Trailblazing the Way for Prosperity, Societal Well-being, and Global Competitiveness

In most developing countries, utilising science, technology, and innovation (STI) in improving productivity and GDP remains a challenge. Despite various initiatives planned and implemented to achieve economic growth, a significant number of STI-related initiatives remain unaligned to meeting economic needs and benefit the society at large. Challenges of the developing world have also been common for Malaysia. For many years, efforts in ensuring that Malaysia remains globally competitive continues through mainstreaming STI as a driver of economic growth in its transformation plans. Malaysia believes that STI is the key lever to change the current production-based economy and provide bigger opportunities for value creation.

Malaysia's Research, Development, Innovation, Commercialisation and Economy (RDICE) Ecosystem

Malaysia's research, development, innovation, commercialisation, and economy (RDICE) landscape is quite different from other developing countries. 79.92% (2018) of researchers in Malaysia are in higher learning institutions (HLIs) while 97.4% (2021) of entrepreneurs are in the micro, small and medium enterprise (MSME) category. Most SMEs do not invest in R&D further unable to create high end jobs. As of January 2023, around 5300 startups were recorded in the country. The percentage of tech-based startups is unknown.

Collaborations between HLIs and business enterprises to problem-solve through high end R&D has not been as significant hence the translation of indigenous technology and product to commercialisation remains a challenge. Apart from research priority areas not being in sync with economic priority areas, the lack of strategic policy directions and inconsistencies hinders focused long-term investments to spur the economy through RDIC activities. The return-on-value from millions of ringgit expenditure in RDI activities has also been poor due to the long existing innovation chasm. In the effort to eliminate the innovation chasm, the National Policy for Science, Technology, and Innovation 2021 – 2030 was launched alongside the 10-10 Malaysian Science, Technology, Innovation and Economy (MySTIE) Framework.

Linking Science, Technology, and Innovation to Economy for Socio-economic Benefits

Acknowledging that the role of science, technology, and innovation (STI) is inevitable in developing an economy, its fundamental influence towards societal development is also essential. In 2020, Malaysia has embarked on a new approach in linking science, technology, and innovation (STI) to economy through the 10-10 Malaysian Science, Technology, Innovation and Economy (MySTIE) Framework. It is aimed to leverage on the strengths of globally leading science and technology to empower the national socioeconomic areas (Figure 1). The framework aims to generate shared economic prosperity across diverse ecosystems in the country while it enables key sectors of the economy to become more knowledge-intensive and innovation-driven.

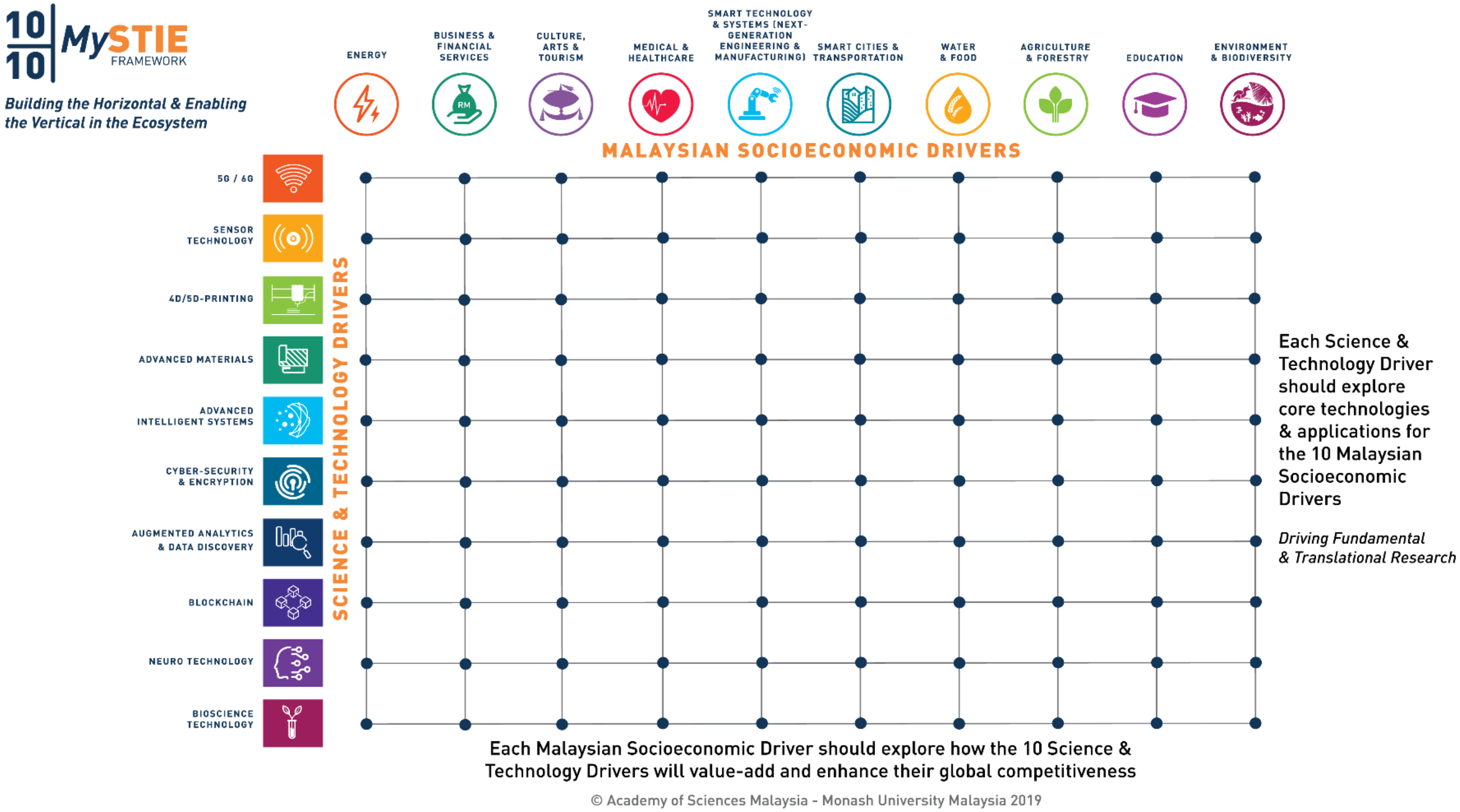

*Figure 1: The 10-10 MySTIE Framework integrates 10 S&T drivers **5G/6G, sensor technology, 4D/5D printing, advanced materials, advanced intelligent systems, cyber-security and encryption, augmented analytics and data discovery, blockchain, neuro technology and bioscience technology** with 10 socio-economic drivers comprising of **energy, business and financial services, culture, arts and tourism, medical and healthcare, smart technology and systems (next generation engineering and manufacturing), smart cities and transportation, water and food, agriculture and forestry, education** as well as **environment and biodiversity***

The framework integrates 10 key Malaysian socio-economic drivers with 10 global leading science and technology (S&T) drivers which are aligned to the nation's strengths and needs. The 10 socio-economic drivers were identified by analysing Malaysia's research priority areas such as the National Key Economic Areas (NKEA), National Science Research Council (NSRC) Priority Areas and analyses of industrial ecosystems in multiple economic sectors. The 10 S&T drivers were clustered from 95 emerging technologies (previously identified through the Academy of Sciences Malaysia's flagship Emerging Science, Engineering & Technology (ESET) Study) supplemented by a series of global studies, patent analysis and technology trajectories over the past years. To date, the framework has been widely adopted as a guiding tool for all relevant ministries, agencies, industries, public and private institutions to plan and implement initiatives.

The framework also introduced an 8-cluster collaborative platform comprising of connectors, producers and manufacturers, technology providers, financing providers, standards setters and regulators, supply chain and logistics providers, market access providers and capacity builders (Figure 2). This platform supports the spirit of collaboration to enable multichannel communication between the stakeholders in which facilitates effective decision-making. The platform is critical for translating research into impactful outcomes while providing a more holistic solution for the community.

Figure 2: Collaborative platform

Guided by the 10-10 MySTIE framework, Malaysia's 30 STIE niche areas were identified (Figure 3) based on four criteria:

1. **Strategic focus** – The potential to become an economic booster and have wide societal impact
2. **Building blocks** - The state of development of niche areas based on 8i STI ecosystem enablers (i.e. infrastructure, infostructure, intellectual capital, integrity, incentives, institutions, interaction and internationalisation)
3. **Aligned** - Alignment to Malaysia's strengths and needs
4. **Targeted yet Inclusive** - Inclusivity and its ability to contribute to multiplier effect to other sectors and communities in localities across Malaysia

Figure 3: Malaysia's 30 STIE niche areas

The STIE niche areas enable confluence of resources, investment, and interventions to transform the country's key economic activities through the application of STI.

The framework amalgamates six elements as a mechanism to realise the impact of STI for socio-economic wellbeing: focus, prioritise, systematise, collaborate, inclusive and future-proof.

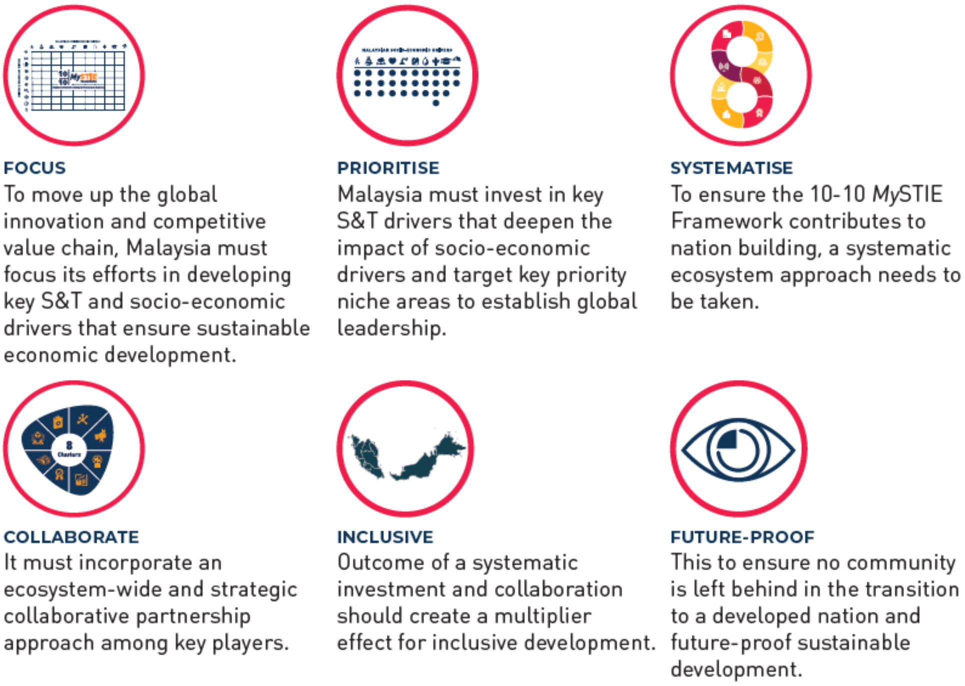

Figure 4: Six elements of the 10-10 MySTIE framework for implementation

To maximise the use of the 10-10 MySTIE Framework, the Ministry of Science, Technology and Innovation (MOSTI) is developing 17 policies and roadmaps for key technology domains such as artificial intelligence, advanced materials, blockchain and nanotechnology. One of them is the Research, Development, Innovation, Commercialisation and Economy (RDICE) Roadmap developed by the Academy of Sciences Malaysia which puts forward strategies and action plans to consolidate the ecosystem. One of the game changing strategies in the RDICE Roadmap is driving innovation through an open RDICE ecosystem. An open RDICE ecosystem allows better collaboration opportunities for solutions that address market needs. It also enables anyone to become solvers or solution providers through multidisciplinary technologies. Another prime strategy proposed in the RDICE Roadmap, taking on Mariana Mazzucato's concept is a mission-oriented approach.

Embarking on a Challenge-led Mission

While recognising STI as the agent for change, it is important to know how Malaysia can engage with mission-oriented innovation to take full advantage of the current technological revolution for economic growth and sustainable development. Mission-oriented innovation is a type of innovation with a clear direction and purpose of why an innovation is needed. Missions provide the means to focus relevant research, innovations and investments on solving key challenges facing the society. Additionally, the whole ecosystem's effort is concerted towards fulfilling the mission.

According to Mariana Mazzucato's Mission Economy, oftentimes, innovation policies are focused on outcomes aiming to support specific technologies and encourage specific startups. A new way of viewing is that innovations must be focused on solving challenges. With an aim to problem-solve, technologies will be developed and with time more startups will grow in response to address the challenge. Malaysia's fragmented innovation ecosystem will need a mission-driven approach to allow more focused policies and investments for RDIC activities.

Premised upon the six elements of 10-10 MySTIE framework, a mission-led challenge can be approached as follows.

Focus

A mission-oriented approach focuses on a problem that affects multiple sectors and players. Vision and purpose for a mission should be set to be aspirational.

Prioritise

Mission should prioritise research and innovation in areas with largest return-on-value and socio-economic impact. Prioritise to provide targeted investment. Providing a continuous funding mechanism that prioritises mission-oriented innovation is complex but crucial in sustaining the momentum of RDIC activities and achieving the set goals.

Systematise

While missions are a method that provides strategic direction by linking STI and economy, policy instruments and initiatives that focus on outcomes are also needed to ensure systematic development. The ecosystem's building blocks such as governing institutions, policy instruments, key players and fund provision should be assessed to evaluate the feasibility of the project to undertake.

Collaborate

While the missions provide strategic focus, having different individuals, organisations, agencies, and ministries playing their roles effectively is essential. An ecosystem-wide collaboration needs to be fostered with all key players to solve specific problems. Mission should create partnerships between the public and private sectors that puts emphasis on co-investment, sharing risks and sharing rewards.

Inclusive

In making participation of RDIC activities more inclusive, missions may involve members of the community to engage and contribute to solving grand societal challenges. Developing locality-specific STIE ecosystem aims to inclusively harness resources and talent in the region. Development strategies should ensure that the building blocks (8i ecosystem enablers) of the local STIE ecosystems are in place and continuously enhanced to meet the socioeconomic needs of the local communities.

Future-proof

Consistent monitoring of mission-oriented projects and regular fore sighting should be conducted to ensure the RDICE ecosystem in adapting to change and is able to mitigate risks associated with uncertainties and volatilities. Achieving a mission should also consider creating a better future for the next generation and for shared prosperity.

To monitor the progress of a mission, appropriate indicators and frameworks need to be used. Accomplishing the mission requires active participation through the whole value chain of RDIC activities with strong governance and institutional support driven by visionary leadership.

Nurturing Future-ready Talent

Ensuring that the race for STI development is parallel to socioeconomic development, Malaysia believes that technology and talent must be developed in tandem. Nevertheless, socio-economic development is not driven by technology but by people who leverage technology as an enabler. Through its National Policy for Science, Technology, and Innovation 2021 – 2030, Malaysia aims to become a high-tech nation by 2030. One of the thrusts of the policy is to empower local talents. competent, agile and adaptive talent pool will become the backbone of a strong high technology nation. The 10-10 MySTIE serves as a catalyst to achieve the strategic goal.

A high-tech nation can be developed by a broad-based innovation model that supports mass businesses to apply and adopt cutting-edge technologies or deep technology. Deep technology is advanced, complex and sophisticated technologies that provide solutions to substantial scientific and engineering challenges. Deep technology is also disruptive technologies that are cross-cutting and goes beyond more than one sector. Malaysia believes that embarking on deep technology can have a big impact in the long run.

According to World Economic Forum survey in 2020, skillset that will be sought after by 2025 include critical thinking, analytical thinking and self-management skills which includes active learning, stress tolerance and flexibility. Additionally, due to increasing interdependency between human and machines, the future workforce needs to be more adaptive to their changing environment. From the other spectrum, data entry clerks, administrative support, assembly and factory workers among others will be redundant in the future. In adapting to globally emerging job roles such as data analysts and scientists, big data specialists, AI and machine learning specialists, cyber security specialists and other roles in high demand, talent need to be equipped with technological and digital knowledge complemented by the right cognitive and interpersonal skills.

Guided by the 10-10 MySTIE Framework, the Academy of Sciences Malaysia, a national think tank listed 115 applications, derivative technologies and sub-disciplines derived from the 10 science and technology drivers (Figure 5). The list is to serve for the benefit of knowledge providers, educators, and students for knowledge discovery and talent planning and development. The list can also be a guiding tool for scholarship sponsors' assessment for field of study.

Article Contribution for Science Portal Asia Pacific (SPAP) Japan
by Academy of Sciences Malaysia

5G/ 6G

a) Machine type communication/IoT communications
b) Medium Access Control
c) Interference Management
d) New waveform design and GHz/THz
e) Massive MIMO technology and intelligent
f) Terrestrial and Satellite Integrated Network
g) AR/VR/XR and internet of senses over 5G/6G
h) Crowdsource Applications
i) Electromagnetic Fields Effect (EMF) on Humans
j) Quality of Experience (QoE)
k) Smart metasurfaces
l) Autonomous mobility
m) Intelligent edge

SENSOR TECHNOLOGY

a) Micro-electro-mechanical Systems (MEMS)
b) Piezoceramics
c) Wearable biosensors
d) Electrochemical sensors
e) Microelectronics
f) Nanosensors
g) Smartdust sensor network
h) Soft sensor
i) Electro-optical and chemical sensors
j) Monitoring and Control Systems
k) Printed sensor system

4D/5D PRINTING

a) Materials Science
b) Advanced Design
c) Software Engineering
d) Advanced Materials
e) Electronic & Controls
f) Robotic & Mechatronic
g) Precise Engineering
h) Additive Manufacturing
i) Computational Modelling
j) Digital Photography
k) Printing materials
l) Printing & flexible electronics
m) Construction & Automobile components

ADVANCED MATERIALS

a) Nanoengineered materials / nanotechnology
b) Derivative Materials
c) Biomaterials Engineering
d) Materials Science
e) Fabrication & Integration Engineering
f) Functional/Smart Materials
g) Metamaterials
h) Organic, Green & Renewable Materials
i) Multi-materials Structures
j) Polymer Science
k) Biomedical Materials
l) Printing & flexible electronics
m) Catalysts

ADVANCED INTELLIGENT SYSTEMS

a) Machine Learning
b) Neural Network
c) Robotics
d) Deep Learning
e) Computer Vision
f) Natural Language Processing (NLP)
g) Knowledge Graphs
h) Generative Adversarial Networks (GAN)
i) Cloud Computing
j) Advanced Control Systems

CYBER SECURITY & ENCRYPTION

a) Network Security
b) Cyber Forensics
c) Cyber Risk Management
d) Cryptography
e) Cloud Security
f) Mobile Application Security
g) Cybercrime legislation and policy
h) Ethical Hacking and Penetration Testing
i) Security Audit and Vulnerability Assessment
j) Secure programming (Encryption)

AUGMENTED ANALYTICS & DATA DISCOVERY

a) Machine Learning
b) Predictive Analytics
c) Text Mining
d) Data Mining
e) Business Intelligence
f) Natural Language Generation
g) Data Management
h) Data Science
i) Cloud Computing

BLOCKCHAIN

a) Cryptography Technology
b) Computer network
c) Distributed Ledger Technology
d) Information systems
e) Blockchain programming
f) Computer Science
g) Security Engineering
h) Software Engineering
i) Database Management
j) Management, economics/crypto-economy and finance
k) Digital Identity Management
l) Business Development
m) Telecommunications

NEURO TECHNOLOGY

a) Neuromodulation & Neurostimulation
b) Neuroprosthetics
c) Brain Sensing Technology
d) Neurorehabilitation Technology
e) Brain-Computer Interface Technology
f) Neurodiagnostics
g) Neuromorphic Computing
h) Neuropharmacology
i) Neuroinformatics
j) Neurofeedback Systems
k) Neuroergonomics
l) Neuromarketing

BIOSCIENCE TECHNOLOGY

a) Gene Editing & Engineering
b) Nanobiotechnology
c) Molecular Omics Technology
d) Bioinformatics & Biocomputing
e) Advanced Biomaterials
f) Synthetic Biology
g) Biofactories
h) Bioseparation and Biorefining Technologies
i) Biosensor Technology
j) Bioreactor and Separation Technologies
k) Metadata Analytics

Figure 5: 115 applications, derivative technologies and sub-disciplines derived from the ten science and technology drivers by the Academy of Sciences Malaysia

Conclusion

As an effort to address economic disparities for a sustainable national development, Malaysia will strive to achieve excellence in STI through various efforts. The strategies backed by 10-10 MySTIE Framework as a tool provides a systematic approach to transform Malaysia into a knowledge-intensive economy by design. This will allow for a focused and inclusive development towards ensuring wealth creation and societal well-being for Malaysia.

---END---