern of the pace and intensiveness of STI adoption within the industries in Malaysia.

## 4.4 INNOVATION CAPACITY OF MALAYSIAN INDUSTRIES

To achieve high-income nation status by year 2020, Malaysia must engage in innovation-driven growth by investing in dynamic capabilities to create, uptake and absorb technologies. Technological innovation and adoption is crucial to ensure sustainable growth with the increasing stringent natural resources.

The Knowledge Content in Key Economic Sectors in Malaysia survey (MyKE- I 2003, II 2007 & III 2015) was conducted to assess the knowledge content and technological readiness of Malaysian industries. From the response of over 4,438 BEs, it was found that the R&D level of Malaysia is typically low compared to the more advanced countries; this is attributed to the fact that most industries acquires knowledge solely by adapting and adopting foreign technologies instead of performing their own R&D (EPU, 2017).

Malaysia's industrial R&D ecosystem lacks strategic focus, has weak linkages between key stakeholders, poor knowledge sharing culture, and weakness in technical education and training ecosystem (firms' inability to translate absorptive capability into adaptive and innovative capabilities) (EPU, 2017). Out of the 21 industries identified, the top three industries with the highest knowledge content are the automotive; chemicals, petroleum &

pharmaceutical and IT services; the three industries with the lowest knowledge content are agriculture, wood-based products and transportation services (EPU, 2017).

This finding correlates with the study on Malaysian Technological Innovation Capability (MyTIC) (MPC, 2012)- only 6% of Malaysian companies are creators (i.e able to create totally new technology or products/or conduct significant improvements to existing technology/ processes). SMEs are either merely adapters (i.e able to upgrade technology) and or adopters (able to acquire technology) hence it is no surprise that novelty of new products from both services or manufacturing sectors are fairly less than 1% (Figure 4.11). Box 4.2 depicts results of a survey by ASM showing similar trend.

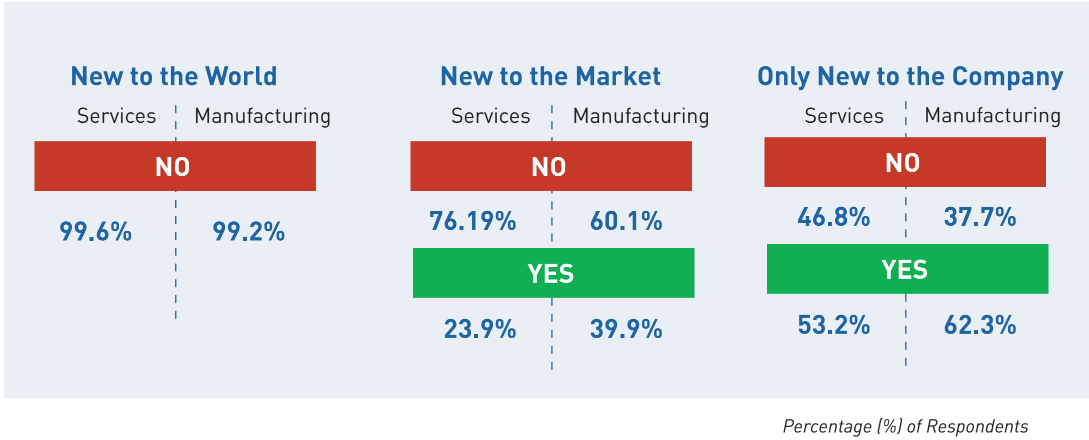



**Figure 4.11**
**Novelty of product innovation in both services and manufacturing sectors**

Source: National Survey of Innovation, MASTIC 2015

### Why do SMEs in Malaysia lack innovation capacity?

- Clear 'future-proof' plans for growth, or to mitigate adverse impact of global forces and uncertainties on their business operations are not foresighted.
- Products and services are released into the market without developing foundational and driver conditions of the ecosystem – this leads to high failure rates and a reputation of producing 'inferior' or 'imitation' products.
- Firms do not invest in the appropriate technology and people for generating good market intelligence – the focus is on short-term economic perspective.

Source: SME Corp Malaysia, 2017

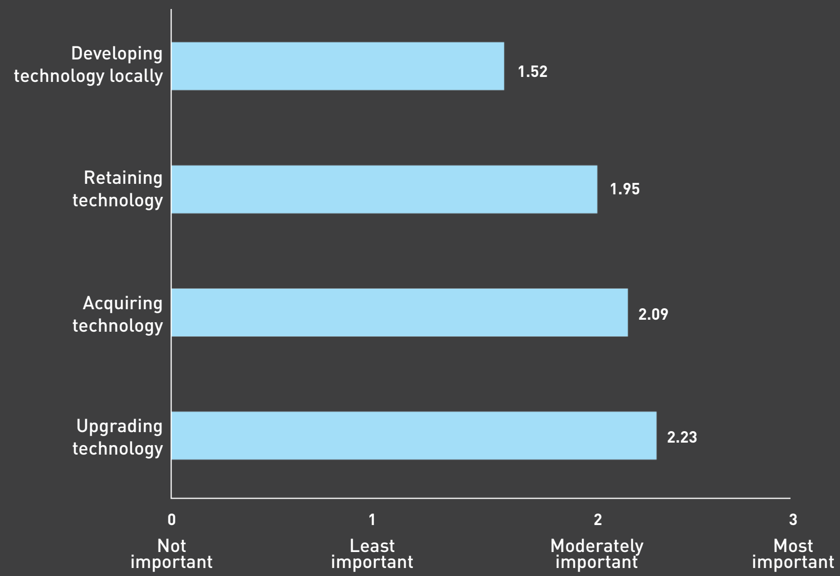
# Box 4-2

## Science Outlook 2017 Survey on Industry Awareness & Perception on STI

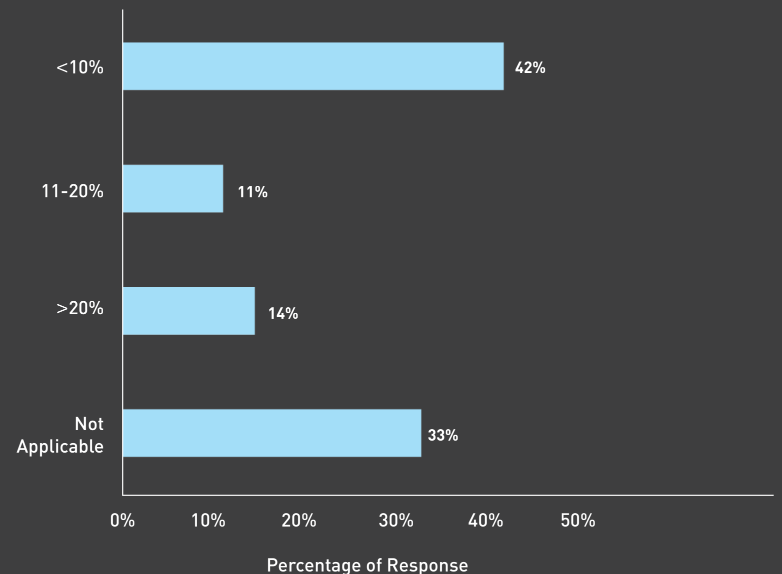
### (A Case Study on Manufacturing and Construction Companies)

The participants of this survey were from manufacturing and construction companies through their association; Federation of Malaysian Manufacturers (FMM) and Construction Industry Development Board (CIDB). In total, 97 companies participated in this survey - 77% SMEs, 5% MNCs and, 2% GLC and others. Our analysis shows that most respondents are merely upgrading and acquiring technologies (adopters and adapters) rather than creating technology. This is likely due to lack of allocation for technology - majority of respondents reported that their company allocated less than 10% for technology acquisition.

**Average ratings of companies' ability in mastering technology**




**Allocation of companies' revenue for technology**



**Top Three inhibiting factors for Successful R&D Engagements**

**Internal Factors**

- Limited financial resources
- Lack of R&D structure
- Lack of skilled R&D personnel

**External Factors**

- Increased capital costs
- Insufficient government funding
- Lack of R&D personnel with the requisite expertise

Source: National Survey on R&D, MASTIC 2016



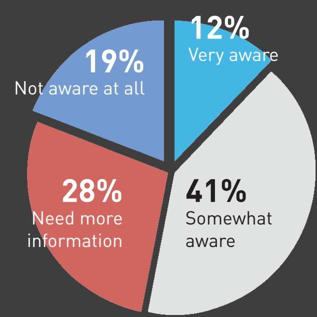
# Box 4-3

## Industry 4.0

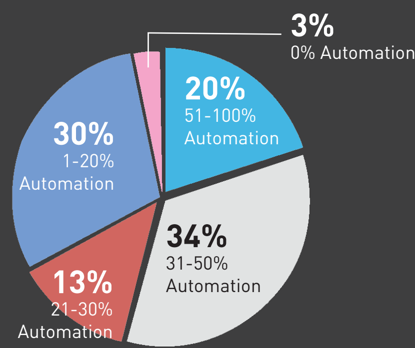
Admittedly, as a tipping point in STI, Industry 4.0 would enable the shift towards more efficient manufacturing lines with fewer dependencies on labour, leading to more reliable and consistent productivity and output. Malaysia is already entering the path of the Industry 4.0. Though the private sector has been identified as the primary engine of economic growth, one of the greatest challenges currently facing the country today is how to facilitate greater involvement of the private sector in driving economic growth in the age of the Fourth Industrial Revolution?

Challenges to the adoption of Industry 4.0:

**Awareness on Industry 4.0**




**Automation level of FMM Members Surveyed**




Source: Federation of Malaysian Manufacturers (FMM)- Malaysian Institute of Economic Research (MIER)-Business Conditions Survey, 2016

The Edge SME Forum 2017 recommends SMEs to consider:

- Data Analytics: Review and adjust existing product portfolios
- Digitize: Automate & Network Enable
- E-Marketing Presence: Digitally integrate with supply chain partners
- Accelerate Talent Management Programs-for Young Talents

To date, MITI is working on the National Industry 4.0 Policy Framework (Myi4.0) for the transition of the industry players towards the adoption of automation and smart manufacturing concepts and technologies (SIRIM Link Vol1, 2017).

## 4.5 EXISTING INITIATIVES TO ENERGISE THE INDUSTRY

### Development Programmes, Funding and Incentives

The Government has put in place variousnational strategies and incentives to elevate innovative capacity of the industries through technology adoption and R&D. Most of these initiatives target the SMEs as they make up the largest portion of Malaysia's BEs and are delivered by various agencies through many platforms. As of 2015-16 (Table 4.6), a total of 283 Government programmes were carried out and benefited 1,095,530 SMEs. These programmes were monitored and reported in the SME Integrated Plan of Action by SME Corp. Majority of the programmes were directed towards developing talent, followed by enhancing market access, financing, programmes for innovation, technology adoption and infrastructure development.

The SME Master Plan 2012-2020 includes programmes to foster innovation among SMEs and entrepreneurs. One of them is the High Impact Programme (HIPs) which aims to help SMEs develop innovations through the prototype to commercialisation stages. The Innovation Certification for Enterprise Rating and Transformation (1-InnoCERT) is a programme facilitated by SME Corp that awards certificates to innovative SMEs. It also facilitates fast-track access to funding or incentives (SME Corp., 2017) to encourage entrepreneurs to venture into high technology and innovation-driven industries. 1-InnoCERT prize include innovation vouchers (a promissory note of reimbursable grant for SMEs; a total of RM45 million as of December 2015) for their advertising and promotion, certification and quality management system, as well as packaging.

Growth of industries is supported by the Government's commitment to strengthening the nation's ICT infrastructure such as the broadband strength and speed, and initiatives such as the Cloud First Strategy, the National Big Data Analytics Framework and Cyber Security Malaysia. The Digital Free Trade Zone (DFTZ) that was launched in 2017 is an initiative to capitalise on the confluence and exponential growth of the internet economy and cross-border e-Commerce activities. It is setup to facilitate seamless cross-border trade and enable local businesses especially SMEs to export their products globally with ease.

**Table 4.4**
**SME Development Programmes 2015-16 (Government-funded) by Focus Areas**

Source: SME Corp Malaysia Annual Report 2016/2017

| Focus Areas | Programmes | | Financial Commitment (RM Million) | | Beneficiaries (SMEs Benefited) | |
|---|---|---|---|---|---|---|
| | **2015** | **2016** | **2015** | **2016** | **2015** | **2016** |
| Human Capital Development | 39 | 38 | 79.4 | 130.2 | 97,095 | 88,254 |
| Market Access | 37 | 30 | 99 | 364.1 | 14,553 | 14,004 |
| Access to Financing | 36 | 30 | 4,393.8 | 4,902.4 | 456,328 | 410,511 |
| Innovation & technology Adoption | 22 | 25 | 258.1 | 300.4 | 11,819 | 2,593 |
| Infrastructure | 16 | 10 | 194.4 | 68.5 | 306 | 67 |
| **Total** | **150** | **133** | **5,024.70** | **5,765.6** | **580,101** | **515,429** |

The first phase of DFTZ has successfully registered over 1,500 SMEs to participate in digital economy and is expected to attract RM700 million worth investment and create 2,500 job opportunities. The Government is also committed to increasing the adoption of e-commerce in the country with the launch of National e-Commerce Strategic Roadmap in 2016 aims to doubling Malaysia's e-Commerce growth rate and reach a GDP contribution for the E-Commerce sector at 6.4% or RM114 billion by 2020 (11th MP).

To realise the implementation of the above, digital infrastructure is indeed a prerequisite to the implementation of key technologies such as big data and borderless transaction. Out of the total of 650 industrial areas nationwide, around 153 of which are already equipped with high speed broadband (HSBB), with the plan to facilitate in total 245 industrial areas. Though the coverage of digital infrastructure HBB is dependent on the demand and requirements by industry, there is dire need to facilitate and support basic digital infrastructure and facilities to enable the realisation of the new economy.

In total, the Government has been very aggressive in intensifying R&D initiatives towards strengthening the national innovation ecosystem via extending sufficient subsidies including incentives as well as associated financial supports to the industries channelled via its agencies as listed in Appendix 4.3. However, due to various innovation

### Reasons for not getting Government Support

**51.02% -** Company is not aware of the incentive available

**19.92% -** Incentives offered does not cover company activities

**7.01% -** Process of getting assistance is too complicated and takes a long time

**22.05% -** Other reasons

### Reasons for not taking advantage of Government R&D Incentives

**39.29% -** Lack of awareness on the availability on the incentives

**20.24% -** No knowledge on how to apply for the incentives

**13.10% -** The company does not qualify for the incentives

**13.10% -** The projects do not qualify for the incentives

**1.19% -** No interest in the incentives

**13.10% -** Others

**Figure 4.12**

**Common reasons by industries on government's assistance**

Source: National Survey of Innovation, MOSTI 2015 and National R&D Survey, MOSTI 2016

actors (ministries and agencies) and weak connections between them, the awareness and benefits of these initiatives and incentives for STI development are not well disseminated (Figure 4.12).

Moving forward, these enterprises need to be more proactive in leveraging the incentives provided by the government to accelerate the adoption of innovation and new technology. Eventually, they also should be less dependent on Government funds and pursue alternative financing options.

The Malaysian Business Angel Network (MBAN) organises a monthly forum for entrepreneurs whose technology related projects/campaigns are about to go live on equity crowd funding (ECF) platforms to pitch to their members and non-members. These pitching sessions offer opportunities for project owners to book investments even before their campaigns go live. MBAN's Accredited Angel Investors are eligible to enjoy a tax benefit amounting to RM500,000 under the Angel Tax Incentive Programme.

Securities Commission Malaysia has also introduced six ECF platforms in 2015 to provide an alternative venue for capital-raising to SMEs and innovative new businesses. In order to facilitate more innovative SMEs, it is necessary to expand the funding pool particularly on pre-seed, seed and Series A funding is necessary for more SMEs to have access to funding.

**ECF Platforms introduced by Securities Commission in 2015**

- FundedByMe
- pitchIN
- eureeca.com
- CrowdPlus.asia
- ataplus
- CROWDO

## Innovation Intermediaries

Several strategic innovation partnership models have been identified to spur technology development and commercialisation to accelerate the productivity growth of SMEs in general. The University-Industry linkage should be leveraged as a long-term, formal and informal relationship that is indispensable in a country's development in the era of knowledge economy. These linkages facilitate knowledge-transfer and catalyse R&D to promote demand-driven research.

Innovation intermediaries are seen as independent third parties i.e. as in Australia - either in the form of mechanisms or institutions that play crucial roles in bringing together a range of different organisations and the knowledge required to create successful innovation. In linking organisations within an innovation system on the national as well as regional level, intermediaries generally focus on technology transfer, commercialisation of ideas and funding. Intermediary activities and services could include providing information about potential collaborators and as a mediator or 'go-between' between collaborating parties (Australia Department Industry, Tourism & Resources, 2007).

In Malaysia, innovation intermediaries (Table 4.5) have been established to assist SMEs in technology adoption or innovation processes. In particular, these intermediaries facilitate innovation in SMEs through demand-driven solutions acquired via collaboration with experienced academics or industrial experts.

Innovation intermediaries should be industry-led in nature to maximise demand-driven research by bringing together industry players and academia to facilitate the STI agenda through collaborative networks.

Knowledge processes involved in the dynamics of innovation can be realised through cluster approach. Therefore, the development of cluster-based economic activities is highly dependent on the characteristics of proximity, regional differences, social capital and interactions/linkages between stakeholders. As such, cluster-based industrial activities have long been taking place in Malaysia, being naturally evolved (i.e commodity-based clusters such as agriculture, wood furniture, etc) and of those established through policy outcomes (i.e technological clusters such as E&E, automotive, ICT, etc).

The Government, since the 9th Malaysian Plan, has established five economic corridors as platforms for economic development including promoting free trade and business incentives. These corridors are expected to build on existing economic strengths unique to the region, attracting investment from within and outside of Malaysia to expand upon the industrial clusters developed in the corridors (see Chapter 1). Chapter 2 has outlined the various benefits of revising cluster mapping for Malaysia to identify the unique innovative industrial clusters in every economic corridor region. These clusters may or may not coincide with the focus areas specific for the corridor; this only means that the corridors have more opportunity of diversifying and building on present niche strengths.

With various effort by government to develop and implement policies and programs that foster and support innovation, industries should take the lead to create high value jobs, rejuvenate investments, spur innovation and commercialisation, towards positioning Malaysia in attracting global markets to propel sustained high income growth. Locally owned STI-based industries (SMEs and start-ups) should aspire into becoming the engines for the nation's growth, taking over the baton from large firms. It is imperative for the Malaysian industries to focus on the development of indigenous capacity and capability.

## Business chambers and industry associations

In reference to Malaysia's multiplex innovation ecosystem (Appendix 4.2) business chambers and industry associations (an approximate total of 3967 registered, as of June 2017, ROS, 2017) should be actively integrated into the ecosystem. They assist members to become more competitive in their sector, and function as the communication point for educational material, trade laws and regulations, training, and many more. In other words, these actors serve as the focal point for communicating the needs of the industry to researchers in IHLs, building niche areas for their industrial clusters with R&D input to generate high value-added products and services.

As Taiwan has demonstrated, chambers of commerce and trade associations have a great role in promoting the interests of the SMEs they represent, especially for R&D and other innovation-driven endeavours (Ministry of Economic Affairs Taiwan, 2017). Therefore, these associations should be incentivised and empowered to disseminate information from government agencies on various STI initiatives and incentives; conduct business matching services; strengthen networking to co-create STI programs and activities; create awareness and enculturation campaigns using effective and innovative ICT channels or dialog sessions to enhance the level of understanding as well as involvement of SMEs, in supporting the STI agenda of the nation.

A continuous, affordable, and readily accessible facilities located with closed proximity are an effective strategy to mobilise and support SMEs, especially those with low innovation capacity. Therefore, collaborative efforts with knowledge institutions, corridor clusters, tech parks and others would better strengthen and elevate Malaysian industries for wealth creation through STI. Along with the assistance of the intermediaries and a conducive STI ecosystem, industries would be projected to produce high value-added products and services that will propel the nation towards high income economy.

**Table 4.5**

## Matrix Analysis of Intermediaries

Source: Strategy Paper 21, 11th MP, EPU 2016, Compiled by ASM, 2017

| Intermediaries | Target Groups | Focus Area | Services Rendered | Source of Funding | Funding Support | Outcomes |
|---|---|---|---|---|---|---|
| SIRIM-Fraunhofer | SMEs in Manufacturing sector | Renewable energy<br>Energy storage<br>Medical devices<br>Automation<br>Industrial design<br>Machinery & Equipment | Demand-driven research, Product & process improvements, Up-scaling & pilot production, Training, Technology audits, Testing inspection, certification & calibration<br><br>Applied research (priority / strategic research) | Government<br>Industry Regional<br>International | Matching grants (Govt: 50-80%; Industry: 20-50%)<br>Soft loans | 336 SMEs took part in the SIRIM's Technology Audit 2015/2016<br>•150 in 2015<br>•186 in 2016)<br>Resulted into:<br>• 67 technology uptakes<br>• 39 packaging & labelling<br>• 43 energy audit<br>• 46 innovation workshop<br>• 30 automation & mechanisation of small & micro enterprises<br>*Source: SIRIM Berhad, 2017* |
| Steinbeis Malaysia Foundation | All companies & business entities | Healthcare<br>Nanotechnology<br>E&E<br>Palm Oil / Rubber<br>Telecommunications | Demand-driven research, Provide subject matter experts (local & foreign) for business solution, Steinbeis Network for market reach, Train companies to attain international standards | Government<br>Self generating income | Cost of services borne by clients (RM30K-50K)<br>Revenue generated will fund Steinbeis | Facilitated 101 applications of project interventions from SMEs (12 Medium, 34 Micro & 55 Small enterprises)<br>90 technical applications<br>11 non-technical applications<br>*Source: Steinbeis Malaysia, 2017* |
| Public Private Research Network (PPRN) | Local Universities<br>SMEs | All economic sectors | Demand-driven research<br>Part-financing projects<br>Connect firms to researchers<br>Contribute facilities to applied research | Government<br>Industries | Matching grants (Govt: RM30K max) | 549 companies registered with applications, 304 projects successfully matched, 246 projects in progress, 57 projects completed (involving 37 companies) *(as at Apr, 6 2016)*<br>*Source: MITI Annual Report, 2016* |
| Platform for Technology Commerciali-sation (PlaTCOM) | SMEs<br>IHLs/GRIs<br>Individual inventors | All economic sectors | Demand-driven research, End-to-end facilitation from concept to commercialisation, IP protection, capacity building & advisory services | Government<br>Industries | Matching grant (from RM5K up to max of RM100K) | Commercialised 5 successful cases of innovation with 50 SMEs facilitated to bring to market, 63 of the IPs have been licensed<br>*Source: MITI Annual Report, 2016* |

## Enhancing Partnerships through Industry-led Collaborative Network

The way forward in today's competitive economy is through collaboration by both industry and IHLs for industry driven R&D and market driven delivery system to close the innovation chasm (NEO-ASM, 2017). Intermediaries serve to facilitate industry to formulate demand-driven R&D in order to draw the participation of researchers through open research calls within a collaborative network. By this means, knowledge-rich products could be developed, while also extending the market reach of the industry concerned. Collaboration enables risk sharing thereby lowering the risks and barriers faced by each player in global market ventures. In the collaborative network, drivers (industry players and researchers) are connected with enablers (Government regulatory bodies, institutions of higher learning and civil society) to catalyse the genesis of ideas leading to disruptive innovations at a very dynamic pace. A collaborative network makes it possible for market information and the creative application of STI for realisation of value and innovative products & services. Two examples of home-grown industry-led collaborative network models – CREST and AMIC are briefly described.



Box 4-4

### Collaborative Research In Engineering, Science and Technology (CREST)

CREST was incorporated in June 2011 and officially operational in June 2012 as an industry-led, public-private initiative to stimulate R&D and innovation in the electrical and electronics (E&E) industry. It was a joint effort by approximately ten leading E&E companies, several universities and Khazanah National Berhad.

With aims to cater industry-led demand driven R&D, CREST as a neutral, trusted entity was established as a catalyst for the growth of Malaysia's E&E industry. CREST facilitates key stakeholders (i.e. the industry, academia and government) in key clusters (Semiconductor &Embedded, Industrial Electronics, Optoelectronics & SSL and Solar which aimed to generate US$16.9B GNI and 157, 000 jobs-Source NKEA E&E Report), both regionally and internationally through an open call concept, where rights to intellectual property and almost 65% of the funding of research are pre-negotiated with mutual trust (either monetary or in-kind). To date, CREST has expanded from E&E to other sectors (e.g. medical, transportation, etc.) to ace Malaysia's competitive advantage. Indeed, CREST is a strategic model to emulate as it has been successful in facilitating industries to technologies and foster collaboration with industry associations, Research Institutes, Universities and Centre of Excellence altogether to benefit the economy as well as in developing a talent pool of scientist and engineers.

## Box 4-5

### Aerospace Malaysia Innovation Centre (AMIC)

AMIC is a private-public partnership established in 2011 by the Government to sustain the competitiveness of Malaysia's aerospace manufacturing industry particularly in aerostructure, and giving Malaysian scientists exposure to global level research and technology (R&T) per one of the key recommendations in the National Aerospace Blueprint.

As an industry-led research centre, AMIC's main role is to provide universities, industries, and research institutes strategic direction in aerospace-related research in collaboration with its partners. AMIC, a Company Limited by Guarantee (CLG) is governed by a Board and started with seed fund amounting RM20 million from the Government. The business model is to be met in either cash or in-kind by the participating collaborators.

AMIC has set two major R&T themes; i.e. Factory of the Future, and S ustainable Aviation with capabilities of technology scouting, capacity building and fostering applied R&T through industrial collaborations. The Factory of the Future or Factory 4.0 concept for aerospace involves automation and digitalisation, predictive maintenance & manufacturing, rapid experimentation and innovation, and concurrent engineering. AMIC also embarked on sustainable aviation in line with the air transport industry's commitment in reducing its greenhouse gas emissions and optimising operations through bio-aviation fuel production and bio-composite material manufacturing.

To date, AMIC has and is working on a total of 28 projects worth RM23.3 million with AMIC contributing 48% of the funding. 60% of these projects have been successfully delivered with measurable outcomes which includes 16 publications, 47 postgraduate engagements and more than 50 plus researches and engineers engaged. AMIC and its collaborators have manufactured components of the Air Asia fleets; AMIC is currently drafting the National Aerospace Research & Technology Roadmap.

## 4.6 CENTRALISED 'KNOWLEDGE REPOSITORY' ON CRITICAL AND CREDIBLE STI INFORMATION FOR THE INDUSTRIES IN MALAYSIA

Moving up the value chain and making a place for oneself in the global value chain will require ingenuity and innovation to keep up with the demands of the rapidly changing economy. The Government is dedicated to pushing industrial policies that will assist industry to be agile in the transformative IR4.0 and beyond. There are a number of resources and incentives available to help Malaysia's industry to innovate and grow in the challenging global market.

Feedback from the industry indicated that most stakeholders have difficulty accessing the required STI information for the industry (i.e. incentives, policies, assistance, etc.) due to the fragmented nature of the information storage. Currently, the available STI information related to industries are scattered in many repositories across many Ministries, Agencies, and other organisations (Figure 4.14). For example, the SMEinfo.com.my has substantial information for industries to leverage upon, such as funding / incentives and etc. for SMEs.

Therefore, a centralised STI knowledge repository on critical and credible STI information for the industry such as funding/incentives, government initiatives and goals, and other resources is recommended. It would serve as a one-stop reference platform to bridge relevant ministerial entities and agencies, institutions of higher learning, research institutes, and industries to energise industries with STI information. In particular, it is imperative for the facilitation of STI-based SMEs and innovative start-ups with essential STI resources to further elevate them into higher value chain.

The virtual platform should be built upon intelligent systems encompassing research and market analytics frameworks and also capture information about teaching, training, facilities, business partnerships, and existing international engagement across scientific and non-scientific disciplines, and it should be accessible to all, who want to use it in Malaysia and abroad. The idea is not to create a monolithic structure, but to find common definitions, standards, and programmes to interlink existing frameworks. The repository's structure should enable analysis across sectors and at national, institutional, and individual scales.

In addition to data and tools, the repository should provide information on different models of collaboration, "lessons learned" and effective practices from different localities. It should also include information about STI priorities, strengths, facilities, and programmes around the globe. The repository should also provide access to the products of forward-looking activities — such as technology assessments, roadmaps, foresight reports, and projections — to point to new opportunities on the horizon using easy-to-use online interfaces.

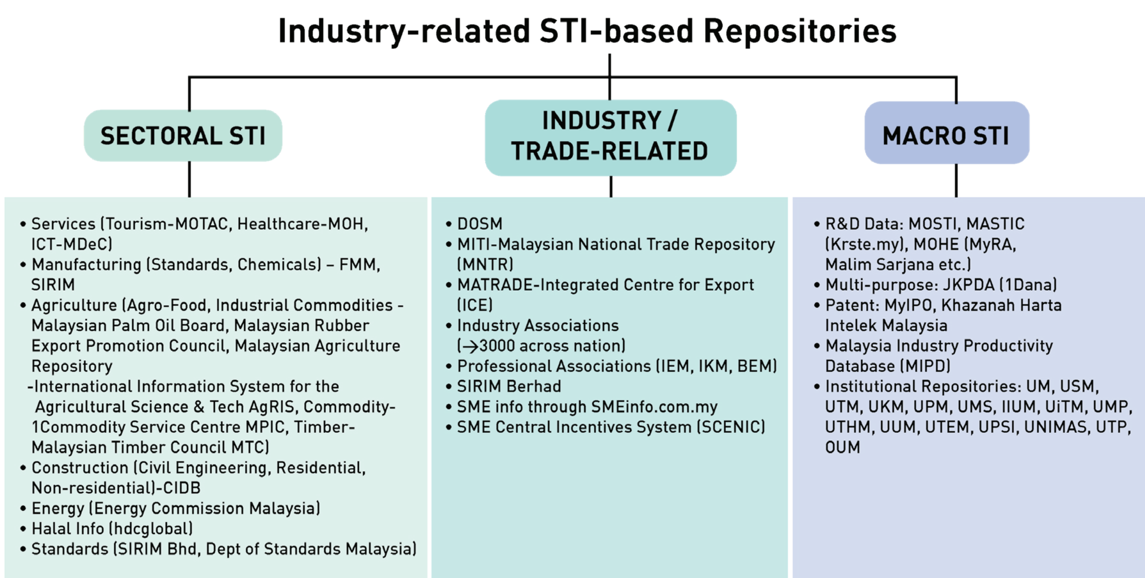



**Figure 4.14**
**List of available STI-based repositories in relation to Industries**

Source: Compiled by ASM, 2017; *non-exhaustive*

## 4.7 WAY FORWARD TO ENHANCE THE INNOVATION ECOSYSTEM THROUGH STI-BASED INDUSTRIES

To remain competitive, several challenges must be addressed. To thrive in the new economy, Malaysian industries should take initiatives to enhance innovation capacity and transform from being mere consumers of technology to producers of high value-added products and services. Also, in order to overcome our weak position in the global STI-based industry value chain, the nation should strategically invest in selected niche STI based industries based on our current strengths and future projections.

1

### Establish Industry-Led Collaborative Networks to Enhance Demand Driven Research and Private Sector Participation

Initiatives to stimulate the uptake of R&D and innovation among industries should be facilitated by industry-led collaborative networks. Collaboration enables risk sharing thereby lowering the risks and barriers faced by enterprises, especially SMEs and innovative start-ups. The dynamics of a successful collaborative network should mainly encompass industry-led and people-driven interactions that shall guarantee the rise of knowledge clusters, leading to and talent hubs (thus enhancing knowledge workers).

2

### Facilitate Dissemination and Monitoring of Industry Related Information through A Virtual Centralised Knowledge Repository and Data Centre

In order to enhance the development of STI-based SMEs and innovative start-ups, it is essential to provide sufficient industry related STI resources. Therefore, a one-stop centre/reference point is necessary to be in place to disseminate available information about the full range of STI-based resources as well as market intelligence information to energise the industries. There is a need to recognise and consolidate the many industry-related STI repositories currently facilitated by various entities. One approach would be to Integration, synergising and coordinating the information of these repositories through a single access must be considered for effective use of resources and optimum output from existing industry best practises.

# FURTHER READING

## Malaysian Start-Ups

Kuala Lumpur has a strategic geographical location in the South East Asia; it has a multicultural society with good command of English to ease international communication. It is a great hub for product testing and has a supportive Government with access to credits and policies (e.g. grants and tax exemption) for start-ups. It is easy to set up a business with relatively cheaper operational costs (low exchange rate) in Kuala Lumpur; the city has been housing 350-650 tech start-ups (Startup Genome, 2017).

However, Kuala Lumpur is not ranked among the global top 20 start-up ecosystems due to its relative lack of Global Connectedness and Start-up Experiences. Nevertheless, Kuala Lumpur has the highest percentage of founders with an undergraduate degree (65%) and one of the highest percentages of women founders in the world at 23%.

## Sweden's Startup Success

According to World Economic Forum (2017), Sweden is the home to Europe's largest tech companies and its capital is second only to Silicon Valley when it comes to the number of "unicorns" – billion-dollar tech companies – that it produces per capita.

Sweden's high levels of taxation have enabled Sweden's tech businesses to benefit from both the social and physical infrastructure. Sweden has advance digital infrastructure, with average internet speed only below Norway and South Korea. Nearly 95% of Sweden's population use internet, while 60% of the population has access to super-fast fiber-optic broadband with speeds of 100 megabits per second. Furthermore, public services, including elderly care, primary and secondary education, and preschools, were outsourced to private firms which could enhance the delivery of these services.

Many public monopolies were also deregulated, including taxis, electricity, telecommunications, railways, and domestic air travel services. A Competition Act was introduced in 1993 to block big mergers and anti-competitive practices. To encourage startups, tax rates were reduced, particularly on corporation tax, which has fallen from 52% in 1990 to 22% today – far lower than the US rate of 38.9%. The Swedish government is even considering lowering the high income tax levels to attract global talent.

"Trust" may be the most important element for Sweden's startup success. High level of trust is deeply rooted in Swedish culture; this could explain why Swedes trust the government to spend their money for them. This in turn creates an environment of a strong social safety net. Innovation is also allowed to take place with high level of trust given to the employees in the form of autonomy by the employers. Trusts between colleagues also encourage more collaboration internally within the company. With trust, large established companies are also more likely to collaborate and share knowledge with small startups.

## The future of intangible assets as collateral?

Knowledge based economy refers to the use of knowledge translated into economical gains. Over the last few years, knowledge has been used extensively to raise efficiency of an organisation and differentiate from competitors. Intellectual property (IP) is recognised as an important asset and to some extent a capital for companies to continue profitability. WIPO defines IP as "creations of the mind; be it invention, literary and artistic works, designs, symbols, names and images that are used in commerce, databases, software, know-how and organisational competencies etc.".

In the business world there essentially three types of assets, namely the monetary asset, the tangible assets and the intangible assets. While much is known about assets such as landed properties, plants and machineries, and monetary assets; there intangible assets are lesser-known. It is also recognised that the values of the first two types of assets are easily determinable.

**Value determination of the intangible assets though, is at infancy in Malaysia.** In the rise of disruptive technologies era, businesses such as Alipay, Airbnb and Grab for instance have no physical presence. This is the face of the new economy. Yet these are known examples of intangible assets that received little recognition for its economic importance. Grab, a technology company that offers ride-hailing and logistics services through its app, is now a Singapore-based company as it failed to secure financial assistance in Malaysia since it had no collateral. The Government then introduced the Intellectual Property Financing Scheme (IPFS) in the 2013 Budget to facilitate the use of intellectual property rights (IPR) as collateral in funding technology companies. Malaysia Debt Venture (MDV) has been tasked to oversee the RM200 million schemes.

**IP is an intangible asset, and is not an acceptable form of collateral in Malaysia.** Commercial banks claim this approach is not needed as not many Malaysian companies are in the ranks of IP creators (do not originate or innovate IP). With no framework in place, banks don't have the expertise in valuation of IP as an asset for collateral. Banks are also in the opinion IPs are insecure as an IP can be invalidated and challenged (TheEdge, 2015). Revolution in the banking sector in Singapore has taken place though; local businesses can now use intellectual property assets (e.g. patents, trademarks or designs) as collateral for bank loans to access capital to grow their operations (Today Online, 2014). The businesses must be locally registered and their IPs must be already generating revenue though. The Thai SME Bank, Chinese Bank of Communications and the Federal Development Bank of Brazil also has taken IP into consideration for financing (BNM, 2014).

The intangible assets are over 80 % of the average business' value (The Malay Mail, 2016) yet Accounting Standards are not helpful in representing the worth of IPs in company accounts (Government of Malaysia, 2014)- IPs are either under-valued, under-managed or under-exploited. Self-generated intangible assets developed such as those through in-house R&D or other types within the company do not appear as such on a company's balance sheet. The foreign brand Coca-Cola as a case in point - its logo was developed internally and does not have a price that can be used to assign fair market value.

Efforts are on the way though; for instances MDV provides financing for companies in exchange of IP assets as collaterals. PlaTCOM Ventures specialises in the valuation of intangible assets and advices SMEs. The Royal Institution of Chartered Surveyors (RICS) has in recent years come about with some good guidelines. Of which the Royal Institution of Surveyors Malaysia (RISM) is referring to develop best practices guidelines on the valuations of intangible assets and is also a source of reference for IA valuation services. MyIPO (Malaysian Intellectual Property Corporation) has also developed some basic guidance notes on IP valuations. In Europe and the US, there are professionals (commonly referred to as business valuers, or valuators, or appraisers) who focus on determining the value of IAs and IP rights. In Malaysia and most other countries, accountants valuing intangible assets are a common practice. Locally, this profession is fairly in its development stage and available in small numbers (Focus Malaysia, 2017).

While realisation is setting pace, the momentum on remedial efforts has to be raised. While SMEs/start-ups secure fund by forming partnerships with established companies and gain from being in the value chain, they should be made aware of the worth of their intangible assets. There is also an urgent need to re-look into the Accounting Standards by all relevant. It will be costly for Malaysia to lose another Grab-like organisation. We need to continue to encourage innovation and reverse the imitator label; for that we need to recognise the intangible assets as financial collaterals.

**Appendix 4.1**

## Different types of Government aids (Fund Managers and Programmes)

Source: Compiled by ASM, 2017; *non-exhaustive*

### TAX INCENTIVES

**MIDA**

Automation Capital Allowance

Production of Selected Machinery and Equipment

High Technology Companies

Green Industry

High Technology/Strategic Project for New Manufacturing Activity

Commercialisation of Public Sector R&D Findings in Resource-based and Non Resource-based Industries

Investment Tax Allowance of 50% and/or Expatriate Posts for In-house R&D

Investment Tax Allowance of 50% of Reinvestment for In-house R&D/ Expatriate Post

Incentives for Production of Halal Food

Venture Capital Programme

Acquisition of Property Rights

BioNexus Tax Exemptions

Reinvestment Allowance (Schedule 7B)

### GRANTS

**MIDA**

Domestic Investment Strategic Fund (DISF)

**SME Corp**

SME Technology Transformation Fund

**PlaTCOM Ventures**

Technology Commercialisation Platform

**SME Bank**

Industrialised Building System (IBS) Promotion Fund Financing Programme

**Bioeconomy Corp**

Biotechnology Commercialisation Fund

**MTDC**

Commercialisation of Research & Development Fund (CRDF)

Technology Acquisition Fund (TAF)

Business Growth Fund (BGF)

Business Start-up Fund (BSF)

Business Expansion Fund (BEF)

**Cradle**

Cradle Investment Programme Catalyst

**MDVB**

Funding Scheme for Technology and Innovation Acceleration

**HRDF**

Future Worker Training Scheme – Enhancement Programme for Employability

**PPRN**

Public-Private Research Network (PPRN)

**LKIM**

High Impact Product Matching Program for Agro-based industries entrepreneurs

**MOSTI**

Smart Challenge Fund

### SOFT LOANS

**MIDF**

Soft Loans Scheme for Automation & Modernisation (SLSAM)

Soft Loan Scheme for SME (SLSME)

Soft Loan Scheme for Services Sector (SLSS)

Soft Loan Scheme for Services Capacity Development (SLSCD)

**SME Corp**

Business Accelerator Programme (BAP)
SME Technology Transfer (STTF)
My Seed SME Scheme

**SME Bank**

Financing Programme for SME (SME-LEAP)
Bumiputera Financing Fund (BFF)

**GreenTech Malaysia**

Green technology Financing Scheme

Appendix 4.2

# List of Innovation Ecosystems, Industry Associations, Knowledge Institutions, Technology & Science Parks, Halal Parks Location & Aerospace World-Class Infrastructure

Source: Compiled by ASM, 2017; non-exhaustive

**Guide:**
**STATE**
**Distribution of SMEs by Economic Sectors** *(Economic Census, DOSM, 2016)*
**Malaysia's Multiple Innovation Ecosystems 2010-2015** *(MyKE-III-EPU, 2017)*
**No. of Industry Associations** *(Registrar of Societies, 2017)*
**Knowledge Institutions (MOHE) & PRIs**
**Technology & Science Parks**
**Halal Parks** *(HDC, 2015)*
**Aerospace World-Class Infrastructure** *(MITI, 2016)*

## PERLIS

**6,808 SMEs**
- 5,669 Services
- 370 Manufacturing
- 703 Construction
- 62 Agriculture
- 4 Mining & Quarrying

**Malaysia's Multiple Innovation Ecosystems 2010-2015 Kuala Perlis**
- Fishery, ICT, Cold-chain process & Halal food

**24 Industry Associations**
- 3 Chambers of Commerce
- 1 Manufacturing Industries
- 3 Small Medium Industries
- 8 Small Business & Hawkers
- 9 Services

**Knowledge Institutions (MOHE) & PRIs**

**1 Public IHL**
- Universiti Malaysia Perlis (UniMAP)

**1 Private IHL**
- Kolej Universiti Islam Perlis

**1 Polytechnic**
- Politeknik Tuanku Syed Sirajuddin

**Halal Parks**
- Perlis Halal Park
- MARA Halal Park Kuala Perlis

## KEDAH

**48,894 SMEs**
- 43,552 Services
- 3,214 Manufacturing
- 1,481 Construction
- 620 Agriculture
- 27 Mining & Quarrying

**Malaysia's Multiple Innovation Ecosystems 2010-2015 Langkawi**
Tourism, Health & Beauty, Finance & Creative Industry

**Alor Setar**
Agriculture & Biotechnology, Precision Farming Machinery, ICT & Information Systems, Mechatronics, Halal Food Industry & Rural BPO

**Kulim**
Automobile, E&E, Robotics, Solar technology, New fuel-cell/batteries, Mechatronics & Smart auto technology

**169 Industry Associations**
- 3 Chambers of Commerce
- 1 Manufacturing Industries
- 3 Small Medium Industries
- 8 Small Business & Hawkers
- 9 Services

**Knowledge Institutions (MOHE) & PRIs**

**2 Public IHLs**
- Universiti Utara Malaysia (UUM)
- Universiti Islam Antarabangsa Sultan Abdul Halim Mu'adzam Shah (UniSHAMS)

**4 Private IHLs**
- Universiti AIMST (AIMST University)
- Albukhary International University
- Universiti Islam Antarabangsa Sultan Abdul Halim Mua'dzam Shah (UniSHAMS)

**2 Polytechnics**
- Politeknik Sultan Abdul Halim Mu'adzam Shah
- Politeknik Tuanku Sultanah Bahiyah

**Technology & Science Parks**
- Kulim Hi-Tech Park

**Halal Parks**
- Kedah Halal Park

**Aerospace World-Class Infrastructure**
- Kulim High Tech Park (Aero Manufacturing)
- Bukit Kayu Hitam Industrial Park (Aero Manufacturing)

## PULAU PINANG

**66,921 SMEs**
- 59,600 Services
- 4,021 Manufacturing
- 2,804 Construction
- 470 Agriculture
- 26 Mining & Quarrying

**Malaysia's Multiple Innovation Ecosystems 2010-2015** Seaport logistics, Nanotechnology, IT & Telecommunication devices, Bio-synthetic sensor & Cognitive science &
Smart computing

**260 Industry Associations**
- 30 Chambers of Commerce
- 25 Manufacturing Industries
- 43 Small Medium Industries
- 104 Small Business & Hawkers
- 58 Services

**Knowledge Institutions (MOHE) & PRIs**

**1 Public IHL**
- Universiti Sains Malaysia (USM)
- Universiti Islam Antarabangsa Sultan Abdul Halim Mu'adzam Shah (UniSHAMS)

**5 Private IHLs**
- Universiti Terbuka Wawasan (WOU)
- Kolej Universiti KDU Penang
- Kolej Universiti Tunku Abdul Rahman Kampus Cawangan Pulau Pinang
- Veritas University College
- Kolej Universiti Komunikasi Han Chiang

**2 Polytechnics**
- Politeknik Seberang Perai
- Politeknik Balik Pulau

**2 PRIs**
- Malaysian Institute of Pharmaceuticals and Nutraceuticals (IPHARM)
- Fisheries Research Institute (FRI)

**Halal Parks**
- Penang International Halal Hub
- Perda Halal Food Park

**Aerospace World-Class Infrastructure**
- Perai Free Industrial Zone (Aero Manufacturing, System Integration)
- Bukit Minyak Industrial Park (Aero Manufacturing)

## PERAK

### 75,140 SMEs
- 66,155 Services
- 4,298 Manufacturing
- 3,133 Construction
- 1,433 Agriculture
- 121 Mining & Quarrying

### Malaysia's Multiple Innovation Ecosystems 2010-2015 Ipoh
ICT for mining, Content industry, BPO for ICT services & Robotics

### Tanjung Malim
Auto Industry

### 243 Industry Associations
- 37 Chambers of Commerce
- 12 Manufacturing Industries
- 36 Small Medium Industries
- 99 Small Business & Hawkers
- 59 Services

### Knowledge Institutions (MOHE) & PRIs
### 1 Public IHL
- Universiti Pendidikan Sultan Idris (UPSI)

### 4 Private IHLs
- Quest International University Perak
- Universiti Teknologi Petronas (UTP)
- Universiti Tunku Abdul Rahman (UTAR)
- "Kolej Universiti Tunku Abdul Rahman Kampus Cawangan Perak"

### 2 Polytechnics
- Politeknik Ungku Omar
- Politeknik Sultan Azlan Shah

### 1 PRIs
- Veterinary Research Institute (VRI)

### Halal Parks
- MARA Halal Park Tambun

## SELANGOR

### 179,271 SMEs
- 161,283 Services
- 9,530 Manufacturing
- 7,606 Construction
- 732 Agriculture
- 120 Mining & Quarrying

### Malaysia's Multiple Innovation Ecosystems 2010-2015 Sabak Bernam
Agriculture & Biotechnology

### MSC
New generation ICT & Telecommunication device, Education,
Financial, BPO, Islamic banking & finance, Digital content, E-learning & Medical tourism

### 699 Industry Associations
- 165 Chambers of Commerce
- 54 Manufacturing Industries
- 100 Small Medium Industries
- 200 Small Business & Hawkers
- 180 Services

### Knowledge Institutions (MOHE) & PRIs
### 4 Public IHL
- Universiti Kebangsaan Malaysia (UKM)
- Universiti Putra Malaysia (UPM)
- Universiti Islam Antarabangsa Malaysia (UIAM)
- Universiti Teknologi MARA (UiTM)

### 29 Private IHLs
- Monash University Malaysia
- Binary University of Management & Entrepreneurship (BUME)
- City University
- Malaysia University of Science and Technology (MUST)
- Malaysia Institute For Supply Chain Innovation (MISI)
- Management and Science University (MSU)
- Perdana University
- Putra Business School(PBS)
- Sunway University
- UNITAR International University
- Universiti Islam Malaysia
- MAHSA University
- Asia Metropolitan University
- Universiti Multimedia, Kampus Cyberjaya
- SEGi University
- Universiti Selangor (UNISEL)
- Taylor's University
- Universiti Teknologi Kreatif Limkokwing (LUCT)
- Universiti Tenaga Nasional Kampus Putrajaya (UNITEN)
- First City University College
- KDU University College
- Kolej Universiti Fairview
- Kolej Universiti Islam Antarabangsa Selangor (KUIS)
- Kolej Universiti Lincoln
- Kolej Universiti New Era
- Kolej Universiti Sains Perubatan Cyberjaya (CUCMS)
- Kolej Universiti Saito
- Kolej Universiti Genovasi
- Heriot-Watt University Malaysia (HWUM)

### 3 Polytechnics
- Politeknik Sultan Salahuddin Abdul Aziz Shah
- Politeknik Sultan Idris Shah
- Politeknik Banting

### 11 PRIs
- Agro-Biotechnology Institute Malaysia (ABI)
- Malaysia Genome Institute (MGI)
- SIRIM Berhad
- Agensi Nuklear Malaysia (Nuklear Malaysia)
- Agensi Angkasa Negara (ANGKASA)
- Malaysian Agriculture Research and Development Institute (MARDI)
- National Hydraulic Research Institute of Malaysia (NAHRIM)
- Fibre and Bio-composite Development Centre (FIDEC), under the Malaysian Timber Industry Board
- Malaysian Palm Oil Board (MPOB)
- Science and Technology Research Institute for Defence (STRIDE)
- Institut Sukan Negara (ISN)

### Technology & Science Parks
- Selangor Science Park
- Subang Hi-Tech Industrial Park

### Halal Parks
- Selangor Halal Hub
- Port Klang Free Zone National Halal Park
- National Halal Park

### Aerospace World-Class Infrastructure
- AAC Subang Nexus (MRO. Engineering & Design, Aero Manufacturing, System Integration)
- AAC Serendah (Aero Manufacturing)

## WP KUALA LUMPUR

### 134,939 SMEs
- 124,052 Services
- 5,201 Manufacturing
- 5,642 Construction
- 7 Agriculture
- 37 Mining & Quarrying

### 759 Industry Associations
- 160 Chambers of Commerce
- 48 Manufacturing Industries
- 161 Small Medium Industries
- 187 Small Business & Hawkers
- 203 Services

### Knowledge Institutions (MOHE) & PRIs

**2 Public IHL**
- Universiti Malaya (UM)
- Universiti Pertahanan Nasional Malaysia (UPNM)

**19 Private IHLs**
- Asia e University (AeU)
- Asia Pacific University of Technology & Innovation (Asia Pasific UTI)
- Asia School Of Business (ASB)
- Global Nxt University
- International Centre for Education in Islamic Finance (INCEIF)
- International Medical University (IMU)
- International University of Malaya Wales (IUMW)
- Meritus University
- Universiti HELP
- Universiti Infrastruktur Kuala Lumpur
- Universiti Kuala Lumpur (UniKL)
- Open University Malaysia (OUM)
- Universiti Tun Abdul Razak (UNIRAZAK)
- Universiti UCSI (UCSI University)
- Kolej Universiti Geomatika
- Kolej Universiti BERJAYA
- Kolej Universiti Poly-Tech MARA Kuala Lumpur (KUPTM)
- Kolej Universiti Teknologi Antarabangsa Twintech, Kampus Sri Damansara
- Kuala Lumpur Metropolitan University College (KLMUC)

**1 Polytechnic**
- Politeknik METrO Kuala Lumpur

**9 PRIs**
- MIMOS
- Agensi Remote Sensing Malaysia (ARSM)
- Institute for Medical Research (IMR)
- Forest Research Institute Malaysia (FRIM)
- Humid Tropics Hydrology and Water
- Resources Centre for Southeast Asia and the Pacific (HTC KL)
- Malaysia Rubber Board (MRB)
- Construction Research Institute of Malaysia (CREAM)
- Mineral Research Centre, Jabatan Mineral dan Geosains (JMG)

### Technology & Science Parks
- Technology Park Malaysia

### Aerospace World-Class Infrastructure
- KLIA Aeropolis (Aircraft Maintenance, Repair & Overhaul-MRO, Engineering & Design, Aero Manufacturing)

## MELAKA

### 31,361 SMEs
- 27,976 Services
- 1,479 Manufacturing
- 1,437 Construction
- 452 Agriculture
- 17 Mining & Quarrying

### 104 Industry Associations
- 20 Chambers of Commerce
- 7 Manufacturing Industries
- 12 Small Medium Industries
- 27 Small Business & Hawkers
- 38 Services

### Knowledge Institutions (MOHE) & PRIs

**1 Public IHL**
- Universiti Teknikal Malaysia Melaka (UTeM)

**3 Private IHLs**
- Universiti Multimedia Kampus Melaka
- Kolej Universiti Agrosains Malaysia
- Kolej Universiti Islam Melaka (KUIM)

**2 Polytechnics**
- Politeknik Melaka
- Politeknik Merlimau

### Halal Parks
- Melaka Halal Hub

### Aerospace World-Class Infrastructure
- Melaka International Airport (MRO)
- Composites Technology City (Aero Manufacturing)

## NEGERI SEMBILAN

### 32,721 SMEs
- 27,382 Services
- 1,826 Manufacturing
- 2,960 Construction
- 503 Agriculture
- 50 Mining & Quarrying

### 95 Industry Associations
- 15 Chambers of Commerce
- 5 Manufacturing Industries
- 6 Small Medium Industries
- 44 Small Business & Hawkers
- 25 Services

### Knowledge Institutions (MOHE) & PRIs

**1 Public IHL**
- Universiti Sains Islam Malaysia(USIM)

**3 Private IHLs**
- Kolej Universiti Linton
- INTI International University Universiti Nilai
- KPJ Healthcare University College

**3 Polytechnics**
- Politeknik Port Dickson
- Politeknik Nilai
- Politeknik METrO Tasek Gelugor

**9 PRIs**
- Inno Biologics Sdn Bhd (InnoBio)

### Halal Parks
- Techpark @ Enstek
- Pedas Halal Park

## PAHANG

### 37,573 SMEs
- 32,469 Services
- 1,752 Manufacturing
- 2,240 Construction
- 984 Agriculture
- 128 Mining & Quarrying

### Cameron Highlands
Tourism, Agriculture, Biotechnology, Flower & Flora, Halal food production & Food industry embedded system

### 164 Industry Associations
- 13 Chambers of Commerce
- 10 Manufacturing Industries
- 34 Small Medium Industries
- 43 Small Business & Hawkers
- 64 Services

### Knowledge Institutions (MOHE) & PRIs
### 1 Public IHL
- Universiti Malaysia Pahang (UMP)

### 4 Private IHLs
- DRB-HICOM University Of Automotive Malaysia
- Universiti Tenaga Nasional (UNITEN), Kampus Muadzam Shah
- Kolej Universiti Islam Pahang Sultan Ahmad Shah (KUIPSAS)
- Widad University College

### 3 Polytechnics
- Politeknik Sultan Haji Ahmad Shah Semambu
- Politeknik Muadzam Shah
- Politeknik METrO Kuantan

### 1 PRIs
- National Institute of Veterinary Biodiversity (NIVB)

### Halal Parks
- TGambang Halal Park

### Aerospace World-Class Infrastructure
- Kuantan Airport (MRO)

## KELANTAN

### 46,618 SMEs
- 43,668 Services
- 1,830 Manufacturing
- 681 Construction
- 366 Agriculture
- 73 Mining & Quarrying

### Kota Bharu
Logistics, Education, Tourism, Education & Healthcare

### 74 Industry Associations
- 10 Chambers of Commerce
- 9 Manufacturing Industries
- 16 Small Medium Industries
- 37 Small Business & Hawkers
- 7 Services

### Knowledge Institutions (MOHE) & PRIs
### 1 Public IHL
- Universiti Malaysia Kelantan (UMK)

### 2 Private IHLs
- Kolej Universiti Islam Sains dan Teknologi (KUIST)
- Kolej Universiti Teknologi Antarabangsa Twintech (TWINTECH), Kampus Kelantan

### 2 Polytechnics
- Politeknik Kota Bharu
- Politeknik Jeli

### Halal Parks
- Pasir Mas Halal Hub
- Pengkalan Chepa Halal Park

## TERENGGANU

### 29,324 SMEs
- 25,688 Services
- 2,010 Manufacturing
- 1,384 Construction
- 185 Agriculture
- 57 Mining & Quarrying

### 77 Industry Associations
- 10 Chambers of Commerce
- 7 Manufacturing Industries
- 10 Small Medium Industries
- 19 Small Business & Hawkers
- 31 Services

### Knowledge Institutions (MOHE) & PRIs
### 2 Public IHL
- Universiti Malaysia Terengganu (UMT)
- Universiti Sultan Zainal Abidin (UniSZA)

### 2 Private IHLs
- Universiti UCSI (UCSI University), Kampus Terengganu
- University College Bestari
- Kolej Universiti TATI

### 3 Polytechnics
- Politeknik Kuala Terengganu
- Politeknik Sultan Mizan Zainal Abidin
- Politeknik Hulu Terengganu

### Halal Parks
- Terengganu Halal Park

## JOHOR

**98,190 SMEs**
- 83,808 Services
- 7,787 Manufacturing
- 4,733 Construction
- 1,772 Agriculture
- 90 Mining & Quarrying

**499 Industry Associations**
- 25 Chambers of Commerce
- 40 Manufacturing Industries
- 41 Small Medium Industries
- 167 Small Business & Hawkers
- 226 Services

**Knowledge Institutions (MOHE) & PRIs**

**2 Public IHL**
- Universiti Teknologi Malaysia (UTM)
- Universiti Tun Hussein Onn Malaysia (UTHM)

**4 Private IHLs**
- Raffles University Iskandar
- Multimedia University (MMU), Kampus Johor
- Kolej Universiti Tunku Abdul Rahman Kampus Cawangan Johor
- Kolej Universiti Selatan

**4 Polytechnics**
- Politeknik Ibrahim Sultan
- Politeknik Mersing
- Politeknik METrO Johor Bahru
- Politeknik Tun Syed Nasir Syed Ismail

**Technology & Science Parks**
- Johor Technology Park

**Halal Parks**
- Sedenak Industrial Park
- Palm Oil Industrial Cluster Tg Langsat

**Aerospace World-Class Infrastructure**
- Senai Airport Aviation Park (MRO)

## SABAH

**58,269 SMEs**
- 52,083 Services
- 1,868 Manufacturing
- 2,625 Construction
- 1,639 Agriculture
- 54 Mining & Quarrying

**Sandakan**
Agriculture, Biotechnology, Smart Agriculture, Bio-diesel & Fishing

**Kudat**
Rural BPO

**Lahad Datu**
AIMS & Environmental technology & Forestry

**Kota Kinabalu**
Experience Industry

**Labuan**
Banking & Finance & BPO

**Samporna**
Fishing & Telecommunication

**Tawau**
Agriculture, ICT & Halal products & services

**478 Industry Associations**
- 67 Chambers of Commerce
- 9 Manufacturing Industries
- 83 Small Medium Industries
- 156 Small Business & Hawkers
- 163 Services

**Knowledge Institutions (MOHE) & PRIs**

**1 Public IHL**
- Universiti Malaysia Sabah (UMS)

**2 Private IHLs**
- Kolej Universiti Borneo Utara (KUBU)
- Kolej Universiti Yayasan Sabah (KUYS)

**2 Polytechnics**
- Politeknik Kota Kinabalu
- Politeknik Sandakan

**Halal Parks**
- Palm Oil Industrial Cluster Lahad Datu
- Labuan Distributive Hub
- Kota Kinabalu Industrial Park

**Aerospace World-Class Infrastructure**
- Kota Kinabalu International Airport (MRO)

## SARAWAK

**61,036 SMEs**
- 55,741Services
- 2,512 Manufacturing
- 1,729 Construction
- 993 Agriculture
- 61 Mining & Quarrying

**Gua Mulu**
Tourism

**Long Seridan**
Lifting & transfer machines, Distance technology & Mobile communication

**Miri**
Agriculture, Biotechnology, Bio-informatics, Education, Logistics Hub & Petrochemical & advanced materials

**Bintulu**
Forestry industry logistics

**Kapit**
Process & systems for forestry industry, Advanced fibre & materials for construction industry & Tourism

**Mukah**
Fishing & Aquaculture

**Sibu**
Agriculture, Biotechnology, Telecommunication & Precision farming

**Oya**
Fishing & Aquaculture

**317 Industry Associations**
- 67 Chambers of Commerce
- 29 Manufacturing Industries
- 26 Small Medium Industries
- 90 Small Business & Hawkers
- 105 Services

**Knowledge Institutions (MOHE) & PRIs**

**1 Public IHL**
- Universiti Malaysia Sarawak (UNIMAS)

**3 Private IHLs**
- UCSI University, Sarawak Campus
- University College of Technology Sarawak
- Curtin University, Malaysia

**3 Polytechnics**
- Politeknik Kuching Sarawak
- Politeknik Mukah Sarawak
- Politeknik METrO Betong

**2 PRIs**
- Malaysian Cocoa Board (MCB)
- Malaysian Pepper Board (MPB)

**Halal Parks**
- Tg Manis Halal Hub
- MARA Halal Park Kuching

**Aerospace World-Class Infrastructure**
- Kuching International Airport (MRO)

# 05
## STI Enculturation

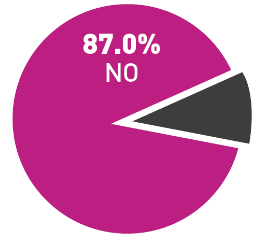
## 1 STI ENCULTURATION SPACES ACROSS MALAYSIA


| 13 | 12 | 7 | 18 |
|---|---|---|---|
| National & State Zoos | Science Centres | Museums with STI Exhibits | Permanent Wild Life Exhibits |

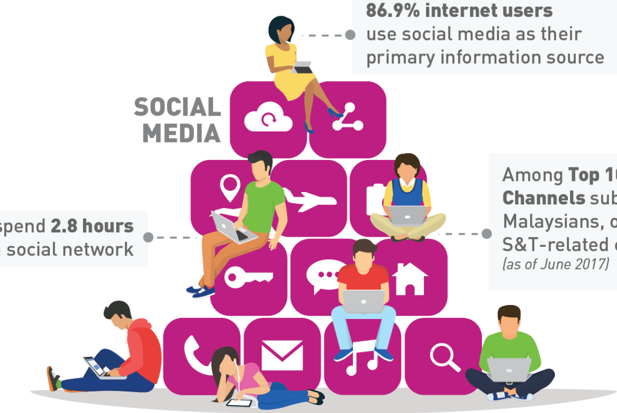
** List is non-exhaustive*

## 2 STI ENGAGEMENT

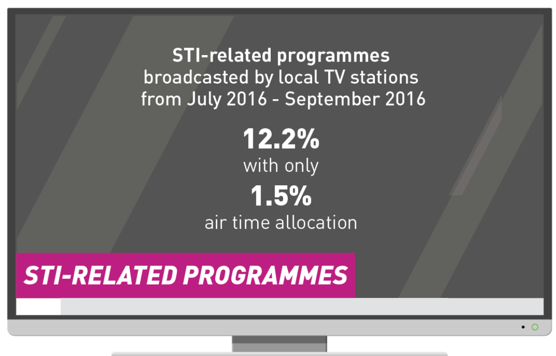
**Industries involvement / promotion in STI-related outreach programmes / activities / events**
*(Industry Awareness and STI Perception, ASM 2017)*




## 2 STI-RELATED INFORMATION SOURCES







## Building a Science Encultured Nation

Science is not just a subject to learn in school; it is a process, a product, and an institution of knowing about the world. Science used to be the domain of the privileged few who can afford the time and resources to investigate philosophy of the natural world. Now, science has become democratised through widespread access to education and information. Although science is ubiquitous, imbedding it in the national culture and psyche to power the integration of science, technology and innovation (STI) in the population remains a challenge.

It is important to create a society which is both aware of the benefits and the development of the sciences as the day-to-day activities of society revolves around the usage of sciences. A society that is aware of science will then seek to further their understanding of it, which in turn contributes to their literacy of it. Creating a science literate society ensures that people, regardless of their background, are able to make informed decisions on issues that matter to them.

## HINDSIGHT

Science Outlook 2015, STI Enculturation Chapter highlighted **four** recommendations.

| 2015 Recommendation | | Development |
|---|---|---|
| • "Science beyond Scientists", is a global philosophy that is relevant for Malaysia as it helps to sensitise the society on various aspects of development, while the nation achieves its 2020 milestone of being a developed economy.<br>• Hence, a strategic long-term STI Enculturation Plan is needed. | EARLY EXPOSURE TO SCIENCE | The Malaysia Education Blueprint 2013-2025 under the Ministry of Education (MOE) addresses the need for early childhood exposure to STI. |
| Such a Plan should define the roles of multiple stakeholders such as the Government, scientists, prosumers, businesses, media, parents and youth, and the society at large, in promoting the cause of science for development. | PLAYERS IN POPULARISING SCIENCE | The present working draft of the National STEM Action Plan by Ministry of Science, Technology, and Innovation (MOSTI), MOE and Ministry of Higher Education (MOHE) has incorporated STI enculturation strategies, hence, addressing three of the recommendations proposed in Science Outlook 2015. |
| The Plan should also clearly define the platforms for public engagements, including the frequency and the content to popularise science amongst non-science communities. | ENGAGE PUBLIC THROUGH MULTIPLE PLATFORMS | Cradle right up to career – an example: The National STEM Movement headed by representatives of several Malaysian universities, Ministries (MOE and MOSTI), private sectors, and NGOs aims to drive the passion in fundamental of STEM, through public engagements.<br>Other entities include professional associations e.g. IEM and environmental NGOs. |
| An STI Enculturation Index will help derive meaningful data, which can be used by critical influencers (such as schools, educationists, parents, industry leaders) to garner interest for STEM disciplines as well as scientific initiatives. | DEVELOP SCIENCE ENCULTURATION INDEX | A dedicated Science Enculturation Index has yet to be developed, however MOE has taken an approach to formulate STEM Student Index. |

## 5.1 STI CULTURE, ENCULTURATION AND WHAT IT MEANS FOR MALAYSIA

Culture is often thought of as the collective manifestation of human intellectual achievement. Enculturation is the acquisition of one's own culture, including its values, behaviours, beliefs, understandings, social norms, customs, rituals, and languages.

STI culture is the expression of all the ways individuals and society appropriate science and technology from acquiring common scientific knowledge and having a general understanding of scientific methods (Godin and Gingras, 2000). It is generally accepted that scientific culture includes scientific literacy, public understanding and acceptance of science and scientific methods, as well as the applications of science in day-to-day life.

STI enculturation is the process through which science culture becomes integrated in the mind and habits of the people, similar to how national and ethnic identity are internalised. The practical value of scientific enculturation is such that it is specified as an objective in science, technology and innovation (STI) policies for Organisation for Economic Cooperation and Development (OECD) countries since the late 1990s.

The complex processes of STI enculturation occur through a variety of formal and informal methods throughout a person's lifetime. Science education in the classroom is the most important formal method of STI enculturation; a great deal of research and investment goes into strengthening science education in Malaysia at all levels (see Chapter 3). Work-related training to keep up with the latest knowledge development and technological trend (e.g. data analytics for product development) is vital for those in STI-related industries. The standards and requirements that protect the population from unpleasantness such as environmental contamination and tainted products by local, regional and international regulation bodies are also a formal avenue of STI enculturation.

It is believed that the strongest agency of science literacy is through informal approaches that incites curiosity and encourages knowledge-seeking habits (Falk and Needham, 2013). The availability and accessibility of designed environments (e.g. science centres, museums, zoos, galleries) for STI enculturation is a strong supporting factor of free-choice learning (Falk et al., 2016; Snow & Dibner, 2016). Casual discussion with peers and family on STI matters, using information gleaned from attending public forums and expositions also promote habits of the mind for STI enculturation (Godin & Gingras, 2000). The media, either mainstream or alternative, play a tremendous role in encouraging or discouraging science literacy (Fenichel & Schweingruber, 2010).


**Figure 5.1**
**STI ENculturation Modality**

Source: ASM, 2017

### Motivations for STI Enculturation

STI is central to modern life as we know it and defines how we interact with the social, economic, political and ethical structures of society. Technological innovations shape many of our daily activities; how we interact in personal and public spheres, what and how we eat, as well as connect and entertain us.

A strong science culture helps to foster a fuller, richer experience of science itself by enabling individuals to figure out and appreciate the world around them through scientific discovery and exploration. Citizens with strong science culture can participate in discussions on the potential risks and benefits of scientific process and technologies (e.g. discussing on whether Malaysia should set up nuclear power plants). They would also be equipped to consider the ethical implications of STI issues in their lives and the community; such as the moral outcome of sharing videos of underage criminals on social media.

The nature of work, growth and development in the 21st century and beyond will be markedly different and progressing in ways that are nearly impossible to predict; the only constant is the role technological development and utilisation in this landscape. Fourth Industrial Revolution underscores the importance of developing a society that is conversant in using and innovating science. STI enculturation can bolster an economy's capacity for innovation by supporting development of advanced STI skills in the population derived from a strong science culture (Council of Canadian Academies, 2014).

STI enculturation is one of the key enablers for Malaysia to move out from the middle- income trap. To date, Malaysians are largely technology consumers rather than innovators (see Chapters 2 and 4). Malaysia's research output at the moment is insufficient to support a shift from middle level manufacturing and services to higher level knowledge economy. Most of the high technology industry niches are occupied by multinational corporations from abroad; more home-grown tech businesses are needed to ramp up Malaysia's productivity. These aspirations can only be achieved with a scientifically literate population.

## 5.2 STI ENCULTURATION INDICATORS

STI enculturation supports the "science environment" necessary to ensure a nation's competitiveness in the current world economy (Bauer & Suerdem, 2016). The strength and weaknesses of a population's STI engagement can be identified using STI enculturation indicators. These indicators are utilised by policy makers to develop the best strategies available to bridge any gaps between science and society. The main indicators are outlined in Figure 5.2; it is important for us to assess STI enculturation in the country by assessing these indicators and coming up with strategies to strengthen it when needed.

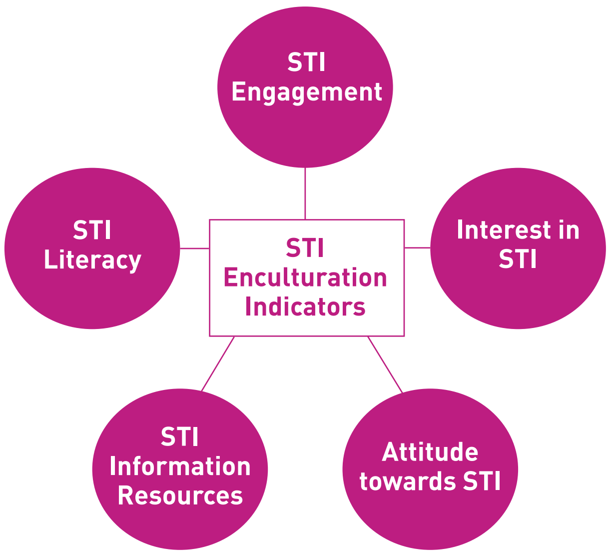



**Figure 5.2**
**STI Enculturation Indicators**

Source: MASTIC, 2014

## 5.3 STI ENGAGEMENT

STI engagement is influenced by access to STI enculturation programmes by connecting with relevant institutions, and enrichment through STI content in the media. Most STI engagements are done through government programmes, public and private institutions of higher learning, and business communities. STI enculturation spaces promote STI engagements through entertainment and enrichment activities. Enumerating all of the activities and players involved is not possible, but having a snapshot of the resources available can assist to strategise enhancement of STI enculturation in Malaysia.

### Government Programmes

To support the country's shift into knowledge-based economy, nearly all of the 24 government ministries have some sort of STI enculturation in their programmes, regardless of whether their mandates are specific for STI development. One of the best examples of ministries engaging in STI enculturation is the Ministry of Health (MOH) as part of their mandate to promote health and disease prevention among the Malaysian population. These programmes are conducted at the federal level by the main body of the Ministry, and supported by various coordinated campaigns at state level by the hospitals, research institutes under the Ministry, and institutions of higher learning. Box 5.1 condensed some of the major campaigns by MOH in 2015 and 2016.

The Ministry of Science, Technology and Innovation (MOSTI) also carries out outreach programmes such as Creativity & Science4u to make the STEM field more attractive to students. MOSTI's latest initiative to inculcate science and technology through the National Innovation and Economy Creative Expo (NICE '17) attracted 345 thousand visitors.

At state level for instance, the Sarawak Biodiversity Centre (SBC) has recognised the importance of public awareness and appreciation towards related biotechnology and local biodiversity initiatives. In 2016, SBC carried out 20 public engagements involving participation of approximately 2,500 researchers, industry players and students. While till mid-2017, 12 programmes were carried out with participation of about 1,250 people from various institutions.



## Box 5-1

### Snapshot of Enculturation Campaigns by MOH in 2015 - 2016

**A Nation Working Together for Better Health**

The Ministry of Health (MOH) is responsible for crafting and implementing health policies, and to deliver healthcare services to the Malaysian population. MOH also conduct campaigns to encourage Malaysians to adopt a healthier lifestyle.

Some of the campaigns were:

1. World Breastfeeding Week
2. MyNutriDiari Smartphone Application
3. "Healthy Eating during Chinese New Year" programme
4. Eat Fruit and Vegetable Campaign in conjunction with MAHA 2016
5. 3rd National Plan of Action for Nutrition of Malaysia (NPANM III), 2016-2025, and Nutrition Research Priorities (NRP) in Malaysia for 11th Malaysia Plan, 2016-2020
6. Healthier Choice Logo (HCL) for smart consumers

Some of the programmes were conducted in collaboration with other ministries and agencies.

### Institutions of Higher Learning (IHLs)

Universities are also venues and promoters of disseminating scientific information to the public through activities such as faculty specific campaigns, public service programmes, scientific societies, film screenings, public forums, inaugural lectures, and many more. These programmes are usually advertised on the university's website, social media account, and traditional print media. These programmes are also opportunities for university students to develop soft skills beyond the classroom such as event management, communication, fund raising, and marketing. Box 5.2 describes one example of STI enculturation activities by a public IHL.

# Box 5-2

## Creating Awareness for Genetic Diseases through Fun Activities

### Learning about Genetic Diseases through the Jeans for Genes (Malaysia) (JG4M) Campaign

Jeans for Genes is a global campaign to deliver inspiring projects and support services for children affected by genetic disorders. Faculty of Medicine, Universiti Malaya and the Genetics Medicine Unit at the Universiti Malaya Medical Centre, established the Malaysian chapter to raise awareness of genetic disorders affecting Malaysia's children and funds to support their treatment.

Together with Biomedical Science undergraduates and the Malaysian Rare Disorder Society, J4GM conduct workshops on genetics and heritable medical conditions in schools and many other public arenas. Their first event was recorded in the Malaysia Guinness Book of Records for DNA double helix structure in denim using over 1,000 pairs of donated jeans. J4GM also collaborate with other societies such as the National Ichtyosis Society, the Apert Syndrome Society, Epidermolysis Bullosa Society (DEBRA Malaysia) with support from corporate sponsors among which were Pfizer, NanolifeQuest, Themed Resorts, Attractions and Hotels (TARH) – Kidzania and Kindness Malaysia.

The J4GMFacebook page (https://www.facebook.com/JeansForGenesMalaysia) feature personal stories, activities, links, and articles related to genetic disorders curated for the public.

## Business Communities

Small and medium enterprises (SMEs) contribute to 36% of Malaysia's GDP. They account for 97% of the total business entities of the country and employ 67% of the workforce. SMEs are expected to be a major contributor of Malaysia's shift into high income economy through innovation-driven productivity gains to move their businesses up the value chain. Therefore, STI enculturation can be a part of their business strategy to develop new markets and maintaining current cadre of clients.

Questionnaires were sent to over two thousand randomly selected companies to assess their involvement in STI enculturation activities. Out of the 75 SMEs that responded, only 13% engage in STI enculturation related programmes. Figure 5.3 summarised the result of the survey.

The Government of Malaysia through its agencies offers many financing schemes to assist SMEs to start or grow their businesses. Agencies related to SME development such as SME Corp, Malaysian Industrial Development Authority (MIDA), and Unit Peneraju Agenda Bumiputera (TERAJU) offer grants and schemes related to STI adoption for SMEs. It would be good to examine how SMEs can be encouraged to embrace STI enculturation as part of their business strategy through their engagement with these agencies.

## Non-governmental organisations (NGOs)

Small Civil society is the third sector of society, along with government and business. It exerts its influence through civil society organisations and non-governmental organisation (NGOs). Civil society plays an important role in engaging with public and forming the public's opinions on important social matters.

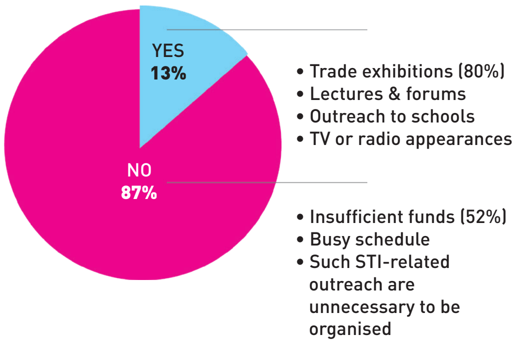



**Figure 5.3**
**STI Engagement of BEs in Malaysia**

Source: Industry Awareness and STI Perception Survey Conducted for Science Outlook 2017

Environmental NGOs (ENGOs) are excellent examples of the power of civil society in STI enculturation. ENGOs provide the link between civil society and the government when addressing issues affecting the environment. They play a major role in pushing governments towards more ambitious environmental policies at all levels by promoting greater transparency and better representation of otherwise marginalised societal interests in policy formulation and implementation. ENGOs also perform vital environmental education services by creating awareness of the issues they champion and its impact on society.

These ENGOs engage in a plethora of STI enculturation as part of fulfilling their mandate. They organise workshops and awareness campaigns, often engaging the community at grassroots level. Most of the activities are either self-funded, financed through donations or nominal fees charged to those who attend the programmes. Some manage to obtain corporate sponsorship from local and international companies. The outreach of each ENGOs differ according to their engagement strategies; mostly measured through attendance such as number of social media "Likes" and "Comments". However, in order for ENGOs to further increase their activities, ENGOs will need to explore new business models to become self-sustainable.

## Box 5-3

### Community-led Turtle Conservation in Terengganu

The state of Terengganu is synonymous with sea turtles for its beautiful coast is an egg-laying destination for the magnificent creatures. Unfortunately, overfishing, environmental degradation, and other factors have endangered the sea turtles' existence.

Persatuan Pemuliharaan Tuntung, Kura-kura dan Penyu Malaysia and Persatuan Khazanah Rakyat Ma'Daerah Kerteh, Kemaman (MEKAR) are among the ENGOs spearheading community-led effort to raise awareness on the protection and conservation of sea turtles in their natural habitat. Marine and forest resource management are also included in their activities.

It was estimated that the programmes of these 3 ENGOs have reached over 250,000 people in 2015 and impacted over 500,000 people in 2016 (based on attendance and social media responses).

There are also STI grassroots movements that utilise social media as a platform for STI activism. These are commonly a loose coalition of individuals sharing the same interest who invest their own time and money to promote activities related to STI. These grassroots movements debunk pseudoscience, give information on, nutraceutical, and health products on the market, share relevant media content, invite knowledgeable speakers to give talks and many more. They are not registered with RoS, hence are not easily quantified and assessed.

Professional associations are commonly non-profit organisations that further the interests of a particular profession; a number of them have STI interest and/or background; e.g. Institute of Engineers Malaysia. Scientific societies are networks of researchers in specific fields that collaborate and communicate their latest discoveries; e.g. Malaysian Society for Biochemistry and Molecular Biology.

These organisations often have periodical meetings at local and international levels. These meetings are also covered by the newsprint media as part of their STI coverage, disseminating the meeting's finding to the general public. The mandates of these bodies include activities related to knowledge propagation (i.e. publishing journals,etc.), standardisation of best practices, and regulation of membership. These activities are part and parcel of STI enculturation of communities with specialised interest and training.

## Box 5-4

### Science Cooperative on Social Media

**Medical MythBusters Malaysia (M3) Fights Medical Myths and Dispenses the Facts**

M3 is a coalition of individuals trained in various medical fields who come together to address the issue of medical pseudoscience on social media. They are made up of physicians, pharmacists, nurses, physiotherapists and medical assistants.

M3 educates the general public on misconceptions such as lotus births, the role of doulas in delivery, vaccine avoidance and many more. They also expose fraudulent businesses that peddle miracle cures, and spread the word on items that have been blacklisted by the MOH.

This coalition can be found on Facebook (105,800 fans) and Twitter (1,790 followers). They are a non-profit, generate no income and are not registered with the ROS.

FB: https://www.facebook.com/MedicalMythbustersMalaysia/

Twitter: https://twitter.com/MedMythbusterMY

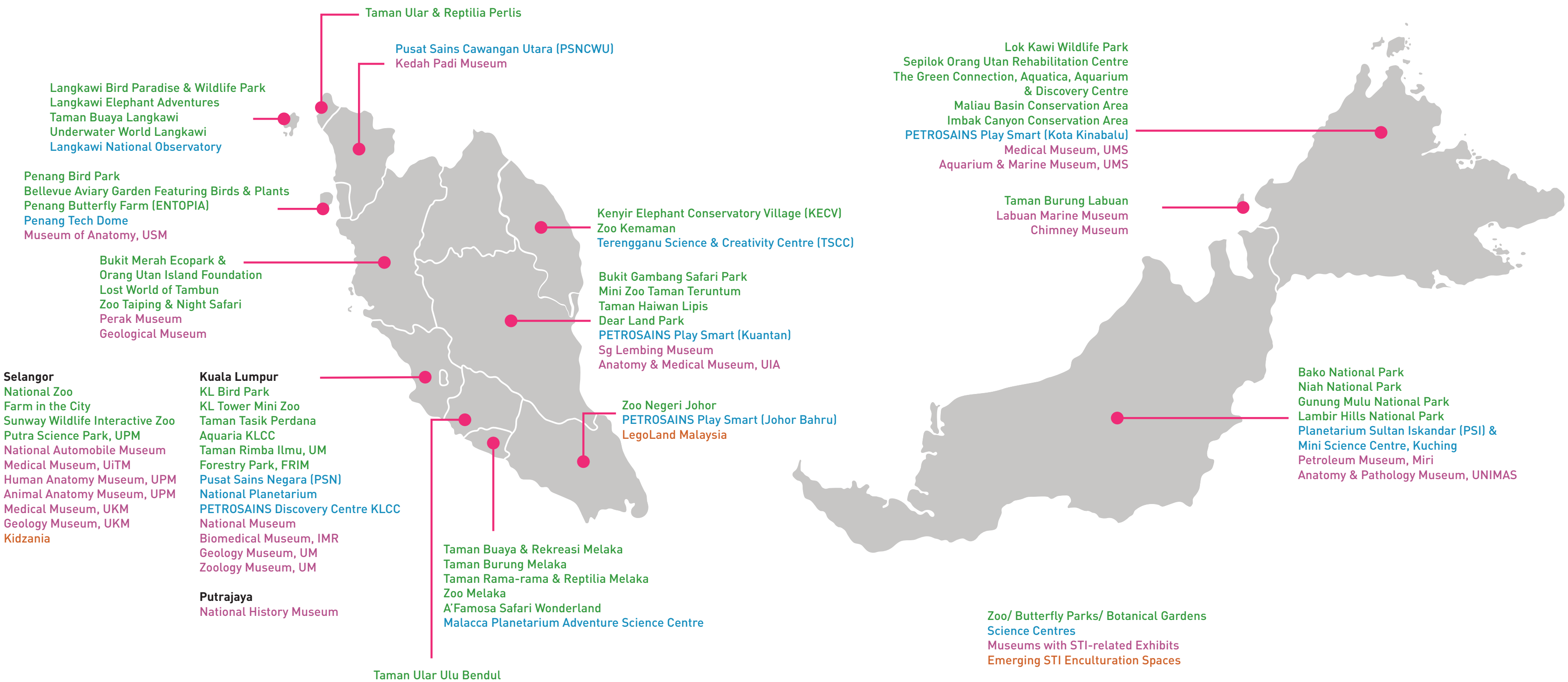



**Figure 5.4**
**STI Enculturation Spaces in Malaysia***

Source: Compilation by ASM, 2017
(*list is non-exhaustive hence not all Federal- and State- level and, Privately owned spaces are listed)

## 5.4 STI AWARENESS

### STI Enculturation Spaces

Out of school experiences appear to have greater contribution to STI enculturation. These experiences are life-long, and enjoyment for it can be inculcated from young. There are many designated environments in Malaysia that serve as STI enculturation spaces such as science centres, museums, zoos, nature preserves, botanical gardens, and aquariums (Figure 5.4) that offer a variety of permanent and temporary exhibitions to enrich STI immersion.

Malaysians enjoy going to science centres, museums, zoos and aquariums; the numbers of Malaysians who go to STI enculturation venues are greater than the EU, South Korea and Brazil (MASTIC, 2014). Most of the visitors are children; probably because visits to such venues are part of school activities. The zoo is the most popular STI enculturation destination, followed by the museum, aquarium, Petrosains, PSNKL and the Planetarium.

Based on a published survey, the number of these visits has been declining since 2002 (Figure 5.5 (a)). These venues (Figure 5.5 (a&b)) should review the effectiveness of their outreach programme and survey their visitors' experience to improve their services to remain relevant with the change of times.

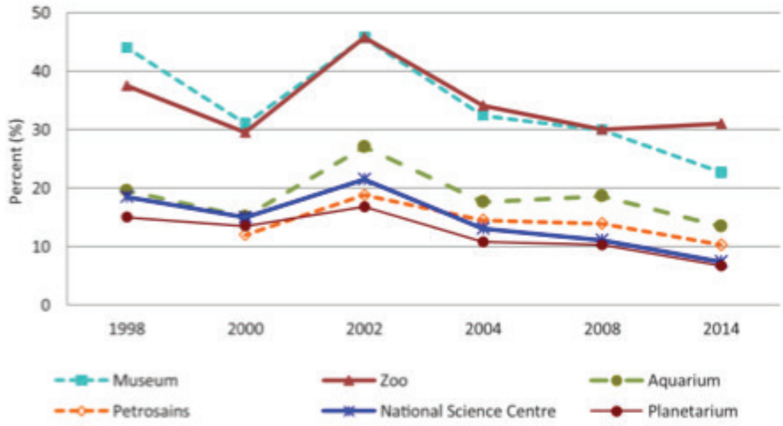



**Figure 5.5(a)**
**Number of Visitors to STI Places from 1998-2014**

Source: MASTIC, 2014

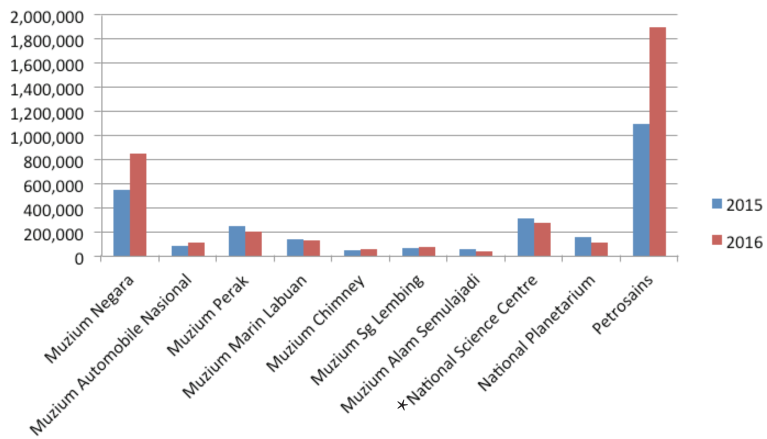



**Figure 5.5(b)**
**Number of Visitors to STI Places from 2015-2016**

Source: Compilation by ASM, 2017

Note: *National Science Centre was close to public from early 2015; data shows visitors for the outreach programmes.

## Science Centres

Science centres are educational facilities that use effective methods to teach science, technology, mathematics and engineering using interactive displays, events and activities. It is a place designed to stimulate curiosity, develop inquiring minds and expose children and adults to positive new experiences. Not just children and young people who get to play around with science using self-guided learning at these centres, but also their families, teachers, and others.

Science centres can be found all over Malaysia; a large number of them are concentrated in Klang Valley. These venues are both private and public initiatives; some are designed primarily as tourist attractions with STI themes.

The Pusat Sains Negara Kuala Lumpur (PSNKL) was closed in early 2015 for maintenance and upgrading exercise. Nevertheless, PSNKL continues their STI enculturation efforts together with Pusat Sains Negara Wilayah Utara through campaigns such as Kelana Sains, Meet the Scientist, Perkampungan Sains, Science Festival, and their mobile exhibits. These outreach programmes have benefit 282,066 individuals in the year 2016.

Petrosains (KLCC) boasts of 7,000 metre square floor exhibition space spanning ten galleries. It continues to record highest number of visitors, achieving over 1.3 million visitors in 2016.

The biggest challenge for all science centres is to have enjoyable and well-maintained displays to attract new and repeat visitors. This requires periodical revamps and funds to do so. Setting up public-private partnerships would be a way for science centres to leverage available resources to keep their exhibits fresh and attract more visitors to their venue.

Science centres can leverage upon the resources and tools of the Association of Science-Technology Centres (ASTC) network to learn and exchange information in science centre development. ASTC has over 600 members in nearly 50 countries – comprising science centres and museums, nature centres, aquariums, planetariums, zoos, botanical gardens, natural history and children's museums – they also count companies, consultants, and other organisations interested in informal science education as their members. The PSNKL, Petrosains, The Penang Tech Dome, Palm Information Centre, and Terengganu Science and Creativity Centre are members of the ASTC.

Closer to home, these local science centres are also active members of the Asia Pacific Network of Science and Technology Centres (ASPAC). Through this regional network, exhibition and staff development programmes are regularly conducted to improve and enhance the offerings provided by these science centres.

## Museums

Museums gather and showcase materials which represent the cultural identities and history of a nation, alongside the country's technological development and innovations. Museums are important institutions for enculturation because visitors can interact with the displays which help them to appreciate the historical, societal and contemporary value of the exhibits. Table 5.1 illustrates the location of museums with STI elements in Malaysia.

The most prominent museums in Malaysia are often run by Federal and State Government agencies; only a few are run by heritage organisations and private endeavours. Melaka has the most museums per capita of all the states of Malaysia; likely because tourism is one of the state's leading sources of revenue. Jabatan Muzium Malaysia (JMM) is responsible for establishing and managing museums funded by the federal government. The STI enculturation aspect of these museums differs depending on their theme as shown in Table 5.1.

**Table 5.1**

## Museums under Department of Museums with STI Exhibits

Source: Jabatan Muzium Malaysia, 2017

**Wilayah Persekutuan Kuala Lumpur**

**National Museum**

Exhibit type:
- Anthropological exhibits
- Exhibits on prehistorical and geological treasures of the country
- Exhibits in technological achievements by Malaysia

**Selangor**

**National Automobile Museum**

Exhibit type:
- Exhibits on Malaysia's automobile industry

**Perak**

**Perak Museum**

Exhibit type:
- Has "Nature gallery" showcasing Malaysian wildlife

**Wilayah Persekutuan Labuan**

**Labuan Marine Museum**

Exhibit type:
- Galleries on Malaysia's marine life
- Galleries on Malaysia's marine habitat
- Exhibits on industries that rely on Malaysia's marine life

**Chimney Museum**

Exhibit type:
- Exhibits on the coal industry
- Showcasing coal mining

**Pahang**

**Sg Lembing Museum**

Exhibit type:
- Showcasing underground tin mining and the relevant technologies involved

**Wilayah Persekutuan Putrajaya**

**Natural History Museum**

Exhibit type:
- Exhibits on Malaysia's flora and fauna

State and agency run museums and galleries are also important features of STI enculturation in Malaysia. Some of the public universities also curate artefacts of their research and other archives that are on display for the general public as well. The Medical Museum of Universiti Malaysia Sabah is open to public. For some though, not much publicity has been done to promote these exhibits to outside audience; announcements of new displays are mostly found in the universities' website and banners within the campus only. Some of the museums, such as the Pathology Museum in the Faculty of Medicine Universiti Malaya, are limited to specific audience (i.e. medical and medical research students) and can only be accessed with permission.

The greatest numbers of visitor flock to the National Museum, probably because it is listed as a major tourist attraction. Central location in Klang Valley is no guarantee of popularity; a number of museums located in Kuala Lumpur and its environs have relatively low number of visitors. Based on the data on the number of visitors of the identified museums with STI related exhibits; the percentage of foreign tourists for the year 2015 and 2016 were 15% and 14% respectively. This could indicate an ineffective outreach programme to make the museums attractive or even known to the general public and tourists. A visit to the JMM and the museums' websites indicated that more could be done to promote their online presence and interactivity to enhance their STI enculturation facet. Privately funded museums such as the Islamic Arts Museum (funded by the Albukhary Foundation) and others also figure importantly in STI enculturation. The Islamic Arts Museum also offer training in archival techniques and restoration technologies. This enrichment is valuable to enhance STI enculturation while promoting cultural and historical appreciation.

### Zoos

Zoos, aquariums, nature reserves, and parks are also vital resources of STI enculturation. Some are under the federal or state government; others are for profit entities, or supported through endowments by private individuals or foundations. These locations serve as educational and recreational centres, often charging entrance fees to support their management. One fine example is the Ma'Daerah Turtle Sanctuary in Kerteh, Terengganu – the sanctuary is supported by BP, Department of Fisheries, and WWF Malaysia – that actively works in turtle protection and conducts education and awareness programmes for marine life and ecosystem.

Zoos, animal sanctuaries, and fauna displays are important resources for nature conservation, as well as educational and entertaining. The stock-taking conducted by ASM yielded a list of zoos and fauna displays that are under Jabatan Perhilitan. This agency is responsible for making sure that the animals are treated according to the designated standard. Not included in the survey are zoos and animal sanctuaries that are administered under State Government such as the Kuala Gandah Elephant Sanctuary. The map in Figure 5.4 shows the locations of these zoos and other fauna displays.

### Emerging STI Enculturation Spaces

There are new spaces that offer STI enculturation that does not fall under the traditional museums, science centres, etc. These are entertainment spaces or theme parks that offer fun activities with STI elements incorporated.

Kidzania is a theme park that offers immersive role play to children located in Mutiara Damansara. They get to experience a variety of careers; from fire fighter to surgeon, sushi chef to astronauts. Exploring the underlying STI basis of these careers is part of the educational experience children enjoy in Kidzania. Kiddo Science Centres are another fun based learning centre which allows children to discover science at a very young age.

Legoland in Nusajaya, Johor is an interactive theme park based on the popular interlocking toy bricks. Lego promotes problem solving through engineering and mathematics to create and re-create structures and landscapes.

Escape games is the basis of Escape Room, a new theme park for puzzle lovers. Visitors get to use their intuition and problem solving skills to escape from a thematic room, either alone or with their friends and family. It is gaining popularity among young people as well as a venue for team building exercises.

## Box 5-5

### Casual Science at Café

Science Café KL is a free monthly event started in 2016 in the pattern of Science Cafés in other parts of the world. Scientists are invited to speak in a casual and lively setting at The Bee in Publika to share knowledge and ideas with public.

There are no long lectures; it is a dynamic, two-way interaction between a scientist and the public. This creates a relaxed engagement where the public feels empowered to learn and the scientists gain valuable perspective on their work.

While in the Northern Region, the Penang Science Cafés organised by the Penang Science Cluster provide a social space for public to learn hands-on science-related topics and issues. These Cafés are also equipped with tools and equipment made available to the public to create prototypes and carryout experiments.

Similar engagement session conducted by Petrosains - #PETROSAINSAfterHours is a platform for continuous learning delivered through demonstrations and talks. This program with topics related to STEM and our daily lives, is aimed at introducing new skills and knowledge to the working adults and youth.

This community is an example of grassroots STI movement powered by social media.

## 5.5 STI INFORMATION RESOURCES

The media — print, broadcast, others — are the most important means for most adults to learn about science once formal education is over. Civic scientific literacy is shaped by the kind of information received and perceived, something to be considered in the nearly limitless information available.

The media sources Malaysians prefer to obtain STI information are television, newspapers, the radio followed by the Internet (MASTIC, 2014). This trend differs between urban and rural population; a higher number of urban populace rely on the Internet when seeking information compared to the rural. Internet penetration is greater in the cities, as well as the access to mobile devices.

### STI Content on Television

Assessment of STI content on television focussed on the four terrestrial television channels that are freely available to all Malaysian households in the Peninsula and Borneo: RTM1, RTM2, TV3 and NTV7. Subscription channels through Astro and Unifi were not included as their viewership is limited. Broadcast and viewership data was purchased from Nielsen Audience Measurement Sdn. Bhd. on all programmes in their database from July 2016 to September 2016.

Sixteen genres were broadcast during the three-month period, of which only two (documentaries and magazines) feature STI content exclusively. News and certain magazine programmes that feature snippets of STI were excluded because it was not possible to assess the quantity of STI elements in those programmes.

Only RTM1 and RTM2 broadcast programmes explicitly related to STI, which make up 12.2% of their total programmes with 1.5% air time allocation. RTM1 had 12 STI-related programmes and RTM2 had 22 STI-related programmes aired from July until September 2016. Eight of the programmes were in English while the rest was in Bahasa Malaysia. The total views of these programmes comprised of 0.8% of the total viewership. This does not differ much from Western European viewers where science programmes reach only 1.3% of the total viewership (Lemkuhl et al., 2014).

All four channels had a total of **6,209,799,000 views** from July to September 2016.

### STI Content in Newsprint Media

Two topmost circulating English and Malay newspapers were chosen to gather information on the number of STI-related news in comparison to two other popular genres (politics and sports). The duration of reporting was from January 2015 to December 2016.

27% of the articles published the English-based newspaper and 18% of articles reported by the Malay-based newspaper concerned STI. More STI-related news is reported in English media which is comparable to data from India where English newspapers report more STI content than Hindi newspapers (Meenu, 2013). Both newspapers have regular column space dedicated to STI alongside current coverage of STI news.

| Number of Articles Published by Malay-based Newspaper | Number of Articles Published by English-based Newspaper |
|---|---|
| **46%** SPORTS *(1025 articles)* | **39%** POLITICS *(1208 articles)* |
| **36%** POLITICS *(816 articles)* | **34%** SPORTS *(1059 articles)* |
| **18%** SCIENCE *(393 articles)* | **27%** SCIENCE *(849 articles)* |

**Figure 5.6**
**Comparison of News Reported in English- and Malay- based newspapers from January 2015 to December 2016**

Data Source: Meltwater, 2016

| Circulation of print edition: | Circulation of digital replica: |
|---|---|
| **English daily** | **English daily** |
| 2015: 1,041,618 copies | 2015: 396,427 copies |
| 2016: 932,821 copies | 2016: 446,096 copies |
| **Malay daily** | **Malay daily** |
| 2015: 994,601 copies | 2015: 13,283 copies |
| 2016: 864,470 copies | 2016: 159,496 copies |

### STI Content in Social Media

Malaysian population has a massive digital footprint (refer fact sheet). For analyses of STI content in social media, YouTube was chosen as the social network hosting STI content viewed by Malaysians. It has return viewers and dedicated subscribers, and its data can be analysed using socialblade.com, a real-time YouTube-certified database. During the period of analysis, out of the 16 categories listed by interest according to socialblade.com, Science & Technology was ranked 12th (Table 5.2).

The most popular channels among Malaysians were Entertainment and Comedy channels, similar to the global trend; the top 3 categories with most subscriptions were Comedy, Film and Entertainment respectively.

S&T channels were not among the Top 20 subscribed channels by Malaysians. However, it was found that Science was ranked 93rd (Samsung Malaysia; 93,000 subscribers) out of the top 100 Malaysian channels with the most subscription (Table 5.3). This indicates that Malaysia's have high interest in technology based content. Therefore, STI content in social media should be more focused on the latest technology trends to garner more viewership.

It is clear that digital media is the medium of choice for dissemination of popular culture and entertainment.

Flexible, interactive and immersive technologies (e.g. augmented reality, virtual reality) will become mainstream and can only benefit STI enculturation. Content providers must be prepared to utilise the various platforms in order to maximise their outreach and not miss the bandwagon. Furthermore, it is important to research both STI content in social media and the perceptions of social media users in order to determine the level of public's understanding towards STI.

Most of STI content available online is in English; those who are not fluent in it are unlikely to surf such content. Less than 50% of the students who had completed six years of primary education are literate in English (Abdullah, Chan & Mazlan, 2013). This lack of foundational literacy hinders STI enculturation because the individual's ability to understand and use new scientific information is hampered. Efforts to upgrade teaching of English by MOE are on-going but this will not benefit those who are no longer in school (MOE, 2013).

One of the Internet's drawbacks is that veracity of published material is left to the discretion of the provider. Anyone with a computer and Internet connection can create content and upload it with no regard to truth and ethical conduct. A strong scientific culture will be a counterweight to the challenge of integrating and interpreting information in this environment (Falk et al., 2016).

Many governments have set up benchmarking of science in the media to facilitate accurate science reporting (e.g. Australian Science Media Centre and Science Media Centre UK). These media centres assist journalists in writing accurate science content on current STI issues, linking media with relevant scientific experts for consultation, as well as running communication training workshop for scientists. Malaysia should consider setting up a science media centre that offer similar services with a vital role in standardising STI terms in Bahasa Melayu and offering expert resources for content providers across the media.

**Fact sheet on Malaysians internet users**

- **77.6%** - Malaysia's internet penetration
- **44 million** - mobile phone subscriptions
- Mobile broadband - means of Internet access for majority of Malaysians
- **2.8 hours a day** - spend on average on social networks
- **Over 7 hours** weekly spent on watching videos on the Internet, streaming and downloading video content
- **86.9%** - use social media as their primary information source

Source: MCMC, 2016,
Malaysian Digital Association, 2016

# Box 5-6

## Facilitating public information sharing in the sciences

The Inspiring Australia report which was commissioned by the Australian Government recommends that "mechanisms to facilitate public information flow and information sharing in the sciences, utilising the knowledge and resources of existing organisations and networks" should be created by the Australian government and that "programs that increase the potential of media and new media coverage of the sciences need to be supported and encouraged". The proposed Science Media Centre should incorporate the takeaways from the "Inspiring Australia" report and network content creators with scientific advisors (e.g. scientists, policy makers) to increase high value content for entertainment and education purposes.

**Table 5.2**

**Top 20 YouTube Channels Worldwide by Category**

Source: SocialBlade, Assessed on 30 June 2017

| Category | USER | SUBSCRIBERS | Rank |
|---|---|---|---|
| Comedy | PewDiePie | 55,945,657 | 1 |
| Film | YouTube Movies | 49,845,397 | 2 |
| Entertainment | HolaSoyGerman | 31,944,303 | 3 |
| Music | JustinBieberVEVO | 29,969,987 | 4 |
| News & Politics | YouTube Spotlight | 25,601,707 | 5 |
| Gaming | elrubiusOMG | 24,786,386 | 6 |
| Sports | Dude Perfect | 19,963,566 | 7 |
| How To & Style | Yuya | 18,568,075 | 8 |
| Shows | SET India | 12,869,977 | 9 |
| People & Blogs | RomanAtwoodVlogs | 12,777,556 | 10 |
| Education | LittleBabyBum ® | 11,275,473 | 11 |
| Science & Technology | CrazyRussianHacker* | 9,913,280 | 12 |
| Nonprofit & Activism | TEDx Talks | 7,885,255 | 13 |
| Pets & Animals | Brave Wilderness | 6,878,399 | 14 |
| Auto & Vehicles | Top Gear | 5,366,683 | 15 |
| Travel | Felix von der Laden | 3,070,130 | 16 |

**As of March 2018, CrazyRussianHacker has reached 10,477,400 subscribers.*

**Table 5.3**

**Top 100 YouTube Channels Subscribed in Malaysia**

Source: Youtube, Assessed on 30 June 2017

| RANK | USER | SUBSCRIBERS | Category (Analysts' view) |
|---|---|---|---|
| 1 | Les' Copaque Production | 1,515,159 | Entertainment |
| 2 | CartoonHooligans | 1,418,976 | Entertainment/Comedy |
| 3 | Monsta | 1,167,028 | Entertainment |
| 4 | Astro Gempak | 1,153,784 | Entertainment |
| 5 | Namewee | 991,357 | Entertainment |
| 6 | Joanna Soh Official | 903,978 | People & Blogs |
| 7 | Laowu | 823,059 | Gaming |
| 8 | JinnyboyTV | 757,814 | Entertainment |
| 9 | Ling BigYong | 748,844 | Entertainment/Comedy |
| 10 | maxman.tv | 581,017 | Entertainment |
| ... | ... | ... | ... |
| 93 | SamsungMalaysia | 93,000 | Science & Tech |

## 5.6 STI LITERACY IN MALAYSIA

Classic literacy is defined as the ability to read and write. Defining literacy in science is a lot more complex because science is an amorphous body of knowledge with specific processes to gain and apply said knowledge. The National Academies of Sciences, Engineering and Medicine suggest that science literacy is the application of foundational literacy skills to a particular area (Snow and Dibner, 2016).

Scientific literacy, i.e. familiarity with the principles and practice of science is a vital base for engaging in science; whether to construct new knowledge or use the information at hand to achieve a desired outcome. Commonly, scientific literacy is measured at individual levels though efforts have been expanded to devise criteria for assessing a population's scientific literacy in a collective manner. A science literate community have traits that can go beyond the average knowledge or accomplishments of individuals in that society. Instilling scientific literacy among the population is a major focus for any country concerned with maintaining their competitive edge in a world of disruptive technologies.

STI literacy is evaluated through the three different parameters; i.e. knowing, understanding, and applying scientific knowledge as outlined in Figure 5.7. These elements of literacy are cultivated through an individual's lifetime and will change according to exposure, interest, and efforts to keep up to date with STI development.

STI literacy is necessary for work and civic demands of the 21st century. It is a compass for making informed decisions in a world saturated with information, not all of them trustworthy. Most of the economic activities rely on high tech applications, requiring familiarity with scientific information and data analysis. Malaysia's move into high income economy needs a population with STI literacy readiness to adapt to the new economic model.

When benchmarked against international education yardsticks, such as the Programme for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMMS), science and mathematics literacy among 14-and 15-year olds in Malaysia are found to be below international average (MOE, 2016a; MOE, 2016b). This is reflected in the outcome of an unpublished pilot survey by Petrosains using Nature of Science Literacy Test (NOSLiT) to measure science literacy of the secondary school students who visit the science centre. NOSLit was developed by the Department of Physics of Illinois State University to assess scientific literacy in high school students to determine the success of their science education. Only 49% of the respondents got the answers right, similar to the observation in a study conducted in Indonesia (Aryanti et al., 2016). Based on these cohorts it is indicated that both Malaysian and Indonesian students barely reached the minimum standard for scientific literacy.

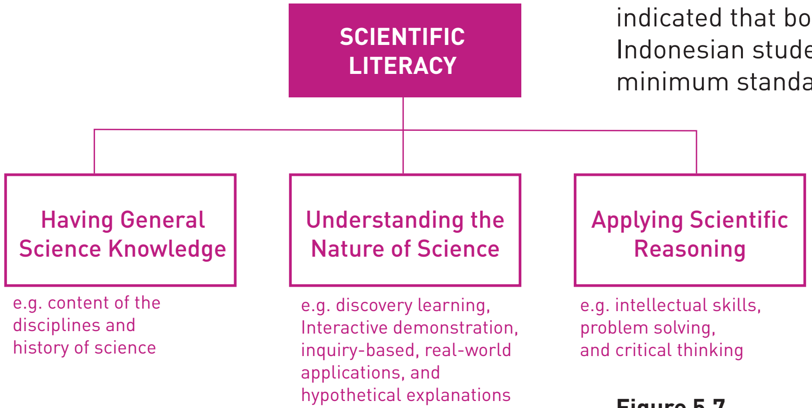



**Figure 5.7**
**Evaluating STI Literacy**

Source: National Research Council (US), 1996

An unpublished pilot survey of scientific literacy was conducted among young urban adults who volunteer at Petrosains using the Test of Scientific Literacy Skills (ToSLS) to measure how they evaluate scientific information and arguments. The subjects were largely from Klang Valley who have passed Sijil Pelajaran Malaysia, and have/yet to have completed their undergraduate degrees. The finding was disappointing; only 47% of the respondents reached the minimum requirement. Although the sample number is very small, the observation indicates that upper secondary and tertiary education in Malaysia has yet to succeed in producing young adults with adequate science literacy.

Measures of science literacy in adult populations often focus on a very narrow set of content and procedural knowledge questions asked within the constraints of large population surveys. Though available measures are limited in scope, they are reasonable indicators of one aspect of STI literacy; i.e. science knowledge. Studies using these measures observe a small, positive relationship between STI literacy and attitudes toward and support for science in general.

MASTIC's periodic surveys of STI literacy in Malaysia depicts an overview of where Malaysia is as an established scientifically literate population. Generally speaking, the Malaysian public's average STI knowledge is less than 50% (1998-2014) and this result tallies with the respondent's education level. It is interesting to note that there is little difference in STI literacy between the urban and rural population in Malaysia. Unfortunately, STI knowledge is still below average across the board (i.e. age, socio-economic background), which is worrisome. When benchmarked against other countries, Malaysians perform worse than USA, EU, Japan and South Korean respondents, but better than China and on par with India (Europeans Commission, 2005; Council of Canadian Academies, 2014).

The MASTIC study (2014) also discovered that at least 20% of the respondents believe some pseudoscience to have scientific value, and roughly 15% believe that it is sort of scientific. This shows that a significant number of Malaysians have yet to develop the needed critical thinking skills to evaluate scientific merits.

Standard literacy is also key to STI literacy; spoken and written language is the medium through which scientific discoveries are disseminated. Effective STI enculturation require STI communication in a commonly understood language using familiar words (Yore, Bisantz & Hand, 2010). Fortunately, basic literacy among secondary school students in Malaysia is very high at 95.2%, with critical literacy at 71.2% when assessed using International Adult Literacy Survey (Abdullah, Chan, and Mazlan, 2013). The students also demonstrated greater Malay language literacy than English and Mathematics (Abdullah, Chan & Mazlan, 2013; Chew, 2012). This underlines the importance of more STI content be made available in Bahasa Melayu for all media platforms for effective STI enculturation in Malaysia.

Research has shown that individuals with fewer economic resources and less access to high-quality education have fewer opportunities to develop science literacy (Snow and Dibner, 2016). Science literacy is also linked to health literacy, which isimportant to help individuals make the best choices to promote and maintain their health (Snow and Dibner, 2016). It is clear that STI literacy among the Malaysian population needs to be strengthened by all the relevant stakeholders at every level.

## 5.7 INTEREST IN AND ATTITUDE TOWARDS SCIENCE

In general, Malaysians are keen on STI, but have little knowledge or appreciation for the nuts and bolts of STI issues that may affect their lives (MASTIC, 2014). Public attitude towards STI were more positive in 2014 compared to 2008; more than half (52.9%) of all respondents (2,653 respondents in total) agreed that science bring more benefit than harm. Youth and children score the highest on STI interest, which is very heartening considering how important science literacy is to this segment of the population. Malaysians' attitude towards STI is comparable to findings in Europe and North America (see Figure 5.8). Malaysians have positive attitude towards science and show interest in STI in general. It is interesting to note that level of STI interest is correlated to educational level. However, when compared to developed nations in the European Union and North America, STI interest in Malaysia is still low (MASTIC, 2014).

| | U.S. (2004 or 2010) | EU (2010) | Japan (2001) | South Korea (2008) | Russia (2003) | China (2001 or 2007) | India (2004) | Canada (2013) | Malaysia (2014) |
|---|---|---|---|---|---|---|---|---|---|
| | Total Agree (%) | | | | | | | | |
| Science and technology are making our lives healthier, easier and more comfortable | 90 | 66 | 73 | 93 | NA | 86 | 77 | 72 | 91.8 |
| With the application of science and new technology, work will become more interesting | 76 | 61 | 54 | 85 | NA | 70 | 61 | 67 | NA |
| Because of science and technology, there will be more opportunities for the next generation | 91 | 75 | 66 | 84 | NA | 82 | 54 | 74 | 94.5 |
| We depend too much on science and not enough on faith | 55 | 38 | NA | 54 | NA | 16 | NA | 25 | 41.8 |
| It is not important for me to know about science in my daily life | 14 | 33 | 25 | 30 | 31 | 17 | NA | 17 | NA |
| Science makes our way of life change too fast | 51 | 58 | 62 | 73 | 30 | 73 | 75 | 35 | 80.8 |

**Figure 5.8**
**Public Attitudes toward STI in EU, North America, China, South Korea, Russia and China**

Source: Council of Canadian Academies, 2014; MASTIC, 2014



# Box 5-7

## Fostering Citizen Science Engagement

Science education outreach researchers contend that most scientific knowledge is obtained through informal free learning; after all, most individuals spend less than five per cent of their lifetime inside the classroom. Informal free learning are often best through entertainment and the availability of STI enculturation spaces are vital to support it.

Visits to science centres, national parks, aquariums and zoos provide entertaining learning opportunities for children, as well as incite curiosity and interest in science from mere passive knowledge acquisition. Adults who visit science centres are more likely to enjoy life-long STI learning. Community learning resources through social activities (e.g. volunteering for a recycling programme) help maintain STI appreciation in day-to-day lives and integrate STI in civic engagement programmes.

STI-based online resources, educational television and radio programmes, magazines, books, etc can stimulate and sustain interest in free choice learning and developing self-identity towards science, as long as they are presented in an attractive and engaging manner. Programmes like MythBusters that have strong aspects of scientific exploration using laymen terms and perspective, are also powerful tools in encouraging the general public to enjoy and appreciate science.

Stimulating and Sustaining Interest in Science for Life (adapted from Falk & Dierking, 2010; Falk et.al., 2016)

# Box 5-8

## STI Enculturation Index

STI culture evaluates knowledge of facts and attitudes toward science and technology in individuals, even though culture is a communal expression. Individuals are not the only literate members of a society; societies as a whole are more or less scientifically or technologically literate. This social dimension of STI culture is not captured by the existing indicators, so there is a need to improve the benchmarking of STI enculturation.

Commonly, STI enculturation are measured from two dimensions: the science indicators and the subjective indicators. Science indicators provide the objective measure of science activities (science and technology performance, STP) such as gross expenditure on research and development (GERD), number of human resource in scientific fields, sum of patents filed and registered, and publication.

Subjective indicators evaluate the community's attitude towards science (public understanding of science, PUS); such as scientific literacy assessment as well as level of interest, attitude, and opinion on science. These qualitative parameters have been shown to indicate the momentum of the science culture in a particular locality.

Combining the objective and subjective indicators into a single model of science culture index can provide an effective method of benchmarking STI enculturation. An index of Malaysia's scientific culture is an important indicator of the country's efforts in sustaining a scientifically cultured society beyond the performance of discrete individuals. Figure 5.8 shows one of the conceptual framework of the STI enculturation index calculation.

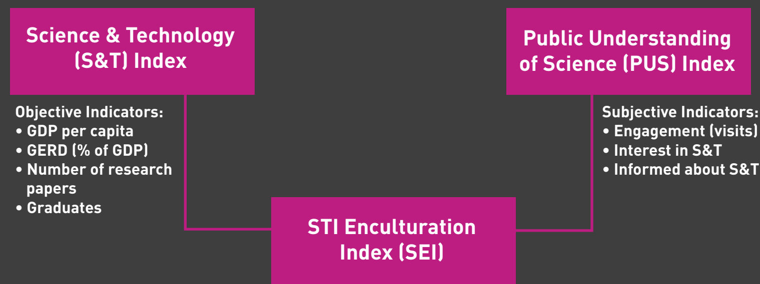



Figure 5.8
**Conceptual Framework of the STI enculturation Index (SEI)**
**Source: Bauer & Suerdem, 2016**

Individual scores from all the indicators can be used to benchmark Malaysia's position against other countries and can be a parameter to monitor our progress in terms of science and technology development. At present, no country has formally adopted a STI enculturation index yet. If Malaysia established the STI enculturation index to benchmark performance of STI policies, the nation may be a trendsetter in STI policies monitoring.

## WAY FORWARD IN ENCULCATING AND POPULARISING STI

Malaysia has an amazing variety of STI enculturation resources accessible all over the country. Nonetheless, the snapshot provided in this report illustrated the need to maintain these resources as well as to connect the various focus points to enhance their roles in nurturing the science culture in Malaysia.

1

### Encourage Public-Private Partnerships to Update and Upgrade STI Enculturation Spaces

The number and variety of STI places in Malaysia is impressive considering the size of the population. Management of these venues should carry out periodic reviews and customer satisfaction surveys to enhance customer experience.

Public-Private partnerships should be encouraged for updating and upgrading these sites to attract more visitors. Creative approaches in maintaining online presence (e.g. virtual tours, seasonal online exhibits, effective social media engagement), collaboration between STI places to share knowledge on best practices in designing and packaging attractive and entertaining exhibits, programmes and activities (i.e. science centres and museums) and setting up mobile exhibits for STI enculturation beyond their physical spaces should also be explored.

STI places should also leverage on local scientists, scientific associations and social innovators such as the "Duta Sains". Duta Sains a programme coordinated by ASM, is designed to improve science literacy and awareness among communities, create a knowledgeable community that is equipped with skills and knowledge to create solutions of local problem. At present, there is a total of 68 Duta Sains in Malaysia (as of January 2018) throughout the states of Melaka, Terengganu, Kedah and Sabah. These Duta Sains can contribute to STI places as content providers giving input on STI.

2

### Virtual Science Media Centre to Strengthen STI Content in Various Media Platforms

A virtual Science Media Centre for STI content resource can improve the quality of STI content across platforms in Malaysia by connecting members of the media (i.e. journalist, entertainment producers, etc.) with relevant members of the STI community (i.e. subject matter experts). This centre will focus on communicating science in laymen Bahasa Melayu and English, encouraging translation and creation of STI content. It will also provide training in effective science journalism and communication, as well as set up a promotional portal to park links to public and private STI enculturation. Some initiatives to bridge the gap includes a Science Journalism Workshop: Changing the Climate Between Scientists and Journalists by ASM and the ScienceJMY communications platform to connect scientists, researchers, communicators and science journalists in Malaysia launched in 2017 by the Institute for Environmental Analytics (IEA). STI enculturation will gain more traction if is presented as fun and entertaining; partnership with media providers as well as content creators is one way to encourage greater STI content creation.

The virtual Science Media Centre should also encourage efforts such as the Universiti Teknologi Malaysia-Kumpulan Utusan annual science and technology fiction competition, and publishers that focus on local science fiction content such as Fixi, Simptomatik Press and Penerbit X together with Perbadanan Kota Buku to strengthen STI creative content production in the country.

3

**Prioritise Development of STI-based Creative Content**

Media analysis showed that the number and the viewership of STI-based contents are low in Malaysia. The analysis also shows that entertainment-based programmes are preferred choice among Malaysians.

The quality and the format of how STI is communicated needs to change to attract viewership/readership. STI-based content needs to be more entertainment-based and collaboration between STI-based content creators with popular entertainment brands (i.e. popular animation creators such as Upin dan IpinTM) can upgrade STI content from the usual dull and dry style to become more vibrant and catchy.

Therefore, prioritisation of development and funding of STI-based content in order to encourage content creators to delve into STI-based creative content is needed. Platforms such as the Content Malaysia Pitching Centre under the National Film Development Corporation Malaysia (FINAS) should prioritise the funding of creative STI-based creative content for entertainment and commercial appeal.

# FURTHER READING

### Evolution of Science Centres and Museums (adapted from Friedman, 2010)

Science has always elicited curiosity for many. European universities began collecting natural history specimens for display and study since the Renaissance era. Formal science museums began to flourish in early 18th century and have since evolved into various types to suit the needs and demands of the time.

The first generation of science and technology museums were created to meet the needs of both academia and industry by displaying the latest technological innovation of the day. They served as research and training centres to familiarise factory workers with the technologies available at that time and were not open to the general public. The Conservatoire National des Arts et Métiers, in Paris, which opened in 1794, was an example of first generation STI museums that centred around training research.

Second generation science and technology museums emerged in early 20$^{th}$ century to engage the public on the latest technologies of the time and to advertise the companies involved in the associated industries. The audience of these museums were no longer limited to scholars and industry personnel. These museums also carry out preservation and collection of old technologies, showcasing them in their exhibits on the history of these industries. Museums during this period were funded by government, industry and private individuals. The Museum of Science and Industry of Chicago is an example of such museums which allowed members of industries to design, build, instal, and maintain some exhibitions - complete with brand-name product promotion.

Third generation science and technology museums appear around the third quarter of the 20th century, which only focused on public education and providing hands-on experience to the exhibits showcased. They started to omit the word 'museum' from their names as a way to distinguish their mode of engagement with the public.

Exhibits of these museums are also different from previous generation of museums in that the exhibits are of pure phenomena and not products of any industry. An example of such museum is The Exploratorium in San Francisco, founded in 1969.

### Calculating the STI Enculturation Index (Bauer & Suerdem, 2016)

The index consists of two types of indicators taking into consideration the objective and subjective indicators. In other words, the index is a function of STP (science technology performance) and PUS (public understanding of science); *SEI = f(STP, PUS)*. Two types of model have been suggested (Rajesh Shukla, Bauer), one with a multiplicative form and the other one with additive form.

The additive form takes the mathematical model as shown in equation 1.

*Science Enculturation Index, SEI =*
*STP + PUS = w1(STP) + w2(PUS) + error (1)*

This model defines the enculturation index as an additive function of objective and subjective indicators. It is a weighted summation model with error parameters. Based on this model, in extreme cases when the public understanding is non-existence (PUS = 0), science culture will be fully defined by the objective indicators (STP). In this model, the subjective measures are defined as additional but not necessary contribution to scientific culture.

The multiplicative form on the other hand takes the model shown in equation 2.

*Science Enculturation Index, SEI =*
*STP x PUS = w1(STP) x w2(PUS) + error (2)*

This model defines the index as a product function of the objective and subjective indicators. In this model, if PUS = 0 (no public understanding of science), the science culture would also have no existence. It defines a stronger model where the subjective indicators are necessary component for the science culture.

# APPENDICES

**Appendix 5.1**

## Number of registered environmental NGOs (ENGOs)

Source: Registry of Society Malaysia, 2017

Johor : **18**
Kedah : **4**
Melaka : **3**
N. Sembilan : **6**
Pahang : **7**
P. Pinang : **13**
Perlis : **0**
Perak : **21**
Selangor : **53**
Terengganu : **3**
Sabah : **15**
Sarawak : **13**
W.P. Kuala Lumpur : **28**

**Appendix 5.2**

## ENGO - STI Enculturation Activities by Persatuan Khazanah Ma' Daerah Kerteh dan Kemaman, Terengganu in 2015 & 2016

**Terengganu**
Persatuan Khazanah Rakyat Ma' Daerah Kerteh, Kemaman, Terengganu (MEKAR)

**Conservation and Awareness**
The Ma' Dearah Turtle Sanctuary Centre is a hatchery and interpretation centre dedicated to the protection and conservation of sea turtles in their natural habitat.

Estimation people impacted:
~2,000 ppl (2015) ~1,000 ppl (2016)

**Activities (2016)**
1. SK Kemasik menjadikan penyu sebagai Ikon sekolah tersebut.
2. Bengkel rancangan penurusan pusat eco-vale - penglibatan msayarakat dalam menguruskan kawasan hutan and sumber marin
3. Jom Kenali Penyu
4. Terengganu Turtle Camp yang dianjurkan oleh Pusat Sains dan Kreatif Negeri Terengganu dgn Kerjasama WWF Malaysia dan Persatuan Khazanah Rakyat Ma'Daerah(MEKAR) di Pusat Santuari Santuari Penyu Ma'Daerah.
5. Seminar dan Bengkel Pemuliharaan Penyu Malaysia.
6. Taklimat mengenai penyu dan kempen kesedaran dan pemuliharaan, di SK Rantau Petronas

**Activities (2016)**
1. Aktiviti "Penyu Berenang Ke Sekolah" ,di SJKC Chee Mong, dan SK Kemasik
2. Lawatan pelajar Uitm Puncak Alam, Fakulti Seni Bina, Ukur dan Pemetaan ke Rumah Penyu, MEKAR untuk mengetahui tentang kegiatan MEKAR.
3. Roadshow Hari Penyu Sedunia [Chukai, Kerteh Padang Hiliran]
4. Program Ramah Mesra Dengan Nelayan.

**Appendix 5.3**
## Number of visitors to Pusat Sains Kuala Lumpur (PSNKL) & Pusat Sains Cawangan Utara (PSNCWU) from 2013-2016

Source: PSN,2017

| Year | PSNKL | PSNCWU | Total |
|---|---|---|---|
| 2013 | 627,973 | 114,751 | 742,724 |
| 2014 | 563,413 | 127,441 | 690,854 |
| 2015 | 138,952 | 181,020 | 319,972 |
| 2016 | 102,290 | 179,776 | 282,066 |

** The National Science Centre KL (PSNKL) was closed to public in the beginning of Q2, 2015 and the whole of 2016; data for 2015 & 2016 show visitors from the outreach programmes only.*

**Appendix 5.4**
## Exhibits at PSN

Source: PSN,2017

### Gallery/Exhibition

**A) No. of galleries before closure of PSN**

1. Eureka
2. Flights
3. Kids Discovery Place
4. Kidz World
5. Little Explorer
6. Pathway to Science
7. Wonderspark
8. Freshwater Fish Aquarium

**B) Addition of 2 new galleries after PSN reopens**

9. Radiasi
10. Survive the Bunker

**Appendix 5.5**
## Exhibits at PETROSAINS

Source: PETROSAINS, 2017

### Gallery

**A) Petrosains**

1. SPACE
2. Geotime Diorama
3. SPARKZ
4. Oil Platform
5. SPEED
6. Refinery Area
7. Molecule
8. Future Energy
9. Maker Studio
10. Digi Cybersafe

**B) Travelling Exhibition**

1. PETROSAINS DinoTrek 2
2. PETRONAS StreetSmart

**C) PlaySmart**

1. Johor Bahru
2. Kota Kinabalu
3. Kuantan
4. Kuching (coming soon)

**Appendix 5.6**
## Number of visitors to PETROSAINS from 2013-2016

Source: PETROSAINS, 2017

| Year | PETROSAINS @KLCC | PETROSAINS OUTREACH EVENTS | PETROSAINS PlaySmart (Satellite Centres) | TRAVELLING EXHIBITIONS | TOTAL |
|---|---|---|---|---|---|
| 2013 | 484,241 | 30,416 | 239,953 | 220,823 | 975,433 |
| 2014 | 638,351 | 80,774 | 199,461 | 164,584 | 1,083,170 |
| 2015 | 646,195 | 72,233 | 295,682 | 81,341 | 1,095,451 |
| 2016 | 1,320,507 | 27,045 | 368,372 | 184,445 | 1,900,369 |

**Appendix 5.7**

## Number of Visitors to Museums from 2015-2016

Source: Jabatan Muzium Malaysia, 2017

| No. | Museums | Malaysian (excluding students) | Malaysian Students | Foreign Visitors | Visitors to Inreach Outreach Programmes | Total |
|---|---|---|---|---|---|---|
| 1 | Muzium Negara | 442,211 | 115,717 | 303,828 | 544,393 | 1,406,149 |
| 2 | Muzium Perak | 168,555 | 261,946 | 4,839 | 31,051 | 466,391 |
| 3 | Muzium Tekstil Negara | 26,254 | 12,882 | 74,872 | 20,653 | 134,661 |
| 4 | Muzium Arkeologi Lembah Bujang | 331,658 | 21,543 | 2,975 | 700 | 356,876 |
| 5 | Muzium Kota Kayang | 72,229 | 29,479 | 2,545 | 20,532 | 124,785 |
| 6 | Muzium Labuan | 98,244 | 17,542 | 4,114 | 10,640 | 130,540 |
| 7 | Muzium Marin Labuan | 240,747 | 13,882 | 7,739 | 13,832 | 276,200 |
| 8 | Muzium Adat | 110,619 | 23,192 | 1,769 | 15,957 | 151,537 |
| 9 | Galeria Perdana | 121,105 | 20,731 | 49,568 | - | 191,404 |
| 10 | Muzium Sungai Lembing | 124,169 | 20,078 | 5,009 | 2,283 | 151,539 |
| 11 | Muzium Seni Bina Malaysia | 78,986 | 11,079 | 20,118 | 17,686 | 127,869 |
| 12 | Muzium Automobil Nasional | 113,104 | 9,085 | 77,002 | 605 | 199,796 |
| 13 | Muzium Etnologi Dunia Melayu | 64,818 | 16,093 | 120,779 | 2,050 | 203,740 |
| 14 | Muzium Lukut | 46,196 | 14,727 | 736 | 16,562 | 78,221 |
| 15 | Muzium Seni Kraf Orang Asli | 143,669 | 26,288 | 141,120 | - | 311,077 |
| 16 | Muzium Matang | 79,951 | 24,944 | 1,397 | 9,115 | 115,407 |
| 17 | Muzium Chimney | 78,332 | 7,602 | 7,245 | 14,836 | 108,015 |
| 18 | Muzium Kota Kuala Kedah | 501,775 | 21,037 | 590 | 4,900 | 528,302 |
| 19 | Muzium Kota Johor Lama | 40,975 | 14,841 | 1,994 | 7,774 | 65,584 |
| 20 | Muzium Alam Semulajadi | 47,721 | 23,165 | 18 | 37,669 | 108,573 |
| 21 | Muzium DiRaja | 113,341 | 34,451 | 121,503 | - | 269,295 |
| 22 | Muzium Muzik | 18,067 | 5,870 | 59,943 | - | 83,880 |
| **Grand Total** | | | | **5,589,841** | | |

**Appendix 5.8**

## List of Zoo and Permanent Exhibit under Jabatan PERHILITAN

Source: PERHILITAN, 2017

### Kedah
*Zoo:* Langkawi Bird Paradise & Wildlife Park
*Permanent Exhibit:*
Underwater World Langkawi
Taman Buaya Langkawi
Langkawi Elephant Adventures

### Penang
*Zoo:* Penang Bird Park
*Permanent Exhibit:*
Bellevue Aviary Garden Feat. Birds & Plants
Penang Butterfly Farm (ENTOPIA)

### Perak
*Zoo:* Zoo Taiping & Night Safari
Lost World of Tambun
*Permanent Exhibit:*
Bukit Merah Ecopark & Orang Utan Island Foundation

### Selangor
*Zoo:* Zoo Negara
Sunway Wildlife Interactive Zoo
*Permanent Exhibit:*
Farm in the City

### WP Kuala Lumpur
*Zoo:* KL Bird Park
*Permanent Exhibit:*
KL Tower Mini Zoo
Aquaria KLCC

### WP Labuan
*Zoo:* Taman Burung Labuan

### Negeri Sembilan
*Zoo:* -
*Permanent Exhibit:*
Taman Ular Ulu Bendul

### Melaka
*Zoo:* A'famosa Safari Wonderland
Zoo Melaka
*Permanent Exhibit:*
Taman Buaya & Rekreasi Melaka
Taman Burung Melaka
Taman Rama-rama & Reptilia Melaka

### Johor
*Zoo:* Zoo Negeri Johor

### Pahang
*Zoo:* Bukit Gambang Safari Park
*Permanent Exhibit:*
Deerland Park
Taman Haiwan Lipis
Mini Zoo Taman Teruntum

### Terengganu
*Zoo:* Zoo Kemaman
*Permanent Exhibit:*
Kenyir Elephant Conservation Village (KECV)

### Perlis
*Permanent Exhibit:*
Taman Ular & Reptilia Perlis

**Appendix 5.9**

## List of STI-based Documentaries/ Magazines in Local Television Channels

Source: Compilation by ASM, 2017

Health Liv.On 2 –Diagnostik
Bumi Kita
Magika Flora
Agro Jurnal
Health Liv.On 2 -Juara Minda
Kekal Sihat
Dari Fail Doktor
Lambaian Pulau
Health Liv.On 2 -Jom Sihat Bro
Agrotek
Health Liv.On 2 -Celik Sihat
Anugerah Alam
Simfoni Alam
Worldwatch -Australia With S.R
Health Liv.On 2 -Cinta Diri
World Watch -Operation Snow T.
Act Fast Xplorasi
Bumi Kita
Simfoni Alam
Diari Sihat
Worldwatch -Man Made Marvels A
Destinasi Borneo Inomedik
Organic Gardening
Health Liv.On 2 -Healthy B.H.M
Terumbu Karang & Pemanasan G.
Health Blitz
Kehidupan Paya
MRT Malaysia A Catalyst for Transportation
Ekosistem Di Hujung Nyawa
Chinese Health Regiment (Eng)
Health Liv.On 2 -Gyms In Sch.
Digitek

Appendix 5.10

## List of Topics Presented at Science Café, KL

Source: Compilation by ASM, 2017

**Dr Amani Salim**
Assistant Professor at International Islamic University Malaysia (IIUM)
13 March 2016
*Multidisciplinary and interdisciplinary approaches in the development of advanced sensor technologies and the applications of these technologies in answering important questions in agriculture, biology, environmental science, medicine and space biology.*

**Fabien Bouhier**
13 April 2016
*Down a quantum hole*

**Dr Aaron Shunk**
12 May 2016
*What can tree rings and sediment layers tell us about climate change? Dr Aaron Shunk presents data from his previous research and tries to contextualise these findings to the current climate change debate!*

**Huan Ung (Biovalence)**
17 May 2016
*In this light hearted talk he will introduce how recreational SCUBA divers can help scientists working on the forefront of drug discovery.*

**Professor Ishwar Parhar**
13 July 2016
*Gender Differences and Brain Ageing*

**Dr Soo-Hwang Teo (CARIF)**
13 April 2016
*Unravelling The Human Genome and Cancer Genome: Is it relevant to me?*

**Dr Steve Janssec**
10 Aug 2016
*Why does life appear to speed up as people get older?*

**Dr Azlina Ahmad Annuar**
1 Sept 2016
*Your Mutant DNA and You*

**Dr Ahimsa Campos-Arceiz**
12 Oct 2016
*The Fascination with Elephants*
*The importance of elephant and megafauna conservation in Malaysia*

**Dr Ong Boon Hoong**
Deputy Director and an Associate Professor at the Nanotechnology and Catalysis Research Centre (NANOCAT) , University of Malaya (UM)
9 Nov 2016
*A Tiny World Called NANO: Past, Present and Future*

**Dr Lai Ching Chai**
14 Dec 2016
*There are Microbes in My Food!*

# 06
# Strategic International Alliance

## 1 TRANSLATING SCIENCE DIPLOMACY INTO ACTION

**Malaysia's STI-related treaties**

**19.4%** (187 out of 964)
**BILATERAL**

**54.2%** (58 out of 107)
**MULTILATERAL**

MOFA, 2017

- Agreements need to translate to benefits related to STI development for Malaysia
- Attract strategic partners
- Effective positioning of Malaysia's STI competencies & capability

## 2 MALAYSIA'S MEMBERSHIP IN STI-RELATED ORGANISATIONS*

- Asia-Pacific Economic Cooperation
- The United Nations Educational, Scientific and Cultural Organization
- Organisation of Islamic Cooperation
- The United Nations
- Association of South-East Asian Nations
- Non-Alligned Movement

*list is non-exhaustive*

## 3 IMPACT ON NATION'S STI CAPACITY

### FUNDING

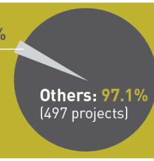
Access to **£735** million in research grants through the Newton Ungku Omar Fund

**Secured £12.2** million as of April 2017

Newton Fund

British Council, 2017

**Member countries STI-related projects funded from APEC 2006-2016**




### KNOWLEDGE TRANSFER

MALAYSIAN TECHNICAL COOPERATION PROGRAMME

**Benefitted** more than **32,000** participants from **143** countries **since 1980**

JICA

Project fpr Development of Low Carbon Society Scenarios for Asian Region

- **135** joint publications
- **100** workshops, seminars and symposiums were held

### EXPERT ENGAGEMENT

Involvement and recognition of Malaysian researchers for the year 2016 in international organisations

**785** members

**152** in leadership positions

## Strategic STI Engagement For Malaysia

Science knows no borders: scientific methodologies are widespread; scientific resources, personnel, and research funding are distributed across the globe. Data, minds, or equipment are no longer limited to geographical locations in advancing scientific knowledge and to find solutions to global challenges. STI advances are also changing the way personal and business concerns are conducted.

Fourth Industrial Revolution is further flattening the global value chain; demanding us to adapt to the rapidly evolving technology driving the industry, and develop home-grown innovations. Thus, STI is a crucial propeller of the country's international competitiveness and sustainable economic development through innovation-driven growth.

Malaysia's strategic STI engagement is centred on building the country's technological capacity and talent. Partners range from United Nations agencies, to governmental agencies such as Japan International Cooperation Agency (JICA), and multinational companies such as Motorola and Daihatsu, as well as universities, research institutions, and international scientific organisations.

International STI alliance is complex and cross-cutting, requiring all stakeholders to work together on a variety of issues such as governance, national foreign policies, trade and international relations, and many more. It can be leveraged upon to promote Malaysia's interest by raising the country's voice in the international arena, increase exposure to global economic proceedings, and be a participatory mechanism in global STI efforts.

## HINDSIGHT

Science Outlook 2015, Strategic International Alliance Chapter highlighted **two** recommendations.

| 2015 Recommendation | | Development |
|---|---|---|
| STI-focused international alliances such as the following should be increased to gain better benefits:<br>i. Individual Country (Inter-Ministries): Partner with respective ministries from various countries and develop a comprehensive engagement plan.<br>ii. Intra ASEAN – MOSTI to MOSTI equivalent: Define development strategies for Intra-ASEAN collaborations.<br>iii. International (ASEAN-Rest of World): Develop ICT and mobile engagement platforms that will allow the ASEAN scientific community to engage with Malaysian STI stakeholders.<br>iv. Scientists as Torch Bearers: Establish multilateral linkages with global research institutions, technology houses, innovation hubs, STEM talent and experts. | INCREASE STI-FOCUSED INTERNATIONAL ALLIANCE | With an increase in Government to Government (G2G) Umbrella Agreements, an increase is also seen in Institutional Level Agreements. |
| Such a Plan should define the roles of multiple stakeholders such as the Government, scientists, prosumers, businesses, media, parents and youth, and the society at large, in promoting the cause of science for development. | POSITION MALAYSIA'S STI CAPABILITIES TO STRATEGIC PARTNERS | There are various efforts by the government positioning Malaysia's STI capabilities through membership in international organisations as well as participation in international high level meetings (refer Appendix 6.8). However, it is difficult to ascertain the impact of inter-institutional collaboration at national level to fully exploit the benefits from the cross border science connectivity. Malaysia may be missing out on opportunities to advance STI through engagement with the international scientific community. |

## 6.1 SCIENCE AND DIPLOMACY

The advancement in both science and technology in the 21st century is growing at a rapid pace. Developing economies especially, can no longer be spectators of this race. STI-based international cooperation based on STI has become significant features of foreign policies of many countries to promote national interests in a globalised world; supporting internationalisation of STI promotes improvements in education, research and development funding, good governance and transparent regulatory policies, as well as opening competitive markets (NRC, 2012).

Science diplomacy is the use of scientific collaboration among nations to address common problems and to construct international partnerships. It uses science – a common language to investigate essential questions about the nature of things – as a tool for diplomacy, which is part of a government's policy (Turekian et al., 2014). The increased internationalisation of science underlines the critical importance of science and scientists in the global policy arena. Science diplomacy comprises three categories as shown in Table 6.1.

**Table 6.1**
### Definitions of Science Diplomacy

Source: National Research Council (US), 2012

**Science in Diplomacy**
**Informing foreign policy objectives with scientific advice**

- Science is used to inform diplomatic decisions or agreements.
- A science study can set out the relevant evidence to help solve a disagreement between two countries; e.g. New Zealand-Australia apple dispute (WTO, 2010) and in Malaysia to use the right tools to solve the transboundary haze issue

**Diplomacy for Science**
**Facilitating international science cooperation**

- Flagship international projects in which nations come together to collaborate on high-cost, high-risk scientific projects that otherwise could not be conducted (e.g. Malaysia and European Organisation for Nuclear Research (CERN) cooperation).
- Can also refer to policies, such as those governing international travel, that facilitate international science cooperation.

**Science for Diplomacy**
**Using science cooperation to improve international relations between countries**

- Using science as a means to improve strained relations between different countries.
- Science cooperation agreements and joint commissions between the United States and the Soviet Union (USSR) or China during the cold war are examples of the role science and scientists can play in diplomacy.



# Box 6-1

## Science in Diplomacy

**Malaysia and Asean Collaboration on Transboundary Haze Pollution**

Following severe land and forest fires in 1997-1998, ASEAN Member States (AMS) signed the ASEAN Agreement on Transboundary Haze Pollution (AATHP) on 10 June 2002 in Kuala Lumpur. The Agreement entered into force in 2003 and has been ratified by all ASEAN Member States. Under the Agreement, ASEAN Coordinating Centre for Transboundary Haze Pollution Control (ACC) was established for the purposes of facilitating co-operation and co-ordination among the Parties in managing the impact of land and/or forest fires in particular haze pollution arising from such fires. The agreement among others contains measures such as National and joint emergency response and, technical cooperation and scientific research.

In this case of ASEAN Agreement on Transboundary Haze pollution, through various initiatives, science was used as one of the methods for diplomacy efforts between the countries in combatting haze issue.

# Box 6-2

## Diplomacy for Science

### Malaysia's Engagement in Antarctic Science

On 1 December 1959, 12 countries signed the Antarctic Treaty 1959 in Washington. The Articles of the Treaty among others recognises that it is in the interest of all mankind that Antarctica shall continue for ever to be used exclusively for peaceful purposes, for freedom of scientific investigation through international scientific cooperation and shall not become the scene or object of international discord.

Malaysia ratified the Treaty as a non-consultative member and became the first ASEAN member state to accede to the treaty on 12 January 2011. In 2012, the Cabinet agreed to establish the Sultan Mizan Antarctic Research Foundation (YPASM) with a seed allocation of RM10 million, as part of the initiatives taken to redouble efforts and strengthen Malaysia's polar science policy.

The Malaysian Antarctic Research Programme engages their international Antarctic research partners for expeditions, international networking, and capacity building. Malaysia was the first Asian country to host the 34$^{th}$ Scientific Committee on Antarctic Research (SCAR) Biennial Meetings and the Open Science Conference in 2016.

Many countries are actively conducting research of national interest through collaborations while maintaining the sovereignty of the Antarctic as a peaceful hub for science. The Antarctic Treaty 1959 defines the use of diplomacy to pursue scientific endeavours.

# Box 6-3

## Science for Diplomacy

### International Institute for Applied Systems Analysis (IIASA)

The International Institute for Applied Systems Analysis (IIASA) is an international non-governmental research organisation located in Laxenburg, Austria. IIASA conducts interdisciplinary scientific studies on environmental, economic, technological and social issues in the context of human dimensions of global change. IIASA provides insights and guidance to policymakers worldwide by finding solutions to global and universal problems through applied systems analysis in order to improve human and social wellbeing and to protect the environment.

Establishment of IIASA was the culmination of six years' effort driven forward by both the US President Lyndon Johnson and the USSR Premier Alexei Kosygin. For IIASA it was the beginning of a remarkable project to use scientific cooperation to build bridges across the Cold War divide and to confront growing global problems on a truly international scale. The first scientist had arrived at IIASA in June, 1973.

Malaysia officially became a member of IIASA in 2011 through the Academy of Sciences Malaysia (ASM). Since then, collaborations between researchers from Malaysian and other IIASA member states started on projects focused on understanding and improving air quality, sustainable land management, the changing energy landscape, and projecting demographics in Malaysia. Additional and ever expanding opportunities for collaborations include developing bespoke Malaysian version of IIASA global models, conducting international assessments in areas of Malaysian strategic interests, partnering with Malaysian institutions to win international research grants, and contributing to Malaysian science diplomacy.

Formation of IIASA serves as a classic example of Science being the similar denomination in building diplomacy between rivalling nations, i.e. build bridges across the Cold War divide.

Science diplomacy is a major source generator of soft power that harnesses national image, reputation, and brand to enhance one nation's interests or to defuse international tensions. Its direct relationship with national interests differentiates it from other forms of international scientific co-operation, which are sometimes commerce-oriented and often happen without direct governmental participation (Turekian et al., 2014).

Nearly every international policy issue has a science, health, technology, or environmental aspect. More policy makers are looking to STI ventures and cooperation to jump starts their economies, solve myriad local problems, and improve the health and welfare of their people. Although science may be apolitical, STI research and development (R&D) is often politicised as scientific investments may lead to profitable outcomes. The stakeholders now include foundations, universities, research centres, non-governmental organisations, and private-sector companies are extending their STI engagement across geographic borders (NRC, 2015).

Malaysia has been actively practising science diplomacy to further develop capacity and capabilities of its STI through cooperation with more advanced nations (Box articles 6.1, 6.2 and 6.3). Malaysia's own strength in terms of experts spurred effective collaborations further.

Science diplomacy in international alliances can take place through Government-to-Government Umbrella Agreements which then allows more detailed agreements between institutions to be translated i.e. joint research collaborations between IHLs. Besides agreements, Malaysia's membership in international platforms also gives an opportunity for our voices to be heard. Finally, trade also assist technology and knowledge transfer to advance Malaysia's STI capabilities.

## *Science Diplomacy, What The Leaders Say*

**1.**
"Malaysia should emphasise and promote more of science diplomacy as S&T can fuel the development of a nation."

**2.**
"Science diplomacy and cooperation are important tools with which we can promote mutual understanding and improve international relations. Malaysia has a proud record in science diplomacy. At the UN General Assembly in the 1980s, for example, we made a determined call for Antarctica to be declared a "common heritage of mankind" under the jurisdiction of the UN."

**3.**
"This notion of the collaborative economy is also manifested in science diplomacy whereby science cooperation serves as a bridge to improve relations between nations to address common problems and to build constructive international partnerships."

**4.**
"Malaysia has leadership roles in several international organisations in which these organisations act as platforms for science diplomacy. ASM has also organised several international programmes that encourage science diplomacy such as the International Conference on Science for Peace in 2016. ASM launched the Network of ASEAN Science Academies, soon to be established by the end of 2017."

**5.**
"Many of the challenges we face today are international whether it's tackling climate change, or fighting diseases, poverty reduction or tackling food security. Therefore, it is important that we create a new role for science in international policy making and diplomacy to place science at the heart of the programme on the international agenda."

1. Dato' Ku Jaafar Ku Shaari, Former Director General of Institute of Diplomacy and Foreign Relations (IDFR) (Intellectual Discourse on Science Policy-Taiwan's Experience in STI Advisory, June 2011)

2. Dato' Sri Mohd Najib Razak, Prime Minister of Malaysia (Keynote Address at Third APEC Chief Science Advisors and Equivalents Meeting, Kuala Lumpur, October 2015)

3. Datuk Seri Panglima Madius Tangau, Minister of STI (Keynote Speech at ASM's 9th General Assembly, Kuala Lumpur, April 2016)

4. Professor Datuk Dr Asma Ismail FASc, ASM President (Interview by The World Academy of Sciences (TWAS) on Initiative in Science Diplomacy in Malaysia, June 2017)

5. Professor Emeritus Tan Sri Zakri Abdul Hamid FASc, Malaysia's Science Advisor to the Prime Minister (Panel Discussion on Energising International Collaboration on STI, Kuala Lumpur, August 2017)

## 6.2 SCIENCE DIPLOMACY VIA INTERNATIONAL AGREEMENTS

International agreements to promote cooperation in scientific research and development can be bi- or multi- lateral, government-wide or at the level of individual technical agencies (e.g., the Nuclear Malaysia Agency or the National Institutes of Health – Clinical Research Centre). These as Umbrella Agreements, carry the weight of being legally binding and having been negotiated on behalf of the Malaysian Government to set up a structure for fostering international science collaboration. They include intellectual property protection, establishing benefit sharing, types of cooperative activities and ways to encourage access to facilities and personnel, as well as clarification on relevant governance matters (Dolan, 2012).

### Bilateral Agreements

Bilateral agreements are defined as Government-to-Government agreements with the aim of promoting goods and / services exchange and are favoured when there is specific requirement or need that can be fulfilled through close negotiation between the two nations.


Malaysia signed a total of 964 bilateral agreements to date; 187 of which are STI-related are signed with 83 other nations. Japan is the largest signatory with 24 bilateral agreements. Asian countries make up the largest percentage of Malaysia's bilateral partner, followed by African countries, Europe, South America, North America, and Oceania (see Table 6.2).

Geographical factor is one of the main reasons for Malaysia to build relationship mostly with Asian countries. Others would be aligned priority areas, trade partnership, as well as promoting common diplomatic agenda. The foreign policy focus on South-South agenda, plus Malaysia's commitment to champion developing countries are likely to be a key factor of Malaysia's engagement with the African and South American continent (MOFA, 2015).

**Table 6.2**

**The 187 STI-related Bilateral Agreements Signed by Malaysia (by Continent and Field)**

Source: Ministry of Foreign Affairs, 2016

| Continent | Africa | Asia | Europe | North America | Oceania | South America |
|---|---|---|---|---|---|---|
| Number of MoU/MoA | 27 | 112 | 26 | 7 | 3 | 12 |
| **Field** | | | | | | |
| Agreement on Economic, Scientific, Cultural & Technical Cooperation | 22 | 47 | 11 | 1 | 2 | 7 |
| Communication | 3 | 15 | 4 | 0 | 0 | 1 |
| Plantation Crop & Commodity | 2 | 5 | 2 | 1 | 1 | 1 |
| Aerospace | 0 | 2 | 1 | 0 | 0 | 0 |
| Education & Training | 0 | 18 | 1 | 0 | 0 | 0 |
| Energy Security Environment & | 0 | 7 | 3 | 3 | 0 | 0 |
| Climate Change | 0 | 2 | 1 | 0 | 0 | 0 |
| Food Security | 0 | 4 | 0 | 0 | 0 | 1 |
| Industry | 0 | 1 | 1 | 0 | 0 | 0 |
| Legislation | 0 | 1 | 1 | 2 | 0 | 1 |
| Medical & Healthcare | 0 | 3 | 0 | 0 | 0 | 1 |
| Transport & Urbanisation | 0 | 4 | 1 | 0 | 0 | 0 |
| Water Security | 0 | 3 | 0 | 0 | 0 | 0 |

Malaysia also has its own strength to consider when agreements are signed. In 2011, National Science & Research Council (NSRC, Malaysia) conducted the nation's R&D prioritisation exercise to ensure that the country's STI investment make the greatest possible contribution to a high-value economy.

Our analysis shows that besides the nine priority areas, Malaysia's bilateral agreements include other areas such as aerospace, legislation, communication, education and training; the largest being Umbrella Agreements on economic, scientific, cultural, and technical cooperation (see Figure 6.1).

Malaysia's bilateral agreements fall into three categories: 1) memorandum of understanding (MoU) on aid to strengthen Malaysia's STI capacity and capabilities; 2) agreement on economic, scientific, cultural and technical cooperation; and 3) cooperation agreements. The nature of agreements signed changed as time progressed; it varies according to the economic objective as well as the leadership of the nation (Saravanamuttu, 2010).

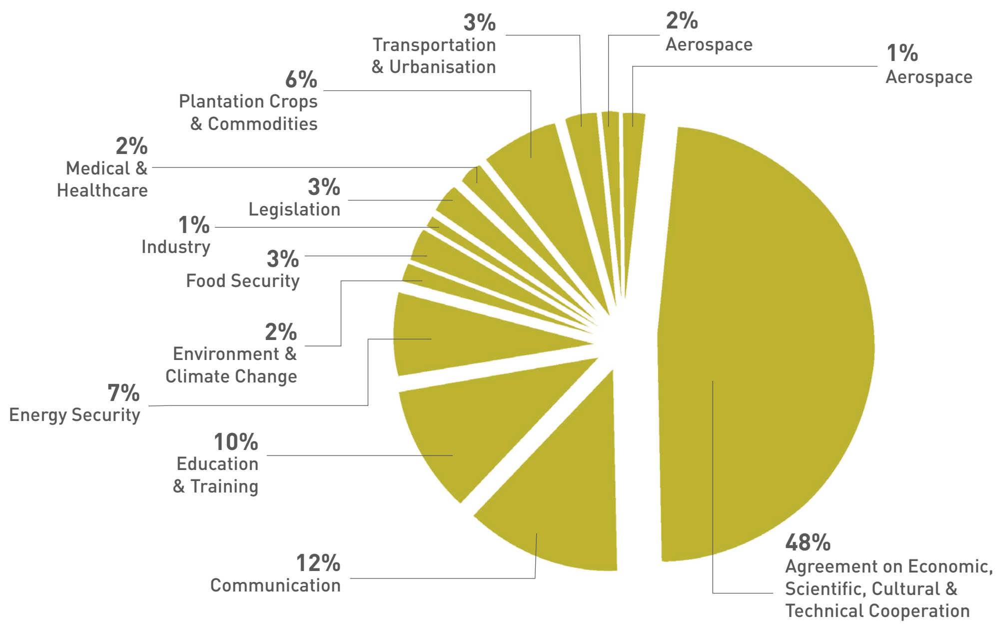



**Figure 6.1**
**Focus Areas of Bilateral Agreements signed by Malaysia until 2016**

Data Source: MOFA, 2016

## Nine national scientific priority research identified by NSCR:

**Biodiversity**
**Cyber Security**
**Energy Security**
**Environment & Climate Change**
**Food Security**
**Medical & Healthcare**
**Plantation Crops & Commodities**
**Transport & Urbanisation**
**Water Security**

A five-year period trend analysis parallel to each Malaysian Plan (RMK) shows MoU on aid are more common in early formation of Malaysia until 1990s. Agreement on economic, scientific, cultural and technical cooperation is the highest in the period in between 1991 to 1995 and signing of cooperation agreement is the highest period in between 2001 to 2005 (Figure 6.2).

The rise in the STI- related bilateral agreements in all three categories began during the Second Malaysia Plan (1971 – 1975) which focused on reducing the economic divide and strengthening the industry. The numbers of bilateral agreements signed – particularly for agreements on economic, scientific, cultural and technical cooperation – soared during the Sixth Malaysia Plan (1991 – 1995) after the intensification of industrialisation where greater economic thrust in Malaysia's foreign policy, creating economic opportunities for Malaysia, and strengthening economic diplomacy was emphasised (MOFA, 2015). A lot of technology transfers were going on in this period as the country builds its industrialisation capability.

The nature of STI-related bilateral agreements signed by Malaysia changed throughout the 50 year period; after 2006 MoU's on aid were seen to have plateau likely because Malaysia had moved from being a lower income country into middle income nation. The number of cooperation agreements spiked in 2001, marking a period of greater bilateral collaboration between nations of near-equal footing; which is remarkable as Malaysia was badly affected by the 1997 Asian financial crisis. Also, by this point, Malaysia had signed Government-to-Government bilateral agreements with 83 countries.

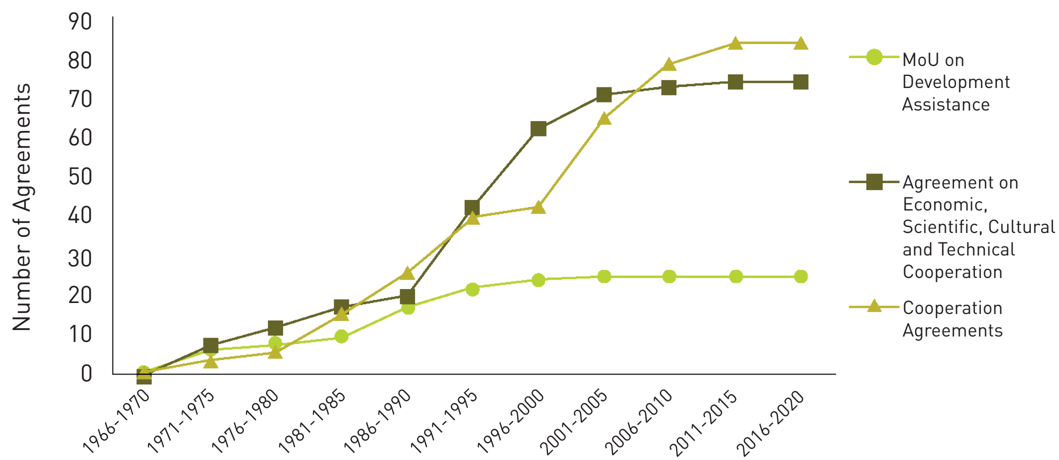



**Figure 6.2**
**Malaysia's Bilateral Agreements from 1966 – 2020**

Data Source: MOFA, 2016

## Case study Bilateral Agreements Signed by Ministries and Their Foreign Counterparts

Although Government-to-Government Bilateral Agreements appear to have slowed down from 2006 onwards (Figure 6.2), the form of bilateral collaboration shifted towards more focused agreements and collaborations initiated by respective ministries with their counterparts of similar portfolio as well as relevant stakeholders. This study looked into STI-related bilateral agreements signed by six ministries (KBS, KeTTHA, KPDNKK, MOHE, MOHR, NRE) from 2004 – 2016. An increase and continuous growth in the number of agreements signed is seen (Figure 6.3).

Of the 81 agreements signed by the six ministries, 53 agreements promote capacity building, 24 agreements support knowledge exchange, and four agreements encourages talent enhancement in Malaysia's STI ecosystem. This trend demonstrates the increasing ability of Malaysia's ministries and agencies to build rapport and gain trust to various international organisations.

National policies in one way or another highly affects the nature of foreign policy expressed by the nation at the time. Hence, it is important to align our National Science, Technology and Innovation efforts to the Nations' foreign policies to fully leverage on international collaborations.

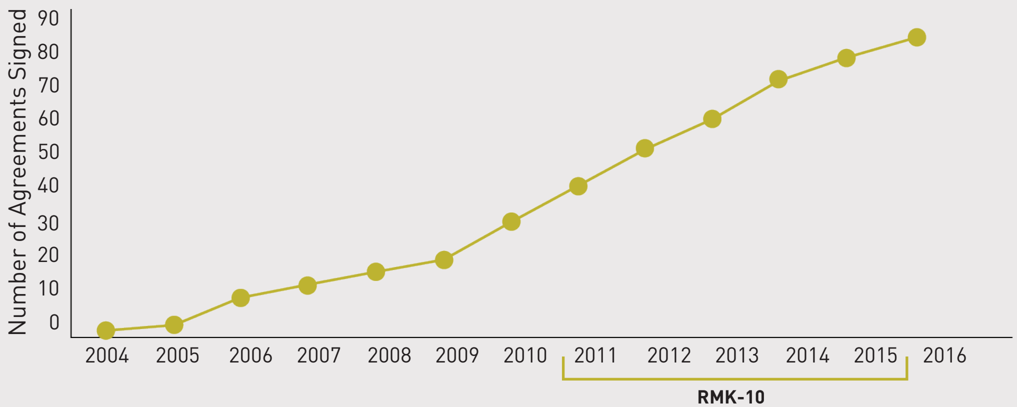



**Figure 6.3**

**Bilateral Agreements (Cumulative) Signed by Six Ministries from 2004 – 2016**

Source: KBS, KeTTHA, KPDNKK, MOHE, MOHR, NRE, 2016

### Multilateral Agreements

Another type of Government-to-Government international treaty is the multilateral agreement which involves three or more sovereign states. Malaysia (*Tanah Melayu* before 1957) signed a total of 107 multilateral agreements, the earliest in 1883 and the latest signed in 2003, with 58 of them being STI-related (Full list is available in Appendix 6.1) . Most of Malaysia's multilateral agreements are signed are in relation to Commodities followed by Disarmament.

STI-related multilateral agreements signed under the Commodities sector are between the years of 1948 with the last agreement signed is in the year 1989. One of the direct effects of most of these agreements is the establishment of international organisations to monitor and regulate the standardisation of these commodities. An example is the signing of the Constitution of the International Rice Commission in Washington on November 29, 1948 after World War 2; it led to the establishment of the International Rice Commission which as of 2013 has 62 member states representing over 98 per cent of global rice production. The IRC promotes international co-operation in the production, conservation, distribution, and consumption of rice.

In the Disarmament sector STI-related multilateral agreements were signed from the beginning of the cold war in 1963. The last agreement was signed in 1997 with the Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on their Destruction, Oslo. The direct effect of these agreements is the setting up of legal frameworks on procedures and regulations. For instance, being a signatory of the Treaty on the Non-Proliferation of Nuclear Weapons, countries are bound by the pillars and articles of the treaty. Violation of the treaty would lead to economic sanctions as done by the US on shipments of heavy fuel oil to North Korea in 2002.

Due to the different nature of these multilateral agreements, this study has categorised the STI-related multilateral agreements defined as below.

**Categorisation of Multilateral Treaties signed by Malaysia until 2016**

**General Regulation:** Set of standard and regulatory measures agreed by signatory countries
No. of treaties signed: **7**

**International Agreement:** Sets of items agreed by the signatory countries
No. of treaties signed: **25**

**International Cooperation:** Declaration of partnerships between signatory countries
No. of treaties signed: **16**

**Legal Framework:** Framework on standard and regulatory that are legally binding
No. of treaties signed: **10**

**Total: 58**

Source: Compilation by ASM, 2017

Majority of STI-related multilateral agreements signed by Malaysia are efforts to monitor, regulate and standardise procedures where science is an important element for an agreement to achieve its objective. By being part of the signatory members, Malaysia can retain its voice in the formulation of the monitoring, regulation and procedures as well as leverage on the advancement of technology of first world countries to boost our STI capacity and capability.

These multilateral agreements are vital in promoting Malaysia's security, international law advancement as well as active participation in the international fora, especially the United Nations system and its specialised agencies. It is a platform where Malaysia can attract knowledge, talent and resources for STI advancement.

Bilateral agreements are mostly signed to pursue Malaysia's internal drive to leverage on global platforms. While most multilateral agreements are signed to retain Malaysia's interest in international platforms which are more vulnerable to external pressures. Hence, strategising to leverage on these agreements is important for Malaysia to fully reap the benefit brought upon from these both STI-related bi- and multilateral agreements.

## Impact of Strategic International Agreements

Measuring the impact of each of these agreements varies according to the nature of the agreement. However, the finding from this study indicates that there is no monitoring mechanism in place and hardly any publicly made available document; summaries of STI related international engagements in Malaysia remain discrete and/or organisation-centric.Measuring the inclusion effect and the outcomes of these agreements is one methodology. Two possible positive impacts observed from being signatory of international agreements are:

*At present, Malaysia has four properties inscribed on the World Heritage List, which are:*

- *Archaeological Heritage of the Lenggong Valley, Perak*
- *Melaka and George Town as Historic Cities of the Straits of Malacca*
- *Gunung Mulu National Park, Sarawak and*
- *Kinabalu National Park, Sabah*

### (a) Access to Resources and Opportunities

Signing regulation binding agreement gives Malaysia access to resources and opportunities; some may include awarding a certain status. An example is the Convention for the Protection of the World Cultural and Natural Heritage (i.e. UNESCO heritage site status) which is a pledge to conserve not only the World Heritage sites situated on its territory, but also to protect its national heritage. This is especially important as cultural heritage is the legacy of physical artefacts and intangible attributes of a group or society that are developed by a community and passed on from generation to generation.

Among the benefits include funding to preserve the properties and forging partnerships; e.g. between UNESCO and Universiti Sains Malaysia (USM) to encourage more scientific researches to be conducted in the Lenggong Valley. This partnership has been key to USM developing their archaeology education, research, and outreach programmes.

Signing regulatory agreements also opens doors for access to expertise; e.g. signing the Statutes of the International Atomic Energy Agency (IAEA) allows Malaysia to tap into the IAEA's expertise to develop the nation's own nuclear programme.

As a signatory of these legal frameworks and regulations, we are included in the decision making and development process of the agreements. Establishing rapport with technology holders encourages transfer of knowledge or technology though this might come much later.

*The Lenggong Valley housed four archaeological sites which span close to 2 million years, one of the longest records of early man in a single locality outside the African continent.*

*Malaysia's commitment to reduce its carbon intensity by up to 40% in 2020 has forced the government to reconsider nuclear energy as a long-term option for Peninsular Malaysia. IAEA was invited to conduct the Integrated Nuclear Infrastructure Review (INIR) in October 2016 and in March 2017; the IAEA delivered this final report pointing out that the finalisation and enactment of the comprehensive Atomic Energy Bill will be an important step for the next phase of the country's nuclear power programme.*

### (b) Access to Global Cooperation Efforts

Though majority of the multilateral agreements are legal frameworks and regulations, 28% of the multilateral agreements signed by Malaysia are to join international cooperation for STI advancement to access experts, knowledge transfer and collaborations.

Malaysia's involvement in the International Treaty on Plant Genetic Resources for Food and Agriculture is an example of having access to the global cooperation efforts. The Gene Bank and Seed Centre of Malaysian Agricultural Research and Development Institute (MARDI) is Malaysia's Focal Point.

Upon ratifying the Treaty, signatory countries agree to make available their genetic diversity and related crop information stored in their gene banks available to all through the Multilateral System (MLS). It also prevents the recipients of genetic resources from claiming intellectual property rights over those resources, and ensures access to genetic resources protected by international property rights is consistent with international and national laws in harmony with the Convention on Biological Diversity, for sustainable agriculture and food security. This puts together the most important crops that account for 80 percent of the food source into an easily accessible global pool of genetic resources for research, breeding and training for food and agriculture.

### Strategies for better impacts

The impact of science diplomacy via international agreements can be further enhanced through better partnerships between local policy makers and technical scientific experts. For a start the Minister of Foreign Affairs (MOFA) should be included in the National Science Council (NSC).

Matters pertaining to STI discussed at the Council will guide MOFA officials on the STI direction of and vision for the Nation. This will indirectly streamline national and international efforts in achieving the aspirations of the Science Agenda.

Another possible strategy is to expand the role of the Science Advisor (to the Prime Minister)'s Office to provide periodic directives concerning S&T components of important foreign policy issues to MOFA. The leadership and guidance on STI-related policies and programmes for addressing priority global issues and advancing Malaysia's interests could be handled by an independent advisory board under NSC chaired by the Science Advisor to advance bi- and multi- lateral interest. This could include personnel from the International Bureau of each Ministries meeting to update their progress concerning their involvement at international platforms.

This advisory board could also monitor and report the impact of these various STI-related bi- and multi-lateral agreements, memorandum of understanding, and other strategic alliance mechanisms. For international reference, at present the following countries have Science Advisors to the Foreign Ministries:

- Japan
- New Zealand
- Oman
- Poland
- Senegal
- The United Kingdom
- The United States

Agreements signed allows for a two way communication both in putting forward Malaysia's stand in global issues as well as in increasing STI capabilities, regardless of the nature and objective of agreements. By employing more effective strategies, Malaysia's strength in STI international alliances can be fully leveraged.

## 6.3 MALAYSIA'S MEMBERSHIP IN INTERNATIONAL STI-RELATED ORGANISATIONS

Strategic international alliance can be built through membership in international organisations; from regional cooperatives, international regulatory bodies, and scientific organisations. Malaysia, under the purview of MOSTI is a member to 26 STI-related organisations or sub-organisation.

### Malaysia's Membership in STI-Related Organisations

**ASEAN**

1. ASEAN Committee on Science and Technology (ASEAN COST)

**APEC**

2. Policy Partnership on Science, Technology & Innovation (PPSTI)

**OIC**

3. Standing Committee on Science & Technology Alliance
4. Science, Technology & Innovation Organisation

**UN**

5. UNESCAP Asian & Pacific Centre for Transfer Technology
6. UN Conference on Trade & Development

**NAM**

7. The Centre for Science & Technology of the Non-aligned and Other Developing Country

**UNESCO**

8. Asian Physics Education Network
9. Humid Tropics Centre
10. International Geoscience Programme
11. International Hydrological Programme
12. International Science, Technology & Innovation Centre (ISTIC)
13. Man and Biosphere
14. Science & Technology Policy Network
15. Intergovernmental Oceanographic Commission

**OTHERS**

16. Antarctic Treaty Consultative Meeting (ATCM)
17. Asia-Europe Meeting (ASEM)
18. International Atomic Energy Agency (IAEA)
19. International Centre for Genetic Engineering and Biotechnology (ICGEB)
20. International Institute for Applied Systems Analysis (IIASA)
21. Pacific Science Association (PSA)
22. Science Council of Asia (SCA)
23. The Academy of Developing World (TWAS)
24. The International Council for Science
25. The International Geosphere-Biosphere Program
26. The World Association of Industrial and Technological Research Organisation (WAITRO)

Source: Ministry of Science, Technology and Innovation, 2016 *non-exhaustive*

Besides the above, Malaysia also has membership in few of the following international organisations/fora on STI matters (also refer Further Reading):

- **D-8 Organization for Economic Cooperation**, in areas which include, science and technology, agriculture, energy, environment, and health.
- **Asia-Middle East Dialogue (AMED)** foster dialogue and mutual understanding, as well as strengthen co-operation between Asia and the Middle East under three broad pillars: political and security issues, economic issues, and dialogue on social, educational, scientific, cultural and media issues.
- **The Forum for East Asia –Latin America Cooperation (FEALAC)** was created to stimulate interaction and mutual understanding between the two regions, of promoting greater political dialogue, and of increasing cooperation in order to foster coordination between the two regions. Working groups hold meetings annually in the diverse areas one of which includes Science and Technology; Innovation and Education.

At agencies level, the national think tank on STI related matters; ASM has created healthy networking with a number of international STI organisations (Figure 6.4).

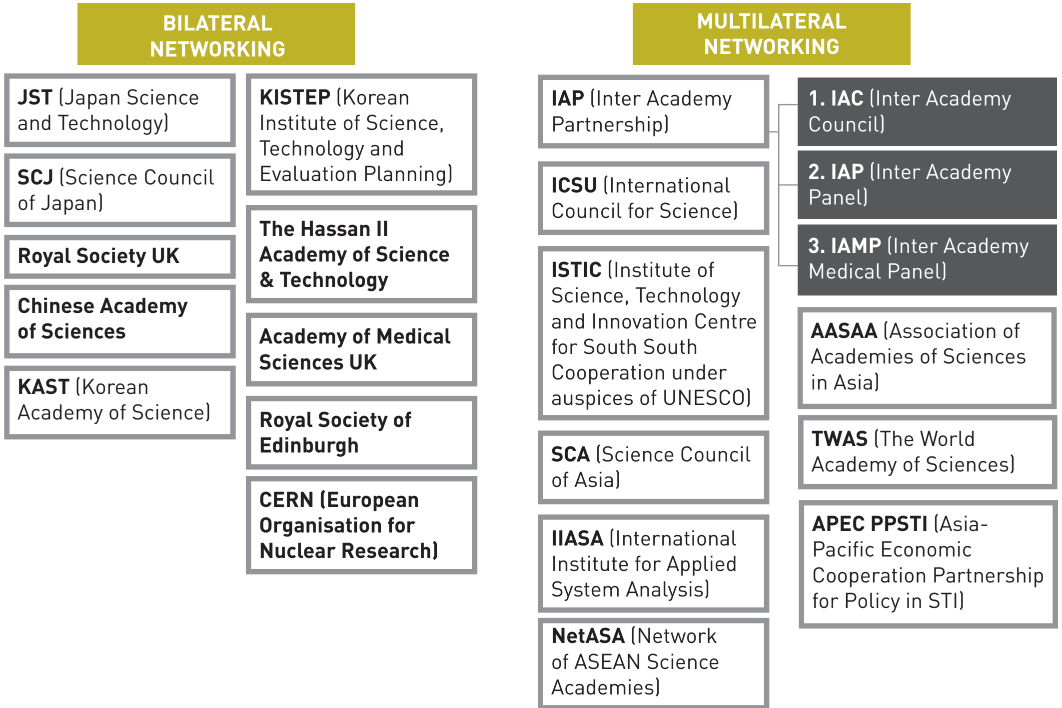



**Figure 6.4**
**ASM's network with other STI organisations**

Source: ASM, 2017; *non-exhaustive*

International networking is important in building the capacity of the country to ensure the impacts of science and technology research, discoveries, ideologies and policies are shared globally. Therefore, it is important for Malaysia to lobby and secure important key positions in international organisations to improve Malaysia's visibility in global STI arena. This will also help in shaping and responding to both local and global challenges especially in vital issues that could affect Malaysia's position and sovereignty.

Since the early 2000s, there have been increasing movement in opposing the commercialisation of Palm Oil Products due to various factors such as sustainability issues, environmental degradation and also native right controversies. Such movements called for banning of palm oil and also labelling of palm oil on palm oil products that could lead to discrimination in purchasing.

Being a leader in the industry, Malaysia is able to spearhead the Roundtable on Sustainable Palm Oil (RSPO) which was established in 2004 with the objective of promoting the growth and use of sustainable oil palm products through credible global standards and engagement of stakeholders. Beginning in 2008, palm oil that meets RSPO introduced standards has been designated Certified Sustainable Palm Oil (CSPO). In regards to this, Malaysia has been recognised by the Roundtable on Sustainable Palm Oil as the largest producer of CSPO, producing 50 percent of the world's supply, and accounting for 40% of CSPO growers worldwide (McDougall, 2011).

At present the Malaysia-EU Palm Negotiation Mission to discuss EU's proposal to ban palm oil from biofuel and renewable energy mix by 2020 which would affect the livelihoods of more than 650,000 smallholders in Malaysia is still ongoing and receiving mixed support. Being an industry leader in palm oil industry empowers Malaysia to keeping a strong stand in these challenging issues.

Having key persons in international organisations/platforms is an added advantage to the country. The appointment of Tan Sri Zakri Abdul Hamid as the founding chair at the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is one such example.

During the IPBES-4 plenary meeting held in Kuala Lumpur, it was agreed to initiate a Global Assessment on Biodiversity and Ecosystem Services for completion in 2019.

Tan Sri Noorul Ainur Mohd Nur had served as the Chairman of UNESCO's Science Commission for the 2015-2017 term. Dato' Seri Mahdzir Khalid is the Chairperson for the Malaysian National Commission for UNESCO. Distinguished Professor Datuk Dr Looi Lai Meng FASc is in her second term as the elected Co-Chair of the InterAcademy Medical Panel. She is also an Examiner (in Histopathology) for both the Royal College of Pathologists, UK and the Royal College of Pathologists of Australasia. Dr Joy Jacqueline Pereira FASc is Vice-Chair of Working Group II (this Working Group assesses the vulnerability of socio-economic and natural systems to climate change, negative and positive consequences of climate change, and options for adapting to it.) of the Intergovernmental Panel on Climate Change (IPCC). The most reason appointment is of the former Penang Mayor Ms. Maimunah Mohd Sharif as the Executive Director of the United Nations Human Settlements Programme (UN-Habitat).

Networking through international memberships and holding key positions at international organisations is crucial for the continuity of Malaysia's interest and global positioning. The advantages of being members of international organisation are discussed.

**Case Study - Malaysia and Association of Southeast Asian Nations (ASEAN)**

ASEAN encompassed a land area of 4.4 million square kilometres with a combined population of 640 million people which covers 8.8% of the world population. Since its formation on 8 August 1967 ASEAN aims to promote intergovernmental cooperation and facilitate economic, political, security, military, educational and socio-cultural integration amongst its members and other Asian countries.

As a founding member of ASEAN, Malaysia has been committed in achieving its various economic, political, and humanitarian missions. This is an important element in Malaysian science diplomacy as the regional cooperative is of geo-political and economic significance to Malaysia and the nations within this region.

In ensuring that the S&T cooperation in ASEAN remains relevant, the ASEAN Committee on Science and Technology (COST) was established in 1978. Other than that, various series of Plans of Action in Science and Technology were also passed under the ASEAN COST flag, with the most recent being the ASEAN Plan Of Action On STI (APASTI) 2016-2025. The APASTI 2016-2025 was developed under the ASEAN Krabi Initiative in 2010 and endorsed by the ASEAN Ministers for S&T at the 16th ASEAN Ministerial Meeting on S&T (AMMST) held on 6 Nov 2015 in Vientiane, Lao PDR (refer Appendix 6.2).

Malaysia gains access to many combined resources as a member of ASEAN. ASEAN-COST for instance has made allocations through the ASEAN Science and Technology Fund (ASTIF) in eight clusters namely: digital economy, new media and social networking, innovation for health & wealth, science & innovation for life, ASEAN innovation for global market, food and energy security, water management, biodiversity and, environment & climate change.

The current S&T cooperation in ASEAN focuses on nine programme areas:

- food science and technology
- biotechnology,
- meteorology and geophysics,
- marine science and technology,
- non-conventional energy research,
- microelectronics and information technology,
- material science and technology,
- space technology and applications, and
- S&T infrastructure and resources development.

**Funding Instruments in ASEAN**

- ASEAN Science, Technology and Innovation Fund (ASTIF)
- ASEAN-India Science & Technology Development Fund (AISTDF)
- ASEAN Development Fund (ADF)
- ASEAN-China Cooperation Fund (ACCF)
- ASEAN-Russian Federation Dialogue Partnership Financial Fund
- ASEAN-ROK Special Cooperation Fund
- ASEAN-India Fund (AIF)
- ASEAN-India Green Fund
- ASEAN Plus Three Cooperation Fund
- ASEAN Pakistan Cooperation Fund
- Japan-ASEAN Integration Fund (JAIF)

Source: ASEAN, 2017

The funding however is competitive; Malaysian researchers or institutions that wishes to apply must ideally propose forward thinking projects that benefit a number of countries in ASEAN to bid for these funds. Hence it would be very beneficial for Malaysian researchers to work with MOFA and MOSTI, the coordinator and focal point in international cooperation in the fields of Science, Technology and Innovation among government ministries and agencies and the private sector in Malaysia, to strategize on the best way to secure the funding.

ASEAN serves as a platform for South East Asia nations to reach out to other South East Asia nations. With majority of ASEAN country being a developing country, science diplomacy is important for all nations to work together in developing STI capacity and capabilities. Science diplomacy in ASEAN allows for international funding, cross-border collaboration and exchange of experience among nations regardless of the political standing.

**Case Study - Malaysia and Asia Pacific Economic Alliance (APEC)**

The Asia-Pacific Economic Alliance (APEC) was formed in 1989 in response to the growing interdependence among Asia-Pacific economies that represent about half of the world merchandise trade. Its 21-member economies is home to around 2.8 billion people and represent approximately 59% of the world's GDP and 49% of world trade in 2015. Malaysia is one of APEC's founding members and served as the APEC Chair in 1998.

At present, Malaysia is the co-chair for PPSTI's Sub-Group on Building Science Capacity. APEC's Policy Partnership for Science, Technology and Innovation (PPSTI) supports the development of STI alliance as well as effective STI policy recommendations in APEC through collaboration between government, academia, private sector and other APEC forums.

Each year APEC funds around 100 projects, with more than USD16 million allocated in 2017. Projects typically include workshops, symposia, publications and research. APEC projects also target policy areas specifically for science and technology through its PPSTI group.

APEC approved and funded 1,574 projects from 2006 to 2016. Malaysia secured funding for 38 projects (2% of the total funded) (Figure 6.5); 15 are related to STI, 14 projects on economy, and nine policy projects. The projects include capacity building projects, workshop funding as well as joint project efforts.

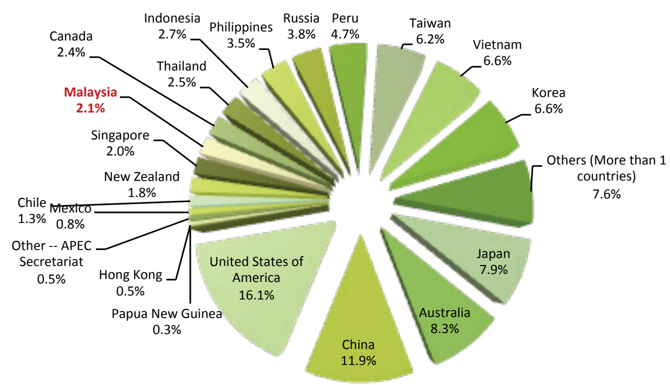



Figure 6.5
**Number of funded projects by APEC from 2006 - 2016**

Asia Pacific Economic Alliance, 2016

One of the APEC-funded projects involves Malaysia conducting Education and Training to Support Nuclear Power Program for APEC Economies; this was proposed by Malaysian Nuclear Agency in 2012. This project is engaged by pooling the available resources of each individual economy in terms of trainers, educators, experts and facilities, in order to educate and train more people in the nuclear field with practical hands-on experiences.

To be successful in bidding for APEC projects, Malaysian applicants must develop creative, cross-cutting, and multi-disciplinary proposals that will benefit other APEC member countries along with Malaysia. Scientists and civil societies should strategize their application by working together with the national focal points of the various international organisations in the Ministries (be it MOFA, MOH etc.) as well as relevant colleagues in other APEC member countries who are expected to participate in the programmes to be funded through the proposal. Malaysian applicants should leverage on the various STI network to come up with projects of true globalisation spirit in order to have a higher chance of success.

Officers from MOFA and MOSTI's international division for instance could mirror each other and actively meet to strategise priorities to maximise opportunities from engagements in multiple international platforms and increase Malaysia's competitiveness; for instance strategising to leverage on the opportunity of the International Silk Road Academy of Sciences (ISRAS). This engagement should include representatives from the International Division of other relevant Ministries i.e. MITI, MOHR and MOHE to name a few.

## 6.4 INSTITUTIONS OF HIGHER LEARNING (IHLS) JOINT RESEARCH COLLABORATION

G2G Umbrella Agreements creates opportunities for collaboration to be forged through strategic international alliances at institutional level with foreign organisations of similar interests. The international networking of STI researchers and experts is unique; crossing national boundaries with partnership traditions that open many doors and support crucial frameworks for joint efforts to address a wide array of problems of broad interest.

Therefore, national science and technology strategies and policies which embed international activities and collaboration will facilitate advances in science and technology through promoting an environment of partnerships and engagement and through increasing the effectiveness of interactions within the global innovation platform. This can be manifested through exchange of researchers and students, joint research facilities use and division of tasks in a larger and broadly defined research programme, and international conferences.

While recognising that most often international science is mostly conducted through informal connections, looking into Malaysia's five Research Universities [MRU: UM, UKM, USM, UPM and UTM] there has been substantial amount of strategic international agreements signed between the institutions and their foreign partners from years 2012 to 2016 (Figure 6.6) resulting in projects funded under these agreements as well as an increase in the number of joint researches in which Malaysian representative in the collaborations are the leading partners (Figure 6.7).

The projects funded under these agreements were both in cash and in kind (including expertise and technology transfers). These funds are utilised in various research fields with medical and health sciences contributing large fraction of the resources.

Increased visibility through the signing of agreements fosters trust among research partners resulting in electing Malaysian representatives as lead researchers in collaborative researches (Figure 6.7). It is important for Malaysian institutions to continue active collaboration with international partners to gain experiences and knowledge transfer.

Malaysian scientists and researchers have also been actively building rapports with international collaborators through formal though not legally binding institutional commitments (i.e. MoU between organisations). As of 2016 alone, 785 international organisation memberships with another 152 posts of leadership were recorded (Figure 6.7).

One of the most common outputs from collaborations is internationally co-authored publications. As science and the scientific method grew in its complexity, such partnerships are inevitable. In the journal Science, internationally co-authored papers are now the norm, representing almost 60 percent of the papers when in 1992; it was slightly less than 20 percent (Holt, 2015).

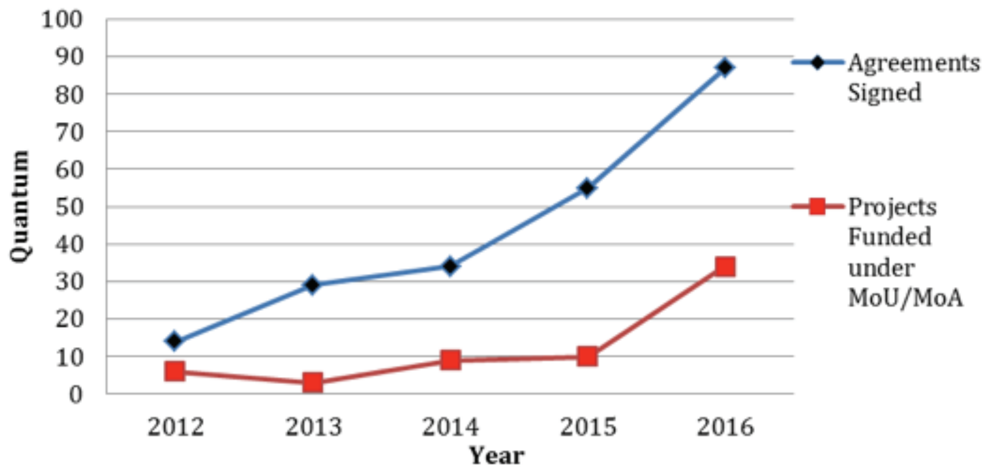



**Figure 6.6**
**International Agreements signed by the Five MRUs and the number of projects funded as of 2016 (Non-cumulative)**

Data Source: MyRA, 2017


**Figure 6.7**
**Involvement and recognition of Malaysian researchers from the Five MRUs in 2016**

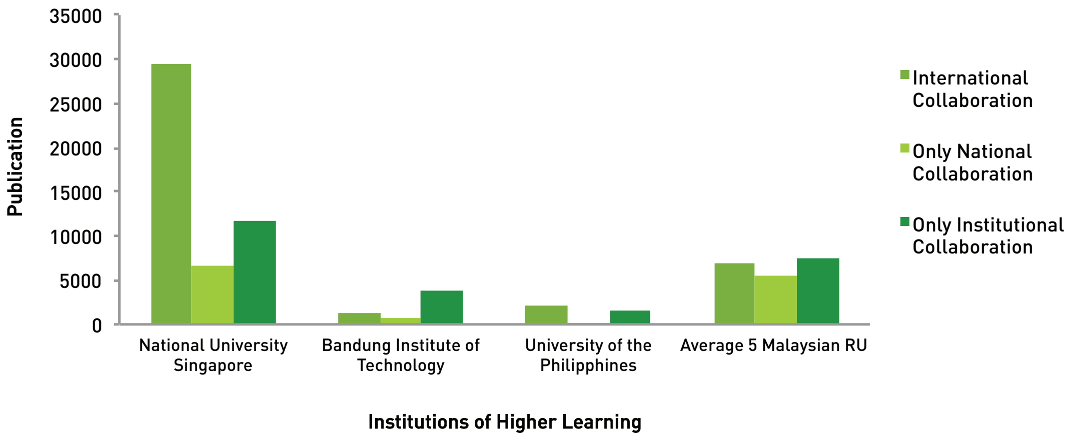
Data Source: MyRA, 2017

Data for Figure 6.8 was retrieved and analysed from Scival Database which indexes journals and publications worldwide. In the MRUs, the numbers of international collaborations and only institutional collaborations are almost similar for the period between 2012 to June 2017. When compared to top institutions of higher learning (IHL) of ASEAN countries; MRUs on average fared well except with our nearest neighbour the National University of Singapore (NUS); there is much catching up to do in terms of international collaborations.

Top universities in most countries use internationalisation as a strategy to boost international collaborations. NUS for instance have a significant number of faculty members from other top universities as visiting fellows and through bi-institutional affiliation programmes. NUS also leverages on top talent in their institution to be appointed as editors for top ranking journals, making it easier for them to collaborate on research and publications.

Malaysia has the Internationalisation Policy for Higher Education in Malaysia, 2011 and Malaysia Education Blueprint 2015-2025 (Higher Education) in place which has networking and collaborative R&D among other measures in these documents. An easy path to further international partnerships would be to leverage on the existing international universities with satellite campuses here such as Monash University, Newcastle University, Nottingham University and Xiamen University by fostering collaboration with their faculty members. This could also lead to resource sharing for sponsoring visiting professors from top-ranked universities.

Since the establishment of the MRUs in 2006, where resources were concentrated to carry out more active research activities, number of publications has shown an increase and is now the highest among ASEAN countries (Figure 6.9). It is believed that this national initiative helps to boost Malaysia's international collaboration in terms of joint publications.




Definition:
International Collaboration: Local IHLs collaborating with IHLs from other countries
Only National Collaboration: Local IHL collaborating with other local IHLs
Only Institutional Collaboration: Collaboration between researchers within the IHL itself

**Figure 6.8**
**Publications from collaborative research among top IHLs in ASEAN countries from 2012 to June 2017**

Data Source: SciVal, 2017

In addressing international collaborations, our analysis showed most collaboration was done with the United States of America (USA) and the United Kingdom (UK) (Figure 6.10). In academic year 2015-2016, on average 17,000 and 7,800 Malaysian students were enrolled in the IHLs in the UK (UKCISA, 2018) and in the USA (US Embassy, 2016) respectively. These numbers are significant alumni members to form collaborations with their Alma matter in future. The trend of Malaysian students in the past was similar in choosing the USA and UK as destinations of choice to further their studies.

Most joint publications are seen carried-out with developed countries. This pattern may be due to network collaboration set up by IHLs staff during their postgraduate studies; a good number of them received scholarships to do their PhDs in USA, UK, Australia and Japan. Malaysia hosts around 2.9% doctoral students in science or engineering (UNESCO, 2015). The UK and Japan are also significant funding sources; presenting a platform for international collaboration with Malaysian researchers. This will be further deliberated in section 6.5.

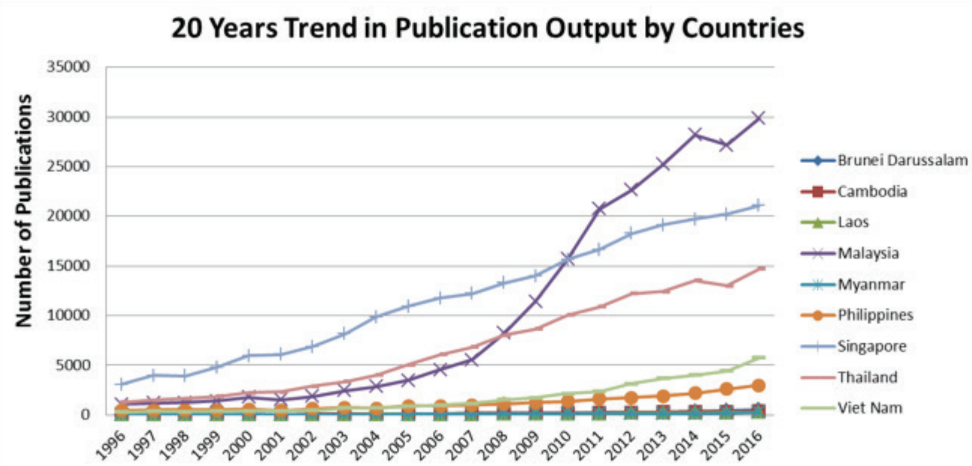



**Figure 6.9**
**20 years trend in publication output by countries**

Data Source: SciVal, 2017

| No | Field | | | |
|---|---|---|---|---|
| | Agriculture | Engineering & Technology | Medicinal | Natural |
| 1 | USA | USA | USA | USA |
| 2 | Iran | UK | UK | Italy |
| 3 | Australia | Japan | Australia | UK |
| 4 | Japan | Iran | Iran | Japan |
| 5 | UK | Italy | France | France |
| 6 | India | France | Japan | Germany |
| 7 | Bangladesh | Germany | Germany | Russia |
| 8 | Nigeria | China | Italy | Turkey |
| 9 | Saudi Arabia | Canada | Spain | Iran |
| 10 | China | Australia | China | China |

**Figure 6.10**
**Top 10 Collaborating Countries with Malaysia based on Co-publications**

Source: SciVal, 2017

In recent years, there has been influx of international students studying in Malaysia. International student admission is also a measure in MOHE's Internationalisation Policy 2011. Enrolling international post-graduate students could play a role in increasing collaboration especially if these students are sponsored by their government. It is interesting to note the number of collaboration with other developing countries such as Bangladesh and Nigeria. The country of origins of these students would explain the increase in the number of international joint publications as seen below.

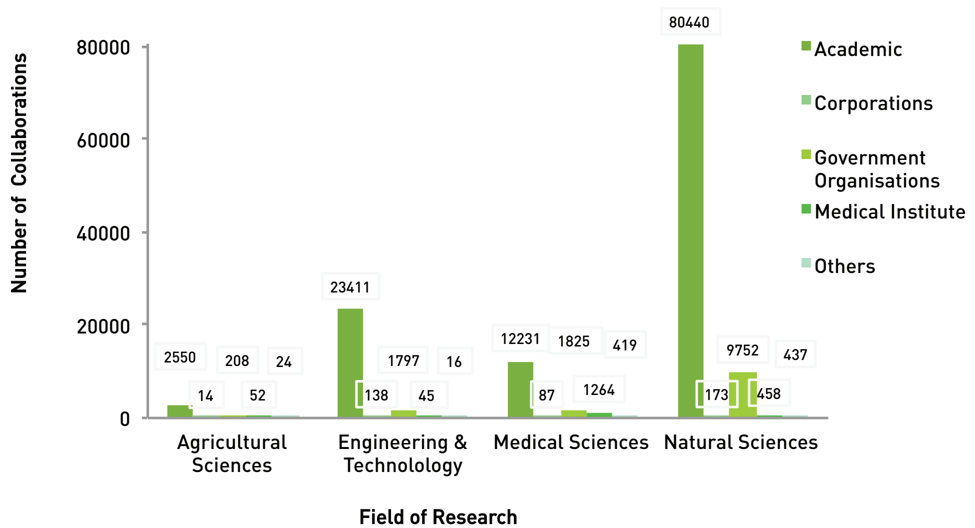
**Top 10 Countries of Origin of International Students Studying in Malaysia**

| | |
|---|---|
| Bangladesh | 34,455 |
| Nigeria | 15,262 |
| China | 11,718 |
| Indonesia | 8,653 |
| Yemen | 5,942 |
| Pakistan | 5,292 |
| Iran | 4,055 |
| Iraq | 3,264 |
| Libya | 3,246 |
| Sudan | 3,002 |
| Other Countries | 35,388 |
| Grand Total | 130,277 |

Source: MOHE, 2017

National initiatives and policies such as the Malaysia Research University initiative and the Higher Education Malaysia Internationalisation Policy 2011 and the Malaysia Education Blueprint 2015-2025 (Higher Education) are an important element in pushing the internationalisation of IHLs in Malaysia. These documents provide necessary guideline, strategy and resources to support internationalisation. Hence, it is imperative to streamline national policies with internationalisation opportunities in future formulations of national policies.

The joint-publication data also shows little collaboration between MRUs and the corporate sector (Figure 6.11). Most developed countries are focusing on demand-driven research which reduces incidents of the 'valley of death' and lead to more successful commercialisation. IHLs realise that collaborations beyond academia could offer more opportunities to solve real-world problems with profit sharing but we also recognise that due to intellectual property rights, IHLs may have limited rights to publish their findings hence resulting in very poor publication output.




Category of organisation-type by SciVal:
Academic: university, college, medical school, and research institute
Corporate: corporate and law firm | Government: government and military organization
Medical: hospital | Other: non-governmental organization

**Figure 6.11**
**Number of Joint publications by Field of Research and Sectors**

Data Source: SciVal, 2017

Most of the Malaysia's international publications are contributed by IHLs rather than research institutes; possibly because it is easier to foster collaboration between academic institutions rather than with other agencies and private sectors. Research institutes are also bound by specific mandates which may require collaboration with partners of similar mandates, i.e Malaysian Agricultural Research and Development Institute (MARDI) with International Rice Research Institute (IRRI) hence contributing to smaller scale of publications or publications not in indexed journals. Limited platform for IHLs and international government organisations/ corporations to collaborate (e.g. Japan Science and Technology Agency – SATREPS) and issues with data confidentiality and intellectual property governance may also inhibit collaborations.

List of the 13 FTAs:

- Malaysia-Turkey (2014)
- Malaysia-Australia (2012)
- Malaysia-India (2011)
- Malaysia-Chile (2010)
- Malaysia-New Zealand (2009)
- ASEAN-Australia-New Zealand (2009)
- ASEAN-India (2009)
- ASEAN-Japan (2008)
- Malaysia-Pakistan (2007)
- ASEAN-Korea (2006)
- Malaysia-Japan (2005)
- ASEAN-China (2004)
- ASEAN Free Trade Area (1992)

## 6.5 STRATEGIC INTERNATIONAL ALLIANCE IN INDUSTRIES

Trade opens opportunities for further strategic international alliances in developing Malaysia's STI capacity and capabilities. Till date Malaysia has signed 13 Free Trade Agreements (FTA) to facilitate better bi- and multi- lateral trading. Besides the Trans-Pacific Partnership (TPP) agreement negotiations of which were concluded on 5 October 2015, Malaysia is also negotiating the following FTAs:

- Regional Comprehensive Economic Partnership (RCEP) agreement;
- Malaysia-EU FTA;
- Malaysia-European Free Trade Association Economic Partnership Agreement (MEEPA); and
- ASEAN-Hong Kong FTA.

FTAs create potential in technology transfers. Therefore, to fully leverage on these FTAs, policy makers must actively identify strengths and niche areas of Malaysian industries to encourage more collaborations.

The shift of Malaysian economy from a commodities based economy to manufacturing has allowed the rapid growth of the manufacturing industry. In 2016, Malaysia's top exports were in electrical and electronic products, chemicals and chemical products, petroleum products, palm oil and palm-based agricultural products as well as machinery equipment and parts. Manufactured products dominated exports, amounting to 82.2% share valued at RM645.67billion (2015: 80.5% share, RM625.43billion) Figure 6.12 depicts dominant and potential trade sectors respectively. Continuous knowledge and technology exchange should be focused in these areas to increase capacity building and talent enhancement in each of these fields.

| DOMINANT TRADE SECTORS: | % | |
|---|---|---|
| • E&E | 36.7 | 64.7% |
| • Petroleum Products, Chemical Products Crude Petroleum & LNG | 22.2 | |
| • Palm Oil | 5.8 | |

| POTENTIAL TRADE SECTORS: | % | |
|---|---|---|
| • Machinery & Parts (Aerospace) | 4.3 | 13.6% |
| • Optical & Scientific (Medical Devices) | 3.5 | |
| • Processed Food (Halal & Ingredients) | 2.3 | |
| • Wood Products (Furniture & Building Materials) | 1.8 | |
| • Textiles & Apparels | 1.7 | |

Figure 6.12
**Malaysia's Dominant and potential trade sectors of 2017**

Source: MATRADE, 2017

Case Study – Malaysia External Trade Development Corporation (MATRADE)

MATRADE's establishment is one of government's actions to strengthen Malaysia's export performances in goods and services. Till date 46 trade andmarketing offices for marketing and  market analysis purposes has been set up globally. Vital information such as market information, import requirements, trade opportunities and market intelligence are important to support existing market information systems and are linked to international information system networks.

This set-up is perfect to develop Malaysia's STI ecosystem further. Among the activities or initiatives includes outreach programmes and factory visits which allows collaboration between Malaysian industries with relevant unit or sections (internal), associations, business chambers and professional bodies.

These activities with the global networks create an opportunity for Malaysia to carry out market analysis which includes trends that could be a game changer in developing STI capabilities and capacity of local Malaysian industries. Our trade missions globally should feed our researchers on the global industry demand to support more relevant researches that could be translated into more viable product and services for viable commercialisation.

## 6.6 SUCCESS STORIES FROM STRATEGIC INTERNATIONAL STI ALLIANCE

### International Funding

The increase in research activities and research talent pools provide a challenge to the functions and role of international funding agencies. Funding agencies must keep abreast with the technical knowledge and technological enhancements in many existing and new fields to predict the need for research and development in these fields.

Sustaining investment in research and development is a challenge. Funding is governed and constrained largely by national and local policies, processes and priorities, while international funds are governed by niche research or are affected by political climates such as Brexit and the change of policy in Trump's administration.

In 2016 alone, 127 research and development projects in MRUs were funded through international funding bodies. This translates to approximately RM21.7 million worth of international research funds *pledged. Most of these international funds were awarded in the Medical and Health Sciences field of which approximately 25% were for clinical trials. Over the period of 2011 to 2016, Japan has been the top funding country, followed by ASEAN, USA and UK. As a perspective, in 2016 the national allocation by the Government for the MRUs including for the High-impact Centre of Excellence (Hi-CoE) is 13.2 times that of international funds *pledged.

Therefore, to reduce dependencies on the Government, researchers should further leverage upon Malaysia's international membership to tap on external resources (see Table 6.3) and secure international funding for ambitious STI projects that have regional impact. Hence, engagement with focal points at various ministries (e.g. ASEAN STI focal point in MOSTI and MITI) is both important and necessary.

**pledge: Total sum allocated for a project awarded in that year but disbursement of funds will be by milestones throughout the estimated time for the completion of the project.*

Case Study - Newton-Ungku Omar Fund (NUOF)

The Newton Fund is part of the UK's official development assistance aimed at developing science and innovation partnerships to promote the economic development and social welfare of partner countries such as Malaysia. The fund has been included as one of the Science to Action (S2A) initiatives and named Newton-Ungku Omar Fund (NUOF) to develop collaboration on research and innovation to address socio-economic issues in Malaysia to enable sustainable growth beyond 2020.

NUOF includes growing capacities of the Malaysian science and innovation community through fellowships, mobility schemes and joint centres; forging research collaborations on development topics; and establishing innovation partners and challenge funds to develop innovative solutions on development topics (Appendix 6.3).

There are 18 British and Malaysian funding organisations working together to fund opportunities for researchers under this fund. Ministries/agencies/organisations that have collaborated and the quantum of funds made available under this partnership (Table 6.3).

**Table 6.3**
**Value of Matching Funds from Ministries/Agencies/Organisations under the Newton-Ungku Omar Fund**

Source: British High Commission, 2017

| Ministries / agencies / organisations | Matching Fund |
|---|---|
| Ministry of Higher Education (MOHE) | £ 805,452 |
| Ministry of Education (MOE) | £ 65,839 |
| Met Malaysia | £ 298,000 |
| PlaTCOM Ventures | £ 457,017 |
| Academy of Sciences Malaysia (ASM) | £ 3,719,485.45 |
| National Disaster Management Agency Malaysia (NADMA) | £ 1,724,500 |
| Malaysian Industry-Government Group for Technology (MIGHT) | £ 5,098,673 |
| | **£ 12,168,966** |

As of April 2017.

NUOF is one of the prime examples of science diplomacy bringing positive impact to the development of STI capacity in the nation. 28 activities have been established and about 100 funding grants awarded since the fund's inception in 2014. NUOF's implementation is jointly managed and coordinated by British High Commission and MIGHT.

The Newton Fund was launched in 2014 and originally consisted of £75 million (RM422 million; exchange rate £1 to RM 5.60) each year for five years. In the 2015 UK Spending Review, it was agreed to extend and expand the fund. The Newton Fund was extended from 2019 to 2021 and expanded by doubling the £75 million investment to £150 million (RM843 million) by 2021, leading to a £735 million (RM4.13 billion) in UK investment up to 2021, with partner countries providing matched resources within the Fund. The extension of the programme reflects on the trust from Malaysia's' UK counterpart brought upon by the quality of Malaysian researchers. In this regards, Malaysia has one of the highest averages in respect of the quality of their applications among the 18 Newton Fund countries.

### Knowledge Transfer

Assistance for supporting research however, need not always be in monetary form. At times technical assistance, knowledge transfer, sharing of facilities and resources adds to the success of important scientific discoveries. The partnership through global STI programmes facilitate policy transfer and knowledge translation by acting as the intermediary manager to make knowledge sources available, and generating opportunities for knowledge exchange.

Case Study - Japan International Cooperation Agency (JICA)

JICA is a governmental agency that coordinates official development assistance (ODA) for the government of Japan. It is chartered with assisting economic and social growth in developing countries, and the promotion of international cooperation.

The Project for Development of Low Carbon Society Scenarios for Asian Region was supported by JICA in collaboration with Japan Science and Technology Agency (JST) under the S&T Research Partnership for Sustainable Development (SATREPS) initiative.

Costing approximately RM 7.1 million, the project to date with 38 core team members comprising experts from various nationalities, this project provides an avenue for both Malaysian and Japanese researchers to collaborate and work together on researches that are themed around Low Carbon Society Scenarios.

135 joint publications were produced from this collaboration. From 2010 to 2016, 100 workshops, seminar and symposiums were held in encouraging the spirit of collaborating and partnership among the beneficiaries of the project.

The Low Carbon Society Blueprint for Iskandar Malaysia 2025 was also published under this project presenting comprehensive climate change mitigation policies, including low carbon society actions and sub-actions, and detailed strategies including measures and programs to guide the development of Iskandar Malaysia towards achieving its vision of 'a strong, sustainable metropolis of international standing' by 2025.

Partnership with JICA enables Malaysia to gain access to the expertise of developed country and at the same time encourages Malaysian researchers to work on building Malaysia's own R&D capacity and capability.

Case Study - Malaysian Technical Cooperation Programme (MTCP)

MTCP was first initiated at the First Commonwealth Heads of Government Meeting (CHOGM) for Asia Pacific Region in Sydney in February 1978. It was officially launched on 7 September 1980 at the Commonwealth Heads of State Meeting in New Delhi to signify Malaysia's commitment to South-South Cooperation, in particular Technical Cooperation among Developing Countries (TCDC).Objectives of MTCP:

- To share development experience with other countries;
- To strengthen bilateral relations between Malaysia and other developing countries;
- To promote South-South Cooperation (SSC);
- To promote technical cooperation among developing countries (TCDC)

The MTCP was first formulated based on the belief that the development of a country depends on the quality of its human resources. In line with the spirit of South-South Cooperation, Malaysia through the MTCP shares its development experiences and expertise towards the promotion of technical cooperation among developing countries, strengthening of regional and sub-regional cooperation, as well as nurturing collective self-reliance among developing countries.

Training in areas essential for a country's development such as good governance, health services, education, poverty alleviation, etc. is provided. Annually more than 80 short-term specialised courses are offered by 80 MTCP training institutions. Since its launching, more than 32,000 participants from 143 countries have benefited from the various programmes offered under the MTCP.

## Expert Engagement

Strategic STI alliance is also a pathway to strengthen Malaysia's presence in world class scientific communities and be invited as consultative partners in numerous international collaborations. It can play a crucial role by enabling incorporation of scientific evidence in the decision-making process through nurturing science communities and institutions such as national science academies, and fostering science advisory ecosystems.

The Global Science and Innovation Advisory Council (GSIAC)

GSIAC was established in 2010 as a platform to assemble great minds from many countries and link them up to our corporate leaders, researchers and policy makers for meaningful, high level discourse to advise the Prime Minister on Malaysia's national priorities . It convened for the first time on 17th May 2011 in New York. The council's main focus areas are Human Capacity Building, Smart Communities, Nutrition and Health, Green Futures and Digital Malaysia.

Since its inception, GSIAC led to the birth of several programmes amounting to USD 100 million. GSIAC was also instrumental in securing the Newton Funds through the S2A initiative. These pilot studies by GSIAC would be carried forward by the NSC for implementation by relevant ministries and agencies.

Case Study - Global Research Consortium: Malaysia Institute for Innovative Nanotechnology (NanoMITE)

NanoMITe was launched in 2015 by the then YB Minister of Education II and was awarded with a LRGS matching grant for five years to undertake 18 research projects under five categories; energy, wellness, medical & healthcare, food & agriculture, electronic, devices & systems and environment.

It is a global research consortium consisting of five MRUs as members and program leaders, 100 Malaysian scientists and collaboration with experts from renowned IHLs in USA, Europe and Asia. Through GSIAC, the proposal on NanoMITE was presented which led to NanoMITe in pursuing formal research collaboration with Harvard, MIT, and world ranking RUs.

The output from the NanoMITE Initiative up until 2017 is summarized in Table 6.9. Full information on the research projects of NanoMITe is as in Appendix 6.5. With collaboration with the vast array of expertise, NanoMITe manages to create high impact scientific research projects which are able to offers solutions to current industrial problems and indigenous output.

The role of Science diplomacy in building R&D ecosystem that responds to industry is evident in the case of NanoMITe. Collaboration with international counterparts will assist Malaysia to jumpstart researches in these programs for the benefit of the Malaysian industries.

**Table 6.4**
### Output of researches under NanoMITe up to 2017

Source: NanoMITe, 2017

| Program | Indexed Journal | Conf/ Proc | Intellectual Property | PhD student | Master student | UG student | Post-Doc Attachment |
|---|---|---|---|---|---|---|---|
| 1 | 8 | 23 | 1(filed) | 9 | 9 | 4 | 2(MIT) |
| 2 | 2 | 5 | 3(filed) | 6 | 8 | 5 | 3(Harvard) |
| 3 | (12) | 25 | | 8 | 8 | 2 | |
| 4 | 22 | 15 | 1(filed) | 9 | 12 | 3 | 1(Harvard) |
| 5 | 17 | 3 | | 5 | 3 | 2 | |
| **Total in 2017** | **49** | **71** | **5** | **37** | **40** | **16** | **6** |

World Health Organisation (WHO)

WHO has been active in Malaysia since the time of Malaysian independence in 1957. In the early years, WHO's cooperation focused on communicable disease control (WHO, 2001).

In recent years, UN agency programmes in Malaysia have become smaller and roles reversed. From the period of 2009 to 2015, Malaysia has made impressive technical contributions at both regional and global levels which include hosting 34 WHO technical meetings covering various aspects of health and safety. Malaysia also hosts the WHO Global Service Centre, located in Cyberjaya, Selangor.

Malaysian experts are also engaged with WHO as temporary advisors and consultants. For instance, they played a key role in responding to various humanity crises such as Typhoon Haiyan in 2013 and WHO global response to Ebola virus disease. These positions are important for capacity-building in other countries on various health issues such as dengue, HIV-resistance surveillance, field epidemiology, disaster risk management as well as mental health (WHO, 2017).

Strategic international alliance especially in the STI domain has positively impacted Malaysia in developing its STI capacity and capability. In return, Malaysia also reciprocated is assisting other partner nations and international platforms to build their capacity. It is important for Malaysia to strategise on strategic international alliance through internal communication such as retraining of talents and cooperation between important national stakeholders to play the right strategy in the nations' best interest, as external strategic communication serves as a soft power in expanding Malaysia's' influence on global STI arena.

Therefore, strategic international alliances, especially in approaching S&T in an integral manner by emphasising cross-sectoral connections and prioritising on our strengths will lead us towards our goals.

## WAY FORWARD TO INTERNATIONALISE STI STRATEGICALLY

Science and technology are important drivers of economic development and are critical in poverty alleviation hence there is a need to understand the value of local and global STI-related developments, and to incorporate this understanding into the nation's foreign policy for the 21st century. This appreciation for the STI agenda needs to be imbued into the front-line diplomats as well as civil servants and policy-makers in the various ministries and agencies. There is a need for symbiosis between this group of people and the expert scientists. The band of Administration and Diplomatic Service Officers (*Pegawai Tadbir Diplomat, PTD*) must be equipped to handle STI-related issues, including assignments to positions that focus on S&T issues.

1

### Leadership In Positioning Malaysia's Strategic STI International Alliances

To further strengthen the strategic STI international alliances, the various international platforms where Malaysia is a member must be fully utilised by our STI key opinion leaders to add to global competitiveness and increase the visibility of Malaysia's STI capacity and capabilities.

Malaysia has many bi- and multi-agreements in place and with the right strategy we can maximize on the S&T elements of future agreements to remain competitive in the technological pace of the 21st Century.

Networks and partnerships put Malaysiaat an advantage for global competitiveness and increase the visibility of Malaysia's STI capacity and capabilities. Therefore leadership in the STI related international alliances also allows for Malaysia's voice to be heard more significantly at global platforms such as the World Economic Forum, OECD, World Trade Organisation and World Bank.

Such fora create opportunities to make presentations or deliver keynotes based on strong Malaysian independent study reports or analysis that can serve as credible data source at international level. This will further facilitate international level understanding and recognition for Malaysia.

2

### Enhance Roles Of Science Attaché In Malaysian Embassies

The roles of Science Attaché in Malaysian embassies should be enhanced and expanded to include strategising, monitoring and evaluating STI-related issues pertinent to the nations' interest.

Scientifically literate and engaged diplomats appointed as Science Attachés at strategic embassies serves as an efficient strategy for Malaysia to connect with important institutions, organisations or even prominent individuals to ride on the technological driven global shift. Therefore, the future batch of diplomat officers should be trained to assume S&T related responsibilities. An alternative suggestion is to involve extensively more technically skilled personnel as PTD for excellent diplomatic insight with sound scientific knowledge.

Among the efforts that can be done is to encourage institutions like the Institute of Diplomacy and Foreign Relations (IDFR) to continuously upgrade science diplomacy resources; train diplomatic services personnel on STI issues, conduct workshop for scientists at universities on international engagement and negotiation and to provide independent, evidence-based scientific advice.

3

**Strengthen Linkages Between Ministry of Foreign Affairs (MOFA) and Malaysian Scientific Community**

The linkages between the Ministry of Foreign Affairs (MOFA) and Malaysian scientific community should be strengthen to include scientific evidences as an avenue for diplomatic decision makings.

The diplomats may need scientific and technological input from subject matter experts while scientists may rely on the diplomats to ensure a successful lobbying process. In diplomatic relationships, scientific evidences could aid in diplomatic decision makings while diplomats understanding scientific matters will help the country in seeking active scientific partnerships.

The authority to decide on the nation's STI direction of the country is MOSTI. Therefore, it is crucial for both focal points in MOSTI and MOFA to build successful partnerships between Malaysia's scientists, STI related civil societies and with other International Divisions of relevant Ministries to strategise before leveraging the networking at international platforms.

Other than partnerships, scientists could also be trained as diplomats to be appointed as Science Attachés and included in MOFA and Malaysia's foreign embassies to advice at senior and strategic level to initiate global scientific collaborations whether for research, advisory services, or funding application. Alternatively, we can leverage on cross discipline talents and science communicators to translate scientific and technical terminologies into diplomatic lingua franca.

4

**Leverage Malaysia's Trade Platforms Globally to Facilitate Market Intelligence in STI Based Industries**

Malaysia's should also leverage on its global trade platforms and trade missions for gathering STI-related intelligence to develop the right STI-related strategies for the Nation.

Trading and investment agencies of Malaysia such as MIDA and MATRADE have been collecting data in the global offices on trade related market intelligence to develop market strategies for the Nation. The collection of data should be extended if it is not already so to STI domains and shared among Ministries especially MOSTI, MOFA and other relevant ministries to strategise on STI internationalisation.

Data should also be shared with funding agencies, research institutions and scientists and, industries for the development of priority research areas based on our strength and global demand and at a greater scale. Korea's Institute of Science and Technology (KIST) for instance has over 80 partner institutes with ongoing collaboration globally which translate into greater competitiveness for Korean R&D and businesses.

# FURTHER READING

## Organisation/fora where Malaysia is a member:

**D-8 Organisation for Economic Cooperation,** also known as Developing -8, is an organisation for development co-operation among the following countries: Bangladesh, Egypt, Nigeria, Indonesia, Iran, Malaysia, Pakistan, and Turkey. The objectives of D-8 are to improve developing countries' positions in the world economy, diversify and create new opportunities in trade relations, enhance participation in decision-making at the international level, and provide better standards of living." The main areas of co-operation include finance, banking, rural development, science and technology, humanitarian development, agriculture, energy, environment, and health (Source: http://www.developing8.org/About.aspx/ | accessed 28 Feb 2018)

**Asia-Middle East Dialogue (AMED)** was conceived by the former Prime Minister of Singapore (presently Senior Minister) Goh Chok Tong to foster dialogue and mutual understanding, as well as strengthen co-operation between Asia and the Middle East. Discussions in AMED are organised under three broad pillars: political and security issues, economic issues, and dialogue on social, educational, scientific, cultural and media issues.

• AMED's membership is open to 49 countries and the Palestinian National Authority (PNA). The 49 countries are Afghanistan, Algeria, Bahrain, Bangladesh, Bhutan, Brunei, Cambodia, China, Comoros, Djibouti, Egypt, India, Indonesia, Iran, Iraq, Japan, Jordan, Kazakhstan, Kuwait, Kyrgyzstan, Laos, Lebanon, Libya, Malaysia, Maldives, Mauritania, Morocco, Myanmar, Nepal, Oman, Pakistan, Philippines, Qatar, Republic of Korea, Saudi Arabia, Singapore, Somalia, Sri Lanka, Sudan, Syria, Tajikistan, Thailand, Tunisia, Turkey, Turkmenistan, UAE, Uzbekistan, Vietnam, and Yemen. (Source: http://www.mofat.gov.bn/Pages/asia-middle-east-dialogue-(amed).aspx | accessed 28 Feb 2018)

**The Forum for East Asia –Latin America Cooperation (FEALAC)** was created in 1999 at the initiative of Chile and Singapore, with the objective of stimulating interaction and mutual understanding between the two regions, of promoting greater political dialogue, and of increasing cooperation in order to foster coordination between the two regions.

The Forum contributes to strengthening and promoting bi-regional relations, since it constitutes the most comprehensive cooperation mechanism involving East Asia and Latin America. Today, it comprises 36 countries: 20 from Latin America (Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, El Salvador, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Dominican Republic, Suriname, Uruguay and Venezuela) and 16 from East Asia (Brunei, Cambodia, China, Singapore, South Korea, Philippines, Indonesia, Japan, Laos, Malaysia, Mongolia, Myanmar, Thailand, Vietnam, Australia and New Zealand).

From an institutional point of view, the Forum currently works on three levels:

• Foreign Ministers Committee, the highest decision-making body of the mechanism. It holds meetings every two years;

• Senior Officials Committee: meets annually; and

• Working groups: hold meetings annually in the following areas: Sociopolitical Cooperation and Sustainable Development; Trade, Investment, Tourism and Small and Medium-sized Enterprises; Culture; Youth; Gender and Sports; Science and Technology; Innovation and Education. (Source: (http://www.itamaraty.gov.br/en/politica-externa/mecanismos-inter-regionais/9789-forum-for-east-asia-latin-america-cooperation-fealac | accessed 28 Feb 2018)

## Malaysia in ASEAN

### Administrative and procedural matters

• Ministry of Foreign Affairs is the National Secretariat of ASEAN for Malaysia

• Ministry of Science, Technology and Innovation (MOSTI) is the coordinator and national focal point in STI international alliance among government ministries and agencies and the private sector in Malaysia through the Committee on Science and Technology (COST).

### Jurisdiction

• MOSTI is responsible in coordinating Malaysia's participation in the following platform on STI:

- ASEAN Ministers' Meetings on Science and Technology (AMMST)
- ASEAN Committee on Science and Technology (COST) Meetings; and
- ASEAN Committee on Science and Technology (ASEAN-COST) Dialogue Partners Meeting.

### Involvement

• Chairmanship of ASEAN in 2015

- ASEAN Leaders signed the 2015 Kuala Lumpur Declaration on the Establishment of the ASEAN Community, as well as the Kuala Lumpur Declaration on ASEAN 2025: Forging Ahead Together on 22 November 2015 during the 27th ASEAN Summit in Kuala Lumpur.

The ASEAN Economic Community – which will come to force in 2025 – is envisioned to be "highly integrated and cohesive; competitive, innovative and dynamic; with enhanced connectivity and sectoral cooperation; more resilient, inclusive, and people-oriented, people-centred, and is integrated with the global economy" (ASEAN Economic Integration Brief, 2017); opening opportunities in developing science, technology and innovation.

• Country Coordinator of the ASEAN Journal on Science & Technology for Development (2012-2017)

• Chaired the Sub-Committee on Marine Science and Technology (SCMSAT) (2015-2017) - National Oceanography Directorate

• Malaysia also held high level posts in ASEAN Federation of Engineering Organization (AFEO)

• Project lead

- In 2017, Malaysia was proposed to several new projects such as:
- ASEAN 2050 Forum: 4th Industrial Revolution,
- ASEAN-Republic Korea Innovation Centre (ARIC)

• Host

- 7th ASEAN Plus Three Junior Science Odyssey 2018

• Participant

- Under various other subcommittees, Malaysia are also actively participating in organising workshops in the area of medical, agriculture, energy, material sciences and computer sciences

## GSIAC

GSIAC is an international council chaired by the Prime Minister with joint secretariats from Malaysian Industry-Government Group for High Technology (MIGHT) and the New York Academy of Sciences (NYAS). The Science obal corporate leaders, Nobel Laureates, eminent global academicians, and researchers. As of 2014, it has 49 members; 25 international members, 15 national council members and nine ex-officio members. The council meets once a year to deliberate on strategic and futurist matters that will benefit Malaysia in the long run.

GSIAC objectives are:

1. To provide strategic advice and serve as sounding board for Malaysia's aspiration to use STI to become a developed nation by 2020;
2. To benchmark Malaysia's STI rank and competitiveness against technologically advanced countries, and improve the nation's STI capabilities;
3. To add value to Malaysia's economic transformation programme objectives;
4. To intensify capacity building through national industry-academia collaboration with world experts and globally renowned organisations; and
5. To generate and increase short-, medium-, and long-term bilateral trade and investment value.

GSIAC collaborative programmes are devised to align with the nation's objectives that are outlined in the 11th Malaysia Plan:

| | 11TH MALAYSIA PLAN STRATEGIC THRUSTS | | | | | |
|---|---|---|---|---|---|---|
| Programme / Initiatives | Inclusiveness | Wellbeing for all | Accelerating HCD | Green Growth for sustainability | Strengthening infrastructure | Reengineering growth |
| Nobelist Mindset Program (PERMATApintar) | | | | | | |
| Bitara STEM Program | | | | | | |
| Collaborative Research on Nanotechnology (NanoMalaysia) | | | | | | |
| Centre of Excellence (UTM, USM & Earth Inst) | | | | | | |
| Smart City:Iskandar Smart city | | | | | | |
| Smart City: Melaka Sustainable City | | | | | | |
| Smart Village: Rimbunan Kaseh (IRIS) | | | | | | |
| Smart Village: Sentuhan Kasih | | | | | | |
| Smart Grid: MGTC & GE | | | | | | |
| Joint Funding on Green Tech | | | | | | |
| MyBiomass | | | | | | |
| Global Cleantech Innovation Program | | | | | | |
| My Body Fit & Fabulous (MyBFF) | | | | | | |
| Digital Malaysia | | | | | | |

### KIST

Korea Institute of Science and Technology (KIST) is a global science & technology research institute in support of innovative international programs and initiatives. It works directly with international communities, countries, and partner institutes.

It has over 80 partner institutes with ongoing collaboration around the world. This extensive network allows KIST to actively pursue international research projects, host international conferences, exchange researchers, and launch other related programs. (Ref: https://eng.kist.re.kr/kist_eng/?sub_num=434 | accessed on28 Feb 2018)

## APPENDIX

### Appendix 6.1

### List of STI-related multilateral treaties signed by Malaysia (Tanah Melayu / Malaya before 1957)

| No. | Sector | Multilateral Treaties | Categories | Year |
|---|---|---|---|---|
| 1 | Intellectual & Industrial Property | Convention for the Protection of Industrial Property & Revision | Legal Framework | 1883 |
| 2 | Transport & Communications | International Air Services Transit Agreement | International Agreement | 1944 |
| 3 | Transport & Communications | Convention on International Civil Aviation | Legal Framework | 1944 |
| 4 | FAO | Constitution of the Food & Agriculture Organisation (FAO) | International Cooperation | 1945 |
| 5 | Narcotic Drugs & Psychotropic Substances | Convention for Limiting the Manufacture & Regulating the Distribution of Narcotic Drugs | General Regulation | 1946 |
| 6 | Narcotic Drugs & Psychotropic Substances | Protocol Bringing Under International Drugs Outside the Scope of the Convention of 13 July 1931 for Limiting the Manufacture and Regulating the Distribution of Narcotic Drugs as amended by the Protocol | General Regulation | 1946 |
| 7 | Commodities | Constitution of the International Rice Commission | International Cooperation | 1948 |
| 8 | Fisheries | Agreement for the Establishment of the Asia-Pacific Fisheries Commission | International Cooperation | 1948 |
| 9 | Narcotic Drugs & Psychotropic Substances | Protocol Bringing Under International Drugs Outside the Scope of the Convention of 13 July 1931 for Limiting the Manufacture and Regulating the Distribution of Narcotic Drugs as amended by the Protocol | General Regulation | 1948 |
| 10 | Road Traffic | Convention on Road Traffic | General Regulation | 1949 |
| 11 | Educational & Cultural Matters | Agreement on the Importation of Educational, Scientific & Cultural Materials | International Agreement | 1950 |
| 11 | Educational & Cultural Matters | Agreement on the Importation of Educational, Scientific & Cultural Materials | International Agreement | 1950 |
| 12 | International Organisation | Statutes of the International Atomic Energy Agency | International Cooperation | 1956 |

| | | | | |
|---|---|---|---|---|
| 13 | Law of the Sea | Convention on Fishing & Conservation of the Living Resources of the High Seas | International Agreement | 1958 |
| 14 | Narcotic Drugs & Psychotropic Substances | Single Convention on Narcotic Drugs, New York | Legal Framework | 1961 |
| 15 | Disarmament | Treaty Banning Nuclear Weapons Testing in the Atmosphere in Outer Space and Underwater | International Agreement | 1963 |
| 16 | Atmosphere and Outer Space | Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies | Legal Framework | 1967 |
| 17 | Intellectual & Industrial Property | Convention establishing the World Intellectual Property Organisation (WIPO) | International Cooperation | 1967 |
| 18 | Atmosphere and Outer Space | The Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space | International Agreement | 1968 |
| 19 | Commodities | Agreement establishing the Asian Coconut Community | International Cooperation | 1968 |
| 20 | Disarmament | Treaty on the Non Proliferation of Nuclear Weapons | International Agreement | 1968 |
| 21 | Environment | International Convention on Civil Liability for Oil Pollution Damage | Legal Framework | 1969 |
| 22 | Commodities | Agreement establishing the Pepper Community | International Cooperation | 1971 |
| 23 | Disarmament | Treaty of the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Seabed and the Ocean Floor and in the Subject | International Agreement | 1971 |
| 24 | Environment | International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage | Legal Framework | 1971 |
| 25 | Narcotic Drugs & Psychotropic Substances | Convention on Psychotropic Substances | Legal Framework | 1971 |
| 26 | Disarmament | Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction | International Agreement | 1972 |
| 27 | Educational & Cultural Matters | Convention for the Protection of the World Cultural & Natural Heritage | International Agreement | 1972 |
| 28 | International Organisation | Agreement for the Establishment of a Regional Animal Production and Health Commission for Asia and the Pacific | International Cooperation | 1973 |
| 29 | International Trade & Development | Agreement Establishing the International Fund for Agricultural Development | International Cooperation | 1976 |
| 30 | Commodities | Agreement establishing the Southeast Asia Tin Research and Development Centre | International Cooperation | 1977 |
| 31 | Commodities | International Natural Rubber Agreement 1979 | International Agreement | 1979 |
| 32 | Communications | Universal Postal Convention & General Regulation of UPU | General Regulation | 1979 |
| 33 | Communications | Postal Parcels Agreement, Rio de Janeiro, 26 October 1979 | International Agreement | 1979 |

| | | | | |
|---|---|---|---|---|
| 34 | Commodities | Agreement establishing the Common Fund for Commodities | International Cooperation | 1980 |
| 35 | Commodities | Sixth International Tin Agreement 1981 *Expired | International Agreement | 1981 |
| 36 | Communications | Asia Pacific Postal Convention, Jogjakarta | International Agreement | 1981 |
| 37 | Commodities | International Convention on the Harmonised Commodity Description and Coding System | General Regulation | 1983 |
| 38 | Commodities | International Tropical Timber Agreement | International Agreement | 1983 |
| 39 | Commodities | Agreement establishing the Association of Tin Producing Financial Agreement | International Cooperation | 1983 |
| 40 | Communications | Universal Postal Convention and General Regulation of UPU | International Agreement | 1984 |
| 41 | Atmosphere & Outer Space | Vienna Convention for the Protection of the Ozone Layer | International Agreement | 1985 |
| 42 | Communications | Constitution of the Asia-Pacific Postal Union | International Agreement | 1985 |
| 43 | Disarmament | Convention on Early Notification of Nuclear Accident | International Agreement | 1986 |
| 44 | Disarmament | Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency | International Agreement | 1986 |
| 45 | Road Traffic | Agreement on the Reconstruction of the Commonwealth Agricultural Bereaux as Cab International | International Cooperation | 1986 |
| 46 | Commodities | International natural Rubber Agreement 1987 | International Agreement | 1987 |
| 47 | Fisheries | Agreement on the Network of Aquaculture Centres in Asia and the Pacific | International Cooperation | 1988 |
| 48 | Narcotic Drugs & Psychotropic Substances | Convention against illicit Traffic in Narcotic Drugs and Psychotropic Substances | Legal Framework | 1988 |
| 49 | Commodities | Terms of References of the International Tin Study Groups | International Cooperation | 1989 |
| 50 | Communications | Asia Pacific Postal Convention | International Agreement | 1990 |
| 51 | Environment | International Convention on Oil Pollution Preparedness, Response and Cooperation | International Agreements | 1990 |
| 52 | Disarmament | Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on their Destruction | International Agreement | 1992 |
| 53 | Disarmament | Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction | Legal Framework | 1992 |
| 54 | Commodities | International Cocoa Agreement (1993) | International Agreement | 1993 |
| 55 | Fisheries | Agreement for the Establishment of the Indian Ocean Tuna Commission | General Regulation | 1993 |
| 56 | Disarmament | Comprehensive Nuclear-Test-Ban Treaty | International Agreement | 1996 |
| 57 | Agriculture | International Treaty on Plant Genetic Resources for Food and Agriculture | International Cooperation | 2001 |
| 58 | Health | Framework Convention on Tobacco Control | Legal Framework | 2003 |

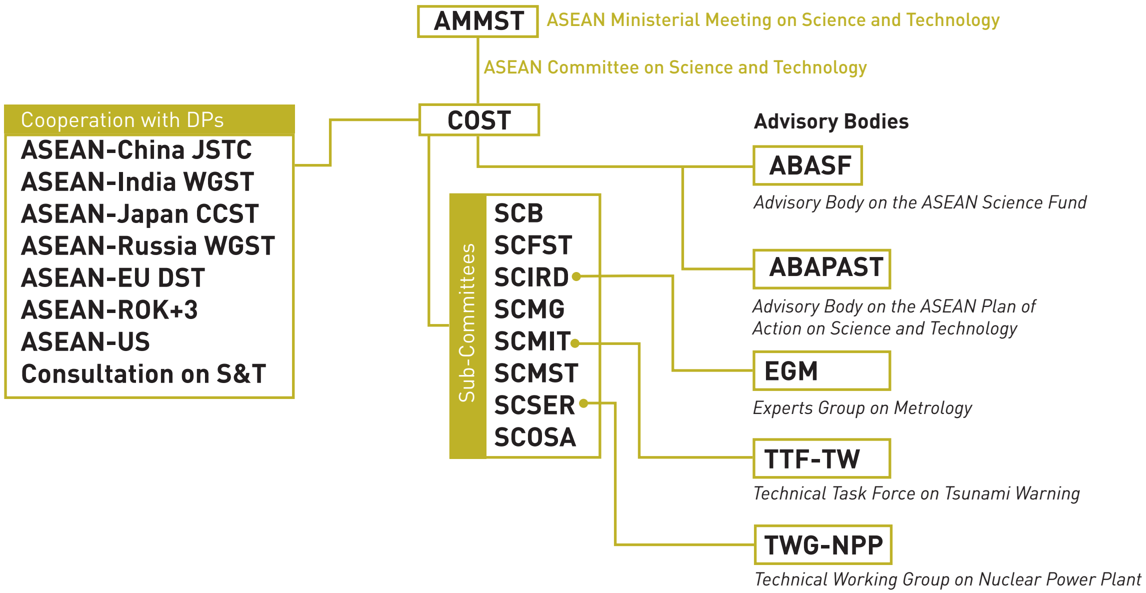
List has been cross-validated with correspondence with the Ministry of Foreign Affairs.

List of bilateral treaties were shared by the following Ministries mostly involving STI-related capacity building, transfer of knowledge, staff exchange for training purposes and technology transfer:

- Ministry of Youth and Sports (KBS)
- Ministry of Energy, Green Technology and Water (KeTTHA)
- Ministry of Domestic Trade, Co-operatives and Consumerism (KPDNKK)
- Ministry of Natural Resources and Environment (NRE)
- Ministry of Human Resources (MOHR)
- Ministry of Higher Education (MOHE)

**Appendix 6.2**

## Existing structure of ASEAN Alliance in S&T




- SCB : Sub-Committee on Biotechnology
- SCFST : Sub-Committee on Food Science and Technology
- SCIRD : Sub-Committee on S&T Infrastructure and Resources Development
- SCMG : Sub-Committee on Meteorology and Geophysics
- SCMIT : Sub-Committee on Microelectronics and Information Technology
- SCMSAT : Sub-Committee on Marine Science and Technology
- SCMST : Sub-Committee on Materials Science and Technology
- SCSER : Sub-Committee on Sustainable Energy Research
- SCOSA : Sub-Committee on Space Technology and Applications
- ABASF : Advisory Body of the ASEAN Science Fund
- ABAPAST : Advisory Body on the ASEAN Plan of Action on Science and Technology

## Sub-committees/AJSTD (ASEAN Journal on Science and Technology for Development)

| Sub-Committee AJSTD | 1 July 2014 - 31 December 2017 Chairperson | Vice Chairperson | 1 January 2018 - 31 December 2020 Chairperson | Vice Chairperson |
|---|---|---|---|---|
| SCB | Cambodia | Indonesia | Indonesia | Lao PDR |
| SCFST | Brunei Darussalam | Cambodia | Cambodia | Indonesia |
| SCIRD | Lao PDR | Malaysia | Malaysia | Myanmar |
| SCMG | Myanmar | Philippines | Philippines | Singapore |
| SCMIT | Singapore | Thailand | Thailand | Viet Nam |
| SCMSAT | Malaysia | Myanmar | Myanmar | Philippines |
| SCMST | Viet Nam | Brunei Darussalam | Brunei Darussalam | Cambodia |
| SCSER | Thailand | Viet Nam | Viet Nam | Brunei Darussalam |
| SCOSA | Philippines | Singapore | Singapore | Thailand |
| AJSTD | Malaysia | Indonesia | Indonesia | Lao PDR |

**Appendix 6.3**

## Selected programmes and the quantum of fund made available through NUOF

### Newton Researcher Link (Grant for Workshop)

Programme to stimulate initial links between, and support capacity building among 'rising star' early career researchers in partner countries and the UK.

Matching Fund: **£125,000**

Duration: **Annually until 2019**

### UK-Malaysia Bilateral Health Research Collaboration

Support Malaysian-UK research collaborations in Medical and Health Sciences.

Matching Fund: **Up to £2 million**

Duration: **Only 1 cycle that covers 2 years research collaboration (2017-2018)**

### Newton Advance Fellowship

Provide established international researchers with an opportunity to develop the research strengths and capabilities of their research group through training, collaboration and reciprocal visits with a partner in the UK.

Matching Fund: **Up to £1.036 million**

Duration: **Annually until 2019**

### Newton Mobility Grant

Help strengthen the research and innovation capacity of researchers from partner countries by assisting them in visiting or sending staff and students to the UK and developing networks, research projects and partnerships with their UK hosts/counterparts and the wider UK research and innovation community.

Matching Fund: **Up to £276,000**

Duration: **Annually until 2019**

**Appendix 6.4**

## NanoMITE Initiatives

### Energy (UTM)

- Solid-Oxide Fuel Cells for Power Industry (UTM)
- Flexible Dye-Sensitized Solar Cells (DSSCs): Printed solar Cells for Renewable Energy (UTP)
- Second generation catalytic pyrolysis of palm oil EFB biomass to jet fuel (UTM)

### Wellness, Medical & Healthcare (UM)

- Pulmonary nanocarrier design and delivery of cisplatin and siRNA for lung cancer treatment (UM)
- Development of palm-based nanoaerosol and nanomagnetosol for pulmonary drug delivery (UPM)
- Nanotoxicology studies of formulations for pulmonary drug delivery (USM)
- Consequences of Smoking among the Malaysian Population(UM)

### Food & Agriculture (UPM)

- Controlled release formulation based on graphene for NDS in controlling GB related disease in oil palm (UPM)
- Nanosensor for early detection of GB and soil quality (UPM)
- Application of the NDS and nano sensor in smart farming for actual detection and control of GB (UPM)
- Nanofabrication of devices for nanosensing and control of GB (UNIMAP)

### Electronics, Devices & Systems (UKM)

- High capacitance vertical aligned graphene inter-digital supercapacitor for powering implanted biomedical devices (UKM)
- Graphene membrane for ultra-sensitive NEMS pressure sensor and nanophone (UPM)
- Graphene-based photonic crystal biosensor for pathogen detection (UIAM)
- Efficient and bright light-emitting diodes on single-layer graphene electrodes (UKM)

### Environment (USM)

- Novel Polymeric Photoactivated Nanomaterials for CO2 Photoreduction with CH4 to Renewable Hydrocarbon Fuels (UTM)
- Syngas production via CO2 reforming of methane using nanocatalys (UPM)
- Chemical conversion of CO2 to value added products over nanomaterials (USM)

**Appendix 6.5**

## To illustrate active networking, expert engagements etc by Malaysian entities, listed below are the International Meetings of ASM in 2017

**1. World Economic Forum (WEF 2017)**
Represented by Hazami Habib
17 – 20 January (Davos, Switzerland)

**2. The 3rd Meeting of the AASSA Expert Group for the IAP Project on "Food and Nutrition Security and Agriculture (FNSA)"**
Represented by Dr Tan Swee Lian FASc
6 – 9 February (New Delhi, India)

**3. IAP SEP Global Council Meeting**
Represented by Academician Dato' Ir Lee Yee Cheong
8 February (Khartoum, Sudan)

**4. APEC 9th Partnership on STI Meeting**
Represented by Nitiavathy Samuel (*obo* Hazami Habib)
18 – 21 February (Nha Thrang, Vietnam)

**5. AASSA – SCJ Workshop on "Role of Science for Inclusive Society"**
Represented by Academician Professor Dato' Dr Khairul Anuar Abdullah
1 – 3 March (Tokyo, Japan)

**6. AASSA – INSA Workshop on "Effects of Climate Change on Sustain Agriculture and Nutrition Security in Asia"**
Represented by Dr Tan Swee Lian FASc
16 – 17 March (New Delhi, India)

**7. The 2nd Plenary Meeting of the IAP Project on "Food and Nutrition Security and Agriculture"**
Represented by Dr Tan Swee Lian FASc
2 -5 April (Halle, Germany)

**8. APEC 10th Partnership on STI Meeting**
Represented by Hazami Habib
11 – 13 May (Ho Chi Minh, Vietnam)

**9. ASEAN – U.S. Science and Technology Fellowship Meeting**
Represented by Nina Azrah
31 May – 2 June (Jakarta, Indonesia)

**10. The Commonwealth Science Conference 2017**
Represented by Academician Distinguished Professor Datuk Dr Looi Lai Meng FASc
13 – 16 June (Singapore)

**11. 90th IIASA Council Meeting**
Represented by Datuk Dr Asma Ismail FASc
19 – 20 June (Vienna, Austria)

**12. IAP SEP International Forum on Science Education**
Represented by Academician Dato' Ir Lee Yee Cheong FASc
2 – 5 July (Beijing, China)

**13. The 6th ASEAN Plus Three Junior Science Odyssey (APT JSO)**
Represented by Asna Asyraf Saedon
10 – 15 July (Hanoi, Vietnam)

**14. Smart Cities in APEC Region**
Represented by Zuriany Zaki
18 August (Ho Chi Minh, Vietnam)

**15. 3rd Asian Innovation Forum**
Represented by Hazami Habib
28 – 29 August (Seoul, Korea)

**16. 2017 Euro-Asia Economic Forum and International Congress on S&T Innovation of International Silk Road Academy of Sciences (ISRAS)**
Represented by YM Tengku Datuk Dr Mohd Azzman Shariffadeen
21 – 26 September (Beijing, China)

**17. AASSA – NAST PHL International Symposium on "Best Practices in Translational Research For Social Development, " in conjunction with the AASSA Executive Board Meeting 2017**
Represented by Academician Professor Dato' Dr Khairul Anuar Abdullah
28 – 29 September (Tagaytay City, Philippines)

**18. Indian Ocean Rim Association (IORA) Innovation Exposition**
Represented by Ratnamalar Rajasingam
28 – 29 September (New Delhi, India)

**19. 14th Science and Technology Forum**
Represented by Hazami Habib
1 – 3 October (Kyoto, Japan)

**20. IAP – HEC Meeting**
Represented by Academician Distinguished Professor Datuk Dr Looi Lai Meng FASc
2 October (Trieste, Italy)

**21. IAP – H EC Meeting in conjunction with the Young Physician Leaders Programme (YPL) and the World Health Summit**
Represented by Academician Distinguished Professor Datuk Dr Looi Lai Meng FASc
12 – 17 October (Berlin, Germany)

**22. Joint Meeting ICSU-ISSC/ICSU GA**
Represented by Professor Ir Dr Ahmad Faizal Mohd Zain FASc
21-28 October (Taipei, Taiwan)

**23. 91st IIASA Council Meeting**
Represented by Professor Datuk Ir Dr A. Bakar Jaafar FASc
12 – 14 November (Vienna, Austria)

**24. 4th Innosight Workshop: Design for a Circular Economy**
Represented by Jagdish Kaur Chahil
14 – 18 November (Taipei, Taiwan)

**25. 8th International Conference of Foresight**
Represented by Hazami Habib
29 November – 1 December (Tokyo, Japan)

**26. Science for Poverty Eradication Committee (SPEC) Conference**
Represented by Prof Dato' Dr Aishah Bidin FASc
9 – 10 December (Beijing, China)

## BUILDING UP THE CULTURE OF DATA SHARING

The Science Outlook 2017 edition analysed fair share of data that had been shared by several institutions (refer Acknowledgement). Data was also available through some online data repositories hosted by renowned international organisations. However the challenge to acquire data specific to STI still remains. For instance there is no readily available data on number of STEM jobs or data on total number of companies that carry out R&D activities based on the current priority areas. Response on ASM's enquiry on cost benefit analysis and return-on-investment for STI related awareness programmes carried out was poor. Stock-take and impact of all international agreements signed was also not available.

Data sharing among institutions need to be encouraged to better formulate national policies and strategies which will reflect current and foresighted global trends. While trying to secure data for this report we observed that not all institutions were comfortable with data sharing. The lack of trust and fear of misrepresentation of data is a possible reason. In some cases, processing time for permission to be granted to access 3rd party data is lengthy probably due to insufficient manpower to process our request. It also becomes challenging when no centralised contact person is assigned. When contact information is not made available, follow-up efforts become truncated. At times, certain databases can only be assessed at the premise of the data provider. We also realised that newer and current STI-related indicators must be considered periodically to cover more holistic elements of STI.

The importance of data to be recorded accurately and systematically will help in producing a fair independent report that reflects the country's stature. When such report is referred by international organisations that produce competitive rankings, representation of Malaysia's STI ecosystem will be fairly reported and our rankings will be more reflective our true strengths.

- COMTRADE, UN
- International Trade Centre
- MyIPO
- MyRA, MOHE
- Registry of Societies of Malaysia
- SCImago, Elsevier
- SciVal, Elsevier
- Statistics portal of DOSM
- UN Statistics
- UNESCO Institute of Statistics
- WIPO
- World Bank Database
- WTO Statistics Database

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Nur Akmal Hayati Mohd Jaffar (EPU)

Aerospace Malaysia Innovation Centre (AMIC)
ASM Northern Chapter
Astro Awani Network Sdn Bhd (AWANI)
Bahagian Perancangan Kecemerlangan IPT
Bahagian Teknologi Maklumat, Pejabat Setiausaha Kerajaan Negeri Selangor
British High Commission
Construction Industry Development Board (CIDB)
Department of Statistics Malaysia (DOSM)
Dewan Perniagaan Melayu Malaysia (DPMM)
Economic Planing Unit (EPU)
Federation of Malaysian Manufacturers (FMM)
German Academic Exchange Service (DAAD)
Intellectual Property Corporation of Malaysia (MyIPO)
Jabatan Muzium Malaysia
Japan International Cooperation Agency (JICA)
Jawatan Kuasa Pelaburan Dana Awam (JKPDA)
JobStreet Corporation Berhad
Kerajaan Negeri Terengganu
Malaysia Digital Economy Corporation (MDEC)
Malaysia Investment Development Authority (MIDA)
Malaysian Bioeconomy Development Corporation Sdn Bhd
Malaysian Science and Technology Information Centre (MASTIC)
Media Prima Berhad
Ministry of Agriculture and Agro-Based Industry (MOA)
Ministry of Domestic Trade, Co-operatives and Consumerism (KPDNKK)
Ministry of Energy, Green Technology and Water (KeTTHA)
Ministry of Foreign Affairs (MOFA)
Ministry of Health (MOH)
Ministry of Higher Education (MOHE)
Ministry of Human Resources (MOHR)
Ministry of International Trade and Industry (MITI)
Ministry of Natural Resources and Environment (NRE)
Ministry of Science, Technology and Innovation (MOSTI)
Ministry of Transport (MOT)
Ministry of Youth and Sports (KBS)
Multimedia University (MMU)
Pejabat Setiausaha Kerajaan Negeri Pulau Pinang
Pejabat Setiausaha Kerajaan Negeri Sembilan
PlaTCOM Ventures Sdn Bhd (PlaTCOM)
Pusat Sains dan Kreativiti Terengganu
Pusat Sains Negara (PSN)
Radio Televisyen Malaysia (RTM)
Sarawak Biodiversity Centre
SIRIM Berhad
SME Corporation Malaysia (SME Corp)
Steinbeis Malaysia Foundation (Agensi Inovasi Malaysia)
Radio Televisyen Malaysia RTM)
The Associated Chinese Chambers of Commerce and Industry of Malaysia (ACCCIM)
The Edge Malaysia
The Institution of Engineers Malaysia (IEM)
The Registry of Societies Malaysia (Ministry of Home Affairs)
Unit Perancang Negeri, Jabatan Ketua Menteri Sarawak
Universiti Malaya (UM)
Universiti Malaysia Perlis (UNIMAP)
Universiti Malaysia Terengganu (UMT)
Universiti Perdana
Universiti Sains Islam Malaysia (USIM)
Universiti Sains Malaysia (USM)
Universiti Teknologi Malaysia (UTM)
Universiti Teknologi Petronas (UTP)
Universiti Tun Hussein Onn Malaysia (UTHM)
Universiti Tunku Abdul Rahman (UTAR)
YSN-ASM Affiliates from Industry

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