NEO

New Economic Opportunities
in STI-based Industries to
serve Emerging Markets

ASM-MPN Study on New Economic Opportunities in STI-based Industries to Serve Emerging Markets

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The cover design illustrates knowledge-based, collaborative networks to enter global markets and connecting the dots to strategise realisation of shared vision

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Foreword

The new economy is about knowledge intensiveness and enhanced innovation capacity, fuelled by the digital revolution and rapid technological advancement. In the new economy, knowledge-intensive, high value-added, technology-enabled and adaptable industries will be at the cutting-edge. The Academy of Sciences Malaysia (ASM) and the National Council of Professors (MPN) believe Malaysia is well-positioned to leverage on new economic opportunities and enter global markets through STI-based industries, collaboration and open innovation. Thus, we have responded to the mandate by the National Science Council by completing this study on 'New Economic Opportunities in STI-based Industries to Serve Emerging Markets'.

The collaborative network model with a shared value ecosystem at its core, is gaining significance globally and is responsible for disrupting conventional industry incumbents in many instances. Drivers (industry players and researchers) are connected with enablers (Government regulatory bodies, institutions of higher learning and civil society) to catalyse the genesis of ideas leading to disruptive innovations at a very dynamic pace.

A collaborative network makes it possible for market information as well as science & technology (S&T) knowledge to be applied creatively to realise value and result in products and services that are unique and differentiated. Collaboration enables risk sharing thereby lowering the risks and barriers faced by each player. This also reduces reluctance to participate in innovative initiatives and makes it easier to enter new global markets.

Dynamic industry-led, people-driven interactions will give rise to knowledge clusters and a talent hub. Malaysia will not only be able to create demand for our high skilled talent and knowledge workers but also be able to tap into talents throughout the region. Gathering the right talent is vital to realize the full potential of the collaborative network.

We would like to take this opportunity to thank the Co-Chairs, YM Tengku Datuk Mohd Azzman Shariffadeen FASc, Vice President of ASM and Professor Dr Jamal Othman, member of the Economic Cluster, MPN for their leadership and commitment. On behalf of ASM and MPN, we wish to thank all stakeholders and workshop participants from the industry, research community, Government ministries, agencies and regulatory bodies as well as civil society who contributed valuable input and insights towards this study.

As the world becomes more connected and collaborative, the motivation to co-create is becoming more prominent. To adapt, we must transform the way we work by making the collaborative network a necessary platform. Every country is now strategizing to survive and thrive in the new economy and Malaysia must not be left behind. We need a paradigm shift from a material to knowledge focus and silo to collaborative approach so that Malaysia can flourish in the new economy.

The collaborative network can be an effective mechanism for Malaysia to leverage on our niches and rise to become one of the top 20 countries in the world, in line with our National Transformation (TN50) aspiration.

Professor Datuk Dr Asma Ismail FASc
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Academician Emeritus Professor
Tan Sri Dr Zakri Abdul Hamid FASc
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Preface

This joint study was mandated by the National Science Council (NSC) to the Academy of Sciences Malaysia (ASM) and the National Council of Professors (MPN) in 2016. The aim is to propose the most appropriate and vital mechanism for Malaysia to leverage on towards expanding global opportunities for economic growth by developing science, technology and innovation (STI)-based industries.

The new economy is driven by knowledge and enabled by fast-paced technology and digital connectivity, allowing radical sharing of ideas across borders. This has given rise to collaborative networks for disruptive innovation that result in knowledge-intensive products and services that offer better value propositions compared with products from market incumbents.

Malaysia's primary challenge in innovation is to bridge the chasm between industry players and the research and development (R&D) community. The answer provided in this report is to facilitate industry to formulate demand-driven R&D in order to draw the participation of researchers through open research calls within a collaborative network. By this means knowledge-rich products could be developed, while also extending the market reach of the industry concerned. Many advanced nations have successfully enhanced their innovation capacity and capability through such collaborative networks.

This study proposes a knowledge-based, collaborative network for disruptive innovation as a mechanism to leverage on new economic opportunities for Malaysian industries to enter new and emerging global markets. The nature of the collaborative network and its key success factors are elaborated in this report. Beyond proposing the mechanism, we have also engaged extensively with relevant stakeholders, involving over 160 participants from 82 organisations to identify the industry sectors in Malaysia that will benefit most from such a collaborative network.

The collaborative network must be industry-led. Other key actors such as researchers, government and civil society need to play their respective roles in an agile knowledge-driven innovation ecosystem, moderated and co-ordinated by a trusted neutral entity. Organisations that can potentially play the role of the trusted neutral entity have also been identified. However, this requires further discussion and optimisation. All parties involved in the network need to work together towards a shared vision if Malaysian industries are to succeed in stepping up their capacity for innovation and thrive in the face of global competition.

Bridging the innovation chasm is essential for Malaysian companies to bring knowledge-based, high-value products and services to the market. The potential outcomes of the proposed collaborative network would be the emergence of thriving knowledge clusters and talent hubs that may lead to sustainable disruptive innovation.

On behalf of ASM and MPN, we wish to thank all participants of the various engagement sessions in the form of roundtable discussions, strategic planning workshops, focus group meetings and expert group meetings for providing open and honest views, ideas and insights.

The establishment of collaborative networks is imperative in our journey to enhance Malaysia's innovation capacity. We hope that this report will assist the National Science Council (NSC) in transforming Malaysian industries to become more STI-based and innovative, thereby enhancing their future competitiveness and sustainability.

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Background & Mandate

As a small open economy, making strategic alliances through multilateral ties among other smaller countries and with larger partners is key for Malaysia to secure access to the global market. As a member of ASEAN, the third largest economy in Asia and the seventh largest in the world in 2014 (AEC, 2016) , one of the most important economic partnerships for Malaysia is the ASEAN Economic Community (AEC). Mooted during the 8th ASEAN Summit under the Bali Concord II Statement in 2003, AEC was subsequently developed under the guidance of the ASEAN Economic Blueprint. The AEC was formally established in 2015, envisioning ASEAN as a globally competitive single market and production base, equitably developed and fully integrated into the global economy (Wolfgang, 2016). Backed by harmonised trade and investment laws, AEC is expected to be a strong, single investment destination offering opportunities in the form of a huge market of US$2.4 trillion, annual GDP growth of around 5.3% since 2006 and over 632 million people.

The Trans-Pacific Partnership (TPP) is a regional free trade agreement (FTA) among 12 countries: Australia, Brunei, Canada, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore, the United States, and Vietnam. The negotiations started in 2008 between four nations, dubbed the P-4 nations (Brunei, Chile, Peru and Singapore which signed an FTA in 2005) and were later joined by the eight additional nations. An agreement on the TPP was reached on October 5, 2015.

Malaysia joined the TPP, the world's largest trade pact after the motion was approved by the Dewan Rakyat and the Senate in 2010 (MITI, 2016a). Membership in TPPA, which account for 40% of world trade and contributed around 37% of the world's GDP, is expected to increase Malaysia's Gross Domestic Product (GDP) by 5.6% and its export by 11.9% by year 2025 (iMoney, 2016). Even with the United States withdrawing from the TPPA, the potential market size remains huge, with a population of 498 million and an accumulated GDP of US$ 9.5 trillion in 2015.

The TPPA promised its member nations comprehensive and robust market liberalization by eliminating tariffs and other barriers to a wide a range of goods and services as well as trade and investments, facilitating the development of production and supply chains among TPP members, sustainable labour and growth in member countries through the development of regional production. Seamless and efficient trade ecosystem are expected by addressing cross-cutting trade issues of regulatory coherence (US-ASEAN, 2016). The trade pact is also expected to be a boon for Malaysian companies, including Small and Medium-sized Enterprises (SMEs), increasing the potential of exports as access to a new and wider market with other members of the TPPA is made available.

Realising this huge potential as an economic boost and to remain competitive and sustainable among member nations, Malaysia through its National Science Council (NSC), decided that there is a need to formulate an appropriate mechanism to identify new and emerging economic opportunities based on science, technology and innovation (STI). NSC is the highest decision making body that sets the strategic direction for STI in the nation. Below is an excerpt of the minutes of the inaugural NSC Meeting (Bil.1/2016) chaired by YAB Prime Minister of Malaysia on the 28th of January 2016:

> *"Penubuhan Komuniti Ekonomi ASEAN (AEC) dan Perjanjian Perkongsian Trans-Pasifik (TPPA) akan menyediakan akses pasaran antarabangsa dan seterusnya akan mengukuhkan pertumbuhan ekonomi negara. Sehubungan itu, Akademi Sains Malaysia dan Majlis Profesor Negara dicadang menggubal mekanisme bagi mengenal pasti peluang pewujudan industri-industri baru yang berpaksikan STI untuk membantu mengukuhkan modal insan dengan kerjasama ahli-ahli ekonomi yang lebih maju."*

The Academy of Sciences Malaysia (ASM) and the National Council of Professors (MPN) have been tasked by NSC to carry out this study and propose the most appropriate mechanism and relevant economic opportunities. The focus is on knowledge-based value creation as well as the role of STI in adding economic value and creating competitive advantage in selected sectors. The study also seeks to identify the strategic direction for Malaysia to pursue in order to position itself within five years as a leading country in selected niche areas of STI-based industries and products. Finally, the study looked into identifying the key actors and the strategic contingency measures Malaysia should undertake to proactively respond to these highlighted challenges and become a successful member in both AEC and TPPA.

The study period spanned 8 months between May 2016 and January 2017. The unit of analysis is Malaysia, while the project proponent is the quadruple helix comprising government, private sector, Research & Development (R&D) community and civil society. Inputs were consolidated from a total of 163 people and 82 organisations during six (6) stakeholder engagement sessions comprising a roundtable discussion, a strategic planning workshop and four (4) focus group meetings. Four (4) expert group meetings were later held in January 2017. Brainstorming sessions and desk-based research were also undertaken by the study team to further support and justify the study's analysis and recommendations.

The engagement session kicked off with a Roundtable discussion which was organized to conceptualize and plan the direction of this study. It was represented by 17 top ranking representatives from ASM, MPN, SIRIM, Economic Planning Unit (EPU), Federation of Malaysian Manufacturers (FMM), The Institution of Engineers Malaysia (IEM) and NanoMalaysia, among others. Following the Roundtable discussion, a strategic planning Workshop participated by 30 representatives of the quadruple helix model was held where four strategic focus areas, namely *Halal Industries, Health and Wellness Industries, Manufacturing Industries* and *value-added Services Industries* were identified as high potential niche areas for economic advancement.

Malaysia is regarded as one of the leaders in the global halal marketplace. By 2020, Malaysia envisages itself as a leading Global Halal Hub. The global market value for trade in halal food and non-food products is estimated at US$2.3 trillion annually, one of the world's fastest growing market (Halal Industry Development Corporation, 2016). The halal industry is wider than just the food sector and also encompasses pharmaceuticals, nutraceuticals and cosmeceuticals as well as logistics and Islamic Finance. Healthcare has one of the highest investment multipliers in the economy and under of the National Key Economic Areas (NKEA) 40 healthcare projects have been announced (PEMANDU, 2013), projected to generate an income of RM6.59 billion by 2020. Manufacturing and its ancillary services have a long and dominant history beginning in the industrialization era back in the 1960's and recent data show that this sector collectively contributed 23% of Malaysia's real GDP. The services sector was listed as one of the continuing primary drivers of economic growth in the 11th Malaysia Plan (2016-2020) and contributed 53.5% of Malaysia's real GDP in 2015.

To discuss further on each of these strategic focus areas, four (4) Focus Group Meetings were organized; one in August and three (3) in September 2016. The outcome from these meetings was the identification of key strengths and possible challenges faced in each of these sectors by being in the AEC and TPPA. The roles of the strategic stakeholders in moving towards an industry-wide transformation, the strategic programmes, interventions, and quick wins were outlined. These meetings were also geared towards developing the innovation ecosystem drivers and enablers.

During the engagements, industry and firm-specific opportunities and challenges were identified and quantified. A PESTELS checklist and SWOT analysis were used to identify major impacting changes expected in Malaysia over the next 5 years by participating in AEC and TPPA. The study looked at external and internal changes beyond the country's control, as well as critical discontinuities and expected disruptions. The PESTELS approach encompassed the political, economic, social, technological, environmental, legal, and spiritual drivers of change, while the SWOT analysis encapsulated the strength, weakness, opportunities and threats. Throughout the engagements, the following framework guided the thought process:

Figure 1
The Mission Development Triangle

**Our driving force: who, what, why or how to position ourselves differently from competitors*

Innovation Taking Advantage of Globalisation

The global economy is rapidly transforming. With the shift towards the post-industrialization economy, physical capital, land, and labour are no longer the main enablers in ensuring a nation's prosperity and sustainability. The economy in the Information Age is no longer driven by cheap labour. Knowledge becomes the currency of the new economy. Intellectual input replaces natural resources or physical endowments as key catalysts of growth and development.

A significant change can be seen in the behaviours of economic actors as the internet breaks down the barriers to human interaction. Location is no longer a barrier. The economy is increasingly driven by collaboration and information sharing. With location being less of a barrier, a conglomeration of academic, scientific, technological, and innovation (STI) capabilities serves as the engine of economic growth. Power structures have also changed. Organisations are driven less by control and more by collaboration. Openness and transparency lead to increased trust. The capitalist system is slowly being overtaken by the sharing economy. Globalisation of the post-industrial era is enabled by fast-paced technology allowing radical movement of ideas across borders.

At a macro level, economies are becoming increasingly interconnected and integrated with the blurring of borders, free movement of resources and a proliferation of free trade and investment partnerships. All of these are making competition in the global economy more intense.

In the context of globalisation and the new economy (Figure 2), Malaysia's active participation in external trade means that there are huge opportunities to be capitalized from the integration of markets. Of particular importance are the ASEAN Economic Community (AEC) and the Trans-Pacific Partnership Agreement (TPPA).

The AEC is important not only because Malaysia is a member of ASEAN, but also because Malaysia trades the most with ASEAN. The AEC has a population of over 632 million and a combined GDP of US$2.4 trillion. In 2015, total trade with ASEAN stood at RM401.33 billion, making up more than a quarter of Malaysia's global trade . The AEC envisions better integration among ASEAN member countries and with the rest of the world, greater competitiveness and more equitable development for the region. The AEC Blueprint 2025, which built on the 2015 blueprint, incorporates new characteristics that are in line with those of the new networked economy - i.e. integrity, interdependence, collaboration, sharing and openness.

Under the AEC, member countries have pledged to undertake concerted efforts to improve innovation and technological capabilities and achieve robust growth through STI and R&D to increase ASEAN'S competitive edge moving the region up the global value chain (GVC) (ASEAN Secretariat, 2015) . With AEC's vision, opportunities abound for Malaysian firms to meet the needs of ASEAN and its members in terms of fostering innovation, increasing standard of living and solving the myriad development challenges in the region.

The TPPA meanwhile, as mentioned in the background section is a high-standard free trade agreement between 12 countries with a market of 822 million people and a combined gross domestic product (GDP) of US$27.6 trillion (RM112.75 trillion). According to the study by PwC on the potential economic impact of TPPA (PwC, 2015), the agreement presents net economic benefits to Malaysia. Compared to our limited market size of 30.21 million people and US$300 billion (RM1.23 trillion) in GDP (Department of Statistics Malaysia, 2016a), the TPP provides Malaysia tremendous opportunities in the form of access to a huge market that makes up about 40% of the global economy (Bloomberg News, 2015). Apart from Singapore, Japan and the US who are already Malaysia's major trading partners, TPP allows Malaysia to access new international markets in Canada, Mexico and Peru, with whom we currently do not have any structured trade

framework or agreements (Business Circle, 2015). The Peterson Institute of Economics estimated that Malaysia stands to gain from the TPPA over US$41.7 billion (RM170.97 billion) in increased exports and US$26.3 billion (RM107.83 billion) in income gains by 2025 (Mitchell, T., 2015; Petri P.A. & Plummer M.G., 2012). The same report also found that Malaysia would be the top four largest recipients of inward foreign direct investments (FDI) as a result of TPP.

As a "high standard", "new generation" trade agreement, the TPP not only covers traditional barriers to trade in goods and services (e.g. tariffs, restrictions on the movement of professionals), investment, technical barriers to trade and other trade-related areas, it also covers new issues such as government procurement, intellectual property rights (IPR), environment, labour and state-owned enterprises (SOE). By confronting the new issues, the TPP sets a new standard for global trade and addresses new challenges in a way that promotes innovation, productivity and competitiveness.

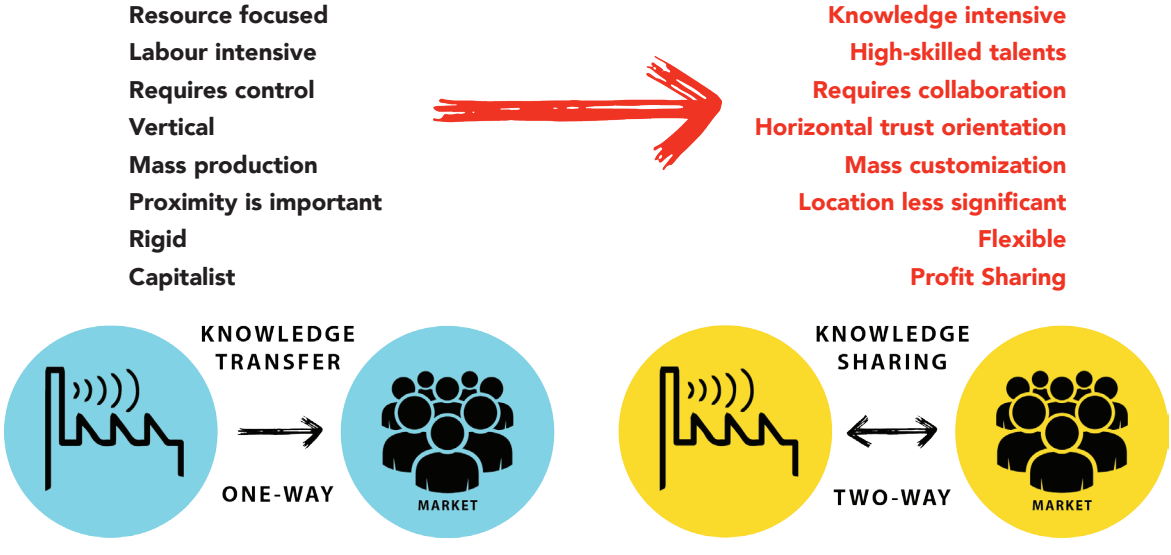
Although the benefits of TPP would not be uniform across all sectors, there are several key sectors that would benefit the most from this pact. PwC found that the sectors that stand to gain the most from this trade pact are textiles, electrical & electronics, automotive, plastics and wood. The Financial Times also reported that Malaysia is one of the four TPP countries to benefit most from signing the agreement, specifically on mechanical and electronic products (Mitchell, T., 2015). Even if TPPA does not materialise, it is a proxy for the inevitable trends of globalisation.

Trade partnerships such as TPP and AEC not only reduce tariff barriers. They provide immense opportunities as markets enlarge. Malaysia is able to enter new markets with barriers to entry in land, labour and capital tremendously reduced. But the true benefits of globalisation may be much greater than mere trade facilitation. With digital transformation, the benefits of trade and economic partnerships are magnified by the facilitation of knowledge exchange. Cross border collaboration initiatives can take place in R&D, commercialisation and innovation – all people-driven. Malaysia will be able to tap into the talents from throughout the region as movement of skilled workers is facilitated. It is far easier to build presence and branding in the new market by leveraging on digital and technology-based innovation. Knowledge and technology can be diffused far more easily.

There is huge potential to be tapped with a large segment of the economy in ASEAN and TPP countries still developing. Many member countries are still grappling with various development challenges. Environmental degradation, poverty eradication, traffic congestion and rapid urbanization are some of the challenges that should become the focus areas for innovation.

STI can be used to bridge the gaps in the basic infrastructure of a developing economy and subsequently leapfrog it to the level of the more developed member countries in an inclusive, scalable, affordable and sustainable way (Valencia, E.M., 2016). The underdeveloped areas present huge opportunities for Malaysian enterprises to innovate. In particular, social enterprises and start-ups should come up with creative solutions using STI and the networked economy to solve the region's many development challengesand profit from the ventures at the same time. Policies should then facilitate innovation by creating an ecosystem in a way that capitalizes on our membership in AEC, TPPA or any economic partnership agreements. The ecosystem should facilitate the creation of technology hubs and enable knowledge exchange through communication and transportation for a higher degree of innovative capacity.

Figure 2
Transformation from Traditional to New Economy



Competitiveness Factors in New Economic Opportunities

Malaysia needs to remain relevant and competitive in this era of globalisation and digital transformation. The following are key competitiveness factors that we must dominate in order to successfully seize the new economic opportunities:

1

KNOWLEDGE INTENSIVE

The most important competitiveness factor is being knowledge-driven. Inputs and outputs from the innovation ecosystem must largely be knowledge-based. The ecosystem shall be sustained by knowledge-based capital (intangible assets such as data, software, patents, designs, trademarks, brand equity, new organizational processes, and firm-specific skills) and knowledge workers to produce knowledge-intensive product or service with high economic value. S&T would be the core as it is omnipresent across all kinds of human activity, including economic sectors, social and cultural engagement, geo-political discourse and even spiritual matters. The mechanism must thus facilitate the development, movement and growth of knowledge-based inputs and outputs. This means encouraging idea generation and enabling smooth knowledge transfer and sharing of knowledge among the entities throughout the ecosystem. The ecosystem must support business investments in knowledge-based capital and create new markets for knowledge-based goods and services. The incentives, institutional arrangements and education and training systems must be aligned with the creation of a knowledge and innovation-based economy.

2

RIDES ON COLLABORATIVE NETWORKS

The second factor – collaborative networks – is a powerful force in the post-industrial economy. It isn't new as mankind has long practised collaboration throughout history. Within tribes, information and experience are shared for individual and collective survival. Tribes merged and cooperated despite widespread inter-tribal rivalry and warfare when mutual gains were possible through sharing of resources and opportunities. In the industrial era, partnerships took many forms such as consortia, cartels and more recently the lab approach.

At present, the information and communication technology (ICT) revolution has made the collaborative economy not only possible, but economically viable. ICT has given rise to the sharing economy, where engagement and collaboration are the core attributes of a mutually-supporting, value-creating system. Ultimately, the collaborative economy is a socio-economic system built upon resource sharing in supply and value chains that empower all participants in the quadruple helix through ICT-enabled network to produce high value-added goods and services.

The benefits of collaborative networks are multifaceted, as follows:

1

Breaking down traditional barriers to interactions

The collaborative network is key to removing the frictions due to time, space and cost. It enables the process of constant interaction between the stakeholders - current or future customers, suppliers, competitors, consultants and academic researchers. It create avenues to integrate knowledge from a number of different fields, to learn from each other through problem broadcasting (or open calls) and to share resources, assets, time and skills towards finding solutions for common problems. It enables multiple experts at various locations to collaborate and enables us to tap into our brains abroad – in other words reducing the cost of brain drain and even turning it into brain circulation. It is changing the way people work and calls for a complete transformation of how human capital is being managed. Open innovation has thus become a serious rival to the closed form that has been the norm until recent times.

2

Creating new markets for our innovation

Online platforms are revolutionising business, challenging traditional business models and breaking down hierarchies. They activate open marketplaces, creating new opportunities for our corporations, entrepreneurs and technopreneurs.

3

Enable development of new knowledge

In most cases, there are many possible ways of providing new functionality to users or applying new technologies. Whether the origin of the innovation is a market opportunity or a new technological capability, the network will enable an iterative and experimental search process. Smooth translation of ideas is possible, starting from conception, technology development, productization and through to distribution.

4

Facilitate movement and sharing of knowledge

The collaborative network is also a powerful way to support information exchange and transfer. The multidirectional information and knowledge flow would lead to the creation of more innovation and knowledge-based products and services. Sharing and openness are fundamental in the network – shared, ubiquitous and transparent data and knowledge base create informed players and customers in the network. Where possible and beneficial, virtual platforms will increase machine-to-machine and man-to-machine interaction, acting as complements to human-to-human interaction.

5

Enabling a non-conventional institutional arrangement that defies traditional hierarchies

An effective and supportive governance structure will support the collaborative network for innovation that is being proposed. Several foundations will create successful collaboration – distributed trust as opposed to centralised governing institutions; shared vision and goals that are laid down at the outset; and complementarystakeholders. Since most innovations are complex and each subsystem has its own limitations, an important part of the innovation process is finding the right balance between conflicting demands. The mechanism must operate under a smart partnership, working together with actors in other nations and regions through distributed dynamic networks, hubs and spokes that facilitate open sharing of knowledge and its application for innovation.

3

SPURS DISRUPTIVE INNOVATION

Innovation must be pursued strategically in order to create real value. In order to do this, firstly, innovation must be meeting market demand. In other words, it must be relevant with the times and aim at solving real world challenges, whether they are commercially or socially driven. Innovation should not be confused with invention or creativity. It is beyond ideas - they must be translated into something that are of value and relevant to society and market needs. It doesn't necessarily come from the inventors, neither is it a linear process. Instead, innovation is the result of an iterative process involving constant interaction between the innovators and the users of innovation that forms a positive feedback loop. Ideas must be diffused into the market – in other words, innovation is incomplete without commercialization, which will not succeed unless it as well as must incorporates the needs and the feedback from the market.

Secondly, nations must pay heed to spurring disruptive innovation – those with the potential to displace incumbents in existing markets, industries and technologies by offering a better value proposition to users and customers. Disruptive innovation is necessary for a small country such as Malaysia. We won't be able to compete head on with existing, bigger and long established players with deep pockets in the global market using conventional measures. To create value and new markets, Malaysian players need to attack underserved markets, particularly the developing ASEAN market where tremendous opportunities lie in providing innovative solutions to various development challenges. The mechanism in the New Economic Opportunities should facilitate the emergence of disruptive innovators to erode the dominant position of mainstream market actors, creating agile players who would be able to create or seize market share.

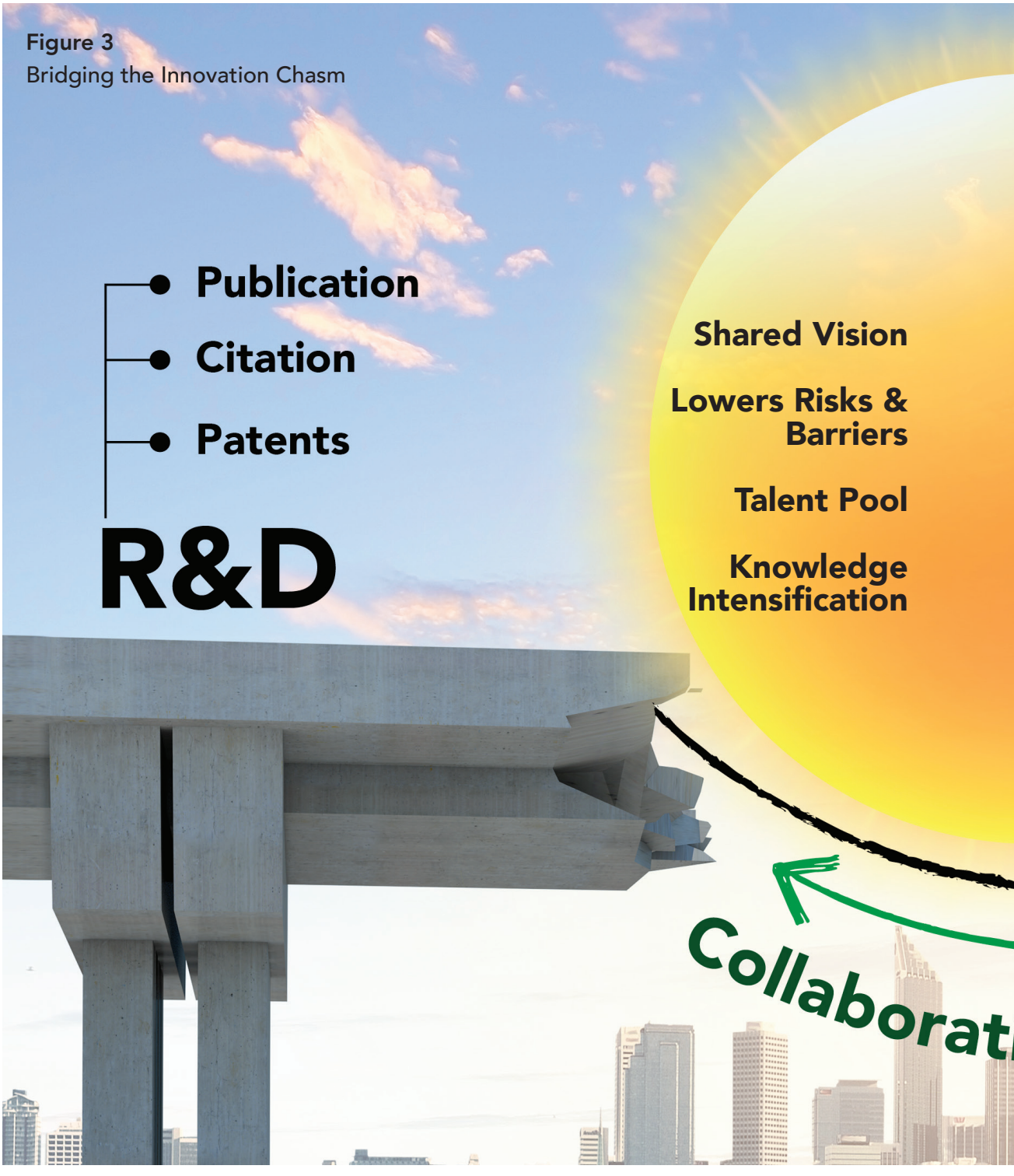
The Challenge for Malaysia - Crossing the Innovation Chasm

From the days of Malaysia Incorporated in the 90's to the formation of Strategy Paper 21 of the 11th Malaysia plan, we have been on the quest to become a high income country where the society is driven by knowledge and innovation. We realised that operating on a low-cost, low value added growth model is no longer sufficient nor sustainable to escape the middle income trap. With rising wages and increasingly scarce and costly resources, we knew that we would stand to lose our comparative advantage. We recognised that we need an innovative society and economy where ideas are constantly generated and realised to produce value.

Innovation is essential for Malaysia to foster sustainable economic growth and prosperity. There is considerable research that shows that investment in innovation

Innovation is essential for Malaysia to foster sustainable economic growth and prosperity. There is considerable research that shows that investment in innovation activities contributes significantly to economic growth for nations at all stages of their development. In fact, it is estimated that between 50 and 80 percent of economic growth comes from innovation and new knowledge (Mulgan, G., 2006). It allows countries and firms to remain agile, responsive and competitive to survive a volatile, uncertain and complex global economy. Innovation creates new products, services and technologies, generates new business models, unveils new markets, solves pressing development challenges and delivers greater economic efficiency – all of which lead to employment growth and an overall improvement in economic wellbeing for the whole of society.

Figure 3
Bridging the Innovation Chasm




Risk Averse
Secrecy
Exclusivity
Profit Oriented
Non-collaborative
Not homegrown technology
Business
Value Creation in Priority Areas
Innovation
Entrepreneurship
Meets Market Demand
ive Network

Science and technology plays a major role in this aspiration, being the backbone of innovation. Tremendous amounts of value added in the economy are rooted in scientific and technological progress such as in the field of engineering, new materials and particularly the ICT. All developed economies are able to enjoy their current position due to S&T as the basis of their innovation and knowledge driven industries. A high level of R&D is the cornerstone in these countries.

After decades of efforts and initiatives, Malaysia has yet to reach the level of an innovative society. This scenario impedes our aspiration to become a high income country, especially our new vision Transformasi Nasional (TN50) that aims for Malaysia to become one of the top 20 nations in the world. At the moment, we are 25th in the Global Competitiveness Index and 35th in the Global Innovation Index while the World Happiness Report ranked Malaysia at the 47th spot.

We have gravely insufficient number of local industry captains to champion underdeveloped niche sectors with tremendous potential. Malaysian firms generally have a low risk appetite and an unwillingness to adopt new technologies, particularly those that are locally driven. With an over reliance on Original Equipment Manufacturer (OEM) and limited product design, Malaysian firms are generally consumers instead of producers of technology. The country occupies a weak position on global supply chain and value chain, struggling to remain competitive as we face intense competition from countries with lower cost of production and operation. As a result of a general lack of innovation, our industries are largely unable to conceive innovative products that are unique and differentiated from the global competition, offering a better value proposition to the users and customers.

Our lack of knowledge-based human capital and skilled talents particularly in STI and a mismatch between talent supply and are huge impediments to Malaysia being an innovative nation. As has been discussed in various other reports, our country's enrolments in STEM education and the share of R&D as well as S&T workers in the workforce are low. Without skilled human capital, local firms are unable to undertake R&D and engage in innovative activities.

The lack of focus in local R&D activities is also a challenge. The R&D environment in Malaysia is deeply fragmented with little synergy with one another. Because R&D is costly, uncertain and often eludes the small and medium industries, there is a

real need to prioritise the focus areas and conduct joint R&D for collective benefit. Current R&D activities lack main drivers and are often not targeted. In addition, the scarcity of high-impact, joint R&D ventures result in low funding and expenditure in R&D and innovation.

Notwithstanding all the challenges hitherto mentioned, the study team found that the primary stumbling block to innovation is our failure to cross the innovation chasm (Figure 3), defined as the gap between two islands occupied by the business and research communities respectively. Innovation requires integration of knowledge and competences from a number of different fields: technology, market, design, economics etc. (Elg., L, 2014). Like different parts of an engine, each part must be well connected to each other and share a common goal in order to reach the desired destination. The relationship between the players on both sides of the chasm has to be symbiotic and complementary. The R&D community lack the business acumen, capacity and capability to deliver products and services effectively to the market, while the business community lack scientific and technical expertise.

Unfortunately in Malaysia, interaction between the R&D and the business communities is scarce if not totally absent. Industry-academia-research institution partnerships are very few and far between. The two islands work and operate in silo with little flow of information and knowledge exchange. Without intensive interaction and a concerted effort between local players (industries and academia), MNCs and stakeholders, knowledge sharing and transfer cannot take place. Interests are misaligned – businesses are reluctant to share information for fear of losing competitive advantage while the researchers are fixated on producing research for patents, citations and publications – a 'publish or perish' phenomenon. As a result, too often ground-breaking and high potential research and patents remain un-commercialized and shelved, leading to a sub-optimal level of value creation, missed opportunities and impeding a widespread adoption of locally developed technology. In addition, information from the market cannot flow into the research community and academia, leading to a huge amount of research conducted without taking into account market demand and thus has little commercial value.

The Mechanism – A Collaborative Network Driven by STI

Malaysia must capitalise on the new opportunities in the STI-based industries and shape its strategies based on the abovementioned competitiveness factors. In particular, this study recommends developing a knowledge-based, collaborative network for disruptive innovation. The cornerstone of the collaborative network is the bridging of the innovation chasm. Given below are the main features of the proposed collaborative network.

Main features of the collaborative network:

1.Value Creation

The collaborative ecosystem is to be developed for all sectors but focus will be on value creation in strategic priority areas. These areas possess high potential for new and thriving economic opportunities; i.e. smart manufacturing, e-Health delivery system, Islamic banking and finance and the halal industry.

2. Drivers and Enablers

The aim of the collaborative ecosystem is to bring together the drivers (industry players and researchers) and enablers (Government regulatory bodies, institutions of higher learning and civil society) of innovation. As such, the network will comprise a broad diversity of symbiotic actors (academia, regulatory bodies, trade associations, law consultants, consumers, prosumers, entrepreneurs including technopreneurs, NGOs, etc.)

3. Knowledge Clusters

There will be knowledge clusters to be developed within each industry. Each cluster provides avenue to gather corporates and researchers with different roles and responsibilities. The researchers will contribute in science and technology - the key stakeholders - enabling high-speed product development with the latest technology, robust test and trial and rapid prototyping to accelerate innovation process. Corporates on the other hand will provide both core and non-core values i.e. product and sales strategy, business requirement, funding, legal and regulatory advice and so on.

4. Knowledge-based, High Value Products and Services

As the collaborative network brings together players from R&D and the market, two mutually reinforcing activities take place. The R&D community brings value creation which is brought to the market as knowledge-based, high value products and services, while market intelligence from market players feed into the R&D community to render demand driven R&D.

5. Positive Feedback Loop

The key feature of the network is the creation of a positive feedback loop based on knowledge, in particular in S&T. There will be continuous improvement made possible by the constant flow of shared information from one stakeholder to another.

6. Talent Magnet

With extensive people-driven interactions taking place in the network Malaysia will become a knowledge hub that draws global talent including Malaysian talent abroad into our innovation ecosystem. From a talent pool the network will expand and develop into a talent magnet. Operating through an online platform breaks down spatial barriers and enables cross-border collaboration. As such the collaborative network will reduce the loss associated with brain drain.

7. Coexist with National Corridors

The ecosystem will coexist with the national corridors [Iskandar Malaysia, Northern Corridor Economic Region (NCER), East Coast Economic Region (ECER), Sabah Development Corridor (SDC) and Sarawak Corridor of Renewable Energy (SCORE)] established under the 9th Malaysia Plan.

8. Jointly Funded

The network will be a public-private partnership jointly funded by the government and industry players.

9. Shared Value Ecosystem

The collaborative network enables alignment of interests leading to the promotion of a shared value ecosystem where coalitions of players pursue efforts to solve common problems that in the end yield both financial and societal benefits.

10. Risk Sharing

Disruptive innovation carries higher risks, potentially higher rewards but players may be prohibited by the high costs. Collaboration enables risk sharing, thereby lowering the risks and barriers faced by each player and reduce reluctance to participate in innovative initiatives.

11. Trusted Neutral Party

The network will be administered by a trusted neutral entity in collaboration with the founding members. This entity will facilitate the founding members to the agenda and priority of the network. It will also initiate and coordinate the formation of the collaborative network. The key stakeholders as explained in point 3 above will work under the light-handed guidance and facilitation of this entity.

12. Intellectual Property Rights

Terms and conditions such as the responsibility matrix (i.e. the roles and responsibilities of specific actors in a project), product ownership, revenue-and-cost sharing as well as intellectual property rights (IPR) shall be ironed out and pre-negotiated through consensus by the actors in the network.

The above features of this collaborative network is emulated and expanded based on the understanding of the CREST model (refer Box 1 for further details) that has been shown to be successful in bridging the innovation chasm in the electrical and electronic (E&E) sector in Malaysia. Other existing intermediaries in the Malaysian innovation ecosystem were also studied as part of this exercise (refer Box 2 for further details).

BOX 1

CREST – A Model to Emulate and Expand

The Collaborative Research in Engineering, Science & Technology (CREST) was incorporated in June 2011 and officially operational in June 2012 as an industry-led, public-private initiative to stimulate R&D and innovation in the electrical and electronics (E&E) industry. It was founded by ten leading E&E companies, several universities and Khazanah Nasional Berhad.

The idea came about through the realization that industry needed real-world solutions while universities were involved in blue-sky research. The industry-led demand-driven R&D gave rise to the collaboration between industry & academia. The captains of the industry presented to the Economic Council, chaired by the Prime Minister their proposal where the Government endorsed the formation of CREST, with an endowment of RM100m for starting up R&D collaboration over 10 years.

A catalyst for the growth of Malaysia's E&E industry, CREST brings the key stakeholders (i.e., the industry, academia, and the government) in collaborative R&D, talent development, and commercialization. It is a neutral, trusted entity that also provides research grant that funds research projects with market growth potential either in universities or industry. Since its establishment, its focus has expanded from E&E to other sectors where Malaysia has comparative advantage.

CREST consists of a number of cluster programmes with higher-value-chain governance at the regional and international levels. 65% of CREST is funded by the industry while the remaining by the government, with companies required to cover at least half of the project research costs. It acts as a trusted neutral entity engaging with industry founders to set the agenda and priorities. Through CREST, stakeholders make open calls for research where intellectual property rights are pre-negotiated and CREST has the right of first refusal.

CREST is a model to emulate because it focuses on high technology sectors with the greatest potential for innovation. It has been successful in facilitating industry to gain access to key technologies and foster strategic cooperation with external research centres of excellence. By doing so it has been instrumental in assisting the industry to move-up the value chain and produce higher value-added products. In addition it has also enabled academics to see their basic discoveries applied in practice and developed a talent pool of scientists and engineers.

Despite its successes, its scope is limited to the R&D process from ideation, research, technology development and product development without venturing into business delivery process (branding, sales, marketing and after sales service). Nonetheless, the business model can bring greater impact if operated on a much larger scale involving more sectors, local firms and research institutions. The model can be applied in bigger ways to help firms and research institutions find ways of benefitting each other and spur more industry-led, demand driven research for a thriving innovation ecosystem.

Activities in the network

1 The players in the platform operate in a coopetition mode – they collaborate and compete in parallel. Individual corporations within the industry operating as members of an ecosystems instead of rivals, collaborating by combining industry expertise to reshape markets and achieve common goals.

2 It is a network of consenting, actively participating actors with founding members coming from the industry. STI-based entrepreneurs will be invited to participate. Here, the network effect is crucial – reaching a sufficient number of players or critical mass for the network to create a significant impact.

3 The network will enable actors to source research funding – a common barrier for researchers to go further. Crowdsourcing and crowdfunding can all come into play through this network.

4 Through this network, any actor can make open calls to crowdsource solutions to a specific problem. The solution will entail among others research and development for scientific, technological and business innovation.

5 A key process in the network is the development of a positive feedback loop between businesses and researchers to build a thriving community of innovators, each aware of its role in the ecosystem as explained above. Interaction will happen throughout the innovation cycle.

6 Businesses will find collaboration with agile start-ups and high-tech researchers beneficial as it not only reduces cycle time but also increases innovation originality with fresh ideas to meet their customers' needs. In return, they will provide inputs on markets needs for researchers and academicians to produce innovations that are relevant for the market. In addition, the clearer purpose of an innovation shall be a great motivation for researchers to innovate better.

7 Corporates will also provide valuable inputs in the form of commercial strategy and service design in order to best meet customer expectation.

8 Being technology driven and explorative, researchers shall continuously refine the product or service requirement based on fast-and-frequent tests. The requirement is not only confined to technology. Through rapid prototyping, the business model would also be tested for robustness. This process shall be iterative. Where applicable, the functions and features shall be then modular to make the product always-on-beta mode - perpetually on testing stage for continuous improvement to meet customer expectation.

9 Once the product reaches the stage where the output is good for deployment, corporates shall work on the product commercialization i.e. market offering with predefined sales strategy, cost control and customer management.

10 Every interaction in the network particularly data from marketing, sales and after sales service will have digital footprints and will feed into the system as big data. The network will institutionalise a framework to carry out big data analytics and market watch i.e. predictive modelling to forecast market trends and user needs. Interactions between actors through the collaborative network and market watch will provide information to build and share business intelligence on new economic opportunities and fuel new digital ecosystems.

11 In a transparent system, the successful shall provide lessons for others to emulate, thus establishing the "rules" for success and modifying behaviour of actors. Credibility i.e. performance and seriousness is rated through self-governing mechanism that will drive out bad behaviour.

Expected function of the network

The Collaborative Innovation Network operates hypothetically in seven steps.

The Concept | The innovation process could start from either top-down based on potential strategic areas i.e. smart manufacturing, e-Health delivery system, Islamic banking and the halal industry or, based on bottom up approach which is usually demand and technology driven proposed by the players in the platform.

Either way, at the concept stage, the initiator shall float a high-level business case or a concept paper that shows the goals and objectives of the proposal. Calling for partners, interested researchers and corporates could either subscribe or be invited to join the project based on respective reputation and credibility. An instant strategic partnership shall then be created at this stage among the interested parties (the team).

Define | Once the team is established, the viability of the business case as well as the business requirement specification (BRS) shall be refined with greater detail and consensus. BRS usually consists of high-level processes, plus and functions and features required to support the idea.

For both technical and commercial objectives, corporates and researchers shall table the high-level solution options with pros and cons. Having options is important as it promotes creativity and originality among players. Over the platform, the team shall assess and agree on the best option to define the solution.

Design | On top of the BRS, the solution has to be elaborated with technical and product requirement i.e. the how. At this stage, to keep the initiative relevant, the team could continuously refine the business requirement based on actual market needs as well as technology changes. Big Data Analytics would be one of the important tools to feed necessary changes on the design. Technical or non-corporate team shall present the high- and low-level design including the test plan to build the solution.

Build, Test and Fix | With the agreed solution design, the technical team will then build the solution and run tests accordingly. The outcome of the tests would be used to refine the solution.

At this stage, rapid prototyping will be highly useful. Even with low-fidelity, it shall give a better sense on the look and feel of the design, function and features. Rapid prototyping will facilitate the team

to have an iterative process between design, build, test and fix. Not only the innovation process shall be faster, getting consensus will also be made easier.

Deploy, Launch and Review | Once the product is fit to be commercialized, the corporate team shall execute the go-to-market plan. This includes distribution, sales and customer management. The corporate team will share the feedback from the market to the innovation team for further refinement.

Outputs of the network

1.
The network aims to cross the innovation chasm in a sustained way over time by creating knowledge-intensive products, services and business models to disrupt the market, enabling industry to seize market share.

2.
The network will empower collaboration for discovery of new ideas, risk sharing and risk reduction, increasing speed to market, leveraging on resources and talent and facilitating the matching between supply and demand of goods and services between peers.

3.
The network will ease bottlenecks that prevent new technologies from being commercialized.

4.
The knowledge-intensive market analysis (big data, etc.) will provide business intelligence for industry to pin-point emergent market opportunities so that they can make the next round of open calls to the S&T community.

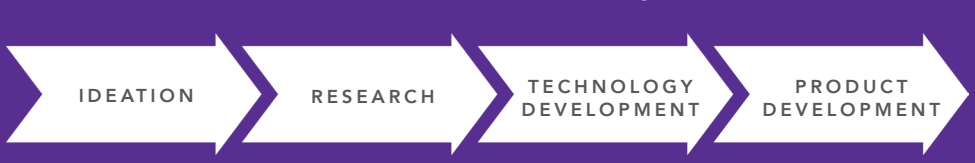
5.
S&T actors are able to engage in demand-driven R&D with the necessary enablers - funding, plus industry expertise and infrastructure.

6.
The network must facilitate digital transformation of Malaysian firms and include sustainability development of talent, shared infrastructure and facilities and strong branding to access wider markets (in ASEAN, TPP countries, etc.).

BOX 2

Strategic Partnership Models

The Government under the country's 10th Malaysia Plan established intermediaries for a continuous R&D and innovation process.



Each of the following entities established plays an active role in the move towards demand-driven R&D:

Public-Private Research Network (PPRN)

The Public-Private Research Network (PPRN) is an entity of the Ministry of Higher Education (MOHE) in collaboration with MTDC and SME Corp., which aims to connect researchers in universities with industries (SMEs) to conduct contract research. The objective is to help SMEs to raise productivity and technological readiness, and subsequently to develop appropriate solutions by teaming with academics with expertise.

The initiative caters to SMEs in all economic sectors and offers matching grants up to RM 30,000 to co-finance the developmental cost of innovation and commercialisation, together with SMEs.

SIRIM-Fraunhofer Partnership

Fraunhofer Gesellschaft (Fraunhofer), Europe's largest application-oriented research organisation, entered into a two-year strategic alliance with the Standards and Industrial Research Institute of Malaysia (SIRIM) in 2014. This partnership is a strategic collaboration which focuses on technology uptake through joint research and technical services to boost productivity of SMEs.

The government offers grants up to 80% while the industries are expected to contribute around 50% to co-finance this initiative. Soft loans are also available. This initiative focuses on SMEs in the manufacturing sector.

Steinbeis Malaysia Foundation

The Steinbeis Malaysia Foundation (Steinbeis), established under the purview of Agensi Inovasi Malaysia (AIM) and modelled after Germany's Steinbeis model aims to bridge academia and industry to promote effective and efficient cooperation in knowledge and technology transfer. Steinbeis provides an innovative platform for collaboration for business solutions and focuses on development of end products.

The cost of services is borne by the clients and the revenue generated help Steinbies to remain self-sustainable. It also offers financial assistance like matching innovation grants for technical and non-technical research by industry players.

PlatCOM Ventures

PlaTCOM Ventures Sdn. Bhd. (PlaTCOM) established as the national technology commercialisation platform is a smart partnership between AIM and SME Corp. This platform provides end-to-end facilitation services from concept to commercialization of innovation in all economic sectors and offers a matching grant up to RM 100,000 (by both the government and industries).

CREST

The Collaborative Research in Engineering, Science & Technology (CREST) is established as a neutral entity in 2011 to solve industry related problems through industry-academia collaboration.
(refer Box 1 for further details).

Research Management Agency (RMA)

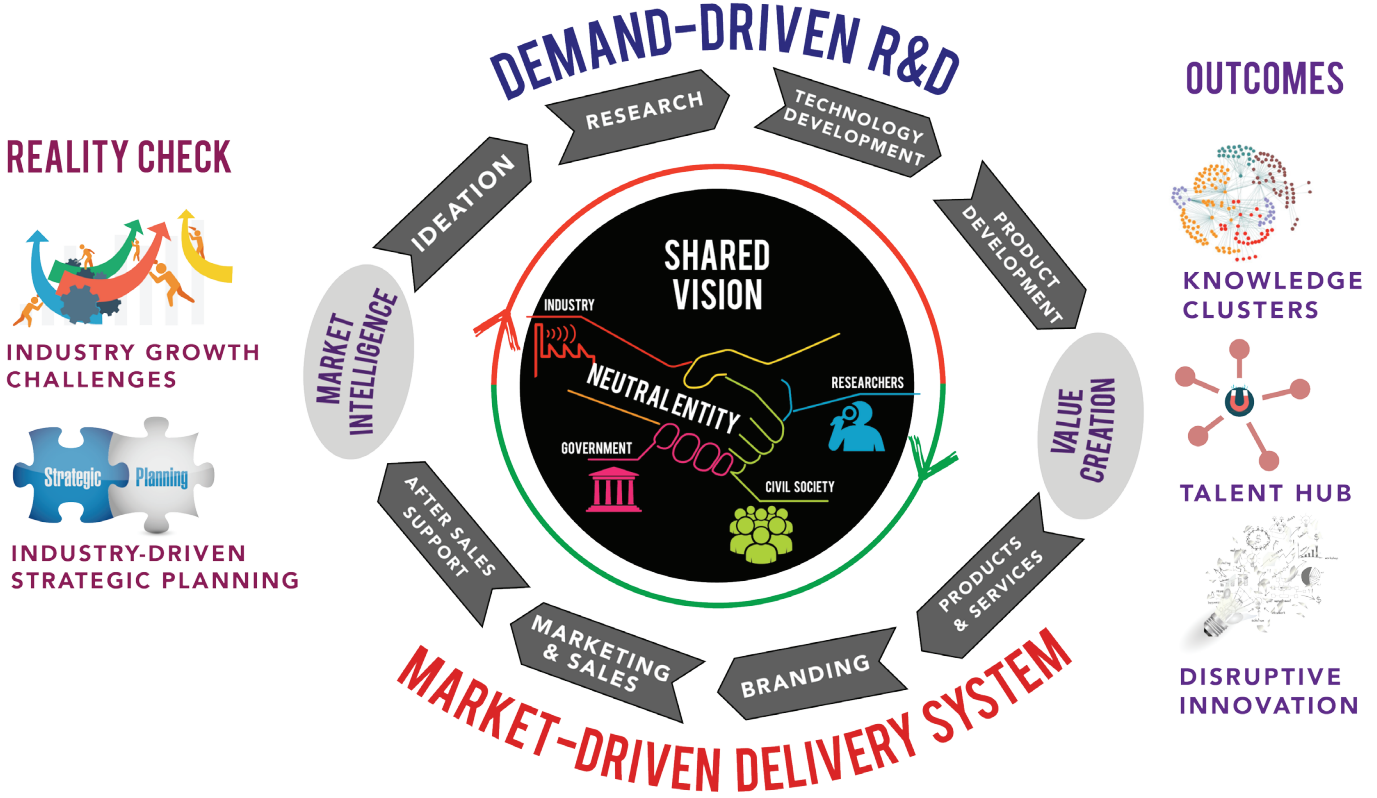
The Research Management Agency (RMA) is one of the four strategies discussed in the Strategy Paper 21 to strengthen the government mechanism to further enhance innovation at the enterprise level.

RMA is expected to function as a dedicated operational agency to drive more demand-driven, collaborative and efficient public R&D&C&I management by consolidating R&D&C&I programmes, building and leveraging on strong network of subject matter experts, and act as the centralized point of contact on matters and grants concerning R&D&C&I.
(Content reproduced from the embargoed report, EPU-PWC, 2016)

Source: EPU, 2015; MITI, 2016b

The proposed mechanism is expected to look beyond the demand-driven R&D to the entire value chain which includes the market-driven delivery system of value created products and services. The market intelligence will complete the positive feedback loop of this value chain. The network will be self-sustaining through organic knowledge clusters and act as a magnet for talent, thus and giving rise to disruptive innovation that enables agile actors to replace non-competitive industry and market incumbent (Figure 4).

Figure 4
The Collaborative Network



Targeted Industry Sectors

Throughout the series of discussions and workshops that the study team has held with various stakeholders, there was a consensus that the opportunities to be gained from being part of TPP and AEC lies in the STI-based industries within Malaysia's core sectors – manufacturing and services. Both sectors play a major part in Malaysia's economy; manufacturing and services constitute 23% and 53.5% of the country's GDP respectively. The stakeholders also proposed that particular attention be given to certain sectors with much untapped potential and can benefit immensely from STI, namely the halal sector and pharmaceuticals and medical and health services in the health and wellness sector.

MANUFACTURING & ANCILLARY SERVICES

Manufacturing has a long and dominant history in the Malaysian economy. From a humble beginning in the 1960's industrialization era, it is now one of the largest economic sector, accounting for RM263bn and contributing around 23% to Malaysia's real GDP (Department of Statistics Malaysia, 2016b) . Nonetheless there is a strong need for our manufacturing sector to evolve in order to remain competitive. Globally, this sector is seeing phenomenal change in the form of the fourth industrial revolution. Emerging technology breakthroughs such as in artificial intelligence, robotics, the Internet of Things (IoT), autonomous vehicles, 3D printing, nanotechnology, biotechnology, materials science, energy storage and quantum computing are driving the manufacturing sector.

The innovation eco-system for the manufacturing sector should facilitate actors in product development, productisation, testing, fine-tuning and large scale roll-out. All of these are to be conducted with minimum amount of human input and intervention, relying instead on "smart" ways of using information and knowledge enabled by intelligent ICT systems.

The E&E and Chemical subsectors are major contributors in the manufacturing subsector. Along with machinery and equipment, these 3 subsectors are the catalytic subsectors identified under the 11th Malaysia plan. Medical devices and aerospace are two other priority growth areas. These subsectors and priority areas are important including in the context of this report, because there is huge room for further value adding and innovation in these industries. The transformation envisaged in all of these subsectors will focus on automation by adopting smart manufacturing, riding on virtual platforms to increase efficiency and high value add through mass customization.

Identified Sectors	
Industry 4.0 Disruptive technologies across all subsectors. Industry 4.0 could increase profit margins and lower costs, potentially creating $25 billion to $45 billion of annual economic impact in ASEAN by 2030 (Tonby, O., et al., 2014).	**Supply Chain & Logistics** New opportunities in the manufacturing sector will depend on an efficient and effective means of fulfilling e-commerce transactions in physical space. ICT enabled supply chains and logistics that are regionally and globally connected will need to be established with Malaysia as a key hub (refer Box 3 for further reading).

BOX 3

Opportunities for the supply chain, logistics and transportation sector in the AEC

Being one of the 12 priority integration sectors, ASEAN's commitment to logistics and transport infrastructure development is being manifested through frameworks such as the ASEAN Single Aviation Market (ASAM) and the ASEAN Single Shipping Market (ASSM). In addition, the AEC Blueprint 2025 also spells out the commitment to establish an integrated, efficient and globally competitive logistics and multimodal transportation system within and beyond ASEAN by operationalising the ASEAN Framework Agreement on the Facilitation of Goods in Transit (AFAFGIT), the ASEAN Framework Agreement on the Facilitation of Inter-State Transport (AFAFIST), and the ASEAN Framework Agreement on Multimodal Transport (AFAMT) .

The ability of Malaysian firms to maximize on these efforts hinges on its ability to embrace "logistics 4.0", i.e. digitalizing and making use of technology such as IoT solutions and robotics to transform our logistics sector. During our engagements with the stakeholders it has been acknowledged that the country owns the best-in-class ports. Nonetheless, there are tremendous opportunities that can be exploited in other segments along the logistics value chain. Transformation of the logistics sector through the applications of technologies such as intelligent transport systems, smart warehousing, swarm intelligence and smart factories, among others, would create further competitive advantage for Malaysian players. In addition to complementing the manufacturing sector in making Malaysia a more attractive investment location, leveraging on smart logistics will enable Malaysian firms to break into other markets and become a regional logistics champion.

Source: ASEAN Secretariat, 2015

Strengths

- Well established industries and expertise in certain niche areas which gives the first-mover advantage.
- A strong role played by various government agencies including as intermediaries between industry and academia and as promoters of local innovation.
- A reliable infrastructure, well-equipped facilities and an ecosystem with strong upstream linkages.
- A successful export performance
- Standards are in place for most products

Leveraging on strengths

- Review and re-evaluate our priority sectors, scrutinizing the sub-sectors where our strengths lie and the type of STI applications needed to offer consumers with unique value proposition.
- Improve the value chain by promoting a widespread adoption of Industry 4.0
- Support the establishment of non-government intermediaries to serve the needs of specific industries
- Re-prioritise exports by focusing on higher value-add products

Lags and gaps

- Cost to export remains high due to the need to undergo multiple testing and certification process to suit the different country requirements. The same could also result in slow product gestation.
- Slow adoption of latest technologies and innovations. The speed of adoption often depends on company size and types of products. Innovation is generally high in large firms and MNCs but low among SMEs.
- Enforcement of IPR regulations is low and affects the ability to build a strong brand
- High dependency on foreign workers, low productivity rate
- A weak end-to-end supply chain ecosystem
- Cost of production is high in Malaysia in comparison to China, India and Vietnam. High efficiency and quality of goods from Vietnam despite the lower production price

Closing the gaps

- Coordinate G2G efforts to harmonise requirements across countries
- Provide support for SMEs to accelerate adoption of the latest technologies
- Encourage the movement from labour-intensive to knowledge based manufacturing

- Provide incentives to increase choice of technologies with higher employment intensity
- Capitalise on TPP (FDI & linkages).
- Build acceptance of Malaysia's product in market by archiving boasting best in quality

Opportunities

- Large consumer-base (AEC & TPP Countries) as well as new trading partners (FTA) (Canada, US, Mexico & Peru)
- Mobility of professionals and high skilled workers within ASEAN and TPP countries to be tapped into to increase productivity
- Opportunity to establish the identity of made-in-Malaysia products
- Servitisation* as a new business model in manufacturing and outsourcing of ancillary services such as design services, supply chain & logistics and R&D

*Servitisation refers to manufacturers offering services closely related to their products, instead of the traditional way of merely selling them. Maintenance contracts and bundled services are examples of servitisation.

Exploiting opportunities

- Leverage on the large consumer base with specific focus on the expanding middle class and the underserved bottom end of the market.
- Regional arrangements to facilitate cross border movement of skilled workers (including grey-collar** workers) and establish mutual recognition of skills and certifications.
- Programs to re-branding Made in Malaysia as well as intellectual property rights are the way forward
- Build regional COE and develop industry captain in ancillary services

** Grey-collar workers are the new knowledge workers in the shop floor who program, operate, troubleshoot, and maintain the increasing number of computer- and network-driven manufacturing devices (Asian Development Bank, 2014)

SERVICES

The services sector contributed 53.8% of Malaysia's real GDP in 2015 (Department of Statistics Malaysia, 2016b) and will continue to be the primary driver of economic growth in the 11th Malaysia Plan (MP). Both the 11 MP and Services Sector Blueprint place great emphasis on knowledge intensive and innovation-led services industries.

With a huge proportion of the population in ASEAN and TPP remain unbanked, uncarded and unconnected (Chaia, A. et al., 2009) , there are plenty of growth opportunities in this sector. In 2014, the World Bank estimated that 73 to 80 percent of the people in Indonesia, the Philippines, and Vietnam have no banking relationships. Even in Malaysia and Thailand where the financial markets are relatively more developed, the figure stood at about 30 percent (The World Bank, 2014).

The transformation envisaged for the services sector shall focus on financial-technology (fintech), where tremendous innovations across the globe are taking place. Fintech describes the delivery of financial services through technology which can be applied to the whole range of financial services, including financial literacy and education, retail banking, investment, crypto-currencies (such as bitcoin) and even in Islamic Banking. Malaysia can position itself as a leader in certain areas by encouraging the development of fintech in the untapped market segments.

Identified Sectors		
Financial services	**High value added services**	**ICT services**
Emerging trends from commoditisation of financial services, changing consumer demands, distributed ledger or blockchain technology and fintechs, among others, are changing the global and domestic financial landscape. Embracing these trends and 'disruptions' will enable Malaysia to seize the opportunities in the region.	Malaysia have the potential to be the regional hub in various high value added industries such as human resources / talent capital, shared service center and education.	The ICT sector does not only stand on its own but also forms the foundation of almost all other sectors and industries today. The unprecedented growth at which this sector is progressing opens up tremendous opportunities, such as in cybersecurity, big data analytics, and IoT that provide immense opportunities to transform other sectors. Connected consumers (including wearables, connected homes, and home automation) represent the largest IoT opportunities in Malaysia.

Strengths

- A relatively advanced ICT services industry, backed by good ICT-related policies and government initiatives.
- Strong public-private partnerships and quality investments focusing on high end technologies in ICT.
- A diverse, multi-cultural and multilingual workforce

Leveraging on strengths

- Develop knowledge hubs in ICT services and other high value added services such as contact centres and shared services

Lags and gaps

- Low uptake of ICT platforms despite the availability due to poor mentality and the reluctance to change

- Archaic or obsolete policies and regulations which have yet to embrace the digital economy and poor implementation.
- Inferior internet penetration, speed, latency, and affordability compared to neighbouring countries
- Immigration Laws preventing smooth movement of resources and skilled labour

Closing the gaps

- Intensify the promotion of platforms developed by organisations such as MIMOS and IAP Integrated Sdn. Bhd. (refer Box 4 for further details).
- Public-private partnerships to increase access, speed, affordability and quality of broadband services especially in the rural and suburban areas
- Develop industry captains who are actively innovating
- Intensify programmes for SMEs to encourage innovation and adoption of technologies
- Review regulatory framework to embrace and support digitalisation and innovation
- Expedite intergovernmental arrangements to facilitate movements of skilled workers

Opportunities

- Free flow of cheaper and talented human capital in the near future resulted from AEC and TPPA
- Professional services sectors are ready to be competitive in the global market
- A regional hub for all sectors as Malaysia has the talent, infrastructure and strong leadership vision from the top
- A regional hub and leader in distributed ledger and blockchain technologies in ASEAN due to a strong acceptance and understanding among relevant stakeholders

Exploiting opportunities

- Tap into underserved areas in ASEAN such as focusing on solving development challenges where huge opportunities can be seized using innovation
- Enhance benefits for expatriates and skilled knowledge workers
- Develop regulatory framework to support the development of Fintech such as distributed ledger and blockchain technologies (refer Box 5 for further details).
- Develop human capital in knowledge based services and encourage technopreneurship especially in higher education institutions

BOX 4

Investment Account Platform

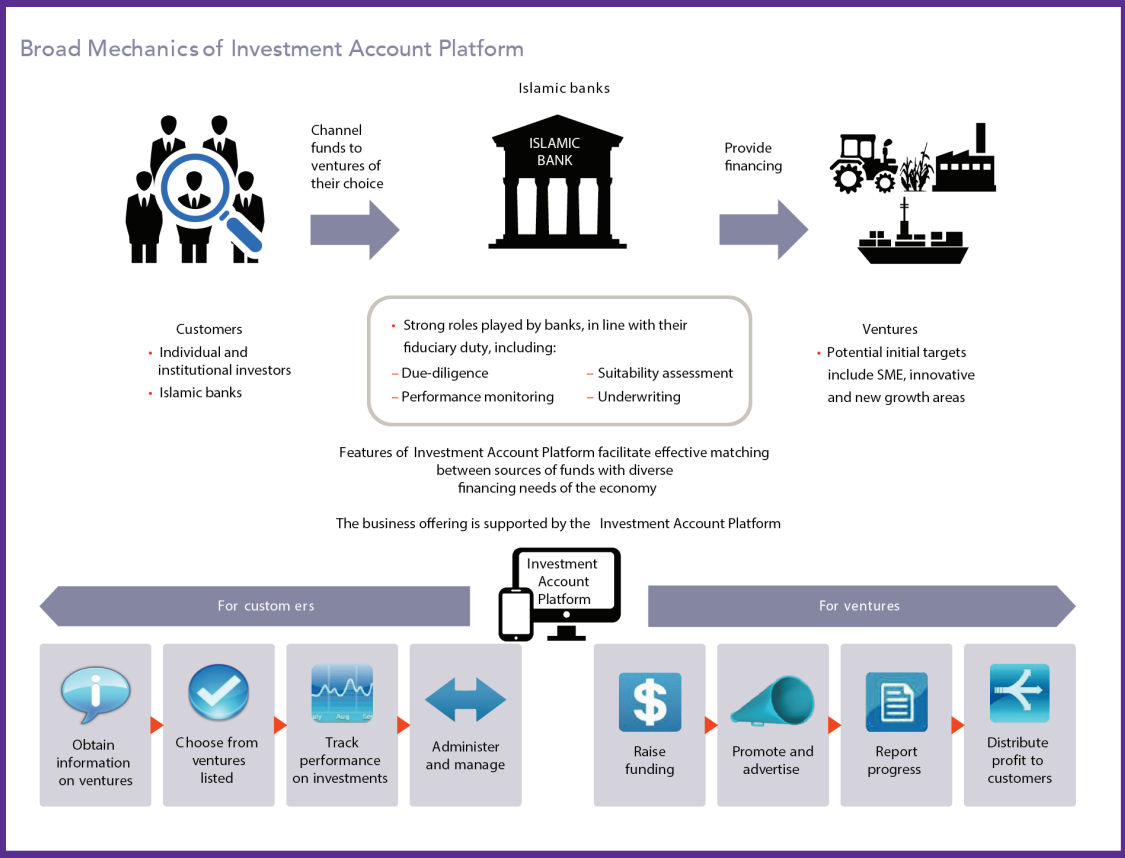
A key strategy to achieve critical mass and provide the widest possible overage of prospective investment ventures and sponsoring institutions is to leverage on shared infrastructure for the delivery of investment account offerings. This would significantly reduce initial investment costs that would otherwise be incurred by individual Islamic banks, while laying the groundwork for further efficiency gains to be reaped in future.

The Investment Account Platform (IAP), which will be developed by the industry, will serve as a centralised multi-bank platform that will allow customers to view and choose from a wide range of ventures sponsored by different Islamic banks for the customers to invest and track their investments. The platform, which will operate on a secured infrastructure similar to internet and mobile banking, will have the following innovative features:

- **Wide choice of viable ventures** – The ventures listed on the platform will be subject to prior assessment and screening for viability by the sponsoring Islamic bank. All ventures listed will be Shariah-compliant.
- **Control over the quality and coverage of important information for decision-making** – Each venture listed will be accompanied by important information provided to customers which must comply with minimum disclosure standards covering the description of the venture, the terms of financing (such as the tenure and profit-sharing ratio), the estimated profit rate and the risk level of the venture as categorised by the sponsoring bank.
- **Ease of transactions** – Customers will be able to specify their preferences in relation to the types of ventures which they wish to invest in, based on factors such as the underlying industry, geographical location, risk level and tenure of financing. Customers can also filter investment ventures based on their selection of the sponsoring Islamic banks.

The Investment Account Platform will be administered by an entity established by the Islamic banking players. The entity will be responsible to coordinate and manage the listing of investment ventures and sponsoring Islamic banks on the platform. Individual sponsoring Islamic banks that leverage on the platform will retain all fiduciary responsibilities to investment account holders in connection with the ventures financed through investment accounts that are offered under the platform. Diagram in the next page illustrates the broad mechanics of the Investment Account Platform.

The platform will be integrated with the existing payment infrastructure and the I.T. systems of the Islamic banks to facilitate the transfer of funds from customers at the inception of the financing and the payment of principal and any profit generated at the end of the financing period. An important distinguishing feature of the platform compared with other platforms, such as crowdsourced funding, is the involvement of banks as a financial intermediary in the transactions.



The platform is envisaged to expand opportunities for consumers to participate on a risk-sharing basis, with greater confidence in financing entrepreneurship and other economic activities. Over a longer duration, the success of the platform could entail inclusion of multi-currency financing for ventures outside Malaysia. The effective implementation of investment accounts, supported by the Investment Account Platform, represents another strategic initiative to propel Islamic finance in supporting real economic activity. This is achieved through the wider expansion of innovative financing structures with a central role played by Islamic banks.

Source: Bank Negara Malaysia, 2015.

BOX 5

Financial Technology Regulatory Sandbox Framework

Bank Negara Malaysia (the Bank) issued details of (Financial Technology) Regulatory Sandbox Framework (the Framework) following a one month consultation on the proposed Framework which was released on 29 July 2016. The regulatory sandbox will enable the experimentation of fintech solution in a live environment, subject to appropriate safeguards and regulatory requirements.

Over 60 comments and suggestions were received from various stakeholders including financial institutions, fintech companies, associations and other corporates. Following the comments and suggestions received, the Bank has expanded the eligibility criteria to clarify the focus of innovations that the sandbox aims to support. Innovations should have clear potential to:

improve the accessibility, efficiency, security and quality of financial services; enhance the efficiency and effectiveness of Malaysian financial institutions' management of risks; or address gaps in or open up new opportunities for financing or investments in the Malaysian economy.

The minimum standards and requirements for participation in the sandbox were also reviewed to encourage wider participation of fintech companies. Applicants to the sandbox should be able to demonstrate that a product, service or solution has been developed to a functional stage and is ready for testing. The applicant must also have a good understanding of risks during testing, with adequate resources committed to effectively manage the risks.

The Bank will inform applicants of their eligibility to participate in the sandbox within 15 working days of receiving a complete application. This will be followed by preparatory engagements between the Bank and the applicant prior to testing.

Mr Aznan Abdul Aziz, Chairman of Financial Technology Enabler Group said, "The Framework reflects the Bank's long standing policy in striking an optimal balance between promoting innovation whilst preserving financial stability and protecting consumer interest. Based on the level of queries and feedback received during the consultation period, the Bank is encouraged and looks forward to receiving applications to test new ideas and deploy new solutions under the sandbox".

The finalisation of the Framework aims to provide an environment that is conducive for the deployment of financial technology to foster innovations in financial services that can contribute to the growth and development of Malaysia's financial sector.

The introduction of the Sandbox is another key initiative by the Bank in providing a conducive regulatory environment for the adoption of innovative financial technology solutions, following the establishment of Financial Technology Enabler Group (FTEG) on 2 June 2016.

The Framework will take effect immediately and is now open for application.

Source: Bank Negara Malaysia, 2016

HALAL

Halal is a market with tremendous opportunity. There are approximately 1.5 billion halal consumers at the global level where a huge unmet demand remains. With the increasing awareness among the Muslim and non-Muslim population alike, the market is expected to reach 2.2 billion people by 2030. Globally, the halal industry is estimated to be worth RM8.3 trillion.

Malaysia is perceived as one of the leaders in the global halal marketplace, largely thanks to the country's proper halal ecosystem that is equipped with comprehensive and proactive policies and development frameworks. The Halal industry is a significant contributor to the economy, accounting for 7.5% of the GDP. As of 2016, there are 1,401 Malaysian companies exporting RM205.1 billion worth of halal products (Halal Industry Development Corporation, 2016). Nonetheless, other countries in the region including countries without a majority Muslim population are also seizing the opportunity in this market.

The Halal industry is not confined to meat or food. The Halal market has widely expanded to include services, namely finance and banking, insurance, education and training, research, certification, consultancy, logistics and healthcare, as well as travel and tours. For the innovation ecosystem, the identified sectors are Pharmaceuticals / Cosmeceuticals / Nutraceuticals and Islamic finance. In addition, the transformation for halal sector will focus on ICT-based delivery systems and developing a Halal supply chain. The ICT-based Delivery system will include sensor based approach to track the entire halalan toyibban process and value chain from raw material delivery to the shelfing of product. Aiming at the halal logistic chain will increase the supply of halal as a premium product.

Strengths

- A strong leadership in Islamic Finance
- First mover advantage in halal standards with a long established national halal logo
- Strong number of Halal Knowledge Personnel (9,000 certified personnel as of 2016 (Halal Industry Development Corporation, 2016)
- Strong regulatory framework with thought leadership, institutional support and infrastructure
- Wide society acceptance to ideas on halal matters
- Establishment of HDC to focus on developing and globalising the Halal Industry (refer Box 6 for further details)
- World-class certification bodies such as NPRA and JAKIM
- The presence of a Malaysia Halal Council to unite matters pertaining to Halal Industry
- Excellent facilities for R&D in halal materials and resources

Leveraging on strengths

- Strengthen the national halal branding including expanding the reach abroad
- Make use of social media and connectivity to expand its reach
- Promoting Malaysia's thought leadership in the region by leading the harmonization of standards
- Establishing a Special Task Force or an Advisory Committee on Halal Pharmaceuticals under the Malaysia Halal Council to champion halal pharmaceuticals, nutraceuticals, medical devices and cosmeceuticals
- Offer R&D services in halal to other countries
- Promote innovation and use of technology such as biotechnology and alternative ingredients to boost value-add
- Develop human capital with understanding of both shariah and science to become halal R&D experts and advisors in the formulation of fatwa

Lags and gaps

- End-to-end regulatory requirement/ legislation not in place
- Incomprehensiveness of Islamic Finance products i.e. Takaful, Insurance
- No standardised definition of Halal confusion around the concept of halalan toyyiban (i.e. what the process entails and the distinction between halal and toyyiban)
- Lack of halal information through our education delivery channels
- Halal requirements that slows down go-to-market e.g the ingredient disclosure requirements that reduce competitive advantage)
- Voluntary nature of being halal certified leading to a lack acceptance from the industries and low level of buy in including among government

agencies and bodies
- Halal logistics that are not cost competitive, resulting in higher prices
- A weak or absent global agenda by strong halal agencies such as JAKIM

Closing the gaps

- To form an accreditation body to certify shariah compliance that expands to non-food or pharma companies
- Built in halal approach within good manufacturing practice, focusing on producing products from halal based sources and methods instead of merely DNA tracing
- Awareness building among all players and stakeholders
- Develop and nurture the concept of concordance and informed choice in our medical establishments where patients and customers will be given the choice and information on halal products besides conventional medical products

Opportunities

- ASEAN makes the single largest Muslim population
- Syariah compliance of blockchain has yet to be developed or determined
- Halal concept has been discussed and integrated in AEC (note: AEC Blueprint 2025 discusses on halal products and food; no mention on halal finance)
- Limited halal cargo and use of traceability technologies (delivery tracking)
- Increasing demand for green freight – halal freight can leverage on this
- Malaysia has the ability and expertise to come up with a halal Pharmacopeia. Indonesia also possesses a halal Pharmacopeia and to note, they are one of five OIC countries that have halal pharmacopeia. Indonesia and Middle East (especially Dubai) are already shifting their efforts to halal industry

Exploiting opportunities

- Leverage on Partnership in Muslim Associations in targeted countries
- Develop a halal blockchain as a niche
- Establish strategic partnerships such as JAKIM together with the National Pharmaceutical Regulatory Agency (NPRA), or partnership with ASEAN countries who are already making headways in halal sector (eg. Indonesia, Thailand, Brunei, and even Japan)
- Seek buy-in from international players to support halal logistics
- Further enhance and develop The Halal Index initiative (the first book in this series, Pig Based Pharmaceuticals, contains over 50 pharmaceutical compounds that can be derived or obtained from porcine sources)

BOX 6

Halal Industry Development Corporation

Halal Industry Development Corporation (HDC) was established in 2006 with the specific objective of acting as Malaysia's one-stop centre for the coordination of the halal industry. HDC is the dedicated Government agency for all halal related industry-related matters and spearheads the development of the strategic halal initiatives which are outlined in the Halal Industry Master Plan 2008-2020 (HIMP) and ensures that the halal industry develops progressively in an integrated and comprehensive manner. As the halal concept cuts across many diverse industries, government agencies and sensitivities that are specific to each global market, HDC is tasked with coordinating the efforts of all the other agencies and complementing them. It facilitates economic growth for the nation by helping business access new markets both locally and globally.

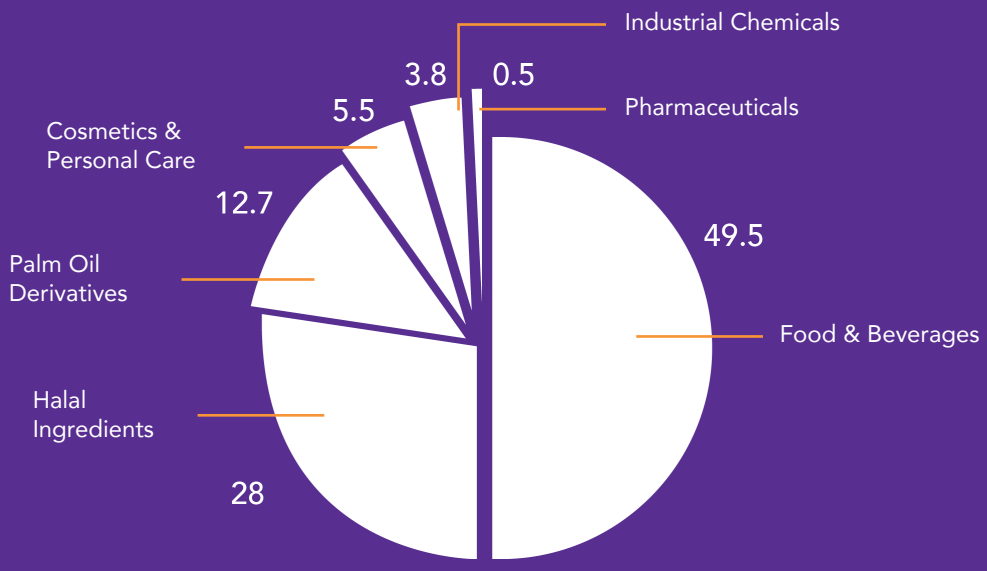
The emergence of halal of the halal industry and its increasing global importance is unnoticeable and since 1996, Malaysia has given unswerving support to the national halal agenda in recognition of its huge economic potential. Although the halal sector is not specifically named as one of Malaysia's National Key Economic Areas (NKEAs) or highlighted in the SME Master Plan 2010-2020, the sector has been integrated into all of Malaysia's major long-term economic policy initiatives. Halal has featured in the Ninth Malaysia Plan (MP) 2006-2010, the New Economic Model of 2010 (NEM), the Economic Transformation Programme (ETP), the 10MP 2011-2015 and the 11MP 2016-2020. In the 2013 Budget, the Government set aside RM200 million for the development of the halal industry.

HDC operates under the guidance of the HIMP. The HIMP is a comprehensive blueprint that runs until 2020 to drive halal as a new source of economic growth. The HIMP frames guidelines to introduce high value-add into halal production, services and trade with a view to creating an industry with a high gross domestic product (GDP) value. The successful implementation of strategies describes in the HIMP will result in Malaysia establishing itself as a Global Reference Centre for halal integrity and knowledge and position Malaysia as a global leader in innovation, production and trade of a number of halal-related sectors. The HIMP formulates five strategic thrusts to accelerate growth in the halal industry:

Thrust 1 : Promote Industry Consolidation
Thrust 2 : Elevate Industry Standards
Thrust 3 : Increase Innovation Capabilities
Thrust 4 : Strengthening Connection to Global Network
Thrust 5 : Strengthening Brands

From 2010, Malaysia's halal exports have recorded average annual growth of RM6.6 billion or 18%. In 2014, exports increased by almost 15% or RM5 billion over 2013, reaching a value of almost RM38 billion and accounting for almost 5% of Malaysia's total trade. By 2020, Malaysia is targeting a halal export industry valued at around RM100 billion.

Halal Exports by Product Category in 2015 (%)



In 2015, total halal export value stood at RM39.41 billion and accounting for 5.05% of Malaysia's export trade. As of 2015, halal industry contributed about 7.5% of Malaysia's GDP, around 250 000 new jobs was created, over 800 halal-certified companies going global, and there are 5226 halal-certified companies in Malaysia. Top export market in 2015 for halal products was China, followed by Singapore, the United States, Indonesia, Japan and Thailand.

The main challenge in halal industry is halal is often confined to food. Halal goes way beyond food as it encompass diverse industries such as ingredients, cosmetics, pharmaceuticals, healthcare services, finance, logistic, tourism, etc. Halal is a value proposition that exists within key elements of the supply chain of the intersecting industry sectors. There are various potential areas for research, technology and innovation towards developing an integrated halal supply chain. The challenge for Malaysia now is to develop a more robust and efficient global supply chain benefitting the Muslim world.

Source: Halal Industry Development Corporation, 2016.

HEALTH & WELLNESS

ASEAN member countries contributed 4% of total revenue earned by the global health travel sector in 2010. With excellent medical facilities, Malaysia is well positioned to be a leading health and wellness destination in ASEAN. For instance, Prince Court Medical Centre has been awarded first place in the 'MTQUA 2013 World's Best Hospitals for Medical Tourists' and Penang is listed in the 'Top 10 Medical Tourism Destinations' in a recent WHO Medical Tourism Report.

Malaysia is a strong competitor to its neighbours Singapore and Thailand in the medical industry especially in health tourism. But competition is increasingly stiff. Other countries are catching up, for example China has the volume to offer healthcare at cheaper price while Indonesia prides its service-oriented culture.

The transformation for health & wellness will focus on e-Health delivery system (refer Box 7 for further details), where the infrastructure at present is far more accommodating than two decades ago when telemedicine was first introduced in this country. It is envisaged that the e-Health Delivery System will boost health tourism, where health and wellness services can be provided online with a trusted network of experts for first and follow-up consultations and treatments.

Strengths

- Low cost healthcare
- Supporting industries to healthcare are available (e.g. Nursing Care Facilities, Skilled Nursing Facilities, General Medical and Surgical Public and Private Hospitals etc.)
- Quality & regulatory frameworks are at par with developed countries although there are lags in implementation
- We are rich in resources particularly in biodiversity

Lags and gaps

- Not focusing on niche areas, e.g. Thailand is known for sexual-orientation switch surgical procedures, Singapore is a choice for second-opinion for patients with life-threatening diseases (we spread ourselves too thinly)
- Regulatory/law/legislative lag
- Different systems between public and private hospitals for medical healthcare
- High barriers to entry
- Immaturity of local technologies and products to reach bigger markets

Opportunities

- Technology/health parks (focusing on Big Data platforms for patient information system management, digital healthcare services, wearables etc.)
- There is capacity to manufacture Malaysia's own medical devices
- No player in AEC in the age-care industry (so far only western countries such as Germany), therefore to focus on ageing-city/ retirement village for expatriate community in Malaysia
- Penetration into regional market
- Increase R&D investment and activity (refer Box 8 for further details)
- Exploitation of local resources
- Integration of supply chain management

BOX 7

Health and Wellness – e-Health Delivery System

Digital transformations and emerging technologies has created many new care options in the healthcare industry, including e-health delivery system through portals, remote consultations, electronic personal health records and wearable devices to deliver on-demand non-emergency medical treatments to patients. E-healthcare delivery system is best described as combination of clinical care and professional collaboration through telemedicine, telehealth and collaboration at-a-distance to connect clinicians, patients, care teams and health professionals to provide health services, support patient self-management and coordinate care across the care continuum (Accenture, 2015).

New approaches to develop people centric, data driven technology solutions will transform the traditional healthcare industry espe-cially more so now with the growing number of chronically ill and aging patient population. The virtual health delivery system is deemed to balance the demand/capacity equation faced by the Healthcare Industry by streamlining work and redirecting clinician time to high-value tasks enabling more clinical care work to get done without expanding the workforce through technology and automation.

The Deputy Director of Telehealth, Ministry of Health (MOH), Dr Fazilah Shaik Allaudin in an interview with the GovInsider (Redtone, 2015) said that some of the new initiatives in Malaysia is to give citizens access to their health data online and share vital statistics from wearable devices with their healthcare providers (home monitoring). The MOH realizes that the current system is fragmented and hospitals will have to start exchanging more information. The integrated healthcare services will become a nationwide practice in 5 to 10 years, with the final aim being public and private sector integration. The first step towards this ambitious plan is by harnessing the power of technology. Enabling factors such as information sharing policy and interoperability plays an important role.

Taking into account the serious move by MOH to revamp the Healthcare Delivery System and the fact that the healthcare expenditure in Malaysia is expected to double to US$25 billion (RM100.25 billion) in 2020 from US$12 billion in 2013 [Tan, S.M., 2016] is enough a reason for Malaysian to embrace the e-Healthcare Delivery System. The e-Healthcare market has the growth potential and the opportunity to reduce cost in the long run with healthier patients.

Past Initiatives in Malaysia

1) Telemedicine Act (1997) (LAWS OF MALAYSIA: Act 564)

Outlines who is certified to practice telemedicine in Malaysia:

(1) No person other than—
(a) a fully registered medical practitioner holding a valid practising certificate; or
(b) a medical practitioner who is registered or licensed outside Malaysia and—
(i) holds a certificate to practise telemedicine issued by the Council; and
(ii) practises telemedicine from outside Malaysia through a fully registered medical practitioner

holding a valid practicing certificate, may practise telemedicine.

However this has never been enforced in Malaysia.

2) MOH's Telemedicine Blueprint (25 July 1997)

The blueprint provided the conceptual model and implementation road map for the roll-out of telemedicine across the nation. This was mooted under the MSC flagship initiatives which included four high impact projects:

2.1) Teleconsultation – came into operation in 2000 and involves 43 health facilities with four disciplines: neurosurgery, cardiology, dermatology and radiology. After more than 10 years of implementation, this technology is almost obsolete and in the midst of next generation TC.

2.2) Lifetime Health Plan a personalized, proactive and prospective LHP to achieve a continuum of care focusing on wellness and illness. However this project had many obstacles and terminated. It was revived in late 2000 and called Malaysian Health Information Exchange (MyHIX). An online sharing system of patient's healthcare records including patient history diagnosis, lab tests, prescription, and discharge summaries; till September 2016, this system has been successfully deployed at 8 healthcare facilities.

2.3) Other projects include Mass Customised/Personalised health Information and Education and Continuing Medical Education. These are ongoing projects.

The entire telehealth plans for the country will be revamped in-line with the latest development in healthcare globally.

4) NKEA's Teleradiology – pilot stage of the Diagnostic Services Nexus (DSN) launched in May 2013 involving four hospitals (Hospital Kuala Lumpur, Hospital Selayang, Hospital Tengku Ampuan Rahimah and Hospital Sultanah Aminah) to reduce waiting times for radiologist diagnostic services by coordinating and distributing the workload using a teleradiology system that connects public and private hospitals. However, this project did not scale up.

The Telemedicine Blueprint and these initiatives had many implementation challenges and currently being addressed and reviewed.

Current Initiatives: CREST's Integrated Health Cluster

Phase 2 of the CREST initiative involves Market-Driven Cluster-Focused: The Internet of Things (IoT) in four other sector besides Manufacturing namely, Smart Cities, Retail, Automotive transportation and Connected Healthcare.

CREST's Connected Healthcare – This initiative is in line with the 11th Malaysia Plan's second thrust: improving well-being for all as well as the MOH's Healthcare Transformation Plan's 5th strategic pillar: ICT transformation for health through public-private/inter-agency collaboration where CREST plans to develop solution for mobile healthcare and mobile emergency services to enable faster services to all communities. CREST is the National Lead Agency for this initiative and within its Connected Healthcare Cluster it includes medical practitioners besides the industry leaders and academic partners. MIMOS's National IoT Strategic Roadmap also identified healthcare as one of the key focus clusters to grow the economy.

This Connected Healthcare application framework will be aligned with MOH's needs and in true CREST's fashion will be industry driven. The framework will include virtual rehabilitation, elderly care, communicable and non-communicable diseases as well as wellness where sensors such as ECG patches and algorithms will be develop for analytics from patient healthcare record database. There are also plans for producing certified medical devices compliant to the Medical Device Authority (MDA) Act 737. The clinical trials will be conducted in partnership with the MOH's hospitals, clinics and Clinical Research Centres (CRC) as well as Clinical Research Malaysia (CRM) and the Sunway Hospital.

With this initiative in place, the new healthcare paradigm will empower the healthcare practitioners, support staff as well as patients at large for it will give raise to better decision making, efficient and faster diagnosis and less wastage. The doctors will be more connected and with more time at hand the probability of having strong knowledge clusters among the young and the experts are higher.

Telemedicine Development Group (TDG)

This is a collaborative platform between stakeholders which consists of policy makers, academia, industry and regulators. It is a strategic innovation among stakeholders to facilitate telemedicine innovations, clinical trials and R&D. This group also plays a big role in promoting awareness and knowledge dissemination in telemedicine in Malaysia. TDG hopes to become the new ecosystem that redefines healthcare.

Challenges

Bandwidth and connectivity will remain one of the biggest hindrances towards achieving the e-Healthcare Delivery System. Once that is in place, the next challenge would be getting the society to adapt to the reformed delivery system and a financing scheme that supports this. More tech-savvy consumers will be appreciated. The trust on the validity of diagnosis and treatment plan will need convincing. And most certainly, the rules and regulations will also have to be reformed.

Benefits

- Virtual monitoring would provide daily updates to manage chronic conditions at home without the need for a clinician. This will enhance the ability to identify new trends and improve overall diagnosis.
  - Documenting vital signs and symptoms from the home without the intervention of a clinician empowers the patient to better identify with their health conditions, translating into higher patient satisfaction.
- Unnecessary hospitalizations, re-admissions and/or emergency room visits will be minimized.
- High probability of patients adhering to the prescribed care plan.
- Especially beneficial to the elderly and post-hospital patient care as it improves ability and confidence to stay independent and in the home for recuperation; also indirectly lowers risk of hospital-related infections i.e. MRSA.
- Extended service to patients who live in rural or remote areas.
- Less hospital errors with integrated patient records.
- Lesser administration issues e.g. lack of beds at hospitals and long waiting time. There will likely be lesser patients at the Emergency Department

with those with less threatening conditions will have immediate access of doctors during off- or non-regular office hours.

e-Healthcare Delivery System, Successful Cases

Hospital Sultanah Aminah Johor Bahru, Malaysia (Hassan et al., 2014) - Teleneurosurgery is the use of communication technologies to transfer medical information related to neurosurgery. It was introduced gradually in government hospitals throughout Malaysia in 2006. By 2012, there were five centres with neurosurgical services operating on this system.

This study reported that teleneurosurgery resulted in reduction of patient number that need to be reviewed in the level III hospitals (tertiary healthcare centres with additional sub-specialties) and an increment in the number of patients that are kept in level II hospitals (tertiary healthcare centres with basic specialties) for observation by the primary team. This impact of such transformation in the medical practice translates to reduction of unnecessary transfer of patients and subsequently cost benefits for patients and medical providers.

Apollo Hospitals Group, India (Solomon, J., 2004) - Apollo's emergence as a global health-care provider in many ways tracks India's economic trajectory over the past three decades. The company has capitalized on the high cost of health-care administration in the U.S. and demands of patients elsewhere, for fast, inexpensive treatment. Hundreds of Apollo's data processors work late-night shifts providing billing services and processing insurance claims for U.S. hospitals and insurers. Apollo even remotely evaluates X-rays and CAT scans. The Apollo laboratories also perform clinical trials for Western drug companies, such as Pfizer Inc. and Eli Lilly & Co.

Brigham and Women's Hospital (BWH), Massachusetts (Licurse, A., 2016) - The virtual care strategy began in 2015 with video-based visits for outpatients with chronic diseases (inflammatory bowel disease, diabetes during pregnancy, mood disorders, hypertension, ischemic heart disease, prostate disease, and airway disorders) requiring frequent follow-up visits and infrequent physical exams, but had difficulty coming into the office. The pilot study had been successful with approximately 600 visits conducted virtually to date, freeing up about 200 hours for participating providers to see other patients.

BOX 8

Clinical Research Malaysia (CRM)

Clinical Research Malaysia (CRM) was established by the Ministry of Health in June 2012 under the country's Economic Transformation Program. Through the inception of CRM, the government aims to promote Malaysia as the hub for industry sponsored research (ISR) and to increase the number of clinical trials to 1000 new and ongoing trials by the year 2020. A Gross National Income (GNI) of 578.4 million is projected to be contributed by these trials.

CRM offers complementary feasibility studies/requests to sponsors or contract research organizations (CROs). The feasibility studies are evaluated by CRM's in-house Feasibility Specialists and the feasibility is disseminated to a large pool of potential investigators. CRM also advices investigators and sponsors/CROs on the clinical trial budget while maintaining full transparency while managing the trial budget. Investigators and sponsors/CROs may also engage CRM's experienced legal team to review and advise on Clinical Trial Agreements (CTAs) and Non-Disclosure Agreements (NDAs).

On a national front, CRM recruits and trains qualified Study Coordinators (SCs) who will be placed at trial sites throughout Malaysia to assist investigators in clinical trials. CRM acts as a one-stop centre for the pharmaceutical, biotechnology and medical device industry with regards to clinical trials and assists them in resolving issues faced with government agencies and regulators.

CRM has developed five key strategies to put in place a comprehensive, enabling and supportive ecosystem that meets the needs of industry players and the medical fraternity. The five strategies are, grow the pool of investigators and sites; attract new ISR to Malaysia; collaborate with stakeholders; create awareness of CRM; and develop human capital.

Within 2010 and 2015, Malaysia has seen a steady increase in the number of ISR from 143 trials to 201 trials. In 2016, there was also more than a 100% growth in CROs and three times more sponsors compared to 2014, a testament of the confidence of foreign investors in Malaysia's capability in conducting ISR.

The GNI created by clinical trials in 2016 totaled over RM 196 million, an addition of RM 71 million from 2015. In its infancy in 2012, CRM had 22 study coordinators that were placed at various sites conducting ISR and this number grew to 93 study coordinators as of September 2016. In 2016, 1491 jobs were created in the clinical research industry in Malaysia, a growth from 1118 jobs in the previous year.

Sources:
- Clinical Research Malaysia (CRM), 2017
- Ooi, A.J.A. and Khalid, K.F., 2017

Way Forward

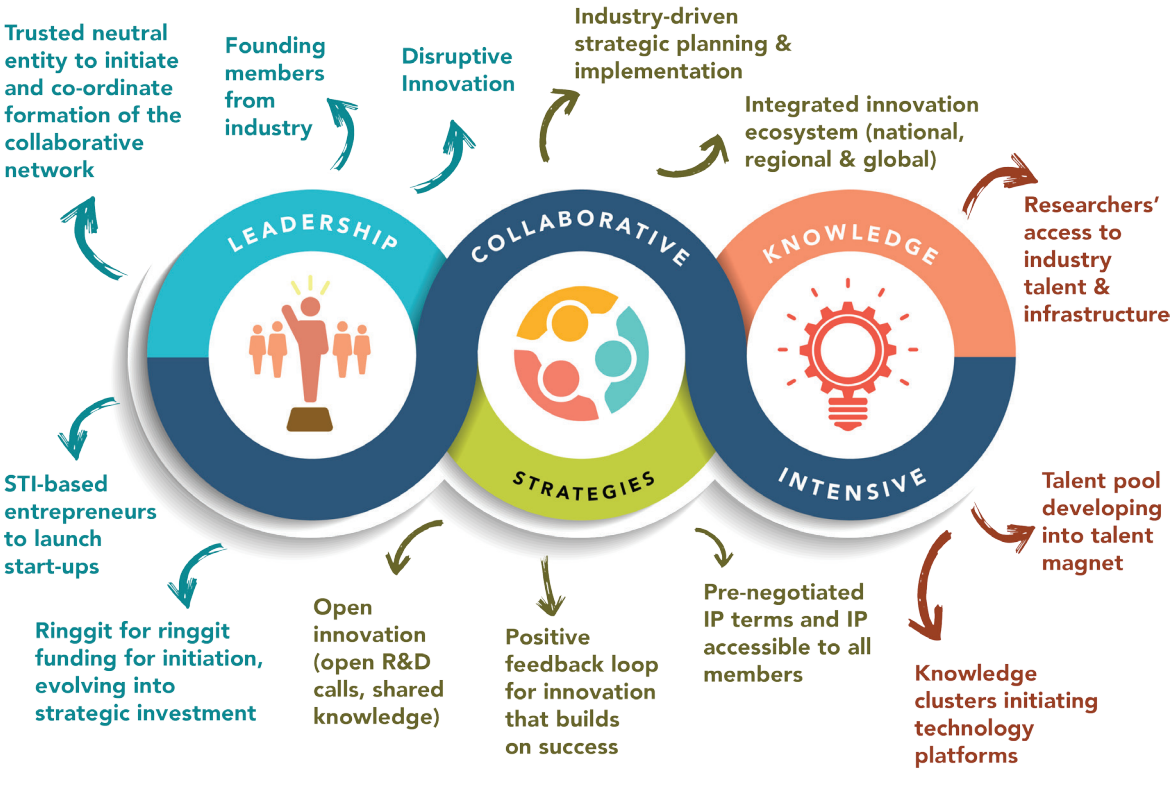
For a very long time we recognised that we need to become an innovative society and economy. We acknowledged that the innovation chasm is a major impediment to this aspiration. A number of initiatives to close the innovation chasm has seen limited success as effective extensive interaction didn't take place.

Establishing a collaborative network for disruptive innovation is a paradigm shift that will enable Malaysia to effectively realise demand-driven R&D and offer an enhanced value proposition to customers based on data-driven market intelligence. This network will enable Malaysian industries to incorporate rich STI-based knowledge content into their products and services, make Malaysia a knowledge hub, and draw global talent into our innovation ecosystem.

This hub must in turn have exceptional capacity to turn creative ideas rapidly into useful innovations. As the collaborative network brings together players from R&D and the market, two mutually reinforcing activities take place. The R&D community brings value creation which is brought to the market as knowledge-based, high value products and services, while market intelligence from market players feed into the R&D community to render R&D demand driven.

The key feature of the network is the creation of a positive feedback loop based on knowledge, in particular in S&T. There will be continuous improvement made possible by the constant flow of shared information from one stakeholder to another. The key success factors for the collaborative network are; leadership, collaborative strategies and knowledge intensiveness, as shown in Figure 5.

Figure 5
Characterictics of a Neutral Entity



The role of the trusted neutral entity (Figure 6) is crucial in connecting the drivers (industry players and researchers) with enablers (government, ministries and agencies, institution of higher learning and, civil society) towards realising the shared vision for the industry.

Figure 6

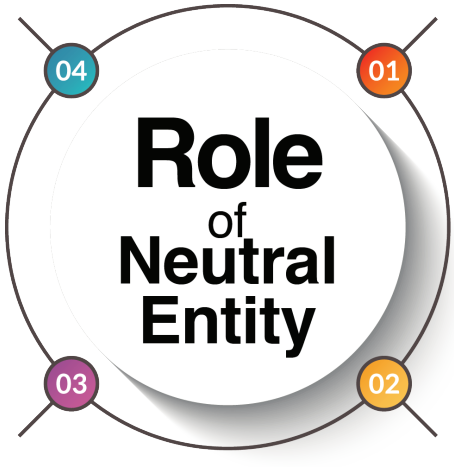
Proposed Role of A Neutral Entity

SHARE KNOWLEDGE

- Stimulate utilisation of value creation from knowledge clusters to move industry forward
- Facilitate joint product development, marketing, sales and after sales support
- Facilitate joint market intelligence

ENGAGE PARTNERS

- Source for founding members from industry
- Engage founding members for reality check to grow, value add and extend market reach of the industry
- Engage research community to participate in demand-driven R&D



CO-FUNDING

- Establish a common fund for R&D among collaborative network partners
- Matching fund between industry and government

DRIVE SHARED VISION AND OUTCOMES

- Formulate shared vision and strategic plan for action by the industry
- Translate strategic plan into open calls for R&D
- Pre-negotiate IP terms
- Co-ordinate selection of research project for funding and execution
- Monitor and evaluate the R&D projects and deliverables

Recommendations & Conclusion

The two key recommendations of this report are as follows:

RECOMMENDATION 1

Adopting the collaborative network mechanism for potential focus areas (Industry 4.0, Fintech in Islamic Finance, Virtual Health Delivery System, Halal Supply Chain) to enable Malaysian industries to become more S&T-based and innovative using homegrown technologies (endogenous), to be coordinated by MOSTI through ASM under the purview of the National Innovation Council (NIC); and

RECOMMENDATION 2

Empowering a trusted neutral entity for each identified industry with the appropriate mandate, resources, and manpower to coordinate the collaborative network for demand-driven R&D and market-driven delivery system.

Malaysia's primary challenge in innovation is to bridge the chasm between industry players and the research and development (R&D) community. Bridging the innovation chasm is essential for Malaysian companies to bring knowledge-based, high-value products and services to the market. Hence, the establishment of collaborative networks is imperative in our journey to enhance Malaysia's innovation capacity in transforming its industries to become more STI-based and innovative, thereby enhancing their future competitiveness and sustainability.

Key words

blockchain a transaction network that potentially can be used by financial institutions and consumers to transact directly with substantial speed, security, transparency, convenience and cost.

business model innovation process to create competitive advantages with unique concept of value creation

collaborative network a network consisting of a variety of entities (e.g. organizations and people) that are largely autonomous, geographically distributed, and heterogeneous in terms of their operating environment, culture, social capital and goals, but that collaborate to better achieve common or compatible goals

crowdsourcing an act of taking job traditionally performed by a designated agent and outsourcing it to an undefined, generally large group of people in the form of an open call
crowdfunding a type of crowdsourcing that involves the crowd raising money required to finance a project or business

digital transformation application of digital technologies to fundamentally impact all aspects of business and society

disruptive innovation a process by which a product or service takes root initially in simple applications at the bottom of a market and then relentlessly moves up market, eventually displacing established competitors

fintech businesses that aims at providing financial services by making use of software and modern technology

global supply chain network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services

global value chain full range of activities undertaken to bring a product or service from its conception to its end use and how these activities are distributed over geographic space and across international borders

innovation chasm refers to the inability of academic research to reach the market as products and services

knowledge clusters a group that, as a result of coming together, create, innovate and disseminate new knowledge

mass customisation process of delivering wide-market goods and services that are modified to satisfy a specific customer need; a marketing and manufacturing technique that combines the flexibility and personalization of custom-made products with the low unit costs associated with mass production
mass productization process of creating large quantities of standardized products efficiently, frequently utilizing assembly line technology to achieve high volume

open call creation of something of economic value based on new jointly generated ideas that emerge from the sharing of information & knowledge

sharing economy type of business built on the sharing of resources, i.e. allowing customers to access goods when needed

References

Accenture, 2015. Virtual Health: The Untapped Opportunity to Get the Most out of Healthcare.

AEC, 2016. ASEAN Economic Community, <http://asean.org/asean-economic-community/>. Accessed on September 2016.

ASEAN Secretariat 2015. ASEAN Economic Community Blueprint 2025. Jakarta.

Asian Development Bank, 2014. Innovative Asia: Advancing the Knowledge-based Economy – The Next Policy Agenda. Cornell University ILR School

Bank Negara Malaysia, 2015. Financial Stability and Payment Systems Report 2014: Development of the Financial Sector.

Bank Negara Malaysia, 2016. Financial Technology Regulatory Sandbox Framework. Press Release, Bank Negara Malaysia
18 Oct 2016.

Bloomberg News, 2015. TPP Trade Deal: Who Stands to Gain, Suffer in Asia-Pacific, <http://www.bloomberg.com/news/articles/2015-10-06/tpp-trade-deal-who-stands-to-benefit-suffer-in-asia-pacific>. Accessed October 2016.

Business Circle, 2015. The Trans-Pacific Partnership (TPP) agreement: Perspectives and a closer look, <http://www.businesscircle.com.my/author/businesscircle/>. Accessed on March 2016.

Chaia, A. et al., 2009. Half the World is Unbanked. Financial Access Initiative Framing Note. McKinsey & Company

Clinical Research Malaysia (CRM), 2017

Department of Statistics Malaysia, 2016a. Malaysia. < https://www.statistics.gov.my/index.php?r=column/cone&menu_id=dDM2enNvM09oTGtQemZPVzRTWENmZz09>. Accessed March 2016.

Department of Statistics Malaysia, 2016b. National Accounts: Gross Domestic Product 2015.
Elg, L., 2014. Innovations and new technology - what is the role of research? Implications for public policy. VINNOVA Analysis. Swedish Governmental Agency for Innovation Systems.

EPU, 2015. Strategy Paper 21: Translating Innovation to Wealth. EPU, <http://rmk11.epu.gov.my/index.php/en/kertas-strategi>. Accesssed on December 2016.

Halal Industry Development Corporation, 2016. Malaysia Halal Industry Report 2015.

Hassan et al., 2014. The Implementation of Teleneurosurgery in the Management of Referrals to a Neurosurgical Department in Hospital Sultanah Amninah Johor Bahru. The Malaysian Journal of Medical Sciences. Vol. 21(2): 54–62.

iMoney, 2016. Is The Trans-Pacific Partnership Agreement (TPPA) Good For Malaysia? <https://www.imoney.my/articles/is-the-trans-pacific-partnership-tpp-good-for-malaysia>.Accessed on September 2016.

Licurse, A., 2016. One Hospital's Experiments in Virtual Health Care. Harvard Business Review, December 09, 2016, <https://www.wsj.com/articles/SB108293099927892916>. Accessed on February 2017.

MATRADE, 2016. Malaysia's Trade with ASEAN, <http://www.matrade.gov.my/en/malaysia-exporters-section/253-asean/4669-malaysias-trade-with-asean>. Accessed on September 2016.

Mitchell, T., 2015. China lays out 'countermeasures' to offset exclusion from TPP. UK Financial Times, October 19, 2015, <http://www.ft.com/intl/cms/s/0/8e81ab8c-763c-11e5-a95a-27d368e1ddf7.html#axzz-41k9kGqo4>.

MITI, 2016a. Malaysia's Free Trade Agreements, <http://fta.miti.gov.my/index.php/pages/view/246>, Accessed on September 2016.

MITI, 2016b. 23rd Productivity Report 2015/2016. Malaysia Productivity Corporation.

Ooi, A.J.A. and Khalid, 2017. Malaysia's clinical research ecosystem and the role of Clinical Research Malaysia in advancing industry-sponsored research in the country, <http://www.appliedclinicaltrialsonline.com/malaysia-s-clinical-research-ecosystem?pageID=1 > Accessed on February 2017.

Petri P. A. & Plummer M. G., 2012. The Trans-Pacific Partnership and Asia-Pacific Integration: Policy Implications. Peterson Institute for International Economics.

PwC, 2015. The Study on Potential Economic Impact of TPPA on the Malaysian Economy and Selected Key Economic Sectors.

Redtone, 2015. Malaysia's Plan to Ovehaul Healthcare, <http://www.redtone.com/malaysias-plan-to-overhaul-healthcare/> Accessed on December 2016.

Solomon, J., 2004. India's New Coup In Outsourcing: Inpatient Care. The Wall Street Journal, April 26, 2004. <https://www.wsj.com/articles/SB108293099927892916>. Accesed on February 2017.

Tan, S.M., 2016. Telemedicine set to take off here. The Edge Market,August 12, 2016, <http://www.theedgemarkets.com/my/article/telemedicine-set-take-here>. Accessed on February 2017.

The World Bank, 2014. Global Financial Development Report 2014.

The World Bank, 2016. Manufacturing, value added (% of GDP), <http://data.worldbank.org/indicator/NV.IND.MANF.ZS >. Accessed on September 2016.

Tonby, O. et al., 2014. Understanding ASEAN: The Manufacturing Opportunity.McKinsey Productivity Sciences Center.

US-ASEAN, 2016. About TPP, <https://www.usasean.org/regions/tpp/about>. Accessed on September 2016.

Valencia, E.M., 2016. Can innovation solve East Asia's most pressing challenges? World Economic Forum, 20 April 2015, <https://www.weforum.org/agenda/2015/04/can-innovation-solve-east-asias-most-pressing-challenges/>. Accessed on October 2016.

Wolfgang, L. 2016. The ASEAN Economic Community: What you need to know. World Economic Forum, May 31 May 2016, <https://www.weforum.org/agenda/2016/05/asean-economic-community-what-you-need-to-know/ >. Accessed on September 2016.

Further Reading

Adner, R. and Kapoor, R., 2016. Right Tech, Wrong Time. Harvard Business Review, November 2016, <https://hbr.org/2016/11/right-tech-wrong-time>. Accessed on November 2016.

Baldwin, R., 2016. The Great Convergence: Information Technology and the New Globalization. Belknap Press: An Imprint of Harvard University Press.

Furr, N. et al., 2016. Managing Multiparty Innovation. Harvard Business Review, November 2016, <https://hbr.org/2016/11/managing-multiparty-innovation>. Accessed on November 2016.

Kramer,M.R. and Pfitzer, M.W. 2016. The Ecosystem of Shared Value. Harvard Business Review, October 2016, <https://hbr.org/2016/10/the-ecosystem-of-shared-value>. Accessed on November 2016.

Maxwell Wessel, M et al. , 2016. The Problem with Legacy Ecosystems. Harvard Business Review, November 2016 <https://hbr.org/2016/11/the-problem-with-legacy-ecosystems>. Accessed on November 2016.

Nair, M. and Shariffadeen,T.M.A. Managing innovation in the network economy: Lessons for countries in the Asia Pacific region. Digital Review of Asia Pacific 2009–2010: 25-42.

Stelios Kavadias, S., et al., 2016. The Transformative Business Model. Harvard Business Review, October 2016. <https://hbr.org/2016/10/the-transformative-business-model>. Accessedon November 2016.

Tapscott, D. and Tapscott, A., 2016. Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World. Portfolio Publisher.

Tapscott, D. and Williams A.D. 2006. Wikinomics: How Mass Collaboration Chnages Everything. Penguin Group, USA.

WEF, 2016. The Future of Jobs: Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution. Global Challenge Insight Report, January 2016. World Economic Forum.

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