



Improving health and well-being in Malaysia is a priority for the government.

A road map for Malaysian science

Plug the digital divide, improve health care, develop biotechnology industries and innovate for the trillion-dollar Halal economy, urges **Asma Ismail**.

Sixty years after independence, Malaysia has the third-highest gross domestic product (GDP) per person of the ten countries in the Association of Southeast Asian Nations (ASEAN). It has achieved this by shifting from producing cheap goods such as tin, rubber, cocoa, timber and rice to more lucrative commodities including oil, natural gas and palm oil. Science and technology are central to the country's economic growth strategy. For example, electronic components, petroleum products and petrochemicals, machinery and food are major exports. The government views biotechnology as a means of enhancing prosperity and wellness.

But new paths must be forged. The economy has slowed since the Asian financial crisis in 1997, as the advantages that have historically made Malaysia attractive for investment — pools of low-skilled labour,

good infrastructure and tax incentives — have diminished. The nation is vulnerable to competitors such as China that produce luxury goods, and countries with lower labour costs, such as Vietnam. However, as a majority Muslim country, Malaysia is well positioned to contribute scientific innovations to premium products and services for the Halal economy.

The nation must tackle three further emerging problems — health problems, rapid urbanization and climate change. Malaysia has the highest level of obesity in southeast Asia, with nearly half of adults classified as overweight or obese. The average



age of the population is rising faster than for any other country in the world. By 2050, 20% of Malaysians will be aged 60 or older, compared with 8% today¹. By 2050, 9 out of 10 Malaysians are expected to live in cities, putting pressure on resources. Malaysia is already on average 1°C warmer than it was in 1999; an increase of another 2°C is predicted by 2050 (go.nature.com/2hdr6sj), along with a higher sea level and increased rainfall.

Malaysia must build on its strengths to overcome these challenges. The country is one of the most biodiverse on Earth, with almost 19,000 species² of animal, plant, fungus and moss as well as ancient tropical rainforests. It has more than 400 vibrant institutions of higher learning and untapped pools of talent, producers and consumers.

Malaysia spends a small proportion of its GDP on research and development (R&D), allocating the sector 1.3% in 2015, compared with 2.5% on average for developed nations³. A lack of national coordination is hampering R&D. Few researchers work in industry, and too little is being spent on translating R&D outputs into products and services in comparison to developed economies, such as South Korea and the United Kingdom⁴. Research is diffused across many institutions.

Malaysia needs a new national-level strategic direction for science, technology and innovation to better focus its efforts. As president of the Academy of Sciences Malaysia (ASM), an independent body mandated to be the country's thought leader for science, technology and innovation, I outline how the science and technology system can be re-engineered to help the economy and people.

MANY BODIES

The Malaysian science, technology and innovation landscape is extremely diverse. Science cuts across 23 federal ministries, and the country has 14 state governments and territories⁴. Overall, 268 entities are involved in implementing policies and initiatives. Central coordination and planning is needed to minimize duplicated efforts, and to overcome the fragmented resources and ineffective decision-making that dilute impacts. Of the total R&D budget, 70% (10.6 billion Malaysian ringgits; US\$2.6 billion) was spent on applied research and 21% went to basic research — proportions in line with developed countries such as the United Kingdom and Singapore. But Malaysia falls short on investment in experimental development, spending just 9% on activities such as prototyping, piloting and scaling-up. By contrast, South Korea, Japan and Ireland spend 62%, 64% and 48% of their R&D budgets, respectively, on translating research into products and services⁴.

Institutions of higher learning host 78% of Malaysian researchers; only 12% are in business enterprises and 10% are in the

government sector⁴. In South Korea, 80% of the country's researchers were in businesses in 2015. In Singapore and Thailand, it was 51%. This shows that Malaysia's R&D is not industry-driven and the lack of high-skilled talent in businesses is limiting translation of research outputs. One reason science has not percolated well into Malaysian industry is that 98.5% of businesses are small or medium-sized enterprises (SMEs). These SMEs lack skilled workers and money to invest in R&D. Three-quarters of the workforce is low-skilled, which can make integrating science a challenge. Large firms were more than three times more productive than SMEs in 2016, in terms of added value per worker, contributing 63% to the nation's GDP. SMEs should step up their productivity and contribute more to economic growth and social well-being.

Networking and collaboration could enhance SME productivity in the short term. But in the long term, Malaysian businesses need to build up and engage more scientists. This will propel them from imitating and adapting to creating.

Another problem is that companies rarely engage with communities who will use the technologies, especially the poorest. Few manufacturers want to produce products for markets that they perceive as unprofitable.

PRIORITY AREAS

In 2017, an ASM study on emerging Malaysian science and technology highlighted five technology areas for investment: biotechnology, digital technology, green technology, nanotechnology and neurotechnology (see 'Technology game-changers')¹. These cut across disciplines and would potentially boost both industry and society.

The Halal economy is another area in which Malaysia is a leader and could contribute more scientifically, by developing products, standards and tracking systems.

Consumers spent US\$2 trillion on Halal products and services globally in 2016, and 1.7 billion consumers adhere to Halal principles such as avoiding animal products and alcohol in pharmaceutical ingredients⁵. These principles are of increasing interest beyond Islamic societies. The Halal market extends from food to finance and banking, insurance, education, health care and tourism. In 2016, the Halal industry accounted for 7.5% of Malaysia's GDP, with 1,400 local enterprises exporting products worth 205 billion ringgits. The government's goal is that by 2020, the Halal industry should make up 8.7% of GDP.

Malaysian scientists are well positioned to develop quality standards and certification systems for Halal products. A range of alternative and substitute ingredients are needed for pharmaceuticals, cosmetic products and foods. Quality and safety must be built in. Food traceability is crucial to allow companies to have confidence in supply chains and

TECHNOLOGY GAME-CHANGERS

Five priorities for Malaysian research

Investment in the following areas would best support the nation's growth³.

Biotechnology. Agriculture has been a key sector for Malaysia's economic growth. Precision farming is set to increase yield, efficiency and market reach, and sustainable agriculture needs to be developed. Biotechnology in health care is another priority. For example, transgenic plants and genetically engineered animals might produce pharmaceutical substances more cheaply than conventional methods.

Digital technology. Malaysia has to tackle its digital divide, especially between rural and urban communities. Whereas 78% of households nationwide have Internet access, only 38% of rural households do^{6,7}. Improving broadband access would enable poor and rural communities to share information and create jobs and wealth. Real-time data analysis, through the Internet of Things and cloud computing for example, could inform decision-making across sectors.

Green technology. Malaysia has pledged to reduce greenhouse-gas emissions by

an ambitious 45% by 2030 as part of the Paris Agreement. Renewable-energy technologies must be advanced to reduce dependency on fossil fuel. Technologies might include fuel cells, solar and ocean thermal-energy technologies.

Nanotechnology. Real-time health monitoring using nanosensors and wearables would improve preventive health care. People could track activities, vital signs, medications and mental and physical states to facilitate early intervention. Affordable over-the-counter biomarker kits should be developed as diagnostic tools, because survival rates are higher for diseases such as cancer if they are caught early.

Neurotechnology. Neurological diseases, such as Alzheimer's and Parkinson's, are on the rise and are expected to become the second leading cause of morbidity and mortality in Malaysia, after heart disease. Incidences are expected to rise in the next decade, owing to longer lifespans and lifestyle and environmental changes. Neurogenerative treatments are needed.

to isolate affected goods quickly should a problem arise. For example, geographic information systems (GIS) and radio-frequency identification trackers can monitor products being transported from farm to user.

Malaysia is a leader in Islamic finance, having a large asset base, many institutions and a strong regulatory framework in this area. The country should encourage the development of alternative forms of financial technology through cloud computing, big-data analytics, artificial intelligence and blockchain.

PULL TOGETHER

Malaysia wants to be a strong scientific nation. Successive governments have paved the way, seeing science and technology as the backbone of development. Now the country needs a lean and well-governed R&D system, spearheaded by a central agency and centred on people.

The new government, elected in May, must start by setting up a central research management agency — similar to the US National Science Foundation — to co-ordinate, plan, monitor and evaluate the country's science, technology and innovation. That agency could be complemented by a technology commercialization agency — for example, one resembling Innovate UK — to drive innovation and commercialization.

More funding will also be needed to promote the later stages of product development. The research and commercialization agencies must forge links among industry, academia and communities.

Developing international collaborations will be important to share Malaysian strengths and values, to exchange knowledge and to spur innovation.

To be a progressive nation, Malaysia must pursue economic growth, human development and societal well-being. ■

Asma Ismail is the president of the Academy of Sciences Malaysia, Kuala Lumpur.
e-mail: asmainformm@yahoo.com

1. Academy of Sciences Malaysia. *Envisioning Malaysia 2050: A Foresight Narrative* (ASM, 2017).
2. Ministry of Natural Resources and Environment. *National Policy on Biological Diversity* (MNRE, 2016).
3. Academy of Sciences Malaysia. *The Emerging Science, Engineering and Technology (ESET) Study as part of the Envisioning Malaysia 2050: A Foresight Narrative* (ASM, 2017).
4. Academy of Sciences Malaysia. *Science Outlook 2017: Converging towards Progressive Malaysia 2050* (ASM, 2018).
5. Thomson Reuters. *Outpacing the Mainstream* (Thomson Reuters, 2017).
6. Malaysian Communication and Multimedia Commission. *Internet Users Survey 2016 Statistical Brief 20* (MCMC, 2016).
7. Malaysian Communication and Multimedia Commission. *Industry Performance Report* (MCMC, 2016).