10 10 MySTIE FRAMEWORK

Trailblazing the Way for Prosperity,
Societal Well-Being & Global Competitiveness

KEMENTERIAN SAINS,
TEKNOLOGI DAN INOVASI
MINISTRY OF SCIENCE, TECHNOLOGY AND INNOVATION

10-10 Malaysian Science, Technology, Innovation and Economy (*My*STIE) Framework
Trailblazing the Way for Prosperity, Societal Well-Being & Global Competitiveness

Academy of Sciences Malaysia
Level 20, West Wing, MATRADE Tower
Jalan Sultan Haji Ahmad Shah off Jalan Tuanku Abdul Halim
50480 Kuala Lumpur, Malaysia

Perpustakaan Negara Malaysia Cataloguing-In-Publication Data

10-10 Malaysian Science, Technology, Innovation and Economy (*My*STIE) Framework
Trailblazing the Way for Prosperity, Societal Well-Being & Global Competitiveness

Download this book at www.akademisains.gov.my/10-10-mystie

ISBN 978-983-2915-49-2

Content

Team

ADVISORS
Professor Datuk Dr Asma Ismail FASc
President, Academy of Sciences Malaysia

Puan Hazami Habib
CEO, Academy of Sciences Malaysia

STUDY TEAM
Subject Matter Experts
Professor Dr Mahendhiran Nair FASc, FCPA (Australia)
Lead

Professor Dr Pervaiz K. Ahmed
Associate Professor Dr Santha Vaithilingam

STI STRATEGIC STUDIES UNIT
Nitia Samuel
Principal Analyst

ASM Analysts
Nur Zuriany Zaki
Mohd Ikhwan Abdullah
Muhammad Haikal Hikmal Hazam
Noratiqah Ahmad
Nurhani Mat Razali
Teng Yu He
Rahmat Shah Putra Samsul Rizal
Nurul Rahimah Abu Bakar

Administrative Support
Sazarul Aini Sabot

Monash University Malaysia Analysts
Daniel Lee Lih Wei
Yeng Hong Qing
Choong Chai Lim

STRATEGIC PARTNER
Technology Foresight Division, MOSTI
Roshana Alma Mohd Ali
Ho Yun Shiang

Editorial & Design Team
Dharshene Rajayah
Syazwani Abu Bakar
Laviinia Dhanagunan
Ammielyya Jusnieza Ahmad Jafri
Muhammad Syafiq Mohamad Shafiee

Acknowledgement

The 10-10 *My*STIE Transformation Book is the product of multiple engagements with various ministries and agencies, industry representatives as well as academics. Our sincere appreciation to all stakeholders for your support and valuable input.

Special thanks to:

National Science Council Malaysia (NSC)
Ministry of Science, Technology & Innovation (MOSTI)
Economic Planning Unit (EPU), Prime Minister's Department
Ministry of Agriculture and Food Industry (MAFI)
Ministry of Communications and Multimedia (KKMM)
Ministry of Defence (MinDef)
Ministry of Domestic Trade and Consumer Affairs (KPDNKEP)
Ministry of Education (MOE)
Ministry of Energy and Natural Resources (KeTSA)
Ministry of Entrepreneur Development and Cooperatives (MEDAC)
Ministry of Environment and Water (KASA)
Ministry of Higher Education (MoHE)
Ministry of Home Affairs (MOHA)
Ministry of Housing and Local Government (KPKT)
Ministry of Human Resources (MOHR)
Ministry of Plantation Industries and Commodities
(formerly known as Ministry of Primary Industries) (MPIC)
Ministry of Rural Development (KPLB)
Ministry of Tourism, Arts and Culture (MoTAC)
Ministry of Women, Family and Community Development (KPWKM)
Ministry of Works (KKR)
National Economic Action Council (NEAC)
Bank Negara Malaysia (BNM)
Malaysian Industry-Government Group for High Technology (MIGHT)
Malaysian Investment Development Authority (MIDA)
National Hydraulic Research Institute of Malaysia (NAHRIM)
Science and Technology Research Institute for Defence (STRIDE)
ADV FusionNex
ASEAN Young Scientist Network (ASEAN-YSN)
Association of Islamic Banking and Financial Institutions of Malaysia (AIBIM)
Bioeconomy Corporation
Birunisoft PLT
Construction Industry Development Board (CIDB)
Cyberview Sdn Bhd
Federation of Malaysian Manufacturers (FMM)
Forest Research Institute Malaysia (FRIM)
Futurise Sdn Bhd
Impact Malaysia
Institute of Labour Market Information and Analysis (ILMIA)
Intellectual Property Corporation of Malaysia (MyIPO)
Malaysia Digital Economy Corporation (MDEC)
Malaysian Agricultural Research and Development Institute (MARDI)
Malaysian Green Technology and Climate Change Centre (MGTC)
Malaysian Institute of Road Safety Research (MIROS)
Malaysian Palm Oil Board (MPOB)
Malaysian Water Association (MWA)
Malaysian Water Partnership (MyWP)
MIMOS Berhad
NanoMalaysia Berhad
National Institutes of Health Malaysia (NIH)
National Nanotechnology Centre (NNC)
Novorient Sdn Bhd
Talent Corporation Malaysia Berhad (TalentCorp)
Yayasan Inovasi Malaysia (YIM)
SME Corp Malaysia
International Medical University (IMU)
UCSI University
Universiti Islam Antarabangsa Malaysia (UIAM)
Universiti Kebangsaan Malaysia (UKM)
Universiti Malaya (UM)
Universiti Malaysia Kelantan (UMK)
Universiti Putra Malaysia (UPM)
Universiti Sains Islam Malaysia (USIM)
Universiti Sains Malaysia (USM)
Universiti Teknologi Malaysia (UTM)
Universiti Teknologi Mara (UiTM)
Universiti Teknologi Melaka (UTeM)
Universiti Teknologi Petronas (UTP)
Universiti Tunku Abdul Rahman (UTAR)

FOREWORD BY THE MINISTER OF SCIENCE, TECHNOLOGY & INNOVATION (MOSTI)

The role of science, technology and innovation (STI) in developing an economy is indisputable. Malaysia gladly acknowledges the fundamental influence of STI on the economy and its impact on societal development. Given the strong linkages between the two, the Ministry introduces the term "STIE" to highlight the importance of an ecosystem approach as an engine for nation building.

The release of the 10-10 *My*STIE Framework is crucial as we embark on a journey of socio-economic transformation powered through the creation of a vibrant STIE ecosystem. The Framework will pave the way for the nation to improve its innovative and creative capability as a means of enhancing economic competitiveness and quality of life.

This Framework serves to bring together diverse stakeholders to collaboratively nurture a strong national STIE ecosystem for the robust development of sectors, thereby enabling a shared prosperity for all citizens of Malaysia. It will bring together partners from different strata of society, leaving no one behind.

I hope that this will be a new dawn for Malaysia, in forging a trajectory to become a dynamic global leader in key niche areas.

Congratulations to the team at the Academy of Sciences Malaysia (ASM) for formulating a forward-thinking tool that will serve as an enabler to facilitate a collaborative and transformative mechanism for high impact and inclusive development of the nation, powered by STI.

KHAIRY JAMALUDDIN

FOREWORD BY PRESIDENT OF THE ACADEMY OF SCIENCES MALAYSIA (ASM)

At the Academy of Sciences Malaysia (ASM), we believe in making science, technology and innovation (STI) a basis for economic development and societal well-being. This is even more necessary now as a result of the significant impact that COVID-19 has had on the world. Much like countries across the globe, Malaysia needs an economic recovery plan that will not only stimulate current economic sectors but spawn new sources of economic growth and societal development. It is necessary for the plan to be an inclusive one and move away from a silo approach.

As the nation's thought leader for matters related to STI, having a bird's eye view of the ecosystem inspired ASM to develop a tool that lays the foundation for the integration of STI with the economy. This will enable Malaysia to reach new heights by harnessing STI to impact its socio-economic growth, resilience and competitiveness.

With the 10-10 *My*STIE Framework, we hope to inject new life into Malaysia's research, innovation and enterprise activities. The Framework provides a fresh holistic ecosystem approach to co-create a new future for the nation.

The 30 National STIE Niche Areas provide an opportunity to build collaborative networks and platforms towards establishing vibrant innovation ecosystems across Malaysia. These ecosystems in turn need to be strengthened through regular foresighting to be agile, relevant and impactful over time. The 10-10 *My*STIE Framework serves as an integrative tool for government, researchers, innovators, industries and communities to work together to transform Malaysia into a harmonious, progressive, prosperous and sustainable nation.

I hope that Malaysians will embrace this challenge and rise to the moment.

PROFESSOR DATUK DR ASMA ISMAIL FASc

Part I

Introducing the 10-10 *My*STIE Framework

01

10-10 *My*STIE Framework

Introduction

The 10-10 Malaysian Science, Technology, Innovation and Economic (*My*STIE) Framework is an integration of 10 key Malaysian socio-economic drivers with 10 global leading science and technology drivers aligned to our strengths and needs.

This Framework provides a systematic approach to transform Malaysia into a knowledge-intensive economy by design. It aims to generate shared economic prosperity across the diverse ecosystems in the country and shift Malaysia up the global innovation value chain.

This Framework will enable key sectors of the economy to become more knowledge-intensive and innovation driven. This will enhance the competitiveness and sustainability of Malaysian industries. It is designed to enhance the quality of life of the *rakyat*.

How was the 10-10 *My*STIE Framework Derived?

Emerging Science, Technology and Innovation (STI) are poised to change the current production-based economy to a knowledge-intensive economy. Such STIs are redefining the socio-economic landscape as well as challenging the conventional boundaries of operation. They provide immense opportunities for value creation to enhance productivity, efficiency and societal well-being. Mega trends, such as rapid urbanisation, demographic shifts and technological breakthroughs are triggering far-reaching impacts on all stakeholders. The world is facing unprecedented risks that require a sound STIE ecosystem to mitigate these challenges. Recognising this, ASM in 2015 embarked on Emerging Science, Engineering and Technology (ESET) Study to provide S&T Foresight as part of ASM's flagship initiative on Envisioning Malaysia 2050.

The ESET study culminated in three major outputs as follows:

284

products, services, technologies, possible applications and outcomes relevant for Malaysia towards 2050

95

emerging technologies and their interlinkages based on Malaysia's strengths and needs in 3 phases:

Present (2015-2020)

Probable future (2021-2035)

Possible future (2036-2050)

21

impactful emerging technologies towards realising Progressive Malaysia 2050, based on feasibility and attractiveness for Malaysia's context, guided by global trends and risks

SCAN HERE TO READ THE
Science & Technology Foresight Malaysia 2050 -
Emerging Science, Engineering & Technology (ESET) Study Report

Timeline Towards 2050: Malaysia's **95** Emerging Technologies

Source: ASM, 2017

Subsequently, ASM undertook a series of analyses to identify the top Science and Technology (S&T) drivers that can develop Malaysia's socio-economic sectors. Research capabilities, outputs (publications, patents and commercialisation activities), outcomes and the research building blocks (e.g. public and private Centres of Excellence (CoEs) and research institutes) were evaluated in order to derive the 10-10 *My*STIE Framework.

Science & Technology Drivers

Global trends on the top S&T drivers that can spearhead economic growth were analysed to identify the potential innovations that can have a major impact on the socio-economic development of communities across the globe.

This analysis was supplemented with other global studies, patent analysis and technology trajectories over the past 10 years.

Following this, the 95 emerging technologies identified in the ESET study were clustered into 10 S&T drivers.

Socio-economic Drivers

The 10 socio-economic drivers were identified by analysing national research priority areas, such as:

- 12 National Key Economic Areas (NKEA)
- Ministry of International Trade and Industry's (MITI) 3 catalytic sub-sectors and 2 high potential growth areas
- 9 National Science Research Council (NSRC) Priority Areas
- 7 Ministry of Education (MOE) Research Grant Clusters

Additionally, industrial ecosystems in multiple economic sectors as examined in "A Study on Knowledge Content in Key Economic Sectors in Malaysia" (MYKE III) (EPU, 2016) were used as supplementary evidence. Surveys and interviews with business leaders were also conducted to identify dynamic capabilities* of each sector.

**Dynamic capabilities (absorptive, adaptive and innovative capabilities) show the ability of the sector to absorb shocks, evolve and change to stronger positions of competitive advantage.*

Source: Analytics by ASM, Nair, Ahmed, Vaithilingam and the team from Monash University Malaysia, 2020

The Formulation of the 10-10 *My*STIE Framework

+

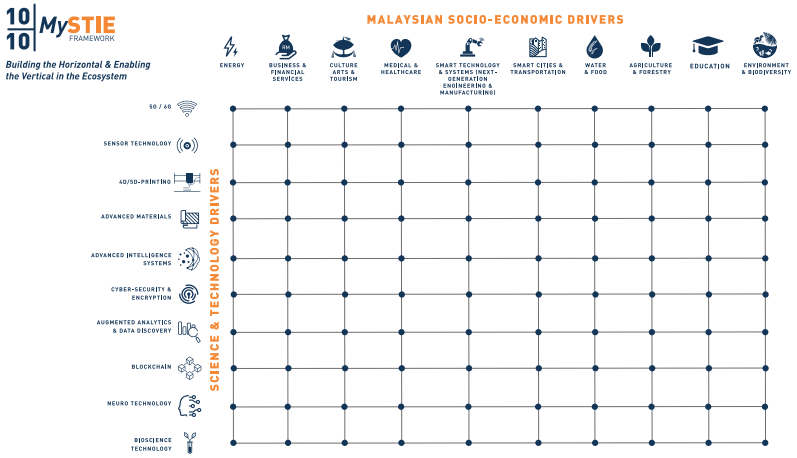
1. National Priority Areas
- 9 NSRC Priority Areas
- 12 NKEA
- MITI (3+2)
- 7 MOE Research Grant Cluster

2. Research Capability
- Publication and Patent Analysis
- MRU Research Capability Index (Quantum and Quality of Publication, (Research Building Block)

3. Analysis of Emerging and Declining Technologies
- Global Patent Analysis
- Technology Investment Analysis

4. Industry Analysis
- MyKE Study III (Phase 1 and Phase 2)
- Surveys and Interviews with Business Leaders

5. Global trends
- Top 10 technology drivers
- Global technology drivers



SCIENCE & TECHNOLOGY DRIVERS 10

5G/6G

Next-generation mobile networks that enable higher frequencies, capacity and lower latency.

SENSOR TECHNOLOGY

High-performance sensors, including microelectromechanical systems (MEMS), magnetic materials and piezoceramics, wearable biosensors and printable wearable electrochemical sensors.

4D/5D-PRINTING

Printing using smart materials that change forms according to the environmental changes or responding to stimulus, and print parts as simultaneous multilayer curved layers, making the objects stronger and more cost competitive than 3D printing.

ADVANCED MATERIALS

New, stronger, durable and efficient heat and energy conducting materials that have wide industrial, biological, medical and other applications.

ADVANCED INTELLIGENCE SYSTEMS

Machines, computer systems and virtual reality technology that mimic the human experience and intelligence processes, which include the use of visual machine systems, speech recognition, expert systems and swarm technology.

CYBER-SECURITY & ENCRYPTION

Technologies, processes, practices and methods that protect information and communication systems (networks, devices and data), mitigating risks associated with malicious attack, digital hijacking, unauthorised access and damage to systems and data.

AUGMENTED ANALYTICS & DATA DISCOVERY

Advanced data discovery methods that enable users to gain insights into patterns of the data generated using various statistical methods, pattern recognition, machine learning, natural learning and other advanced data analysis tools.

BLOCKCHAIN

Digital ledger system that is democratic, incorruptible, efficient, verifiable and holds permanent record of every transaction of value among multiple economic agents.

NEURO TECHNOLOGY

Technology that enables the study of brain processes, brain-computer interface, decision-making, behaviour and neurological disorders.

BIOSCIENCE TECHNOLOGY

Technology that uses biological processes, systems or living organisms to manufacture products or produce technology based on molecular biology, bionics, bioengineering, genetic engineering and nanotechnology.

Source: Analytics by ASM, Nair, Ahmed, Vaithilingam and the team from Monash University Malaysia, 2020

10 SOCIO-ECONOMIC DRIVERS

ENERGY

This sector is constituted by a complex and inter-related network of entities involved in the production, management and distribution of energy to fuel the economy and improve the quality of life of the *rakyat*. This includes both renewable and non-renewable energy sources.

BUSINESS & FINANCIAL SERVICES

This sector encompasses services that support business functions broader economy, such as Information Communication Technologies (ICT), logistics, financial services and other professional services.

CULTURE, ARTS & TOURISM

Malaysia is a confluence of diverse range of people and cultures. This sector covers a wide array of activities including expression and application of creative content and artworks. Tourism sector leverages on the diverse cultural heritage and natural resources of Malaysia.

MEDICAL & HEALTHCARE

Medical and healthcare encompass all goods, services and payment mechanisms for prevention, restoration, cure, maintenance of one's physical, mental or emotional well-being.

SMART TECHNOLOGY AND SYSTEMS (NEXT-GENERATION ENGINEERING & MANUFACTURING)

Smart technology and systems that create resilient utilisation of resources through self-monitoring, troubleshooting, optimising and integrating manufacturing processes and supply chains. This allows for adaptive data-driven decisions and intelligent cyber-physical systems.

SMART CITIES & TRANSPORTATION

Smart cities and transportation involve integration of physical and natural infrastructure with advanced technologies to deliver sustainable, resilient, and prosperous living conditions.

WATER & FOOD

Water and food are core to the sustainable development of communities across the globe. This demands a well-integrated ecosystem to ensure water and food security to address the challenges of rising population, urbanisation, climate change and economic disparities.

AGRICULTURE & FORESTRY

Agriculture and forestry is an important socio-economic driver for Malaysia. Agriculture encompasses crops, livestock, and fisheries. Agriculture and forestry are key sectors for food security, employment and revenue generation for the country.

EDUCATION

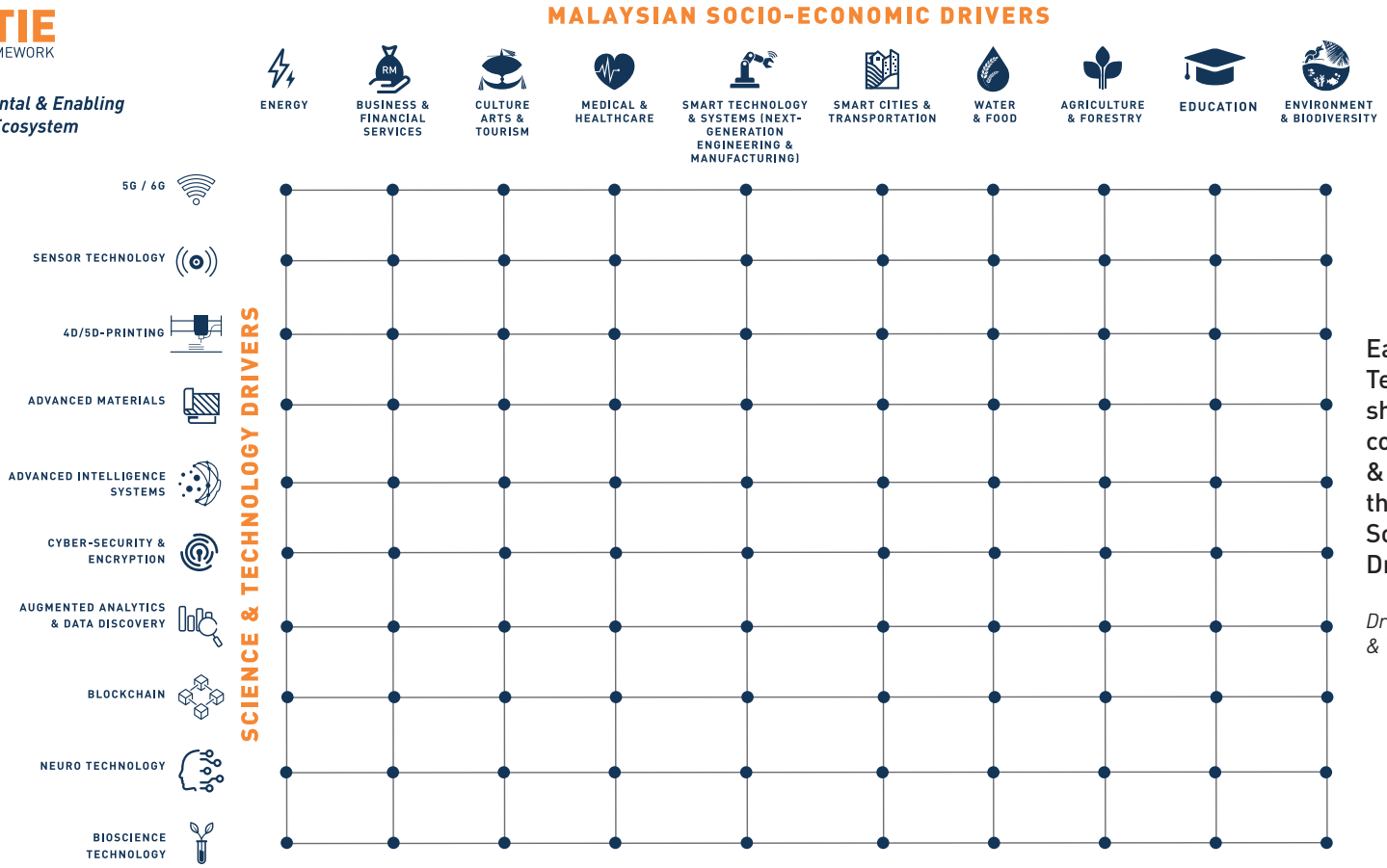
Education spans from pre-school to post-doctoral and continuing education. The purpose of education is to nurture a creative society and a skilled workforce. The education sector is also an important revenue earner for the country.

ENVIRONMENT & BIODIVERSITY

Preserving and conserving the natural environment and biodiversity of Malaysia are important in harnessing its value for sustainable development. This requires a sustainable approach to unlocking the value of terrestrial and marine ecosystems.

10 10 MySTIE FRAMEWORK

Building the Horizontal & Enabling the Vertical in the Ecosystem



Each Science & Technology Driver should explore core technologies & applications for the 10 Malaysian Socio-economic Drivers

Driving Fundamental & Translational Research

Each Malaysian Socio-economic Driver should explore how the 10 Science & Technology Drivers will value-add and enhance their global competitiveness

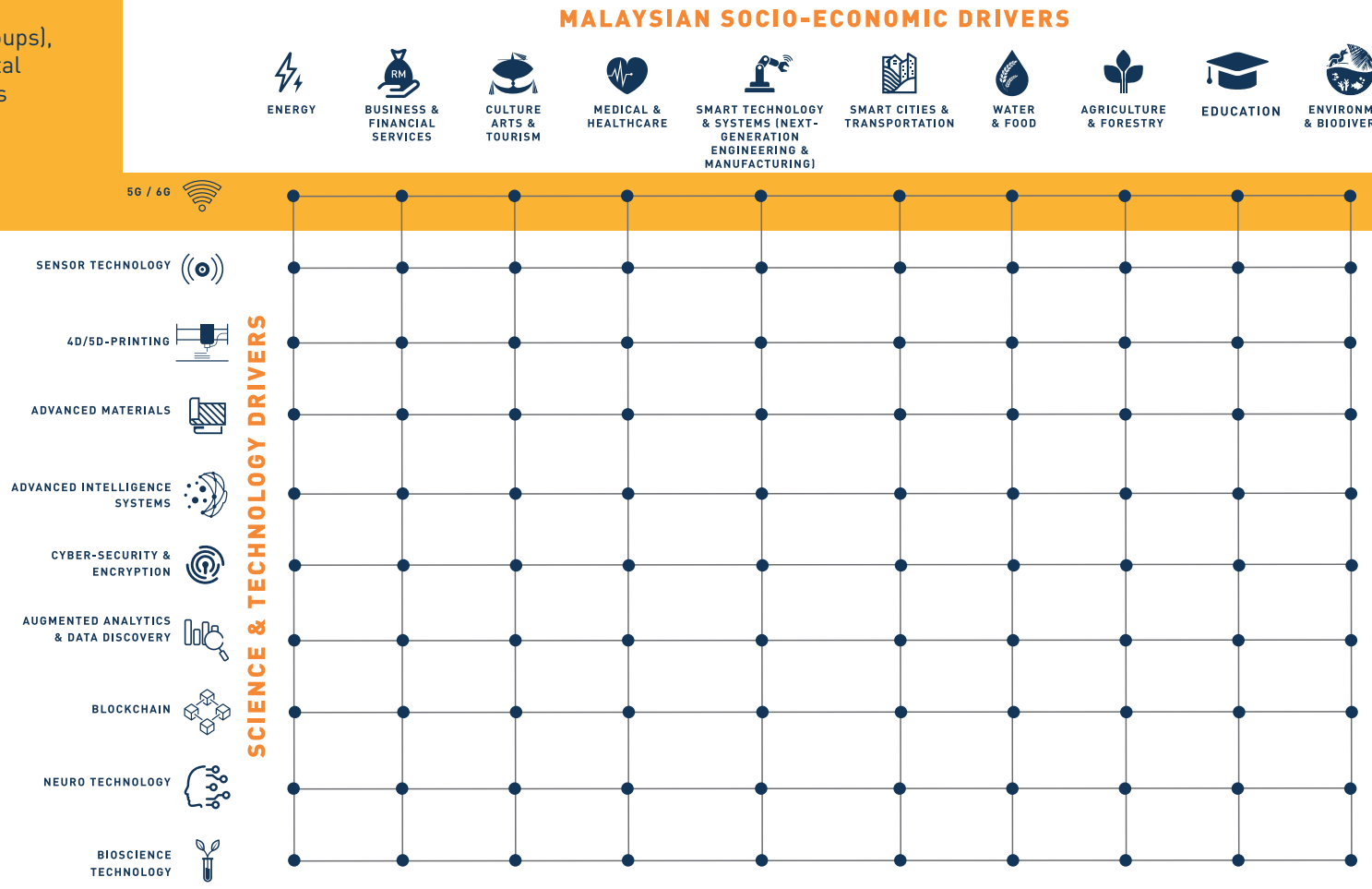
10-10 *My*STIE Framework: An Example of Establishing Center of Excellence

For S&T drivers to create value, it is imperative that they are linked to the socio-economic drivers. The 10-10 *My*STIE framework will enable Malaysia to couple S&T and socio-economic drivers to spur national development. This framework consists of 10 key Malaysian socio-economic drivers and 10 global S&T drivers.

It is envisaged that the framework will identify fundamental, applied and experimental R&D in the 10 global S&T drivers needed to transform the 10 Malaysian socio-economic drivers in moving up the global innovation value chain, enhance economic competitiveness, reduce inequalities and raise the *rakyat*'s quality of life. This will transform Malaysia to become a united, prosperous and environment-friendly nation by 2030.

Multi-stakeholder partnership model: Establish a Center of Excellence (CoE) to lead R&D in 5G/6G. The CoE should be constituted by multiple stakeholders. As part of the CoE, research universities are to undertake fundamental research that complements the work of other institutions (e.g. other universities, GLCs, industries and community groups), undertaking applied and experimental research and translational outcomes in the 10 socio-economic areas.

Technology View of the World Mapped against Malaysian Socio-economic Drivers: Horizontal Perspective of 10-10 *My*STIE Framework



10-10 *My*STIE Framework: An Example of Transforming The Agriculture & Forestry Socio-economic Driver

An example of the 10-10 *My*STIE Framework application is the transitioning of the Agriculture & Forestry sector to be more knowledge- and technology-intensive. While the Agriculture & Forestry sector remains an important generator of economic wealth and employment for the nation, it has remained labour-intensive rather than driven by technology. As a consequence, this sector has remained dependent on foreign countries to meet its agro-food needs.

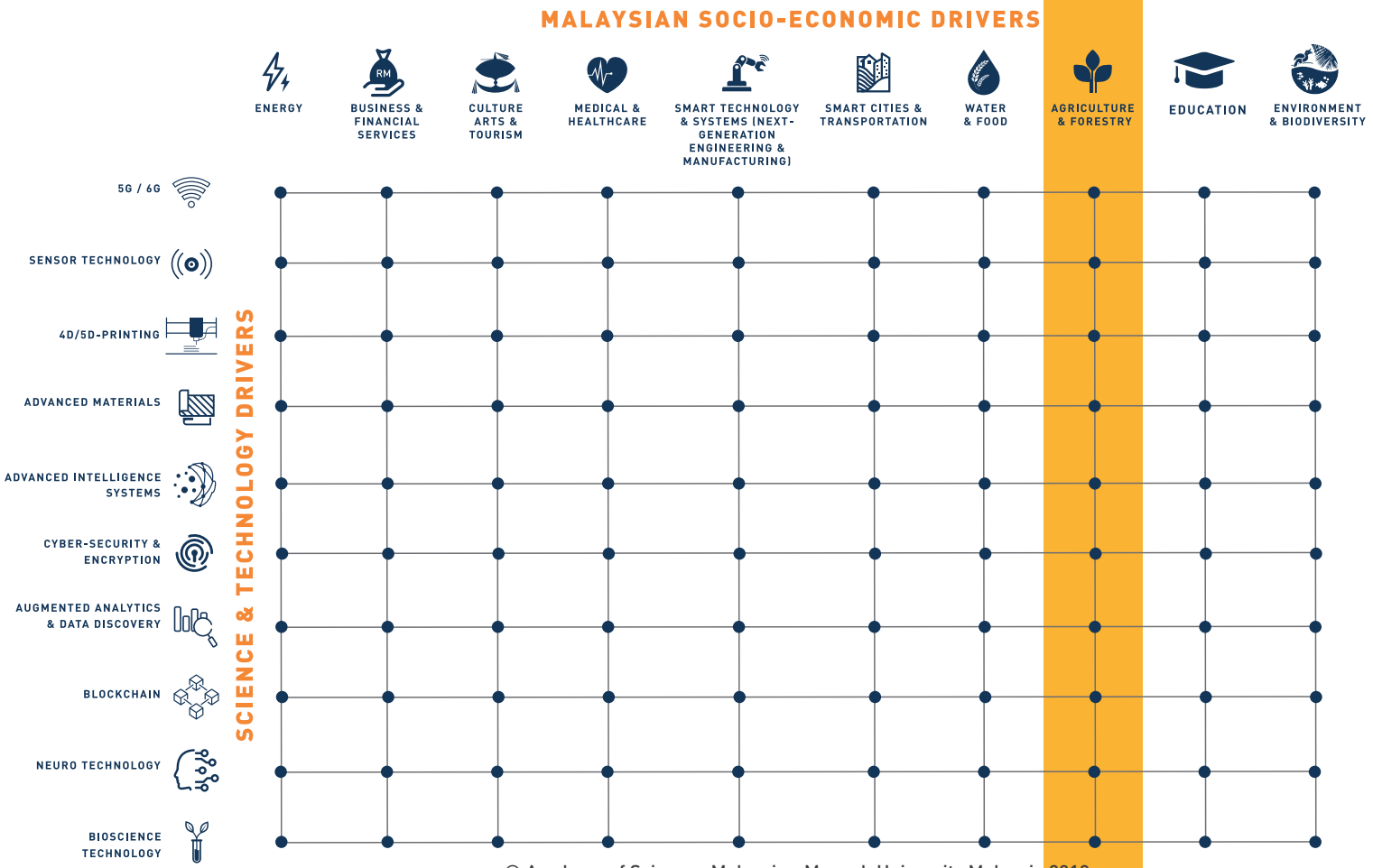
Technologies such as 5G/6G, Advanced Intelligence Systems and Augmented Analytics and Data Discovery can be deployed to create drone-enabled precision farming. Alternatively, technologies such as Sensor Technology, Neuro Technology and Bioscience Technology can be utilised to develop real-time multimodal data collection and discovery via advanced drone / bio sensors.

Hence, to enhance the competitiveness of the Agriculture & Forestry sector, multiple S&T drivers should be utilised to create core innovations to raise the Return on Value (ROV*) of the sector.

** Return on Value (ROV) is the value gain as a result of continuous improvement using new S&T drivers, systems, processes and new business models. In the context of STI, managing our resources effectively and efficiently will enhance the value proposition of the STI initiatives for all stakeholders, which in turn will increase its ability to raise the return on investment (ROI). The ROI is hence a function of ROV.*

Technology View of the World Mapped against Malaysian Socio-economic Drivers: Vertical Perspective of 10-10 *My*STIE Framework

A national agriculture strategic plan should focus on investing in the ecosystem such that it develops and applies the 10 S&T drivers to enhance the Return on Value (ROV) of the sector. This will not only increase the quality and global competitiveness of the sector, but will also spawn new economic sub-sectors like agribusiness, agritech and agri-green financing / sukuk. A strong S&T-driven agriculture sector will also have positive multiplier effect on other socio-economic drivers. This in turn can further boost Malaysia's food industry and the Halal economy.

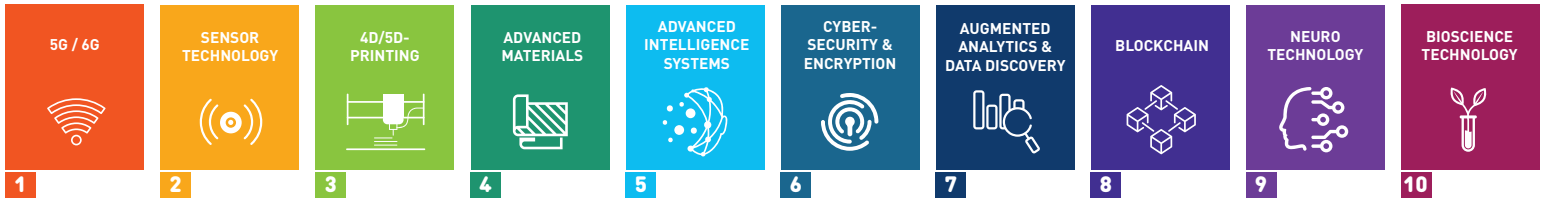


Application of the 10-10 *My*STIE Framework to the Agriculture & Forestry Socio-economic Driver

Case study of how the 10-10 *My*STIE can be utilised to develop the next generation technologies for raising the return of value and competitiveness of the agriculture and forestry sector.

Catch-up (Current) Technologies

- Smart plants with embedded biosensors — 2 4 5 7
- 5G collars for real-time farm animal health and behaviour tracking — 1 2 9 10
- Centralised agricultural & forestry database in ASEAN — 1 6 7
- Molecular genetics to develop new viable mass-produced crops — 10
- Mass-customisation with 3D/4D/5D printing — 3
- Drone-enabled precision farming — 1 5 7
- Enhanced security controls in highly connected farming — 6 9 10
- Blockchain technology to trace compliance and accountability — 8



Leap-frogging Technologies (Next-Generation Research & Application)

- Automated precision farming (Machine-to-machine communication via 6G network) — 1 5 6 7 9 10
- Brain-computer interfaces for enhanced / swarm drone control for more efficient precision farming — 5 9 10
- Real-time multimodal data collection and discovery via advanced drone/ bio sensors — 2 7 9 10
- 4D/5D Printing with adaptable materials when exposed to light/ heat/water for reactive agriculture protection structures — 2 3 4
- Blockchain-based drone traffic management for secure automated precision farming and forest activity monitoring — 1 2 5 7 8

Source: Analytics by Nair, Ahmed, Vaithilingam and the Monash University Malaysia Research team, 2020

How can **agriculture and forestry innovations** be integrated with **other sectors**?

Smart Technology & Systems (Next-Generation Engineering and Manufacturing)

+

Environment & Biodiversity

+

Energy

2 5

Integration of gene-edited algae farms with industrial plants to automate carbon capture systems for biofuel production

Smart Cities & Transportation

+

Water & Food

2 5

Vertical farms with automated solar-powered hydroponic systems within citiesto shorten supply chains

Multiplier Effect of Modernising Agriculture and Forestry to other Socio-Economic Drivers

AGRICULTURE & FORESTRY

SMART AGRICULTURE
Modernising the Agriculture Sector

The 10-10 *My*STIE Framework encourages the convergence of technologies that facilitates the transformation of each sector. This, in turn, creates a multiplier effect on other socio-economic drivers. For instance, modernising the agriculture sector can give rise to a vibrant agrotourism industry, and thereby providing a lucrative revenue stream.

Leveraging value creation opportunities requires careful curation of an ecosystem and its constituent systems and processes. This will continuously drive the multiplier effect and positive market externalities to create greater socio-economic impact for all stakeholders.

ENERGY

- Generation of feedstock and renewable energy from biofuels

BUSINESS & FINANCIAL SERVICES

- Smart Integrated Supply Chain
- Global Halal Services

CULTURE, ARTS & TOURISM

- Development of agrotourism

MEDICAL & HEALTHCARE

- Exploration of alternative ingredients, bioactive compounds and biomaterials
- Development of functional food and herbal product

SMART TECHNOLOGY & SYSTEMS (NEXT GENERATION ENGINEERING AND MANUFACTURING)

- Farm mechanisation and automation
- Development of smart farm monitoring

SMART CITIES & TRANSPORTATION

- Smart Integrated Transportation of agriculture products
- Normalised urban farming
- Connected rural and remote agriculture and fishing communities

WATER & FOOD

- Effective water irrigation and drainage systems

EDUCATION

- Personalised and experiential learning through a curriculum designed for tropical agriculture
- Development of a global centre with expertise in tropical agriculture

ENVIRONMENT & BIODIVERSITY

- Effective natural resources and environmental management (e.g. soil, flood, air quality)
- Modernised sustainable replanting programme
- Effective management of the marine and coastal communities
- Conservation of flora, fauna, indigenous animals, plants and insects

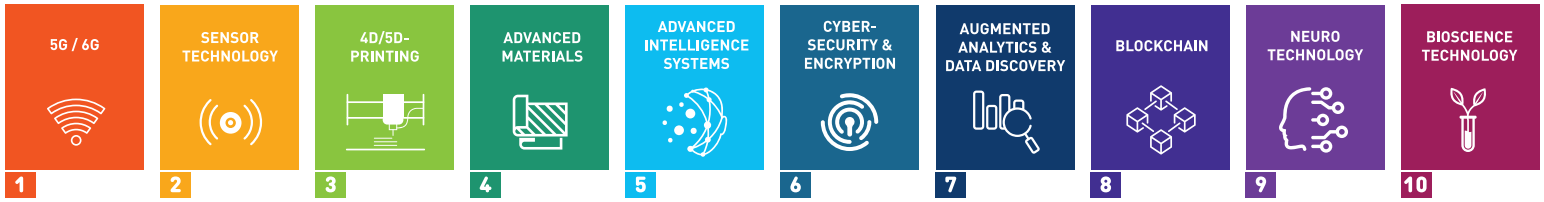
Source: ASM Analytics, 2020

Science & Technology Application Maps

Application of the 10-10 *My*STIE Framework to the Energy Socio-economic Driver

Catch-up (Current) Technologies

- Wind farms equipped with IoT sensors and AI software for automated operations and remote management — 1 2 5 6 7
- Corrosion-resistant coatings for efficient renewable fuel combustion chambers — 4
- 5G-connected sensors for efficient energy production and asset management — 1 2
- National and regional data repositories for renewable and non-renewable energy sources — 6 7
- Drone equipped with AI algorithms and optical sensors for automated real-time gas leak detection — 1 2 5 7
- AI-based platform to perform simulations of subsurface oil assets for efficient offshore explorations — 5 7
- Metal additive manufacturing for precise turbine components and shortened prototyping cycles — 3 4



Leap-frogging Technologies (Next-Generation Research & Application)

- 5G-connected underwater drones for autonomous subsea equipment inspection and oil reservoir discovery — 1 2 5 6 7
- Sprayable perovskite cells for scalable and more efficient solar power generation — 4
- Silicon-based nanoparticles for high capacity electric vehicle batteries — 4
- CRISPR gene-edited microorganisms for biofuel production — 10

Source: Analytics by Nair, Ahmed, Vaithilingam and the Monash University Malaysia Research team, 2020

How can **energy innovations** be integrated with **other sectors?**

Agriculture & Forestry
1 5 2 7
Automated sun tracking solar panels for electricity independent hydroponic systems

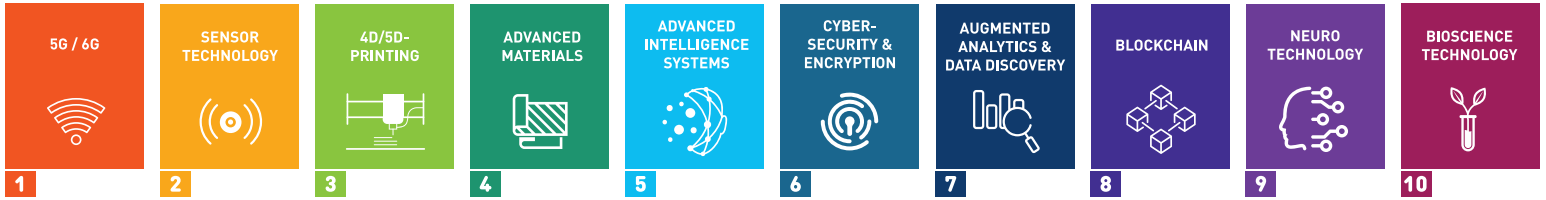
Smart Technology & Systems (Next-Generation Engineering & Manufacturing)
+
Environment & Biodiversity
1 2 5 7
Automated industrial waste heat recovery systems to reduce energy costs and carbon dioxide emissions

Smart Cities & Transportation
+
Business & Financial Services
1 2 5 6 7 8
Decentralised electricity grid with peer-to-peer trading via blockchain-enabled smart contracts

Application of the 10-10 *My*STIE Framework to the Business and Financial Services Socio-economic Driver

Catch-up (Current) Technologies

- 5G-connected immersive virtual reality entertainment services (e.g. live concerts, festivals) — 1
- 3D-printing of product at last mile to shorten retailer supply chains — 3
- Machine learning for dynamic predictive digital advertising — 5 7
- Blockchain-based financial services and virtual banking — 1 5 6 8
- IoT sensors for critical asset monitoring in logistics and healthcare facilities — 1 2 7
- Unmanned aerial vehicles for package delivery services — 1 2 5 6 7 8
- Predictive analytics for investment management solutions — 5 7



Leap-frogging Technologies (Next-Generation Research & Application)

- AI-based digital platforms equipped with vision systems and RFID sensors for remote human resource and asset management — 1 2 5 6 7 8
- Autonomous drone fleet services with AI-driven flight path rerouting using real-time air traffic, weather and geospatial data — 1 2 5 6 7 8
- 5G-connected drones and sensors for autonomous retail management — 1 2 5 6 7 8
- Biological encryption keys for digital financial transactions — 6 8 10

Source: Analytics by Nair, Ahmed, Vaithilingam and the Monash University Malaysia Research team, 2020

How can **business and financial services innovations** be integrated with **other sectors?**

Culture, Arts & Tourism — 1 6 / 2 7 / 5 8
Facial recognition payment systems at tourist destinations using visions systems linked to 5G-connected tourist database

Smart Technology & Systems (Next-Generation Engineering & Manufacturing) — 1 6 / 2 7 / 5 8
Seamless end-to-end supply chain connectivity through automated secure blockchain payments and real-time logistics tracking

Medical & Healthcare — 1 / 5 / 7
AI-driven health insurance services to identify claims eligibility based on pattern recognition and offer insurance packages using information shared in cloud healthcare database

Application of the 10-10 *My*STIE Framework to the Culture, Arts and Tourism Socio-economic Driver

Catch-up (Current) Technologies

5G multi-access edge computing for virtual reality live broadcasting and interactive exhibits
1 2 5

Interactive 4D-printed plants for immersive cultural exhibitions and filmmaking
2 3 4 5

5G-enabled virtual tours for smart tourism
1 2 5 6 7 8

Using neural networks and machine learning for music compositions and instrument emulation
5 7

Using visual sensors and drone technologies to create 3D digital replicas to preserve cultural sites
1 2 5

AI software and sensors to translate real-time dance movement into music
2 5 7

Natural language processing and machine learning for enhanced travel search queries in foreign languages
1 5 7

1 5G / 6G
2 SENSOR TECHNOLOGY
3 4D/5D-PRINTING
4 ADVANCED MATERIALS
5 ADVANCED INTELLIGENCE SYSTEMS
6 CYBER-SECURITY & ENCRYPTION
7 AUGMENTED ANALYTICS & DATA DISCOVERY
8 BLOCKCHAIN
9 NEURO TECHNOLOGY
10 BIOSCIENCE TECHNOLOGY

Leap-frogging Technologies (Next-Generation Research & Application)

Use of blockchain certificates for copyright protection and piracy prevention of digital media content
1 6 7 8

Deep learning algorithm for automated dance choreography generation that is human-replicable, style-consistent, and beat-matching for arts and sports
5 7

Machine learning algorithms to identify trends in social media data and user search history for the prediction of future travel patterns and customised travel packages
1 5 6 7 8

Detection and predictive analysis of possible artifact and fossil zones using satellite imagery databases and 5G-connected drones equipped with ground penetrating sensors and AI software
1 2 5 6 7

Source: Analytics by Nair, Ahmed, Vaithilingam and the Monash University Malaysia Research team, 2020

How can **culture, arts and tourism innovations** be integrated with **other sectors?**

Business & Financial Services
Blockchain technology for tracking and tracing high-value artwork sales thorugh smart contracts and distributed ledger
6 8

Medical & Healthcare
Brain computer music interfacing to enable music compositions by brain impaired patients to restore brain functionality
2 5 10

Environment & Biodiversity

+

Smart Cities & Transportation
1 2

Smart cities with eco-friendly initiatives, cultural vibrancy and heritage preservation are important factors for attracting tourists to the country

Application of the 10-10 *My*STIE Framework to the Medical and Healthcare Socio-economic Driver

Catch-up (Current) Technologies

- Medical Robots — 1 2 5 7
- Long-lasting HEPA filters for PPE respirators — 4
- 5G+ thermal imaging temperature monitoring/ surveillance and gating system — 1 2 5 7
- Encryption of cloud computed data and patient data — 1 6 7
- Blockchain technology to trace and track pandemic data — 7 8
- SMART ambulances transmitting real-time patient data — 1 5 7
- 3D/4D-printed respirators, face shields and PPEs — 3
- Virtual map for contact tracing — 1 7
- Antiviral treatment using CRISPR — 10
- Automated viral genetic structure prediction and analysis — 5 7 9

1	2	3	4	5	6	7	8	9	10
5G / 6G	SENSOR TECHNOLOGY	4D/5D-PRINTING	ADVANCED MATERIALS	ADVANCED INTELLIGENCE SYSTEMS	CYBER-SECURITY & ENCRYPTION	AUGMENTED ANALYTICS & DATA DISCOVERY	BLOCKCHAIN	NEURO TECHNOLOGY	BIOSCIENCE TECHNOLOGY

Leap-frogging Technologies (Next-Generation Research & Application)

- Intelligent contact tracing and pandemic monitoring systems using swarm technology and network analysis — 2 5 6 7 8 9
- Algorithms to monitor news outlets and online media platforms to predict infection spread and future infected cities during early stages of the pandemic — 5 7 9
- Sharing of pandemic-related data using differential privacy by encrypting data with noise to prevent reverse-engineering of original data — 6
- 5G+ thermal imaging equipped drone swarms for surveillance and movement control — 1 2 5 9
- Study on mutation of new strains of viruses – new drug therapies — 5 7 10
- SMART PPEs – AI-driven infection detection wearable systems — 2 3 4 5

Source: Analytics by Nair, Ahmed, Vaithilingam and the Monash University Malaysia Research team, 2020

How can **medical and healthcare innovations** be integrated with **other sectors?**

Smart Cities & Transportation
Pre-fabricated, modular and temporary buildings equipped with medical robots to cope with patient spikes — 5

Water & Food
Machine learning algorithms to predict future disease outbreaks for early mobilisation of resource supply security measures — 5 7 9

Smart Cities & Transportation + **Business & Financial Services** — 1 2 7

Contactless screening booths and facial recognition payment systems at high-density areas and transport hubs to minimise physical contact

Application of the 10-10 *My*STIE Framework to the Smart Technology and Systems (Next-Generation Engineering & Manufacturing) Socio-economic Driver

Catch-up (Current) Technologies

- Global factory quality management through dynamic edge-cloud computing — 1 2 5 6 7
- Personalised products using scalable 4D-printing manufacturing — 3 4
- Automated robotic assembly and intralogistics lines — 1 2 5 6 7
- Demand forecasting for inventory and supply chain management using predictive analytics — 5 7 9
- Blockchain technology for IP protection and secure sharing to manufacturers — 6 8
- Machine learning algorithms and IoT sensors for predictive maintenance — 1 2 5 7

1. 5G / 6G
2. SENSOR TECHNOLOGY
3. 4D/5D-PRINTING
4. ADVANCED MATERIALS
5. ADVANCED INTELLIGENCE SYSTEMS
6. CYBER-SECURITY & ENCRYPTION
7. AUGMENTED ANALYTICS & DATA DISCOVERY
8. BLOCKCHAIN
9. NEURO TECHNOLOGY
10. BIOSCIENCE TECHNOLOGY

Leap-frogging Technologies (Next-Generation Research & Application)

- Assembly lines with automated predictive maintenance capabilities, whereby replacement parts are automatically 3D/4D-printed and installed by robots — 1 2 3 4 5 7
- End-to-end, remotely controlled production lines using modular robotic production cells and automated guided vehicles (e.g. robots, drones) — 1 2 5 7
- Machine learning and neural networks to derive patterns for production process improvement using sensor data protected by biological encryption keys — 2 5 6 7 10
- Automated dynamic edge-cloud computing and digital twin technologies to scale production output based on big data-driven demand forecasting (e.g. social media posts, market data) — 1 2 5 6 7

Source: Analytics by Nair, Ahmed, Vaithilingam and the Monash University Malaysia Research team, 2020

How can **smart technology and systems innovations** be integrated with **other sectors**?

Medical & Healthcare — 1 5 7
Production output based on demand forecasting using digital media data to predict undersupply of critical medical equipment during initial stages of disease outbreaks such as COVID-19

Business & Financial Services — 1 6 2 7 5 8
Direct manufacturer to consumer transactions using drone delivery services and facial recognition payment

Environment & Biodiversity

+

Agriculture & Forestry

6 8

Blockchain technology to ensure sustainable manufacturing through use of smart contracts to determine certification and regulatory compliance of raw materials

Application of the 10-10 *My*STIE Framework to the Smart Cities and Transportation Socio-economic Driver

Catch-up (Current) Technologies

- Advanced polymer and metallurgy additive manufacturing for 3D-printed buildings and vehicles — 3 4
- IoT sensors for smart parking sharing mobile services — 1 2
- AI street cameras for predictive analysis and crime prevention — 5 7
- Blockchain technology for cybersecurity and monetisation of smart city data — 6 8
- 5G network and AI-based travel system for smart airports — 1 2 5 6 7 8
- IoT sensor and camera equipped street lights for city data and traffic management — 1 2 5 6 7
- Vehicular sensor data platform for smart city mapping and planning — 1 2 5 7

1	2	3	4	5	6	7	8	9	10
5G / 6G	SENSOR TECHNOLOGY	4D/5D-PRINTING	ADVANCED MATERIALS	ADVANCED INTELLIGENCE SYSTEMS	CYBER-SECURITY & ENCRYPTION	AUGMENTED ANALYTICS & DATA DISCOVERY	BLOCKCHAIN	NEURO TECHNOLOGY	BIOSCIENCE TECHNOLOGY

Leap-frogging Technologies (Next-Generation Research & Application)

- 5G connected dynamic traffic management system to autonomously shift vehicular flow based on sensor traffic data, accidents, and weather conditions — 1 2 5 6 7
- Autonomous air vehicles and air traffic rerouting — 1 2 5 6 7
- 5G-connected autonomous public transport road vehicles — 1 2 5 6 7
- Living biomaterials for self-healing and self-assembling buildings — 3 4 10
- Autonomous drone fleets equipped with sensors and AI software for surveillance and city data collection — 1 2 5 6 7 8
- Personal mobility vehicles integrated with wider mass transit vehicles for last mile — 1 2 5

Source: Analytics by Nair, Ahmed, Vaithilingam and the Monash University Malaysia Research team, 2020

How can **smart cities and transportation innovations** be integrated with **other sectors**?

Agriculture & Forestry
Automated vertical farming production based on big data driven demand forecasting

1 2 5 7

Energy
Decentralised electricity grid through blockchain-based monetisation of electricity generated by buildings equipped with solar window panes

1 2 5 6 7 8

Medical & Healthcare

+

Business & Financial Services

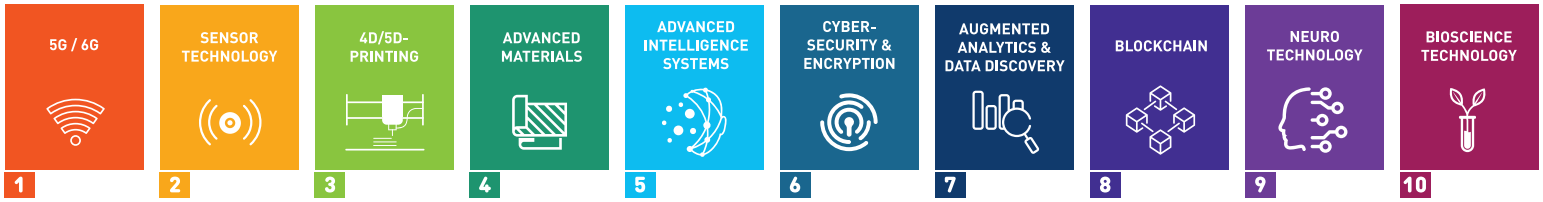
1 2 5 6 7 8

Public transportation equipped with facial recognition payment systems and 5G thermal body temperature monitoring system to identify potential COVID-19 infected passengers

Application of the 10-10 *My*STIE Framework to the Water and Food Socio-economic Driver

Catch-up (Current) Technologies

- Automated beekeeping to protect major pollinators and crops — 1 2 5 7
- AI and machine learning to regulate food prices based on real-time supply and demand fluctuations — 1 5 6 7
- Sensors for real-time supply chain food quality monitoring to reduce food waste — 1 2 5 7
- Connected water supply lines using AI and IoT sensors for predictive maintenance — 1 2 5 7
- Blockchain technologies to boost supply chain agility, resilience, and response to food shortages — 6 7 8
- Drought and flood forecasting for effective reservoir management and early disaster mitigation — 1 2 5 7



Leap-frogging Technologies (Next-Generation Research & Application)

- Replacement of unsustainable factory farms with 3D-printed vegan meat and lab-grown animal-based meat alternatives — 3 4 10
- AI and deep learning algorithms to monitor quality and predict future availability of transboundary water resources for the food industry — 1 2 5 6 7 8
- Real-time monitoring of biological environmental sensors in water supplies using autonomous microscopes for early supply threat detection — 1 2 5 7 10
- Nanomaterials for efficient water desalination and water treatment plants — 4
- Gene editing to increase crop yield and food quality — 10

Source: Analytics by Nair, Ahmed, Vaithilingam and the Monash University Malaysia Research team, 2020

How can **water and food innovations** be integrated with **other sectors?**

Smart Cities & Transportation — 4
Integration of stormwater capture and purification systems with city infrastructure as additional water supply source

Smart Technology & Systems (Next-Generation Engineering and Manufacturing) — 1 5 2 7
Cloud-based sensors for early detection of industrial waste and leakage in rivers and water sources

Agriculture & Forestry

+

Business & Financial Services — 1 2 5 6 7 8
Demand forecasted food supply chains with end-to-end optimization and transparency to prevent supply shocks

Application of the 10-10 *My*STIE Framework to the Education Socio-economic Driver

Catch-up (Current) Technologies

Student safety monitoring through 5G-connected IoT sensors and social media data analytics for bullying prediction
1 2 5 7

Blockchain technology for verification of digital academic certifications
1 6 8

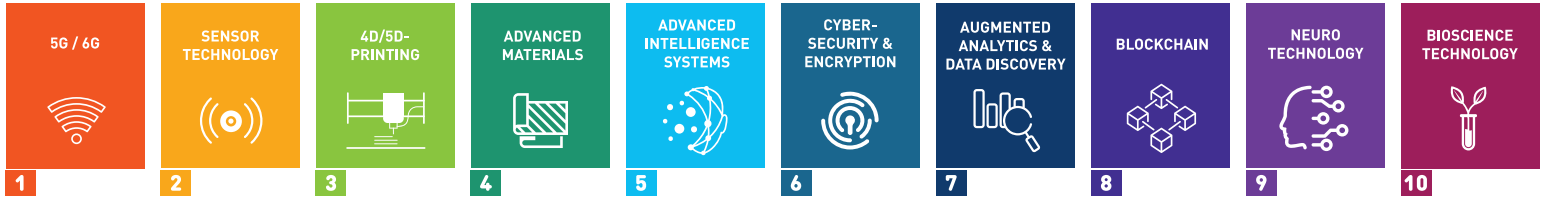
IoT sensors for cloud-based school facilities management systems
1 2 5 6 7

Machine learning technologies to offer personalised curricular content and early prediction of failing students
5 7

Machine learning-based grading machine for student work assessments and personalised learning feedback
5 6 7

Remote laboratory monitoring and experiments through IoT-connected sensors and automatable equipment
2 5 6 7

Virtual reality simulations for engaging and immersive interactive education
1 2



Encrypted tracking of student bio- and neuro-metrics for early identification of mental health stress
1 2 6 7 9

Virtual reality 3D/4D/5D-design and printing for rapid prototyping in engineering and creative arts
1 3 4

AI-led teaching with blockchain powered self-guided and modular curriculum
5 6 7 8

Intuitive heads-up display in a virtual reality classroom with seamless access to information and advanced analytics
1 2 5 7

Leap-frogging Technologies (Next-Generation Research & Application)

Source: Analytics by Nair, Ahmed, Vaithilingam and the Monash University Malaysia Research team, 2020

How can **education innovations** be integrated with **other sectors?**

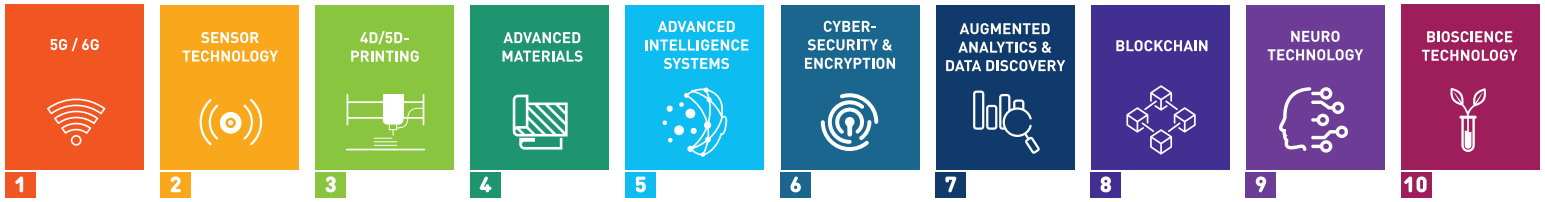
Smart Cities & Transportation
1 2
City-wide enabled learning environments via augmented realities to balance in-classroom VR only experience

Multiple Sectors
1 2
Interactive virtual classrooms for remote experiential learning beyond school locations (e.g. factory, forest, enterprise, museum) to cultivate strong talent pipelines

Application of the 10-10 *My*STIE Framework for Precision Biodiversity (Environment and Biodiversity Socio-economic Driver)

Catch-up (Current) Technologies

- Audio/Video monitoring system using 5G connectivity and AI models to prevent illegal poaching and deforestation — 1 2 5 7
- River robots for automated waste collection and recycling — 1 2 5
- Mangrove forest restoration using drones and sensors for tree-planting, land mapping, and data collection — 1 2 5 7
- Satellite imagery and AI algorithms for real-time monitoring of sustainable fisheries — 1 5 7
- Cloud-based computer vision systems and deep learning algorithms for automated wildlife species monitoring — 1 2 5 7 9



Leap-frogging Technologies (Next-Generation Research & Application)

- Molecular cataloguing to safeguard against biopiracy — 7 10
- Blockchain technology for sustainable digital bioeconomy — 1 6 7 8 10
- Autonomous oceanic waste capture systems with anti-collision beacons and real-time tracking and monitoring — 1 2 5 7
- Gene editing and modification of genomes for socio-economic benefits and to help endangered species adapt to environmental change — 7 10
- Digitisation of Malaysia's flora and fauna as a valuable genomic resource for agriculture, conservation, medicine and the growing global bio-economy — 7 10
- Synthetic biology for protecting threatened species and restoring degraded ecosystems — 5 7 10
- Tracking and elimination of invasive species using machine learning and computer vision — 1 2 5 7
- DNA barcoding as a global standard for the identification of biological species and assessment of biodiversity — 7 10

How can **precision biodiversity** be integrated with **other sectors**?

Water & Food — 8
Blockchain to verify legal food sources and combat illegal fishing

Culture, Arts & Tourism — 5 7 9
Evaluating the environmental impact of ecotourism using machine learning algorithms

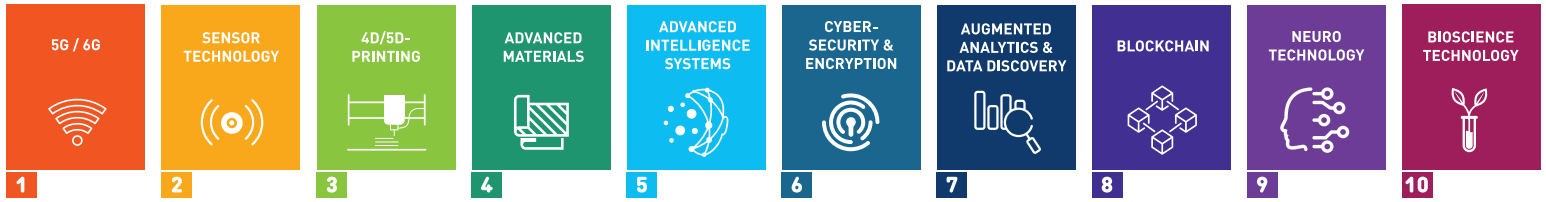
Smart Cities & Transportation — 1 5 2 7
Active air pollution forecasting and solution provision using AI algorithms for pattern recognition using meteorological, satellite, traffic, and social network data

Source: Analytics by Nair, Ahmed, Vaithilingam and the Monash University Malaysia Research team, 2020; Modified by ASM Special Interest Group on Precision Biodiversity, 2020

Application of the 10-10 *My*STIE Framework: An Example for the National Defence Systems

Catch-up (Current) Technologies

- Shorten supply chains by integrating additive manufacturing in munitions, chip systems, and textile production for on-site production — 3 4
- Autonomous robots for mines & explosive detection clearance — 1 2 5 6
- Data analytics for detection of malicious cyber activities and network systems cyber security integrity — 2 5 6 7
- Autonomous unmanned ground vehicles for last mile resupply — 1 2 5 6
- Low observable material for high stealth, low radar detection of military aircraft — 3 4
- Network-enabled swarming drone squadron for unmanned air combat support — 1 2 5 6 8
- Autonomous robot submarines for marine patrolling, reconnaissance, and payload deployment — 1 2 5 6 7



Leap-frogging Technologies (Next-Generation Research & Application)

- Secure communication system with constant cryptographic protection for fighter jets — 5 6
- Conversational AI for hands-off verbal command and control of ground robots — 2 5 6 7
- Modification of skin microbiome to reduce mosquito feeding of military troops — 10
- Brain-computer interface controlled swarm drones for high level & complex military tasks — 1 2 5 6 9
- Next-generation antidotes for neuro-toxins (biological & chemical warfare) — 9 10
- UAVs with blockchain architecture for IoBT security — 1 2 5 6 8
- Next-generation wearable materials to detect and withstand chemical, biological & nuclear warfare — 2 3 4

Source: Analytics by Nair, Ahmed, Vaithilingam and the Monash University Malaysia Research team, 2020

How can other sectors leverage on **national defence systems innovations**?

Smart Cities & Transportation — 1 6 2 7 5 8
Smart drone surveillance for homeland security

Energy — 1 4 2 5 6
Solar power satellite space energy harvesting for terrestrial remote installation usage

Smart Technology & Systems(Next-Generation Engineering & Manufacturing)

+

Business & Financial Services — 1 6 8
Blockchain technology to streamline military supply chains

Medical & Healthcare — 1 4 2 5 3 7
Discoveries of new medical therapies, vaccines and Personal Protective Equipment (PPEs)

02

The Journey to Identify National STIE Niche Areas (2021-2025) using the 10-10 *My*STIE Framework

10-10 *My*STIE Framework Engagements
Inclusive input from policy makers, the scientific community, academia, industry captains and STI professional bodies

Series of engagements since March 2020

80 Stakeholder Engagements
Workshops, Focus Group Discussions & Presentations

300+ People Engaged

75 Ministries/ Agencies/ Industry Players

4 International Entities

604 Industry Captains
Provided inputs through Business Sentiment Survey 2019/2020

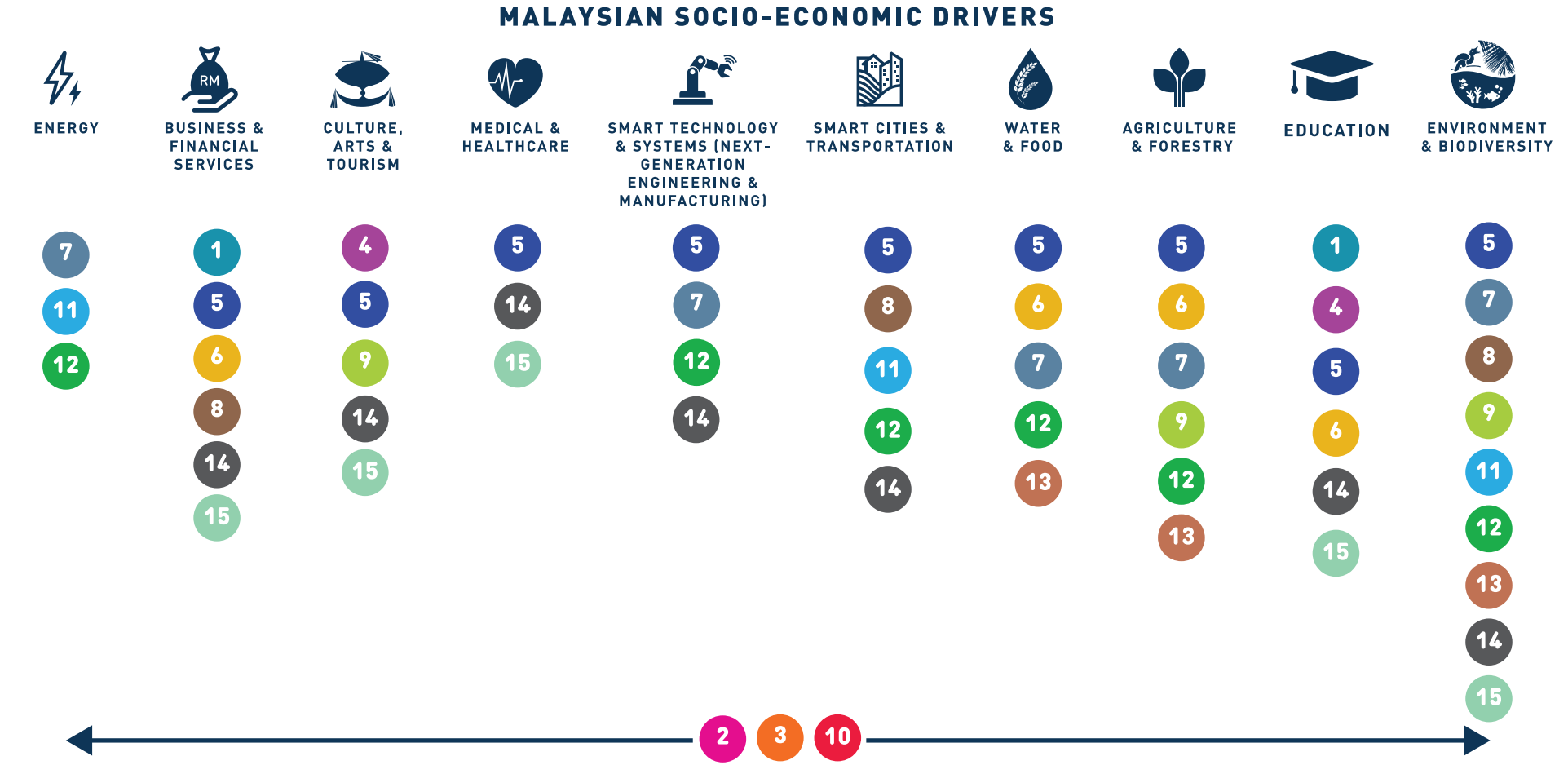
9 Position Papers

4 Joint Task Force

6 Strategic Studies for New Policy Formulation & National Plans

Linking the 10-10 *My*STIE Framework to National Plans

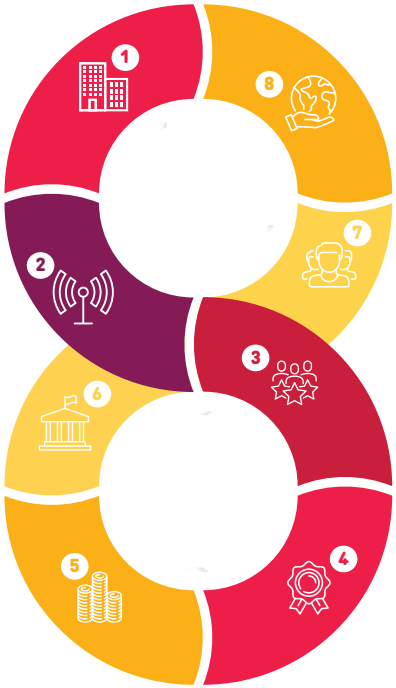
Shared Prosperity Vision 2030 (SPV2030) is a national pledge to achieve an inclusive knowledge-based economy across the Key Economic Growth Activities (KEGA).



Source: ASM Analytics, 2020; MEA, 2019

Ecosystem Analysis

An analysis was carried out using two tools (i.e. 8i STI ecosystem enablers and SWOT analysis) to evaluate the current ecosystem for each of the socio-economic drivers. This included horizon scanning of the national landscape (i.e. national policies and plans) and stakeholder engagements to ensure careful selection of S&T drivers to enhance the ROV of the socio-economic drivers.



8i STI Ecosystem Enablers

01 / INFRASTRUCTURE
PHYSICAL & NATURAL
Quality and sophistication of the infrastructure that supports the growth and development of the industry and the broader economy.

02 / INFOSTRUCTURE
DIGITAL INFRASTRUCTURE
Digital infrastructure that provides seamless integration of multiple value chains within and across the industries and communities. These systems provide seamless flow of information for market intelligence and strategic decision making.

03 / INTELLECTUAL CAPITAL
TALENT STOCK
Skills (technical, entrepreneurial and leadership) and knowledge (general and specialised) of the talent stock.

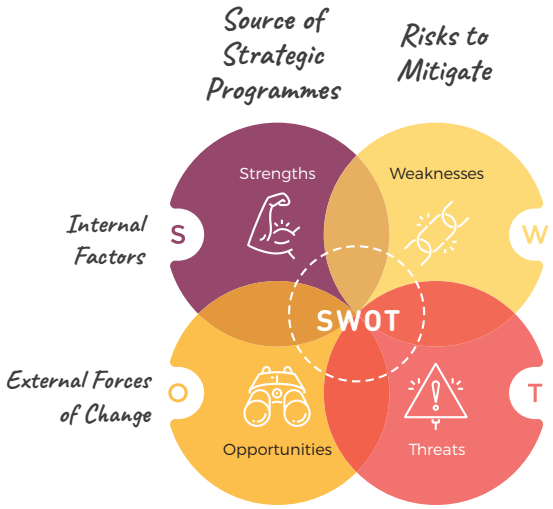
04 / INTEGRITY
GOOD GOVERNANCE
Governance systems to manage processes and ensure commitment to continuous improvements and adherence to best practices.

05 / INCENTIVES
FISCAL AND NON-FISCAL
Incentives to encourage R&D, adoption of new technologies, innovation, commercialisation of local technology, and market expansion, including globalisation of local technology.

06 / INSTITUTIONS
GOVERNANCE BODIES
Quality of the institutions of governance (e.g. regulatory bodies, industry associations, institutions of learning / research institutes etc.) that support systematic development of markets, industries and communities.

07 / INTERACTION
STRATEGIC PARTNERSHIPS
Level and quality of collaboration, co-creation and knowledge sharing among stakeholders.

08 / INTERNATIONALISATION
GLOBAL BEST PRACTICES & STANDARDS
Depth and breadth of engagement with global knowledge and innovation networks, institutions of governance and global supply chains.



Source: Analytics by Nair, Ahmed, Vaithilingam and the team from Monash University Malaysia, 2020

Cross-cutting Challenges
of the 10 Malaysian Socio-economic Drivers

INFRASTRUCTURE : Enhanced investment in infrastructure not in tandem with resources for maintenance

Infrastructure investment is expected to increase ~9% per annum between 2013 and 2025, but "limited maintenance due to inadequate financial resources has affected the quality of infrastructure."
Source: EPU, 2016; 11th MP Mid-Term Review (2018)

INFOSTRUCTURE : Low connectivity and lack of integrated data management

- Gaps in deployment of high-speed broadband infrastructure in key industrial and training locations to support Industry 4.0 needs
- Need for data integration platforms for data-driven decision making
- Rural connectivity remains weak. "Malaysian users in thinly-populated rural areas have the connection to 4G just 44% of the time.
  Source: Identification of National STIE Niche Areas using 10-10 Framework Workshop, 12 March 2020; OpenSignal, 2019

INTELLECTUAL CAPITAL : Low innovative capability

Knowledge content is mostly at absorptive and adaptive levels and rarely transcend to innovative capability. This is reflected in Malaysia's rank of 53 out of 131 in 'Knowledge Workers' of Global Innovation Index 2020.
Source: EPU, 2016; Global Innovation Index 2020

Talent shortages and skill gaps to face Industry 4.0

High skilled workers make up only 24.4% of workforce in 2019. The 11th Malaysia Plan targeted the percentage of high skilled workers to increase from 25% in 2019 to 35% by year 2020.
Source: DOSM (2019), 11th MP (2015)

Over-reliance on foreign workers

Over-reliance on low-skilled foreign workers, particularly in construction (28.3%), agriculture (25.8%) and manufacturing (25.7%). The target under 11 MP is 15% of foreign workers from total workforce by 2020.
Source: 11th MP (2015); 11th MP Mid-Term Review (2018)

INTEGRITY : Need for governance systems and commitment to comply with global standards

Inability to conform to international standards due to lack of knowledge, resources and coordination resulting in goods and services not being able to penetrate global market.
Source: Identification of National STIE Niche Areas using 10-10 Framework Workshop, 12 March 2020

INCENTIVES : Fragmentation of incentive landscape

There are more than 100 incentives administered by 32 agencies. There is a need to streamline and re-engineer incentives to be more outcome-driven and impact-driven
Source: Bank Negara Malaysia, 2017

INSTITUTION : Need for agile and adaptable regulation and legislation

Institutional and legislative frameworks are incongruent with current trends and needs, thus requiring a review.
Source: Identification of National STIE Niche Areas using 10-10 Framework Workshop, 12 March 2020

INTERACTION : Lack of knowledge-based efforts, collaborative strategies and championing of change

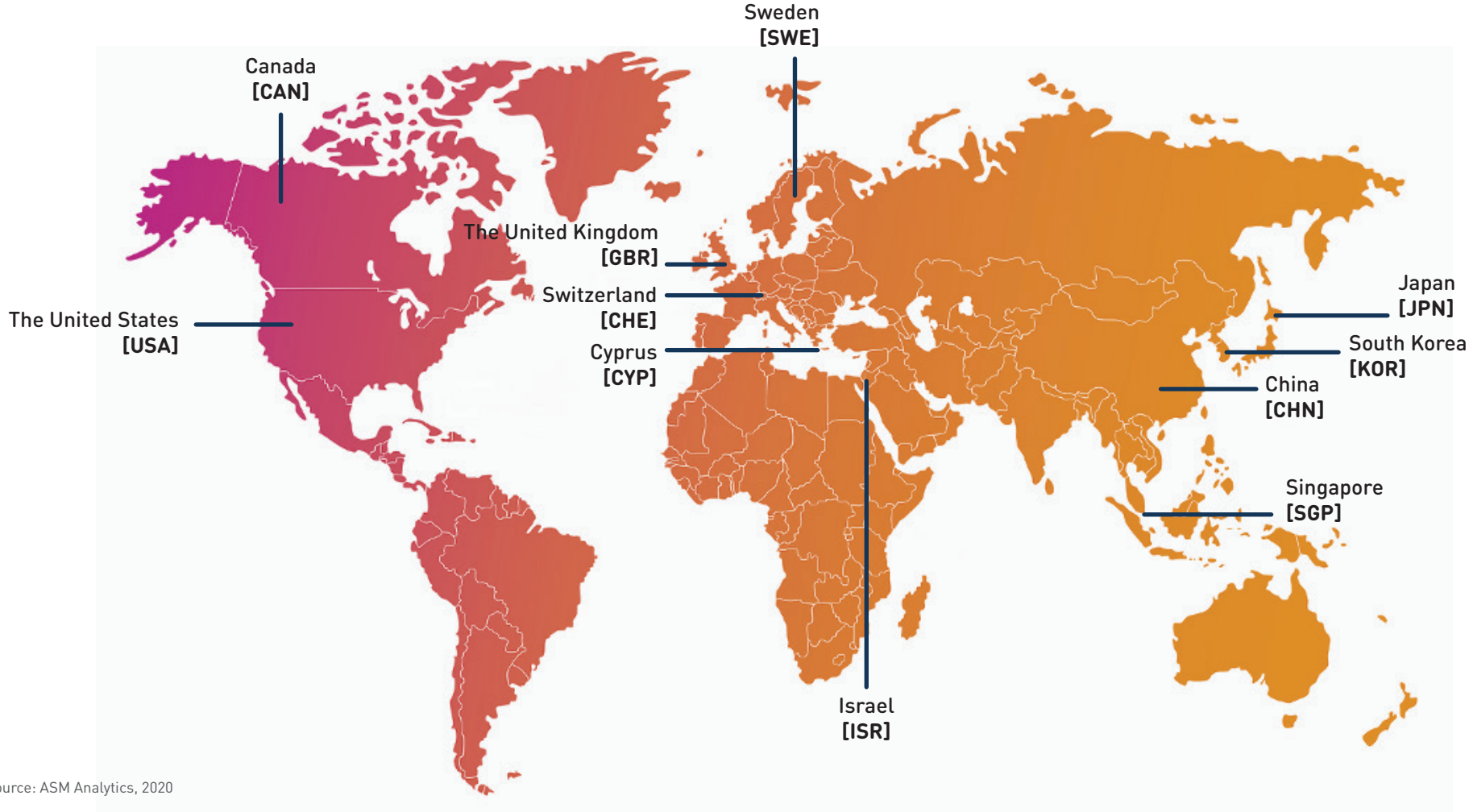
- Poor communication and linkages within the value chains causing disconnect among players
- Lack of interaction and commitment among authorities, NGOs and community representatives to resolve critical issues on the ground
  Source: Identification of National STIE Niche Areas using 10-10 Framework Workshop, 12 March 2020

INTERNATIONALISATION : Need for effective market positioning and strong branding in international markets

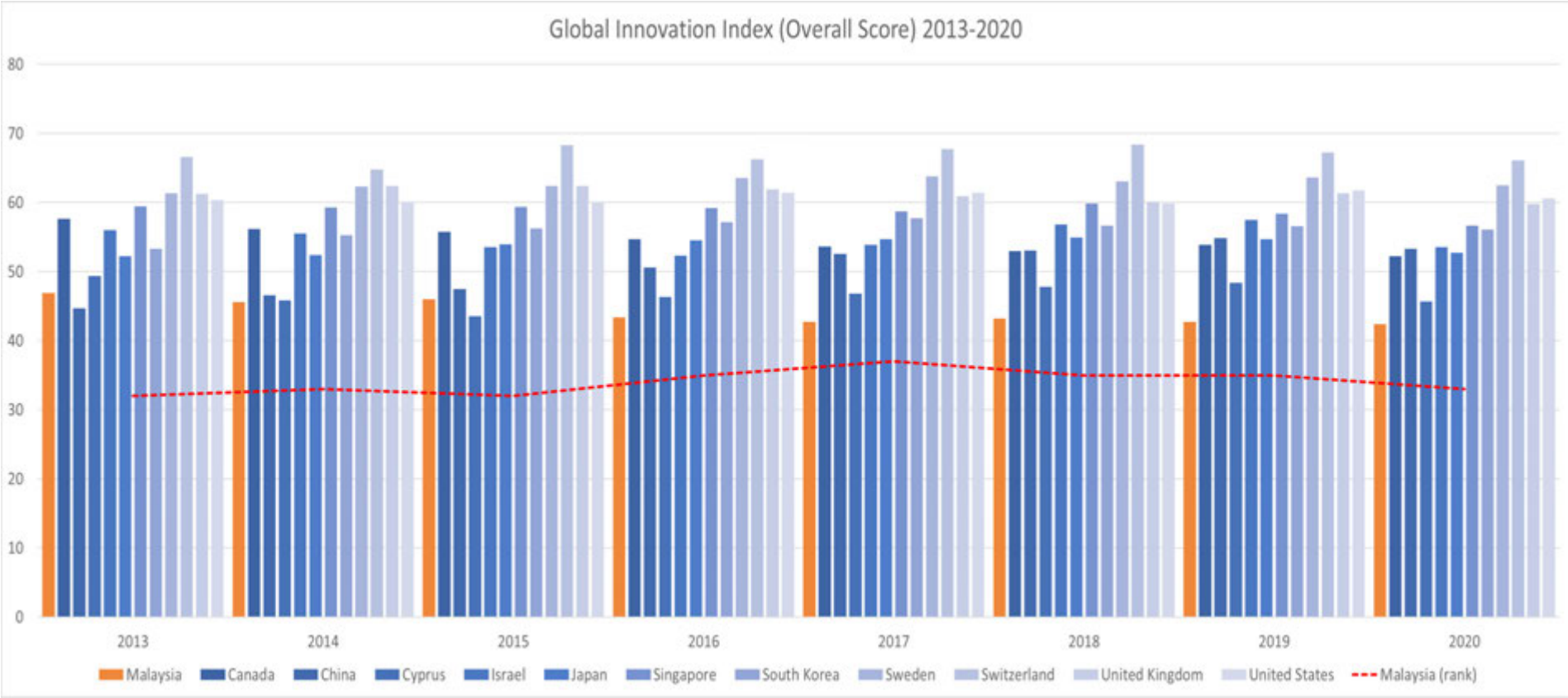
Malaysia has many competitive advantages, such as rich biodiversity and unique culture that can be leveraged to improve Malaysia's standing in the international arena. However, there needs to be greater understanding and adherence to international standards.
Source: Identification of National STIE Niche Areas using 10-10 Framework Workshop, 12 March 2020; EPU, 2016

Global Scanning and Benchmarking Analysis

Disruptive technologies and rapid innovations in the era of Industry 4.0 are changing the way we think and work. Scanning of policies, plans and practices in building a competitive innovation ecosystem across 11 countries provided valuable insights to emulate best practices. As progressive nations are fundamentally supported by strong STI ecosystems, it is important for Malaysia to identify our own competitive advantage to position Malaysia strategically in the international arena. A total of 11 countries were selected based on their higher ranks in the Global Innovation Index 2020 in comparison to Malaysia. Also, these are the top performing countries in their respective regions. Key strategies of the benchmarked countries are mapped with the 8i parameters to give an overview of best practices in building an innovative ecosystem.



Source: ASM Analytics, 2020



Analysed by ASM, Source: Global Innovation Index 2013; 2014; 2015; 2016; 2017; 2018; 2019; 2020

Malaysia's progress in STI development is reflected in the overall ranking in the Global Innovation Index (GII) from 2013 to 2020. Malaysia's highest rank over the last 7 years was at 32 in 2013. Since then, both Malaysia's overall rank and score have been declining, with the lowest performance in 2017 (ranked 37th out of 127 countries). While Malaysia's performance in the GII has stagnated, other innovative countries, such as Sweden and the UK, remained at the top of the rankings due to their strong STI ecosystems. Additionally, China has taken a great leap in climbing the rank. Best practices from the countries who have consistently performed well in the ranking should be taken into consideration in drafting strategies to improve Malaysia's STI ecosystems.

Global Scanning and Benchmarking 8i Analysis

INFRASTRUCTURE

Establishment of Technology and Innovation Hub as technology testing beds

[CYP] Cyprus Digital Innovation Hub (CyDi-Hub) was established as the regional network hub for researchers and businesses, as well as an incubator for industry players. They provide access to infrastructure and technical services that include product 3D design & prototyping, robotics, mechatronics, electronics & communication, IoT and software solutions etc.

[CHE] 5 innovation parks under Switzerland Innovation provide opportunity for business to access knowledge and infrastructure in the research institutes, bridging the gap between basic science and industry. The Swiss Business Incubation Centre (BIC) of CERN Technologies in Park Innovaare provides industry players the access to technology couching on CERN's unique technologies, know-how, IP and seed fund.

[CAN] Canada established the 'Innovation Superclusters' initiative to develop superclusters in 5 key national industries: 1) Next Generation Manufacturing; 2) Digital Technology; 3) Protein Industries; 4) Ocean; and 5) Scale AI Supercluster. The superclusters aim to bring industries, SMEs and post-secondary institutions to develop high-potential technologies.

Integrate IoT in smart city planning

[KOR] A few cities in South Korea have integrated various technologies for smart city development. Songdo's central pneumatic waste disposal system automatically collects rubbish to recycle, bury, incinerate or convert to energy. Cheonggyecheon Stream Restoration adopts ICT and sensors to control the water level and water quality; Seoul's Bus Management System is an integrated control center that monitors operations in real-time, communicates directly with bus drivers and gathers information on vehicle positioning, location and speed.

INTEGRITY

Establish platform for stakeholders to discuss integrity-related issues

[GBR] The UK Chief Acquisition Officers Council (CAOC) created an online platform to allow stakeholders to discuss federal acquisition process, particularly on reporting and compliance requirements, updated innovative solutions for procurement & contracting practices. SMEs and non-traditional government contractors are also involved to improve the existing technical or strategic assistance programmes.

Strengthen patent policies to enable technology transfer

[CHN] Law of the People's Republic of China on Promoting the Transformation of Scientific and Technological Achievements (2015 Amendments) allows independent transfer of scientific and technological outputs to other parties, as well as authorising others to utilise the scientific and technological outputs for practical transformation.

Deploy highly secured and transparent system

[SWE] Swedish land registry authority, Lantmäteriet, tested a way to record property transactions and mortgage deed processes on blockchain. The system operates on a private blockchain which has land authority and banks holding copies of the records. When the land title changes, each step of the process is verified and recorded on blockchain.

Source: ASM Analytics, 2020

INFOSTRUCTURE

Pushing forward 5G internet and its next-generation technologies

[CHN] The Internet Plus Initiative (2015-2020) is a 5-year plan to integrate Internet, cloud computing, IoT, big data and other digital technologies across all economic sectors. The initiative commits to increase percentage of GERD/GDP on research in digitilising economic sectors, reduce dependency on foreign technology innovation, increase investments in home-grown solutions, enable access to 100 MBps internet connections across large cities and expand broadband connectivity to 98% of population.

[CAN] The Canadian federal government and the provincial governments of Quebec and Ontario invested in the Evolution of Networked Services through a Corridor in Quebec and Ontario for Research and Innovation (ENCQOR) project, a five-year (2018-2023) initiative that supports R&D of 5G technologies by establishing a pre-commercialisation corridor equipped with an open digital test bed that allows companies and researchers to test innovative ideas and solutions.

Build a trusted digital environment that enable more value-added services

[SGP] Singapore's National Digital Identity (NDI) platform provides a secure digital credential, as well as a platform for authentication, authorisation and consent that provide citizens a single digital identity to do transactions. The NDI will enable private and public sectors to develop value-added services on a common and universal trusted framework. It also allows seamless interactions across domains and services where users can log in using their fingerprint, facial recognition or a 6-digit password.

INTELLECTUAL CAPITAL

Provide funding to encourage young talents entering aging industry

[GBR] The UK Government is encouraging the younger generation to enter industries with an aging workforce through a funding programme. The "UK-Young Entrance Support Schemes" is an example in the agriculture industry, whereby grants are given to applicants as young as 16 years old to start farming business.

Reskill talent for job security

[SWE] EU practices the concept of flexicurity. For instance, Sweden has established a job security council, Trygghetsrådet (TRR) that provides help to laid-off workers. Employers pay into these job-security councils (operated as private organisations) and if they lay employees off, these workers will receive financial support and job counselling from the council to help get them back into the workforce as soon as possible.

Provide future-proof education

[SGP] Singtel Optus invests in six to 20 months internship programme across all five polytechnics in Singapore, providing opportunities for 300 students annually to learn skills in IoT, cyber security, cloud and other digital skills.

Source: ASM Analytics, 2020

Global Scanning and Benchmarking 8i Analysis

INCENTIVES

Provide tax incentives and subsidy for foreign and domestic technology transfers programmes

[JPN] The Japan External Trade Organisation (JETRO) has a 'Subsidy Program for Global Innovation Centers' which subsidises the cost of foreign companies in establishing innovation centers and conducting research on IoT in collaboration with Japanese firms.

[KOR] Tax credit is given to SMEs for income derived from the leasing of patents or utility model rights where the company has file registration of such rights. Tax credit is also granted for transfer or lease, merger or acquisition of technology innovative companies.

Encourage commercialisation of innovations through patent box system

[CHN] China established a national patent box system, which provides tax breaks for revenues earned from patents, giving a favorable tax rate to firms that invest at least 3-6% of gross revenue in R&D, generate 60% of their revenue from IP, or have a substantial percentage of skilled workers or high-tech occupations.

[CAN] Quebec and Ontario have employed a patent box system that allows corporate income related to the sale of patented products to be taxed at rates which are significantly lower than those applied to ordinary business income. The patent box system provides firms with a strong incentives to innovate and commercialise the innovations in the local jurisdiction.

INTERACTIONS

Establishment of industrial alliance among key players to provide solutions

[SGP] A*STAR formed industrial alliances with 13 companies to develop IoT solutions for manufacturing industries, particularly in aerospace, offshore and marine, and land transport.

[CAN] The National Research Council of Canada's Industrial Research Assistance Program (NRC IRAP) helps SMEs to build innovation capacity and take ideas to market through a network of over 250 Industrial Technology Advisors (ITAs). ITAs focuses on assisting SMEs with technology and new product development, as well as connect universities and national laboratories with SMEs.

[USA] Manufacturing USA is a public-private partnership that brings together industry, academia, and government partners to leverage existing resources and co-invest in manufacturing innovation and accelerate commercialization. It consists of 14 innovation intermediaries that focus on advanced functional fabrics, photonics, additive manufacturing (3D printing), robotics, biofabrication, clean-energy smart manufacturing, advanced lightweight composite materials, digital manufacturing, flexible hybrid electronics, biopharmaceutical manufacturing, advanced semiconductor components, chemical and material processing, and remanufacturing of materials.

Source: ASM Analytics, 2020

INSTITUTIONS

Establish central coordinating and planning body for R&D funding of research

[GBR] The UK Research and Innovation (UKRI) is a central body that coordinates with the seven research councils, Innovate UK and Research England, as well as works with the UK government in effectively directing funding to research areas that are strategic for the UK.

[ISR] The Israel Innovation Authority is a public funded independent agency. Through collaborations, it provides a variety of practical tools and funding platforms for early stage start-up, growing high-tech companies, funding for R&D infrastructure, international collaboration, advanced manufacturing and innovation programs for societal challenges.

Establish innovation intermediaries and collaborative networks for market-driven R&D

[GBR] Catapult Centres are a network of independent technology centres located nation-wide and globally that provide support to translate R&D products into commercial products and services in specialist sectors (i.e. Cell & Gene Therapy, Future Cities, Satellite Applications etc.) for future growth, trade and productivity.

INTERNATIONALISATION

Introduce international matching funds to encourage collaborative research with innovative countries

[GBR] EUREKA has established a £4 million competition fund that connects researchers and businesses to 41 "EUREKA" countries to fund international collaborative research. Some of the investments by EUREKA include £1 million fund for medical technology and smart mobility through GlobalStars fund, £2 million for smart manufacturing, and £1 million for artificial intelligence and quantum.

Provide tax deduction for innovative companies to internationalise

[SGP] Double Tax Deduction for Internationalisation (DTDi) initiative encourages local businesses to embark on international expansion and internationalisation. The DTDi is aimed at small-business ventures to create market presence in other countries, such as marketing, trade shows, networking and sourcing for local partners, which provides additional time and effort to these businesses who are often lean in operations. Under the DTDi initiative, local businesses carrying out select overseas business activities are entitled to a 200% tax deduction of up to $150,000 on expenses for these activities.

Strengthen position in international market through collaboration

[JPN] "Partnership for Quality Infrastructure" promotes Japan's safe and high-performance technology to the rest of the world through providing attractive loan assistance systems for infrastructure development in the partnering countries. For example, Japan collaborated with India to use Japan's Shinkansen train system to build the high-speed railway project between Mumbai and Ahmedabad.

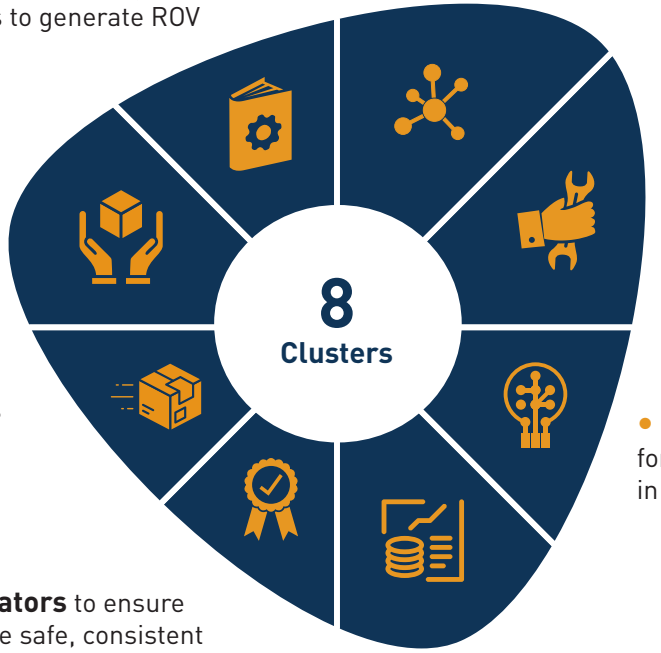
Source: ASM Analytics, 2020

Collaborative Platform

While the National STIE Niche Areas provide strategic focus, the translation on the ground cannot happen effectively unless there is a collaborative platform that brings together key players to spearhead concerted action. The collaborative platform provides a more holistic solution and effective implementation of strategies, policies and programmes. In order to develop a conducive ecosystem to support and sustain key economic growth activities and societal well-being at localities across Malaysia, we need 8 clusters:

- **Capacity Builders** are important as innovation is driven by people with knowledge, competencies and resources. As such, continuous training is vital to ensure people have the skills to generate ROV

- **Connectors** to bring stakeholders together and facilitate effective networking and collaborative strategies



- **Market Access Providers** are important for goods and services to cross borders and expand economic activities and revenue streams

- **Producers and Manufacturers** to make the goods and provide services that underpin the economic activities

- **Supply Chain and Logistics Providers** involve a network of businesses and activities to take products and services from source to consumer such as the National Technology and Innovation Sandbox

- **Technology Providers** to harness technology for solutions creations in overcoming challenges in each respective sector

- **Standards Setters and Regulators** to ensure products, services, and systems are safe, consistent and reliable to enter the global markets

- **Financing Providers** to roll out alternative financing options for businesses to operate

Source: ASM Analytics, 2020, Adapted from European Commission, 2014

A functional collaborative platform comprising of the 8 clusters working together can give rise to a knowledge-based economy. Effective collaboration between stakeholders is needed to help address economic disparities by implementing high impact projects across localities in Malaysia.

The collaborative platform is critical for translating research into transformative outcomes for the community.

The platform also enables multichannel communication and feedback between the stakeholders. This facilitates effective decision-making and implementation of strategies.

Harnessing Multiple STIE Ecosystems Across Malaysia

Northern Corridor Potential STIE Ecosystems

*non-exhaustive

Manufacturing Projects:
Top 5 areas in Perlis

1. Plastic Products
2. Electronics & Electrical Products, Food Manufacturing
3. Rubber Products
4. Textile & Textile Products
5. Transport Equipment

Manufacturing Projects:
Top 5 areas in Kedah

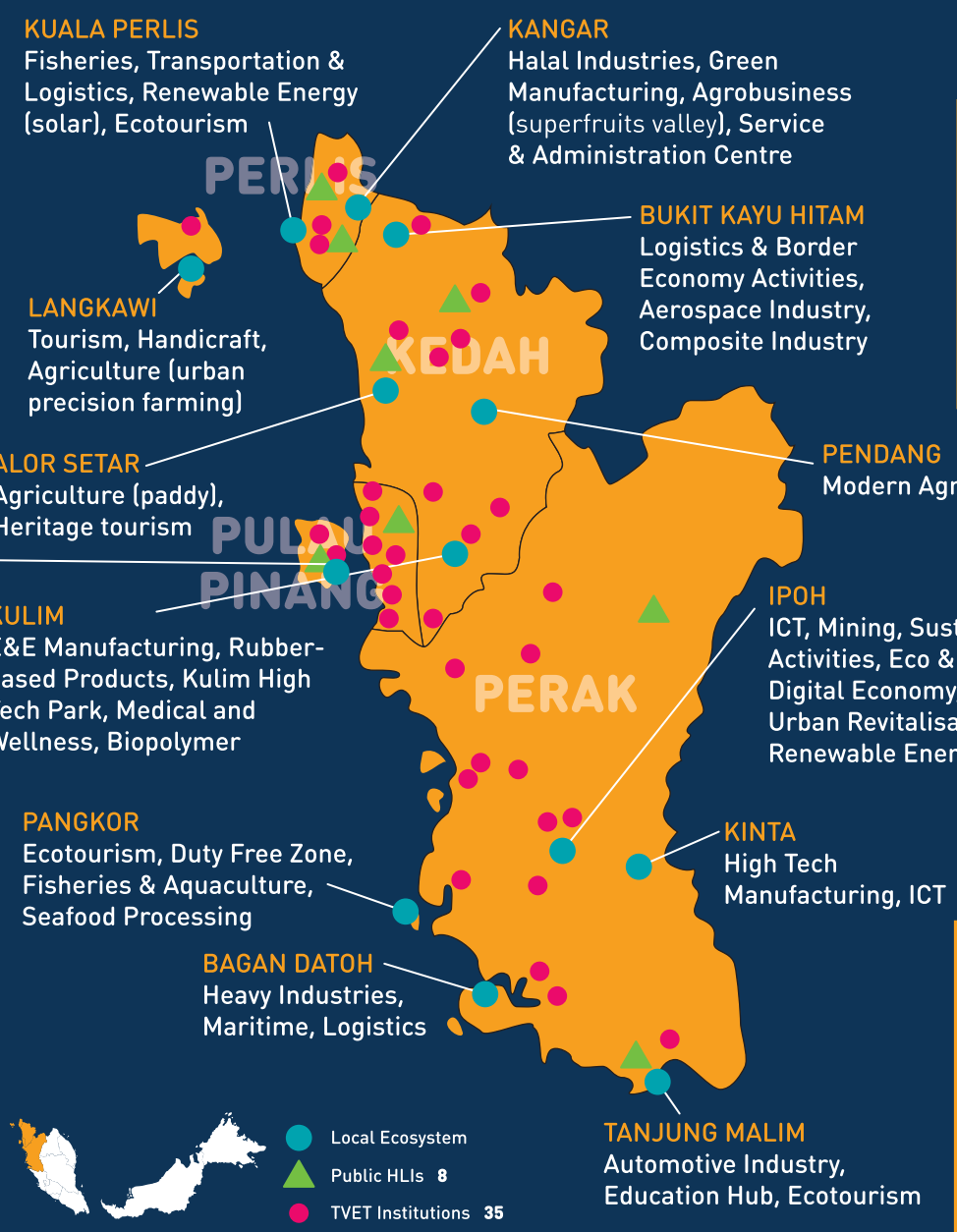
1. Electronics & Electrical Products
2. Transport Equipment
3. Fabricated Metal Products
4. Plastic Products
5. Rubber Products

Manufacturing Projects:
Top 5 areas in Pulau Pinang

1. Electronics & Electrical Products
2. Machinery & Equipment
3. Fabricated Metal Products
4. Plastic Products
5. Basic Metal Products, Food Manufacturing

Manufacturing Projects:
Top 5 areas in Perak

1. Electronics & Electrical Products
2. Non-metallic Mineral Products
3. Rubber Products
4. Food Manufacturing
5. Plastic Products



Source: ASM Analytics, 2020; Nair, 2011; MIDA, 2020

East Coast Region Potential STIE Ecosystems

*non-exhaustive

Manufacturing Projects:
Top 5 areas in Kelantan

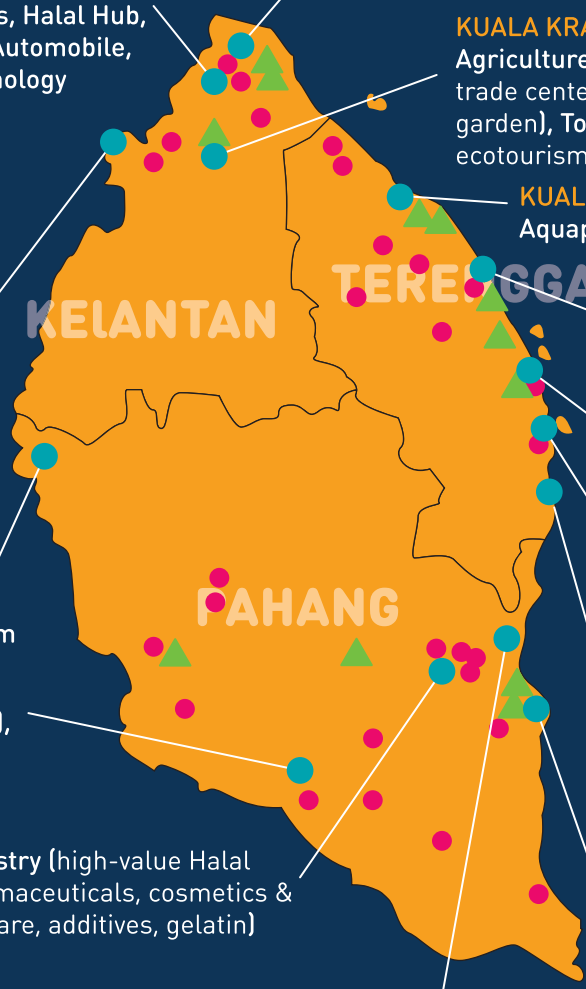
1. Electronics & Electrical Products; Wood & Wood Products
2. Textile & Textile Products
3. Chemical & Chemical Products; Non-metallic Mineral Products; Rubber Products
4. Basic Metal Products; Furniture & Fixtures
5. Food Manufacturing; Leather & Leather Products

Manufacturing Projects:
Top 5 areas in Terengganu

1. Chemical & Chemical Products
2. Petroleum Products (including Petrochemicals)
3. Wood & Wood Products
4. Transport Equipment
5. Non-metallic Mineral Products

Manufacturing Projects:
Top 5 areas in Pahang

1. Wood & Wood Products
2. Chemical & Chemical Products
3. Petroleum Products (including Petrochemicals)
4. Electronics & Electrical Products
5. Food Manufacturing



KOTA BHARU
Handicraft, Tourism (historical heritage), Transportation & Logistics, Education & Trainings, Halal Hub, Textile, Automobile, Biotechnology

PASIR MAS
Halal Industry (high-value downstream Halal food products), Tourism, Duty Free Zone (retail), Aquaculture

KUALA KRAI
Agriculture (marketing & trade center, herb & fruit garden), Tourism (agro- & ecotourism)

KUALA NERUS
Aquapolitan

KUALA TERENGGANU
Agriculture (coffee, rice, pepper, cotton goods), Textile, Food Processing, Arts & Crafts, Timber, Tourism (culture, heritage, history, beaches), Education & Trainings, Business Services, Transportation & Logistics

DUNGUN
Agriculture (nutraceutical, medicinal herbs), Fisheries

KERTEH / KEMAMAN
Oil & Gas, Petrochemical, Tourism (Hutan Lipur recreation), Transport & Logistics (support and services to the petroleum industry), Heavy Industries

GEBENG
Polypropylene-based Petrochemicals, Oil Palm Biomass, Palm Oil-based Products

PEKAN
Automotive (manufacturing & assembly hub), Maritime Industry

JELI
Wood Industries, Minerals, Herbs, Automobile, Gold & Quartz Mining, Ecotourism

CAMERON HIGHLANDS
Agriculture Biotechnology, Flower Industry, Halal Food Production, Food Industry, Tourism

TEMERLOH
Agriculture, Aquaculture (patin fish), Transportation & Logistics

GAMBANG
Halal Industry (high-value Halal food, pharmaceuticals, cosmetics & personal care, additives, gelatin)

KUANTAN
Fishing, Aquaculture, Oil Palm, Petrochemical, Food Manufacturing, Port & Logistics, High Technology Industries (stainless steel, E&E, ICT, renewable energy), Tourism (themeparks & family oriented resorts)

Local Ecosystem
Public HLIs **12**
TVET Institutions **28**

Source: ASM Analytics, 2020; Nair, 2011; MIDA, 2020

Central Region Potential STIE Ecosystems

*non-exhaustive

SHAH ALAM
Automobile & Machinery, Telecommunications, Tourism & Hospitality (i-City), Education

SABAK BERNAM
Agriculture Biotechnology, Smart Agriculture, Cottage Industry

CYBERJAYA
Technology Hub (smart grid technology, wearable technologies, green technology, biotechnology and ICT-related technologies), Smart Mobility, Smart Healthcare, Digital Creative

PORT KLANG
Seaport Logistics, Halal Hub

KUALA LUMPUR
Financial Services, Business Services, Education, Health, Hospitality Services, Communication Services, Tourism

PUTRAJAYA
Diplomatic Hub, Federal Administrative Centre

SEPANG
Airport Logistics, Agriculture (Fruits), Tourism

Manufacturing Projects:
Top 5 areas in Kuala Lumpur

1. Electronics & Electrical Products
2. Machinery & Equipment
3. Textiles & Textile Products
4. Transport Equipment
5. Fabricated Metal Products

Manufacturing Projects:
Top 5 areas in Selangor

1. Electronics & Electrical Products
2. Machinery & Equipment
3. Transport Equipment
4. Fabricated Metal Products
5. Plastic Products

Local Ecosystem
Public HLIs **11**
TVET Institutions **15**

Source: ASM Analytics, 2020; Nair, 2011; MIDA, 2020

Southern Region Potential STIE Ecosystems

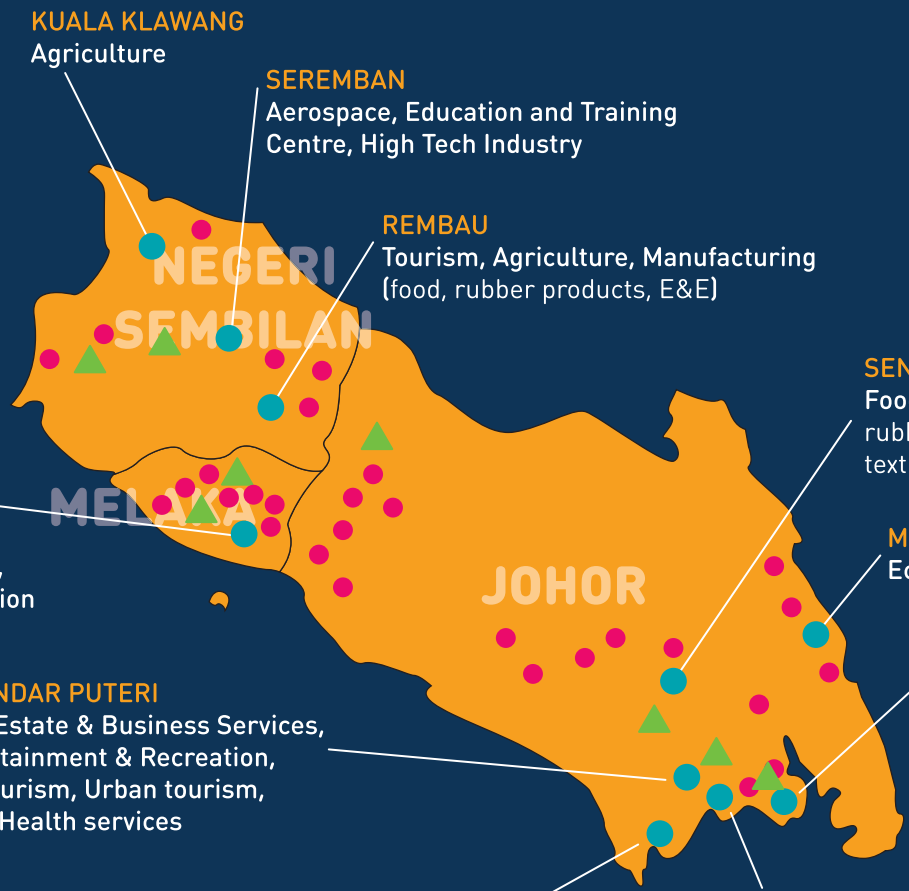
*non-exhaustive

Manufacturing Projects:
Top 5 areas in Negeri Sembilan

1. Electronics & Electrical Products
2. Machinery & Equipment
3. Chemical & Chemical Products
4. Fabricated Metal Products
5. Non-Metallic Mineral Products

Manufacturing Projects:
Top 5 areas in Johor

1. Electronics & Electrical Products
2. Fabricated Metal Products
3. Textiles & Textile Products
4. Furniture & Fixtures
5. Plastic Products



KUALA KLAWANG
Agriculture

SEREMBAN
Aerospace, Education and Training Centre, High Tech Industry

REMBAU
Tourism, Agriculture, Manufacturing (food, rubber products, E&E)

BANDARAYA MELAKA, JASIN & ALOR GAJAH
Heritage Tourism, ICT, Halal Hub, Aquaculture, Logistics & Transportation

SENAI-SKUDAI
Food crop, E&E, Agriculture (palm oil & rubber) **Manufacturing** (polymer, ceramics, textiles, industrial paints, furniture, paper)

MERSING
Ecotourism, Fisheries, Agribusiness

EASTERN GATE DEVELOPMENT ZONE
Logistics Hub & Transshipment, Food & Agro Processing, E&E, Downstream Petroleum-related Activities, Manufacturing (plastics, chemicals, polymer, industrial paints, metals, furniture, cement & concrete)

ISKANDAR PUTERI
Real Estate & Business Services, Entertainment & Recreation, Ecotourism, Urban tourism, E&E, Health services

WESTERN GATE DEVELOPMENT ZONE
Logistics Hub & Transshipment, Ecotourism, E&E, Power plant

JOHOR BHARU
Financial Services, Arts & Culture, Hospitality, Urban Tourism, E&E, Health Services, Manufacturing (polymer, plastic, textiles, industrial paints, metals)

Manufacturing Projects:
Top 5 areas in Melaka

1. Electronics & Electrical Products
2. Fabricated Metal Products
3. Machinery & Equipment
4. Plastic Products
5. Transport Equipment

Local Ecosystem
Public HLIs **8**
TVET Institutions **30**

Source: ASM Analytics, 2020; Nair, 2011; MIDA, 2020

Sabah Potential STIE Ecosystems

*non-exhaustive

Local Ecosystem
Public HLIs **2**
TVET Institutions **11**

KUDAT
Fishing & Aquaculture, Cottage Industries, Tourism, Transportation & Logistics

KOTA KINABALU
Transportation, Agriculture & Fisheries, Education, Tourism, Bio & Food Tech, Automotive, Wood & Rubber

GUNUNG KINABALU
Tourism

PAPAR
Agro-based (food and specialty crops/natural products), Oil & Gas

LABUAN
Oil & Gas, Services (banking & finance, business process outsourcing, insurance, real estate), Halal Hub, Tourism, Transportation & Logistics

SIPITANG
Oil & Gas

KENINGAU
Agriculture & Livestock

SANDAKAN
Aquaculture, Manufacturing (furniture), Food Processing, Education, Palm Oil, Tourism, Trade and Financial Services, Transportation & Logistics

LAHAD DATU
Agriculture (palm oil, palm oil processing, cocoa, rubber) Timber, Tourism, Oil & Gas, Transportation & Logistics

SEMPORNA
Fisheries, Tourism, Telecommunication

TAWAU
Agriculture (cocoa, palm oil), Timber, Aquaculture, Trade and Financial Services, Tourism, Transportation & Logistics

Manufacturing Projects:
Top 5 areas in Sabah

1. Wood & Wood Products
2. Food Manufacturing
3. Chemical & Chemical Products
4. Non-metallic Mineral Products
5. Transport Equipment

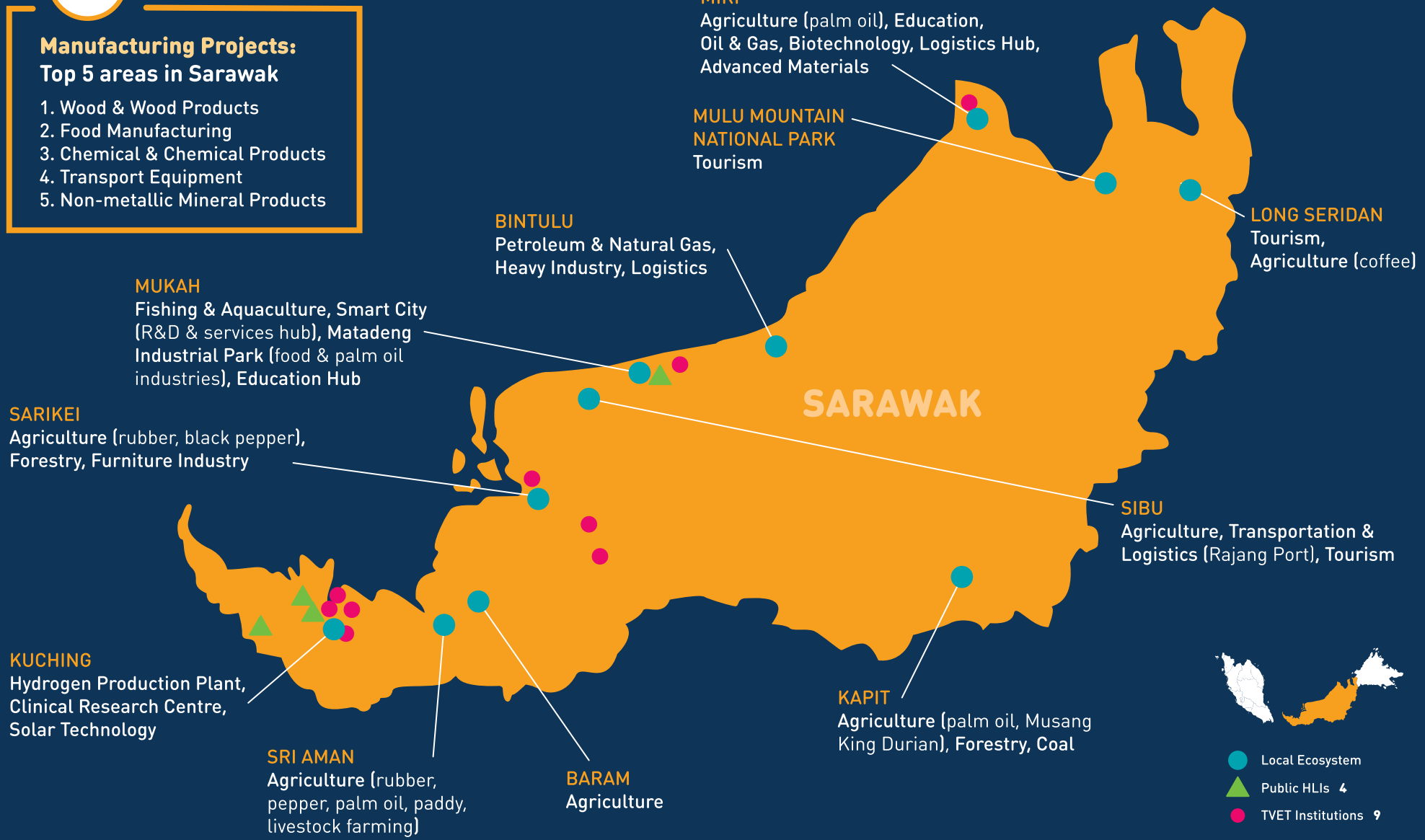
Source: ASM Analytics, 2020; Nair, 2011; MIDA, 2020

Sarawak Potential STIE Ecosystems

*non-exhaustive

Manufacturing Projects:
Top 5 areas in Sarawak

1. Wood & Wood Products
2. Food Manufacturing
3. Chemical & Chemical Products
4. Transport Equipment
5. Non-metallic Mineral Products



Source: ASM Analytics, 2020; Nair, 2011; MIDA, 2020

Basis for National STIE Niche Areas

The National STIE Niche Areas are identified based on 4 key criteria:

03

30 National STIE Niche Areas for 10 Socio-economic Drivers

The 30 National STIE Niche Areas were identified through a series of stakeholder engagements to ensure that they are aligned with national aspirations. These niche areas were endorsed by the National Science Council on 14 July 2020 and will be reviewed every 2-3 years to ensure relevance to changing times.

Energy

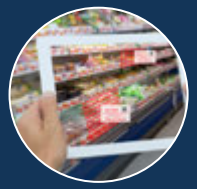
Diversified Renewable Energy

Energy Storage System

Microgrid

Business & Financial Services

Subscription Business Models & Sharing Platforms

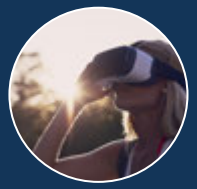


Digitalised & Autonomous Services

Fintech in Islamic Finance

Culture, Arts & Tourism

Creative Content & Heritage

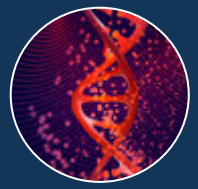


Digitalised Tourism

High-Value Tourism

Medical & Healthcare

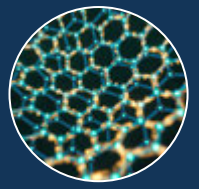
Digital Health



Precision Medicine

Clinical Trials Hub for Developing Countries

Smart Technology & Systems (Next-Generation Engineering and Manufacturing)



Advanced Materials for Circular Economy & Sustainable Society

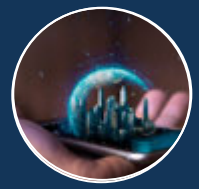
Next-Gen Smart Factories

Manufacturing of Smart Devices & Technology Development

Smart Cities & Transportation

Integrated Urban Infrastructure & Infostructure Management

Smart Systems for Connected Rural-Urban Communities



Human-Centred Design & Analytics

30 National STIE Niche Areas for **10** Socio-economic Drivers

Water & Food

Premium Halal Food

High-Value Seafood

Agriculture & Forestry

Local Superfood

Premium Tropical Fruits

Integrated Water Resources Management

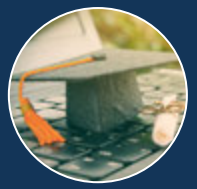
Local Agricultural Input

Smart Supply Chain Management for Sustainable Forest Products

Education

Personalised & Experiential Learning

Micro-credentials



Global Online Learning: Promoting Local Content

Environment & Biodiversity

Precision Biodiversity

Innovative Eco-Products from Waste

Impact of the National STIE Niche Areas

The 30 National STIE Niche Areas have been classified in terms of their weightage of contribution as follows:

12 niche areas are identified as
ECONOMIC BOOSTERS

11 niche areas are classified as (combination of economic and social impact)
DUAL-IMPACT ENABLERS

07 niche areas are identified as
Ssocietal well-being catalyst


Digitalised & Autonomous Services


High-Value Tourism


High-Value Seafood

Subscription Business Models & Sharing Platforms


Premium Halal Food


Premium Tropical Fruits


Fintech in Islamic Finance

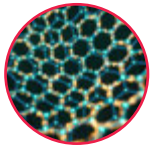

Clinical Trials Hub for Developing Countries


Next-Gen Smart Factories


Digitalised Tourism


Manufacturing of Smart Devices & Technology Development


Global Online Learning: Promoting Local Content


Advanced Materials for Circular Economy & Sustainable Society


Creative Content & Heritage


Integrated Water Resources Management


Local Superfood


Energy Storage System


Integrated Urban Infrastructure & Infostructure Management


Smart Supply Chain Management for Sustainable Forest Products


Diversified Renewable Energy


Micro-credentials


Innovative Eco-Products from Waste


Local Agricultural Input


Digital Health


Precision Medicine


Precision Biodiversity


Microgrid


Personalised & Experiential Learning


Smart Systems for Connected Rural-Urban Communities

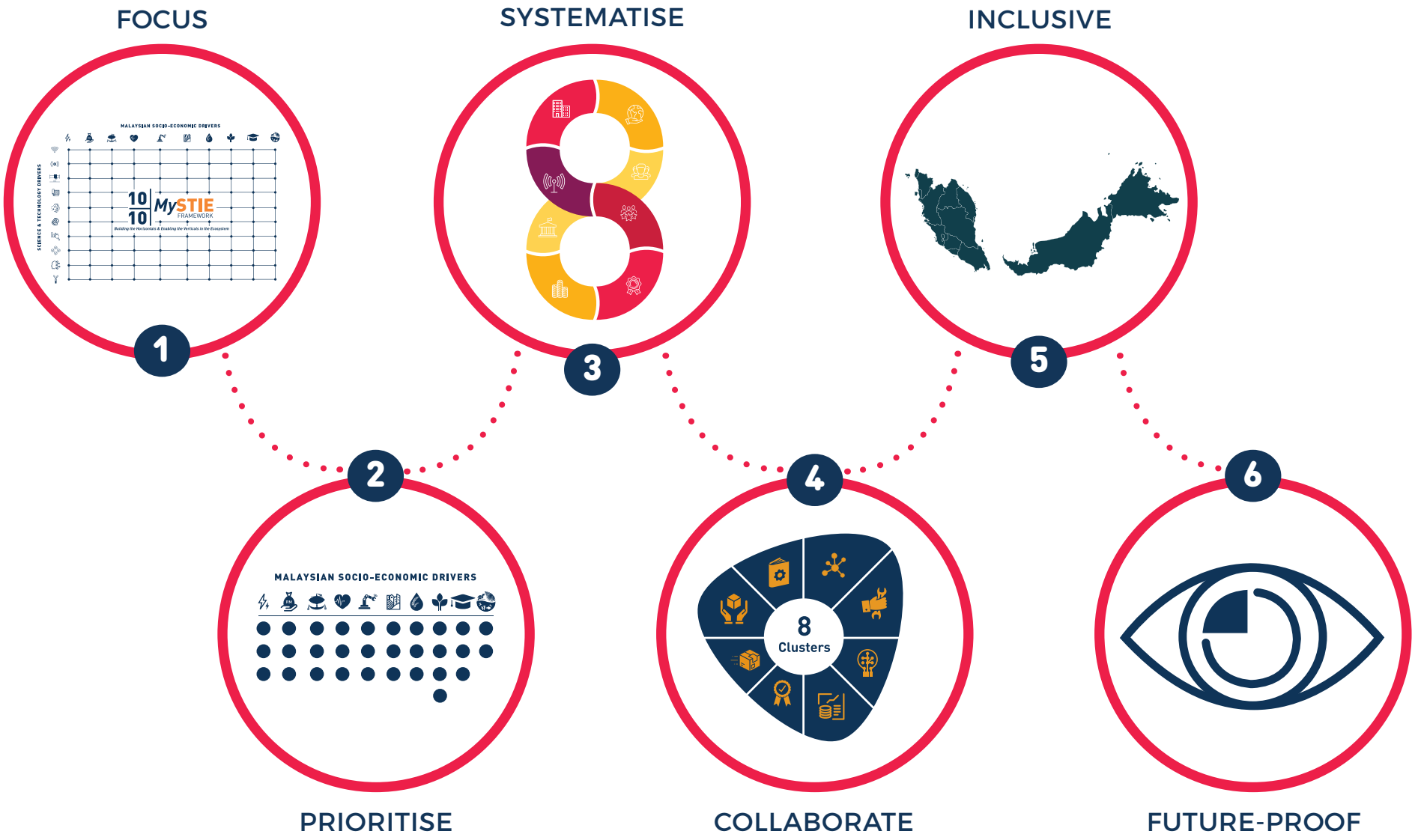

Human-Centred Design & Analytics

Part II

Implementing the 10-10 *My*STIE Framework

Part II of this transformation book aims to provide a step-by-step guide on the use of the 10-10 *My*STIE Framework to develop vibrant and agile STIE ecosystems.

10-10 *My*STIE: Implementation Steps



Source: Analytics by ASM and Nair, Ahmed, Vaithilingam and Monash University Malaysia Research Team, 2020

Malaysia is an open and small economy with scarce resources. To move up the global innovation and competitive value chain, Malaysia must **focus** its efforts in developing key S&T and socio-economic drivers that ensure sustainable economic development. In this context, Malaysia must invest in key S&T drivers that deepen the impact of socio-economic drivers and target key **priority** niche areas to establish global leadership. To ensure the 10-10 *My*STIE Framework contributes to nation building, a **systematic** ecosystem approach needs to be taken. It must incorporate strategic **collaborative** partnership approach among players such that they create a multiplier effect for **inclusive** development. This is to ensure no community is left behind in the transition to a developed nation and **future-proof** sustainable development.

The 10-10 *My*STIE Framework will enable the deployment of high impact projects to address needs of communities as well as quality of life at specific localities across Malaysia. The mechanism comprises 6 steps, premised upon an ecosystem approach (8i STI ecosystem enablers) as follows :

1

FOCUS

Build an understanding of the emerging global technologies (10 S&T Drivers) and how they impact your core operations and influence key socio-economic areas.

2

PRIORITISE

Identify niche areas for priority investments to build positions of global leadership based on strengths and needs in your core business, in relation to the emerging global technologies.

3

SYSTEMATISE

Define a holistic approach (8i STI ecosystem enablers) to ensure systematic development that deepens the impact of S&T drivers on socio-economic development.

4

COLLABORATE

Foster an ecosystem-wide collaboration with key players for the deployment of high-impact projects at identified localities to create multiplier effect for shared prosperity.

5

INCLUSIVE

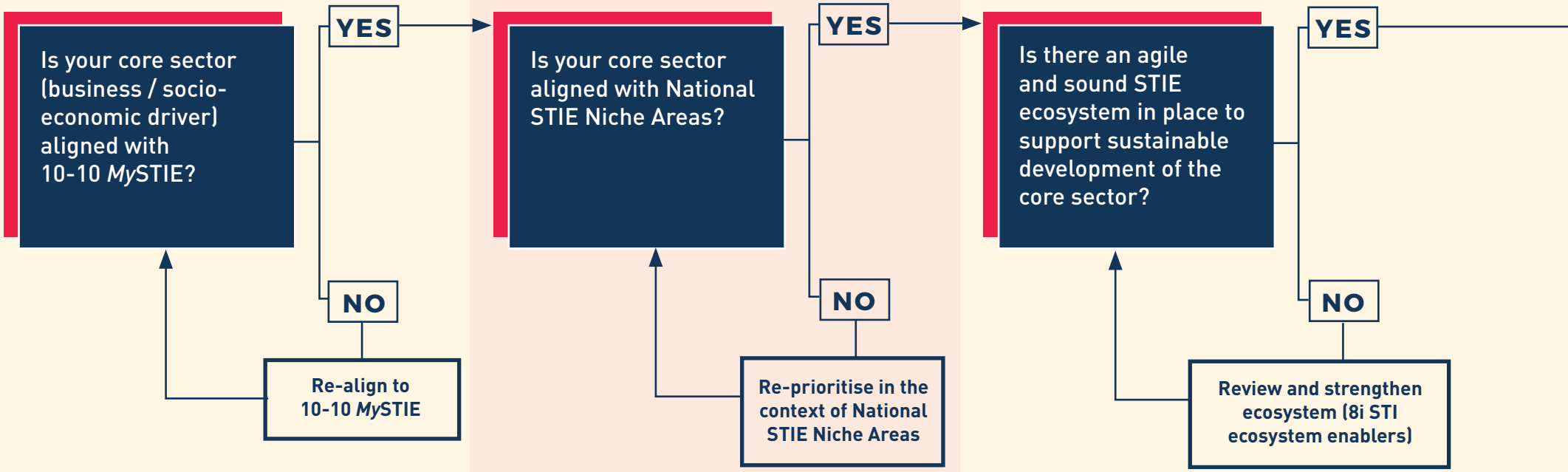
Initiate locality-specific STIE ecosystems to inclusively harness resources and talent to enhance return on value and improve the quality of life of the *rakyat.*

6

FUTURE-PROOF

Conduct regular foresighting to ensure the STIE ecosystem is adapting to change and is able to mitigate risks associated with uncertainties and volatilities.

10-10 *My*STIE Process Flow for Nurturing Vibrant and Agile STIE Ecosystems



Ecosystem Development Strategies

Step 1

FOCUS

Identify key subsectors and their stages of development as well as incorporate appropriate S&T drivers to raise the quality and ROV of these subsectors

Step 2

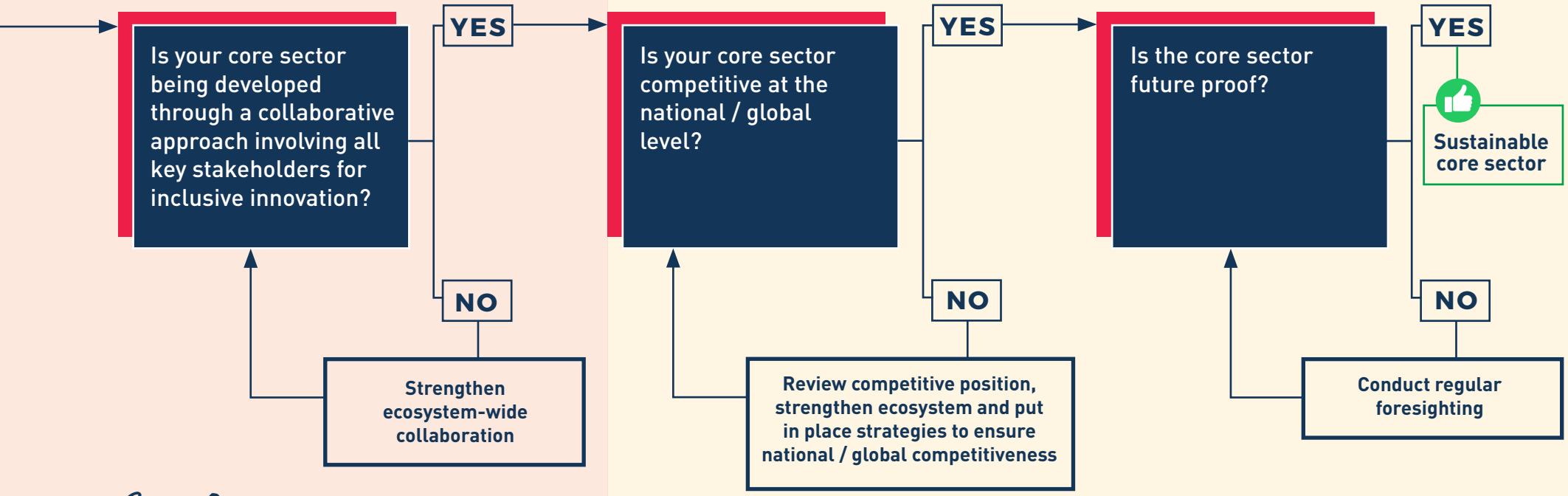
PRIORITISE

Identify niche areas within the key economic sectors to build positions of global leadership based on the emerging and frontier S&T drivers

Step 3

SYSTEMATISE

Define a holistic approach (8i STI ecosystem enablers) to ensure systematic development that deepens the impact of S&T drivers on socio-economic development



Step 4 & 5

COLLABORATE

Foster an ecosystem-wide collaboration with key players for the deployment of high-impact projects at identified localities to create multiplier effect for shared prosperity.

INCLUSIVE

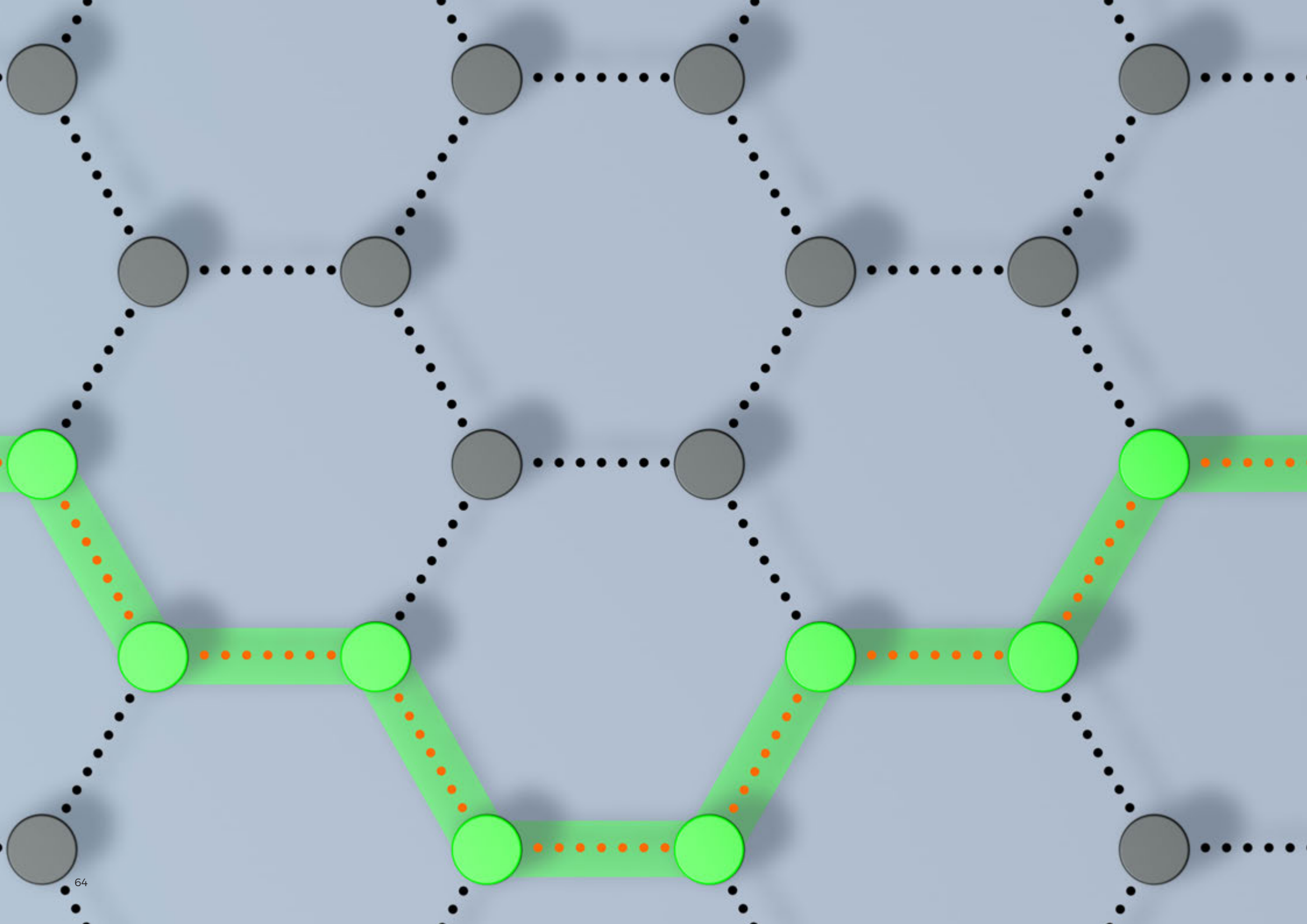
Initiate locality-specific STIE ecosystems to inclusively harness resources and talent to enhance return on value and improve the quality of life of the *rakyat*.

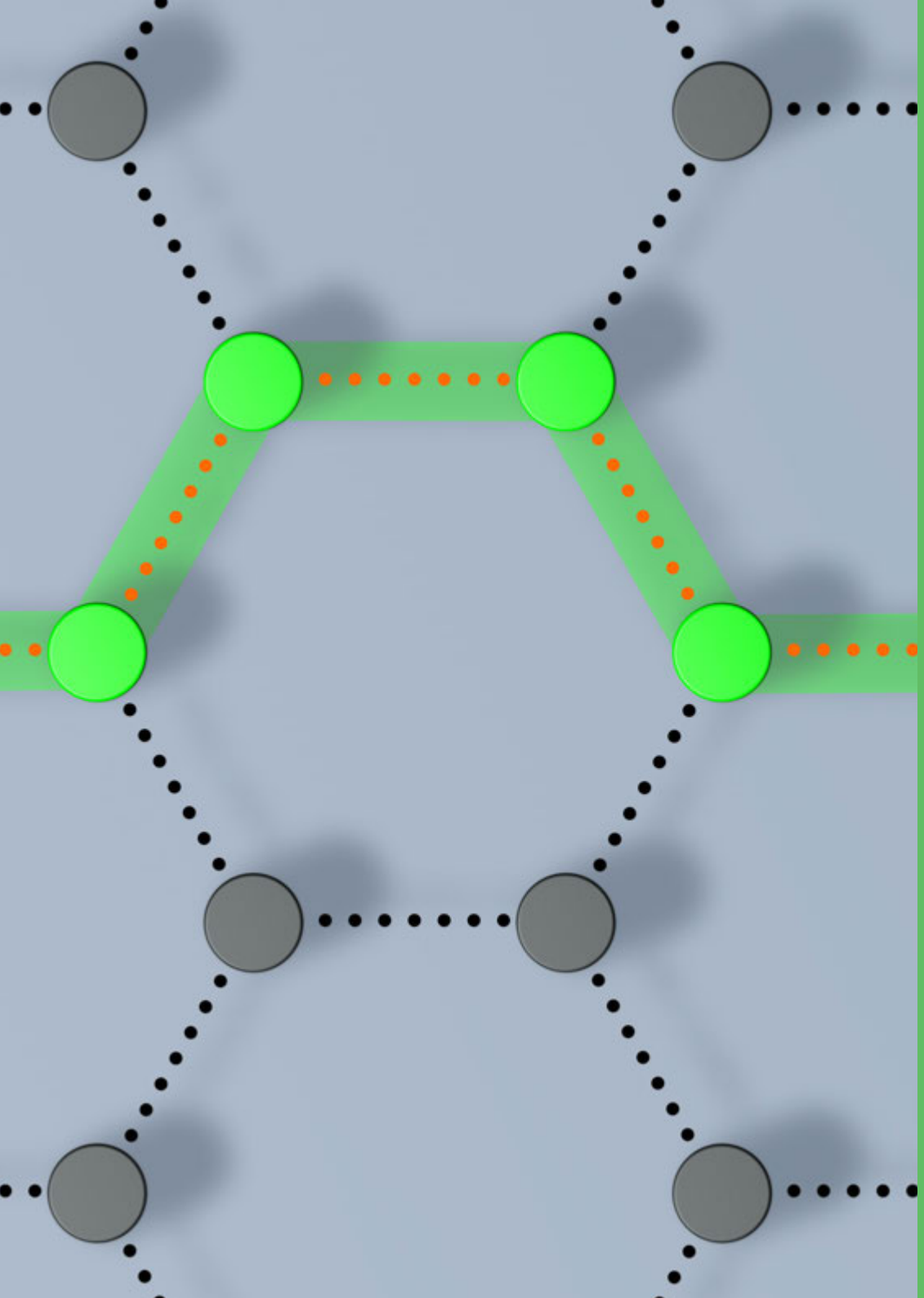
Step 6

FUTURE-PROOF

Conduct regular foresighting to ensure the STIE ecosystem is adapting to change and is able to mitigate risks associated with uncertainties and volatilities.

Source: Analytics by ASM and Nair, Ahmed, Vaithilingam and Monash University Malaysia Research Team, 2020





Potential High-Impact Initiative: Becoming A Pace-setter in the Global Halal Economy

A game-changer for Malaysia would be to position the Malaysian Halal ecosystem as a producer of premium products and services for the global market. This would require a strong collaborative platform constituted by Halal scientists, regulators and other key stakeholders for the holistic development of a robust Halal supply chain. An agile and sound Halal ecosystem underpinned by the 10-10 *My*STIE Framework will translate into several multiplier effects on the socio-economic drivers of the country.

An STIE driven Halal ecosystem will not only meet domestic market needs but will extend its footprint globally. For example, if the Malaysian Halal Certification establishes and incorporates global environmental standards, it will build competitive advantage.

*** Halal Science** is a scientific research pursuit aimed at supporting, expanding and sustaining the Halal industry globally. This encompasses analysis and the use of new technology to create innovative products and services with great impact to society and environment.

Source: ASM, 2019

10-10 *My*STIE Process Flow for Nurturing Vibrant & Agile STIE Ecosystems for Halal Economy:

Current Trajectory

An agile and strong Halal ecosystem can generate multiplier effects for all socio-economic drivers.
Refer to page 68-69

Is your Halal sector aligned with 10-10 *My*STIE?

YES

NO

Re-align to 10-10 *My*STIE

Aligned to 20 out of 30 National STIE Niche Areas.
Refer to page 70

Is your Halal sector aligned with National STIE Niche Area?

YES

NO

Re-prioritise in the context of National STIE Niche Areas

10-10 *My*STIE underpinning the Halal industry by operationalising *Maqasid al-Syari'ah*.
Refer to page 71

Is there an agile and sound STIE ecosystem in place to support sustainable development of the Halal sector?

YES

NO

Fragmented ecosystem.
Refer to pg 71

Review and strengthen ecosystem (8i STI ecosystem enablers)

Ecosystem Development Strategies for Halal Economy

Step 1
FOCUS

Identify key Halal subsectors and their stages of development and incorporate appropriate S&T drivers to raise the quality and ROV of these subsectors.

Step 2
PRIORITISE

Identify niche areas within the Halal sector to build positions of global leadership based on the emerging and frontier S&T drivers.

Step 3
SYSTEMATISE

Define a holistic approach (8i STI ecosystem enablers) to ensure systematic development that deepens the impact of S&T drivers on the Halal sector.

If we ramp up our Halal Industry by underpinning it with 10-10 *My*STIE, Malaysia has the potential to raise its global market share from 2.2% in 2018 (as cited in Halal Industry Master Plan, 2020) to 5% in 2030, estimated at RM1 trillion.

Future Trajectory

Develop a Halal collaborative platform that engages multiple players to harness the various Halal ecosystems across the country.

Refer to page 72-73

Is your Halal sector being developed through a collaborative approach involving all key stakeholders for inclusive innovation?

YES

NO

Strengthen ecosystem-wide collaboration

Halal STIE ecosystem is sound, robust and agile in meeting HACCP standards and garnering a larger share of the global Halal market.

Refer to page 74

Is your Halal sector competitive at the national / global level?

YES

NO

Review competitive position, strengthen ecosystem and put in place strategies to ensure national / global competitiveness

Continuously undertaking foresighting and signposting to invest in the S&T drivers that will ensure that the Malaysian Halal industry becomes a pace-setter leading global development in the 10 socio-economic drivers.

Is your Halal sector future proof?

YES

Sustainable Halal sector

NO

Conduct regular foresighting

Step 4 & 5

COLLABORATE

Foster ecosystem-wide collaboration with key players for the deployment of high-impact projects at identified localities to create multiplier effect for shared prosperity.

INCLUSIVE

Initiate locality-specific STIE ecosystems to inclusively harness the resources and talent to enhance return on value and improve the quality of life of the *rakyat*.

Step 6

FUTURE-PROOF

Conduct regular foresighting to ensure the STIE ecosystem is adapting to change and is able to mitigate risks associated with uncertainties and volatilities.

Future trajectory for Halal

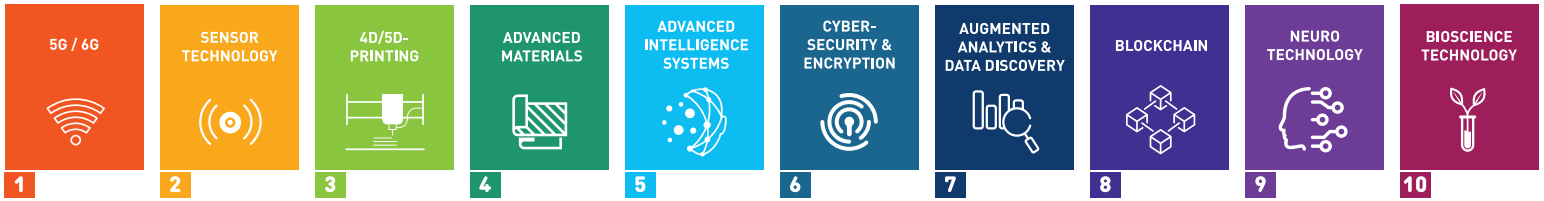
Current trajectory for Halal

Source: Analytics by ASM and Nair, Ahmed, Vaithilingam and Monash University Malaysia Research Team, 2020

Application of the 10-10 *My*STIE Framework: An Example for the Halal Supply Chain

Catch-up (Current) Technologies

- Real-time supply chain product tracking and AI-driven data insights for demand forecasting — 1 2 5 6 7 8
- Dynamic predictive digital advertising to Halal markets and consumers — 1 5 7
- End-to-end Halal compliance and traceability via blockchain — 1 2 5 8
- End-to-end Halal compliant e-commerce ecosystem — 1 2 5 6 7 8
- Blockchain-driven Islamic financial services, FinTech and virtual banking — 1 5 6 7 8
- AI-driven ethical precision farming using IoT sensors to monitor animal welfare in meat industries in accordance to Islamic principles of care and stewardship — 1 2 5 6 7 8
- Dynamic edge-cloud computing for automated operations and Halal monitoring in 5G-connected factories — 1 2 3 5 6 7 8



Leap-frogging Technologies (Next-Generation Research & Application)

- IoT sensors using nanoparticles and biosensors for rapid Halal authentication along the supply chain — 1 2 4 5 6 8 10
- Centralised repository of Halal compliant products, services, producers, and merchants — 1 5 6 7 8
- Genetic cultivation of viable mass-producible for Halal food and feed crops — 10
- Automated warehousing and logistics powered by unmanned intralogistic robots, autonomous trucks, and drone fleets, equipped with 5G-connected IoT sensors for real-time Halal compliance monitoring and tracking — 1 2 5 6 7 8

Source: Analytics by Nair, Ahmed, Vaithilingam and the Monash University Malaysia Research team, 2020

How can other sectors leverage on Halal supply chain innovations?

Agriculture & Forestry
1 4 2 5
5G-connected biosensors for real-time monitoring of farms and fisheries for adulteration detection at source

Culture, Arts & Tourism
1 6 5 7
Personalised Halal-friendly holiday packages derived from pattern recognition of online search history and purchase behaviour

Medical & Healthcare
+
Business & Financial Services
6 8
Blockchain ledger tracing systems track certification of pharmaceuticals and medical devices manufacture for Halal assured healthcare services

Multiplier Effects of a Vibrant Halal Ecosystem on the 10 Socio-economic Drivers

GLOBAL HALAL SUPER CORRIDOR

GAME CHANGER FOR MALAYSIA

A strong Halal ecosystem in Malaysia will serve to create several multiplier effects on the socio-economic drivers. The strength in the ecosystem will spawn new sectors, increase revenue streams and enhance Return on Value (ROV) for the *rakyat*.

ENERGY

- Renewable Energy (ethical and clean energy)

BUSINESS & FINANCIAL SERVICES

- Halal Fintech for financial needs of Halal business
- Blockchain for green sukuk
- Traceability of financial transactions – ensure data privacy & protection, prevention of fraud and financial crimes

CULTURE, ARTS & TOURISM

- Islamic Culture & Arts
- Muslim friendly tourism – streaming of digital content of local culture and arts to the global community

MEDICAL & HEALTHCARE

- Halal vaccines, medical therapies and nutraceuticals clinical trials

SMART TECHNOLOGY & SYSTEMS (NEXT -GENERATION ENGINEERING & MANUFACTURING)

- Development of new smart-tech & devices to manage the Halal Industry
- Integrated system for Halal ingredient and product development

SMART CITIES & TRANSPORTATION

- Eco-friendly townships & transportation systems
- Halal supply chain (e.g. logistics, production, export and import) – seamless integration of multiple supply chains across multiple localities and jurisdictions

WATER & FOOD

- Food security and safe food systems
- Traceability of contamination in water and food sources

AGRICULTURE & FORESTRY

- Sustainable agriculture, fishery & forestry industries

EDUCATION

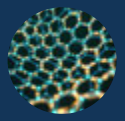
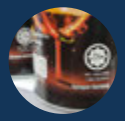
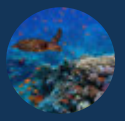
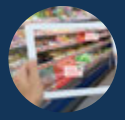
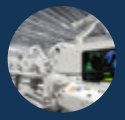
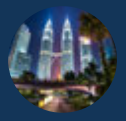
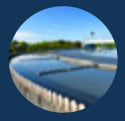
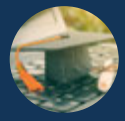
- Global Halal education industry covering STEM & non-STEM programmes / micro-credentials for the Halal economy

ENVIRONMENT & BIODIVERSITY

- Malaysia as a "Tropical Paradise" through the preservation and conservation of natural habitat in line with Islamic thought

Source: Analytics by ASM and Nair, Ahmed, Vaithilingam and Monash University Malaysia Research Team, 2020

National STIE Niche Areas for 10 Socio-economic Drivers Mapped to the Halal Economy

Energy	Business & Financial Services	Culture, Arts & Tourism	Medical & Healthcare	Smart Technology & Systems (Next-Generation Engineering and Manufacturing)	Smart Cities & Transportation	Water & Food	Agriculture & Forestry	Education	Environment & Biodiversity
 Diversified Renewable Energy	 Subscription Business Models & Sharing Platforms	 Creative Content & Heritage	 Digital Health	 Advanced Materials for Circular Economy & Sustainable Society	 Integrated Urban Infrastructure & Infostructure Management	 Premium Halal Food	 High-Value Seafood	 Personalised & Experiential Learning	 Precision Biodiversity
 Energy Storage System	 Digitalised & Autonomous Services	 Digitalised Tourism	 Precision Medicine	 Next-Gen Smart Factories	 Smart Systems for Connected Rural-Urban Communities	 Local Superfood	 Premium Tropical Fruits	 Micro-credentials	 Innovative Eco-Products from Waste
 Microgrid	 Fintech in Islamic Finance	 High-Value Tourism	 Clinical Trials Hub for Developing Countries	 Manufacturing of Smart Devices & Technology Development	 Human-Centred Design & Analytics	 Integrated Water Resources Management	 Local Agricultural Input	 Global Online Learning: Promoting Local Content	
							 Smart Supply Chain Management for Sustainable Forest Products		

All 10 Socio-economic Drivers
20 National STIE Niche Areas
} **are directly or indirectly related to Halal**

The 8i Halal Ecosystem Framework
(10-10 *My*STIE operationalising *Maqasid al-Syari'ah*)

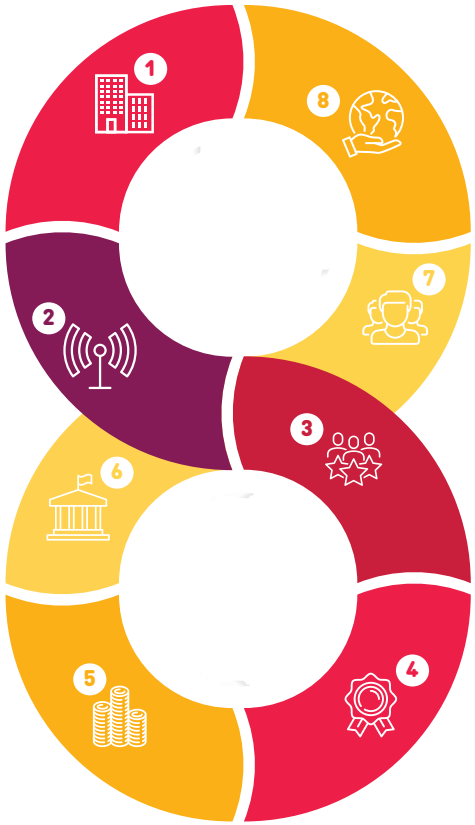
01 / INFRASTRUCTURE
High quality and sophisticated physical and natural infrastructure (farms, forests, rivers, oceans and environment) underpinned by a sound STI strategy that support the growth and development of the Halal ecosystem in a sustainable way.

02 / INFOSTRUCTURE
Digital infrastructure that provide seamless integration of multiple value chains within and across the Halal ecosystem - these systems provide seamless flow of information for strategic decision-making, market intelligence and goods & services.

03 / INTELLECTUAL CAPITAL
Talent stock in the Halal ecosystem - this covers general, specialized, technical, entrepreneurial and leadership skills to transform the Halal value chain (upstream to downstream) into a knowledge intensive global supply network.

04 / INTEGRITY
Governance systems to manage the ecosystem efficiently (good traceability and tracking of information, goods and services) - continuous improvement of the system to raise the Return on Value (ROV) for all stakeholders.

Drivers of Halal Ecosystem



A resilient Halal supply chain supported by a robust holistic ecosystem.

05 / INCENTIVES
Fiscal and non-fiscal incentives to encourage R&D, adoption of new technology, innovation, commercialisation of local technology and market expansion strategy, including globalisation of local technology and knowledge – driving process improvement and new product development.

06 / INSTITUTIONS
Quality of the institutions of governance (government agencies, regulatory, standard bodies, industry associations, community organisation, institutions of learning / research institutes) that support the systematic development of the Halal ecosystem – continuous institutional innovation and development. Continuous foresighting of the STI will ensure the resilience and agility of the ecosystem.

07 / INTERACTION
Strong collaboration and partnership among Halal stakeholders to ensure continuous transformation and development to improve productivity, efficiency and global competitiveness.

08 / INTERNATIONALISATION
Depth and breadth of engagement with global Halal-related knowledge & innovation networks, institutions of governance & standard boards and global value chains – expansion of global innovation footprints and market reach (adhere to OECD food, safety and environmental standards).

Source: Analytics by Nair, Ahmed, Vaithilingam and team from Monash University Malaysia, 2020

Collaborative Platform for Halal Industry

Connectors
- YIM, Yayasan Hasanah, NGOs, ASM, i-Connect, TPM, MiGHT, MTDC, NanoMalaysia, MaGIC
- Connect farmers to the 7 clusters (e.g. connect to technology groups: robotics, drones, sensors)

Capacity Builders
- HLIs, TVET Institutions, HRDF, MARDI, HDC

Market Access Providers
- FAMA, FELCRA, MATRADE

Producers and Manufacturers
- Farmers, Ranchers (Farmers' Organization Authority)
- Food companies (e.g. Ramly, Linaco, Kawan Food)

Supply Chain and Logistics Providers
- Solution provider e.g. Katsana (start-up under MaGIC for fleet management)
- Kontena National
- HAFA

Technology Providers
- Agencies (e.g. HDC, MARDI, MIMOS, TPM, MTDC, CREST, MARii, MDEC, etc), HLIs, private companies (e.g. Celcom, Alltech Biotechnology Malaysia, AGCO GSI, Emsdee)
- Amalgamate existing directories: MOHE Compendium of Public Universities R&D Products, MaGIC start-ups, MDEC, MIMOS Technology

Standards Setters and Regulators
- Standards Malaysia, SIRIM, MAFI, MOH, Department of Veterinary Services
- Halal assurance: JAKIM, HDC

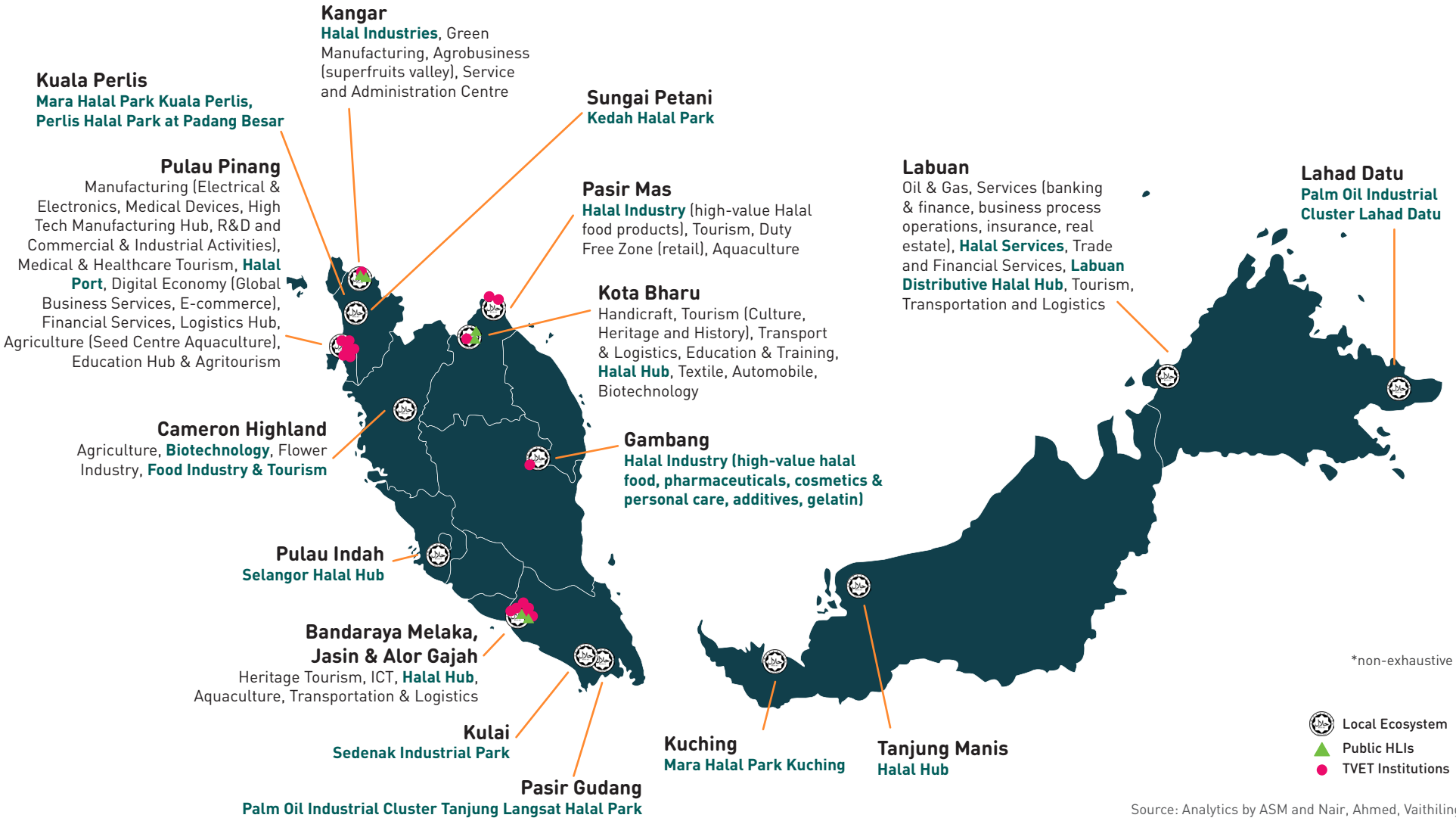
Financing Providers
- Solution providers e.g. MoneyMatch (trusted seamless cross-border trade payments)
- Venture Capital (e.g. MAVCAP, MDV, Cradle Fund)
- Alternative funding: Zakat, Wakaf, Islamic Banking
- AgroBank (crop insurance)
- MIDA, MTDC grants

YIM (Yayasan Inovasi Malaysia); **TPM** (Technology Park Malaysia); **MIGHT** (Malaysian Industry-Government Group for High Technology) **MTDC** (Malaysian Technology Development Corporation); **MaGIC** (Malaysian Global Innovation & Creativity Centre); **HDC** (Halal Development Corporation Berhad); **MARDI** (Malaysian Agricultural Research & Development Institute); **CREST** (Collaborative Research in Engineering, Science & Technology); **MARii** (Malaysia Automotive Robotics & IoT Institute); **MDEC** (Malaysia Digital Economy Corporation); **MOHE** (Ministry of Higher Education); **MAVCAP** (Malaysia Venture Capital Management Berhad); **MDV** (Malaysia Debt Ventures); **MIDA** (Malaysian Investment Development Authority); **MAFI** (Ministry of Agriculture & Food Industries); **MOH** (Ministry of Health); **JAKIM** (Department of Islamic Development Malaysia); **FAMA** (Federal Agricultural Marketing Authority); **FELCRA** (Federal Land Consolidation & Rehabilitation Authority); **MATRADE** (Malaysia External Trade Development); **HLIs** (Higher Learning Institutions); **HRDF** (Human Resources Development Fund); **TVET** (Technical & Vocational Education and Training)

*non-exhaustive

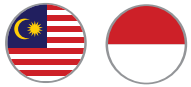
Source: ASM Analytics, 2020; Adapted from European Commission, 2014

Key Halal Related Socio-economic Activities at Localities Across Malaysia



Source: Analytics by ASM and Nair, Ahmed, Vaithilingam and Monash University Malaysia Research Team, 2020

Global Benchmarking on Halal Ecosystem

GOVERNANCE	Centralised Halal governance at national level	
	Non-centralised Halal governance either state-based or coordinated by NGOs	
CERTIFICATION	Centralised Halal certification	
	Non-centralised Halal certification	
	Internationally recognised certification	
HALAL SCIENCE	Top-down government initiative, infrastructure support and funding	
	Consortium for Halal Science established	
	Research activities confined to institutional level	
INDUSTRY	Positive collaboration with Halal Scientist and key stakeholders for product development and innovation	
	Industry initiatives to develop Halal markets	

Note:

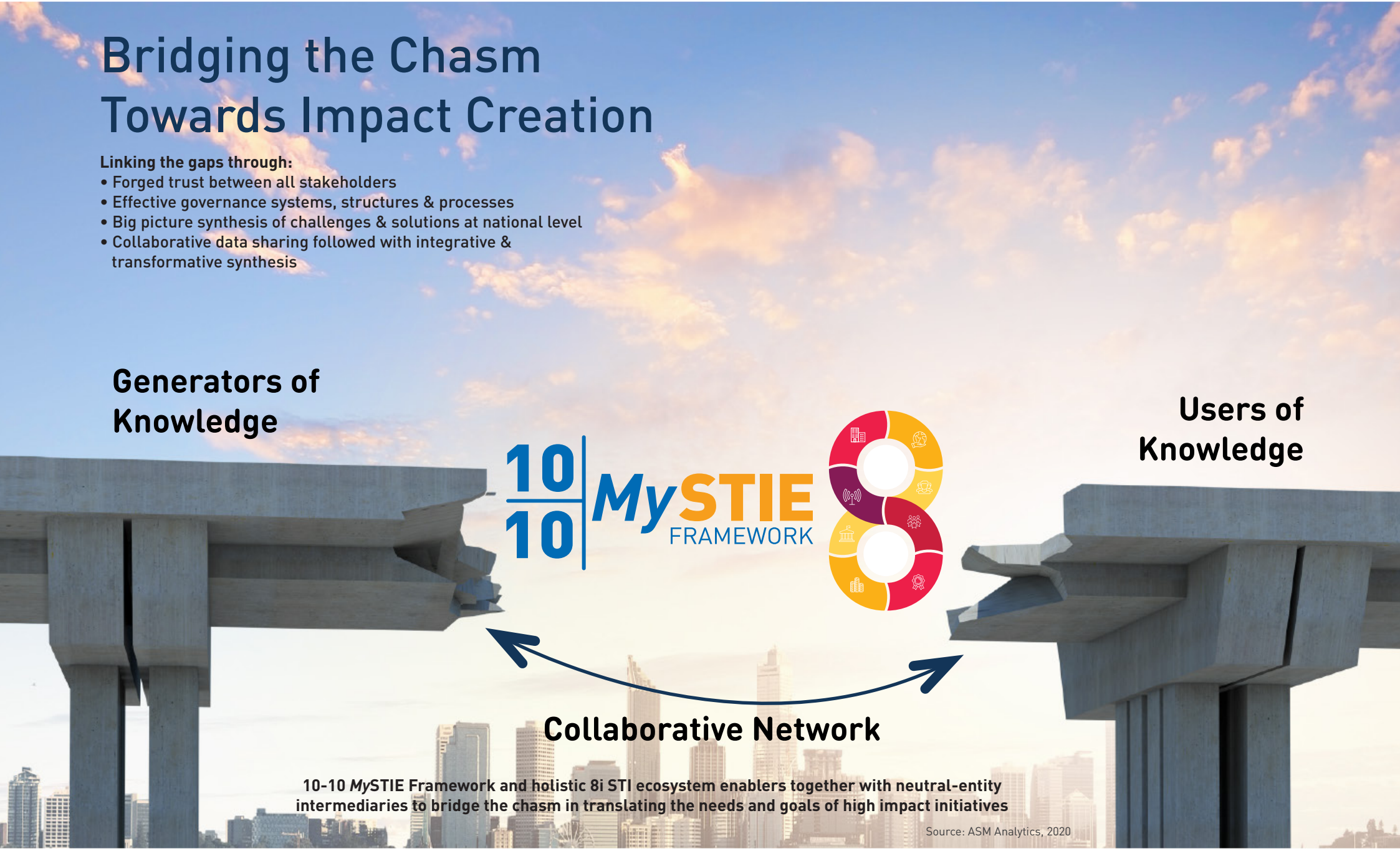
Malaysia, Thailand, Indonesia, Japan, South Korea, United Arab Emirates, Brazil, New Zealand, Australia

Source: ASM, 2019

Bridging the Chasm Towards Impact Creation

Linking the gaps through:

- Forged trust between all stakeholders
- Effective governance systems, structures & processes
- Big picture synthesis of challenges & solutions at national level
- Collaborative data sharing followed with integrative & transformative synthesis



10-10 *My*STIE Framework and holistic 8i STI ecosystem enablers together with neutral-entity intermediaries to bridge the chasm in translating the needs and goals of high impact initiatives

Source: ASM Analytics, 2020

Malaysia recognises the need in embracing STI to weather unprecedented crises while becoming a knowledge-based society. A wholesome fertile ecosystem would encourage knowledge to move across innovation actors to reach end-users. An effective knowledge transfer between generators and users will create an impact to the economy and society.

Current STI ecosystems in Malaysia face challenges in bridging the chasm between generators of knowledge and users of knowledge. Generators of knowledge are individuals or entities who are involved in the creation of new ideas, knowledge, products, services or initiatives with set goals. On the other hand, users of knowledge are the recipients of those creations who put them into practice.

This widening chasm exists due to lack of trust between stakeholders within the ecosystems which mainly stems from the different modes of communication that hinder effective delivery of targeted goals. Another issue that contributes to this chasm is the absence of "big picture synthesis", which is required to inter-lace strategic thinking to solve national issues and challenges. This is because most stakeholders operate in silos within their own specialisation and are trained to analyse and not to synthesise.

To address these issues, a national-level framework is needed to bring people together and synergise the planning. The 10-10 *My*STIE Framework acts as an intermediary in translating knowledge to solutions for national-level challenges. This Framework must be concurrently applied with an ecosystem approach (8i STI ecosystem enablers) to ensure maximum impact is achieved. Along with this Framework, neutral-entity intermediaries are needed to function as connectors between parties within the quadruple helix to achieve common goals. Some existing connectors in the Malaysian STI landscape are Collaborative Research in Engineering, Science and Technology Centre (CREST) and i-Connect by the Academy of Sciences Malaysia.

Preparing Malaysia Today for Tomorrow

Malaysia in 2030

2030 Malaysia powered by a vibrant and state-of the-art STIE ecosystem will ensure inclusive socio-economic development and sustainable management of natural resources. The economy will be led by several Malaysian pace-setter institutions and industries that have strong knowledge networks and supply chains to build global competitive advantage. These are envisaged to generate positive spillover impacts on the quality of life and wealth of the nation. The economy will not leave any community behind as it transitions to become a **sustainable, progressive, prosperous and harmonious developed nation.**

10 10 MySTIE FRAMEWORK

Malaysia Today

2020 Malaysia is a nation still grappling with widening socio-economic disparities across different social groups, ethnicities and regional localities, even after 63 years of independence. Despite having a RM1.42 trillion economy, Malaysia has yet to fully realise its economic growth potential. The economy is still dependent on low-skilled labour and is experiencing shortages in key skills relevant to a knowledge-intensive economy. The economy is caught in the "middle-income trap" and is vulnerable to global economic uncertainties. This could undermine environmental sustainability and the social fabric of the nation.

Source: Analytics by ASM and Nair, Ahmed, Vaithilingam and Monash University Malaysia Research Team, 2020.

References

A. Allotey, P. and Jacqueline, L.Y.-R. (2018). *World Health Day 2018 – Lessons from Malaysia on Universal Health Coverage.* [online] World Health Organization. Available at: https://www.who.int/malaysia/news/detail/18-04-2018-world-health-day-2018-%E2%80%93-lessons-from-malaysia-on-universal-health-coverage#:~:text=Malaysia%20has%20achieved%20universal%20health%20coverage.&text=It%20has%20a%20low%20incidence [Accessed 26 Sep. 2020].

A Practical Manual for Producers and Exporters from Asia. Regulations, Standards and Certification for Agricultural Exports. (n.d.). *Global Gap.* [online] Available at: http://www.fao.org/3/ag130e/ag130e12.htm.

Abdullah, K. (2017). *Integrated River Basin Management Report*. [online] Department of Irrigation and Drainage. Available at: https://www.water.gov.my/index.php/pages/view/708.

Abu Dardak, R. (2019). Trends in Production, Trade, and Consumption of Tropical Fruit in Malaysia. *FFTC Agricultural Policy Platform (FFTC-AP)*. [online] Available at: https://ap.fftc.org.tw/article/1381 [Accessed 27 Jun. 2020].

Academy of Sciences Malaysia (2015). *Carbon Free Energy: Roadmap for Malaysia.* [online] Academy of Sciences Malaysia. Available at: https://issuu.com/asmpub/docs/cfe_lowres.

Academy of Sciences Malaysia (2017). *Science & Technology Foresight Malaysia 2050: Emerging Science, Engineering & Technology (ESET) Study*. [online] Issuu. Available at: https://issuu.com/asmpub/docs/eset_study_report.

Academy of Sciences Malaysia (2020). *Precision Biodiversity SIG (Embargo).*

Adajian, T. (2007). *The Definition of Art (Stanford Encyclopedia of Philosophy)*. [online] Stanford.edu. Available at: https://plato.stanford.edu/entries/art-definition/ [Accessed 7 Jul. 2020].

Adnan, H. (2010). *Time to boost Malaysia's tropical fruit exports*. [online] The Star Online. Available at: https://www.thestar.com.my/business/business-news/2010/08/03/time-to-boost-malaysias-tropical-fruit-exports.

Ahmad Nordin, M.I., Abdul Ghani, N.A., Chong, E. and Abu Bakar, Z.-F. (2019). Food Imports and the Exchange Rate: More than Meets the Eye. *BNM Quarterly Bulletin*. [online] Available at: https://www.bnm.gov.my/files/publication/qb/2019/Q3/p3ba.pdf.

Alam, M., Siwar, C., M Wahid, M., Rafiqul, I.M. and Toriman, M.I. (2010). *The relationships between the Socio-Economic profile of farmers and paddy productivity in North-West Selangor, Malaysia*. [online] Available at: https://www.researchgate.net/publication/227439774_Socioeconomic_Profile_of_Farmer_in_Malaysia_Study_on_Integrated_Agricultural_Development_Area_in_North-West_Selangor.

Alexander, M. (2017). *Special Report: Malaysia's healthcare sector provides a catalyst for growth.* [online] Global Risk Insights. Available at: https://globalriskinsights.com/2017/04/malaysia-healthcare-sector/.

Anang, Z., Padli, J., Abdul Rashid, N.K., Mat Alapiah, R. and Musa, H. (2019). *Factors Affecting Water Demand: Macro Evidence in Malaysia*. Jurnal Ekonomi Malaysia, 53(1), 17-25

Anastasia (2015). *An Introduction to Sharing Economy* | Cleverism. [online] Cleverism. Available at: https://www.cleverism.com/introduction-to-sharing-economy/.

Anon, (2016a). *A Study on Knowledge Content in Key Economic Sectors in Malaysia Phase III (MYKE III) Phase 1*. [online] Available at: https://www.epu.gov.my/sites/default/files/2020-02/MYKE_PHASE_1_part1.pdf.

Anon, (2016b). *A Study on Knowledge Content in Key Economic Sectors in Malaysia Phase III (MYKE III) Phase 2*. [online] Available at: https://www.epu.gov.my/sites/default/files/2020-02/MYKE_PHASE_2.pdf.

Anon, (n.d.). *MANUFACTURING & LOGISTICS SECTOR*. [online] Available at: http://www.sedia.com.my/SDC_EPP/Manufacturing_EPPs.pdf [Accessed 30 Sep. 2020].

APAD (n.d.). *Annual Review 2017*. [online] Agensi Pengangkutan Awam Darat (APAD). Available at: https://www.apad.gov.my/sites/default/files/spad-annual-review-2017-en.pdf.

Atkinson, R.D. (2018). *How to Reform Worker-Training and Adjustment Policies for an Era of Technological Change*. [online] Information Technology & Innovation Foundation. Available at: https://itif.org/publications/2018/02/20/technological-innovation-employment-and-workforce-adjustment-policies.

Augustin, R. (2019). *Undiagnosed: The case of Malaysian urban poverty*. [online] Free Malaysia Today. Available at: https://www.freemalaysiatoday.com/category/nation/2019/09/02/undiagnosed-the-case-of-malaysian-urban-poverty/.

Aziz, H. (2019). *Getting industry to lead TVET.* [online] NST Online. Available at: https://www.nst.com.my/education/2019/10/526383/getting-industry-lead-tvet [Accessed 1 Jun. 2020].

Bank Negara Malaysia, (2011). *Financial Sector Blueprint 2011-2020*

Bhuiyan, T.R, Reza, M.I.H, Choy, E.A. and Pereira, J.J (2018) *Direct Impact of Flash Floods in Kuala Lumpur City: Secondary Data-Based Analysis*. ASM Science Journal, 11(3), 145-157

Belyh, A. (2019). *An Introduction to Sharing Economy | Cleverism*. [online] Cleverism. Available at: https://www.cleverism.com/introduction-to-sharing-economy/.

Borneo Post Online. (2017). *MyHDW, public-private integrated platform for data sharing*. [online] Available at: http://www.theborneopost.com/2017/04/19/myhdw-public-private-integrated-platform-for-data-sharing/.

BOTS Team (2020). *Digi showcases Malaysia's first 5G-connected ambulance*. [online] NST Online. Available at: https://www.nst.com.my/lifestyle/bots/2020/01/557870/digi-showcases-malaysias-first-5g-connected-ambulance.

BP (2019). *BP Statistical Review of World Energy: 2019 | 68th edition*. [online] Available at: https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2019-full-report.pdf.

Brian, M. (2019). *Designing for the Edge: 5 Trends in Smart Security. Western Digital Corporate Blog*. Available at: https://blog.westerndigital.com/designing-edge-5-trends-smart-security/.

Bujang, A.S. and Abu Bakar, B.H. (2019). Agriculture 4.0: Data-Driven Approach to Galvanize Malaysia's Agro-Food Sector Development. *FFTC Agricultural Policy Platform (FFTC-AP)*. [online] Available at: http://ap.fftc.agnet.org/ap_db.php?id=1072.

BusinessToday (2019). *Universal Robots To Help Malaysian SMEs Embrace Automation - Business Today.* [online] BusinessToday. Available at: https://www.businesstoday.com.my/2019/05/24/universal-robots-to-help-malaysian-smes-embrace-automation/.

Butler, R.A. (2006). *Malaysia: Environmental Profile*. [online] Mongabay. Available at: https://rainforests.mongabay.com/20malaysia.htm.

Catapult Network - Summary (2017). (n.d.). [online] Catapult Network. Available at: https://s3.eu-west-1.amazonaws.com/media.www.catapult/wp-content/uploads/2017/08/02164038/Cross-Catapult-Network-Executive-Summary-2017.pdf.

Chang, L. (2016). *China outlines its latest Five Year Plan, called Internet Plus*. [online] Digital Trends. Available at: https://www.digitaltrends.com/web/china-internet-plus/.

Chia, R.G. ed., (2018). *Astrotourism Takes Off In Asia | Asian Geographic Magazines.* [online] Asian Geographic. Available at: https://www.asiangeo.com/travel-and-adventure/astrotourism-takes-off-in-asia [Accessed 9 Jun. 2020].

China Intellectual Property Magazine. (n.d.). *Law of the People's Republic of China on Promoting the Transformation of Scientific and Technological Achievements*. [online] Available at: http://www.chinaip-magazine.com/en/law-show.asp?id=41 [Accessed 22 Oct. 2020].

Chitluri, S.S., Tadivaka, B.R., Javvaji, R. and Raju, A. (2019). Smart Waste Management using Internet-of-Things (IoT). *International Journal of Innovative Technology and Exploring Engineering*, 8(9), pp.2518–2522.

Choudhury, A.R. (2017). McKinsey, *A*Star's ARTC to train workers on Industry 4.0 (Amended)*. [online] The Business Times. Available at: https://www.businesstimes.com.sg/government-economy/mckinsey-astars-artc-to-train-workers-on-industry-40-amended.

CISCO (2017). *Skilling the Current and Next Generation Workforce for a Digital Economy: Perspectives from Career and Technical Education (CTE) Leaders from the Asia Pacific.* [online] Available at: https://www.cisco.com/c/dam/en_us/solutions/industries/education/cte-summit-report.pdf.

Collins, F. S. (Mar 19, 2015) *Day 1 - Vision for the Cohort and Precision Medicine Initiative - Dr. Francis Collins.* YouTube. https://www.youtube.com/watch?v=ObBYk0MOuDM. [Accessed on 7 May 2020]

Cornell University, INSEAD, and WIPO. (2020). *The Global Innovation Index 2020: Who Will Finance Innovation? Ithaca, Fontainebleau, and Geneva.*

Corner, S. (2017). *Singapore govt forms Industry 4.0 alliance.* [online] IoT Hub. Available at: https://www.iothub.com.au/news/singapore-govt-forms-industry-40-alliance-473795.

CRM. (2020). *Clinical Trial Capability in Malaysia*, National Science Council Bil.2 2020

CYBERJAYA Global Technology Hub Blueprint CYBERJAYA GLOBAL TECHNOLOGY HUB BLUEPRINT. (2014). [online] Cyberview Sdn Bhd. Available at: http://www.cyberjayamalaysia.com.my/docs/default-source/default-document-library/global-technology-hub-blueprint.pdf?sfvrsn=2 [Accessed 27 Nov. 2020].

Cyberview (n.d.). Cyberview | *Our Story*. [online] Cyberview. Available at: https://cyberview.com.my/about/our-story [Accessed 24 Apr. 2020].

Cyberview Sdn Bhd (n.d.). *Cyberview | Accelerator*. [online] cyberview.com.my. Available at: https://cyberview.com.my/industry/cyberview-living-lab/accelerator.

CYRIC (n.d.). *Cyprus Digital Innovation Hub (DIH)*. [online] CYRIC. Available at: https://www.cyric.eu/cydi_hub/.

Debolina, C. (2019). *Malaysia Education Market Outlook to 2023 - By K-12 Education, Higher Education, Test-Preparation Education and Vocational Education.* [online] www.kenresearch.com. Available at: https://www.kenresearch.com/education-and-recruitment/education/malaysia-education-market-outlook/251372-99.html [Accessed 20 Jun. 2020].

Department of Statistics Malaysia (2019). *Compendium of Environment Statistics*. [online] Department of Statistics Malaysia Official Portal. Available at: https://www.dosm.gov.my/v1/index.php?r=column/cthemeByCat&cat=162&bul_id=QXp4UnZmekFnVGNINy9GemxBWWZTZz09&menu_id=NWVEZGhEVlNMeitaMHNzK2htRU05dz09.

Department of Statistics Malaysia Official Portal. (2019). *Tourism Satellite Account 2018*. [online] Available at: https://www.dosm.gov.my/v1/index.php?r=column/cthemeByCat&cat=111&bul_id=Wk1KWlpxZTRDWnVhVWNMV21ZVVY3Zz09&menu_id=TE5CRUZCblh4ZTZMODZIbmk2aWRRQT09 [Accessed 9 Jun. 2020].

Department of Statistics Malaysia Official Portal. (2018). *Graduate Statistics* https://www.dosm.gov.my/v1/index.php/index.php?r=column/cthemeByCatandcat=476andbul_id=cDJkZjM5b2hjdjJZMDlvNDlueU54Zz09andmenu_id=Tm8zcnRjdVRNWWlpWjRlbmtlaDk1UT09 [Accessed on 24 April 2020].

Dermawan, A. (2019). *Fishermen urged to venture into aquaculture.* [online] NST Online. Available at: https://www.nst.com.my/news/nation/2019/09/519960/fishermen-urged-venture-aquaculture#:~:text=GEORGE%20TOWN%3A%20Malaysian%20fishermen%20have.

Department of Statistics Malaysia. (2019). Domestic Tourism Survey 2018

DinarStandard. (2019). *State of the Global Islamic Economy Report 2019/20, DRIVING THE ISLAMIC ECONOMY REVOLUTION 4.0.* www.salaamgateway.com/SGIE19-20

Dzulkifly, D. (2020). Muhyiddin: *Tourism industry hit hardest by Covid-19, faces RM3.37b loss | Malay Mail*. [online] www.malaymail.com. Available at: https://www.malaymail.com/news/malaysia/2020/03/13/muhyiddin-tourism-industry-hit-hard-by-covid-19-to-lose-rm3.37b-while-gdp-s/1846323.

Economic Planning Unit. (2016). A Study on Knowledge Content in Key Economic Sectors in Malaysia, Phase III

Economic Planning Unit. (2017). Malaysia Productivity Blueprint.

Economic Planning Unit. (2019). Water Sector Transformation 12th Malaysian Plan (2021-2025)

Economic Planning Unit. (2020). Roadmap for the National Agenda on Water Sector Transformation 2040 (Embargo)

Enabel (n.d.). *Skills for a better future. [online] Enabel - Belgian Development Agency*. Available at: https://www.enabel.be/story/skills-better-future.

Enterprise Singapore. (n.d.). *Double Tax Deduction for Internationalisation*. [online] Available at: https://www.enterprisesg.gov.sg/financial-assistance/tax-incentives/tax-incentives/double-tax-deduction-for-internationalisation [Accessed 10 Nov. 2020].

European Commission (2014). Cluster Collaboration and Business Support Tools to Facilitate Entrepreneurship, Cross-sectoral Collaboration and Growth_

European Commission (2015). *Blending in the Energy Sector*. [online] European Union. European Union. Available at: https://europa.eu/capacity4dev/t-and-m-series/documents/blending-energy-sector.

East Coast Economic Region, https://www.ecerdc.com.my/en/ [Accessed on 20/09/2020]

Energy Storage Association. *Why Energy Storage Technologies of Energy Storage*. https://energystorage.org/why-energy-storage/technologies/ [Accessed 10 June 2020]

Fakhar, A., A. Haidar, A.M., Ahmed, M.M. and Rahman, A.K. (2018). *Sustainable Energy Management Design for Bario Microgrid in Sarawak, Malaysia*. In: 2018 IEEE 7th International Conference on Power and Energy (PECon). IEEE, pp.327–332.

Food Industry in Malaysia. (2018). [online] Available at: https://www.mida.gov.my/home/administrator/system_files/modules/photo/uploads/20180903103354_Food%20Industry%202018_V4.pdf.

Fresh Plaza. (2017). *Malaysian Government Sets up New Tropical Fruit Export Company with $22m.* [online] Available at: https://www.freshplaza.com/article/2174045/malaysian-government-sets-up-new-tropical-fruit-export-company-with-22m.

Ganeshwaran, K. (2019). *House prices beyond affordability of most Malaysians.* [online] The Star Online. Available at: https://www.thestar.com.my/business/business-news/2019/10/25/house-prices-beyond-affordability-of-most-malaysians.

GlobalData UK (2019). *Wearable Technology in Healthcare - Thematic Research*. [online] GlobalData. Available at: https://store.globaldata.com/report/gdhcht026--wearable-technology-in-healthcare-thematic-research/.

Global Trade and Innovation Policy Alliance. (2019). National innovation policies: What Countries Do Best and How They Can Improve. P. 95. Washington, USA.

Government of Canada (n.d.). *Innovation Superclusters Initiative*. [online] Canada.ca. Available at: http://www.ic.gc.ca/eic/site/093.nsf/eng/home [Accessed 12 Oct. 2020].

GOVTECH SINGAPORE. (n.d.). *National Digital Identity*. [online] Available at: https://www.tech.gov.sg/scewc2019/ndi [Accessed 15 Oct. 2020].

Grand View Research (2018). *Halal Food Market Size Worth $739.59 billion By 2025*. [online] Grand View Research. Available at: https://www.grandviewresearch.com/press-release/global-halal-food-market.

Halal Development Corporation (HDC) Berhad. (2018). Halal Industry Master Plan.

Halberd Bastion. (2018). *Canadian ENCQOR project to build 5G communication highway*. [online] Available at: https://halberdbastion.com/intelligence/news/canadian-encqor-project-build-5g-communication-highway.

Halper, M. (2018). *GE Current partners with Nokia to provide ... IT.* [online] LEDs Magazine. Available at: https://www.ledsmagazine.com/smart-lighting-iot/smart-cities/article/16701688/ge-current-partners-with-nokia-to-provide-it [Accessed 20 Nov. 2020].

Haroon, R. (2020). Employ big data to cater to tourists' needs, wants. [online] NST Online. Available at: https://www.nst.com.my/opinion/columnists/2020/06/598672/employ-big-data-cater-tourists-needs-wants.

Hassan, M.G., Nordin, N. and Ashari, H. (2015). *Sustainable manufacturing practices implementation in Malaysia industries. Jurnal Teknologi,* [online] 77(4). Available at: https://www.researchgate.net/publication/283526293_Sustainable_manufacturing_practices_implementation_in_Malaysia_industries.

Hassan, O.H., Abidin, S.Z., Legino, R., Anwar, R. and Kamaruzaman, M.F. eds., (2015). *International Colloquium of Art and Design Education Research (i-CADER 2014).* [online] www.springer.com. Springer Singapore. Available at: https://www.springer.com/gp/book/9789812873316.

Home. (n.d.). *Sarawak Corridor of Renewable Energy (SCORE), Malaysia.* [online] Available at: https://www.recoda.com.my/ [Accessed 25 Sep. 2020].

Hong Liang, L. (2020). *Hutchison Ports Thailand introduces autonomous truck technology.* [online] Seatrade Maritime News. Available at: https://www.seatrade-maritime.com/ports-logistics/hutchison-ports-thailand-introduces-autonomous-truck-technology.

Hyonhee, S. (2020). *South Korean cafe hires robot barista to help with social distancing. Reuters.* [online] 26 May. Available at: https://www.reuters.com/article/us-health-coronavirus-southkorea-robots/south-korean-cafe-hires-robot-barista-to-help-with-social-distancing-idUSKBN2310T9.

International Association for Medical Assistance to Travellers (2020). *Malaysia: Air Pollution.* [online] www.iamat.org. Available at: https://www.iamat.org/country/malaysia/risk/air-pollution.

Investopedia (2019). *Sharing Economy.* [online] Investopedia. Available at: https://www.investopedia.com/terms/s/sharing-economy.asp.

Irena, A. (2011). *What Are Financial Services? Finance and Development,* [online] 48(1). Available at: https://www.imf.org/external/pubs/ft/fandd/2011/03/basics.htm.iskandarmalaysia.com.my. (n.d.). Iskandar Malaysia. [online] Available at: http://iskandarmalaysia.com.my/ [Accessed 25 Sep. 2020].

Ismail, A., Hassan, R., Bakar, A.A., Hussin, H., Hanafiah, M.A.M. and Asary, L.H. (2018). *The Development of TVET Educator Competencies for Quality Educator. Journal of Technical Education and Training,* [online] 10(2). Available at: https://publisher.uthm.edu.my/ojs/index.php/JTET/article/view/2291 [Accessed 27 Nov. 2020].

Israel Innovation Authority. (n.d.). *Bilateral Programs for Parallel Support.* [online] Available at: https://innovationisrael.org.il/en/program/bilateral-programs-parallel-support [Accessed 12 Oct. 2020].

Jamal, R. (2017). *Precision Medicine: Is Malaysia Ready? Asia-Pacific Journal of Molecular Medicine,* [online] 7(1), p.4. Available at: http://spaj.ukm.my/apjmm/index.php/apjmm/article/view/34.
James, C. (2020). Energy Sector. [online] Investopedia. Available at: https://www.investopedia.com/terms/e/energy_sector.asp.

James, F. (2019). *Everything You Need to Know About Education 4.0.* [online] QS. Available at: https://www.qs.com/everything-you-need-to-know-education-40/ [Accessed 26 Sep. 2020].

Japan External Trade Organization. (n.d.). *Investing in Japan: JETRO Incentive Programs.* [online] Available at: https://www.jetro.go.jp/en/invest/incentive_programs/.

Joe, D. (2020). *5G in Asia – rollout plans won't be affected by COVID-19 says GSMA. Tech Wire Asia.* [online] 7 May. Available at: https://techwireasia.com/2020/05/5g-in-asia-rollout-plans-wont-be-affected-by-covid-19-says-gsma [Accessed 11 Jun. 2020].

Joon Ian, W. (2017). *Sweden's blockchain-powered land registry is inching towards reality.* [online] Yahoo! Finance. Available at: https://au.finance.yahoo.com/news/sweden-blockchain-powered-land-registry-103713689.html [Accessed 20 Nov. 2020].

Jotham, L. (2020). *Digital Health: Treating industry woes one issue at a time.* [online] The Edge Markets. Available at: https://www.theedgemarkets.com/article/digital-health-treating-industry-woes-one-issue-time.

Joy, L. (2019). *Banana trader and planter sees export opportunities for the fruit.* [online] The Star Online. Available at: https://www.thestar.com.my/business/smebiz/2019/11/04/banana-trader-and-planter-sees-export-opportunities-for-the-fruit.

Kementerian Kesihatan Malaysia. (2019). *Health Facts 2019 Booklet (Reference Data for 2018).* [online] Available at: https://www.moh.gov.my/moh/resources/Penerbitan/Penerbitan%20Utama/HEALTH%20FACTS/Health%20Facts%202019_Booklet.pdf.

Kementerian Pendidikan Malaysia (2013). *Malaysia Education Blueprint 2013-2025 (Preschool to Post-Secondary Education).* [online] Available at: https://www.moe.gov.my/menumedia/media-cetak/penerbitan/dasar/1207-malaysia-education-blueprint-2013-2025/file.

Kementerian Pendidikan Malaysia (2015). *Malaysia Education Blueprint 2015- 2025 (Higher Education).* [online] www.mohe.gov.my. Available at: https://www.mohe.gov.my/muat-turun/awam/penerbitan/pppm-2015-2025-pt/5-malaysia-education-blueprint-2015-2025-higher-education.

Khan, F.F.F. (2020). *Hanya 19 peratus pilih aliran Sains.* [online] Berita Harian. Available at: https://www.bharian.com.my/berita/pendidikan/2020/05/694083/hanya-19-peratus-pilih-aliran-sains [Accessed 2 Jul. 2020].

Khatri, H. (2019). *Malaysian users in thinly-populated rural areas connect to 4G just 44% of the time.* [online] Opensignal. Available at: https://www.opensignal.com/2019/10/31/malaysian-users-in-thinly-populated-rural-areas-connect-to-4g-just-44-of-the-time-0 [Accessed 20 Jun. 2020].

Khazanah Research Institute (2018). *The School-to-Work Transition of Young Malaysians.* [online] Khazanah Research Institute. Available at: http://www.krinstitute.org/assets/contentMS/img/template/editor/20181212_SWTS%20Presentation%20DR%20LIM%20.pdf.

Khazanah Research Institute. (2015). *Population Ageing: Can We "Live Long and Prosper"?* [online] Available at: http://www.krinstitute.org/kris_publication_Population_Ageing_Can_We_Live_Long_and_Prosper.aspx.

Khazanah Research Institute (2017). *KRI Brown Bag Seminar #2 - Malaysia: Current Scenario and Way Forward for the Fruit Industry.* [online] Available at: https://www.slideshare.net/KhazanahResearchInstitute/kri-brown-bag-seminar-2-malaysia-current-scenario-and-way-forward-for-the-fruit-industry [Accessed 1 Jun. 2020].

Khor, Y.-L. (2019). Analysis | *As Malaysia ramps up its durian exports to China, quirky product offerings may be answer to rivalling Thailand's dominance. South China Morning Post.* [online] 6 May. Available at: https://www.scmp.com/week-asia/opinion/article/3008935/malaysia-ramps-its-durian-exports-china-quirky-product-offerings.

Knoema. (n.d.). *Malaysia - Urban population as a share of total population.* [online] Available at: https://knoema.com/atlas/Malaysia/Urban-population.

Kotler, N. and Kotler, P. (2000). *Can Museums be All Things to All People?: Missions, Goals, and Marketing's Role.* Museum Management and Curatorship, 18(3), pp.271–287.

Lämmer-Gamp, T. (2014). *Cluster Collaboration and Business Support Tools to Facilitate Entrepreneurship, Cross- sectoral Collaboration and Growth European Cluster Observatory REPORT.* [online] Available at: https://www.clustercollaboration.eu/sites/default/files/eu_initiatives/cluster-collaboration-and-business-support-tools-to-facilitate-entrepreneurship-cross-sectoral-collaboration-and-growth_en_0.pdf [Accessed 2020].

LIEW JIA, X. (2020). *Council wins Asean Clean Tourist City Standard award again.* [online] The Star. Available at: https://www.thestar.com.my/metro/metro-news/2020/01/24/council-wins-asean-clean-tourist-city-standard-award-again.

Malay Mail. (2019). *Education Ministry: Revenue from international students expected to grow to RM15.6b | Malay Mail.* [online] Available at: https://www.malaymail.com/news/malaysia/2019/09/12/education-ministry-revenue-from-international-students-expected-to-grow-to/1789792 [Accessed 24 Apr. 2020].

Malaysia Digital Economy Corporation (MDEC) Sdn Bhd (2020). *MDEC Islamic Fintech Report.* [online] MDEC. Available at: https://mdec.my/wp-content/uploads/FinTech-Report.pdf.

Malaysia Digital Economy Corporation (MDEC) Sdn Bhd (2017). Digitisation in Manufacturing Sector.
Malaysia Productivity Corporation (2019). Productivity Report 2018/2019. [online] Malaysia Productivity Corporation. Available at: http://www.mpc.gov.my/wp-content/uploads/2019/09/Productivity-Report-18_19-latest-as-at-250919-1.pdf.

Malaysian Communications and Multimedia Commission (2018). *Internet Users Survey 2018: Statistical Brief Number Twenty-Three.* [online] Malaysian Communications and Multimedia Commission. Available at: https://www.mcmc.gov.my/skmmgovmy/media/General/pdf/Internet-Users-Survey-2018.pdf.

Malaysian Healthcare Performance Unit (2020). *Malaysian Health at a Glance.* [online] Available at: https://www.moh.gov.my/moh/penerbitan/MYHAAG2018.pdf.

Malaysian Industry-Government Group for High Technology (MIGHT). (2019). MyForesight 5th Edition.

Malaysian International Food & Beverage Trade Fair (MIFB). (2020). *The fish processing industry in Malaysia.* [online] Available at: https://mifb.com.my/2020/03/17/fish-processing-industry/ [Accessed 10 May 2020].

Malaysian Investment Development Authority (MIDA) (n.d.). *Medical Devices*. [online] MIDA. Available at: https://www.mida.gov.my/home/medical-devices/posts [Accessed 20 Jun. 2020].

Malaysian Timber Council (2017). *Malaysia Forest and Environment: Facts & Figures.* [online] Available at: http://www.mtc.com.my/images/cms/MTC_Fact_Sheet.pdf.

Manufacturing USA. (n.d.). *Manufacturing USA.* [online] Available at: https://www.manufacturingusa.com/ [Accessed 21 Oct. 2020].

Marie Ide, L. (2020). *Disrupting Healthcare Through Tech: The Next Wave of Health IT Innovation.* [online] Medical Economics. Available at: https://www.medicaleconomics.com/view/disrupting-healthcare-through-tech-the-next-wave-of-health-it-innovation.

MATRADE. (n.d.). *Top 10 Major Import Products, 2019 - MATRADE.* [online] Available at: http://www.matrade.gov.my/en/malaysian-exporters/services-for-exporters/trade-market-information/trade-statistics/28-malaysian-exporters/trade-statistics/4545-top-10-major-import-products-2019.

Michael, T. (2020). *Malaysia plans tougher penalties for illegal loggers in forest law reform. Reuters.* [online] 31 Jan. Available at: https://www.reuters.com/article/us-malaysia-forests-lawmaking/malaysia-plans-tougher-penalties-for-illegal-loggers-in-forest-law-reform-idUSKBN1ZU1Y7.

Ministry of Education. (2019). Quick Facts 2019 Malaysia Educational Statistics.

Ministry of Higher Education. (2018). Framing Malaysian Higher Education 4.0: Future-Proof Talent.

Ministry of Education. (2019). Mid-term Review of Malaysia Education Blueprint 2015 – 2025 (Higher Education) (Embargo).

Ministry of Education. (2019). Amanat Ketua Pengarah Tahun Baru 2019.

Ministry of Education. (2019), An Impact Study on the Implementation of the Malaysian Research Universities (Embargo).

Ministry of Education (2018). *Status Pelaksanaan Projek Pembangunan Semula Sekolah-sekolah Daif di Sabah, Sarawak, Labuan Dan Semenanjung Malaysia 2016-2018.* [online] Available at: https://www.moe.gov.my/en/muat-turun/penerbitan-dan-jurnal/maklumat-prestasi-projek-daif/2771-maklumat-projek-daif/file [Accessed 24 Apr. 2020].

Ministry of Energy, Green Technology and Water (2015). *National Energy Efficiency Action Plan.* [online] Available at: https://www.pmo.gov.my/wp-content/uploads/2019/07/National-Energy-Efficiency-Action-Plan.pdf.

Ministry of Energy, Science, Technology, Environment and Climate Change. (2018). Malaysia's Third National Communication and Second Biennial Update Report submitted to the United Nations Framework Convention on Climate Change.

Ministry of Foreign Affairs in Japan (2015). *Partnership for Quality Infrastructure: Investment for Asia's Future.* [online] Available at: https://www.mofa.go.jp/files/000081298.pdf [Accessed 10 Nov. 2020].

Ministry of Health (2019). *Malaysia National Health Accounts Health Expenditure Report 1997- 2017.* [online] Available at: https://www.moh.gov.my/moh/resources/Penerbitan/Penerbitan%20Utama/MNHA/Laporan_MNHA_Health_Expenditure_Report_1997-2017_03122019.pdf.

Ministry of Housing and Local Government (2018). *Malaysia Smart City Framework - Executive Summary.* [online] Kementerian Perumahan dan Kerajaan Tempatan. KPKT. Available at: https://www.kpkt.gov.my/resources/index/user_1/GALERI/PDF_PENERBITAN/FRAMEWORK/FRAMEWORK_SMART_CITY_EXECUTIVE_SUMMARY.pdf.

Ministry of Natural Resources & Environment (NRE) (2016). *National Policy on Biological Diversity 2016-2025.* [online] Available at: http://www.kats.gov.my/ms-my/PustakaMedia/Penerbitan/National%20Policy%20on%20Biological%20Diversity%202016-2025.pdf.

Ministry of Human Resources (MOHR) (2019). TVET Malaysia – The Way Forward, https://tvet2019.ppks.edu.my/pdf/TVET%20Malaysia%20-%20The%20Way%20Forward.pdf [Accessed on on 1 June 2020]

Malaysian Communications and Multimedia Commission. Smart City Initiatives by PLAN Malaysia, https://www.mcmc.gov.my/skmmgovmy/media/General/pdf/Sesi-5-Rangkakerja-Berteraskan-Aspek-Informasi-(PLANMalaysia).pdf [Accessed on 22 April 2020]

Malaysian Qualification Agency. (2019). Guideline on Micro-credential.

Mohamed Radhi, N.A. (2020). *More households embracing waste separation.* [online] NST Online. Available at: https://www.nst.com.my/news/nation/2020/02/568249/more-households-embracing-waste-separation.

Mohd Jani, M.F. and Siohong, T. (2010). *Potential of Selected Malaysian Tropical Fruits In Europe: Strategic Framework To Penetrate Eu Market. Journal of Agribusiness Marketing • Special Edition.* [online] Available at: http://www.fama.gov.my/documents/20143/0/se+1.pdf/7437f7ed-fce0-15c4-a59d-0b9f88932535.

Moné, L. (2019). *Which Governments Are Using Blockchain Right Now?* [online] https://consensys.net/. Available at: https://consensys.net/blog/enterprise-blockchain/which-governments-are-using-blockchain-right-now/?utm_campaign=ConsenSys%20Newsletterandutm_source=hs_emailandutm_medium=emailandutm_content=80467613and_hsenc=p2ANqtz--zOUwxuYK6daqZLBVjcSvsDfB415Gmyr-mqQ1XAqQ0DBWsYHR6cYWw7Fnjsuktv-dBE40ojH5MBFbBgDSRn1mh1AV0So0Oxmwv6hGdQVMHowX-COCQYand_hsmi=80467613 [Accessed 24 Apr. 2020].

Muniandy, U. (n.d.). *Government Policies, Facilitations & Assistance For The Plastics And The Mould And Die Industries Malaysia.* [online] Seminar on Government Policies, Facilitations and Assistance for the Plastic and the Mould and Die Industries. . Available at: http://www.mpma.org.my/Documents/1.0%20Presentation%20Slide_Chemical%20&%20Advanced%20Material%20Division%20.pdf.

MySejahtera (2020), https://mysejahtera.malaysia.gov.my/intro/ [Accessed on 5 May 2020] Myunggu, K. (2020). How is Seoul, Korea transforming into a smart city? [online] World Bank Blog. Available at: https://blogs.worldbank.org/sustainablecities/how-seoul-korea-transforming-smart-city#:~:text=Seoul [Accessed 20 Nov. 2020].

Nair, M. (2011), "Inclusive innovation and sustainable development: leap-frogging strategies to a high income economy," in editor Ramachandran, Ramasamy, ICT Strategic Review 2011/2012, PIKOM and MOSTI, Malaysia, Chapter 11, 225-257. 2

National Audit Department. (2018). Auditor-General's Report Series 1 2018

National Integrated Water Resources Management Plan Strategies and Road Map. (2016). [online] Academy of Sciences Malaysia. Available at: https://issuu.com/asmpub/docs/web_vol1_gf.

National Research Council of Canada, Industrial Technology Advisors: The Human Face of Innovation. https://www.nrc-cnrc.gc.ca/eng/irap/about/advisors.html.\ [Accessed by 20 Oct 2020]

Natixis Investment Managers. (2019). Global Retirement Index 2019.

Newleaf Plantation Berhad. (n.d.). *Durian Plantation Malaysia Durian iFarm.* [online] Available at: https://newleaf.com.my/durian-plantation-malaysia/.

NST Online. (2020). *Letters: Prospects just as good with TVET.* [online] Available at: https://www.nst.com.my/opinion/letters/2020/03/574472/prospects-just-good-tvet [Accessed 24 Apr. 2020].
OECD (2016a). Preventing Corruption in Public Procurement. [online] OECD. Available at: http://www.oecd.org/gov/ethics/Corruption-Public-Procurement-Brochure.pdf.

OECD (2016b). R&D Tax Incentive Support : Canada. [online] Directorate for Science, Technology and Innovation. Available at: https://www.oecd.org/sti/OECD-STI-RDTaxIncentives-CountryProfile_CAN.pdf [Accessed 12 Oct. 2020].

OECD (2019a). *R&D Tax Incentives : Korea, 2019.* [online] OECD. Directorate for Science, Technology and Innovation. Available at: https://www.oecd.org/sti/rd-tax-stats-korea.pdf.

OECD (2019b). *The road to 5G networks: Experience to date and future developments. OECD Digital Economy Papers.* [online] Available at: https://www.oecd-ilibrary.org/docserver/2f880843-en.pdf?expires=1606635634&id=id&accname=guest&checksum=96259D7D6B0CEF3CB5447ACC1036575A.

Opensignal. (2019). Malaysia, April 2019, *Mobile Network Experience.* [online] Available at: https://www.opensignal.com/reports/2019/04/malaysia/mobile-network-experience.

PADU (n.d.). 2018 Annual Report. [online] Ministry of Education Malaysia. Available at: https://www.padu.edu.my/wp-content/uploads/2019/07/AR2018-Eng.pdf.

Pearly, N. (2019). *Halal food leaders: Malaysia, Australia and Pakistan retain top APAC spots in Global Islamic Economy report's Top 10 list.* [online] Food Navigator-Asia.com. Available at: https://www.food-navigator-asia.com/Article/2019/12/18/Halal-food-leaders-Malaysia-Australia-and-Pakistan-retain-top-APAC-spots-in-Global-Islamic-Economy-report-s-Top-10-list.

Perumal, B. (n.d.). *Freshwater.* [online] WWF-Malaysia. Available at: https://www.wwf.org.my/about_wwf/what_we_do/freshwater_main/.

Portal Rasmi Unit Perancang Ekonomi, Jabatan Perdana Menteri. (2019). *Shared Prosperity Vision 2030.* [online] Available at: http://www.epu.gov.my/sites/default/files/2020-02/Shared%20Prosperity%20Vision%202030.pdf.

Powell, D. (2019). *5G: The Connectivity game-changer Coming to Your Roads*. https://iotnowtransport.com/. [online] 15 Nov. Available at: https://iotnowtransport.com/2019/11/15/74190-5g-the-connectivity-game-changer-coming-to-your-roads/.

Privacy Shield Framework. (n.d.). *Malaysia - Smart Cities.* [online] Available at: https://www.privacyshield.gov/article?id=Malaysia-Smart-Cities [Accessed 22 Apr. 2020].

Puvaneswary, S. (2019). *Malaysia pushes for digitalisation in its tourism industry.* [online] TTG Asia. Available at: https://www.ttgasia.com/2019/08/27/malaysia-pushes-for-digitalisation-in-its-tourism-industry/ [Accessed 6 Jun. 2020].

Rahmat, S., Cheong, C.B. and Abd Hamid, M.S.R. (2016). Challenges of Developing Countries in Complying Quality and Enhancing Standards in Food Industries. Procedia - Social and Behavioral Sciences, 224, pp.445–451.

Reinhart, J. (2014). *Why The Success Of "Sharing Economy" Startups Hinges On Who Owns The Inventory.* [online] Business Insider. Available at: https://www.businessinsider.com/the-success-of-the-sharing-economy-2014-2?IR=T [Accessed 20 Aug 2020].

RMIT University (n.d.). *The future of learning and teaching: Big changes ahead for education.* [online] RMIT University. Available at: https://www.rmit.edu.au/study-with-us/education/discover-education/the-future-of-learning-and-teaching-big-changes-ahead-for-education [Accessed 26 Sep. 2020].

Rueben Ananthan, S.D. (2019). *Crime Trends and Patterns in Malaysia | | Kyoto Review of Southeast Asia. Kyoto Review of Southeast Asia.* [online] Aug. Available at: https://kyotoreview.org/trendsetters/crime-trends-and-patterns-in-malaysia/.

San Ong, T., Heng Teh, B. and Suat Lee, A. (2019). Contingent Factors and Sustainable Performance Measurement (SPM) Practices of Malaysian Electronics and Electrical Companies. Sustainability, 11(4), p.1058.

Sarkar, A.N. (n.d.). *Innovations in designing Smart Cities as Living Labs (1).* [online] The Smart City Journal. Available at: https://www.thesmartcityjournal.com/en/articles/1466-innovations-designing-smart-cities-as-living-labs-1 [Accessed 22 Apr. 2020].

Scottish Government (2018). *Young Farmers and New Entrants Start-Up Grant Schemes.* [online] Rural Payments and Services. Available at: https://www.ruralpayments.org/publicsite/futures/topics/all-schemes/new-entrants/young-farmers-and-new-entrants-start-up-grant-schemes/#:~:text=The%20Young%20Farmers%20Start%2DUp [Accessed 20 Oct. 2020].

Seafood Sourcing and Investment Intelligence. Malaysia's Seafood Sector. https://seafood-tip.com/sourcing-intelligence/countries/Malaysia/. Accessed on 15 May 2020.

Sean, G. (2019). *A new era of microcredentials and experiential learning.* [online] University World News. Available at: https://www.universityworldnews.com/post.php?story=20190213103113978 [Accessed 2 Jul. 2020].

Shen, C.M., Megat Mohd Zainuddin, N., Maarop, N., Yaacob, S., Ab Rahim, N.Z. and Wan Hassan, W.A. (2018). Design of Frog Virtual Learning Environment (Frog VLE) Aesthetics Model for Malaysia Primary Schools. Open International Journal of Informatics (OIJI), [online] 5(1), pp.23–31. Available at: http://apps.razak.utm.my/ojs/index.php/oiji/article/view/90/67.

Singh, K. and Jee Yee, T. (2020). Cyberview Unveils a New Masterplan to Stake Cyberjaya's Claim as Southeast Asia's and Malaysia's Premier Tech Hub. https://www.digitalnewsasia.com/. [online] 7 Aug. Available at: https://www.digitalnewsasia.com/digital-economy/cyberview-unveils-new-masterplan-stake-cyberjayas-claim-southeast-asias-and [Accessed 26 Nov. 2020].

Smart Campus Transforms Learning at the International School of Kuala Lumpur. (2018). International School of Kuala Lumpur. Available at: https://www.iskl.edu.my/community/pantherblog/blognews/~board/2018-2019-news/post/smart-campus-transforms-learning-at-the-international-school-of-kuala-lumpur.

Sobian, A. (2018). *Water is life, use it wisely, don't waste it.* [online] NST Online. Available at: https://www.nst.com.my/opinion/columnists/2018/12/440092/water-life-use-it-wisely-dont-waste-it.

Solid Waste Management Lab 2015. (2015). [online] Available at: https://www.kpkt.gov.my/resources/index/user_1/Attachments/hebahan_slider/slaid_dapatan_makmal.pdf.

SOLS 24/7. (n.d.). *SOLS Tech*. [online] Available at: https://www.sols247.org/sols-tech/ [Accessed 21 Jul. 2020].

Steven, M. (n.d.). *The Technological Training Revolution: Virtual TVET*. [online] The 4th International Conference on Innovative Education and Technology (ICIET 2019). . Available at: http://www.iciet.rmutt.ac.th/wp-content/uploads/2019/07/Steven-McKee-TVET-Revolution-R3-short-Thailand-ICIET.pdf.

Suchithra Padmajan, S., Gyoung Hwa, J., Taeyeong, Y. and Sang Ouk, K. (2019). A perspective on R&D status of energy storage systems in South Korea. Energy Storage Materials, 23, pp.154–158.

Sunway Medical Centre (n.d.). *Sunway Robotic Surgery Centre*. [online] www.sunwaymedical.com. Available at: https://www.sunwaymedical.com/sunway-robotic-surgery-centre.

Suruhanjaya Tenaga. (n.d.). *LSS Progress by Region*. [online] Available at: https://www.st.gov.my/en/web/industry/details/2/17 [Accessed 25 Sep. 2020].

Suruhanjaya Tenaga. (2019). *Malaysia Energy Statistics Handbook 2019*. [online]. Available at: https://meih.st.gov.my/documents/10620/bcce78a2-5d54-49ae-b0dc-549dcacf93ae.

Suruhanjaya Perkhidmatan Air Negara. (2017). Water Tariff and Rates in Malaysia.

SWCorp (2019). Taken from The Star Article - https://www.thestar.com.my/news/nation/2019/07/30/generating-more-waste-than-ever [Accessed on 20 June 2020]

Tashny, S. (2019). *SCMP*. [online] South China Morning Post. Available at: https://www.scmp.com/news/asia/southeast-asia/article/3014925/china-buy-us120-million-durians-year-malaysia-spike-sales.

Taylor, M. (26 March 2020) Deforestation risks rise as coronavirus hinders SE Asia protection. Thomson Reuters Foundation. https://news.trust.org/item/20200326102213-ntsuv/ [Accessed 4 May 2020]

Technavio Research (2020). *COVID-19 Impact and Recovery Analysis - Digital Health Market 2020-2024 | Increase in the Number of M&A Activities in the Market to Boost Growth |*. [online] Business Wire. Available at: https://www.businesswire.com/news/home/20200626005125/en/COVID-19-Impact-and-Recovery-Analysis---Digital-Health-Market-2020-2024-Increase-in-the-Number-of-MA-Activities-in-the-Market-to-Boost-Growth-Technavio.

Thales. (n.d.). *What is a smart city? Technology and examples*. [online] Available at: https://www.thalesgroup.com/en/markets/digital-identity-and-security/iot/inspired/smart-cities [Accessed 27 Sep. 2020].

The Edge Markets. (2012). *Malaysia could tap fertiliser market*. [online] Available at: https://www.theedgemarkets.com/article/malaysia-could-tap-fertiliser-market [Accessed 1 Jul. 2020].

The Malaysian Reserve. (2019). *Food import bill hits RM34.2b as of August.* [online] Available at: https://themalaysianreserve.com/2019/11/19/food-import-bill-hits-rm34-2b-as-of-august [Accessed 23 Jun. 2020].

The Medical Futurist. (2020). *10 Ways Technology Is Changing Healthcare - The Medical Futurist.* [online] Available at: https://medicalfuturist.com/ten-ways-technology-changing-healthcare [Accessed 26 Sep. 2020].

The Star. (2015). *Easy learning in SMART classroom.* [online] Available at: https://www.thestar.com.my/news/education/2015/02/15/easy-learning-in-smart-classroom [Accessed 1 Jun. 2020].

The Star. (2019). *Letters: We dream of an electronic medical record system.* [online] Available at: https://www.thestar.com.my/opinion/letters/2019/12/20/we-dream-of-an-electronic-medical-record-system.

Tobi, E. (2017). *Rocket Fuel Logged 97% Revenue Growth For Platforms Business In '16.* [online] MediaPost. Available at: https://www.mediapost.com/publications/article/295625/rocket-fuel-logged-97-revenue-growth-for-platform.html.

TRADE IMPACT FOR GOOD - From niche to mainstream Halal Goes Global. (2015). [online] International Trade Centre. International Trade Centre. Available at: https://www.intracen.org/uploadedFiles/intracenorg/Content/Publications/Halal_Goes_Global-web(1).pdf.

Transport Statistics Malaysia 2018. (2019). [online] Ministry of Transport Malaysia. Available at: https://www.mot.gov.my/en/Statistik%20Tahunan%20Pengangkutan/Transport%20Statistics%20Malaysia%202018.pdf.

Tvaronavičienė, M. and Ɖlusarczyk, B. (2019). Energy Transformation Towards Sustainability. First ed. Elsevier.

Udaya, S. (2015). Smart buildings for efficient energy management. *Digital News Asia.* [online] 5 Jan. Available at: https://www.digitalnewsasia.com/insights/smart-buildings-for-efficient-energy-management [Accessed 20 Jun. 2020].

UK Research and Innovation. Introducing UKRI https://www.ukri.org/about-us/who-we-are/ [Accessed by 20 Oct 2020]

United Nations - Statistics Division. (2011). *Environmental Indicators: Waste.* [online] Available at: https://unstats.un.org/unsd/environment/wastetreatment.htm [Accessed 18 Jun. 2020].

United Nations Foundation. (2014). Microgrids for Rural Electrification: A critical review of best practices based on seven case studies.

USDA Foreign Agricultural Service. (2018). *Malaysia: Retail Foods Annual.* [online] Available at: https://www.fas.usda.gov/data/malaysia-retail-foods-annual-2 [Accessed 25 May 2020].

Varouj, A. (n.d.). How Canada is Leading the Adoption of Smart City Technology. *TECH TALK.* [online] Available at: https://products.gecurrent.com/sites/products.currentbyge.com/files/How-Canada-is-Leading-the-Adoption-of-Smart-City-Technology.pdf [Accessed 20 Nov. 2020].

Volocopter.com. (2019). *Volocopter - Home.* [online] Available at: https://www.volocopter.com/en/.

Walton, J.K. (2012). *tourism | Definition, History, Types, Importance, & Facts. In: Encyclopædia Britannica.* [online] Available at: https://www.britannica.com/topic/tourism [Accessed 7 Jul. 2020].

Wei, X. (2017). *China promotes Internet Plus manufacturing to boost innovation, competitiveness.* [online] The State Council of China. Available at: http://english.gov.cn/premier/news/2017/10/30/content_281475926427288.htm.

Whitler, K.A. (2016). *How The Subscription Economy Is Disrupting The Traditional Business Model.* [online] Forbes. Available at: https://www.forbes.com/sites/kimberlywhitler/2016/01/17/a-new-business-trend-shifting-from-a-service-model-to-a-subscription-based-model/?sh=5f0c09704a5f.

World Bank Group (2018). *Malaysia Economic Monitor (June 2018): Navigating Change.* [online] The World Bank Group. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/29926/127679.pdf?sequence=5&isAllowed=y.

World Bank Group (2019). *Agricultural Transformation and Inclusive Growth: The Malaysian Experience.* [online] World Bank Group. Available at: http://documents.worldbank.org/curated/en/617611574179512389/pdf/Agricultural-Transformation-and-Inclusive-Growth-The-Malaysian-Experience.pdf.

World Bank Group (2020). *Assessing the Effectiveness of Public Research Institutions in Fostering Knowledge Linkages and Transferring Technology in Malaysia.* [online] World Bank Group. Available at: https://openknowledge.worldbank.org/handle/10986/34612

www.etawau.com. (n.d.). *SAIP SABAH AGRO INDUSTRIAL PRECINT (SAIP).* [online] Available at: http://www.etawau.com/Agriculture/Agro_SAIP.htm [Accessed 27 Nov. 2020].

www.sedia.com.my. (n.d.). *Sabah Economic Development and Investment Authority (SEDIA).* [online] Available at: https://www.sedia.com.my/ [Accessed 25 Sep. 2020].

Zhe, Z. (2020). *The construction of "patent box" tax system in China. Academic Journal of Humanities & Social Sciences,* [online] 3(1), pp.123–132. Available at: https://francis-press.com/uploads/papers/0rbufHaytWi19p7GIUWjk1nl3HNUS0CIfb7GnJG6.pdf [Accessed 30 Nov. 2020].

www.akademisains.gov.my

ISBN 978-983-2915-49-2