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CONFERENCE PAPERS OF NEW FRONTIERS: IPS-CFE CONFERENCE ON THE FUTURE ECONOMY OF SINGAPORE

edited by
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IPS Exchange Series

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PREFACE

"New Frontiers: IPS-CFE Conference on the Future Economy of Singapore" was held over one-and-a-half days from 12–13 July 2016. Around 300 people from the public and private sectors, trade associations, unions and academia attended the conference. The conference featured six panels, including academics specialising in computing, engineering and entrepreneurship; business and industry leaders; and economists. The titles of the six panels are: Industries of the Future; Ecosystem of the Future Economy; Future Work; Productivity and Innovation; Globalisation and Regionalisation; and Responding Together.

This was followed by a dialogue session with Committee of Future Economy (CFE) members, headlined by Minister S Iswaran, the Co-Chairman of the CFE and Minister for Trade and Industry (MTI).

The conference is part of the efforts of the CFE, a 30-member committee comprising members from different industries that operate in both global and domestic markets, as well as enterprises both large and small. The CFE builds on the 2010 *Report of the Economic Strategies Committee*, and aims to keep the Singapore economy competitive by helping to position the country for the future, and to identify areas of growth with regard to regional and global developments.

The New Frontiers: IPS-CFE conference was held with several aims in mind:

- To gather the views of academics and stakeholders, which will inspire new ideas. Alongside the contributions of the CFE subcommittees, inputs from the conference will contribute and enrich the primary recommendations of the CFE report at the end of 2016.
- To build consensus and a shared understanding of Singapore's challenges, opportunities and constraints; strategies needed to cope with changes; and the role of different stakeholders.
- To encourage partnerships and collaboration from presenters and participants of diverse backgrounds, interest and sectors, and to activate the shared responsibility of all stakeholders for economic development.

To achieve these objectives, several measures were taken to increase active engagement and participation by the audience. Boards were placed outside the conference venue to enable participants to suggest new ideas on initiatives and collaborations that the conference may have inspired and highlight blind spots that may have been missed. In addition, a special session was held in the afternoon of the second day of the conference to encourage audiences to share, discuss and pen down their responses and new ideas about the topics. A summary of their suggestions is available in Annex 1.

Introduction

OVERVIEW OF PANELS

PANEL ONE: INDUSTRIES OF THE FUTURE

Academics from the universities shared their insights into trends in the industries of the future; how they will operate; and how Singapore can benefit from the opportunities they offer. Industries that were discussed by the panel include: advanced manufacturing and factories of the future; the construction industry; medical technology; crowdsourcing; and cyber security.

PANEL TWO: ECOSYSTEM OF THE FUTURE ECONOMY

Academics from the universities shared their insights into the supporting ecosystem required in the future economy, including physical and virtual infrastructure; high-tech high-touch service delivery models; predictive technologies; mobility lifestyle; education-as-a-service; sharing economy infrastructure; design culture and maker labs; and the role of government.

PANEL THREE: FUTURE WORK

Singapore faces multiple challenges regarding its work force. First, it has to sustain economic growth under demographic conditions of limited workforce growth. Second, it has to adapt to the changing nature of work. Third, it has to give greater attention to creativity, deep skills, risk-taking and continuing education as the country approaches the technology frontier.

The panel analysed the macro-level trends that will re-shape the labour market in the coming years, and identifies viable responses to them. It discusses the role that companies and educational institutions can play in ensuring the relevance of the workforce in the future.

PANEL FOUR: PRODUCTIVITY AND INNOVATION

Given the critical importance of productivity growth and innovation for the future economy, as well as the need for improvement in Singapore's productivity and innovation efficiency, particularly in the

domestic-oriented sectors, the panel explored strategies to spur innovation and raise productivity in the Singapore economy.

The speakers discussed ways to harness technology to improve productivity; develop ecosystems that enable collaboration between stakeholders; address behavioural challenges to productivity growth; and formulate the strategies that the Singapore government should pursue to position itself for the future.

PANEL FIVE: REGIONALISATION AND GLOBALISATION

The panel discussed three aspects of regional trade integration and the opportunities for businesses therein, including the signing of the Trans-Pacific Partnership (TPP) trade agreements; economic growth opportunities of the immediate near-abroad Iskandar-Riau region; and emerging trends that may lead Singapore to look to the region for its third phase of growth.

PANEL SIX: RESPONDING TOGETHER

In Singapore, the government played a large and highly successful role in shaping its economic landscape over the past 50 years. However, the developmental state model may be giving way to a plurality of approaches to growth that allows a range of other economic actors to take up a pro-active role.

This panel discussed the role that some key change agents, including the government, trade associations and labour unions play to bring about architecture of the future economy, in light of the earlier discussions.

EXECUTIVE SUMMARY

KEY TRENDS

Dr Alpesh Patel highlighted the growth of "Industry 4.0" and integrated manufacturing, which offers productivity improvement opportunities, develops new value pools, and reconfigures value chains. Companies should explore new business models such as intellectual property rights (IPR), platforms, as-a-service and data-driven models for growth.

The second trend is the emergence of ASEAN markets as a driver of growth, given the progress in regional trade integration, ASEAN's expanding population, and rising GDP per capita. These provide additional opportunities for SMEs in Singapore to be the next driver of growth and to create value in the economy. Speakers like Professor Loh Han Tong and Dr Walter Theseira identified ways to take advantage of these opportunities, in particular in the services industries, by using high value-added, high-tech and high-touch service delivery models. Online platforms can also be used to reduce traditional barriers to internationalisation. For example, Mark Lee shared that online platforms like Amazon enable textile suppliers to sell directly to customers, disintermediating traditional brand-retailer networks. Branding, business capabilities, cultural intelligence and languages need to be reinforced to enable companies based in Singapore to expand in the region and beyond.

The third trend was the threat and opportunities posed by automation and artificial intelligence. Speakers from the third panel highlighted the importance of creating an adaptive learning workforce that can quickly re-learn new skills, and the importance of building strong foundational quantitative skill sets to enable this. Wong Su-Yen also emphasised the role of social context, and the need to broaden mindsets at the social, organisational and individual levels towards the definition of talent, long-term talent development, and social attitudes towards failure, to enable a creative economy.

Speakers noted that the lack of design capability in Singapore inhibits companies moving upstream, and the corresponding need to bridge the gap between tertiary and vocational skill sets and to offer skills-

on-demand through technology and blended learning environments. Patrick Tay added that technology generates the potential for job re-design and professionalisation of blue-collar work, which will be enabled by more rigorous professional certification.

KEY CHALLENGES

Speakers noted several challenges for Singapore. Singapore currently may not be best-positioned to partake in the future economy due to its poor performance in innovation productivity and trade deficits in intellectual property in services. Prof. Richard Liew and Prof. Arnoud De Meyer noted that despite investments in upstream research, Singapore still lacks mid-to-downstream development capabilities, as well as the ecosystem of an intricate network of service organisations, including a dynamic group of small and medium engineering service companies, designers, prototype builders, financiers, analytics and marketing companies, and business model developers; as well as access to dynamic and innovative markets. This reduces the absorptive capacity of upstream investments.

The second challenge is to build collaborative networks. Dr John Powers shared that a study conducted under the Future of Cities project found that the current market for R&D services was quite thin. The co-location of firms and related parties was insufficient to develop collaborative linkages. While the majority of sampled firms in the study contracted elements of R&D work to one another, it was disproportionately concentrated in the development side and limited to a few areas. The presence of “curator” agents such as incubators, government agencies and investors was needed to induce and stimulate innovation processes.

The third challenge is to raise productivity. Dr Ivan Png shared the behavioural obstacles to productivity improvement, such as biases, agency problems, and collective action problems.

KEY RECOMMENDATIONS

Several suggestions were offered during the conference. Prof. John Pang suggested the expansion of on-demand facilities — open to public access — for digital and customised manufacturing. These

"Manufacturing Enterprise labs" would be designed to foster an entrepreneurial and engineering culture, while tapping on the experience and expertise of a growing pool of retiring engineers. Assoc. Prof. Ng Teck Khim suggested fostering a "nation of inventors" through user-friendly MakerLabs, which provide the tools, space and skills for the public to prototype and design products.

A suggestion was given by Prof. Richard Liew to adjust public procurement criteria to enable greater local industry development. He shared that the construction industry is mired in a negative spiral. Public contracts are awarded to the lowest bidder, which creates competition for the lowest tender price. This creates outsourcing to cheap, low-skilled foreign labour or offshore construction production and services, which reduces local hiring and depresses wages and productivity. To reverse this spiral, the government should tweak procurement criteria for public infrastructure, to award contracts based on price, quality, innovation, employee enhancement, and sustainability, and spur the implementation of innovative solutions and materials. This will create a positive spiral of quality-based competition, stronger skills and talent development among local workers, deeper local corporate capabilities, better track records, and higher industry productivity. Worker and construction levies should also be used to fund research and industry upgrading programmes.

Edwin Khew shared several ways that trade associations can play a larger role in industry, through incubatorships, thought leadership, training and conferences, and working with overseas partners to promote the industry in the region. He highlighted an example of the Sustainable Energy Association of Singapore (SEAS) working closely with the Ministry of Foreign Affairs (MFA) and Asian Development Bank (ADB) to train policymakers from Asia to understand and implement renewable energy in their home countries. These activities develop goodwill and business networks within the region, which help to create attractive markets for Singapore firms.

Another solution was the expansion of the sharing economy, where skills, resources and goods and services are shared in an on-demand basis. For example, Dr Yu Han shared that the use of mobile connectivity and networks have been used in China and Japan to enable productive ageing and mentorships, and to build

complementarities between the technical know-how of the young and the experience and capital of the ageing but skilled population. Sharing economies also play a role in establishing social trust and creating new markets for goods and services. Dr Francis Yeoh noted that regulation should be light-touch and enabling in order to ensure the growth of the sharing economy.

STAYING FLEXIBLE AND RESILIENT

Speakers also engaged in thinking about Singapore's economic and urban strategy. Sanjeev Sanyal noted that given the current period of radical uncertainty that we live in, the government should avoid making bets that create infrastructural lock-ins, such as the "Detroit Syndrome" which contributed to the decline of the American city. As Singapore does not have the luxury of diversification across several cities as large countries do, the emphasis should be on retaining policy flexibility and agility to ensure resilience. It should capture the "second mover advantage" by falling behind, waiting to see what works, and implementing successful infrastructure and policies better than others. This sparked a lively exchange among audience. Some recommended an "innovate early, fail fast" approach to experimentation as an alternative, while others felt that Mr Sanyal's approach depended on contextual factors such as speed of change and level of analysis (firm levels versus government action).

Chapter 1
Industries of the Future

SOME THOUGHTS ON THE FUTURE ECONOMY

Arnoud De Meyer
President, Singapore Management University

When the government initiated the consultations on the Future of our Economy early this year, SMU's faculty had a lively internal debate on what such a future could hold. These discussions were summarised in a paper that we submitted to the Committee on Future Economy, and a copy is available on our website (www.smu.edu.sg).

Our faculty come from very diverse disciplines and there is a thus a wealth of variety in their ideas. But it struck me that there were some common themes emerging from these debates. Throughout the document the words "innovation" and "disruption" come back again and again. And the emphasis of the recommendations is on the creation of an ecosystem in which innovation can blossom. A second theme is the economic opportunities offered by connectivity based on information and communication technologies (digital connectivity). A third theme is that Singapore can be a leader in the tropics in the development of a closed loop economy.

COMMON THEMES

There is no need to repeat that markets are shifting to this part of the world, and thus sources of innovation will come our way also. This is not a forecast anymore — it is a reality. Some large Korean or Chinese companies e.g., Samsung, Alibaba, Tencent or Huawei are leading this evolution, but also more regional medium-sized companies such as our local Hyflux, Manila Water in the Philippines or City Developments Limited (CDL) are developing innovative products and business models that can conquer the world. Multinational companies are also distributing their R&D worldwide and a lot of it is shifting to Asia. But do we get a competitive share of all these activities into Singapore? After all, we have great universities and research laboratories that can educate future innovators and produce research that can be deployed in innovative products and processes. We have one of the best intellectual property (IP) legislations in the region if not in the world, thus protecting the innovator. And we are located at the heart of South East Asia, a region with more than 600 million

consumers. We have everything going for us, haven't we? But I am convinced that we have not realised our full potential as innovators. We can do a lot better in innovation if we can improve our ecosystem and innovation infrastructure, and if we commit fully to the markets around us.

Innovation does not happen in a vacuum. The economically successful commercialisation of creative ideas and research results requires an intricate network of service organisations that can help the innovator. It requires a dynamic group of usually small- and medium-sized engineering service companies, designers, prototype builders, financiers, analytics and marketing companies, and business model developers. That is what I call the innovation ecosystem. Large multinational corporations (MNCs) usually have such an ecosystem in house, or can call on long-term partners elsewhere in the world. But our local innovators need such support.

It is of course a bit of a chicken-and-egg challenge: innovators need such an ecosystem, and the ecosystem will not develop without the innovators as customers. That is where the MNCs can help: rather than working with their traditional suppliers overseas, we may ask and encourage them to develop local partnerships as the seeds for a local innovation ecosystem. This has happened elsewhere. Silicon Valley developed partially around the demand created by HP, Fairchild and its successors, and Intel. And in Shenzhen you will find a very extensive network of small- and medium-sized companies that can collectively design and produce almost any electronic device or gadget.

Successful innovators also require markets. We are lucky to have South East Asia around us. But I sometimes have the impression that our local entrepreneurs always look very far over the horizon and aim at markets in China or the United States, two notoriously difficult markets to enter. Markets in Vietnam, the Philippines, Thailand or Indonesia may also be difficult, but they are close, and thus easier to monitor and manage. We also have a lot of friends in these countries — young people who have studied and worked here, and feel comfortable with working with Singapore companies. But do our young Singaporeans feel comfortable with them? I sometimes doubt it. Our young people need to be encouraged to get to know these

markets and to develop the intercultural skills and languages to operate there.

The second theme that I picked up from my colleagues consists of all the opportunities that are offered by digital connectivity. This goes to the DNA of Singapore. We exist because we connect with people and countries. The port and the airport are both key hub infrastructures around which Singapore has built an extensive business of connecting people. Logistics, trading, transhipment, transit passengers at Changi buying at duty free shops, financing trade, you name it — it all has to do with Singapore being a high-performing node in an international network. Can we do the same in the international digital network? Can Singapore be the high-performing node in a network of storing and sharing data, protecting data and cyber security, analytics, simulations and large scale computing for finance or marketing? If we can handle ships and planes better than anybody else, we should be able to be the best transit point for bits as well. That will require an investment in technology. All of our universities are engaged in research on analytics and cyber security. But I believe we also require a heavy investment in international discussions on regulation and legislation on data handling. As one of my colleagues argued: “It will require [Singapore] playing a role in the data ‘sovereignty’ debate, much as the European Union and the United States have been working on the new ‘Privacy Shield’ provisions beyond the 2000s approach of ‘Safe Harbour’ for cross-border data sharing.”

The third theme is the opportunity for Singapore to be a leader in the closed loop economy, i.e., reducing waste and carbon emission. There are other cities or small countries that strive to be a leader in this. One thinks naturally of some of the Canadian or North European cities, e.g., Copenhagen and Amsterdam. But none of them are on the equator. Singapore is in a unique position to develop its own approach to a closed loop economy, to be a “living lab” for a circular economy, one that is relevant to many cities in Latin America, India or Africa.

GETTING THERE

Developing an ecosystem for innovation, reaping the benefits of digital connectivity and being a leader in a low-carbon, circular economy can be excellent goals. But what does it require to get there? The

discussion among SMU faculty focused naturally a lot on how we need to adjust our education. One of the recurrent themes was that we have to invest more in “learning how to learn”. We realise that what we teach our students today, beyond the foundations, may well become obsolete in five or 10 years. Therefore, it is important that we provide sufficient opportunities to our students on how to learn from what they do in the job, how to conceptualise from their experiences. Experience based learning will therefore become much more important in the coming years.

We also believe that the world’s challenges will require interdisciplinary solutions. One can get those by bringing experts from different fields together. But you need also the people who can bridge the differences in jargon, methodology, etc., that exist between the different disciplines. Economists, cyber-engineers and lawyers will have to work together when we want to create a hub for digital connectivity, yet they may not speak the same language and have very different ways of analysing similar problems. Somebody will need to coordinate the creation process. Therefore we will need to create more opportunities in our educational system to develop interdisciplinary knowledge and thinking.

Thirdly, we strongly believe we need an evolving entrepreneurial culture in Singapore. We can be proud that over the years more and more of our young people have become entrepreneurs. Our incubators are full, and the government is providing substantial support for budding entrepreneurs. We are proud at SMU that we can count more than 350 entrepreneurs among our alumni. Now that we have that stock of entrepreneurs, we need to ensure that they can grow their businesses. There needs to be a shift from startup to scale-up. Let’s not dream too much about “unicorns”, or these companies that grow quickly into a turnover of more than a billion US dollars. They will be very rare. I am convinced that we have a better chance of building up 20 companies or more with a turnover of US$100 million. We perhaps would also be better off with them, because more employment will be created locally by 20 of the medium-sized companies than one unicorn, which probably will need to go global and thus create employment overseas.

These are just some of the ideas that were discussed at SMU. Feel free to go to our website and comment on some of these ideas. We don't think we have the solutions, but we hope that some of our ideas can stimulate your own thinking.

This paper was first published in The Straits Times' *"Opinion" section (p. A44) on July 16, 2016.*

MANUFACTURING CHALLENGES AND OPPORTUNITIES FOR INDUSTRIES OF THE FUTURE

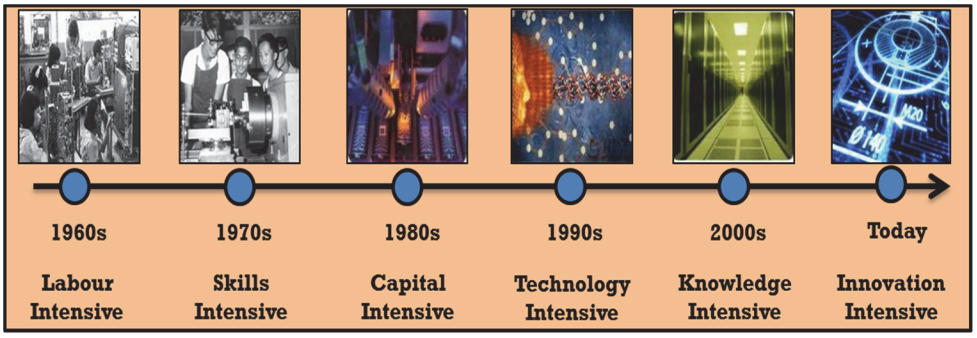
John H L Pang
Professor, School of Mechanical and Aerospace Engineering, College of Engineering, Nanyang Technological University

INTRODUCTION

Manufacturing is a key pillar of Singapore's economy. However, the manufacturing sector growth trend needs new investments to change the course towards sustained positive growth in the coming years. The RIE2020 Plan (Research Innovation Enterprise 2020 Plan) will take Singapore to the next stage of development. Advanced manufacturing and engineering has been allocated $3.3B to grow eight key sectors of industry over the next five years from 2016 to 2020. The goal is to support economic growth, create good jobs and to preposition our economy for the future.

The evolution of Singapore's manufacturing industry started from the 1960s embarking on low-cost and labour-intensive industrialisation programmes. By the 1970s, the manufacturing sector grew to become the largest sector in the economy with ever increasing investments from MNCs to locate expanding production capacity in Singapore (see Figure 1). Singapore's manufacturing industry had become more skills-intensive and moved up the production food chain to profitable semiconductors, electronic devices, computer peripherals and precision engineering sectors.

FIGURE 1: EVOLUTION OF SINGAPORE MANUFACTURING



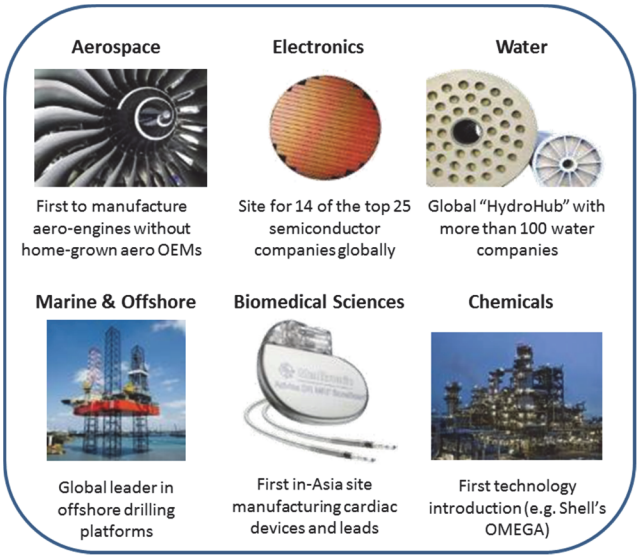
Source: EDB (2016)

The 1980s saw a shift towards capital-intensive industries with increasing organic growth of local government-linked and public sector operations complimenting and reinforcing growing MNC operations. In the 1990s, science- and technology-intensive industries rode on Information Technology (IT) to increase productivity, and we moved up the manufacturing value chain by embracing new developments in science and technology.

From 2000 to present, Singapore has transformed itself to be a knowledge-based and innovation-intensive modern developed economy. R&D is the cornerstone of the country's economic investments with the widening contributions of the A*STAR Research Institutes (RIs) and National Research Foundation (NRF) stewardship of the national research and innovation strategies till 2015.

Manufacturing is a critical sector contributing to 20% of Singapore's GDP over recent years. The manufacturing sector comprises 9,000 establishments and employs over 400,000 workers. Singapore's manufacturing industry has transformed to a diverse portfolio of industries with key areas in Aerospace, Biomedical Sciences, Chemicals, Electronics, Marine & Offshore, and Water Technologies as shown in Figure 2.

FIGURE 2: KEY AREAS OF SINGAPORE'S MANUFACTURING INDUSTRY



Source: EDB (2016)

RESEARCH, INNOVATION AND ENTERPRISE INVESTMENTS IN SINGAPORE

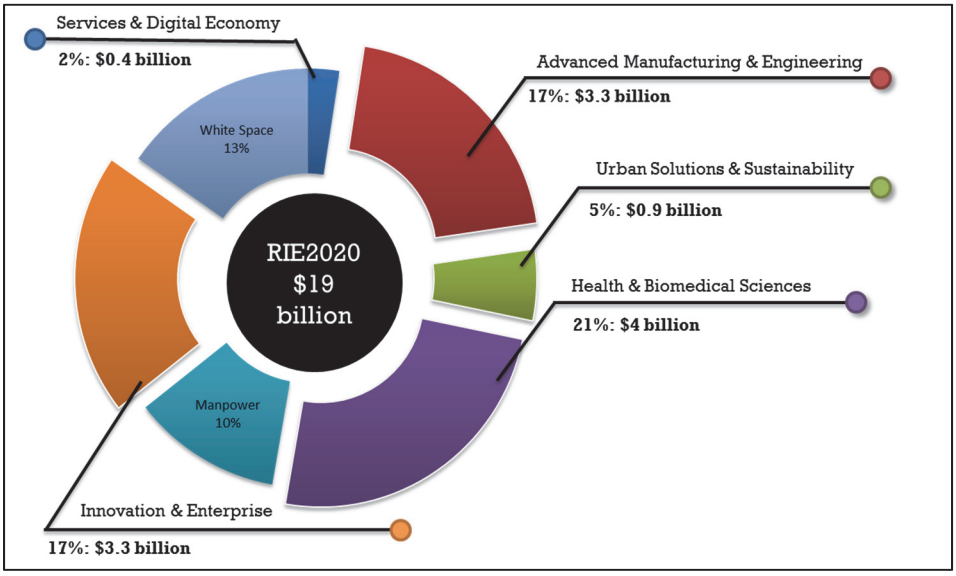
Research, innovation and enterprise are cornerstones of Singapore's national strategy to develop a knowledge-based innovation-driven economy and society. Public investment in research and innovation has grown over the last 25 years. Under the last five-year RIE2015 Plan, Singapore has committed $16 billion over 2011 to 2015 to establish Singapore as a global R&D hub. This will be sustained with the RIE2020 plan to fund research, innovation and enterprise with up to $19 billion from 2016 to 2020.

Singapore needs to improve the transformation from innovation to enterprise by pushing ahead with value creation towards value capture. The RIE2020 plan provides $3.3 billion for "Innovation and Enterprise" to bring research towards commercialisation. A sustained funding of $2.8 billion will continue to promote novel academic research, and $1.9 billion for manpower development to build a strong research and innovation RSE community.

To further maximise impact, funding will be prioritised in four strategic technology domains where Singapore has competitive advantages and important national needs as shown in Figure 3. The four technology domains are:

- Advanced Manufacturing and Engineering ($3.3 billion).
- Health and Biomedical Sciences ($4 billion).
- Urban Solutions and Sustainability ($0.9 billion).
- Services and Digital Economy ($0.4 billion).

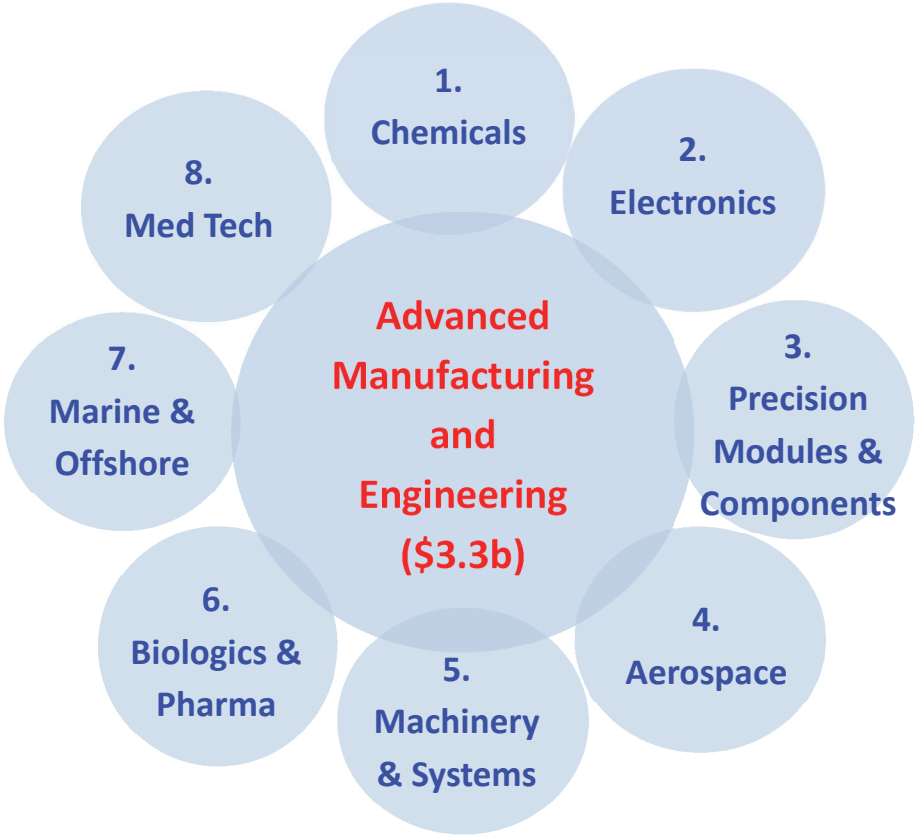
FIGURE 3: RIE2020 PORTFOLIO



Source: NRF (2016)

It is clear that a significant portion of RIE2020's portfolio has been allocated to Advanced Manufacturing and Engineering ($3.3 billion). This will develop the technological capabilities that support the growth and competitiveness of Singapore's manufacturing and engineering for eight sectors (see Figure 4).

FIGURE 4: ADVANCED MANUFACTURING AND ENGINEERING (AME) SECTORS



MANUFACTURING CHALLENGES MOVING AHEAD

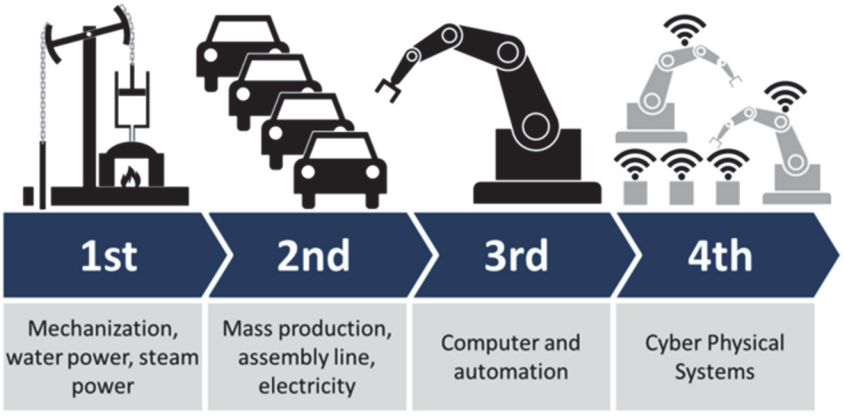
Singapore has to continue to stay ahead of the competition in pushing harder towards a knowledge-based and innovation-intensive economy of the future. The manufacturing sector has to move up the value chain in to advanced products, production systems and intelligent control of systems. Manufacturing industries of the future will have to be manpower-lean and highly automated, leveraging on Robot-Assisted Manufacturing(RAM) technologies, Digital Manufacturing (DM) technologies, and Industrial Internet of Things (I^2oT) technologies, and emerging trends for Factories of the Future towards Industry 4.0 (see Figure 5).

These emerging technologies will have a significant impact on the future manufacturing landscape of Singapore. As Singapore moves ahead towards 2020, focus on advancing manufacturing technologies and productivity improvement in manufacturing operation requires strategic action plans.

Boosting productivity through technology-enabled solutions requires significant investments in the following manufacturing technologies of the future:

- Additive Manufacturing (Rapid prototyping, new product designs, materials)
- Advanced Robotics (Robot assisted manufacturing, extreme environments)
- Manufacturing IT (Process optimisation, cyber-physical systems, I^2OT)
- Advanced Materials (Enhanced functionality, new designs, cost savings)
- Advanced Manufacturing systems (lean manufacturing, inventory reduction)
- Factory of the Future developments towards Industry 4.0, (see Figure 5).

FIGURE 5: INDUSTRY 4.0 — FOURTH INDUSTRIAL REVOLUTION



Source: Christoph Roser via Wikipedia (2016)

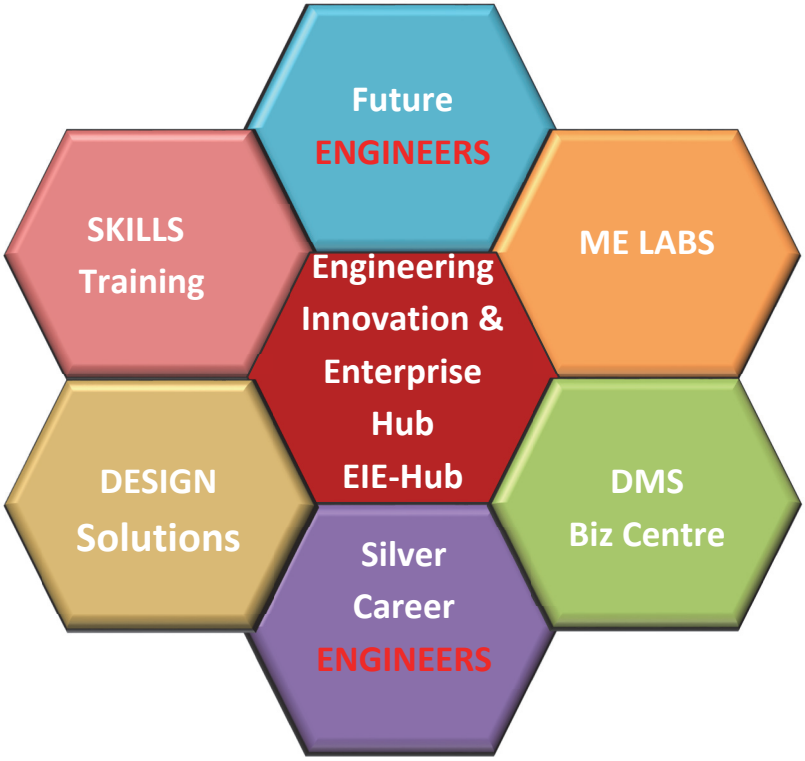
MANUFACTURING OPPORTUNITIES OF THE FUTURE

The future of manufacturing will be driven by multidisciplinary talent across different knowledge domains, such as product knowledge, manufacturing processes, systems design and industry knowledge. This presents a unique opportunity to tap the RIE2020 Plan to promote university-institute-industry collaborations with research-innovation-enterprise efforts to carry out impactful translational research — from value creation to value capture for Singapore-based manufacturing enterprises. The RIE2020 Plan will continue to steer and nurture stronger research, innovation and enterprise developments at the highest levels.

However, to many small enterprises and Singaporeans in the HDB heartlands, the RIE2020 initiatives do not have a direct impact on their way of life. Some resources and programmes are needed to cater for small enterprises and Singaporean freelance enterprises (OMO [One Man Operated] or OWO [One Women Operated]) businesses. Can some RIE2020 programmes be brought to help encourage simple and small enterprises to take root, grow and nurture a new self-employed enterprise community in the future? Manufacturing enterprises are too expensive for small or self-employed enterprises to venture in to due to the prohibitive high cost of capital investments and rental cost to run a manufacturing business. Sub-contracting manufacturing operations to existing SMEs will also be prohibitive in terms of cost to make any manufacturing enterprise viable. Hence, manufacturing enterprises in the heartlands are restricted to low-cost services and tailor-made goods.

With the advent of new trends towards “Customised and Personalised Products” and the modern reality of low-cost 3D-modelling, 3D-printing and other manufacturing technologies, it may be timely to look in to setting up public access Manufacturing Enterprise (ME) lab facilities. Figure 6 shows an Engineering Innovation & Enterprise (EIE) hub of the future with capabilities for skills training, design solutions, ME lab facilities and DMS (Design-Manufacture-Sell) centres to encourage a new generation of future engineers who are design and IT smart — to lead new enterprises of the future specialising in customised or personalised products.

FIGURE 6: ENGINEERING INNOVATION & ENTERPRISE (EIE) HUB OF THE FUTURE



This can spark off a Design-Manufacture-Sell (DMS) business model industry of the future. The pride of saying that these products are "Designed-Manufactured-Sold" in Singapore will be a way of life in our future. Customised products such as electric personal mobility devices; customised, 3D-designed, 3D-printed and sold in Singapore products can be a sustainable reality for small, self-employed and free-lance enterprises of the future.

Singapore has great potential in embracing Engineering Innovation and Enterprises (EIEs) of the future. The EIE hubs can also be patronised by a great but ageing silver generation of engineers who have the depth of experience in DMS culture, given their stints in leading corporations of the world — in order to start "silver career" engineering enterprises of their own. The opportunity of blending the complimentary skills of future and silver career engineers is a potent combination for EIEs, and manufacturing enterprises of the future.

CONCLUSIONS

Singapore has transformed itself into a knowledge-based and innovation-intensive economy but more is needed to facilitate further growth of the manufacturing sector. Manufacturing challenges for industries of the future will be driven by global trends towards developing Factories of the Future (Industry 4.0), Robot-Assisted Manufacturing, Digital Manufacturing and Industrial IOT technologies.

These emerging technologies will have significant impact on the future manufacturing landscape of Singapore in terms of manufacturing jobs and skills required. Singapore has great potential in embracing EIEs of the future. Promoting manufacturing enterprises is one way forward and small local SMEs and Singapore-based enterprises can embrace the manufacturing challenges and opportunities moving towards these industries of the future.

Engineers will continue to be our national assets for Singapore's manpower talent in the future. We have an army of engineers servicing leading MNCs, large SMEs, GLCs and the public sector, and contributing to Singapore's economic growth. Retiring such engineering talents from the innovation and enterprise sector is a great loss to any nation. The successful nations of the future are the ones that are able to harness its silver career engineers to be engaged in highly productive and "silver careers" in innovation and enterprise. Promoting manufacturing enterprises is one way forward, while investing in public-access EIE hubs and ME-labs can spur future and silver career engineers, and small Singapore enterprises in the heartlands to embrace and participate in the manufacturing enterprise opportunities of the industries of the future.

FUTURE ECONOMY ON URBAN DEVELOPMENT AND INFRASTRUCTURE

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ABSTRACT

Scientists and engineers in Singapore are working on possible ways to avert global warming and a rising sea level due to climate change, and gradually transform the nation into a low-carbon society. Key strategies are in place to develop alternative/renewable energy, low-energy buildings and a smart transportation system, and to shift away from the use of fossil fuels and other high-carbon footprint products that contribute to global warming. Although the government has invested heavily in R&D to build a smart nation with sustainable infrastructures and urban solutions that are uniquely Singapore, many of these critical infrastructures including MRT tunnels, land reclamations, healthcare facilities and key installations were built by foreign contractors. Government policies and incentives are required to empower more local companies to engage projects through joint ventures with foreign corporations and to create an environment for them to upgrade their skills to produce quality, innovative and cost-competitive services. Funding for mid- and down-stream research is necessary to allow novel ideas and innovative products created from up-stream R&D to be brought to real applications and to benefit the local SMEs. With technological development and adoption through R&D and educational collaborations between local tertiary institutions and government agencies to provide lifelong learning and continual skill developments for the local workforce, a sustainable eco-system can be created to support the building of our smart nation.

BUILDING A SMART NATION

More than half of the global population is currently living in cities. In Asia, medium-sized cities (i.e., 1 to 5 million inhabitants) and cities with less than 1 million inhabitants are growing at faster rate than other parts of the world besides Africa. The United Nations projected that by 2030 the number of large and megacities will be increased by

nearly 50%, while the smaller-sized cities are expected to increase by more than a third of its present number of about 1,000 (United Nations, 2014). The growing population and cities are already putting tremendous pressure on the present depleting resources, infrastructure need, waste management and climate change. As reported by the Organisation for Economic Co-operation and Development (OECD) in its 2011 key findings on strategic transport infrastructure needs, not even half of the international gateway and inland transport infrastructure demand in 2030 has been built at the time (OECD, 2011). Green transport policies are necessary to protect the environment and sustain future development.

For the city-state of Singapore, which has seen rapid transformation from mangrove forests to one of the world's most advanced cities today, the ongoing concerted efforts and firm commitment of its government have placed the country on the global map for its achievements in sustainability and green practices. Although energy efficiency has been and will still be the main focus of sustainable urban development in our small nation — due to its limited natural resources — the lack of space and water catchment area is also a very important tipping balance to our country's future development and economy growth. To sustain the population growth in this land-scarce island, more spaces and fresh-water reservoirs have to be created to increase the physical land area by several folds. A future urban development to triple the current physical land space and fresh water supply, while conserving the environment and preserving our built heritage, can be achieved through innovation and development of new technological capabilities and solutions by the efficient use of airspace, deep underground space and sea space. Large-scale land reclamations have been carried out for decades to support Singapore's booming industrial-based sector and entrepot trade, which are the two main economic strategies of the country. This includes among others, the reclamations of Changi Airport that began in 1975, Tuas industrial area in 1980s, Jurong Island in 1995, and the ongoing Pasir Panjang Terminal (PPT) reclamation works since the 1990s. Concurrently, with the expansion of PPT Phases 3 and 4, reclamation works are also in progress for the new mega Tuas Port development to free up prime land for residential and mixed-use developments.

At present, approximately 23% of Singapore's land area is reclaimed land and the majority of these reclamation projects are helmed by foreign construction companies. The above-listed reclamation projects, except for the new Tuas Port, were all completed by Penta Ocean Construction, a renowned Japan construction firm that has under its belt 40% of the total reclaimed area in Singapore. Reclamation for the new port was awarded to a joint venture of South Korean and Belgian firms. Besides land reclamation, Penta Ocean Construction has an impressive list of completed and ongoing healthcare institution projects that includes Changi General Hospital, Mount Elizabeth Medical Centre, NUH Medical Centre and Sengkang Hospital. The recently opened Ng Teng Fong General Hospital was constructed by GS Engineering and Construction Corporation from South Korea.

The dominance of foreign companies in the construction of Singapore's key infrastructure is of some significance. At the end of 2012, a $2 billion next-generation Transmission Cable Tunnel Project was awarded to five foreign construction companies and one of these is a joint venture with a local contractor. The Mass Rapid Transit (MRT) rail network that serves as the backbone of Singapore's public transport system since 1987 was also constructed by various foreign companies mainly from Japan, South Korea, Europe and China. Although the presence of local companies has become more evident in recently awarded contracts for the MRT network, many of these local companies secured the contracts through joint ventures with their foreign partners. Some projects that required "track records" such as tunnelling work received no bids from local companies. It is obvious that despite having world-class infrastructure, we are yet to build a skilled workforce identity of our own in the same context.

CHALLENGES IN THE INDUSTRY

The Global Enabling Trade Report 2014 by the World Economic Forum ranked Singapore as the most open country to international trade and investment among 138 countries in the world (Hanouz et al., 2014). The ranking measures the factors, policies and services that enable trade across borders in a country, based on data from the World Economic Forum's Executive Opinion Survey, International Trade Centre, World Bank, the United Nations Conference on Trade

and Development, IATA (air transport), ITU (telecommunication) and Global Express Association (express delivery).

The open economy strategy has brought successful economic development for Singapore and the country has benefited from the inflow of Foreign Direct Investments (FDIs) from global investors and institutions in the past three decades. Although the major bulk of FDIs in Singapore are in the finance & insurance, wholesale & retail, and manufacturing sectors, the presence of large and well-established foreign and multinational companies that originate from other countries is also noticeable in the building and construction scene. While these non-local corporations should be credited for transforming Singapore landscape to the modern urban state that it is today, our future development should not continue to rely heavily on them. The continual reliance on foreign companies to build our infrastructure projects has inadvertently suppressed the growth of local builders and contractors. To date, only a very few local companies have the financial capacities and technical capabilities to compete with the foreign or multinational corporations, and they often choose to compete for projects with smaller contract values. For instance, only four out of 35 (11.3% of total S$9,437.65 million as shown in Table 1) of the Downtown Line (DTL) and seven out of 25 (16.0% of total S$8,307.375 million) of the Thomson-East Coast Line (TEL) civil engineering contracts including design and construction of stations, tunnels and depot were awarded to our local contractors. Out of the small percentage, two of the four DTL civil contracts and three of the seven TEL civil contracts were joint ventures with foreign companies.

TABLE 1: SINGAPORE COMPANIES' STAKE IN DTL AND TEL CIVIL CONTRACTS

DTL	***Singapore***	***Korea***	***Japan***	***China & HK***	***India***	***Europe***	***South Africa***	***Australia***	***Total***
S$ mil	1,067.25	3,394.28	1,406.15	1,140.96	841.2	826.83	675.25	85.73	9,437.65
%	11.3	36.0	14.9	12.1	8.9	8.8	7.2	0.9	100
TEL	**Singapore**	**Korea**	**Japan**	**China & HK**	**Europe**	**Taiwan**	**Australia**		**Total**
S$ mil	1,327.56	2,063.61	2,194.7	2,046.105	414.645	69.1	191.665		8,307.375
%	16.0	24.8	26.4	24.6	5.0	0.8	2.3		100

The Japanese companies have been and are still one of the most dominant builders and contractors in Singapore. Their unrelenting emphasis on quality assurance and completion timing over cost is well known and has earned them the trust from past and future clients, and cemented their foothold in the building and construction industry. Such characteristics and philosophies of the Japanese builders and contractors should be taken as role models by our budding local companies. Moreover, the Japanese builders and contractors have had many decades to perfect their trade and practice and to establish their system and reputation through R&D. In comparison, our local builders and contractors lack experience, funding, capital, manpower and more often than not focus heavily on cost control to survive or maximise net worth, while competing within the same arena with the far more established foreign and multinational corporations.

Due to the inherently high land, material and labour costs in Singapore, more and more construction services and production, for example, steel fabrication and prefabricated, prefinished volumetric construction are being driven overseas or outsourced since arbitrage of land, material and labour cost is a much simpler and effective solution. The local fabricators are also facing tremendous challenge from China, which is mass-producing and exporting steel around the world with less regard for economic cost. In this instance, the foreign and multinational corporations will have the advantage of outsourcing the production to their home or other countries. Inadvertently, our construction industry is moving in a negative spiral towards zero value-add to Singapore as illustrated in Figure 1. Local companies, especially small and medium enterprises (SMEs), are too occupied with competition from all sorts of external forces and have little time or resources to innovate, enhance productivity and develop future skills. Without the development and retention of services, knowledge, technology, skills and intellectual properties in Singapore, the building and construction industry will become unsustainable in the future.

In order to create the multiplier effect and add value in the building and construction industry, prioritisation on quality, innovation, productivity and sustainability over cost is required to move the industry into a positive spiral as shown in Figure 2. Competition for contracts should no longer be assessed solely on price throughout the construction supply chain. A new sustainable eco-system in the

industry could be created through government's future policies that empower more local contractors to engage work through joint ventures with their foreign counterparts, and create an environment for them to develop partnerships that produce good-quality, innovative and cost-competitive services.

FIGURE 1: NEGATIVE SPIRAL IN THE BUILDING AND CONSTRUCTION INDUSTRY

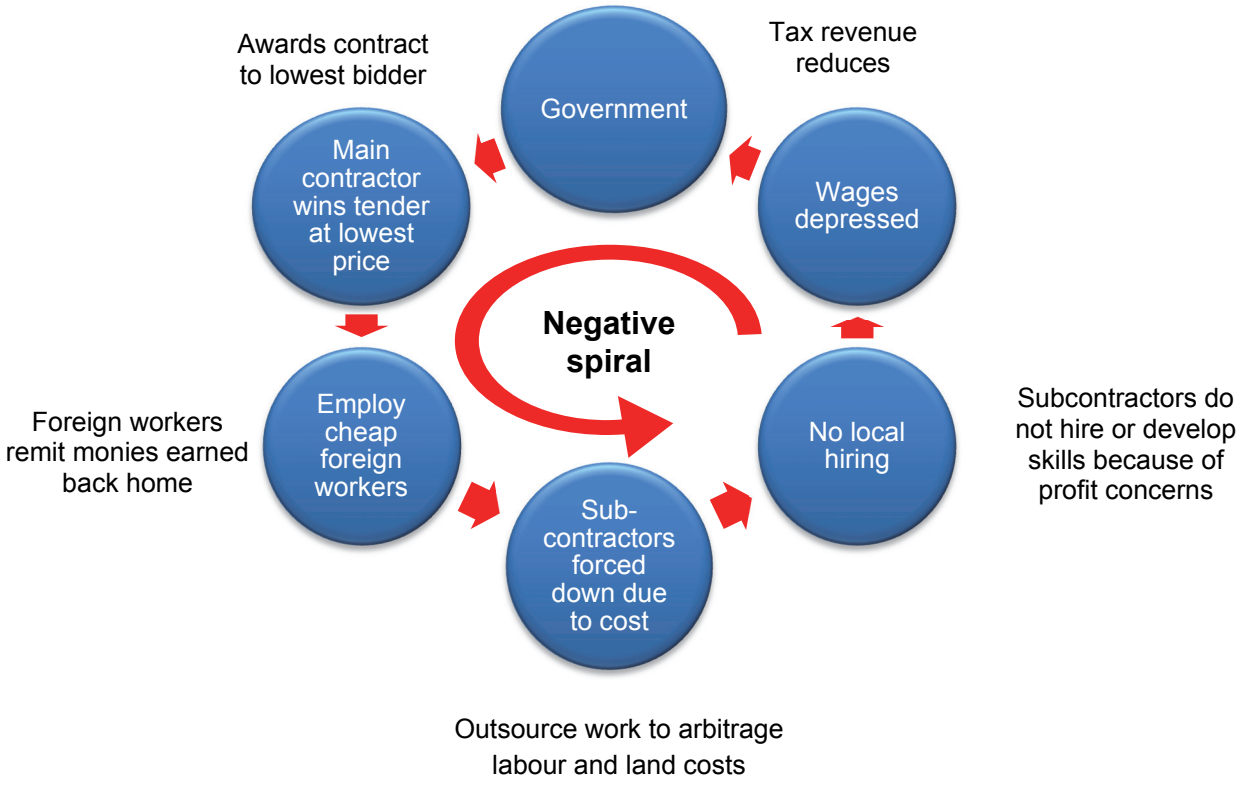

FIGURE 2: POSITIVE SPIRAL IN THE BUILDING AND CONSTRUCTION INDUSTRY

INVESTING IN RESEARCH AND EDUCATION

The government of Singapore has allocated billions of dollars through its research agencies to support the nation's R&D efforts in selected fields of science and technology. Aside from funding for academic institutions, the Research Incentive Scheme for Companies (RISC) was introduced in 1992 to encourage investment in R&D by the industry to build up their capabilities and R&D facilities. Private R&D is also promoted through tax exemptions or deductions schemes — for instance, the highly successful Productivity and Innovation Credit (PIC) scheme announced in Budget 2010 to encourage industry investment in innovation and productivity improvements.

More recently, test-bedding programmes, platforms and labs were also rolled out under collaborations between government agencies, local universities and/or industries to facilitate the translation of new building and construction technologies into commercial solutions for Singapore and beyond. For instance, the NUS-CDL Smart Green Home and NUS-CDL Tropical Technologies Laboratory are being constructed under partnership between National University of Singapore (NUS) and City Development Limited (CDL) to test-bed smart and green technologies to improve the quality of life in Singapore. Nonetheless, the exclusivity of such platforms may still limit local institutions and industries from fully leveraging on them to collaborate, further develop and capture more value from R&D.

In the Research Innovation Enterprise 2020 (RIE2020) Plan announced in early 2016, where S$19 billion was allocated for the nation's R&D initiatives over the next five years, the government plans to increase the private sector R&D spending from the current 1:1.5 ratio of public to private funding to 1:1.8 (Lok & Kek, 2016). Despite the significant efforts and support by the government for R&D, investment by private building and construction companies is still scarce and limited to large government-linked corporations and developers. There were also concerns that SMEs may not be able to fully tap into or benefit from government funding like RIE2020 as compared to the larger corporations.

To overcome this, it is proposed that a construction levy be imposed on the total contract value with a designated portion channelled to

develop the core competency of the companies and the rest to a combined pool to fund mid- and down-stream R&D. The combined pool can be made available to local companies for R&D purposes.

Among currently available R&D funding schemes, public funding from government institutions often prefers research projects that would lead to breakthrough innovations (up-stream R&D) while private funding from industries favours projects that solve practical problems, and creates value and products that are nearly ready to be adopted (down-stream R&D). The lack of support for mid-stream research between these two ends is creating leakage in the R&D output and should not be ignored. The proposed levy scheme will bridge this gap and ensure skill development for our local companies.

To develop the skilled future of Singapore contractors, government agencies and local institutions should work together to educate a group of experts in green building technologies, urban development and infrastructure solutions. Lifelong learning and continuous skill development training on urban infrastructure and sustainable technology can be offered through educational partnerships between local tertiary institutions and government agencies like URA (land use), HDB, BCA, and JTC (building, infrastructure), LTA (transportation system), MPA (port and maritime operation), PUB (water resources and management), NEA (environment, energy efficiency and climate change) and CAAS (airport management and air hub development). These partnerships will provide market-driven, solutions-oriented and experiential learning programmes to industry practitioners and working professionals so that they can support and sustain the technological advancement and applications necessary to drive Singapore's development in the next 50 years.

CONCLUSION

Our homegrown expertise and capabilities have begun to slowly emerge and mature only in recent years. Future economic policies should now ease the over-reliance on foreign and multinational corporations in building our nation's key infrastructures. Strong links between the universities, government agencies and industries are necessary to further develop, capture more value from R&D and to install a framework to facilitate the translation of technologies into

commercial solutions for Singapore and the world. This will spawn new companies and new jobs for the future. The unique experience learned from building a green, sustainable and smart nation can be exported to other countries, which are inspired to follow suit. We should be well known for building our smart nation with world-class infrastructures and not buying them.

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SINGAPORE'S FUTURE MED-TECH INDUSTRY: GROWING, AND CHANGING SHAPE?

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Singapore's Medical Technology (Medtech) Industry is maturing, and the paper touches on the changes in size and shape of the industry of the future. This paper shares some of the challenges and insights on providing healthcare, of managing and overseeing healthcare systems, and of leading R&D in a complex economy like Singapore's, from the perspective of a surgeon, a health services and policy researcher, and an Institute Director.

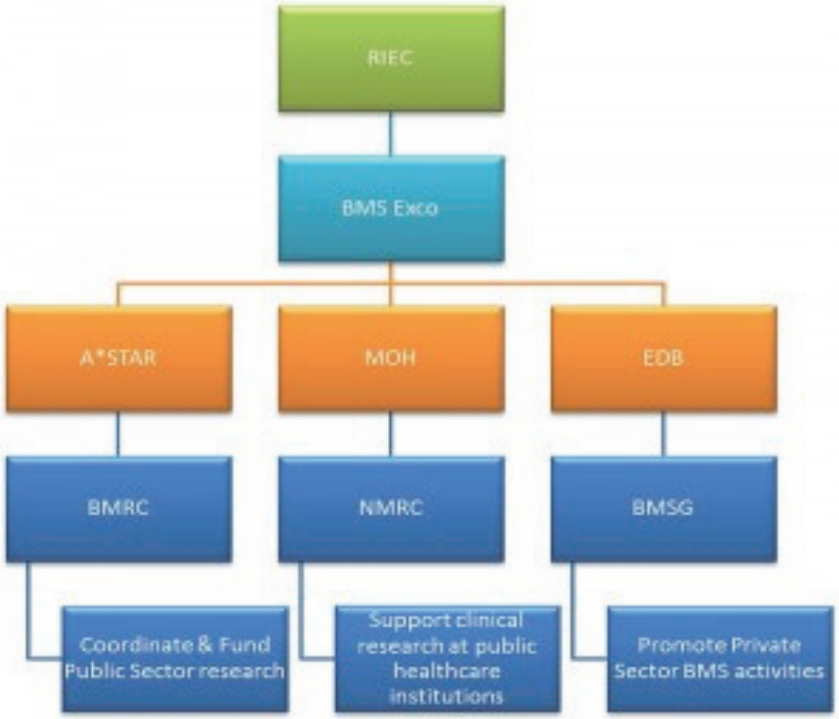
The Lee Kong Chian School of Medicine, Singapore's third medical school, is open for business, and training doctors. It will graduate the first cohort in August 2018 and is a partnership between NTU and Imperial College London, one of the world's top medical schools and, like NTU, a very technology-oriented university. NTU alone publishes over 1500 health-related papers and files over 100 health-related patents every year, the vast majority of which come from the College of Engineering and the School of Physical and Mathematical Sciences. Now ranked among the top engineering and technology-oriented universities in the world, NTU is well positioned to provide leadership in the further development of Singapore's health and medical technology industry.

The new Nanyang Institute of Technology in Health & Medicine aims to be the bridge between NTU's engineering capabilities and the medical world, including the medical school, the hospital and health service providers, and government partners such as Economic Development Board (EDB). It aims to solve grand health and medical challenges through high-performance teams of clinicians, scientists and engineers, supporting them with state of the art infrastructure and facilities.

SINGAPORE'S MEDICAL TECHNOLOGY ECOSYSTEM

Singapore's Medtech Ecosystem is sophisticated and complex. It is overseen by the Singapore Biomedical Sciences Medical (BMS) Executive Committee, and the key stakeholders are A*STAR, the Ministry of Health, and EDB. The Ministry of Education also has a significant role through the leading universities (NUS, NTU, SIT, SUTD).

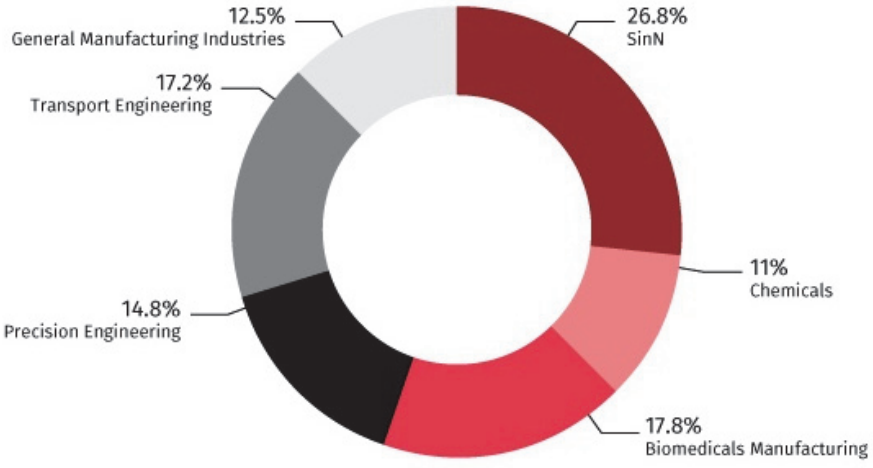
FIGURE 1: SINGAPORE MEDTECH ECOSYSTEM



Source: National Research Foundation (2016)

The Medtech industry in Singapore has done well, and is currently a big part of the Singapore economy. Biomedical Manufacturing contributes about 17.8% in terms of value-added of the Manufacturing Sector. Chemicals and Precision Engineering, which also consists of medical components, contributes substantial additional value of 11.0% and 14.8% respectively.

FIGURE 2: SINGAPORE ECONOMY SECTOR BREAKDOWN- NORMAL VALUE ADDED BY % SHARE



Source: Ministry of Trade and Information (2015)

In 2011, Singapore's medical technology sector contributed about S$4.3 billion in output and about 9,000 jobs. This was almost triple the output of S$1.5 billion in 2000, reflecting substantial, rapid growth over the decade.

However, the sector is not just about manufacturing and R&D. Singapore is also a leading trading and distribution hub for the region, which has attracted approximately 30 multinational corporations to establish Medtech development activities. Singapore has substantial imports and exports in that sector, and improvements have been made to streamline procedures for trade. New streamlined import declaration requirements for health products that have been implemented by the Health Sciences Authority (HSA). Submission of import permit applications has been facilitated via TradeNet, Singapore's online customs system.

Based on BMI Research, it is predicted that Singapore's Medtech Industry will grow by a CAGR of 8.6%, from US$525.9 million in 2014 to US$795.8 million in 2019, which varies by product area, and growth is expected to be fairly continuous over the five years.

FIGURE 3: SINGAPORE'S MEDICAL DISTRIBUTION HUB

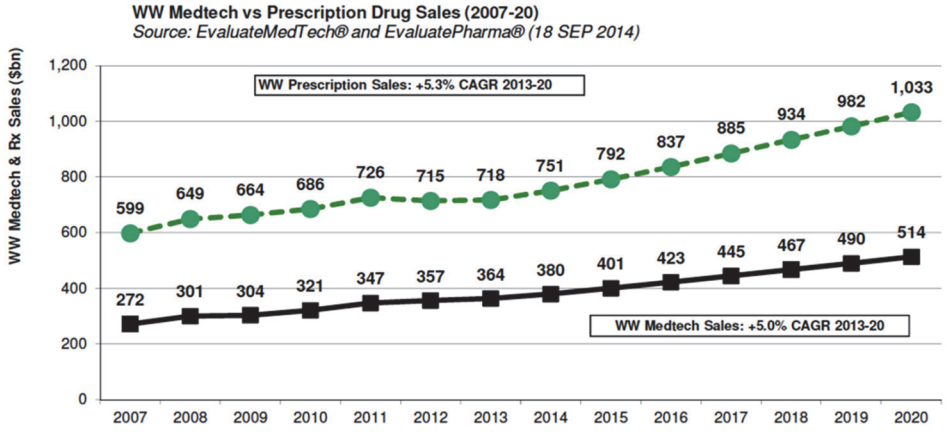
	Imports	Exports
2014	USD3,440.9mn	USD5,765.4mn
2015	USD3,253.8mn	USD5,920.6mn

Source: Ministry of Trade and Information (2015)

GLOBAL DEVELOPMENTS IN MEDICAL TECHNOLOGY

In the global scene, analysts predict that the Medtech industry will continue to grow. The data presented is based on EvaluateMedTech's World Preview 2014. The green line in Figure 4 refers to pharmaceuticals, predicted to grow at a CAGR of 5.3% from 2013-2020, and expected to be a trillion-dollar industry by 2020. The black line refers to the medical device industry, valued at over US$400 billion currently, which is predicted to grow at 5.0% CAGR from 2013-2020, and to reach US$514 billion by 2020.

FIGURE 4: GROWTH OF GLOBAL MED-TECH INDUSTRY

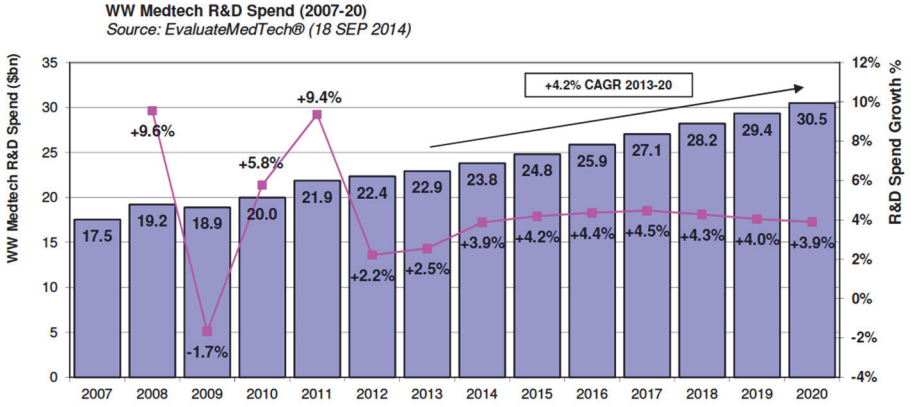


Source: EvaluateMedTech (2014)

The global R&D Medtech Sector, which is about a USD 25 billion dollar industry currently, is predicted to continue to grow at about 4.2% annually to reach USD 30 billion by 2020. Currently, about 20% of research expenditures is outsourced from multinationals to governments and research institutes. Singapore currently captures

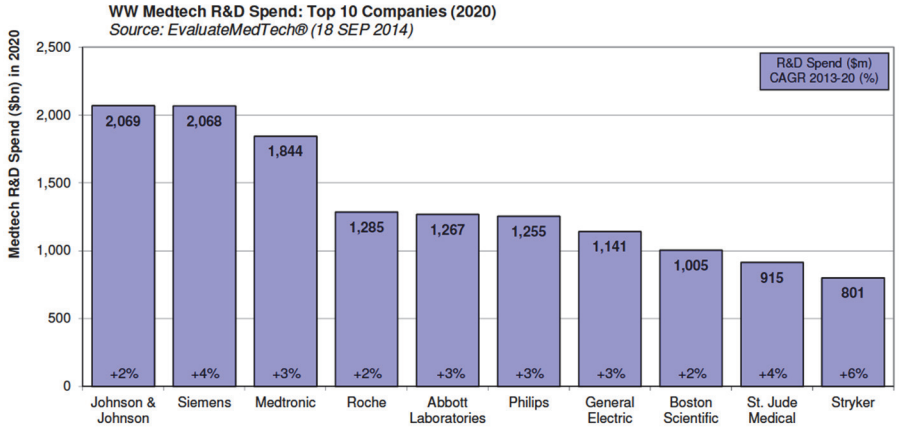
only a fraction of this, and there may be opportunities to capture significantly more.

FIGURE 5: GLOBAL R&D SPENDING ON MEDTECH



Source: EvaluateMedTech (2014)

FIGURE 6: TOP 10 COMPANIES IN 2020 FOR GLOBAL R&D SPENDING ON MEDTECH



Source: EvaluateMedTech (2014)

The world of MedTech is broad, and covers a wide range of areas, from tissue engineering, through to devices, through to electronics and data. Many of the industries that are going to substantially change the world, the disruptive technologies, will have effects on the healthcare industry. The industries with major impacts on health

include: mobile internet, the Internet of Things, advanced robotics, next-generation genomics, and advanced materials.

Mobile internet will change the way we provide services and access healthcare data. It creates increasingly inexpensive and capable mobile computing devices and Internet connectivity, which will have a potential economic impact in 2025 of US$3.7 trillion to $10.8 trillion. This implies a 10-20% potential cost reduction in treatment of chronic diseases through remote health monitoring. Component technologies of mobile internet include: wireless technology; small, low-cost computing and storage devices; advanced display technology and natural user interfaces; and advanced, low-cost batteries. Key applications of these technologies include service delivery, raising worker productivity, and additional consumer surplus from the use of mobile-internet devices.

The Internet of Things will change the amount of useful health-related data, from that which is collected in the laboratories and the doctor's surgery, to almost every possible imaginable interface- in the home, the workplace, the streets etc., as it relates to health and well-being. It will involve building networks of low-cost sensors and actuators for data collection, monitoring, decision-making and process optimization. This is expected to generate potential economic impact in 2025 of US$2.7 trillion to US$6.2 trillion, and offers potential to drive productivity across $36 trillion in operating costs of key affected industries. Component technologies include advanced, low-cost sensors; and wireless and near-field communication devices, such as radio frequency identification tags (RFID). Key applications of IOT include process optimisation, especially in manufacturing and logistics, the efficient use of resources, and remote health-care delivery, and the introduction of sensor-enhanced business models.

Advanced robotics create increasingly capable robots with enhanced sensors, dexterity and intelligence; used to automate many tasks, with a potential economic impact in 2025 of US$1.7 trillion to US$4.5 trillion, and offers the potential to improve the lives of 50 million amputees and those with impaired mobility. Component technologies include artificial intelligence and computer vision, advanced robotic dexterity and sensors, distributed robotics, and robotic exoskeletons. Applications of advanced robotics would include areas in robotics

surgery within the operating theatre; those which displace the need for humans in the pharmaceutical departments, such as at Tan Tock Seng hospital, which have automated the backend of the drug packaging and delivery service; human augmentation, and personal and home-care robots.

Next generation genomics is changing the amount of information that doctors have of their patients and opening up many opportunities for diagnostics and therapeutics. It enables fast, low-cost gene sequencing, advanced analytics, and synthetic biology (ie, "writing" DNA), with potential economic impact in 2025 of US$0.7 trillion to US$1.6 trillion. Extending and enhancing lives accounts for 75% of potential impact of this technology, through faster disease detection and new drugs. Component technologies include advanced DNA-sequencing technology, DNA-synthesis technology, and big data and advanced analytics. Key applications include disease treatment, agriculture, and production of high-value substances.

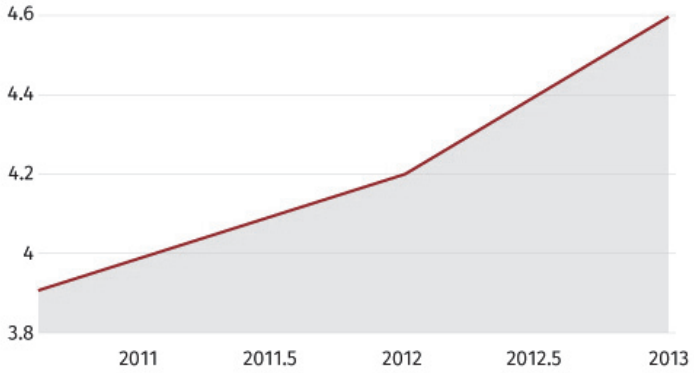
Advanced materials are changing what we can do in terms of re-building broken human body parts and re-creating new spare parts, enhancing the human capability, and nanomedicine. It creates materials that have superior characteristics such as better strength and conductivity, or enhanced functionality such as memory or self-healing capabilities. It generates potential economic impact in 2025 and applications of US$0.2 trillion to US$0.5 trillion. Nanomedicine could be used to deliver targeted drugs to 20 million new cancer cases worldwide in 2025. Component technologies include grapheme, carbon nanotubes, nanoparticles, and other advanced and smart materials such as piezoelectric materials, memory metals and self-healing materials.

HEALTHCARE COSTS IN SINGAPORE

However, one of the major health concerns in Singapore, as elsewhere, is the rise in healthcare costs. According to DPM Tharman, healthcare spending in Singapore is expected to rise from over S$9 billion in 2015, to over S$13 billion in 2020. This is due to at least two major reasons: first an aging population with greater healthcare expenditure in the later years of life, and second, increased

government spending due to the positive move towards a universal healthcare system through Medishield Life.

FIGURE 7: SINGAPORE'S EXPENDITURE ON HEALTHCARE IN S$ BILLIONS



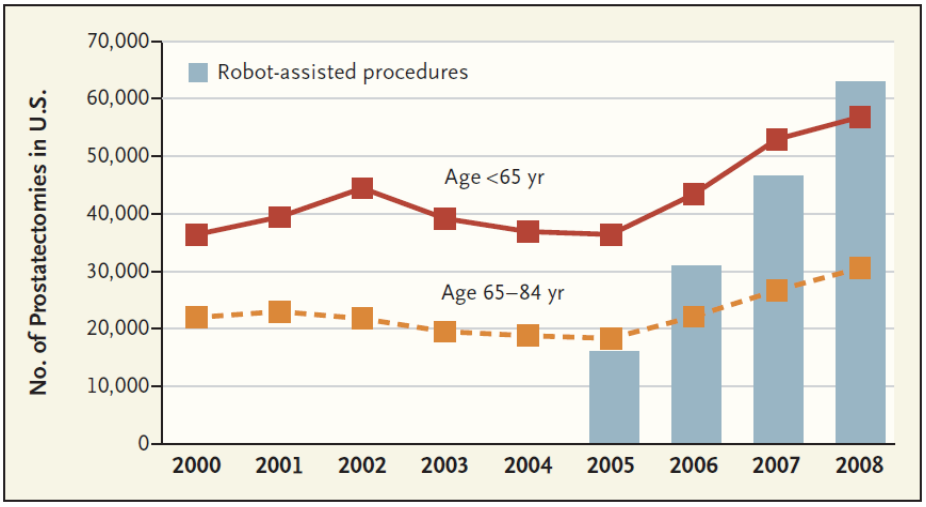
Source: World Bank (2014)

This raises the question of how technology impacts healthcare costs. There are technologies that may decrease costs, and others that will likely increase them. Technology may be cost-saving by being more effective at achieving a result, or through efficiencies particularly replacing labour costs. It can raise costs in two main ways. The first is through the increase in life expectancy, and the second is through the direct increase in treatment costs. Fifty years ago, 80% of the contribution of technology to life expectancy occurred before the age of 60. Now, technology is contributing to increased life expectancy after the age of 60. Hence technology currently is more about allowing old people to grow older, rather than saving the lives of young people.

An often-cited example of advanced technology being more expensive than other ways of achieving an outcome is robot-assisted surgery. Robotics technologies can lead to increases in costs, because they are simply more expensive than previous treatments, such as open or minimally invasive surgery, and their introduction leads to an expansion in the types and numbers of patients treated. This means increased demand and numbers of procedures. For example, for prostatectomies in the US - one of the more common operations done using robots - the introduction of robot-assisted procedures has led to increased number of procedures, and has

increased the costs for the treatment of prostate cancer, not reduced it.

FIGURE 8: NUMBER OF PROSTATECTOMIES IN U.S.



Source: Gabriel I. Barbash, S. A. G. (2010). "New Technology and Health Care Costs — The Case of Robot-Assisted Surgery." The New England Journal of Medicine 363(8): 701-704.

NEW PRIORITIES FOR FUTURE BIOMEDICAL INNOVATIONS

This raises fundamental questions, where the industry environment will be encouraging Medtech as a form of economic revenue for the country through R&D and manufacturing, and a healthcare system that is struggling to cap costs, of which Medtech is one of the major drivers. The conversation in the approach to healthcare systems will need to be reframed, and it needs to be done through an inter-disciplinary, multi-party, multi-partisan conversation, which involves health, industry, trade, economists and other whole-of-government actors, because this is fundamentally a whole-of-society issue.

Present convention evaluates technologies on the basis of their ability to change the quality of care, and makes the case that new technology should be used if it is better than the old one. However, researchers are less used to evaluating technology on the basis of costs, and will typically hand it over to industry to let the market work that out. It is even less familiar with combining the two, and assessing the value of

care, which lies in the relation of quality improvement to increased cost.

Moving forward, three effects of every innovation have to be considered:

- Quality of care
- Cost of care (Generally ignored so far)
- Value of care (Changes in quality relative to changes in cost, ignored and mostly needed to reduce the healthcare costs)

Increasing demand for high technology diagnostic and therapeutic health care facilities and their availability may come into conflict with medical necessity, social justice and cost effectiveness. We need sophisticated health economics to answer questions about relative costs and benefits of new technologies.

A global shift in conversation is needed, but in terms of organised government, and willingness to have inter-governmental departments talk to each other, Singapore presents a special opportunity to take the lead in bringing together different stakeholders to define the future of the Medtech industry and sustainable healthcare.

CONCLUSIONS

“Economic prosperity, aging population, the growing middle income population and sensitive public policy are key demand drivers of better healthcare and infrastructure. This will ultimately manifest in a gradual but undeniable shift in health outcomes of the population together with the related areas of the healthcare ecosystem.”

Minister for Health Singapore, Mr Gan Kim Yong

Technology has a major role in improving the quality of life. Some, such as antibiotics and diuretics, can reduce costs, but it is their value to healthcare that should guide how enthusiastically innovative technologies should be embraced. Some will be valuable because they achieve the same for less. Some will be valuable because, even though they cost more, they achieve much more. Technological assessments will therefore become essential, to evaluate the efficacy

of new technologies and to provide realistic information to the healthcare providers as well as patients for decision making.

The Ministry of Health has recently created the Agency for Care Effectiveness (ACE), which evaluates New Technologies before adopting them. Post-market surveillance will also be critical to understanding the real impact of technology, both in terms of the quality and cost of the introduction of technologies into society. Governments, universities and medical schools, such as NTU and the Lee Kong Chian School of Medicine, have vital roles in ensuring that cutting edge science and robust approaches are harnessed to answering these big questions that every healthcare system must face.

CROWD COMPUTING FOR PRODUCTIVE LONGEVITY

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ABSTRACT

Today, major population centres in the world (e.g., U.S., China, and Japan) are experiencing population ageing. As the current generation of seniors demonstrate relative good health and willingness to contribute to productive ageing activities after retirement, the perceptions that regarded seniors as being similar to the handicapped has changed. Such a change in perception has initiated a change in the gerontechnologies landscape — from one primarily focused on assistive technologies towards one that encourages productive longevity. Over the years, the research community has made progress in many areas of crowd computing. These progresses can be directed at serving the elderly to help them achieve productive longevity goals. In this report, we highlight opportunities for crowd computing to help unleash the productive capacity embedded in the elderly population. We will discuss a number of areas where significant innovations can emerge by combining crowd computing with gerontology research, and discuss lessons drawn from other ageing societies and opportunities for Singapore.

INTRODUCTION

In today's world, an unprecedented wave of population ageing is sweeping through many nations. Japan and Germany have already been termed "Super Aged" nations (with more than 20% of the population over 65), with Canada, Spain, Finland and Greece lined up to join this category by 2020 (Duggar & Praagh, 2014). By 2030, 34 countries, including the US, UK, China and Australia, will also become Super Aged nations. Such a worrying trend is putting increasing

strains on healthcare systems and public health budgets, prompting many to caution about a worldwide “silver tsunami” (Das, 2015).

Currently, the prevailing perception of senior citizens is that they are physically and cognitively frail. With this perception, much research effort in the field of gerontechnologies focuses on developing assistive technologies for the elderly (Bouma et al., 2009). However, with improved nutrition and medical care, most seniors are enjoying many more years of relative health than previous generations (Rowe, 1997).

As the demographic shift towards fewer young people takes place, there is also some questioning of the traditional contract between the working generation and the retired generation. Traditionally, the intergenerational contract has been built on the basis of intergenerational reciprocity. As the old-age support ratio around the world dwindles (United Nations, 2013), the new norm is likely to require seniors to bear more of the costs of their longer lives through active participation in socio-economic development activities post retirement (Harper, 2014). To age successfully, the maintenance or enhancement of physical and cognitive functions and full engagement in life through productive activities and social connections will be the key foci (Arbesman & Lieberman, 2012; Johnson & Mutchler, 2014; Lum, 2012; Thanakwang & Isaramalai, 2013). Therefore, gerontechnologies should also change from treating seniors similar to the disabled, to actively engaging them in various aspects of successful ageing.

Crowd computing offers great promises to addressing this challenge. Many existing individual dimensions of crowd computing research — when re-looked in the context of interacting with the elderly, — can lead to novel research breakthroughs. In order to make a more significant impact, an ecological approach to organise the resources across multiple research teams to build synergy is needed to tackle system-level challenges. In this report, we will discuss how crowd computing can be combined with gerontology research to empower productive longevity. We will also discuss crowd computing based initiatives in Japan and China, and how Singapore could initiate and benefit from similar approaches.

PRODUCTIVE AGEING AND ALGORITHMIC CROWDSOURCING

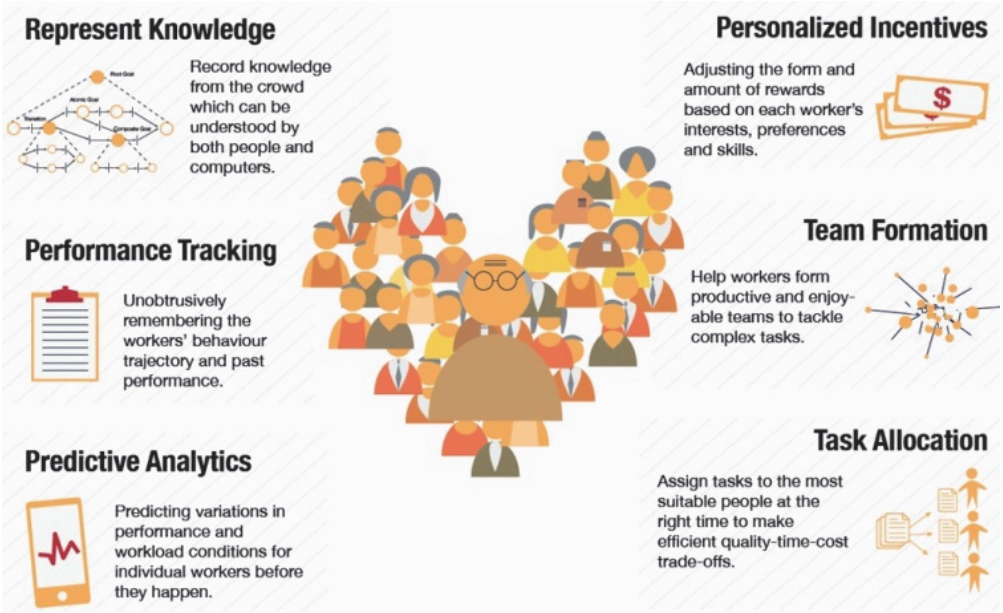
Productive ageing activities (e.g., volunteering) and even those providing no enhancement to fitness have been found to lower the risk of mortality as much as fitness activities do (Glass et al., 1999). Crowdsourcing presents a promising solution for bridging seniors with productive ageing activities in a flexible way. Currently, no commercial crowdsourcing platforms provide explicit support to elderly users. Nevertheless, technology components that build crowdsourcing platforms for productive ageing are starting to emerge. In this aspect, the Joint NTU-UBC Research Centre of Excellence in Active Living for the Elderly (LILY) in Singapore is currently in a world leading position in the field of algorithmic crowdsourcing.

The research programme in productive ageing technologies at LILY encompasses all six major sub-fields of algorithmic crowdsourcing as shown in Figure 1. Knowledge representation tools that provide a human interpretable format for representing knowledge and processes that can also be easily interpreted by a computer have been proposed (Yu, Shen & Miao, 2007; 2008). For motivating the elderly to participate in crowdsourcing, works that combine human factors into intelligent agents such as in Yu, Shen, Miao & Tan (2011) can be leveraged. Support for collaboration among older crowdsourcing workers can be achieved through multi-agent organisation technologies (Li et al., 2009) as well as intelligent interface agents (Yu, Cai, Shen, Tao & Miao, 2010; Wu et al. 2013; Cai et al., 2014). Trustworthy computing research also provides many useful models to foster trust among the older workers (Yu, Shen, Miao, Leung & Miyato, 2010; Yu, Shen, Leung, Miao & Lesser., 2013; Liu et al., 2013; Liu et al., 2014; Qiu et al., 2014). In addition, intelligent technologies are emerging, which can help optimise the quality-time-cost trade-off to improve the productivity of large crowdsourcing systems, (Yu, Shen, Miao & An, 2013; Yu, Miao, An, Leung & Lesser, 2013; Yu et al., 2014; Yu, et al, 2015b), even in situations in where workers with diverse skills must collaborate to accomplish tasks (Pan et al., 2016; Yu et al, 2016). Our latest work in managing complex multi-stage crowdsourced tasks with automated dynamic pricing decision support can potentially help productive ageing agencies obtain superlinear productivity from the elderly crowd (i.e., achieving a collective productivity larger than the sum of individual productivity).

It is currently in the process of being published in the *Nature* sub-journal *Scientific Reports* (Yu et al., forthcoming). These innovative intelligent technologies, combined with appropriate changes in policies governing the hiring of older workers, hold the key to sustaining socio-economic growth in ageing societies.

Recently, LILY is also preparing to publish the world's largest dataset on crowdsourcing decision-making strategies demonstrated by users with the *Nature* sub-journal *Scientific Data* (Yu et al., forthcoming). With it, the research community can gain more insight to crowdsourcing behaviours and work towards more intelligent and personalised crowdsourcing control strategies to help seniors achieve productive longevity.

FIGURE 1: LILY'S PRODUCTIVE AGEING RESEARCH PROGRAMME



LESSONS FROM CHINA

As the important socio-economic impact of population ageing becomes increasingly apparent, governments and organisations of countries in the front line of this demographic shift are starting to

formulate various initiatives and programmes supporting the ageing populations. In this section, we highlight several examples of such policies from ageing countries, including those initiated in a top-down manner by governments and those initiated in a bottom-up manner by grassroots organisations, and how crowd computing research can make an impact under these policy frameworks.

China's Mass Entrepreneurship and Innovation (MEI) programme[1] is a top-down approach for crowdsourcing entrepreneurship and innovative ideas. While MEI is not specifically aimed at active and productive ageing — it is an open-ended call for entrepreneurship and innovation by mass collaboration — the scheme has provided a platform for the elderly who have the experience, skills or capital to take up different roles in the entrepreneurship and innovation.

Under the MEI programme, many crowdsourcing-based MEI businesses are starting to emerge in China. For example, the Weitianshi Alliance[2] focuses on building a community of experienced small-scale angel investors (who are often senior citizens) to serve as mentors for the young who wish to start up their own businesses based on their innovative ideas. The mentors have the options to invest their own money into startup companies in which they see potential, and can play an active role in helping the young technopreneurs steer the companies towards success. In exchange, the mentors are given shares in the companies they supervise.

Feedback from both the mentors and the technopreneurs are tracked in order to help them build up a profile that can be seen by future users when they decide which mentor or technopreneur to approach. Major Internet companies in China, such as Baidu, Tencent, and Taobao, have all set up their crowdfunding platforms to support MEI. Just as crowdsourcing-based platforms for MEI experience a period of rapid development in China, so will crowd computing related research and development receive increasing attention accordingly.

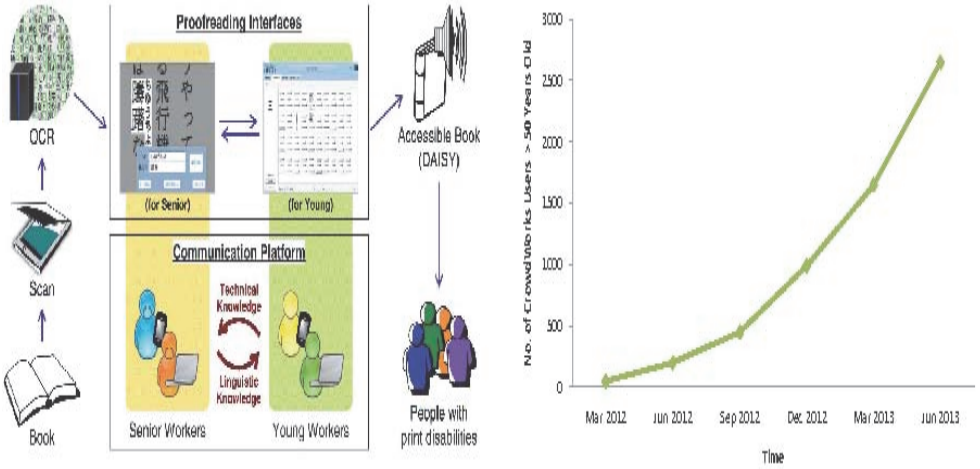
[1] For details, see http://english.gov.cn/policies/latest releases/2015/06/16/content.281475128473681.htm
[2] For details, see http://www.weitianshi.cn/ and http://thebridge.jp/en/2013/06/japan-seniors-employment

LESSONS FROM JAPAN

In contrast, Japan has embraced crowdsourcing as a tool for active and productive ageing following more of a bottom-up approach. An example of collaborative crowdsourcing for productive ageing in Japan is shown in Figure 2. In this case, people across different generations contribute their knowledge to convert traditional Japanese scripts into e-books. The elderly who are familiar with the intricacies of traditional Japanese scripts contribute their linguistic knowledge, while the young assist the elderly by providing their technical know-how, i.e., scanning books with traditional Japanese scripts to enable elderly workers to process them (Kobayashi et al., 2013).

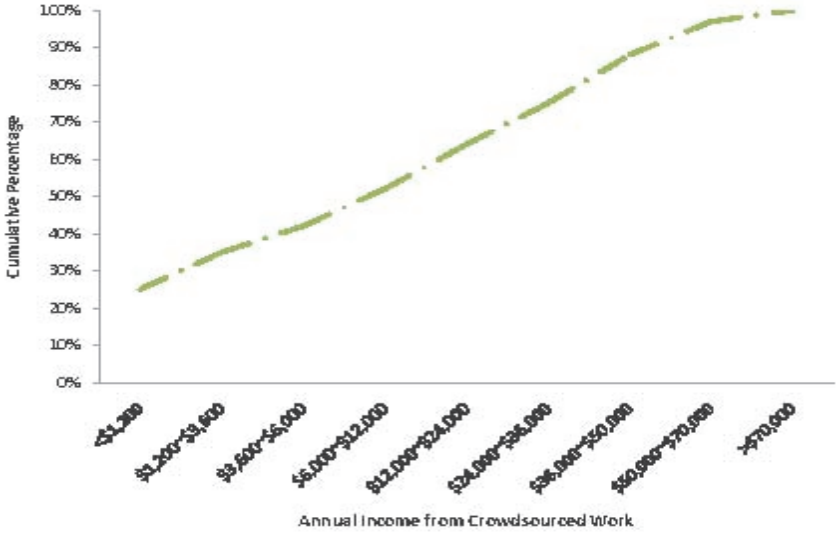
In Japan, crowdsourcing is starting to become a viable source of work and income for many people aged 50 and above. According to a recent survey conducted by Crowd-works — a crowdsourcing marketplace in Japan, the cumulative distribution of annual income derived from crowdsourced work by people aged 50 and above in Japan is as illustrated in Figure 3 (Hirano, 2013). It can be observed that over 50% of aged crowdsourcing workers earn between US$1,200 to US$12,000 annually from performance crowdsourced tasks, making it a significant supplementary component of their income. More than 10% of them can even earn between US$36,000 to US$70,000 per year from crowdsourced work, significantly higher than the average annual income by working age adults in Japan.

FIGURE 2: OVERVIEW OF INTER-GENERATIONAL COLLABORATIVE CROWDSOURCING FOR PRODUCING E-BOOKS IN TRADITIONAL JAPANESE SCRIPTS



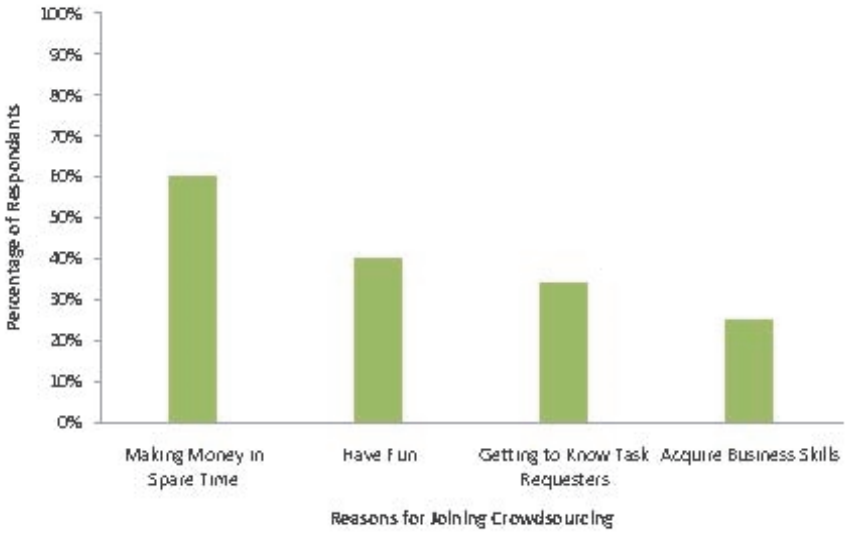
Source: Kobayashi et al. (2013), "Age-based task specialization for crowdsourced proofreading"

FIGURE 3: CUMULATIVE PERCENTAGE DISTRIBUTION OF ANNUAL INCOME DERIVED FROM CROWDSOURCED WORK BY PEOPLE AGED 50 AND ABOVE IN JAPAN



Source: Crowdworks via Hirano (2013)

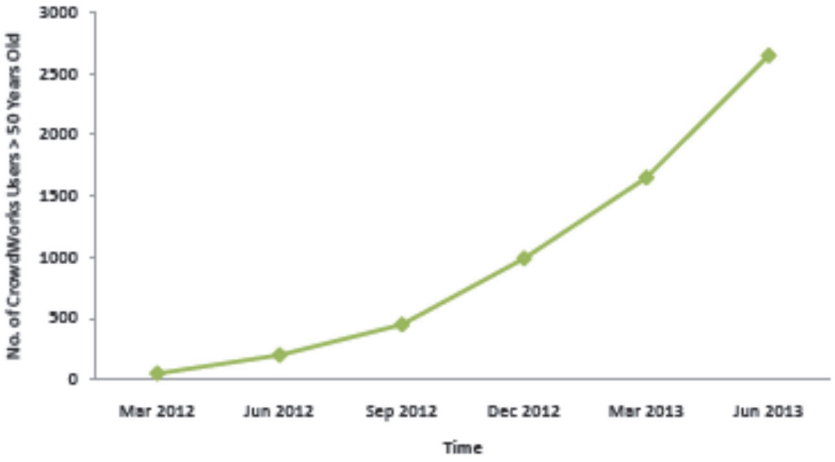
FIGURE 4: REASONS CITED BY PEOPLE AGED 50 AND ABOVE IN JAPAN FOR JOINING CROWDSOURCING



Source: Crowdworks via Hirano (2013)

Various reasons are cited by the aged survey respondents about why they join crowdsourcing (Figure 4). Over 60% of them did so in order to obtain more income during their spare time. Having fun is also a compelling reason with more than 40% of them selecting it as one of the reasons they join crowdsourcing. Socialising is also an important reason for more than 30% of them for joining crowdsourcing. Around a quarter of them selected acquiring business skills as one of the reasons, indicating that crowdsourcing can also be perceived as a venue for personal growth and life-long learning. So far, the number of crowdsourcing workers aged 50 and above is growing at an exponential rate as tracked by CrowdWorks in Japan (Figure 5).

FIGURE 5: GROWTH TRAJECTORY OF USERS AGED 50 AND ABOVE IN CROWDWORKS, JAPAN

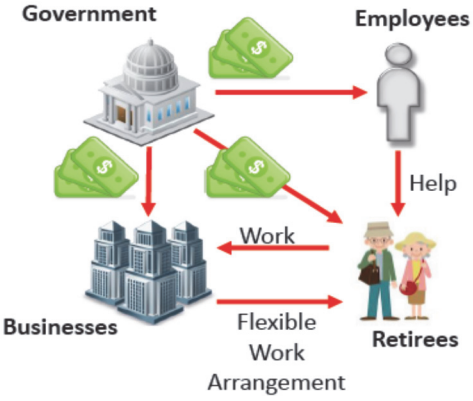


Source: Crowdworks via Hirano (2013)

OPPORTUNITIES FOR SINGAPORE

Singapore has already laid a strong policy foundation for crowdsourcing based productive ageing to thrive. A major policy initiative that is closely related to active ageing is the Ministry of Manpower's WorkPro programme, which focuses on incentivising retirees to keep contributing to national development.

FIGURE 6: THE WORKPRO PROGRAMME IN SINGAPORE



Through the WorkPro programme, the government provides the much-needed monetary support to promote companies to hire qualified retirees back to the workforce, in order to tap into their skills and experience honed over entire careers. The scheme includes three types of monetary support as illustrated in Figure 6. First, retirees who wish to re-enter the workforce can apply for salary top-ups and bonuses from WorkPro if they stay in the workforce for a designated amount of time. Second, current employees of companies re-hiring retirees who are willing to provide on job training and support for them can apply for financial incentives from WorkPro. Lastly, companies that re-hire retirees can apply for grants from WorkPro in order to re-design the workplace to make it age-friendly, and train their human resource executives to be more well-versed in how to engage with aged workers. This resembles very much the complex workflows of inter-generational collaborative crowdsourcing in which workers with different skills cooperate to solve tasks that cannot be accomplished by an individual (Pan et al., 2016). If crowd computing can be used to complement the WorkPro programme, it is possible to enable the programme to transcend organisational boundaries and enable a larger pool of retirees to work on projects they are interested in whenever they wish to.

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CYBER SECURITY: A GROWTH SECTOR IN SINGAPORE'S FUTURE ECONOMY

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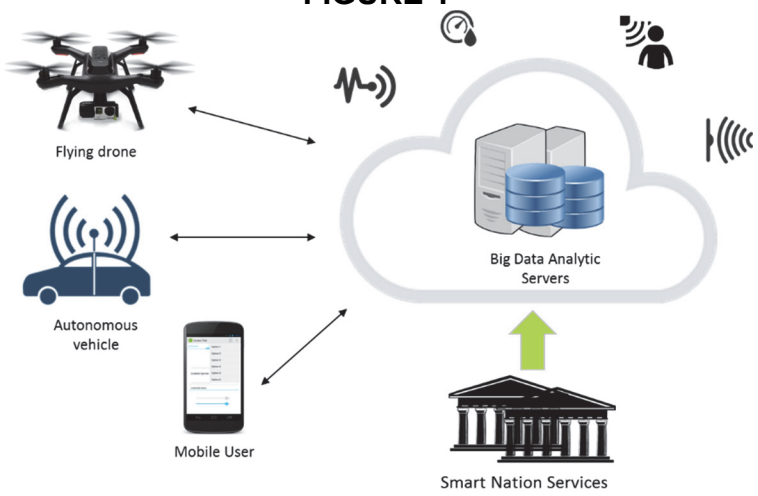
CYBER SECURITY IN THE DIGITAL ECONOMY

Future industry will be enhanced and enabled by the innovative use and widespread adoption of advanced cyber and big data technologies. As Singapore prepares to deal with challenges for the next wave of growth, substantial efforts have been spent in analysing and understanding the global trend of industry and economic development, with the aim of positioning Singapore to remain a hub of actions in the future economy of the world.

In the backdrop of ambitious efforts by most developed countries in embracing smart city/nation technologies to re-invent and enhance every aspect of their social and economic activities — such as manufacturing capabilities, government operations, citizen's mobility, healthcare and quality of life for the aged, etc. — advanced cyber and data sciences technologies are aggressively and innovatively exploited and adopted in order to achieve the following objectives:

- Automation;
- Data-centric decision making;
- Borderless market; and
- Disrupting existing business models and enhanced efficiency.

FIGURE 1



Cyber Security is a key enabler for industries of the future in a smart nation. Given the heavy reliance on cyber technologies for supporting daily activities of the society, security and resilience of the cyberspace is of critical importance. A smart nation needs a trusted, resilient and robust infrastructure in order to keep Singapore in the heart of the global, digital economy.

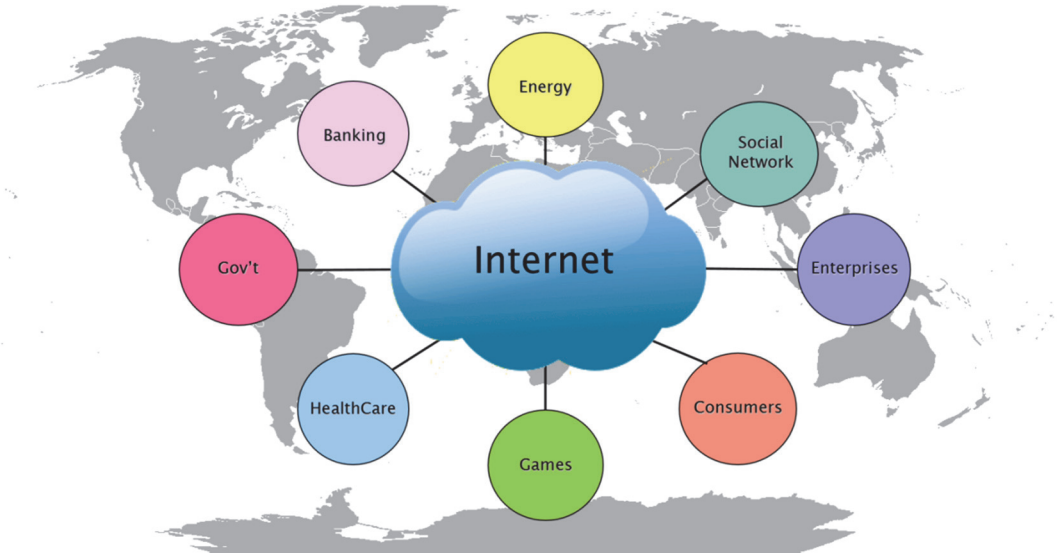
IN CYBERSPACE

The pervasive adoption of Internet technology has led to its evolution from an internetworking technology to the notion of a cyberspace where individuals and organisations conduct part of their daily activities. Due to the ever-increasing demand for improved productivity and business agility, the world has witnessed a most pervasive adoption of infocomm technology in every sector of our society — ranging from government and telecommunications, to energy and banking and financial. Furthermore, within each sector, the underlying information systems and industrial control systems are increasingly interconnected by, and becoming part of the Cyberspace.

The Cyberspace is a global interconnection of infocomm infrastructure that is pervasively integrated into our daily lives. The Cyberspace is a virtual space created by technological components interconnecting various stakeholders including state organs, government agencies, business enterprises and individuals. The activities carried out in the

Cyberspace include government operations, businesses transactions, supervisory control and data acquisition of critical utilities infrastructures, remote access to information assets, and social interactions of ordinary citizens. The Cyberspace has become an integral part of people's daily life and is critical to the normal functioning of the society.

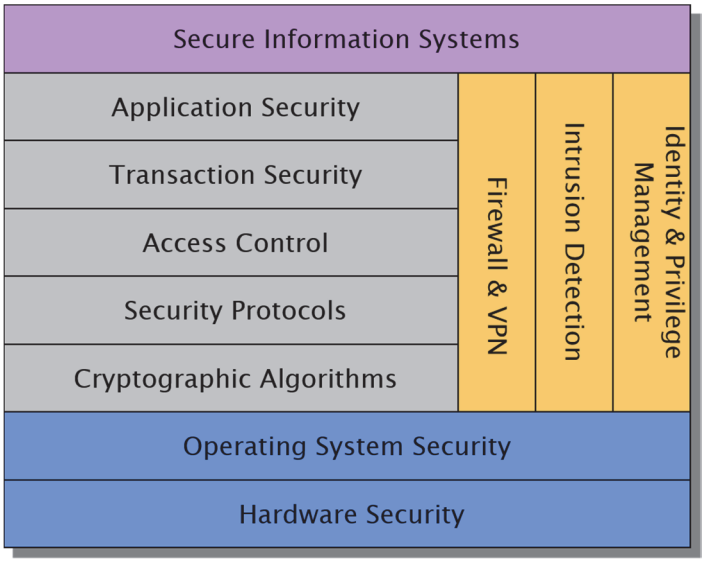
FIGURE 2



WHAT IS CYBER SECURITY?

The objectives and the underlying technological requirements of Cyber Security are very different from those of traditional enterprise security that most practitioners in the ICT space are familiar with. Traditional enterprise security are typically characterised by some technology framework that covers the protection needs of the various layers of a typical IT system.

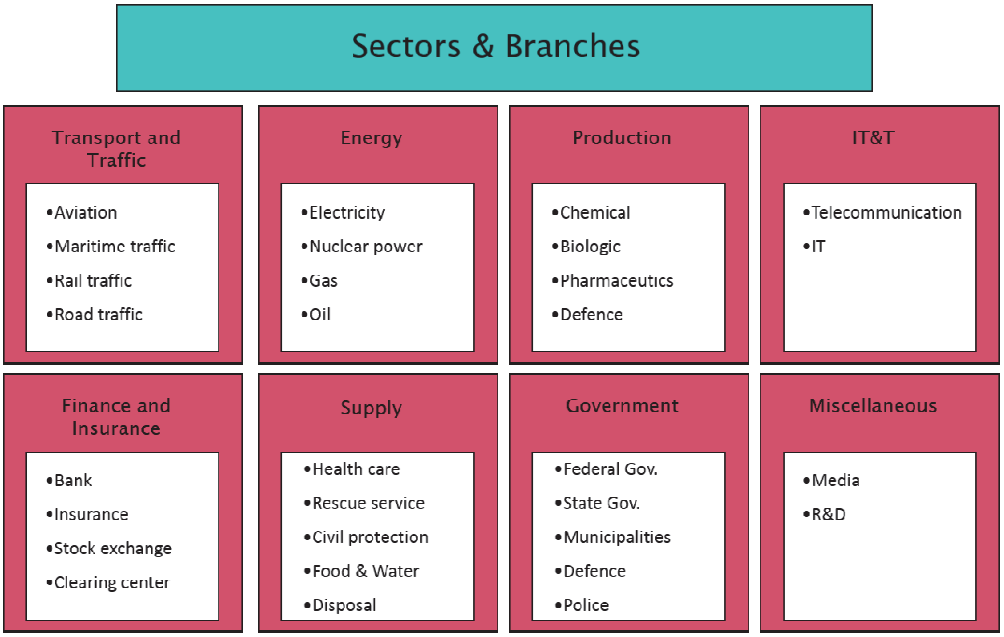
FIGURE 3



Security of the cyberspace is a concern not only to individual computers, people and enterprise. It is obvious from experiences that Cyber Security incidents could lead to serious disruption of daily activities and even social unrest. Cyber terrorists and state-funded cyber warfare activities tend to take the long-term and low-profile approach that gradually infiltrates Critical Information Infrastructure (CII) systems. Besides, the Cyber Security problem is not limited to CII because sophisticated cyber attackers tend to make use of non-CII systems as stepping-stones towards the CII targets.

The Cyber Security market is much bigger than traditional enterprise security. While the latter typically aims to address the protection needs of IT (Information Technology) systems, the former also put a great deal of emphasis on the protection needs of OT (Operation Technology) such as Industrial Control Systems (ICS) and SCADA (Supervisor Control and Data Acquisition System), etc.
In order to capture the new opportunities of cyber security in the OT space, there is a pressing need for cyber security professionals to develop a deeper understanding of OT systems (especially the systems and application architecture, system and application software, communications and control protocols, etc.) in various security-critical sectors.

FIGURE 4



Cyber Security is a problem created by real-world applications of the cyberspace. The solutions to it hence require deep understanding of such real-world applications. Specifically, Cyber Security professionals need to deal with key questions, such as the following:

- Understand the nature of the underlying data and system to be protected
- Understand the threat models of the open network infrastructure on a global scale
- Identify the risk and trust models of application systems in different industry domains
- Understand applicable policy and regulations for governing the behaviour and conduct as well as rights and liabilities of all stakeholders
- Study and implement the Cyber Security regimes for policing and surveillance of the Cyberspace in order to safeguard the Cyberspace as a safe and robust environment for conducting business and social interactions
- Design and establish the protocols and mechanisms for cross-border cyber crime investigation and tracking of cyber criminals,

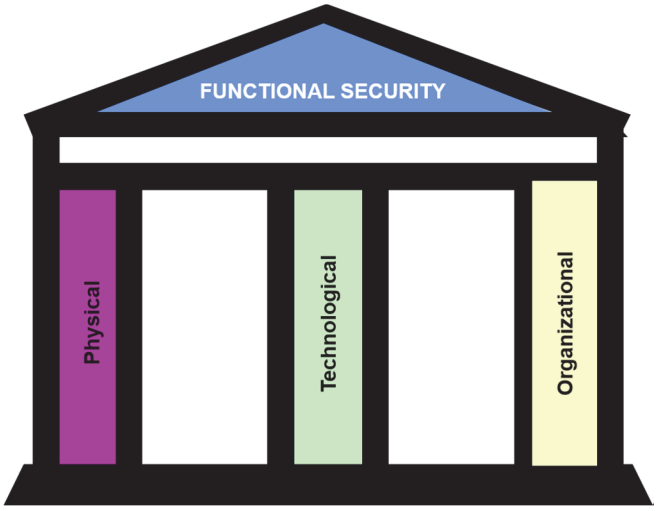
- Design and develop forensic methodologies and tools for gathering court-admissible evidence in the cyberspace in order to support law enforcement.

It is obvious that Cyber Security is a truly multi-disciplinary problem requiring expertise from various knowledge domains including:

- Science and Technology: Networking, Distributed Systems, Lightweight Security Protocols and Mechanisms for IoT, User Behavior Analytics for attacker profiling
- Legal and Public Administration: Governance, Policy, Law and Regulations
- Social Science: Organisational and people's behaviour
- Industry-specific knowledge: This requires deep understanding of the threats, risks and trust models of critical systems and infrastructures operating in the Cyberspace such as:
    - e-Government
    - Telecommunications
    - Banking and finance
    - Water
    - Power and energy
    - Healthcare
    - Transportation
    - Aviation

The study of Cyber Security is a field of multi-disciplinary nature that requires a coherent body of knowledge to analyse and address cyber security issues in a holistic manner. Cyber Security is not a purely technological issue. In order to achieve effective and efficient security and resilience of the Cyberspace, it requires a combination of physical approaches, technological approaches as well as organisational approaches.

FIGURE 5



SUMMARY AND RECOMMENDATION

The objective of supporting Cyber Security as a future industry is to develop a Cyber Security workforce with skills to understand Cyber Security issues and practices from technical, operational and organisational points of view.

Capability development in Cyber Security is urgently needed to meet the skills and manpower needs of the future economy of Singapore. Academic curriculum in Cyber Security should be devised to understand and address real-world problems, and they should have a comprehensive structure that aims to develop the various important skills of Cyber Security. A Cyber Security curriculum needs to be built on strong foundations in knowledge areas such as distributed systems, communication networks, software engineering etc. The curriculum should allow specialisation in key activities in the Cyber Security domain such as Monitoring and Surveillance, Protection and Cyber Defence, Secure Design and Development, Investigation and Response, as well as Governance and Regulations.

FIGURE 6

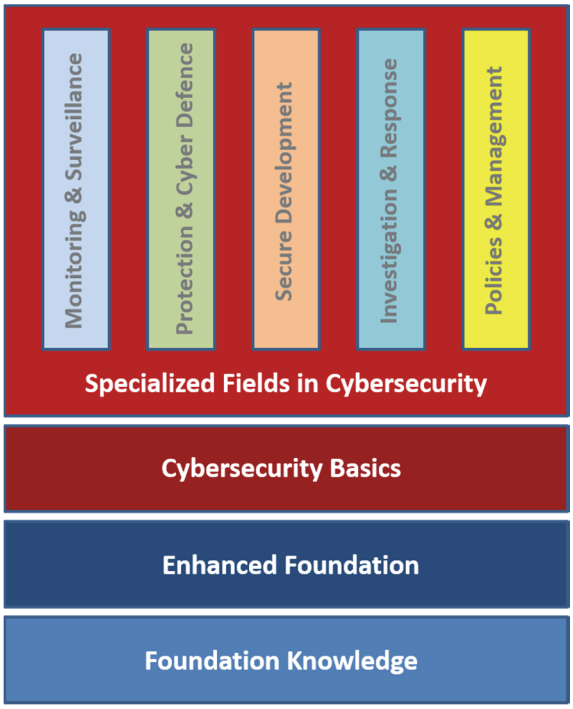
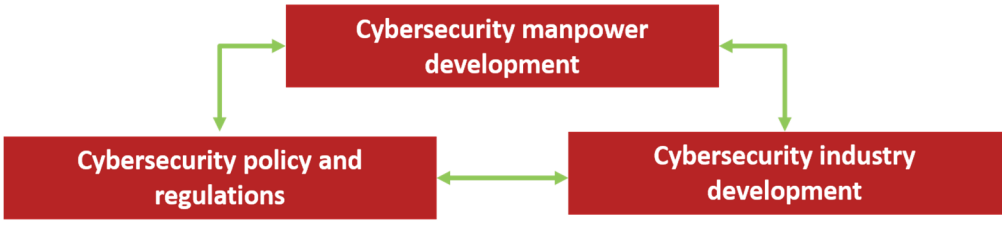


FIGURE 7



Chapter 2

Ecosystem of the Future Economy

VISIONS AND RECOMMENDATIONS FOR AN INCLUSIVE FUTURE ECONOMY OF SINGAPORE

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ABSTRACT

We envision that our future economy will see many diverse fields flourishing, driven by the advent of advanced technologies and the mastery of craftsmanship to produce innovative and high-value products and services. These will be supported by the synergy of high-tech solutions and high-touch skill sets from across a broad spectrum of the workforce.

In this paper, we propose recommendations that advocate equal opportunities to maximise one's potential, tapping on regional opportunities, and positioning small and medium-sized enterprises (SMEs) as the next engine of growth.

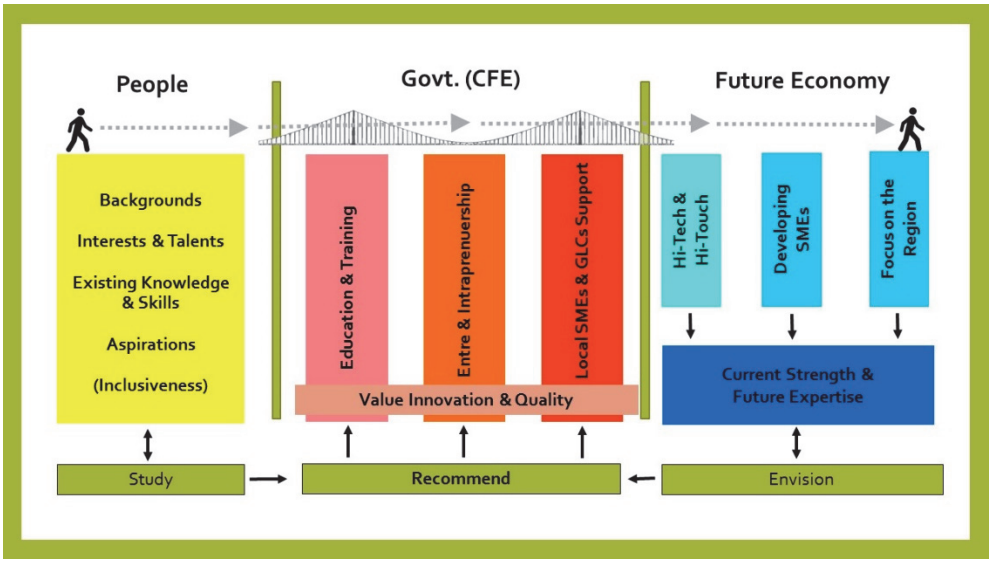
METHODOLOGY

We adopted the following methodology:

1) Study the relevant demographic profiles of people for inclusiveness;
2) Envision a future economy; and
3) Propose a set of recommendations to the government aimed at bridging Singaporeans to this future economy.

In the next section, several notable profiles of our population are highlighted. In Section 3, three broad visions of the future economy are presented. Finally, several recommendations that can bridge our people to the envisioned future economy are described, as depicted in Figure 1.

FIGURE 1: CONTEXT AND OVERVIEW OF THE RECOMMENDATIONS



THE PEOPLE — AN INCLUSIVE APPROACH

Singapore is not blessed with many natural resources. Without a skilled and diligent labour force, Singapore's economic success would not have been attainable. The island nation continues to charm talented job seekers globally; and this further emphasises the need for the local labour force to continually upgrade and reskill to remain relevant in the workplace.

Recently, Singapore introduced SkillsFuture, a national movement to enable all Singaporeans to develop to their fullest potential and contribute to the workforce. This is a lifetime movement in light of changes in the nature of work and jobs as technology advances. SkillsFuture will play an important part in charting Singapore's next phase of development towards an advanced economy and inclusive society (Government of Singapore, 2016). Every individual's skill, passion and contribution counts. In shaping the future economy for the people, Singapore Institute of Technology (SIT) wishes to highlight the idea of "inclusiveness" by identifying multiple starting points, pathways, and peaks of excellence that are relevant to the cross-section of our people.

We propose to consider the spectrum of: (a) backgrounds; (b) interests and talents; (c) existing knowledge and skills; and (d) aspirations.

Based on the spectrum highlighted above, we identified polytechnic graduates as a key segment of the population. Polytechnic graduates comprise more than 40% of each cohort that entered school in Primary 1, and there is an increasing trend of students opting for a polytechnic education (even among those who qualify for junior colleges). These students have diverse interests and skill sets and are well positioned to undertake key responsibilities in the future economy.

We also emphasise the need to holistically develop our future economy for our population, which is broadly distributed across the left-brain and right-brain oriented spectrum. In the current situation, technology-driven initiatives have been relatively over-exploited; hence, there is a need to prioritise the development of alternative skill sets and industries for those that prefer to venture outside of the high-tech industries.

ENVISIONING THE FUTURE ECONOMY

We envision the future economy to have the following three broad characteristics. They are: (1) High-Tech and High-Touch; (2) Focus on the Region; (3) Focus on SMEs.

High-Tech & High-Touch

We envision that the future economy will see many diverse fields flourishing from the mastery of craftsmanship to advance technologies. As such, we propose that value creation be supported by both high-tech solutions and high-touch[1] skill sets and mindsets in the future economy.

Of late, high-tech developments have been in the limelight; some examples include the Internet of Things, Big Data Analytics, and Smart Cities. However, the human touch remains essential in many of

[1] The term “Hi-Tech Hi-Touch” was first coined by John Naisbitt in the early 1980s. See Naisbitt et al. (2001), *High Tech High Touch Technology and Our Accelerated Search for Meaning*.

these sectors. The term “high-touch” reminds us that many complex tasks require more than high-tech to receive a satisfactory solution, and that high-touch skill sets should be developed concurrently for tasks that will be perform better by humans. For instance, most people will not want robots to raise their children. Furthermore, based on the principle of “inclusiveness”, we ought to recognise that not everyone can or wishes to work in high-tech industries. High-touch industries would include hospitality and tourism, culinary (including the future of local hawker food), healthcare, and areas that will benefit from high levels of artistry and craftsmanship (in diverse fields from hairdressing to design). It is our vision that both high-tech and high-touch skill sets play equally important roles in Singapore’s future economy.

In fact, high-tech with high-touch are not mutually exclusive and indeed, the high-touch industry will leverage high-tech solutions. These are evident in smart tourism, smart hairdressing, smart urban farming, etc. In the case of hairdressing, for instance, technology can assist in the selection of hairstyles by fitting different styles to faces; although ultimately, the reassuring attention of a competent hairdresser is still required and irreplaceable.

Focus on the Region

The first wave of economic development in Singapore 50 years ago was based on looking out to the first-world economies of Europe, Japan and the United States, where the main objective was to create jobs, attract foreign direct investment, learn from the developed economies, and offer Singapore as a market segment for the goods and services produced.

With capabilities and expertise built up from the first wave, the second wave 30 years ago shifted to China and India, where Singapore companies found opportunities and markets in the emerging economies of China and India. The Singapore brand was leveraged to partner with local Chinese and Indian governments and share expertise in economic development.

We envision that the region will become the natural focus (low-hanging fruit) for Singapore in the future. More specifically, the ASEAN region will be the third wave on which Singapore should ride.

Singapore's hinterland is ASEAN and it is geographically situated in the centre of ASEAN. With a market of 620 million people, an estimated GDP of US$2.5 trillion (in 2014) and a projected annual growth of over 5% to the year 2018, ASEAN will be the fourth largest single economy — behind the European Union, United States and China — by 2030 with a GDP of USD10 trillion (OECD, 2014; ISEAS et al., 2014). The growing middle class and sizeable young population in ASEAN forms a prominent market for Singapore's businesses. The establishment of the ASEAN Economic Community (AEC) in 2015 underscores the economic potential of this region.

The nations in the ASEAN region are at different stages of economic development and remain open to opportunities and are at risk of threats. Singapore should identify the current and future employment gaps in the ASEAN region that the workforce can fill. The opportunities in ASEAN will be based on: (a) increasing level of economic and social maturity; and (b) continual evolvement and adaptation of the region. Various indicators from the World Bank's World Development Indicators[2] illustrate the case for the placement of Singapore's human capital in the region to contribute to the development of ASEAN nations. For instance, based on the data (not shown here), we can see that the ASEAN region has low population growth, an ageing population (especially in Singapore, Thailand and Vietnam), and falling birth rates (notably in Laos, Cambodia and Brunei). We envision that Singapore may build on the linkages in ASEAN to tap on the larger market and opportunities while sharing our expertise on economic and social matters as well as in providing humanitarian assistance when needed. Such opportunities are made possible by the committed investment in Singapore's human capital through training and education, where the benefits will not just be enjoyed by the island nation, but actualised to the greater ASEAN region.

Focus on SMEs — Can *Mee Pok* be Like "Ramen"?

We note that SMEs employ 70% of workforce but provide only 50% of economic output (MTI, 2013). As they employ the majority of the

[2] Indicator proxies include Birth rates, Employment (in Agriculture, Industrial and Services), Enrolment in Secondary Vocation, Labor Force Participation, Life Expectancy, Percentage of Population older than 65 years old, Population Growth, and Self-Employment rate.

labour force, more should be done to propel SMEs towards greater success. SMEs should be acknowledged and primed as the new engine of growth.

The majority of SMEs perform a particular function within a value chain supporting MNCs, but few have explored outside of their specialised roles to other stages of the value chain. SMEs will need to broaden their scope in the value chains to progress beyond supporting MNCs in the future economy. There have been success stories in the defence sector where SMEs have produced and supplied parts and components as well as finished products for Singapore Technologies. Another notable product would be the desalination of seawater to potable water. SMEs should explore regional opportunities with emphasis on vertical development in the supply chain.

An analogy of this vision is for the local *Mee Pok* noodles to attain the status of Japanese Ramen. Mee Pok is relatively undervalued and unknown in comparison with the well-known Japanese culinary export, Ramen. Yet, *Mee Pok* has the potential to be a culinary flag bearer and a value-added culinary export in the same vein. In other words, our SMEs' products and services will need to have the intricacy, consistency, design, image and status of the Ramen in the future economy. SMEs should learn to take measured steps towards advancement without having their existing positions threatened.

SMEs can offer greater employment opportunities to the workforce and provide greater economic output. A broader and sustained development calls for greater resources towards SMEs' development and ensuring that the impacts trickle down and across the value chain. Singapore-branded goods and services may offer a way out for the SMEs in the future economy — but this will not be possible without embracing the future economy and engaging to maintain a competitive edge. In this way, SMEs can emulate the *Mittelstand*[3] of the German-speaking countries.

[3] *Mittelstand* are small and medium size enterprises with highly specialised capabilities. They are renowned for their innovative and high value products.

Current Strengths & Future Expertise

Thus far, the vision articulated in the above section points to two segments of Singapore's response: First, to build on existing core strengths and second, to explore expertise for the future.

The current strengths of Singapore include the following:

- The Singapore brand — A globally trusted brand that stands for safety, efficiency and high productivity. Singapore firms in the logistics and transportation sector have been able to compete on a global standing.
- Education — Singapore's education system is globally recognised with its universities and institutions ranked internationally; making it an appropriate tool to develop human capital.
- Niche areas — These include medical tourism (by engaging technology to complement high-touch services), finance (pillar of the Singapore economy), infrastructure (port, airport, waste and water), sovereign fund investments and humanitarian aid.

Future areas of expertise that can be developed include the following.

- Design — Singapore has invested in design (as a potential forte) enabling significant differentiation to products and services. While resources have been pumped into this area, we have yet to witness successes observed in Japan and Taiwan.
- Sustainable, smart and liveable cities — Singapore is an early mover and has leveraged this model of success to offer development services towards sustainable, smart and liveable cities for the region.
- Culture — Being in the region with a multicultural setting, Singapore is an ideal place to develop products and services for a wide range of demographics.

We propose that Singapore consolidate and exploit existing core strengths and build on future expertise for the region with the use of high-touch and high-tech industries.

RECOMMENDATIONS FOR THE CFE

Considering the lifecycle of an average individual from schooling to entering and contributing to the workforce, we propose three tiers of efforts in *bridging* our people to the future economy (refer to Figure 1). They are "Education and Training", "Entrepreneurship and Intrapreneurship", and "Local SMEs Support".

Education and Training

In general, we recommend integrating the entire spectrum of education and training institutes (for example, institutes of higher learning, polytechnics, Institutes of Technical Education, arts institutions, and other vocational institutes) towards an inclusive model for the people. In view of the importance of both high-tech and high-touch in the future economy, we advocate an education and training landscape that is balanced, and one that will synergise the applications of the two types of skill sets and industries. We also propose education and training initiatives that gear our future workforce to capitalise on the regional market. Some specific recommendations below also point towards a build-up of regional "soft power" by bringing AUs, local SMEs and established firms closer to the region. In summary:

- Translate the purpose of internship from supporting companies to one of a learning model.
- Introduce initiatives in educating and training the marrying of high-tech and high-touch solutions (highlighted in the preceding section). For instance, at SIT, we encourage the cross-pollination of ideas and projects between faculty and students from high-tech and high-touch programmes.
- Emphasise the concept of life-long education from institutes to companies, thus enabling a mindset of continuous education in line with SkillsFuture.
- Extended internships in tertiary education will further increase the readiness of our workforce before graduation. SIT facilitates Integrated Work-Study Programme (IWSP) where students spend eight to 12 months acquiring real work skills and integrating them with the knowledge they have learnt. Through the IWSP, students will need to understand

organisations at the process and system level to find ways to improve efficiency and implement them successfully. They may also bring in new ideas or even create new products and services to generate new growth pathways.

- To train innovation-driven students through working closely with the industry. Applied learning and research models can be developed to suit the hands-on curiosity of students. In SIT, faculty members supported by the administration and professional officers are geared to do applied research and learning with industry partners.
- Concerted efforts at the university level to include teaching materials that provide insights into the region. For example, exploring more uses of text and reference books that contain regional cases.
- "Dual Studies" programme where a degree programme alternates between coursework and laboratory work in AUs, followed by a practical phase in a local regionalised firm. This is currently implemented in SIT with German companies, where SIT further trains students through applied learning pedagogies, gearing them to make a positive impact on the industry and the wider community.
- Students in AUs to have the opportunity to spend some time in the region via government-to-government initiatives, university efforts, and local contacts. We could utilise the platform of partnerships and sponsorships with SMEs to propel students to the region. For instance, SIT has the Regional Exposure to Accounting Practices (REAP) and the Regional Immersion in Sustainable Engineering (RISE) programmes, to widen students' perspectives and expose them to the cultural, economic and social nuances prevalent in the Asia Pacific region.
- With the ageing population and low population growth in ASEAN, the targeted sectors would be nursing, healthcare and pharmaceutical. Auxiliary services that support the transition for employment from agricultural to services sector in the ASEAN region should also be prioritised in the accounting (regulation), engineering (solutions) and hospitality sectors.
- For an individual who has graduated from a higher institution, success from a tertiary education is no longer measured by the professional practices of doctors and lawyers. The transition at

the local level is now moving towards arts and design as well as the perennial sector of engineering — which allows the actualisation of skill sets learnt from schools. As nations in the ASEAN region are at different stages of economic development, innovative thoughts can be crafted as real solutions to meet real social challenges.

Entrepreneurship & Intrapreneurship

With support from the government, the future economy has to be driven and shaped by the people. Entrepreneurship and intrapreneurship programmes for high-tech and high-touch industries, and design thinking will facilitate the self-actualisation needs of the people. It is recommended that we leverage on entrepreneurs overseas with strong Singapore links as mentors to students and SMEs. We may also expand the role of networks created by Singapore over the past decades.

Local SMEs Support

We propose a focus on developing local SMEs for economic sustainability of the nation, as they are critical in our next phase of economic development. The future SMEs will create quality jobs, catering to a diversified workforce.

Alongside the development of high-tech industries, there should be a concerted promotion of identified high-touch industries for instance, creative, culinary, design, and hospitality sectors.

We should benchmark our SMEs against the models of the German and Japanese counterparts. For example, in order for local SMEs to have access to high-quality manpower, local SMEs should start implementing forward-looking talent development initiatives, which is in line with the SkillsFuture movement.

With the economic rise of the regional countries, we recommend that SMEs move aggressively into the regional market. Our SMEs may support the development of the region with knowledge and experiences developed locally such as, education, healthcare, water, public housing and transport infrastructure. The creation of familiar support structures in the region will encourage the regional expansion,

such as more Singapore-branded schools and established healthcare facilities. The facilities will allay concerns for Singaporeans venturing out of the country. We may develop an expertise to enable local companies to tap the region by integrating the vertical value chain — a shift away from adding value to creating value. In the longer term, SMEs in the region will provide a bridge for local undergraduates to learn and in the future tap on the overseas markets. A virtuous cycle can therefore be realised.

Value Innovation and Quality

An additional recommendation is to have a substantial shift in attitudes of the Singapore population, whereby success in what we do in the society should be measured in terms of quality and innovation. Passion and pride during the initial and design phase of products and services can translate to innovation and quality in the final product and service delivery. Emphasising on innovation and quality will enhance the three recommendations made above (as shown in Figure 1.

FUTURE DIRECTIONS

In training our future workforce, we have recommended close symbiotic relationships with industry to facilitate applied learning and research to meet industry needs, while providing students with broad-based skill sets and knowledge. Training and education should also enable our workforce to tap on the fast growing ASEAN economy. As waves of technological change continue to disrupt industry and jobs, the workforce should be trained to learn, unlearn and relearn based on contextual needs. Tertiary education should further develop the innovative and tinkering spirit in our workforce, to encourage the transformation of our businesses. Rooting our workforce in their communities should start from their years in school; it will create and enable their professional and social networks, which will be critical in their future careers.

The recommendations made in this article are broadly related to the SIT DNA, which encompasses a holistic approach highlighting an individual's career journey. The SIT DNA is a set of four traits: Thinking Tinkerer; Able to Learn, Unlearn and Relearn; Catalyst for Transformation; Grounded in the Community, which are incorporated

into the formal curriculum, appropriate pedagogy, consistent messaging, and a nurturing campus environment.

About 70% of each cohort of young people have taken the polytechnic/ITE education route. We identify them as a key pillar of the "people" as represented in Figure 1. Based on their diverse knowledge, interests, talents and aspirations, they are trained to take up the challenges of the envisioned future economy — one that focuses on high-tech and high-touch skill sets, intra and entrepreneurial spirits, SME development, and regional opportunities.

Although Singapore is recognised as an established brand, sustained efforts must be made to ensure the brand values do not erode. Central to this is the quality of human capital whereby inclusiveness must be fundamental to policy considerations. Singaporeans must continue to have a strong foundation in the knowledge and skills of the 21st century in both high-tech and high-touch areas. They will also need to:

1) Have an enterprising spirit;
2) Be well connected in the region; and
3) Be able to help both local SMEs and established firms take advantage of emerging opportunities in the region and beyond.

By considering the entire spectrum of the population, no one will be left behind.

CONCLUSION

In this new era of development, we must leave no one behind, and every individual should have full access to opportunities by leveraging both high-touch and high-tech technologies.

Acknowledgement

We would like to acknowledge the contributions of SIT staff and students whom we have engaged through online and face-to-face ideation exercises.

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TRANSLATING INNOVATION INTO GLOBAL ECONOMIC IMPACT THROUGH FUTURE SERVICE INDUSTRIES

Dr Walter Edgar Theseira
Perspectives from SIM University (UniSIM)

With Contributions From (in alphabetical order): A/P Cheah Horn Mun; Dr Fang Zheng; Dr Kang Soon Hock; Dr Kiang Tze Peng; Prof. Koh Hian Chye; A/P Lee Pui Mun; A/P Markus Leibrecht; A/P Lim Beng Soon; Dr Lim Chee Han; Nabilah Isa; A/P Randolph Tan Gee Kwang; Dr Kevin Tan Seah Yeow

INTRODUCTION AND ABSTRACT

Singapore has a unique opportunity to develop service industries that translate data-driven innovations into implementable solutions for developing economies worldwide. Rapid advances in mobile-networked technologies have generated tremendous amounts of data and new business models that have disrupted and transformed the services industry in developed countries. However, the impact of these innovations on growth in many developing countries could be muted. High-quality infrastructure has lagged economic development. Poor connectivity and public services, inadequate health and social services, and a dearth of skilled professionals will make it hard for developing economies to catch up to the technological frontier. Boosting growth through technological innovation will soon become crucial to many economies, who like Singapore, will exhaust input-driven growth and will face manpower shortages and greying populations within a few decades, if not sooner.

Singapore's service industries can provide critical knowledge-based exports that can help the region and the world develop at the technological frontier. We envision Singapore developing a competitive advantage in the export of services in the following areas: *Predictive Technologies*, where analytics driven by big data generated by mobile networks and sensors can be deployed to solve business problems globally; *Mobility Lifestyles*, where consumer-oriented services can be developed, aggregated, and exported to users no matter where they are around the world; and *Education-as-a-Service*,

where just-in-time training to meet changing manpower needs, driven by business model disruptions locally and abroad, can be delivered both in the classroom and remotely. These service industries will build on our current and future advantages in connectivity — physical, socio-economic, and cultural — to bridge innovations from across the East and West. Singapore can, and must transform its economy to become a highly competitive regional and global exporter of future technology goods and services — to lead the region in translating innovation into economic impact.

In this report, we start by outlining the general case for promoting knowledge-based, export-focused service industries in Singapore. Then, we discuss why these service industries of Predictive Technologies, Mobility Lifestyles, and Education-as-a-Service service were identified as key strategic areas.

THE CASE FOR KNOWLEDGE-BASED, EXPORT FOCUSED FUTURE SERVICE INDUSTRIES

Singapore is ideally positioned to become a global leader in human-capital intensive, export-oriented service industries. While in this report, we focus primarily on Predictive Technologies, Mobility Lifestyles, and Education-as-a-Service, many other future service industries will grow from innovations such as 3D-printing technology, intelligent robots, and self-driving vehicles, as well as growing demand for services targeted at a globally ageing population such as smart medical services, geriatric healthcare, and “silver” entertainment and recreation.

The future services sector is an integral complement to high value-added manufacturing and engineering — the other pillars of our economy. A strong future services sector will be a key reason why Singapore continues to attract high value-added manufacturing industries, which seek physical proximity to centres of innovation and creativity, rather than medium and low value-added manufacturing that simply seeks the lowest costs. Global trends support this, with high value-added, technology-intensive manufacturing growing rapidly in the United States in recent years despite the otherwise tremendous cost disadvantages of manufacturing in a developed economy.

Future service industries will also provide good jobs for Singaporeans and the best global talent — a key factor in continuing to ensure that Singapore is able to overcome constraints of a limited domestic talent pool. The future services industries, with their potential for creativity, self-actualisation and personal growth, will prove attractive to a generation of Singaporeans who are globally minded and who might in the absence of such opportunities migrate to innovative cities elsewhere in the world.

Services are an integral part of trade in the most advanced countries worldwide. Within the OECD, services comprised 21.5% of total trade in 2014. While Singapore's services sector already contributes to nearly a quarter of total trade, Singapore's actual position in the service industries of the future that will embrace creativity, innovation and applied technology, is weaker than it appears.

Singapore has strengths in more "traditional" services industries focusing on accounting and financial services, consultancy and management services, building and construction services, logistics and transportation services, among others. However, these are not services industries with the same potential for growth and global impact as the future services industries we discuss — although they will remain key parts of the services economy.

Unfortunately, Singapore's preparedness for the knowledge creation and application that will define future services industries may need further improvement, despite heavy national investments in research and development funding. One broad trade statistic that reflects a country's strength in knowledge-creation industries measures charges for the use of intellectual property (IP), by covering payments made into and out of a country for IP. If we consider Singapore's trade in IP as a proxy for our potential strength in knowledge intensive future services industries, a startlingly weak position is revealed. Although Singapore does have healthy exports of IP — standing at approximately 1% of GDP — Singapore also imports more than 7% of GDP in IP services. Overall, Singapore is a substantial net importer of IP — unlike the United States, Japan, South Korea, the OECD and Switzerland, all of who are net exporters of IP.

While Singapore's substantial imports of intellectual property are not a net loss to our economy, as they reflect value added processes in Singapore that make use of intellectual property invented abroad, we should be concerned that Singapore — despite a highly educated population and substantial investments in R&D — looks more like China and less like Switzerland when it comes to net IP trade.

Developing future services industries centred on innovation, creativity and applied technology will require sustained effort over the next decade. But it can, and must be done. We now outline and make the case for several key thematic future services industries: Predictive Technologies, Mobility Lifestyle, and Education-as-a-Service.

PREDICTIVE TECHNOLOGIES

"Predictive Technologies" refers to the host of sensing and tracking devices, and data analytics, which when combined, enable accurate prediction of future events based on past patterns. This combination of technologies may one day predict and enable automated action in many work tasks and activities, thus replacing or complementing humans in many kinds of work. Some have termed this Industry 4.0, or the 4th Industrial Revolution. While prior Industrial Revolutions were built on the steam engine, the electricity grid and computers, our present revolution is built on the combination of data, networked systems, and advanced and ubiquitous computing resources.

The present application of Predictive Technologies is centred around "big data", motivated by recent advances in data collection and storage, allowing organisations such as banks, telecommunications companies, and Internet giants like Google and Facebook, to aggregate and analyse massive streams of consumer data. With data analytics, big data owners can gain insights at a speed and level that was not possible in the past. Those who hold useful data that they are able to analyse quickly will be able to act before their competitors do.

However, the future application of Predictive Technologies will move beyond conventional sources of "big data" and will make use of networked and mobile sensors that track decision-making in all aspects. The particular relevance of Predictive Technologies for Singaporeans is that it will help us transcend our limitations to growth.

For example, predicting consumer behaviour will help cut waste, allow for leaner inventories, and allow more efficient staffing for retail, logistics and manufacturing. This allows Singaporean enterprises to achieve more with less manpower — which is a key growth constraint. Predicting hospital admissions and traffic behaviour allows our public services to function more efficiently, again allowing us to achieve more with less public expenditure and taxation.

Singapore should be ready for a future economy that relies heavily on Predictive Technologies and business intelligence. Significant investments in present big data analytics can be made today. But to lay the foundations for future applications of Predictive Technologies, investments must be made in the entire eco-system, ranging from hardware and software development, to business consulting services that help enterprises integrate the latest innovations into their workflows and processes.

MOBILITY LIFESTYLE

“Mobility Lifestyle” relates to the prevalence of mobile devices and their use in performing many diverse tasks. Our everyday lives as Singaporeans are already shaped by a tremendous amount of online transactions, information search, fitness and physical tracking and social interactions.

At the present, our Mobility Lifestyle is largely centred on consumer-oriented applications that help make our lives more flexible and convenient. One growth industry will likely be the aggregation of services for consumers who want flexibility and convenience.

However, the real potential for the mobility lifestyle Mobility Lifestyle lies in using mobile applications and technologies to help newly industrialising economies leapfrog stages in their economic and social development.

For example, while the introduction of Fintech (or technology enabled financial services) provides just an alternative means of interacting with banks for most Singaporeans. Fintech can introduce financial services for the first time to millions in developing countries who have never had a formal bank account or have a physical bank branch near them.

This means the emerging middle class throughout the region and the world may have their first interaction with many consumer services that we take for granted, through the online and mobile world, rather than through the "brick and mortar" establishments that we are used to in Singapore.

Singapore is uniquely positioned to help enable a Mobility Lifestyle for ASEAN and for the developing world. In ASEAN, Internet and broadband usage is still growing at double-digit rates in many countries. In Indonesia, the Philippines, Thailand and Vietnam, Internet use is growing at approximately 10% per year, while broadband growth is similarly robust. By contrast, in the developed world, across the OECD Internet and broadband growth is a modest 2–3% per year.

Singapore must not only embrace the Mobility Lifestyle in the form we know it — as entertainment and consumption for the global elite — but also as an enabler of economic and social development for billions of emerging consumers throughout the world.

EDUCATION-AS-A-SERVICE

"Education-as-a-Service" is a means of addressing the tremendous changes to the economy and nature of work that will be facilitated by the growth of future services industries. Education-as-a-Service will use innovations in technology to help deliver education tailored for the individual and for industry's needs, scalable both in terms of the quantity of students educated, and in terms of the quality and intensity of education.

While Massively Open Online Courses (MOOCs) provide a tantalising glimpse at this future, Education-as-a-Service must go further. The problems with MOOCs include high dropout rates, a lack of credible certification mechanisms, and little or no localisation to suit the context of the student. While MOOCs have expanded the knowledge available to mankind, they have not replaced conventional education systems anywhere.

Yet there is a growing need to replace or re-invent conventional education systems. The future economy of Singapore will require re-

inventing education, including university education. To deliver the kind of education needed to help graduates and trainees address the evolving nature of work, including the potential replacement of tasks and jobs by disruptive innovations, Singaporeans must have the mindset to continually upgrade themselves. As the jobs of tomorrow are not here yet, self-directed and lifelong learning skills and attitude are critical. Universities can at most prepare graduates directly for the first few jobs. After that, graduates have to prepare themselves for future jobs — but they can still be supported by universities if we are prepared to offer Education-as-a-Service.

The traditional degree / diploma model has significant shortcomings that require re-invention. Today's tertiary education is a luxury good with high fixed costs, of physical capital, human capital of instructors, and opportunity costs for students. While this luxury good is suitable for the global elite who presently are the main consumers of education, and drives research and mastery at the highest levels, the model may not be the most appropriate to provide access to quality training and education opportunities for many who lack the resources. More to the point, present tertiary education stresses academic mastery while relegating practical skills acquisition to internships and part-time work. The most important skills involve the ability to search for knowledge, understand knowledge and apply knowledge. Job preparation therefore has to do more with soft skills and attitude than hard facts and knowledge. This changes the way a university should think about education.

We are in the midst of a historic transition in ASEAN — away from primary production and basic industrial activities, towards higher value-added, post-industrial services and high skills-based manufacturing. While in Singapore more than half the resident workforce is employed as PMETs, in many key ASEAN economies such as Thailand and Vietnam, less than 20% of the workforce is employed in these high-skill positions. As ASEAN develops, demand for high-skill labour will inevitably grow rapidly.

However, there are signs that many ASEAN countries are not fully equipped domestically to cope with the tremendous increase in demand for tertiary education and skills training that will be required to transition to a high skill economy. The gross enrolment ratios in

tertiary education of all types in most ASEAN economies, save Singapore, are well below 50%. Moreover, there are increasing concerns that tertiary education does not produce graduates and trainees with the right skills for domestic employment opportunities and growth — leading to phenomena such as the massive export of highly trained university graduates from the Philippines to work in lower-skilled positions abroad.

There are tremendous opportunities in ASEAN for Singapore to position itself as a hub for the training needs of the region by leveraging our connectivity both as a transport hub and as an education hub. Singapore's Education-as-a-Service can provide the upskilling and finishing touches that enhance the value added to any and every possible industry. Our Education-as-a-Service can serve as a conduit for the entire region to attain a higher level of training and satisfy developmental needs. Hence, we should position (in terms of its infrastructure, staffing and linkages) Singapore education establishments as a hub, drawing on the expertise of the world and bringing this expertise to Singapore where our regional neighbours can access it. In essence, we provide the stage for the world's skills and knowledge and facilitate our neighbouring countries in acquiring the skills they need. In this way, Singapore can make itself relevant not only for the region but also globally.

CONCLUSION

Our overall vision is that Singapore, as an exporter of future service industries, lies at the hub of an increasingly connected world, and an increasingly connected ASEAN. We are already a physical hub for international trade and finance. But we can and must do more to become a hub for innovation, creativity and applied technology for ASEAN and the world. We stand positioned to help enable growth and development for a connected world. We must develop Predictive Technologies to improve productivity and overcome constraints on growth; Mobility Lifestyles to help the global emerging middle class leapfrog decades of development; and Education-as-a-Service to address the tremendous demand for job-ready skills that will be generated by the growth of innovations and technologies as yet unknown.

BECOMING A SMART "SHARING" NATION

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THE SHARING ECONOMY

The sharing economy is profoundly changing the economy and society worldwide. Trailblazers Uber and Airbnb, together with numerous clones, have massively disrupted the rules of commerce, wreaking havoc to established business operations and causing headaches to government regulators (even as they bring delight to consumers who benefit from their services), and incited angry protests across the world from Canada to China among workers, whose rice bowls had been severely threatened.

Estimated to be worth US$15 billion currently, the sharing economy is projected to grow to a staggering US$335 billion within a decade (PwC, 2015). Investors have clearly bought in to the super growth story. Uber, arguably the sharing economy's top icon, raised US$14.11 billion in 16 funding rounds since it started in 2009 to reach a valuation of US$62.5 billion (Crunchbase, 2016). This is bigger than established corporate behemoths such as Ford and General Motors (Chen, 2015).

Without owning any rooms, Airbnb, another icon of the sharing economy, boasts 2 million accommodation listings (including 1,400 castles) in 34,000 cities worldwide and has hosted 60 million guests since it started renting out airbeds in San Francisco less than a decade ago in 2008 (Airbnb, 2016).

DEFINITION & CHARACTERISTICS

The basic concept of "sharing" is not new — timeshare resorts, second-hand bookstores and equipment rental shops all embody the principle of re-use that is central to the sharing economy. What is different today is that technology advances in many areas have reached a tipping point, making sharing applications not just possible but also easily implementable on an unprecedented scale. Such is the power wrought by the convergence and interplay of today's

technologies — the ubiquity of the Internet, mobile networks, smart phones, GPS and digital maps, social networks, cloud computing and data analytics.

Rachel Botsman, an early expert on the subject, defined the "Sharing Economy' as an economic system based on sharing underused assets or services, for free or for a fee, directly from individuals (Botsman, 2015). As an emerging area, it is also known by various other names, such as collaborative economy, on-demand services, peer-to-peer transactions and platform-based businesses (Parker et al., 2016). Business professor Arun Sundararjan, a recognised authority in this space, described the following characteristics of the sharing economy in his 2016 book, as follows (Sundararajan, 2016):

- Largely market-based: Creates markets that enable the exchange of goods and the emergence of new services
- High-impact capital: Opens new opportunities for everything, from assets and skills to time and money, to be used at closer to full capacity
- Crowd-based "networks" rather than centralised institutions or "hierarchies"
- Blurring lines between the personal and the professional
- Blurring lines between full employment and casual labour

The core idea underpinning the sharing economy is therefore, the ability to achieve the use of otherwise under-utilised assets nearer to their full capacity.

GROWTH AND ACCEPTANCE

The growth of the sharing economy in recent years has been explosive worldwide, particularly in the big cities, for both labour platforms (such as Uber and TaskRabbit) and capital platforms (such as Airbnb and Getaround). A major reason for this exponential growth is that participants are overwhelmingly positive about their experiences. A large majority of US adults in a 2015 PwC survey strongly agreed that the sharing economy is better for the environment, builds a stronger community, and its services are more affordable, convenient, efficient and fun (PwC, 2015).

What is noteworthy is that millennials make up half of sharing economy participants, underscoring its huge potential impact in the future (Colby & Bell, 2016).

Indeed, one writer has eloquently described our embrace of the sharing economy as entering into a new era of Internet-enabled intimacy (Tanz, 2014) .

> *We are hopping into strangers' cars (Lyft, Sidecar, Uber), welcoming them into our spare rooms (Airbnb), dropping our dogs off at their houses (DogVacay, Rover), and eating food in their dining rooms (Feastly).*
>
> *We are letting them rent our cars (RelayRides, Getaround), our boats (Boatbound), our houses (HomeAway), and our power tools (Zilok).*
>
> *We are entrusting complete strangers with our most valuable possessions, our personal experiences — and our very lives. In the process, we are entering a new era of Internet-enabled intimacy.*

SOCIAL AND ECONOMIC BENEFITS

Singapore is ideally suited to embrace the sharing economy because of its multiple constraints as a geographically small nation as well as its dense population, excellent infrastructure and tech-savvy population. The fast pace of work and life leads to a high demand for services that provides time-saving, comfort and convenience.

More important than the benefits enjoyed by the direct participants of on-demand services (consumers, providers and platforms) are the system level benefits to the country. "Sharing" increases the utilisation of assets, encourages re-use, provides additional income opportunities to individuals and households and draws economic contribution from across the population, thereby addressing the perpetual challenge of raising workforce productivity.

In addition, an active sharing economy is fertile ground for entrepreneurship, allowing startups to try out different ideas as they seek to emulate the likes of Uber and Airbnb. Active participation

among the population as providers of on-demand services would effectively turn a large proportion of citizens into “micro-preneurs”. Once a person starts to own and operate a business (however small), he begins to see new opportunities for growth, which would naturally lead him to experiment with new ideas to achieve better efficiency and higher output, spurring the innovation process.

Equally important are the social and environmental benefits that accrue from the widespread availability of sharing economy services. Increasing the utilisation of under-used assets means greater re-use, less wastage and hence higher return on assets. Shared rides in cars mean fewer trips, less congestion and lower emissions, exactly in line with Singapore’s aim to be a car-lite society.

Many on-demand services, such as hosting guests on Airbnb, can be provided by retirees and senior citizens, allowing them to continue contributing to the economy, but with the flexibility to work at their own pace. This supports the call of “active ageing” for seniors. Not only will this bring much-needed supplementary income on top of retirement funds, it could also be a source of new and rich social experiences.

It can be argued too that an active sharing economy will cultivate better social responsibility. When a person has played the role of both service provider and consumer, he can be expected to appreciate both sides better and be more tolerant of the shortcomings of others. Furthermore, the sharing economy depends heavily on user ratings and reviews, which naturally become strong incentives for good behaviour.

RISKS AND CONCERNS

What are the downsides of the sharing economy? The greatest concern is undoubtedly safety. How safe is it to take a ride with strangers or to allow them into your property? Despite a few highly publicised cases of Airbnb homes being ransacked or Uber riders being assaulted by drivers, the momentum of the sharing economy has not slackened, suggesting that the perceived risks associated with sharing economy activities may be no greater than that of normal business transactions.

There are legitimate concerns however, about whether sharing economy players are competing fairly. Are they enjoying the benefits of a regulated marketplace without having to pay the cost or abide by the rules of the system? These may include the need for licenses to operate and the obligation to meet quality standards on safety and service delivery. The perceived unfair playing field has been the chief grouse of taxi operators worldwide, including in Singapore, against the likes of Uber and Grab (Lim, 2016).

On short-term lettings such as those enabled by Airbnb, concerns include whether residential neighbourhoods would be disturbed by the constant flow of baggage-lugging tourists in large numbers (Chua, 2016). And in the case of condominiums, whether an apartment owner should be charged higher service fees to account for the greater use of common facilities by his guests.

There are also issues relating to taxation (should service providers be treated the same as registered businesses in terms of tax?), as well as concerns about negative fallout arising from the disruption to existing stable business structures. These issues, while complex, are not insurmountable. Solutions would be found in due course, as they are the same issues affecting many other cities worldwide.

OPPORTUNITY FOR SINGAPORE

Under the recently announced Smart Nation initiative, the government aims to harness the power of infocomm technologies, networks and data to support better living, create more opportunities, and support stronger communities (Prime Minister's Office, 2016). Many aspects of the sharing economy can help to realise this vision. As part of its Smart Nation vision, Singapore could thus promote and develop itself as the "sharing capital" of the world. It could become a global leader in this space, providing a "living lab" to pilot innovative business models.

While the momentum of the sharing economy is unstoppable, many regulatory hurdles remain and many countries would continue to face resistance from displaced workers and other socio-political challenges. Singapore has comparatively fewer challenges to deal

with and is therefore well positioned to ride this wave for maximum benefit and impact.

The right regulatory approach should be one with a light touch, leaving the industry to self-regulate as much as possible. This was in fact the preferred approach expressed by respondents to the PwC survey noted above. A level playing field is desirable, but the regulators must allow the competitive forces of the market to determine the winners.

Regulators should err on the side of liberality, not caution. It is better to stretch the envelope and learn from mistakes when they happen, than to design a regime to eliminate all risks.

Many cities in the world are also seeing the same benefits of the sharing economy and have declared their ambitions to become "sharing cities". Examples are London (HM Government, 2016), Amsterdam (Sharenl, 2016) and Seoul (Guerrini, 2014). Singapore can clearly also benefit from the experiences of these cities, even if they have only recently started on their journeys.

RECOMMENDATIONS

What can the government do to realise the immense potential benefits of the sharing economy?

It is important first to communicate a vision for Singapore to be the 'Sharing Economy Capital' of the world. Singapore should aim to be a "Smart Sharing Nation".

A Sharing Economy Office can be set up to deal with the most pressing issues affecting sharing projects such as liability insurance, certification, training, etc., especially in the hot areas of housing, transport and logistics. Regulations should be administered with a light touch, with the aim of *enabling*, rather than *controlling* transactions. Ensuring a fair and conducive operating environment is key but protecting incumbents to maintain the status quo should not be a consideration.

Government data should be made readily available to companies that need them to design their business models and calibrate their

activities. Where possible, guidance should be given on new opportunity areas.

The government can send a powerful message of its commitment through leading by example. It can do so by requiring that “shareable” assets belonging to government agencies be made available for public sharing, an approach taken by London and Seoul. Shareable assets include auditoriums, training rooms, specialised equipment, meeting areas and office space. Strong resistance will undoubtedly be voiced by these agencies, which will cite confidentiality and security reasons. While legitimate concerns have to be addressed, the government must be prepared to demonstrate its willingness to take some risks by opening up.

The sharing economy is fertile ground for the incubation of tech startups. The government should therefore actively encourage and support startups operating in this space, by giving them opportunities to test-bed new technologies and business models in pilot projects.

For the Sharing Economy Office to be effective, it needs to continually keep abreast of developments in the field. The rich and diverse expertise of the local universities could be tapped to carry out research in such areas as data analytics, consumer behaviour, risk analysis, etc. These projects would enable a comprehensive knowledge base on the sharing economy to be built up. Such knowledge would also be valuable input for developing economic strategies for the future.

Finally, it is important to plan for continual learning and improvements by having forums for the sharing of success stories and best practices.

CONCLUSION

Like it or not, the sharing economy will become a very significant part of the future business landscape, with far reaching and perhaps as yet uncertain social consequences. Singapore is exceptionally well placed to benefit from this opportunity, which not only provides economic benefits, but also addresses many of the challenges and aspirations of our nation. Everyone could (and in due course, would) be part of this new economy - often as both provider and consumer at the same time. Trust is a central element in these transactions — both

buyer and seller must be prepared to trust and take some risk. If well regulated and managed, the sharing economy will contribute greatly to realising the government's vision of creating opportunities and supporting strong communities for Singapore.

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BUILDING A NATION OF INVENTORS FUELLED BY A CONNECTED ECONOMY

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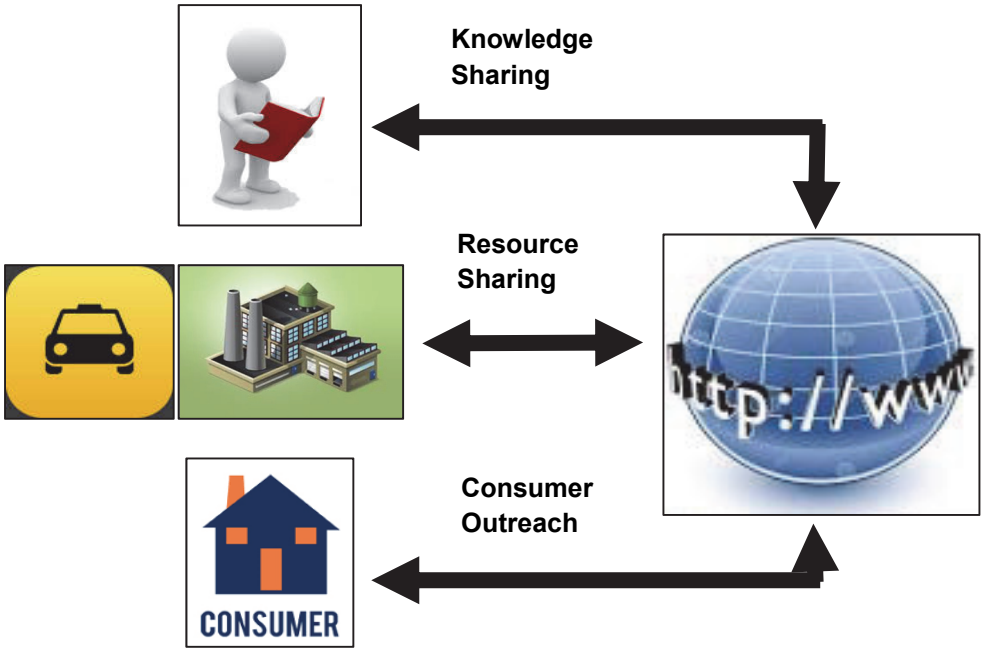
CONNECTIVITY CREATES A DIRECT PATH FROM INVENTOR/ PROVIDER TO CONSUMER

Connectivity is a major reason for the flourishing of a sharing economy. Knowledge is shared through the Internet. Resources are shared through efficient and timely exchange of demand and supply information. Goods are distributed from manufacturers straight into consumer homes without much help from middlemen (see Figure 1).

FIGURE 1: CONNECTIVITY ENABLES THE SHARING ECONOMY. IT DEMOCRATISES KNOWLEDGE, RESOURCES AND MARKET ACCESSIBILITY



Traditional economic activities that thrived on inefficiencies in human connectivity and inefficiencies in the sharing of information or

resources will give way to future economic models. Connectivity is the enabler of these changes and its potential has to be understood well.

Connectivity has brought about the democratisation of knowledge, resources, and market accessibility. An example is the flourishing of crowdsource activities. We are seeing more and more crowdsource economic models, such as raising of investment funds, sharing of niche skills like plumbing, sharing of transportation resources like Uber, and sharing of general services like food delivery. Even crowdsourcing for ideas and services in a timely manner to respond to unexpected crisis facing a country becomes feasible now.

Our future lies in uncovering what connectivity offers beyond what we have been witnessing. Greater connectivity means the timely flow of information, timely and effective sharing of resources, and smart logistics. With reduced overhead needed for middleman and availability of shared resources, it has become feasible for individuals to invent or create new products or services, which require a myriad of skill sets and resources that in the past would have been possible only in large companies or factories.

PEDAGOGY CHANGES TO UPLIFT EVERYONE REGARDLESS OF EDUCATIONAL QUALIFICATION

Individuals, regardless of educational qualifications must therefore be empowered to be relevant to this new era, to invent, create and build new products and services.

Creativity and *hands-on skills* are critical. The key to this is all-round education.

Traditional training in schools and universities must still be supported and promoted because in-depth knowledge is still needed to solve some of the more complicated problems such as big data analytics and advanced robotics, etc. Information technology will continue to play a critical role in this transformation process.

The challenge is, given the need to have in-depth training for our manpower resources in the respective areas, how do we then empower each individual with basic proficiencies in all-round skill

sets?

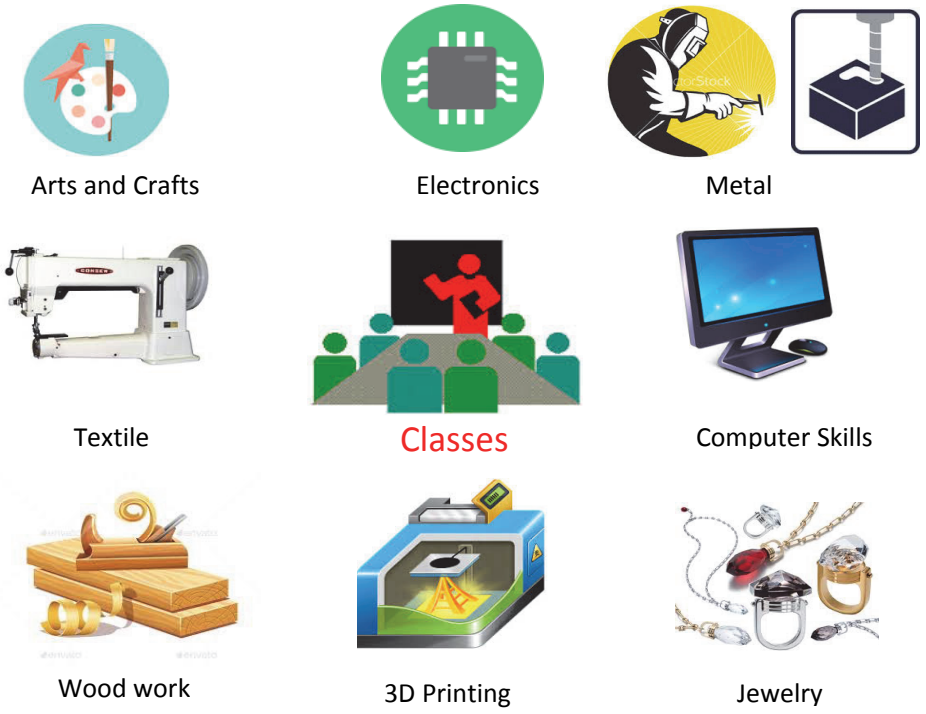
We will need to build upon our current educational resources. Specifically, the gap between vocational training and university level academic training should be bridged. Technology can help to mitigate the differences in aptitude in learning for different individuals. Educational tools and sharing tools could be developed so that academic knowledge traditionally acquired at higher institutions of learning could also be customised and made accessible to ITE-trained professionals. This is achievable. What is needed is to change the way we teach and also distil the knowledge and skill sets to an appropriate level useful enough for every individual to innovate. Traditional pedagogy of education should also be adapted to suit people of different learning preferences and aptitude. Similarly, vocational skill sets and know-how from Institutes of Technological Education should also find their way to the university-trained professionals, as many of these vocational skill sets are enabling tools for product innovations and design.

SKILLS AND KNOWLEDGE "ON DEMAND" — CREATE AN ENVIRONMENT THAT PROMOTES MAKER CULTURE

To facilitate the exchange and sharing of skill sets for people of different educational background, we will need to create an environment for it. We could for example set up a network of TechShop[1] type of facilities (Figure 2), perhaps as an extension to the current effort for life-long learning. We could create a network of physical workspaces complete with machines, materials and expertise for users to learn, share and build creative products.

[1] For an overview of TechShop, see http://www.techshop.ws/index.html

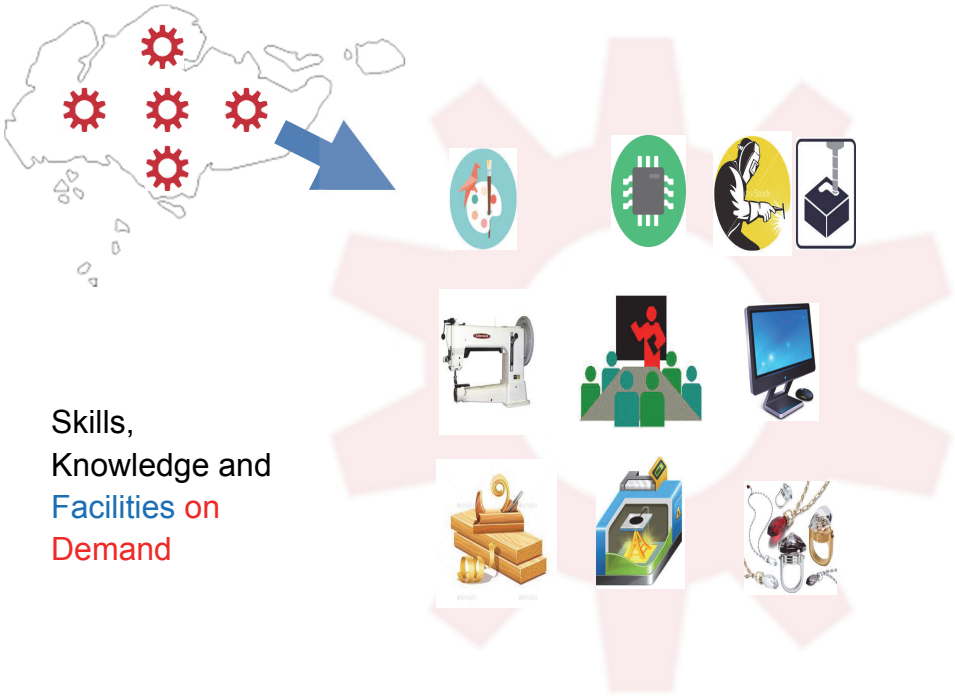
FIGURE 2: TECHSHOP-LIKE ENVIRONMENT



We need to start from young. Schools could for example set up "Invention Clubs". Students could gain access to the TechShop-like network of physical workspace and facilities to learn the craftsmanship and get immersed in an environment where people build things. Through the activities in this network of shared physical workspaces and resources sprinkled at four to five strategic locations on our island, we could aim to build a nation of inventors (Figure 3). There are enough successful products that have come out of TechShops that could inspire all of us (Jackson, 2011).

Classes could be conducted at such "Makers premises". Essentially, we need to create an environment to facilitate and promote skills and knowledge "on-demand".

FIGURE 3: SKILLS, KNOWLEDGE AND FACILITIES AVAILABLE "ON DEMAND" — A NETWORK OF "TECHSHOP"-LIKE RESOURCES TO PROMOTE SELF-INSPIRED TRAINING OF MAKERS SKILLS TOWARDS NURTURING A NATION OF INVENTORS



ENHANCE SOCIAL MOBILITY, AMONG OTHER BENEFITS

The benefits of setting up such kind of shared workspaces and facilities are two-fold.

First, it makes expensive machineries available to every man in the street, and enables all-round skill sets to be shared, learned and nurtured. Moreover, intellectual property (IP) protection can be made affordable to every inventor in this collective effort. A nation of inventors with sufficient IP protection will mean a nation with healthy social mobility, as opportunities for creation of wealth is open to everyone.

Second, besides serving the needs of economically active individuals, it could also be a platform for active ageing for retirees to continue to

put to good use their life skills and also to pass on their skill sets to younger generations.

MAKE "MAKING" A PART OF OUR CULTURE

It is not realistic to expect everyone to become an inventor just because we set up a network of TechShops across the island. What is realistic however, is to instil the "Making" culture in every Singaporean. We should also look into teaching pedagogy to make vocational skills and academic skills available "on-demand" to everyone, regardless of educational qualifications. It is not easy, but doable. Once we start to have success stories, they will set off an avalanche of successes. We should strive to make this happen as it brings in tremendous benefits, including the enhancement of social mobility.

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Chapter 3
Future Work

THE FUTURE OF TALENT IN SINGAPORE 2030: A SUMMARY[1]

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INTRODUCTION

In early 2016, the Chartered Institute of Personnel and Development (CIPD), in collaboration with the Human Capital Leadership Institute (HCLI) launched a research collaboration that looked 15 years into Singapore's future. Singapore's sustained success increasingly depends on how well all players — the state, society, organisations and individuals themselves — are able to grow the human capital that is engaged in value creation within the economy. As a small city-state, Singapore has already built capability to attract and deploy talent, but it also has the opportunity to reflect on its identities, its values and the kind of nation it wishes to be, and to "cultivate" the breadth, depth and quality of its people to shape that future.

This paper is an edited summary of a 50-page research report. In particular, this condensed version focuses on the one baseline and three distinct synthesised futures for Singapore 2030 — a result of assembling drivers and trends to explore alternative scenarios. In this paper, a maturity framework is also presented. This maturity framework looks at the choices that the different players *could* — rather than *should* or *would* — make, in response to each alternative scenario. It is a scaffold to remind us that everyone has choices. This summary paper, like the original full report, is an invitation to stop, be still and listen to oneself before making the first step into the future.

[1] This paper is an edited summary of a fuller research report, "The future of talent in Singapore 2030" (© CIPD, HCLI 2016). The latter was written by Dr Wilson Wong, Dr Stella Martorana and Dr Sarah Dunleavy from CIPD, with support from HCLI. This particular summary paper was edited by Rebecca Siow and Wong Su-Yen from HCLI. You can access the original research report, complete with references, here: http://hqasia.org/research-reports/2030-future-talent.

THE FOUR SCENARIOS

Scenarios are short stories designed to include plausible but potentially extreme developments in order to stimulate discussions on current assumptions of the future. A scenario is not a prediction and no one scenario is likely to play out in its entirety. Here, we present four scenarios set in 2030 Singapore. We have selected some drivers, investigated trend data to support (or test) our chosen drivers and the underpinning assumptions about them, and synthesised several mini-scenarios for which three were selected in addition to the one representing the status quo.

The four scenarios are:

- *Steady as she goes*. This is a baseline scenario where 2030 is recognisably a projection of the present. There are no nasty surprises or assumptions, and current trends — the focus on academic achievement as a proxy for talent; full employment; reliance on foreign talent, and so on — are played out.
- *No one is an island*. This synthesised scenario explores a future where technology has removed the middle person in many relationships. For example, lenders and borrowers do not need the bank as an intermediary when they use peer-to-peer, crowdsourcing platforms. This also causes change in the social and political arenas.
- *Fortress Singapore*. This synthesised scenario is primarily driven by threats to security. Singapore conscientiously strengthens its defensive capabilities to protect itself against physical, cyber, civil, political, economic and psychological attacks.
- *Bless thy neighbour*. The final synthesised scenario where Singapore has a vision of a stable, prosperous region and draws on its financial and human capital to lead the transformation of the region.

The next few sub-sections elaborate on the most relevant and pronounced drivers and trends behind each scenario.

Steady as She Goes

This baseline scenario assumes no major disruptions. The future in 2030 Singapore is recognisably a continuation of the present.

Economic drivers and trends

Globally, economic growth in the last 20 years has been uneven but generally sluggish. South East Asia and East Asia have proven to be resilient with higher than average growth. The principal focus of government is to sustain economic growth by ensuring that Singapore is an attractive business and investment destination. While the costs of doing business in Singapore are high, its competitiveness is maintained by a highly skilled, industrial action-free workforce, stable rule of law, world-class infrastructure, efficient logistics and joined-up policies.

The government maintains a pragmatic approach, adjusting policy in response to or in anticipation of macro-economic signals. Inward migration policies are sympathetic to the needs of businesses but also linked to higher requirements for the up-skilling of the available labour. Singapore is even more of a service economy and has invested heavily in new technologies to increase per capita value added of its workforce. The healthcare sector, for example, is increasingly driven by technology with virtual physician consultations, automated dispensaries and fewer nurses because of global demand, as most developed countries face ageing populations.

Following established trends in other developed nations, a national minimum or living wage is about to be implemented in 2030. The steady exodus of baby boomers has been managed by government initiatives to raise the retirement age, and by incentives that keep citizens active in the workforce for longer. With inflation and unemployment generally low, the local workforce continues to enjoy real improvements in their material standard of living. The rapidly ageing workforce, however, remains a risk to further sustained economic growth in the years ahead.

Political drivers and trends

The region, despite occasional crises in governance, remains politically calm. Tensions between ASEAN and East Asian neighbours are managed diplomatically. The two Koreas, despite occasional spats, have remained relatively calm. In Singapore, the People's Action Party (PAP) retains its dominant majority. Singapore is celebrating 65 years as an independent nation. It continues to maintain a sophisticated future and foresight capability to guide long-term strategic choices — in the economy, in security and in international relations. It has continued to encourage more networks and partnerships across the region via scholarships and awards for young talent as well as mid-career professionals. These have forged a cadre of up-and-coming Asian leaders who share Singapore's belief in good governance, open markets and strong, principled leadership, mostly.

Social drivers and trends

Singaporeans remain socially conservative and self-reliant. The small families and rapid ageing have increased the care responsibilities of those of working age. This, coupled with the continued widening of income inequality, has meant greater state support for adult care services and enhanced social welfare support.

Compared with 2015, the citizenry is far more vocal about what they consider "unfair" policies. Better educated and with rising expectations of the state, they are more critical users of public services. The older population are now a political force, organising to lobby for "fair" policies for those who have contributed over a lifetime of work but are no longer economically active.

The social demands for higher standards of fairness have resulted in a new Employment Act. This ensures enhanced benefits (i.e., maternity, paternity, paid sick leave), greater flexibility in work arrangements, and clearer employer obligations to ensure the health and well-being of their employees and contractors. These have resulted in higher labour force participation by women and older

workers, as both groups are better able to balance work and personal commitments.

No One is an Island

This scenario examines how technology, politics and social shifts contribute to a citizenry that takes greater personal ownership of their lives and life choices in 2030.

Political drivers and trends

Singapore now has a small but growing entrepreneur class. Many of the new immigrants in 2015 have used their global networks to build new businesses in low-tax, high-skills Singapore. These emergent businesses are thriving, encouraged by a more experimental policy environment, working with these entrepreneurs to adjust and create policies, or simply accepting that these new organisations should be allowed the space to try things out without policy guidance — at least while both sides learn what works best.

This "crowdsourcing" policy approach works so well that this is applied to other areas where fresh ideas are needed, such as in adult care. With an ageing population, small families and increasing expectations of what the state can deliver, policy experimentation has resulted in a number of non-profit initiatives led and delivered by the community. Another reason for encouraging a variety of approaches to managing social issues is the diversity of the citizenry. Many immigrants of 15–20 years ago have settled in Singapore. While they appreciate the prosperity and security of this city-state, they want more say in policies that impact them, such as education and civil liberties.

The government recognises that the social compact is shifting. The price for innovation — a more diverse professional class and greater community ownership of social issues — is a need for more transparent, co-created policy. While this has been a success in adult care, the decentralised delivery of education, greater freedom of expression and equality of sexual minorities will raise more tensions in a largely conservative population, one happy to turn to the state for every solution. Nevertheless, the benefits of a more mature relationship are clear: a more trusting relationship between citizen and state; higher awareness and ownership of the issues of the day; and the injection of new thinking and solutions.

Social drivers and trends

The success of the new migrants and their visibility as entrepreneurs in emerging sectors have brought new business models and ways of working which contrast sharply with the conventional preference for a secure, lower-risk professional career. These emergent sectors are looking for skilled, highly motivated employees who may not have gone to the best universities. These emergent businesses, while not secure, offer an exciting alternative to those not immediately looking for a career but a developmental opportunity where their ideas and energies can be channelled to the creation of something new and novel.

For those who do want to take paths less travelled, Singapore now has thriving start-ups (mainly in technology) and numerous grassroots organisations providing experimental solutions to social issues. A greater shared ownership of issues — a result of a policy-light approach — has also brought other advantages. The sharing economy is beginning to emerge. Car ownership, long seen as an essential signal of success, is now seen as unsustainable and has been largely replaced by car-sharing schemes.

Even established institutions are responding to the shift to crowdsourced, co-created solutions. Many colleges and universities have redesigned their evening enrichment classes to reflect the demand of lifelong learning in the heartlands. The range of topics have been eclectic, reflecting the fact that not all the tutors are academics. Many are talented amateurs who have worked with the universities to deliver 10-week programmes. Programmes are subsidised and usually over-subscribed. A spin-off of these programmes is that they have built trust in the universities, many of which have set up pilots that identify and study areas of concern to communities, and to then experiment with different solutions to these. Sometimes it is a technology solution, sometimes an education solution and oftentimes one of just joining the dots to enable a local solution to be delivered.

Technology drivers and trends

Singapore, keen to adopt technologies that increase efficient use of scarce resources, has adopted driverless vehicles. As the technology matured, Singapore set about putting in place the legal framework and the procedures and infrastructure to enable driverless vehicles.

On the whole, most citizens are pleased with the innovation. Shoppers are able to book vehicles 10 minutes on average before they require transport. They are no longer held hostage to shift patterns and drivers who only pick up passengers if they are “on their way”. This has revolutionised the internal logistics system when coupled with road-pricing systems so the road infrastructure is optimally used — a consideration in a land-scarce nation. The logistics industry has worked closely with the government to integrate goods transportation with systems at the ports and at the airport.

In the financial sector, several innovations are impacting business. Peer-to-peer lending is now more than a curiosity. Although still small, peer-to-peer transactions now amount to some S$50 million per year and are growing as trust grows. The big draw is that the return is about 200 basis points above that offered by the best fixed-deposit accounts with similar tenures, reflecting the risk profile. There is also the sheer convenience of payment systems that disintermediate banks using any mobile ICT device. Crowd-funding is also growing, with entrepreneurs, inventors, film and the performing arts using this route to fund some of their projects.

Blockchain technology is now a mature technology allowing a clear logging of every transaction, providing a straightforward evidentiary trail. This has reduced the number of disputes on the evidence. The Singapore Stock Exchange (SGX) moved their equities clearing and settlements system onto the blockchain five years ago. There is greater use of smart contracts — automated protocols that facilitate, verify or enforce a contractual clause — providing more security than traditional contract law. This has impacted on the demand for legal and judiciary services. While there are still complex cases requiring technologically savvy lawyers who can understand smart contracts, which can fail, by and large the caseload because of block- chain technology is far smaller in 2030.

Fortress Singapore

This scenario explores threats to security as drivers, whether real or perceived, and how that affects the construction of reality in 2030.

Political drivers and trends

The failure or inadequacy of national governance is widespread in South East Asia. There have been several high-profile reports of politicians and corporations involved in bribery and fraud. Weak or immature institutions and a lack of investigative freedom in the media mean there is little accountability.

While some countries have tentative "democratic" rule, most are autocracies. A few are embroiled in fiscal crises. As these states border on failing, there are flows of migrants and refugees to neighbouring states. Singapore is steadfast in refusing entry to all irregular migrants, despite calls by the international community to demonstrate humanity to refugees. There is increased capital flight, mainly to the security of Singapore and beyond. With regional governments focused on economic and financial crises, separatist groups in Indonesia, Malaysia, Laos, Thailand, Cambodia, Vietnam, Myanmar and the Philippines are emboldened and maintain a steady stream of guerrilla activity. These form fertile ground for more fundamentalist belief systems to thrive — some based on ethnic lines, some on nationalism and some religious. Considerable resources are spent by governments on surveillance, domestic intelligence and equipping of internal security forces. In Singapore, security agencies have thwarted some attacks, but several cyber-attacks in the form of "denial of service" have occurred.

The South China Sea is also tense with territorial disputes, and historical animosities between countries surface every so often. Singapore, mindful of its dependence on open international shipping lanes, has formed a clear and firm alliance with the United States, providing not just logistical and servicing support for US vessels and planes and joint military exercises, but intelligence and financial contributions. In the region there is a fine balancing act between the two largest economies — China and Japan.

The focus on economic integration, while maintaining a very light touch on social and political maturity, means that ASEAN remains a region of mixed fortunes, developing at very different rates. The

percentage in ASEAN who have reached the middle classes have risen slightly in 15 years. The notable increases have been in Vietnam, the Philippines, Cambodia and Myanmar, while in Malaysia and Thailand the numbers have plateaued — but of course with vastly different levels of disposable income.

Social drivers and trends

Instability in the region has fanned xenophobia. There is considerable resentment against professionals in the region relocating to Singapore, placing strain on Singapore's open-door policy to talent. The activation of Total Defence in the face of real and virtual security incursions has united Singaporeans tribally – those born in Singapore (the 'us') and the non-locals (the 'them'), who are seen as freeloaders in the good life, not subject to the demands of military service and defence call-ups.

Xenophobia is further legitimised in the rise of fringe groups who advocate a closed-door policy, discriminatory policies and even social segregation. These attitudes damage Singapore's open-for-business brand and discourage the flow of top talent to Singapore. Some good people decide to move to more welcoming markets, such as the Gulf States.

Technological drivers and trends

Singapore's Smart Nation 2025 programme has been a huge success, and it has derived huge benefits from being the most networked country in the world for the past decade. This has enabled better and more intrusive state surveillance to match counter-surveillance technologies and techniques which are easily accessible. This is necessary as Singapore's highly interconnected systems make it particularly vulnerable to cyber-attacks. In the past year alone, nearly a hundred companies have been targeted and several dozen have had their communications suspended for several hours. Data theft is a growing problem. Anecdotally, there are more cyber security consultants working in Singapore, many from Singapore's ally Israel. Another sign that cyber-security is an issue is a couple of high-profile international investigations involving transactions through Singapore

involving bribery and breaches of US anti-money-laundering arrangements.

With Singapore's position as the first "smart nation", privacy has become a divisive social issue. Drone technology, video analytics of CCTV, social media and big data analytics have placed personal privacy front and central in the debate. Singapore, like other highly developed nations, saw government surveillance continue well into the mid-2020s. However, a backlash emerged when whistle-blowers revealed the full extent of surveillance.

Bless thy Neighbour

Singapore recognises that it is, in the longer term, mutually beneficial for it to build the capability of ASEAN to deliver better lives to their millions.

Environmental drivers and trends

In 2020, five years after COP21 on stabilising global warming was signed, the region continued to struggle to diversify from a carbon economy. More immediately, this was the third successive year of heat and water stress across swathes of continental Asia. Ineffectual responses from many ASEAN countries impacted Singapore. Food prices soared across the region as crops failed in many parts of Asia. In conjunction, burning of peat land continued unabated, making air quality an annual crisis in the city-state by 2020. Mitigating the effects of climate change and environmental pollution to ensure socio-economic stability became a priority for Singapore and ASEAN.

Economic drivers and trends

Despite the regional crises, Singapore continues to grow. Its GDP per capita (purchasing power parity) in 2030 exceeds US$130,000, an increase of more than 60% in 15 years.

In 2020, following the decimation of the agricultural lands in much of ASEAN, Singapore was invited by the other ASEAN countries to lead the rebuilding of economies now experiencing rising levels of poverty after many years of progress. Despite initial reservations, Singapore

saw that this was an opportunity to validate its model of development, develop its cadre of leaders and build long-term relationships and markets in its “hinterlands”.
Working with the World Bank, the Asian Development Bank, the Asian Infrastructure Investment Bank, the UN Development Programme, and private foundations, Singapore mobilised talented Singaporeans in public and private sectors. All were excited by the vision for a region badly scarred by years of environmental disasters. Through selected investments and investments in infrastructure and the development of human capability, Singapore began a sustained programme of technical assistance to the region. Drawing on its considerable expertise in financing and its AAA sovereign rating, it secured long-term funding for the programme.

Applying its tripartite model of unions, employers and government, Singapore brokered fair wages, a comprehensive education and skills programme and consultative, management practices in ASEAN economic zones located in hitherto high-poverty areas. These pilots were soon replicated successfully elsewhere, improving hundreds, then thousands, of lives. In 2030, the “bless thy neighbour” programme has delivered schools, bridges, good government and sustainable land management practices in many parts of ASEAN. Singapore’s model of using partnerships has accelerated the replication of pilots all over South East Asia and beyond. In return, Singapore has developed strong and long-lasting relationships in the region, improved governance and resilience, and reduced security risks.

Technological drivers and trends

There are now “blue economy” pilots across ASEAN funded by various development agencies, and some are models of innovation. Investment and advances in energy storage have helped to increase the number of renewable energy initiatives. Singapore’s decision in 2020 on decarbonisation has brought economic advantages, as other nations now look to its expertise in moving to clean energy and a more sustainable economy.

By 2030, Singapore is the world’s first “smart nation”. People have lived through 15 years of convergence into a brave new world

characterised by speed, disruption, innovation and exponential development, mainly driven by advances in technology and entrepreneurship. It is the confidence, maturity and openness of its citizenry that has shifted Singapore from an economic miracle to a leading developed nation.

OUR POSSIBLE RESPONSES

While the scenarios present the possible visions of 2030, what is evident in each of them is the role of agency, the actions arising from individuals' choices. Before the future is here, each of us will first make a series of choices. Each choice is a small step towards the future, paving the path towards one or another scenario.

The shape of talent in Singapore, therefore, is also a function of our own choice. More often than not, we react in ways that are familiar, applying our worldview. We choose to accept the situation and adjust who we are to meet it (and/or the expectations of others), unsurprisingly arriving to predictable outcomes. Other times, we question the premise on which the situation is presented and try to change or challenge that reality, and in so doing alter the future. Accepting or challenging the predominant paradigm reflects different levels of "maturity" of the actor making that choice.

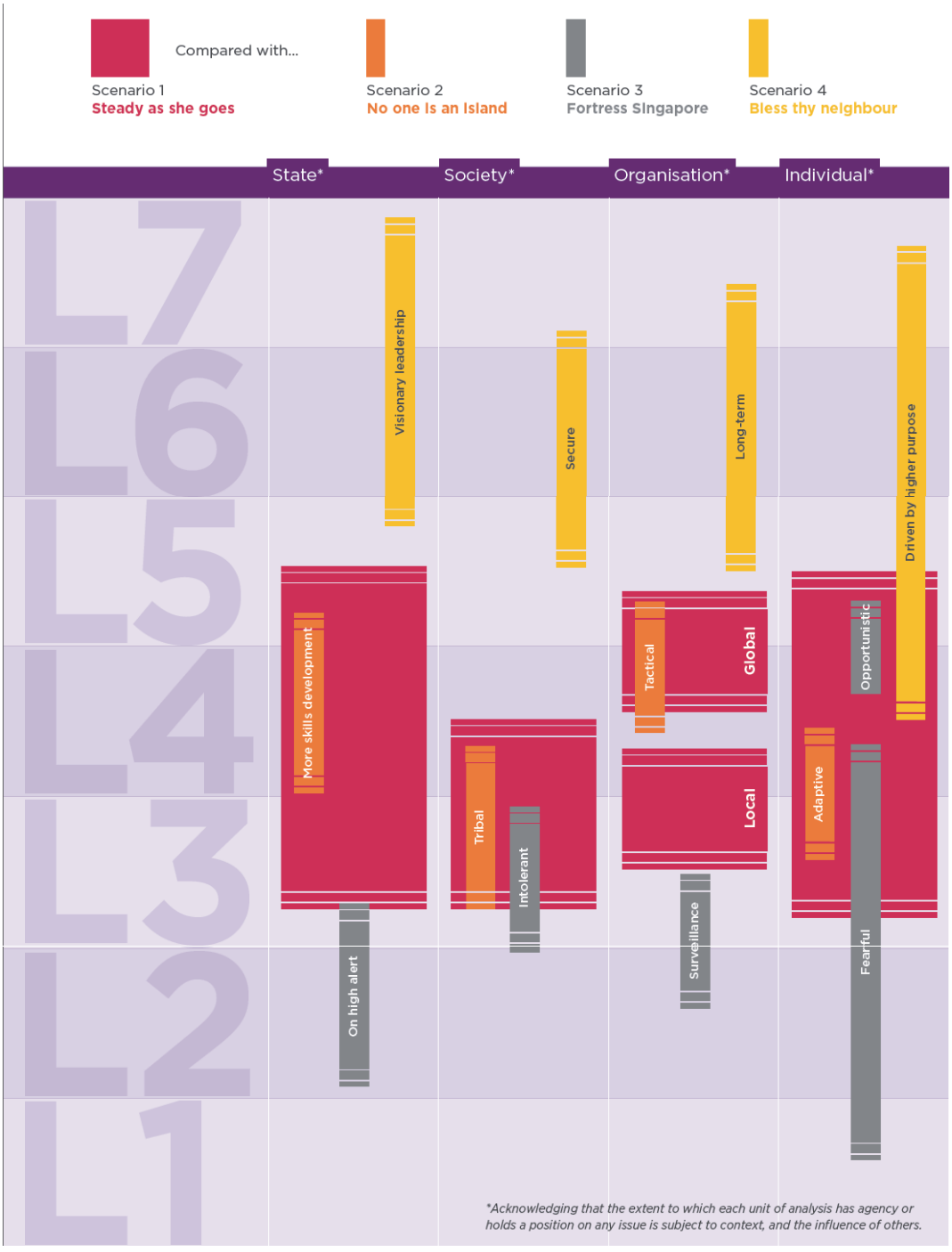
As the focus of this report is on talent, it would be remiss not to discuss how different levels of maturity can shape responses to any situation. In Figure 1, the four actors — the state, society, the organisation and the individual — make very different choices at seven different levels of maturity.

FIGURE 1: MATURITY FRAMEWORK DESCRIBING CHOICES BY THE FOUR ACTORS: STATE, SOCIETY, AN ORGANISATION AND INDIVIDUALS

Level of maturity	State*	Society*	Organisation*	Individual*
LEVEL 7 Visionary. Sees issues holistically and grapples with principles, identity and what will make a difference. Systemic approach.	Leads on global issues for the long-term good of all. An exemplar of principled, inclusive governance. Willing to take tough decisions, while also forgiving of fallibility.	Able to enact and live by espoused principles, especially when defending the rights, interests or dignity of others.	Assumes leadership in making long-term, difficult, sometimes immediately costly decisions for the long-term benefit of the whole.	Weighs up choices using ethical principles for the whole/'greater good' beyond the needs of oneself. Mastery of important externalities.
LEVEL 6 From 'me' to 'we'. Appreciates complexity of values and ethics. Accepts and respects difference and diversity.	Sees itself as a force for good. Appreciates the interests and cultures of other nations.	Able to rise above sectarian interests and finds common ground on which to build stronger bonds without dismissing difference.	Sees itself and behaves as an integral part of society.	Sees oneself as part of something bigger and appreciates the validity of the other's view. Appreciates and understands risks well.
LEVEL 5 Interconnectedness. Joins the dots. Innovates. Able to identify patterns and make connections to achieve goals in a new way.	Applies innovative and creative approaches to address issues of the day. Human capital is one key resources to better, fulfilling lives for citizens.	Able to engage conceptually (vs. 'I am the measure of all knowledge/truths'). Creative, questioning and able to tackle sacred cows. High trust.	Openess to trying new thinking and ways of working. Takes risks. Failure does not result in censure. Confident.	Makes new connections and creates something new. Beginning to think 'outside the box'.
LEVEL 4 Learning and developing. Belief in progress and one's agency to effect change.	Sees integrated development of human capital (education, skills, industrial master plan, and so on) strategically as national interest priorities.	Values learning of all kinds. The development of individual potential for own sake is important.	Nurtures a culture of learning both individually and corporately. Learning and development is encouraged and supported.	Aware of the need to develop potential and is constantly learning.
LEVEL 3 Belonging. Establishing interconnections that foster group identity.	Has developed a national identity/ mythology which all are encouraged to embrace.	Shows some respect and tolerance of the 'other'. Embraces difference and bestows rights on minorities within comfort levels.	Supports social networks and communities reinforced by common values, functions, interests, and so on	Has ability to analyse situation and adapt response to achieve prescribed outcome.
LEVEL 2 Order. Planning and processes in place to ensure consistency but not always rigorous or disciplined.	Has functioning administration delivering public goods and infrastructure.	Establishes common rules of engagement and recognised authorities to lead and arbitrate.	Seeks consistency and predictability by setting up policies and procedures.	Able to apply those skills and knowledge under direction.
LEVEL 1 Survival. No systems. Ad hoc, uncertain, dynamic and reactive.	Ensures that there are the bare necessities. Subsistence.	Caters to basic needs. Some security. Basic freedoms to go about one's life.	Has basic administration to run a business. Adjusts where and when necessary.	Has knowledge and skill for the task at hand.

So, which choices of the state, society, organisations and individuals does each of the four scenarios represent? Figure 2 illustrates.

FIGURE 2: CHOICES OF THE FOUR ACTORS REPRESENTED IN EACH SCENARIO



In ***Steady as she goes***, the baseline scenario, we see a blend of Level 4 and 5 choices. Society, being fairly conservative, operates between Levels 3 and 4. The state contributes at Levels 3, 4 and 5, depending on the issues at hand. In Singaporean or local organisations, the default management style is top-down, command and control, albeit with some autonomy within prescribed functions (Levels 3 and 4). At the same time, the world of entrepreneurship and many international MNCs, dominated by foreign investors and innovators, adopt different practices, and often a more inclusive management style (Levels 5 and 6). For individuals, there is strong individual motivation to learn, improve and advance (Levels 3–5).

In ***No one is an island***, the default reaction is mainly in Levels 3 and 4, with very few progressive tactics at Level 5. As disintermediation occurs, value chains are redrawn and new ways of deriving value emerge. This will result in a recalibration of expectations and goals by individuals. The imperative is to pick up the signs early and to learn, evolve and adapt. It is likely that this will create primary allegiance to oneself and to one's unique selling point rather than to one's organisation(s). The individual is strongly motivated by employability and, in the face of an economy where there are few social safety nets, there is a lot of reliance on social networks, family and individual resilience (Level 3). In order to successfully transition from one employer to another, individuals will have to demonstrate a higher than normal propensity for risk and resourcefulness to retrain quickly (Level 4).

For organisations seeking to attract and retain such talent, HR develops sophisticated learning environments with strong social networking and community-building elements. Employers run mentoring and reverse mentoring programmes to facilitate integration, flow of knowledge and expertise. The war for this talent is keen and companies are increasingly sophisticated in their approach, integrating investments in their employer brand and segmenting the workforce using behavioural data to develop offers that are salient. Flexible working and pay, performance-based bonuses and training courses supported by data and analytics are used to entice and to retain talented individuals. These are responses at Levels 4 and 5.

For the state, the likely responses to the situation are at Level 4 — ensuring access to lifelong learning via a variety of routes and having the appropriate incentives (financing schemes, training funds, tax incentives, employer tax advantages for learning and development schemes). At the same time, the precarious skills market will contribute to rising inequality, thus threatening unity. To mitigate this risk, the state may choose to respond at Level 3, creating pathways and safety nets for people in transition. The state can also choose to operate at Level 5, of course, with the consent of the citizenry. The changes in the economy offer an opportunity to encourage a more mature social compact where citizens take on more responsibility for communal issues. Encouraging greater grassroots ownership provided through co-created solutions is one way of building resilience by addressing and rising above differences.

In ***Fortress Singapore***, real (and perceived) threats encourage a fearful, protectionist culture, one that is suspicious of the "other" — certain foreigners; regional partners; some internal threats; interest groups; and so on. There are clear divides between "us" and "them". Here, the primary response is at Levels 2 and 3.

The state is focused on building unity against unseen enemies (Level 3) and all the time fearful of chaos, hence the emphasis on order, obedience and sacrifice (Level 2). Surveillance and private data are constantly used by the state for profiling and intelligence-gathering.

For the individual, the situation offers several advantages. There is a sustained investment in security and a high demand for a range of specialists. Moreover, as loyalty and trustworthiness are central to maintaining secure systems, there is an investment in national human capital is high.

In organisations, workers are subject to digital surveillance; their performance and productivity is carefully monitored. Employees are now familiar with the regular collection of data and measurement using a slew of metrics. This provides insights on the workforce, transforming the recruitment, assessment, performance management, and learning and development functions, for instance, but there are limits to the power and accuracy of the diagnostic capability.

Society at first operates at Level 3, largely tolerating difference within its own comfort area. As people are called on to be the eyes and ears of the state to counter terrorism activity, the extent of surveillance is normalised. So, where there is a paucity of information, the narrative is made up. These stories affect the psychological defences built up over the years as more and more question the argument that privacy is a luxury Singapore can ill afford.

The irony of the talent paradigm in Fortress Singapore is that, while the likely choices of the actors are protectionist (Level 2), the technology is very advanced and has far-reaching consequences that can really only be appreciated at Level 5 and beyond. One reaction may be a conscious choice by organisations to decrease use of surveillance and focus on building a culture of trust, favouring face-to-face interaction and sharing ideas in person. Similarly, individuals can opt to go offline to preserve some small area of personal privacy. A constant trickle of talented emigrants will be seeking to escape the heightened tensions of Fortress Singapore in search of 'a simpler life".

Finally, and in sharp contrast, the ***Bless thy neighbour*** scenario has Singapore possessing a global big-picture "we are in this together" paradigm. This scenario represents a choice to unlock the potential of human capital to shape the future, not just for "us", but for all. The ability of the various actors to operate at Level 7 reflects a huge given. Security and survival are no longer the prime consideration. The economy is doing well and Singapore is at the top of the food chain. It is this stability that offers an opportunity to apply the 'we are in this together' different mindset.

Singaporeans have become increasingly conscious of the impact of their behaviour on the environment. They acknowledge their role as guardians of the planet for the next generation rather than exploiters of natural resources. Its citizens engaged with the climate change debate and sought to move towards even more ambitious decarbonisation targets than COP21.

Organisations operating in Levels 6 and 7 see themselves as an integral part of society and hold themselves accountable to a wide number of stakeholders. Their raison d'être is not just profit but delivering sustainable value to society. Companies are concerned not

just with developing employees for tasks at hand, but see value in human development, realising that investments in communities that they touch are the only way they build viable, successful societies who can in turn generate further value to more people.

The state retains its role as the honest broker while the diversity of voices and interests shape and deliver on a global — not local or individual — vision.

Compared with the other three scenarios, the actors here recognise that their decisions, like ripples in a pond, affect many others across time and geographies. In addition to factoring in more externalities when making decisions, such as long-term impact, sustainability, and inter-generational fairness, there is a profound shift in identity. The citizen here sees that they have a responsibility and a role far larger than that of building the Singapore nation; it is a recognition of a common humanity and a vision of that common future. This is a rare leadership, one that has the potential to be transformative, altering the frames of reference for what is possible.

CONCLUSION

In the introduction, we said that this paper is an invitation to stop, be still and listen to oneself before making the first step into the future. Whether a specific scenario will be realised is yet unknown. Yet, which would you strive towards?

As we move forward as a nation, it will be necessary to ask the following questions:

- What other contributions or qualities of talent do we desire for Singapore?
- What do we lose as a society if we focus only on what our talent can deliver in the short term?
- In a complex, interrelated world that is unlikely to become more secure, is our present understanding of talent adequate? How open and aware, are we on diversity, discrimination and bias?

DEVELOPING CORE SKILL SETS

Luuk van Breda
Worldwide Business Solutions Pte Ltd

We are talking about what it will take to integrate the future generation into the workforce and what is needed to upgrade the existing workforce. Both are interesting questions, which need to be answered, both by employers as well as by the education system.

For the second question, do we need to integrate technology in all subjects and how should this be achieved, in both the short and long term? Do we have to change the way we teach, from early age to the time of becoming part of the workforce? How do we implement these aspects to get a future generation who are fulfilled in jobs and not jump around?

Singapore is not the only country asking these questions and many are not sure that there will be opportunities for all, because of new technologies.

Coming back to the education industry, yes we have to change, but the ways to do so is up for discussion with all the relevant parties in education and in industry.

We have to acknowledge that not all of us end up with a university degree, and that those without one can play a big role in in society.

Many have set up SME organisations and proved that they can thrive and become very successful in their specific sectors. They employ probably half of the workforce.

The trend for the workforce of the future is such that Singapore will need 1,500 to 2,000 new SMEs in the next five years. The young have to stop looking for jobs for life, but should aim to start the companies of the future, with the advice and help from PMEs as mentors.

We need organisations to start reversing the pyramid in their organisations and have their employees become involved from top to bottom.

Who knows more about the customer? The person who listens daily to the customer, or the Board of Directors? Which person walks around the company every day and knows more about the work force? We should be asking these questions, and how we should use these to create more productivity and reduce attrition. *There should be no job-hopping anymore.*

We have to start this today — we cannot wait till tomorrow — but we also have to control technology. There is a danger that it will take over our personal lives, our companies and the way we live. There are many stories we all know and see. Walking on the street, you see people talking or texting; ride on the MRT and eight out of 10 look at their tablets or phones — not to learn, but to watch the latest movies. Go to a restaurant and you see a family of four, the parents on their phones and the kids having iPads to keep them occupied. They probably do the same at home.

We need to know when to put aside technology: communicating, to understand the other person; listening, to know what the other party needs; negotiating, to get the best deal out of a situation; presenting, in all forms, from getting a job to showcasing yourself and your product.

All these issues are important for the trends of employment in the future and all parties need to discuss and make decisions, which will set the tone for the next 50 years and beyond.

All of us have 5,000 ideas and concepts over a lifetime, so we should make use of them. Set aside about an hour at home or at school to discuss the ideas and aspirations of the young person at school, college or university, to have a positive mindset that they can reach for anything.

At organisations, corporates, SMEs and government departments, take an hour a week to discuss these ideas and concepts. After a time, organisations will realise the effects of productivity as the people feel they are part of the organisation. Sport and business are connected, we learn as a team and we succeed as a team.

Use the five Ws and one H (who, what, when, where, why and how). All of the above is based on the strengths of the people, who are all able, as long as they have a chance to show their abilities.

CREATING WORK FOR ALL

Tan Eng Chye
Deputy President (Academic Affairs) and Provost, National University of Singapore

This article examines what the drivers are, and how best, as Singapore's flagship public university, we ought to shape our educational offerings, to serve the nation's manpower needs. Manpower is Singapore's only resource. All the more it is imperative that we harness the potential of every individual, so that each can seize opportunities and contribute productively in this VUCA (volatile, uncertain, complex and ambiguous) world.

It is sometimes said that universities or academic institutions are bastions of traditions. Notwithstanding, in this globalised world, top universities are cognizant that they must evolve to stay relevant whether in research or education. No university is operating in an ivory tower — the role of a university is to bring impact and value to community, society and the wider world. Similarly, NUS is evolving with the times, so that we continue to serve and bring value to Singapore and the wider world.

FUTURE WORK

NUS recognises that the world has evolved, and is evolving. This presentation will discuss what future work could look like, and this sets the context for the sort of world that an NUS education needs to prepare our graduates for.

In January 2016, the World Economic Forum published a report titled "The Future of Jobs" (WEF, 2016). The report describes how we are now living in what is known as the digital or 4th industrial revolution. The speed of breakthroughs and innovations has no historical precedent. When compared with the previous industrial revolutions of steam power, electricity and IT and electronics, the 4th industrial revolution is evolving at an exponential pace. It is not just the speed with which changes are occurring, but its impact is invasive, extensive and pervasive, disrupting production and business models across every industry. And changes and the waves of globalisation are felt

more acutely in a small, open and in other words exposed economy as Singapore.

Digital technologies and automation will impact jobs. With driverless cars, will there be taxi-drivers in future? Already, digital technology and innovation have given rise to the Sharing Economy, such as AirBnB and Uber, disrupting traditional business models of hotels and taxis. *The Economist* once painted a rather stark scenario that text-mining programmes could displace professional jobs in legal services; biopsies will be analysed more efficiently by image-processing software; accountants may gradually be replaced by tax software. Even in the domain of journalism and writing, where one imagines human input is vital, machines were already able to turn basic sports results and financial data into news stories (*The Economist*, 2014).

There is however, no need to be overly pessimistic. The 4th industrial revolution also accords many opportunities to individuals, particularly those who are flexible, creative and innovative, and are able to harness what technology has to offer. Arguably, it is easier to launch a startup, innovate a product and sell to global consumers. Technology has enabled access to a worldwide market. There are YouTube stars and bloggers reaching out to the world from their humble homes, and becoming worldwide sensations. The top 13 DIY filmmakers on YouTube raked in over US$50 million in 2015 alone. In this new economy, those who create, invest or leverage on hit ideas (such as YouTubers) will earn disproportionate returns.

IMPACT ON EDUCATION

What then are the implications of this new economic order on education, particular, for students and graduates in Singapore?

First, graduates can no longer expect to stay in the same industry, or the same job for life. Industries will come and go; changes are inevitable. Graduates in this new economy can expect to venture into multiple jobs across their working life. Second, *The Economist* in a recent article titled “Re-educating Rita”, stated that as more tasks become susceptible to automation, the tasks where human skills are most valuable will constantly shift (*The Economist*, 2016).

We can only conclude that moving forward, continuing education will become a fact of life, and many adults will have to upgrade and seek education alongside full-time work. A degree prepares you for the immediate job ahead, but as knowledge becomes obsolete more quickly, one will need to continually retool and reskill. Lifelong learning is absolutely essential for each of us to remain effective and relevant in our work and lives, in a fast-paced and rapidly changing environment, regardless the industry or vocation we are in.

EQUIPPING GRADUATES FOR LIFELONG LEARNING

How then do we prepare and equip our graduates with the capacity for lifelong learning?

First, NUS will ensure that we continue to provide students with strong and rigorous training in their degree disciplines. NUS has built a reputation for producing graduates with strong technical skills and know-how. Over the years, our departments have grown in international stature; many are today counted as among leaders at the forefront of research and discovery. This has positive spin-offs on education, as students get to learn from academic leaders in their disciplines, in an environment of curiosity, disciplinary passion, as well as in well-equipped laboratories.

NUS Departments are now taking steps to align our solid disciplinary education with industry needs. Departments are engaging more closely with industry, involving industry partners in curriculum design and planning. NUS has also mounted significant partnerships, an example being the Keppel-NUS Corporate Laboratory, based at the Faculty of Engineering, to develop capabilities and technologies to maintain Singapore's position as a global leader in the offshore and marine industry. NUS has also phased internships as an intrinsic part of our curriculum, beginning with students from the School of Computing and the Faculty of Engineering, thereby integrating working and academic learning in a meaningful way.

Second, beyond strong and solid disciplinary training, NUS recognises that there are essential skills and attributes that we need to impart to our graduates to enable them to be lifelong learners. Given the rapid changes, on-the-job or job-specific skills will come and go.

What becomes more imperative than ever are: (1) Having a solid foundation of basic literacy and quantitative skills; and (2) a broad base of 21st century skills and attributes that include, amongst others, a global outlook, communication skills, a resourceful and curious and creative spirit, personal mastery, and perseverance. These are traits that are highly valued by employers and they are an indicator of how well a person can adapt to change and to pick up new skills.

Hence, in recent years, NUS has implemented deliberate initiatives to infuse these elements into our curriculum, to prepare our graduates for a world of changes, technology and lifelong learning. The revised general education curriculum ensures that all students are given training in quantitative reasoning, writing, expression and communications, and critical thinking. The Centre for Future-Ready Graduates was set up to impart soft skills and life skills to our graduates, via a specially designed “Roots and Wings” programme.

Technology-enhanced learning exposes students to new pedagogies and new ways of learning, particularly to leverage IT to tailor, pace and enhance their learning.

NUS also has an extensive overseas exchange programme — possibly one of the largest of its kind in the world — where some 2,000 students go overseas each year for a semester-long exchange, and we welcome a similar number of international students to our campus each year. All these initiatives work in tandem to equip our students with the capacity and the mindset to take on lifelong learning.

DRIVING LIFELONG LEARNING — A DEDICATED SCHOOL OF LIFELONG LEARNING AND EDUCATION

In recognition that lifelong learning will become a feature of the new economy, NUS is positioning itself to be a major driver and contributor to continuing and professional education in Singapore and the region. The university’s role does not stop after our students successfully complete their undergraduate programmes. In June 2016, NUS was the first autonomous university in Singapore to set up a dedicated School of Lifelong Learning and Education, or SCALE.

SCALE will be a powerful complement to our existing undergraduate and graduate programmes. Through SCALE, working adults will get the opportunity to acquire new knowledge and skills from a leading university. All programmes offered through SCALE will be designed and developed in close consultation with industry. In doing so, we seek to help Singapore companies and industries stay competitive by honing the expertise and skills of their employees. The curriculum will emphasise experiential learning of skills that are immediately applicable and useful to the industry. For individual learners, SCALE programmes are designed with the working adult learner in mind — and this requires a different approach from designing programmes for full-time students. SCALE will fully leverage IT so that learners can engage in self-directed learning. Learners can also tap the rich and comprehensive resources at NUS, such as the library, laboratories, and leading research experts in the field.

I hope that this article has given you some understanding of how NUS sees the future of work, and how, as Singapore's flagship public university, we are endeavouring to prepare our graduates to navigate and thrive in this new future landscape, and how NUS will support Singapore's manpower strategies for the future.

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Chapter 4

Productivity and Innovation

CUI BONO? BEHAVIOURAL CHALLENGES TO INCREASING PRODUCTIVITY

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ABSTRACT

Productivity can be increased by macro and micro measures. Macro measures work well for organisations subject to domestic or foreign competition. Micro measures may be specific to each organisation. However, the challenges are how to overcome status quo bias and weak incentives for the people bearing the cost of change.

THE PRODUCTIVITY CHALLENGE

Productivity can be increased on two margins — one is to find new ways of producing more with less resources, the other way is to raise the productivity of underperformers. Studies of productivity in the United States, China and India have found considerable dispersion of productivity within and across countries (Syverson, 2004; Hsieh & Klenow, 2009). Within a country and industry, the difference in productivity between the 10th and 90th percentiles of businesses may be a factor of two. That means that businesses in the 10th percentile can double their productivity by achieving the productivity of those in the 90th percentile.

Although no similar studies have been carried out for Singapore, it is quite reasonable to believe that our industries exhibit similar dispersion. The evidence is indirect but compelling. It is related to the obvious question of why businesses differ so much in productivity. While most would think of differences in technology as being the explanation, an important reason is differences in management (Bloom et al., 2013). In a famous randomised controlled experiment in the Mumbai area textile industry, businesses that were assigned management consultants achieved higher productivity, and the higher productivity persisted even after the consultants left.

The moral of the story is that businesses with better management achieve higher productivity. In the Singapore context, multinational

corporations score much higher than domestic businesses on modern management practices (Lee & Freebody, n.d.). To the extent that management drives productivity, this in itself suggests that there is considerable dispersion in productivity between Singapore businesses in the same industry.

Recall the two ways to increase productivity — finding new ways to produce more with less and raising the productivity of under-performers. The former requires innovation and exploring the unknown. By contrast, the latter seems like almost a "free gift" — just getting the bottom performers to learn from and follow the high performers. So, how can the government help?

One answer is that the government need not do anything. According to the Adam Smith and Charles Darwin school of thought, the forces of market competition will weed out inefficient and less productive businesses. As they contract or exit, the inefficient and less productive businesses would release human, physical and other resources. The more efficient and productive businesses would grow and absorb these resources. The overall productivity of the industry would increase as the more productive businesses expand and the less productive contract.

Market forces work well in industries that are highly competitive in the economists' sense of "perfect competition". They work to some extent even in industries that are not perfectly competitive. In Singapore, between 2010 and 2013, the productivity of export-oriented industries grew by 2.1% per year, while the productivity of domestically oriented industries shrank by 0.3% (MTI, 2014, pp.9–12).

However, most if not all businesses enjoy some degree of market power. To the extent that they are shielded from competition, market forces are blunted. The problem is more acute for enterprises and organisations that do not face competition or are not subject to financial discipline. These include regulated monopolies, non-profit organisations, and the government itself.

How can such organisations raise productivity? With the absence of external pressure from competitors, raising productivity depends on internal initiative — from within the organisation. The ways to raise

productivity may well be specific to each organisation. To this extent, there is no simple formula that works everywhere.

A key challenge is behavioural. *Cui bono*? This Latin phrase means "who benefits?" It is a key forensic question in legal investigation. Economists would couple this with another equally important question: "Who bears the cost?"

CUI BONO?

The key behavioural challenges are that the benefits and costs of raising productivity accrue to different persons, and psychologically, we tend to follow the status quo. And, importantly, there is no arrangement for the person who benefits to compensate the person who incurs the cost. Economists would say that there is a potential positive externality, which remains unexploited. So, productivity remains stuck in status quo.

Let me illustrate with a few examples. Each of them illustrates the possibility of doing more with less, but without any innovation.

In November 2015, the Asia-focused international bank, Standard Chartered Bank, announced that quarterly revenue had dropped 18% and impairment losses more than doubled, resulting in a pre-tax loss of US$139 million as compared with a US$1.53 billion profit in the previous year. The bank announced that it would cut 15,000 positions and issue new shares to raise US$5.1 billion.

The intriguing question is what those 15,000 people were doing that suddenly ceased to be useful. When the bank was making huge profits, the profit masked 15,000 unnecessary staff. The Toyota production system advocates lowering the water level to expose the rocks. (Recall the bygone era when the rest of the world avidly learned manufacturing skills from Japan.) But, who will force the lowering of the water level? Apparently, it takes a crisis. In normal times, the status quo prevails because shareholders get the benefit while managers incur the cost.

I have often found it useful to compare practices across countries. It is a simple form of benchmarking that can be quite illuminating. An

obvious difference in retailing between Singapore and New York is at the point of sale. Here, our store cashiers print separate receipts for payment and mode of payment (whether NETS, debit card, or credit card). But why? In New York and probably many other cities, the store cashier prints just one receipt, which saves time for cashier and customer, and reduces paper waste.

I wonder what is locking us into the system of two receipts? Again, my guess is the benefit goes to one party (the shareholders of the store), but the cost is incurred by managers, who would rather have it easy.
The next two examples are from the non-profit world. I have always been puzzled why NUS teaching facilities are so cold – so cold that the NUS Coop Store advertises jackets to keep students warm during lectures. One morning, I arrived early and saw the cleaner at work. Well, she felt hot. So, no surprise, the thermostat was set to the lowest temperature. The benefit of energy saving accrues to the University but the cost (in discomfort) is borne by the cleaner.

The condo in which I live has several million dollars of sinking fund deposited in bank fixed deposits. I've suggested several times to invest in Singapore government bonds, which are just as safe (perhaps even safer) and yield more. But, the management committee is not willing to change. I doubt that any one of them individually puts their entire savings into bank fixed deposits. The benefit of additional income accrues to the condo but the cost (in extra effect) is borne by the management committee.

Since 1994, the government has required new drivers to display a triangular "P" plate on their cars. When asked in Parliament, the then Senior Minister of State for Home Affairs conceded that the government could not say that the "P" plate had reduced road accidents. Then why, after 20 years, do we hang on to this regulation?

The example of the "P" plate seems rather trivial but it does illustrate the bigger point. Over 20 years ago, someone thought it a good idea. More than 20 years later, no one has taken the initiative to validate the concept – despite there being plenty of data. It is just a matter of comparing the rate of accidents among those in their 11th month of license with those in their 13th month.

CONCLUSION

Raising productivity will require overcoming two behavioural challenges. One is to overcome status quo bias. The other challenge is related: it is to share the benefits of raising productivity with those who incur the costs of action.

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SINGAPORE: FLEXIBILITY VERSUS CUTTING EDGE

Sanjeev Sanyal

We live in a period of radical change — a turning point in history that comes every generation or two. Even as we deal with the second wave impact of the information technology revolution, we are witnessing major innovations in diverse fields like artificial intelligence, additive manufacturing and genetic engineering. However, technology is not the only area witnessing important shifts. The rise of China and India, Brexit and the turmoil in American politics all suggest simultaneous changes at multiple levels from the geo-strategic to national politics and local social dynamics.

Such a state of radical uncertainty is always difficult to navigate as these multiple factors interact in infinite different ways. Thus, these are moments when history could go down multiple paths. So, how should Singapore respond?

Over the last half century, Singapore has climbed the economic ladder from British naval base to shipping and manufacturing hub, then on to become a financial centre and more recently an entertainment and education cluster. On this journey, the city-state carefully studied successful models in the rest of the world and flexibly adapted them to its own use. I remember clearly how successful global cities like London and New York were carefully studied in the early 2000s when Singapore decided to try to turn itself into Asia's global city (Sanyal, 2007). In short, Singapore's success has historically depended on being a really efficient second mover.

The above strategy, however, now may seem to have reached its logical limit as Singapore has arguably reached the urban frontier. There may be segments where the city-state can do better but overall it is one of the most advanced cities in the world. So, not surprisingly, there are a growing number of experts who feel that Singapore has no choice but to invest heavily in a number of emerging, untested technologies or be left behind. But, is this the only available strategy?

A HISTORY OF RADICAL SHIFTS

The first ever international conference of urban planners was held in New York in 1898. The central topic of discussion was horse manure! Cities of that time were drowning in horse manure and the leading experts of the time waxed eloquently on what to do with the stuff. A few years earlier, *The Times* of London had estimated that by 1950, every street in the city would be buried nine feet deep in manure (Morris, 2007). None of the experts imagined that horse manure would become irrelevant in less than two decades due to the automobile.

By the 1920s and 1930s, the biggest urban problems were overcrowded slums and streets gridlocked by traffic. Every major city in the world suffered from this — southern Manhattan and East London looked no better than the slums that plague today's developing countries. The leading experts of the time believed that the solution was to decongest cities. So, after the Second World War, the US invested heavily in building suburbs and highways that allowed people to leave the city. The American dream was all about the suburban house, the car in the front drive and a television and a telephone in the living room. All this technology and social engineering, however, did not improve the cities. Instead, inner cities across the United States collapsed between the 1960s and the 1980s. Detroit, once the most important industrial hub in the world, went into a downward spiral from which it has never recovered. Cities in northern England suffered similar decline.

In the early 1990s, urban centres face yet another technological shift — the Internet and mobile telephony. The considered opinion of the leading urban experts was that these new technologies would end urban agglomeration forever, especially for large cities. Why would anyone live in an expensive crowded city, so the thinking went, when one could work on the ski slopes or on a beach? Contrary to all expectations, the biggest and most expensive never had it so good. Cities like London and New York went through a boom and the world's most expensive real estate became even more expensive. It turned out that post-industrial societies used information technology in ways that favoured elite global cities — a model that Singapore would successfully replicate.

SECOND MOVER ADVANTAGE

The most important lesson of urban history is that so-called experts are poor at judging the long-term implications of structural shifts. While it is important to closely observe emerging trends, one needs to be wary of being swayed by the allure of technological wizardry (and other forms of punditry). What matters in the long run is flexibility to deal with the unexpected.

Singapore is often accused of being poor at generating its own innovations. Instead it is seen as a very good second mover — an efficient adapter of other people's innovations. But, one must ask, why is that such a bad thing in a world of radical uncertainty? The US can afford to experiment with a number of different models and suffer Detroit-like failures, but Singapore is a city-state that cannot take such a risk. It is far more prudent for it to allow others to test new ideas and adopt them as their urban and economic implications become clearer.

I am not arguing that Singapore should never invest in cutting-edge technologies or urban solutions. There are some areas where Singapore has developed a cluster and innovations will organically emerge. These should be supported. However, there is a case for Singapore to conserve most of its limited resources for the time being while the world undergoes the structural shift. This may imply that Singapore falls behind for a bit but then, the city knows how to catch up — its ability to catch up is second to none. It is far more dangerous for the city-state to invest heavily in experimental backbone technologies and economic models that may lock it into a dead end.

In short, being the biggest and best is not always the best strategy. The main point about the Tyrannosaurus Rex is not that it was a top predator with large teeth, but that it is extinct; while the super adaptable cockroach is still around.

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Chapter 5

Globalisation and Regionalisation

BENEFITS OF THE TPP FOR SINGAPORE

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INTRODUCTION

The Trans-Pacific Partnership (TPP) is one of the most consequential trade deals in history, rivalling NAFTA and China's accession to the WTO. It goes far beyond capturing Mexico and Canada in Singapore's preferential trade reach, though these are both important. TPP means all signatories will follow very similar rules and practices for many trade and economic issues, as well as reducing tariffs more than Singapore's existing trade deals.

WHAT'S DIFFERENT ABOUT TPP?

The TPP has broader coverage than other PTAs (preferential trade agreements). It covers markets for all goods (including agriculture), services, investment, government procurement, e-commerce with meaningful promises for opening 30 chapters included in agreement, plus over 5,000 of appendices and side letters.

The TPP is deeper than any other PTA. It has new rules for areas like intellectual property, food and food safety (SPS), standards (TBT), environment, labour, competition, customs, etc. It will create shared norms: every member has the same commitments, but varying time frames for some members to implement the commitments.

While sensitive products are often excluded or carved out of trade agreements, TPP does relatively more in these areas such as rice, sugar, meat, fish and autos. Tariffs will drop to zero on 90% of all goods trade between the TPP members. Most of the remaining tariffs will go to zero over next 7–10 years. Tariff escalation, where a raw material is subject to more tariffs following processing, is largely removed — this is especially key for raw materials exporters and agricultural goods to unlock higher value processing.

Services and investment openings will be on the basis of a "negative" list, which will have much broader impact than most Asian PTAs which

use positive list. There will be recognition of qualifications and a temporary entry chapter for business mobility — making it easier to work in other TPP countries.

The investment chapter is stronger than many existing bilateral investment treaties; basic rights are clarified, expropriation rules and procedures are better and legal recourse allowed through the controversial Investor-State dispute resolution.

There are new services areas, in particular digital trade which is hitherto not dealt with in any depth among non-American PTAs.

Government procurement markets will be opened for the first time in many countries, though only above certain thresholds at the federal level. There will be new procedures in place for transparency in tendering.

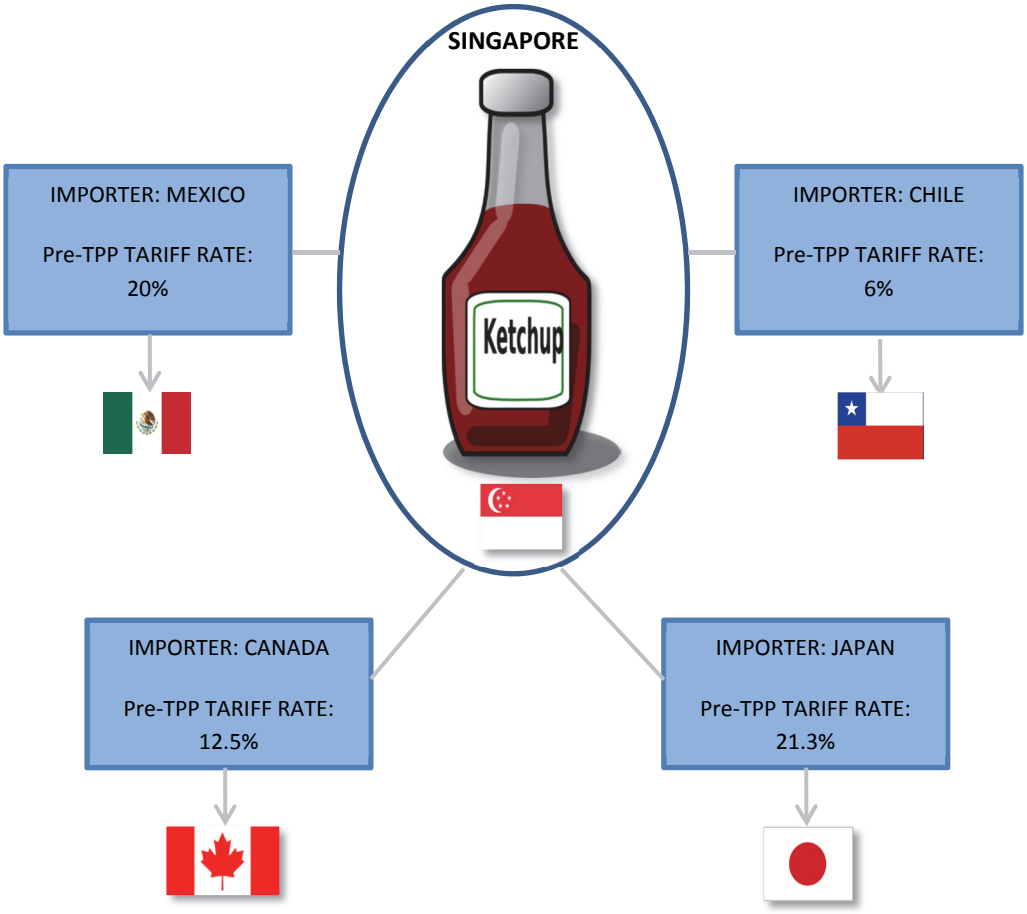
Non-traditional chapters are also included such as labour and the environment, those are unlikely to make a significant difference to Singapore which will not have to introduce a minimum wage.

The TPP is legally binding, a “living agreement” open to revisions as needed and is likely to see new members added in the future.

TPP IMPACTS

TPP will change the competitive landscape, and smarter firms will see ways to benefit from better market access and lower costs. It could certainly impact supply chains in ASEAN; areas previously not possible may be in play now. For instance, if we choose a simple product like tomato ketchup, we see that supply chains may vary a lot. The illustration shows Singapore now has access to markets at lower tariffs rates and can compete with domestic producers.

FIGURE 1: EXAMPLE OF TARIFF PRE-TPP



However, goods have to meet the "rules of origin" (ROOs) to gain access to lower tariff rates. In the TPP, the ROOs can change for each product and most involve a tariff shift. This is different from the way that most ASEAN agreements calculate ROOs. This might mean that sugar will come from Australia rather than Indonesia, and tomatoes from Malaysia rather than Thailand — even though Singapore had zero tariffs on those products, they would have made the ketchup ineligible for TPP lower tariffs as less than 45% of the value was from a TPP country. This shows how Singaporean manufacturers and investors will need to look closely at the patchwork of PTAs in the region to find the best configuration for their supply chains.

REGIONAL INTEGRATION UP CLOSE: SINGAPORE AND THE NEAR ABROAD

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As we know, Singapore is well placed in global and regional production networks and has successfully carved out a niche for itself as a centre for many types of services, from finance to logistics. However, while the global is important, so is the local. Although Singapore is connected to many far-reaching networks, it is also geographically rooted in a specific location. In addition, its land and labour constraints, as well as its status as a metropolis mean that it interacts extensively with its immediate neighbours.

Historically, Singapore has had deep linkages with proximate areas to the north such as Johor in Malaysia and the Riau Islands in Indonesia to the south. Due to political decisions taken by national leaders in the late 1980s to promote greater economic integration, the linkages between the three territories have grown deeper over the last 30 years.

As Singapore has grown in terms of its economy and population, so too have its neighbours. In 1990, the city-state had a population of 3 million and a per capita income of US$16,000 dollars. Johor had a population of 2.1 million and a per capita income of US$3,700, and the Riau Islands had a population of 560,000 and a per capita income of US$2,500. Looking forward to 2030, Singapore is estimated to have some 6 million people. Using very conservative estimates, Johor and the Riau Islands will have 4 and 2.8 million people, respectively. However, should these two territories continue to attract substantial numbers of people from elsewhere, these figures could reach 5 million in each location. Most of these people will be young, urbanised, formal sector workers, constituting an important source of labour for cross-border investment, as well as consumers in their own right. Given Singapore's land and labour constraints, it is likely that interactions between all three territories will continue and grow increasingly complex.

The ISEAS-Yusof Ishak Institute has been carrying out a three-year multidisciplinary study on the relationship between the three territories, particularly how it has progressed since 1990, what the drivers and barriers to economic integration are, and what are some of the trends that we can expect to see. Based on this, I would like to make five points.

First, while the decision to promote greater economic integration between the three territories in 1990 was made at the national level, political developments in Malaysia and Indonesia since then have made things more complex. Negotiations will no longer be trilateral national-level negotiations, or even two sets of bilateral negotiations, as the Indonesia-Malaysia axis did not develop significantly, but rather two sets of multi-levelled relationships.

Looking north, the Malaysian federal government has always been the entity to propel or break momentum for integration. Despite being a federal polity, and having a constitutionally mandated set of responsibilities for state governments, strong and disciplined political party structures within UMNO meant that the centre-state division of responsibilities was blurred. While the Menteri Besar of Johor was chosen through state-level elections, the fact that he had to answer to the UMNO Party President, who was also Prime Minister, affected his autonomy. This situation has evolved somewhat. Over the past two years, the political climate within Malaysia has changed and we have begun to see an unusual degree of independence from state-level leaders, particularly in states such as Johor, Sarawak and Sabah. Furthermore, Johor has a new Sultan and Crown Prince, who have expressed opinions on matters ranging from the causeway to teaching English in school as well as secession from the Malaysian Federation.

Looking south, the Riau Islands have been dramatically affected by the decentralisation reforms enacted in Indonesia in 2001. In 2004, the Riau Islands opted to secede from the larger province of Riau, which included part of Sumatra. While the new province scores well in terms of overall competitiveness, it has consistently scored badly for governance, perhaps due to the issues inherent in building a government from scratch. Furthermore, the number of local governments in the province has increased from two to seven. And, at the moment, there are discussions of an additional local

government and even a new province including the Natuna and Anambas islands.

Second, in addition to an awareness of a greater number of state actors, we must also be cognizant of their motivations. In this sense, the context in Malaysia and Johor is more reassuring for investment from Singapore. Since 2006, the Malaysian federal government has pursued a geographically diverse policy of regional development, seeking to catalyse growth in areas outside the Klang Valley. Iskandar Malaysia is one of five growth corridors, and is arguably the most important and successful, receiving substantial investment for infrastructure and marketing. Furthermore, the Johor state government is a key stakeholder in Iskandar's success, particularly because of its underlying fiscal arrangements. It raises some 80% of its own revenue, and is also able to retain profits made through the sale of industrial land — thus ensuring its buy-in in development projects.

The panorama in Indonesia is less positive. During the New Order, the Riau Islands were key to the central government's industrialisation strategy and had high levels of political backing. In recent times, the Islands have become one growth centre among many and scarcely received a mention in the ambitious national infrastructure development plan, MP3EI. And, in January this year, the Jokowi administration stated that it would disband the agency charged with handling investment into Batam. In terms of fiscal independence and autonomy, the provincial government is very dependent on transfers from the centre, which, in turn, are tied to staffing. And, its own revenue sources are not linked to the underlying health of the economy. As a result, over the past six years, the focus of the provincial government has turned away from industrialisation to the promotion of culture and traditional agricultural industries such as fishing and farming.

Going by previous trends, Johor has managed to cement itself as a more attractive investment destination, receiving on average twice the quantum of manufacturing investment, as well as many more electronics firms than Batam.

Third, we must also understand the mindset and policy frameworks of government officials in these locations and how they perceive success. Looking at the declining terms of trade for manufactures, some academics have promoted services as the new manufacturing and the way to generate income and jobs, and many policymakers seek to secure investment across a range of sectors to provide security.

Thus, Iskandar Malaysia has nine target sectors, of which six are in services, and most additional incentives are targeted at promoting investment into these sectors. In addition, policymakers I have talked to have expressed a certain disenchantment with manufacturing, particularly the electrical and electronic (E&E) sector, stating that it is too mature and cyclical. In the Riau Islands, the focus is still very much on manufacturing. Yet, it is also about getting investment across a range of sectors — some shipbuilding, some electronics, oil and gas, heavy vehicles, and rubber tubing — as this diversification is seen to provide security.

I would differ with these two approaches on two points. First, the future of manufacturing and second the pursuit of diversity as opposed to specificity. I would argue that in tomorrow's economy, manufacturing still has an important place. Singapore, for one, is committed to retaining a core of manufacturing. In addition, many service sector jobs are low skilled. Furthermore, few service sectors can generate the demand for down-stream jobs in technologically demanding supporting sectors in the manner that electronics and autos do. Second, in striving to attract investment across a range of sectors, you can stretch scarce human resources too thinly, disperse policymaking attention, and sacrifice economies of scale and potential for synergy between firms in the same or similar sectors.

Based on an analysis of the composition of the E&E sector in the three locations in 1995 and 2012, we can see that over time Singapore is shedding some of the less technologically-intensive activities such as consumer electronics, computers and peripherals, and components and boards. In turn, more technologically intensive sectors such as semiconductors and communication equipment are growing. However, we do not see either Johor or Batam capturing these production spaces. Rather, these two locations have also lost firms

producing consumer electronics and computers and peripherals, and there is little growth in newer, more promising sectors.

While Johor comes off much better in this analysis than Batam, it is still sacrificing unfulfilled potential due to this focus on services and diversification — rather than specialisation. An analysis of the investment decisions of two large hard disk drive firms illustrates this point. Seagate and Western Digital have high-end facilities in Singapore, important research and development functions in Penang, and only basic manufacturing facilities in Johor. Yet, between Penang and Johor, the latter has an almost unbeatable advantage due to its proximity and well-developed courier networks.

Fourth, while greater economic integration can generate jobs and higher income, there are other factors at play, too. A survey carried out by the ISEAS-Yusof Ishak Institute in 2014 — of Johoreans and their attitudes to Singapore and Singaporeans — generated interesting findings. In general, the news was positive, with Johoreans having an overall positive attitude of Singaporeans and the economic prospects offered by Iskandar Malaysia. However, there are potential sources of concern, regarding issues such as: the price of water charged to Singapore; inflation; rising house prices; and the benefits of Iskandar Malaysia to the wider community. Some of these issues point to the difference into investment in the near abroad for production as opposed to consumption.

Similarly, when we look at the Riau Islands, while the province is the second wealthiest in Indonesia after Jakarta, for many of the Archipelago's inhabitants, this has not been an unqualified success. The creation of large numbers of formal sector jobs has led to high rates of migration from other parts of the country, leading to concerns about the ethnic composition and character of the province that was created to preserve the Archipelago's unique identity. To illustrate, in 1970, the population of Batam was 7,000 people. Today it is 1.2 million. Much of this influx has consisted of people from other parts of Indonesia, as opposed to natural population growth. Due to this, industrialisation has, for many, come to be associated with large-scale change and feelings of dislocation and dispossession.

Fifth, looking forward, while the interactions between Singapore and the other two territories — particularly Johor — are likely to continue, we can expect greater interaction between Johor and the Riau Islands Province, particularly in the area of services. University of Technology Malaysia (UTM) in Johor already has a healthy population of students from Indonesia and particularly the Riau Islands. There is a well-developed tourist industry, taking people from Batam and Bintan to Legoland and other parts of Johor. And, perhaps most importantly, local Johorean players in the medical sector are catering to people in the Riau Islands looking for affordable health care of quality. Thus, the most under-developed leg of the erstwhile SIJORI Growth Triangle looks to develop more in future, which would bode well for its sustainability and also constitute a new business opportunity.

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LOOKING FOR THE NEXT PHASE OF GROWTH: A STRONGER REGIONAL INTEGRATION?

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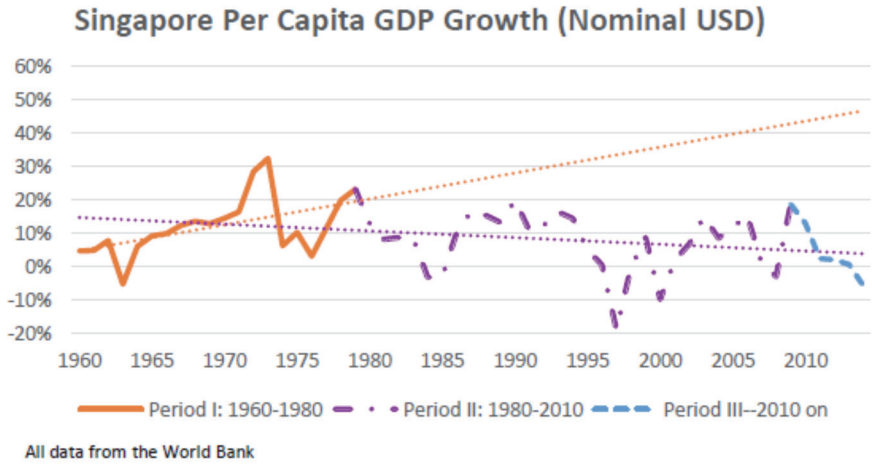
FIRST PHASE OF SINGAPORE'S GROWTH (1965–1980) — GEOGRAPHIC ENDOWMENT AND EFFECTIVE INSTITUTIONS

The first phase of Singapore's growth began from its independence — its take-off growth stage. Its economic logic then was based on its geographical endowment — astride one of the main trade routes linking the Straits of Malacca and the South China Sea. It distinguished itself from the region by having an effective government that built equally credible and effective institutions, thereby enhancing its attractiveness as a strategically located trade hub and investments location in the region. Singapore invited and attracted foreign MNCs and inflows of FDI, offering incentives that ranged from tax-exempt status to providing a well-trained workforce. It deliberately sought to climb the value chain through increasing the skills, knowledge and sophistication of the local populace — hence also their wages and presumed productivity. In this phase of growth, it continued to remain linked to regional dynamics, riding on the inflow of FDI into the region but clearly distinguishing itself by occupying the higher end of the value chain.

FIGURE 1: RATES OF GROWTH, 1960–2014



SECOND PHASE OF SINGAPORE'S GROWTH (1980–PRESENT) — BEYOND THE REGION: RIDING GLOBAL DYNAMICS

The early 1980s marked the start of the second phase of Singapore's economic growth — the crucial stage of growth that broke through the typical middle-income trap and resulted in Singapore being a high-income economy. In this phase, Singapore moved beyond the economic dynamics of the region and latched onto the dynamics of globalisation that saw world trade growing at unprecedented rates. It built on the foundations of the previous period, but in particular, it took advantage of its location between the Middle East and the energy-hungry economies in the Far East to position itself onto a major global supply chain — the oil and gas industry. Singapore became part of the global supply chain and grew to become the biggest refining export centre in Asia and a top three refining centre in the world today. Petroleum-related products form a third of Singapore's manufacturing exports, or about 5% of the economy. This enabled Singapore to redefine its economic trajectory, augmenting its upgraded manufacturing sector and its increasingly sophisticated services industries.

However, growth was mainly driven by strong government's involvement as is witnessed by the emergence of large government-linked corporations like Keppel, Sembawang, CapitaLand and DBS. Singapore recognised the declining contribution and competitiveness of its manufacturing sector that was driven by foreign capital, technology and entrepreneurship. Government-led initiatives to develop its own presence in parts of the ICT and life sciences industries were generally unsuccessful but its services sector has grown and diversified especially business and financial services.

Moving forward, the choices are quite clear: Should Singapore maintain the sizable presence of it manufacturing sector which has been declining, or develop new services industries to make up for the decline in manufacturing's contribution? If the latter, what would be the new high value-added services sector? Can the government still lead, as facilitator, regulator and player, in these efforts?

DOMESTIC CONSTRAINTS AND GLOBAL TRENDS

In charting its next growth strategy, Singapore has to recognise the ever-present constraint on land and the impositions of its own demographics. Further, it has to recognise the demands of an increasingly mature democracy especially with regard to issues around quality of life and distribution of wealth creation.

Changes to international institutions of trade for example redefine the external environment that Singapore has to operate within. Multilateralism at the WTO level seems to have lost out to bilateral trade agreements or FTAs defined geographically such as the TPP. The 2008/2009 Global Financial Crisis has brought about calls for reforms of institutions that were set up during the post-Second World War era to govern global monetary and financial stability. Such reforms will affect an economy such as Singapore.

Further, the global economy has seen some re-calibration. The prolonged commodity cycle ended, and the era of high oil prices seems to have ended; this has changed not just the economics of energy but also global geopolitics. As a major oil and gas industry player, Singapore will be vulnerable to changes in the so-called post-hydrocarbon world. On the other hand, there will be opportunities in renewable energy and the overall sustainable agenda especially in dealing with increasing global trend of urbanisation.

However, taking into account the internal constraints that Singapore faces, in terms of land, labour etc., and the changing external dynamics taking place in terms of the TPP, China, and developments in the region, these will pose hurdles to growth unless Singapore is able to effectively transition to a third phase of growth that takes advantage of these trends.

The growth of global trade has seen the atomisation of supply chains and their geographic distribution, spreading across many countries. Higher specialisation within supply chains has meant that size of firm or capacity is no longer a barrier to entry for firms to be part of international trade, opening up such opportunities for new firms — home-grown firms — to enter.

Finally, there is a north-eastward shift of the global centre of gravity. The rise of the Pearl River Delta, the Mekong Basin and possibly the Irrawaddy will re-define global economic supply chains in fundamental ways. In addition, the development of the East-West railway by Chinese companies that link the West coast of Myanmar and the East Coast of Thailand has the potential to restructure maritime routes and may potentially divert large volumes of cargo from the Straits of Malacca. Singapore will have to play a major role in the region to anchor the economic centre of gravity in this part of South East Asia.

THIRD PHASE OF GROWTH FOR SINGAPORE — THE MALACCA STRAITS DIAGONAL OPTION?

In the face of these trends, a possible third phase of growth for Singapore would be a refocus on the ASEAN region, both to leverage its future growth potential as well as use the ASEAN region as a platform to deepen Singapore's positioning in East Asia, which will undoubtedly be a major growth area in the future global economy.

ASEAN has been a laggard in building formal institutions compared to many other regional arrangements, but there is much social capital to build on — in the form of informal relationships and existing business relationships between firms and investors within the region, especially within its immediate hinterland.

If Singapore wishes to retain its presence in manufacturing, especially in nurturing and expanding the footprint of domestic firms, and if it wants to leverage the surplus it has generated over the last 50 years, it should consider using the Malacca Straits Diagonal as an anchor for opportunities and as a counterbalance to the emergence of competing manufacturing centres in Northeast Asia. The opportunities offered by improved connectivity, a possible new industrial hinterland and supply chain rationalisation would be significant. This will be aided by improved connectivity in the form of a dual-track electrified line along peninsula Malaysia all the way to Bangkok, and the High Speed Rail system to be built between Singapore and Malaysia.

The Malacca Straits Diagonal perspective goes beyond the Batam-Iskandar perspective in a geographical sense. More importantly, it also redefines the economic logic of Singaporean firms, one which

redefines what “domestic footprint” is and that footprint — its markets, etc. — is built on an existing economic density that can be potentially linked to the greater emerging dynamics further north. To use the World Bank’s “three Ds” in its 2009 World Development Report (*Reshaping Economic Geography*), the “distance” and “density” parts of the strategy are obvious. The “division” part will change drastically, having already changed for the better in recent years.

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Chapter 6
Responding Together

THE ROLE OF GOVERNMENT

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INTRODUCTION

We have been blessed as a nation and as a people to have lived, witnessed and enjoyed the Singapore miracle in our country's first 50 years. Much reflection was made last year when Singaporeans celebrated SG50. As reported by CNN journalist, Ingrid Piper, right after SG50 National Day (Piper, 2015):

> *It's the world's fourth-largest financial center; operates one of the busiest container ports in the world; and it's the only Asian country to have an AAA credit rating from Standard & Poor's, Moody's and Fitch Ratings. It's also one of the world's most liveable cities [Workcentral, 2016] — rated as the greenest in Asia, despite having around 5.5 million people living in an area of just 750 square kilometers (289 square miles).*

Piper however, questions Singapore's future with the headlines of her report reading: "Can the Singapore success last another fifty years?"

Our response to Piper's question must be single-mindedly, a resounding "yes", but it is going to take all of us collectively to make it happen.

This paper will attempt to discuss three topics:

- Key trends in technology
- Disruptive business models
- Role of the government in shaping the future of the Singapore economy

KEY TECHNOLOGY TRENDS

From Programmable Systems to Cognitive Systems

Technology is advancing more rapidly today than at any other time in human history. Everything is becoming instrumented, interconnected and intelligent. The notion of a smarter planet was first tabled by then IBM in Nov 2008 (Palmisano, 2008). Internet of Things digitises our world, providing us with prolific amounts of data and new delivery models that allow business to engage in new value creation. Studies have shown that of all the vast amount of data collected, only 1% of the data is used.

Much has been said about the disruptive technologies that will transform life, businesses and global economies. In a McKinsey paper in 2013, 12 emerging technologies were identified as having the biggest potential "to disrupt the status quo, alter the way people live and work, and rearrange value pools" (Manyika et al., 2013).

In this paper, I would like to put forward two technology trends that I believe will have big opportunities for Singapore — Cognitive Systems and Blockchain.

COGNITIVE SYSTEMS

Amid the ever-growing market of new technologies, one capability — cognitive computing — is expected to be revolutionary for multiple industries and, indeed, society in general. There is increasing demand for services; citizens' and clients' expectations for more engagement and enhanced personalised experience is the new normal. On the flip side, operational risk and complexity is on the rise. Add to that a growing need for resiliency and security. While the digital age has provided governments and enterprises with a massive amount of data brimming with insights, organisations still struggle to unlock its full value. Advances in the pioneering area of cognitive computing can help bridge the gap between data quantity and data insights. Cognitive-based systems can build knowledge, understand natural language and provide confidence-weighted responses. And these systems can quickly find the proverbial needle in a haystack,

identifying new patterns and insights — something particularly relevant in complex information environments.

As much as 88% of the data available to us right now is dark. This refers to the data generated every day, which is stored away for compliance but is not monetised or leveraged for analysis. A *Forbes* article noted: "At the moment less than 0.5% of all data is ever analysed and used; just imagine the potential here" (Marr, 2015). The potential in this data is impossible to effectively explore and realise with traditional systems. Through cognitive computing, all data sets become open to analysis because cognitive computing is essentially the simulation of human thought processes. Cognitive systems can mine not only immense amounts of data that advanced analytic systems can, but also the unlimited *varieties* of data — through pattern recognition and natural language processing — that the human brain can (Manyika & Chui, 2015).

> *As computer learning capabilities grow, they will become co-collaborators with humans.*
>
> — Grady Booch, IBM Fellow, *June 18, 2013*

Cognitive systems learn at scale, reason with purpose and, most different from predictive analytics, *interact with us in ways that feel more natural.* This includes:

- Understanding: The ability to understand data, structured and unstructured, text-based or sensory, in context and meaning, at astonishing speed and volume
- Reasoning: The ability to form hypotheses, make considered arguments and prioritise recommendations to help humans make better decisions
- Learning: The ability to ingest and accumulate data and insight from every interaction continuously, using systems that are trained, not programmed, by people who enhance, scale and accelerate their expertise

Cognitive systems augment human capabilities, and have the ability to scale human expertise. Cognitive systems like IBM Watson can help revitalise industries and impact the future (IBM, n.d.).

When you add cognitive systems to your programmed systems, you are able to shift the role technology plays in your business, from enabler to advisor. Business technologies that automate and detect can now also advise and enhance human expertise.

BLOCKCHAIN

According to 2015 World Economic Forum Survey, 10% of Global GDP will be stored on blockchains by mid-2020s.

Blockchain has been touted as the next generation of the Internet. It has the potential to radically transform multiparty business networks, enabling significant cost and risk reduction and innovative new business models. With the advent of blockchain, there is great potential to transform the ways that businesses work together and that people interact — everything from trade finance systems to airline reservation systems to auto insurance claims.

In a 2016 paper by IBM Fellow, Gerry Cuomo says:

> *Blockchain creates trustworthy and efficient interactions. It's a distributed ledger shared via a peer-to-peer network that maintains an ever-expanding list of data records. Each participant has an exact copy of the ledger's data, and additions to the chain are propagated throughout the network. Therefore, all participants in an interaction have an up-to-date ledger that reflects the most recent transactions or changes.*

The "block" is the record and the "chain" is the collection of blocks that populate the ledger. In this way, Blockchain reduces the need for establishing trust using traditional methods. Blockchain technologies must be enhanced to meet the needs of businesses. The core technology must be adapted to further address security and privacy concerns — creating an enterprise-ready blockchain. In addition, computer systems and networks must be architected so they can scale up to handle an immense volume of transactions, so that governments and industries can begin to use the technology to handle their core organisational processes — and complete their tasks in seconds rather than minutes.

Blockchains must be open and interoperable. For blockchain to fulfil its full potential, it must be based on non-proprietary technology standards to assure the compatibility and interoperability of systems. Furthermore, various blockchain versions should be built using open-source software, with a combination of liberal licensing terms and strict governance, rather than proprietary software — which could be used to suppress competition. Only with openness will blockchain be widely adopted and will innovation flourish.

Blockchain will greatly benefit from government participation. It's critical from a national competiveness point of view for Singapore companies and government agencies to lead the world in understanding the potential of blockchain and putting it to use. Because of the transparency made possible by blockchain, government agencies will be able to understand better what is going on within financial and commercial systems — and spot potential problems before they become critical.

Singapore has played the role of a trusted trading hub. With blockchain, Singapore, can take this role, even further. There is a race to take the lead with blockchain innovations across various sectors.

BLOCKCHAIN INNOVATION — A CASE STUDY IN THE MAKING

The recently announced collaboration between the EDB, MAS and IBM to set up the first IBM Center of Blockchain Innovation is a case in point. IBM researchers will work with government, industries and academia to develop applications and solutions which are based on enterprise blockchain, cyber security, and cognitive computing technologies. The Center will also engage with small- and medium-sized enterprises to create new applications and grow new products in financial technology and trade. In addition to drawing from the expertise in the Singaporean talent pool and that of the IBM research network, the Center will also engage with small- and medium-sized enterprises to create new applications and grow new markets in finance and trade.

DISRUPTIVE BUSINESS MODELS: "UBERISATION"

The success of Uber and Airbnb has sent shockwaves in their respective industries. The largest taxi company does not own a single

taxi and the largest hospitality chain does not own a single room. Whether it is Uber or Airbnb or Alibaba or Samsung, technology innovation underpins the new capabilities but it is the innovative business model that disrupts the value chain.

Businesses are re-composing with digital transformation. New apps are consolidating data and providing capabilities to engage new audiences. Insights from non-traditional sources of data are being infused in business processes to create new business moments. With this, new innovations are composed leveraging digital services from a broad ecosystem.

One example is Car2Go, a Daimler subsidiary. They launched a "Mobility Service" in major European and US cities. Customer can check free cars parked all over the city, book a car, open and start it via their smart phone — and drive away.

The model is focused on mobile assets and mobile customers. On the asset side, remote monitoring and data analysis are essential to managing its vehicle fleet. On the customer side, the reliability of the mobile service is at the top of the list, along with the ability to capture and analyse demand data from usage to preferences to satisfaction. Ultimately, their success depends on executing both sides of the equation. As their Chief Technology Officer said: "We are doing business in an area where an automotive company typically does not operate, which is implementing cool mobile services for our customers." (Eeles, 2015)

Another example is that of a European city. Facing increased debt levels and shrinking budgets, this major European city wanted to shift to an outcome-based contract strategy for its municipal groundskeeping and maintenance agreements. Previously, the city had paid these contracts exclusively based on the number of hours worked — even if the work was substandard. Under a new model, the city would adjust payments based on the quality of work, encouraging better performance from vendors and reducing waste. To make this plan a reality, the government would need an effective management tool to properly track the performance of so many agreements.

The city built a service management and control platform that delivers near real-time visibility into the status of maintenance contracts as well as work quality by combining data from maintenance systems, project timelines, onsite reports and even input gathered from citizens through a public portal. With this holistic view into existing assets — such as parks, roads and public lighting — government staff can tie vendor payments to performance and even identify patterns within service records to detect potential equipment problems or process bottlenecks. For instance, the city can now structure contracts to require that park trash bins be emptied when full. The city can then track vendor activity logs, reports from park employees and even citizen feedback to ensure that the work is completed fully before payment. Further, by mining available records, the city can identify periods when waste increases, such as days surrounding a summer holiday, and coordinate with a vendor to make sure it takes appropriate measures. The local government can now more efficiently use its resources, such as by turning off streetlights when it is still light outside, cutting the total cost of some public services by up to 6%. At the same time, the new solution offers simplified management of the technology used to track maintenance, reducing related IT costs by 10–20%. Furthermore, now that vendor payments are tied to performance, the city has realised an overall increase in the quality of services delivered, improving the appearance of public spaces and the reliability of city services, which helps attract tourists and new business.

THE INSIGHTS ECONOMY

Until recently, I/T value was created mainly in the back office, by the codification of business process and logic, and rolling that out across the enterprise in the form of business applications.

But today, I/T value is created by the insights that are derived from countless structured and unstructured data sources — those that sit *inside* your company and increasingly, those that exist *outside* your company, like Twitter, social streams and weather data. It is not the “thing” in the Internet of Things that matter; it is the insights that are gleaned from the data, which trillions of devices generate across the Internet of Things, that help in decision-making, that will enable

creation of new value across the enterprise, and across the eco-system, that really matter. We see the dawn of the Insight Economy.

Singapore probably has the highest density of data per capita and per square metre, being home to the HQ and data centres of many global MNCs and of course, our local Singapore MNCs. As IBM Chairman and CEO, Ginni Rometty put it simply in 2012: "Data is the new oil". For Singapore, this analogy is particularly useful as Singapore 1.0 did ride on the oil industry. Once again, we need to develop the skills and capabilities in business analytics. Imagine that we add to that capability — security and cognitive and deep industry, Singapore will continue to be highly relevant to the global economy.

ROLE OF GOVERNMENT – SG50 AND BEYOND

To create the future, we must understand the past.
— Tim Kastelle

As we envision the future that we will create together, we should understand our past, learn from the lessons of our journey so far, and develop our collective response to the opportunities and challenges ahead of us to ensure that Singapore 2.0 will be even better than 1.0, for ourselves and for our children and future generations to come.

1) Lead with a Vision: "From Mudflat to Metropolis to a Smart Nation"

The government played a leadership role, championed by our founding prime minister, the late Mr Lee Kuan Yew and his pioneer government and civil service, in the making of Singapore 1.0, turning the "mudflats to a metropolis". In September 1965 — soon after our separation from Malaysia — the then PM Lee delivered a speech at Sri Narayana Mission: "This is not a country that belongs to any single community; it belongs to all of us. We have made this country from nothing, from mudflats. Today, this is a modern city. Ten years from now, this will be a metropolis. Never fear!" (Salim, 2015)
Mr Lee and his team rallied Singaporeans with the vision to take Singapore from "Third World to First". This type of visionary leadership is a key role of the government.

It's inevitable that in the next 50 years, change will remain a constant. After all, throughout Singapore's first 50 years, we had continually transform and reinvent ourselves — first from a trading port to a manufacturing centre, then from an industrialised economy to a knowledge economy. Prime Minister Lee Hsien Loong, in his National Day Rally Speech of 2014, yet again set in motion our transformation agenda to becoming the world's first smart nation. PM Lee most definitely is well informed of the disruptive technologies that are emerging everyday and the threats these technologies pose to our workers and our industries and to Singapore. At the same time, however, PM Lee obviously recognises the opportunities these disruptive technologies offer. As DPM Tharman recently puts it, "Singapore companies must embrace disruption in order to maximise the enabling potential that technology offers."

The vision of Singapore 2.0 is set in motion as we journey from an intelligent island to the world's first smart nation (Palmisano, 2008). We are already seeing positive response from the Singaporeans as we see an uptake in enrolments for computer science and engineering at our polytechnics and universities. Singapore is once again perceived by countries and cities far and near, to be taking the lead in the transition to "Industry 4.0" with PM Lee's smart nation vision.

2) Government as the Master Strategist

> *Strategy without execution is daydreaming.*
> *Execution without strategy is hallucination.*

Singapore's miracle has been attributed to our leaders deciding on a few right strategies, and then, of course, executing those strategies brilliantly.

One of the key pillars of Singapore 1.0 is our "export-oriented economy funded by foreign-direct investments". *The Economist* had an article that explains what the key factors are that drove Singapore's success (*The Economist*, 2015). Amongst the winning strategies include the fact that under Mr Lee Kuan Yew, Singapore welcomed foreign trade and investment. Multinationals found Singapore a natural hub and were encouraged to expand and prosper. What are our key selling points? Most widely acknowledged are our

hardworking, English-educated and skilled workforce, a stable and transparent government, strong tripartite industrial relations, pro-business policies, and highly efficient institutions.

Staying relevant to global MNCs has been a key strategy that contributed to Singapore's success. This strategy has been in a large part led by the government. Government policies were designed to capture the FDI of MNCs into Singapore that leads to jobs and skills development for Singaporeans; and growth in our economy. The government created outstanding marketing machinery in the EDB to sell the advantages of Singapore and to "bid" for jobs for Singaporeans. Our government officials and civil servants have long been reputed amongst the MNC community as probably the toughest but best Government Inc. to work with. Attracting the MNCs to our shore amidst a competitive landscape is a feat but even more desirable for MNCs is that Singapore delivers on its promise. The government has played a leadership role in ensuring that in Singapore, everything works like a well-oiled machinery for business, and this role should continue to be a key focus of our government going beyond SG50. Some of the critical success factors of ensuring that Singapore stays relevant to MNCs and global economy include:

- A positive business climate that facilitates the ease of doing business, the rule of law that governs contract and Intellectual Property (IP) protection, and a stable and efficient government that reduces the political and business risk. Singapore is ranked 2nd for the fifth consecutive year in the Global Competitiveness Index (GCI) Report 2015–2016 (World Economic Forum, 2016). The economy can rely on top-notch infrastructure, a transparent and efficient institutional framework and a stable macroeconomic environment.

- Since independence, the government has focused on education as the single most important factor for improving the competitiveness of Singaporeans — ensuring upward mobility, better jobs and better lives at every education level. In the same GCI report, Singapore is ranked first in Math & Science Education, the best higher education and training system in the world (overtaking Finland) and is well placed to improve

technological adoption (ranked fifth) and business sophistication (ranked 18th) (World Economic Forum, 2016).

- This strategy has led to the creation of local SMEs participating in the supporting industries around the key industries, and MNCs that have laid its roots in Singapore as a result of the successful promotion by EDB over the years. Jurong Island and the petrochemical industries have been developed around the oil and gas MNCs like Shell, Exxon, etc.; ICT industries around IBM, HP, etc.; and in more recent years, the biotech industries have developed around the pharmaceutical MNCs like Pfizer, GKS, etc.

- Be Future-Ready: Dare to Transform, Ability to Execute

- The government at each inflexion point of industry or product cycle transition has created programmes and initiatives to support the businesses in Singapore, especially the SMEs in developing new skills and enhancing productivity and at times, even to relocate and shift certain parts of the value chain, out of Singapore to lower-cost neighbouring jurisdictions. Many of our industries are once again facing the twin challenges of global economic downturn amidst structural value chain dislocation. Several initiatives can be seen in Budget 2016, from shorter-term support like higher corporate income tax rebate, help for SMEs to secure loans, extensions of the special employment credit scheme as well as specific help for the struggling marine and process sectors, to medium- to longer-term initiatives like Industry Transformation Programme, TechSkill Accelerator and SkillsFuture. Our government's continued executive will and leadership in shaping the economic pathways moving forward is another reason why Singapore continues to offer a competitive advantage for businesses that few others in the region can offer.

- Connector to the larger regional markets, and a bridge between West and East, specifically with China.

- Inked in 1989, the SIJORI Growth Triangle is a partnership arrangement between Singapore, Johor (in Malaysia), and the Riau Islands (in Indonesia) that combines the competitive strengths of the three areas to make the sub-region more attractive to regional and international investors. More specifically, it links the infrastructure, capital, and expertise of Singapore with the natural and labour resources and the abundance of land of Johor and Riau.

- The Suzhou-Singapore industrial Park, the Wuzi-Singapore Industrial Park, the Bangalore Industrial Park, the Tianjin Eco-City, Guangzhou Knowledge City and more recently, the Chongqing-Singapore project, the Andhra Pradesh and Sri Lanka collaborations are a few of the more significant government-led regionalisation initiatives intended to help our SMEs to regionalise while at the same time, playing connector role for the MNCs, which are already in Singapore, to venture together into those markets.

The outcome of this strategy is that many MNCs like IBM have grown in Singapore and in the region along with the country just as Singapore's economy has grown alongside the growth of these MNCs. Companies like IBM, Shell, DHL, Unilever and many other global enterprises have a global footprint in our small island despite the limited domestic market. The Singapore government does a very good job of closely studying the strategies of global corporations and aligning Singapore's agenda to follow this growth. The collective wisdom of the global enterprises around the world is certainly one of the key sources of inputs which our policymakers consider.

Many countries have the same aspiration. Execution is what takes the strategy from aspiration to realisation. The outcomes must reflect the strategic intent — job creation; capacity building, both leadership and technical; higher value and control point in the global value chain; stickiness and sustainability. Many of our MNCs are good corporate citizens, and have developed a cadre of leaders and professionals amongst the Singaporeans beyond achieving the mutual economic win-win that is to be expected.

The role of the government in defining the strategy and ensuring its success is going to be even more pertinent for the future economy as the competitive landscape intensifies.

MULTINATIONALS IN SINGAPORE'S NATIONAL AGENDA: A CASE STUDY

Taking IBM as a case in point, IBM in Singapore grew from a three-man representative office set up in 1953 to become a significant employer in Singapore with a global footprint on our little island — from sales and distribution to industry solutions centre of competence and services integration hub; from hosting the IBM Asia Pacific Headquarters to being the only IBM Manufacturing Facility outside of the Americas for IBM mainframes and Power UNIX servers; from research collaboration to software development; from global treasury operations to global supply chain control tower; from our Cognitive Solutions Consulting to Cloud Platform & Services; and from strategic outsourcing to Software-as-a Service.

Each of IBM's investment milestones can be mapped closely to the Singapore government's economic roadmap.

When Singapore set up its first national computerisation plan in 1981 and the civil service led the way with the Civil Service Computerisation Programme, skilled ICT staff was needed in a big numbers and in a short period of time. There was then only 700 data processing professionals. The National University of Singapore, the then National Computer Board and IBM collaborated to set up the Institute of Systems Science, to train fresh and mid-career non-IT professionals to transition to systems analysts, even as the universities step up to accelerate the number of computer science undergraduates. And, like they say, the rest is history. Thirty-five years hence, the Institute of Systems Science has an alumnus of 100,000 ICT professionals out of the 140,000-member ICT community in Singapore.

When Singapore needed to train hundreds of thousands of office workers in the use of Personal Computers and Office tools like word processing, spreadsheets and email systems, IBM collaborated with the then National Computer Board, in PC computer user education industry in Singapore.

We are witnessing yet another major technological shift with the dawn of what IBM calls the cognitive era of computing, where we see the convergence of big data analytics, Internet of Things, artificial intelligence, mobile, social and cloud. These technologies are affecting all industries, and no aspect of existing value chains is spared.

In 2013, IBM partnered with the National University of Singapore, in collaboration with the Economic Development Board to set up the Centre for Business Analytics, to skill up professionals with a one-year Master of Science in Business Analytics and address the increasing need for big data analytics professionals (NewsHub, 2013).

And in October 2014, NUS Business School and School of Computing partnered IBM to be the first university in South East Asia to offer "Watson Cognitive Systems Education". Watson technology mimics human decision making-scales and democratises expertise. It processes information like a human by understanding language, generating hypotheses based on evidence and continual learning.

And, just this July, IBM has announced plans to establish the first IBM Center for Blockchain Innovation in Singapore. In the first collaboration of its kind with Singapore's EDB and the Monetary Authority of Singapore, IBM researchers will work with government, industries and academia to develop applications and solutions, which are based on enterprise blockchain, cyber security, and cognitive computing technologies. The Center will also engage with small- and medium-sized enterprises to create new applications and grow new products in financial technology and trade. In addition to drawing from the expertise in the Singaporean talent pool and that of the IBM Research network, the Center will also engage with small- and medium-sized enterprises to create new applications and grow new markets in finance and trade (Fintech Singapore, 2016).

Other MNCs in other industries have similar stories to tell — be it Shell and Exxon in the oil and gas industry; Micron and Applied Materials in the semi-conductor industry; Proctor & Gamble and Unilever in the consumer packaged goods industry; DHL and FedEx in the logistics industry; or Citibank and Prudential in the financial services industry.

The Singapore government has an excellent knack of following where the future growth of these industries and these companies are headed, and making Singapore the best possible location and partner for these MNCs to bet their growth strategy with. Singapore has developed a vibrant and diversified corporate ecosystem that grows our economy and creates good jobs for Singaporeans.

A criterion for success is the country's capacity to nurture and attract talent. Singapore has done well in the past. We need to continue to ace in this regard, going forward. Policies have to be balanced to ensure that we apply "different strokes for different folks (industries)" and not "one size fits all".

To realise the vision of Smart Nation, we urgently need more skilled professionals in business data analytics and data science, cyber security and cognitive computing. And in the other sectors, likewise, there are key skills in science and engineering that we will need if we are to continue to improve our capabilities. Sometimes, as we ramp up our capacity, there is a need and in fact, an advantage, in attracting talented skills from across the globe, to complement and supplement the Singapore core. At the same time, at the "lower end of the spectrum and in the service industry, there is a urgent need to drive increased automation and leverage technology where it makes sense, while encouraging our Singaporeans to master craftsmanship in those *seemly* "lower-skilled jobs". There is also a need to change the perception of Singaporeans about certain so-called low-end jobs and inculcate a culture of "going beyond our comfort zone" to respect to the security guards, the cleaners and the gardeners.

3) Government as Catalyst and Venture Capitalist for Innovation

In the first 50 years, when the government decided on a strategy, it often had to lead the way and be the catalyst to move the strategy forward

A parallel strategy to that of attracting MNCs and foreign direct investment is to grow our own Made-in-Singapore companies. In the first 50 years, we have seen the birth and growth of Temasek-linked companies, affectionately known as TLCs, like DBS Bank, Singapore

Airlines, Keppel Corporation, CapitaLand, ST Engineering, Singtel, PSA and others (Temasek, n.d.).

NUS Business School recently published the ranking of top 100 Singapore listed companies based on market cap (NUS Business School, 2016). The majority of the companies on the top 50 are TLCs. Among non-TLCs, only OCBC and CDL count amongst the top 25.

Through Temasek, the government has successfully played the role of catalyst and venture capitalist in different sectors of the market, to grow some of the biggest brand names in the world.

4) Growing Singapore MNCs and SMEs

Accelerating and regionalising or globalising Singapore MNCs and SMEs is as important as staying relevant to MNCs. I would however, lament that despite our high ranking on the world competitiveness stage, Singapore does not have global brand names besides a few TLCs, to boast of. This has been a recognised challenge. The importance of having a strong SME wing in our economy is increasingly important as SMEs employ more than 70% of the workforce.

To take a page from Switzerland's playbook, and other countries with a higher innovation index than Singapore's, we learn that the key factors of success is: a) world class research institutions; b) high spending on research and development (R&D) by companies; c) strong co-operation between the academic world and the private sector; and d) higher level of business sophistication in their innovation eco-system.

The Industry Transformation Programme, SkillsFuture, TechSkills Accelerator and other instruments in the Budget 2016 will certainly support the urgent transformation of our SMEs and Singapore workers, and grow the local MNCs & SME wing of our economy. The challenge is that it takes the local MNCs and SMEs as well as our workforce to engage and truly be a part of the execution of the strategy.

The government's role as catalyst could extend to the private sector in areas of innovation where it matters. This said, there is the twin challenge of government being overly involved and private sector initiative being lacking or even stifled. In this role, the government will need to weigh the value and impact and the consequence.

One point to consider is that the outcomes and lessons learnt along the sprints in the journey is increasingly important to consider as agility becomes the name of the game. Hence, the KPIs (key performance indicators) and the measurements of success at the end of the project may need to be reviewed to reflect the more agile approach that is necessary in today's environment. That said, governance and prudence, which is the cornerstone of our reputation as "trustworthy", needs to be guarded.

In these turbulent times when a perfect storm seems to be brewing across the globe, with disruptive technologies potentially dis-intermediating businesses and disrupting value chains; when terrorism and cyber-threats gets to be top of mind of CEOs and boards and the government; and when the slowdown of global economies is going to be felt by the citizen on the street — the role of government as the catalyst to drive change and transformation; to embrace technology disruption; to create culture of startups even within large enterprise and institutions; to invest and venture into new technologies and capabilities; to push and pull everyone along to co-create and establish vibrant eco-systems and platforms; and to invest in talent at every level, will be our Singapore 2.0 narrative for "widening the gap to global competition" or "closing the gap in innovation." (Singapore ranks 11th place for the innovation pillar in the above-mentioned GCI report.)

As DPM Tharman Shanmugaratnam noted, "Many incumbent players will become disrupted, or will become redundant. Some jobs too will become redundant. But at the same time, there is something profoundly enabling about these technologies. Whether it's blockchain, or digital commerce, or even artificial intelligence, it's going to be profoundly enabling for a broad range of enterprises, as well as for us as human beings" (Lim, 2016).

5) Government as Connector and Bridge

This is still a key lever for businesses, and having perfected the art, the Singapore government needs to continue doing the excellent but challenging job of diplomacy, marketing and facilitating business dealing overseas.

The government needs to orchestrate Singapore companies and MNCs invested in Singapore, to team up and collaborate to co-create value in the eco-system that will enable the whole to be bigger than the sum of the parts, and be the most competitive with the best value proposition. This will give the opportunity for our local SMEs and startups to scale-up by partnering or through mergers and acquisitions.

6) Government as Facilitator/Orchestrator or Integrator/Builder

In the world of shared and insights economy, it is all about the eco-system. It is necessary for the government to take the lead in changing the culture by example. For instance, this means creating a builder-inventor culture, and to ensure that there are capabilities within agencies to adequately provide necessary public services of strategic nature, e.g., water, public transport, etc. It is not necessary for the government to play the integrator or builder role if the private sector or an eco-system of public and private sector players generates a larger impact in the long run.

MY ASPIRATION FOR SINGAPORE

We have come so far as a country and as a nation in a large part because we have been blessed with great leaders in government — those in political service as well as in our civil service. It is not by chance but by design and sure will of the Singapore people. Singaporeans need to feel proud that Singapore is indeed “Home, Truly”.

We need to be as agile just as we are efficient. Innovate early, fail fast — nothing is a complete success all the time.

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THE ROLE OF TRADE ASSOCIATIONS

Edwin Khew
Chairman, Sustainable Energy Association of Singapore (SEAS)

The Sustainable Energy Association of Singapore (SEAS) represents the interests and provides a common platform for companies in Renewable Energy, Energy Efficiency, and Financial Institutions to meet, discuss, collaborate and undertake viable projects together. The Association is a non-profit, non-government business association, and its mission is to assist its members in achieving sustainable growth locally and regionally through business development, market development, as well as training and learning platforms. SEAS plays a strategic role in aiding the realisation of Singapore's vision, to be a global centre for sustainable energy, where products and solutions are developed and exported.

ROLE OF AN ASSOCIATION TO SUPPORT THE INDUSTRY

Most associations struggle with how they can stay competitive and relevant to their members and thus stake the claim of go-to association for their sector. There is also a need to grow the sector, at the same time ensuring that the association stays financially viable in order to continue offering its services effectively, rather than deal with challenges of survival.

RELEVANT PROGRAMMES AND INITIATIVES

It is imperative that the associations address the needs of the companies they represent, with programmes that support their businesses and long-term goals. Associations should also act as a bridge between the government and the companies so as to have an ongoing dialogue on policies and government led initiatives.

AREAS THAT SEAS HAS SUPPORTED ITS MEMBERS

Knowledge Development and Capacity Building

SEAS has been doing training and capacity building since its inception in 2006 in areas relating to sustainable energy, i.e., energy efficiency

and management, renewable energy, carbon trading as well as funding and financing of clean energy projects.

The Sustainable Energy Centre of Excellence (SECOE) is an initiative of SEAS supported by the Asian Development Bank and IE Singapore. The Centre aims to bridge knowledge gaps and provide a neutral learning environment in Singapore to policymakers from 46 developing member countries. To date, 171 senior policymakers have attended SECOE workshops

Since 2014, SEAS has been organising the Asia Clean Energy Summit (ACES), Asia's leading event focusing on clean energy technology, policy and finance, supported by leading government agencies, research institutes and industry in Singapore. ACES provide a common platform for regional thought leaders in both the public and private sectors to collaborate on critical issues and opportunities in harnessing clean energy for the future

Thought Leadership

In the last 10 years SEAS has embarked on various programmes and services to help our members as well as be the voice of the sustainable energy industry at large. On 22 November 2013, SEAS launched its first White Paper. It is a concerted effort by SEAS members, who are industry experts, to put together a document that can inform and educate various stakeholders on how renewable energy in Singapore can play an important part in our energy mix.

SEAS has also completed work on a second White Paper on e-mobility. The paper, titled "Creating a level playing field for electric vehicles in Singapore" will be launched in July 2016.

Business Development

SEAS has been actively involved in growing this industry sector by working with its member companies as well as companies that adopt sustainable technologies and services. By offering a combination of financing, advisory and consulting services, SEAS can help in the development of sustainable energy technologies and provide support for companies to test and showcase their innovations in Singapore.

The SEAS Enterprise Development programme has also been set up to assist Singapore-based companies, in particular for SMEs, with consultancy services, project development and the commercialisation of new technology. SMEs can access funding for collaborative project development within their sector or through a MNC partnership.

THE ROLE OF THE LABOUR MOVEMENT IN THE FUTURE ECONOMY

Patrick Tay
Assistant Secretary-General, National Trades Union Congress

INTRODUCTION

To better serve an increasingly diverse and sophisticated workforce, the Labour Movement is focusing its efforts on three fronts: Evolving Needs, Expanding Services and Growing Network so as to cater to the varying job expectations and needs of our working people.

EVOLVING NEEDS

One of the challenges facing Singapore is an ageing population. By 2020, for every retiring local, 1.1 locals are expected to enter the workforce, down from 1.4 in 2014 (Ministry of Manpower, 2016). Much has been done by the tripartite partners to help mature workers over the years. Re-employment age has gone up, and will increase further to 67 next year. The Tripartite Alliance for Fair and Progressive Employment Practices (TAFEP) has been set up to promote and ensure fair employment practices, provide grants and incentives for employers to redesign jobs, and hire mature workers. Companies should also train their mature workers for new equipment and work processes. Mature workers have to embrace technology as it evolves with time, to adapt and learn to work with technology, work processes and equipment.

The profile of the overall workforce is also changing with a growing pool of professional, managers and executives, freelance, and self-employed workers. Currently, there are over 738,000 Professionals, Managers and Executives (PMEs), or 34% of resident workforce, while Professionals, Managers, Executives and Technicians (PMETs) comprise 54%. There are also an estimated 200,000 freelance and self-employed workers.

The worker profile in Singapore has evolved beyond just rank and file workers to PMEs, freelancers, mature workers, young workers, with some on part-time work and others on full-time arrangements. The

definitions of how the Labour Movement cares for, is fair to and grows with workers must evolve and expand so as to remain relevant and inclusive.

EXPANDING SERVICES

As the economy is transforming, workers need to develop new skills sets, as global trends like the rise of technology reshape the nature of jobs. Striking a balance in relation to passion, skills and jobs is one of the challenge for workforce especially the young.

The Labour Movement continue to provide traditional services such as protection and representation for rank and file workers, and go beyond to expand its suite of services to include professional development, training, placement and networking. One such example is the Employment and Employability Institute (e2i), an initiative of the National Trades Union Congress (NTUC), supported by the Workforce Development Agency (WDA), the Singapore Labour Foundation (SLF), and the Singapore National Employers' Federation (SNEF) — and it continues to create better jobs and better lives for working people. Since 2008, e2i has helped more than 470,000 working people through developing better skills, job-matching, and improving productivity with companies.

In term of upskilling, the Labour Movement has recently collaborated with the Nanyang Technological University (NTU) College of Professional and Continuing Education to bring relevant courses to all working people looking to upgrade their skills to fulfil their career aspirations. NTUC will tap its network of unions, U Associates[1], partners and NTUC Social Enterprises, to mobilise workers to upskill and reskill for better jobs in the future. For a start, working people can look forward to 28 Technology Enabled Learning (TEL) courses jointly identified by NTUC and NTU. Subsequently, the collaboration seeks to further identify and develop more suitable courses to meet the specific needs of our working people.

[1] U Associate is a flagship programme designed to engage and support professional associations and the growing PME workforce.

Apart from growing its suite of services, the Labour Movement will also need to go beyond a one-size-fits-all approach to look at providing tiered services.

GROWING NETWORK

The Labour Movement is developing new models of outreach by building a strong network of unions, associates and partners. Today, it has 60 unions and a national taxi association. The Labour Movement also has 31 U Associate partners — professional bodies representing more than 150,000 working people from different professions — complementing what unions do for its 900,000 members. The Labour Movement works with professional associations or guilds through the U Associate programme to reach out and provide professional development courses and networking opportunities to help working people succeed in the increasingly competitive global market

Among Singapore companies, 70% are small and medium enterprises (SMEs). Under U SME, the Labour Movement has signed 42 Memoranda of Understanding representing workers from more than 3,000 SMEs. These efforts will continue as the Labour Movement strives to reach out, advocate for and represent workers in every sector of our economy.

FOREIGN WORKFORCE

The foreign workforce forms a third of the total workforce that drives the economy. Their concerns, protection and opportunities to grow are important to the Labour Movement as a part of the all-inclusive focus on workers.

The Labour Movement represents foreign workers on two levels. On the unionised level, as the foreign workforce supplements the Singapore core; the needs of foreign workers in these unions are represented and are within the scope of negotiation of unions' collective bargaining and agreements. This is exemplified by the similar wages and benefits they receive when compared to local workers.

There are also 75% of foreign workers working in non-unionised companies in Singapore. The Migrant Workers' Centre, an initiative of the NTUC and the SNEF improves the welfare of migrant workers, particularly the lower skilled and waged by addressing their concerns like wage and workplace disputes. The Centre for Domestic Employees was also launched by NTUC in January 2016 to better assist domestic helpers in Singapore, who are predominantly foreign domestic workers (FDWs).

RECOMMENDATIONS

Mature Workers

As Singapore braces for a manpower shortage, employers should tap the vast reserve of the ageing workforce. Though much has been done to help employers, there are many who are under-utilising their mature workers. The employers' mindset has to change. The Labour Movement recommends that employers leverage WorkPro funding support to redesign jobs and create progressive and age-friendly workplaces for mature workers.

PMEs

In 2015, 71% of retrenched workers were PMETs. The Labour Movement therefore recommends the following:

1) Employers to tap various programmes to support the development of PMEs such as the Career Support Programme, the Professional Conversion Programme which covers more than 20 sectors, and P-Max which provides funding support for small and medium enterprises to adopt progressive human resources practices in hiring and retaining PMETs.

2) Workers to seek career advisory and training services to improve employability at U PME centre and NTUC e2i career services. Workers need to take ownership of their own career development, up-skilling and upgrading, to take on the quality jobs in the economy.

3) Professional associations and guilds to tap and partner the Labour Movement via the U Associate alliance to grow their network,

enhance their service offerings and strategic capabilities by tapping the programmes jointly developed.

4) Funding and scaling the Career Activation Programme (CAP), which is a programme by the Labour Movement to provide peer-to-peer network and coaching, emotional support and confidence building for displaced PMEs (especially those above 40 years).

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Chapter 7

Dialogue Session with CFE Members

DIALOGUE SESSION WITH CFE MEMBERS

Chairperson

Mr Lee Tzu Yang, Member, Academic Panel, Institute of Policy Studies

Panellists

Mr S. Iswaran, Co-Chairman, Committee on the Future Economy and Minister for Trade and Industry (Industry)

Ms Goh Swee Chen, Chairman, Shell Companies in Singapore

Mr Caesar Sengupta, Vice President, Product Management, Google

Mr Mark Lee, Chief Executive Officer, Sing Lun Holdings Limited

INTRODUCTION

Key themes of the discussion include: the role of the government and regulation in the economy; encouraging innovation; balancing the concerns of people and business; and foreign labour in Singapore.

MINISTER S. ISWARAN ON THE CFE

The CFE process is national effort that reaches out to different stakeholder groups in society in order to canvass views broadly, and gather them in a manner that leads to cogent ideas for the government to act on.

The nature of the challenges requires adaptions and responses, both in the short to medium term, as well as investing in capabilities for the longer term. That is the context for broad engagement about the future economy, and it is reflected in the composition of the main committee, and in the sub-committee and outreach activities. Three key areas for panel discussion are:

1) **Transitions:** The world is transitioning from physical to financial to digital flows. Singapore has thrived by being well positioned at the nexus of these flows. How are we to position ourselves, our

companies and our people for the digital flows that are growing at an exponential rate?

2) **Innovation and Technology:** We need an environment that is enabling, and capacity that is deep and broad in the system, to ensure that innovation pervades all segments and all sectors in the economy.

3) **Broad Implications of Changes:** We need a collective response, a significant role for institutes of higher learning and other educational institutions — in both pre-employment training and continuing education, and the engagement with industry; as well as working with industry associations to generate larger capability for a robust and adaptable economic system.

GOH SWEE CHEN ON THE ROLE OF MNCS IN SINGAPORE

Ms Goh described the three roles of MNCs in Singapore:

1) Development of human capital. Shell currently hires 3,100 employees, comprising 43 nationalities. It is a microcosm of Singapore, a global and vibrant enterprise, just as Singapore is a global and vibrant city. Shell also works with institutes of higher learning to build skill sets in its workforce.

2) Providing opportunities for innovation and collaboration with SMEs in Singapore. Shell has two major facilities in Singapore: a Lukoil blending refinery and a chemicals complex. This provides an ideal sandbox to work with enterprises and entrepreneurs in Singapore to develop “Made in Singapore” innovation.

3) Developing new energy sources for power, and to bring these into Singapore.

CAESAR SENGUPTA: PERSPECTIVES FROM GOOGLE

Mr Sengupta said that the mobile revolution started in Asia, and the world is looking to Asia for growth and for innovations. Singapore is in the middle of Asia, and in the middle of one of the fastest-growing regions in the world, South East Asia. Internet users in South East

Asia are expected to grow from 220 million to 480 million by 2020, creating an overall business of US$200 billion out of South East Asia, focused on the Internet, by 2025.

With Singapore at the centre, it has the opportunity to disproportionately benefit from this. Singapore has all the right ingredients to exploit this growth, and for companies to build on top of this, including reliable, fast Internet, a good education system, very good connections to the rest of the world, and a populace that is gaining the right kinds of skill sets to drive digital innovation.

The Internet is a driver for growth. It disproportionately benefits small businesses. It helps them target their users better and reach users across long distances, which is harder for small companies to do. Through its Go Global Program, Google works with SMEs to help them understand how to use and leverage digital and web to further their business globally.

SMEs do not always need to change their business models to go digital. They just need to think about how to use the digital technologies to enable their services to expand across the region. Google has started an engineering team to build products for the region in Singapore, and is looking forward to collaborating with companies here.

MARK LEE: PERSPECTIVE OF SMES

Mr Lee noted that the textile industry still exists in Singapore; it continues to supply textiles to many well-known textile and sporting brands around the world. MNCs provide an eco-system of supplier networks that allow small companies to grow.

However, even SMEs in “traditional” industries have to continually ensure that they remain relevant through the changes and digitisation of the economy. Mobile platforms like Amazon allows suppliers like Sing Lun to sell its wares directly to end-customers through private labels, enabling the disintermediation of the brand-retailer network as more shoppers go online. Sing Lun is learning the online model ahead of other competitors, and helps existing clients adapt as well.

SMEs should also tap the government for assistance. For example, IE Singapore supplies political risk insurance, which has helped Sing Lun cover the effects of the riots in Vietnam.

DISCUSSION

Government Strategy for Supporting Industry

During the discussion, Minister Iswaran highlighted the government's strategy for supporting the growth of industries in Singapore. Given the broad range of sectors, complex technological and economic shifts, and changing business models, the government is not best placed to identify specific areas or shifts. However, it can play a role in creating enabling environments.

In doing so, it needs to prioritise its resource allocations in particular sectors to optimise the use of resources in that space. One strategy is to look at industries with broad impacts across a wide range of sectors such as robotics, and to identify key areas that intersect existing strengths in industry, and where there is strong private sector interest and motivation, such as precision engineering and robotics. This ensures that companies downstream are able to design, manufacture, adapt and improve the technologies developed for different kinds of applications. The government's role is to catalyse and build industry capacity in these sectors to position Singapore well for the future. This is not picking winners per se, but an informed, optimising strategy in allocating limited resources.

Government Regulatory Approaches

A participant suggested that the government should reconsider its regulatory approach, and develop a pro-innovation "permissionless" regulatory regime where the default is less regulation, with the government stepping in ex-post to correct problems.

Minister Iswaran acknowledged that regulators have a balancing act in regulating to safeguard public safety, health and systemic integrity, and to provide space for experimentation. However, the core mission of regulators — to ensure a safe and stable environment — cannot be comprised. Hence, more work needs to be done to develop

mechanisms and solutions that allow regulators to operate with greater flexibility and dexterity, in order to create a regulatory environment that strikes this balance in terms of mindsets, systems, risks and rewards. One example of regulatory innovation is the MAS sandbox for Fintech companies, which enables innovations to be trialled, tested and scaled.

Overcoming Barriers to Innovation

Innovation is a resource-intensive and risky process, and horizontal or vertical collaborations are effective ways to overcome the resource constraints to innovate. The Partnerships for Capability Transformation (PACT) scheme by Spring Singapore aims to foster deep partnerships among SMEs, large organisations and government to collaborate on innovation. Singapore's ability to compete and differentiate itself as a system rests on its ability to execute on innovation, and this requires collaboration of system players, to generate an effective system response, so that new solutions are developed.

On the one hand, capacity building in terms of skills, infrastructure and linkages are needed, but the mindset — to be willing to experiment and innovate and fail — is equally important. Technical skills without the instinct to try something new would not result in innovation.

Representing the Voice of People and Businesses

A participant asked about how the government manages the conflicts between people and businesses, over issues such as foreign labour inflows. Minister Iswaran said that the tripartite system has sought a path that works for business and Singaporeans. It is important to find areas of overlap and common interest, and everyone has to make adjustments for the common good.

With regard to foreign labour, Singapore will continue to need a judicious mix of foreign and local labour to contribute to the economy. The key is to ensure that there is no productivity gap between foreign and local labour, and this requires discernment about the skills of labour inflows into Singapore.

Chapter 8

Key Themes of the IPS-CFE Conference

KEY THEMES OF THE IPS-CFE CONFERENCE

LOW INNOVATION EFFICIENCY AND TRADE DEFICITS IN INTELLECTUAL PROPERTY

Singapore's research and development (R&D) development has been aimed at establishing Singapore as a world-class R&D hub through the development of human, intellectual and industrial capital. Progressively larger sums were expended to drive research, innovation and enterprise — S$6 billion was budgeted for 2001 to 2005, and a further S$13.5 billion for 2006 to 2010, S$16 billion for 2011 to 2015, and S$19 billion for 2016 to 2020 in the current RIE2020 plan.

However, R&D productivity needs improvement. IPS Senior Research Fellow Manu Bhaskaran noted that the 2015 INSEAD Global Innovation Index ranked Singapore first globally on "innovation inputs", but less well in its "outputs". It also placed 100th in the world for "innovation efficiency", the ratio of the "output sub-index" over the "input sub-index".

Dr Walter Theseira noted that Singapore recorded a significant net trade deficit in the key areas of intellectual property (IP) and business services. Singapore's net IP trade position is more similar to developing rather than developed countries. This is due to high imports of IP by Singapore's high-tech manufacturing using intellectual property created abroad, as well as the relative absence of Singapore-based firms producing intellectual property that is valued outside of Singapore.

This points to broader deficits that are obstacles to innovation productivity — chief of which is the lack of downstream development capability and access to suitable markets. Professor Arnoud De Meyer from SMU noted that innovation does not happen in a vacuum. In an earlier article in *The Straits Times* ("Wanted: Twenty $135 Million Companies") published in July this year, Professor De Meyer explained that economically successful commercialisation of creative ideas requires working complementarities within an intricate network of service organisations, including a dynamic group of small and medium engineering service companies, designers, prototype

builders, financiers, analytics and marketing companies, and business model developers — in addition to the network with MNCs and research institutes that constitutes an innovation eco-system. These are mutually supported by a deep and specialised pool of skills, with access to large, dynamic and innovative markets.

Numerous gaps in Singapore's innovation eco-system were addressed during the conference by panellists. These extend from the absence of a critical mass of high-growth, innovative SMEs in the eco-system, to strong cost — as opposed to quality competition — in Singapore's domestic industries; severe skills gaps, particularly the availability of deep skills in STEM subjects (e.g., Science, Technology, Engineering and Mathematics) and applied mathematics and computer science; lack of regional cultural intelligence and awareness to operate in the fast-growing region; and behavioural factors that prevent collaboration and the maximising of potential of the workforce. The subsequent themes cover some of these shortages and the policy measures that may be put in place to address them.

The main policy challenge would be to build platforms and enable linkages that effectively overcome the barriers of access to larger markets, and to develop and harness the deep skills and corporate capabilities to implement the changes required.

REGIONAL INTEGRATION AS THE NEXT GROWTH DRIVER IN SINGAPORE

Several speakers, including Dr Walter Theseira, Professor Loh Han Tong, Dr Nungsari Ahmad Radhi, Dr Francis Hutchinson and Caesar Sengupta, emphasised the opportunities for growth by tapping on rising consumer demand in ASEAN and the broader Asia Pacific region, brought about by a growing population, rising GDP per capita, and the lowering of trade barriers with the signing of the TPP and the upcoming ASEAN Economic Community (AEC).

PLATFORM ECONOMY FOR B2B: TEST-BED AND DEVELOPMENT

Mr Sengupta suggested that Singapore could strengthen its hub status in the region by being the place to test-bed and develop B2B

cloud platforms, which can be deployed across the region, leveraging the critical mass of MNCs and emerging market multinationals (EMMs) assembled here, and its role as a major trading, finance and logistics hub.

This will enable Singapore to define a Smart Nation niche as a platform economy in a crowded marketplace, and to create effective synergies across its physical, digital and financial flows. This will also enable Singapore to take advantage of its size and resources as an ideal test-bed for products, as suggested by Mr Sengupta. For example, multiple international and regional financial institutions based in Singapore create a natural ecosystem for Fintech (i.e., financial technology) development, for example in transactions (e.g., blockchain).

Janet Ang noted that for blockchain to fulfil its full potential, it must be based on non-proprietary technology standards to assure the compatibility and interoperability of systems. Furthermore, the various blockchain versions should be built using open source software, with a combination of liberal licensing terms and strict governance, rather than proprietary software — which could be used to suppress competition. Only with openness will blockchain be widely adopted and will innovation flourish. Blockchain will greatly benefit from government participation. It is critical from a national competiveness point of view for Singapore companies and for government agencies to lead the world in understanding the potential of blockchain and putting it to use.

INSIGHTS TO THE ECONOMY AND THE INTEGRATION OF PRODUCTION NETWORKS

Dr Alpesh Patel noted that Industry 4.0 is characterised by technologies that will disrupt manufacturing all along the product life-cycle, such as data, connectivity and computational power, analytics and intelligence, human machine interaction, and advanced production methods. This will transform production as companies will increasingly integrate and apply technology from an end-to-end perspective in the value chain — from research to sourcing, making, distributing and servicing, in an integrated way without silos.

Business models will increasingly adapt to capture new sources of value. Examples are: as-a-service (payment by usage subscription models); platforms (open-system platforms for developers; broker platforms); intellectual property-based (licensing or add-on services); or data-driven (direct or indirect monetisation of data-driven insights).

Professor De Meyer recommended that Singapore locate the value drivers and key resources in new kinds of high value-added manufacturing, and site them in Singapore to integrate Singapore's production in global networks of high-tech manufacturing.

DEVELOPING COLLABORATIONS AMONG ECOSYSTEM PLAYERS

The key to successful ecosystems such as Silicon Valley, Dr Gillian Koh noted during the discussion, is the spirit of collaboration among its researchers, technologists and entrepreneurs. Dr John Powers noted that cross-sector collaboration and contract of R&D services in Singapore are low. In addition, co-location is an insufficient driver of collaborative activity, and active curatorship and place management by government, incubators and angel investors are needed to accelerate linkages.

At IPS, referencing Dr Patel's suggestions to develop collaborative ecosystems, we suggest that policymakers identify how government assistance can be used to nudge ecosystem players to overcome competitive instincts, and identify complementarities to cooperate in areas of technological implementation, which will be highly beneficial to Singapore.

Trade associations involving companies with large networks across the region (such as the Association of Banks in Singapore and the Singapore International Chamber of Commerce) play a crucial role. In addition, the government can take the lead in creating regulatory convergence in digital standards, to quicken the pace of integration in the region.

Dr Patel noted that competitors might cooperate if they see that it is in their self-interest to do so. He shared a case of 15 competing aeronautical engineering companies in the EU, pooling resources to

develop a research institute and sharing information. It is necessary to define the problem statement such that it provides clear room for each competitor to reap their own advantage.

REBALANCING TOWARDS THE REGION

At IPS, we think that Singapore may have to re-balance its society, education and aspirational culture (which has looked mainly to the West) somewhat, to position itself to better understand the region, and appreciate its nuances and markets. Singapore needs to develop closer personal and institutional links to the region to be a more effective link between ASEAN and the world.

We suggest expanding regional third languages options in Singapore schools, beyond Malay and Bahasa Indonesia, to include Thai, Vietnamese or Burmese. In addition, greater flexibility should be allowed for students to exercise that option, in particular on a non-examinable basis. This would raise the cultural, political and economic awareness of the future generation of Singaporeans of their immediate neighbours.

In a Post-It, a conference participant argued for additional bilateral exchange schemes or scholarship schemes to be developed. Selected students could be seconded to regional universities for one semester, where they would be hosted by their counterparts. Subsequently, these counterparts could come to Singapore and be hosted by Singaporeans.

HISTORICAL PERSPECTIVE ON SINGAPORE'S TRANSITION

Dr Nungsari Ahmad Radhi provided a historical perspective on Singapore's growth. He said that Singapore's economic strategy since independence is characterised by two phases and it is entering a third phase, which is marked by greater economic integration with the region.

New trends have posed hurdles to Singapore's growth model, and the challenge for Singapore is to transition to a third phase of growth that takes advantage of these trends:

- The onshoring of Chinese production and potential growth of the China-Mekong sub-region as a manufacturing powerhouse, as well as the railway being built by China that connects the west coast of Myanmar with the east coast of Thailand and allows trade to circumvent Singapore's port.

- A shift from the traditional cost-price dynamic of economic competition to a quantity-innovation dynamic, where the basis of competition is quantity and innovativeness. Similarly, a shift away from capital accumulation to total factor productivity as a source of growth.

- A shift towards clean, renewable energy in a post-hydrocarbon world.

- The growing use of online exchange platforms, e.g., Uber and Airbnb.

- The growing democratisation of trade, which was previously the domain of large companies; this trend is accelerated with increasing trade liberalisation.

- The growth of cities and small new firms that possess the ability to disrupt the prevailing economic order.

Given these trends, a driver for Singapore's third phase of growth would be growth in the ASEAN region. Taking into consideration the growth potential of ASEAN countries and their economic liberalisation efforts, this could yield significant growth potential for both local companies and MNCs based in Singapore.

Dr Nungsari suggested that Malaysia could serve as a good gateway for Singaporean companies seeking to internationalise. Beyond the Iskandar region of Johor Bahru, the Malacca Straits Diagonal could serve as an anchor for the push into the region. This is bolstered by the electrified dual-track rail line being laid from Thailand to Kuala Lumpur, and a proposed high-speed rail system between Singapore and Malaysia. The opportunities offered by improved connectivity, possible new industrial hinterland and supply chain rationalisation would be significant.

FUTURE SERVICE INDUSTRIES

Dr Theseira suggested that future services industries could occupy the intersection between Singapore's strengths in services and IT infrastructure, and demand in the growing ASEAN consumer base. He suggested that Singapore looks into developing expertise in predictive technologies, mobility lifestyles and education-as-a-service.

Next-generation predictive technologies integrate data from networked and mobile sensors to understand and predict consumer decision-making, which enable users to reduce waste and have leaner inventories and staffing, hence raising productivity.

Mobility lifestyles businesses, such as e-commerce, disrupt traditional brick-and-mortar businesses; the former have great impact in emerging markets by bypassing traditional obstacles to scale, such as infrastructure and red tape.

Education-as-a-service uses technology to deliver education tailored for individual/industry needs, and is scalable in both quantity of users and intensity of education. In particular, this provides the option of creating blended learning environments, where online classes are used to impart course materials, while face-to-face interaction are used to develop rigorous critical thinking skills. This aims to overcome some of the limitations of the present Massive Online Open Course models, such as limited local adaptation and lack of commitment.

Professor Loh Han Tong also highlighted the growth potential of high-tech, high-touch service delivery models made possible by technology. This employs both technology and the human touch in a complementary way to create better services. An example is the use of visualisation software in hair salons that simulates and projects different hairstyles on the customer onscreen, so as to decide on the hairstyle. This requires complementary skill sets by the hairstylist. Tapping on its expertise in programming and services, and the potential growth of data-driven cognitive systems based in Singapore, companies may develop these service delivery models for commercialisation in the region and beyond.

DEVELOPING SMES IN SINGAPORE

The need to develop a critical mass of high-performing SMEs to anchor high value-added activities and increase productivity growth in Singapore was a major thread in the conference, raised by speakers in various panels. Some suggestions include the government taking the lead in developing quality-based procurement criteria, developing collaborative pods, "hunting in packs" when overseas, enhancing the role of trade associations, and using online platforms such as e-commerce (e.g., Amazon) to bypass traditional barriers to entry in foreign markets.

IMPROVING PROCUREMENT CRITERIA TO DEVELOP SMES IN SINGAPORE

Due to small markets in Singapore, government procurement is an important source of demand that can accelerate the growth of SMEs and local companies. Therefore, procurement policies should be aligned to the long-term interests of both the end-user and the industry.

Professor Richard Liew shared that the construction industry in Singapore is foreign-dominated, due to lack of track records in local firms. For example, the share of total revenue of Singapore builders in the Downtown Line is 20.2%, while that in the Thomson Line is 15.6%. The industry is mired in a negative spiral. As contracts are awarded to the lowest bidder, it creates competition for the lowest tender price. This creates outsourcing to cheap low-skilled foreign labour or offshore construction production and services, which reduces local hiring and depresses wages and productivity. Businesses in Singapore become unsustainable, with no multiplier effect due to leakages.

To reverse this spiral, the government should tweak procurement criteria for public infrastructure to award contracts based on price, quality, innovation, employee enhancement, and sustainability, and spur the implementation of innovative solutions and materials. This will create a positive spiral of quality-based competition, stronger skills and talent development among local workers, deeper local corporate capabilities, better track records, and higher industry productivity. This

in turn generates greater tax revenues to finance better quality construction. In the long run, this would be better for both the consumer (here, the government) and the industry.

Ms Ang also suggested adjusting government procurement in an agile and cognitive era to balance between cost, proven capability and local skills build-up. Cities such as Madrid use mobile connectivity to cut costs and support outcome-based maintenance contracts. Technological monitoring enables service providers to be paid for quality of services rendered over the life of the product — with key performance indicators (KPIs) and service-level agreements (SLAs) — rather than for completed projects.

COLLABORATIONS TO INTERNATIONALISE

Successful internationalisation may require resource commitments over a long period of time, and the Singapore market is too small to generate the revenues required for these commitments, posing a major obstacle to internationalisation. Several suggestions were offered by the speakers.

Dr Luuk van Breda suggested that government-linked companies (GLCs) and SMEs form consortium “pods” to pool resources and address the financial issues connected with doing business abroad, as seen in other countries such as the Netherlands. These pods tapped the existing networks of companies in the foreign country, as well as the knowledge of mentors for assistance.

Professor Richard Liew suggested that public projects in Singapore should encourage joint ventures to enable local firms to build capability and track records, for example in the construction of Smart Nation infrastructure. Furthermore, GLCs are exporting urban infrastructural solutions to overseas markets, e.g., Tianjin Eco-City, Guangzhou Knowledge City, Nanjing International Water Hub — and should be encouraged to work closely with SMEs.

Industry trade associations can play a key role in industry development, by developing a collaborative spirit among industry players through collective participation in training, conferences and social events, developing industry thought leadership, and creating

industry-funded incubator programmes to draw entrepreneurs from around the world. Edwin Khew from the Sustainable Energy Association of Singapore (SEAS) shared that SEAS has worked closely with the Ministry of Foreign Affairs (MFA) and the Asian Development Bank (ADB) to establish the Sustainable Energy Centre of Excellence, which trains policymakers from Asia to understand and implement renewable energy in their home countries. These activities develop goodwill and business networks within the region, which help to create attractive investment destinations for Singapore firms.

USING ONLINE PLATFORMS TO GO GLOBAL

Assoc. Prof. Ng Teck Khim noted that high mobile and Internet connectivity allowed the monetisation of ideas and business models in a faster, more effective and scalable manner, which presented an unprecedented opportunity for inventors.

Minister S. Iswaran shared that online platforms could enable companies to sidestep barriers to internationalisation and be born-global. Mr Mark Lee concurred that e-commerce platforms like Amazon have resulted in the disintermediation of the brand-retailer network, where more shoppers go online. This allows textiles and goods suppliers like Sing Lun to sell its wares to end-customers directly through private labels. In order to take advantage of these platforms, SMEs should learn the online model ahead of other competitors.

BUILDING INFRASTRUCTURE, CURATORSHIP AND PLACE MANAGEMENT IN ECOSYSTEM DEVELOPMENT

Dr John Powers noted that Singapore could learn from the experiences of innovation ecosystems of New York City and London. In New York City, the local government had intervened to create affordable spaces and carried out large-scale urban redevelopment to connect different actors of the innovation economy. The innovation ecosystem in London has taken a more organic process — one of urban in-migration of knowledge workers and “creative economy” types, aided by light-touch policies. Flexible land use controls and zoning have allowed for a new wave of tech firms to populate underutilised sections of central London, while area management

policies to maintain adequate affordable working spaces have helped to prevent rental escalations for businesses.

BUILD ON-DEMAND FACILITIES TO DEVELOP AN ENTREPRENEURIAL AND ENGINEERING CULTURE

Several speakers, such as Janet Ang, noted that Singapore lacked design-and-build capabilities, which inhibited its companies from going upstream. In this regard, Assoc. Prof. John Pang suggested that Singapore should develop manufacturing enterprise labs ("ME-labs") to develop an entrepreneurial and engineering culture, and to better utilise its pool of silver engineers. These ME-labs could allow SMEs to design, manufacture and sell customised products at low fixed costs by providing facilities-on-demand, which include 3D printing and additive manufacturing, and digital manufacturing services.

Assoc. Prof. Ng suggested that Singapore should aim to develop a culture of innovation through a "maker movement", supported by a series of "TechShops", that would enable entrepreneurs to build prototype designs. Singapore should emulate the example of the US in ensuring that the TechShops are open to public access and are as user-friendly as possible. To ensure these TechShops are fully utilised, building awareness and accessibility is crucial, and partnerships with industry associations and institutes of higher learning need to be fostered.

SKILLS AND QUALITIES REQUIRED FOR A FUTURE-READY WORKFORCE

Wong Su-Yen and Professor Tan Eng Chye noted that that it was critical to cultivate learning adaptability, agility and resilience, and to create a culture of lifelong learning in the workforce, as technological advances impacts skills sets required for all industries, and industry sectors and opportunities come and go quickly.

Professor Tan highlighted that the development of mathematical, statistical and computational reasoning is a core foundational skill in the future economy. This enables the adaptive learning and application of skills that are in demand in a data-driven economy, such as data science, business analytics and information security. Hence,

one of the key roles of the university is to provide rigorous disciplinary grounding in these areas. Professor Tan shared that Singapore graduates remained under-equipped in quantitative reasoning, which inhibited the ability to develop the deep skills required to move up the value chain.

Other speakers noted the importance of supporting qualities and skill sets, including the willingness to take risks and soft skills such as creativity, communication, listening and intercultural skills. Ms Wong emphasised the need to broaden the conversation on talent to move beyond skills to include the needs, aspirations and personal mastery of human capital.

She also noted the importance of social and organisational attitudes in enabling the development of talent. For instance, social attitudes towards failure need to change to induce greater risk-taking. In addition, employees must move beyond short-term hiring practices to define longer-term goals for talent development.

DEVELOP SKILLS-ON-DEMAND LEARNING PLATFORMS

Assoc. Prof. Ng noted that hands-on skills, creativity and knowledge are three critical human capital requirements of innovation. Access to knowledge and skills has to be democratised so that vocational skill sets and academic knowledge can be fused. This calls for the curricular boundaries between vocational (ITE) and tertiary institutes to be bridged through pedagogical advances, as well as new learning platforms that offer skills on-demand, which cater to people of different learning preferences.

The National University of Singapore has developed a school of continuing and lifelong education for adult learners. It sets an example that effectively leverages on technology and develops a certifications-based curriculum, to adapt the learning environment to the needs of working adults. The school offers courses that teach graduates skill sets or competencies, and multiple certificates from such courses can be “stacked” towards earning a degree.

As an example, the school also leverages technology to offer blended learning environments. Course materials are provided online; while

face-to-face classes will be offered to build deeper critical thinking skills amongst the students. In addition, gamification platforms will be used as study aids. Platforms will also be used to encourage team-based learning.

OVERCOMING BEHAVIOURAL OBSTACLES TO PRODUCTIVITY IMPROVEMENT

Professor Ivan Png highlighted individual behavioural obstacles to productivity improvement. In particular, collective-action problems may result in unproductive status quos, as the costs are widely dispersed while the gains accrue to a few players.

At IPS, we think that consumers can effectively harness mobile online apps to identify such problems and suggest collective productivity solutioning. This may create opportunities to co-create solutions by customers and businesses. Another recommendation is for the government to set up a Behavioural Policy Unit to identify and provide solutions to resolve behavioural issues in government, and to work with trade associations to raise awareness and develop initiatives to address behavioural problems in the workplace/marketplace.

OPENING REGULATED SECTORS TO GREATER COMPETITION

Professor Png also highlighted that the top 10% of companies in an industry are generally 1.9 times more productive than the bottom 10%, due to poor management practices. In addition, regulated monopolies or oligopolies that lead to less competition have reduced incentives to raise productivity. Singapore should review its policies in regulated monopolies and oligopolies, as well as its competition policy to ensure greater levels of competition.

However, Professor Liew noted that competition should not be for competition's sake — while competition matters (i.e., quality versus price), it should not be at the expense of firm collaboration in other areas, or of long-term innovation and value-creation in the industry.

REGULATION IN THE FUTURE SHARING ECONOMY

The sharing economy enables skills, resources and goods and services to be shared in an on-demand basis. For example, Dr Yu Han noted that sharing economy networks have been used in China and Japan to enable productive ageing, foster mentorships, and build complementarities between the technical know-how of the young, and the experience and capital of the older and skilled population. Sharing economies also play a role in establishing social trust and creating new markets for goods and services.

Regulations should be administered with a light touch, with the aim of *enabling*, rather than *controlling* transactions. To expedite the development of a sharing economy, a Sharing Economy Office could be set up to deal with the most pressing issues affecting sharing projects such as liability insurance, certification, training, etc., especially in the hot areas of housing, transport and logistics. Ensuring a fair, safe and conducive operating environment is key, but protecting incumbents to maintain the status quo should not be a consideration.

RESPONDING TO UNCERTAINTY AND DIFFICULTY IN FORECASTING: SECOND-MOVER, MULTIDISCIPLINARY, AND "INNOVATE FAST, FAIL EARLY" APPROACHES

Sanjeev Sanyal argued that due to radical technological changes, it would be impossible to guess how the combination of factors would play out when forecasting the future. Picking winners in an environment of radical uncertainty poses great risks. Experts could make mistakes, which creates the danger of being locked into the wrong technology, infrastructure or economic model.

Singapore's competitive advantage lies in its flexibility, not its innovativeness. It is safer for Singapore to be a "second mover": to wait and see what works, and study and adapt best practices from the rest of the world, and to do them better. In particular, flexibility should not be sacrificed by committing to expensive backbone infrastructure unless the latter has been proven to work. Singapore should watch developments closely but keep its options open. Another option is to allow organic growth to take place.

Professor De Meyer suggested a different response. The difficulty in predicting the progress of innovation meant that Singapore would do well to pursue an interdisciplinary approach to innovation, and to target enabling industries with a broad range of applications, such as cyber security and blockchain.

During the discussions, a participant noted that the life-cycle of innovation would get shorter, and so the solution should instead be to run more agile experiments, and align more closely with forward-thinking companies at the frontier. It is necessary to innovate fast and fail early to preserve flexibility. However, another participant noted that at the firm level, it may be necessary for the firm to be the first mover, while at the national level, a second-mover approach allows the firm to bear the costs of experimentation, might be more prudent.

ASKING THE RIGHT QUESTIONS

A participant said that in uncertain times, the government should be asking questions about the qualities that it should aim to nurture in Singaporeans, rather than specific projects that the government should initiate. That is, Singapore should begin by asking what it wants to be as a society.

In IPS, we think that Singapore should aim to develop and communicate its conception of value, which would be a source of soft power, both commercially and in other areas. For example, companies in the US lead the world in services due to the soft power of its producers and consumers in defining consumer trends and values

ANNEX 1: POST-IT SUGGESTIONS BY CONFERENCE PARTICIPANTS

A1. HARNESSING TECHNOLOGY TO CREATE "CONTINUOUS MERITOCRACY"

A1.1 A conference participant suggested that Singapore should develop a new credentialing system, moving beyond paper qualifications to include credentials, peer reviews, state validation, and self-assessment. This should form the foundation of new assessment criteria for hiring, as well as HR practices. At the broader level, this can serve as a means for showcasing individual credibility when offering services in the sharing economy.

A1.2 At the organisational level, data should be collected and analysed to understand employee strengths and weaknesses to build better teams, and to generate employment and employability insights.

A1.3 Another post-it referred to the importance of teaching communication and teamwork skills within the curriculum, on how to maximise their strengths and mitigate their weaknesses through teamwork.

A2. Social Trust and Collaboration

A2.1 Social trust is key to enabling collaborations of the future economy. However, a number of participants expressed concern that with an ageing population, inter-generational conflicts may arise. Another issue is the breakdown of social trust between people and establishment if the economic benefits of automation accrue to only a few. Another fault line is that between SMEs and MNCs. Some Post-Its expressed concern that the government tends to engage the latter, while giving less attention to SMEs, which are at a natural disadvantage relative to the "big boys".

A2.2 One Post-It emphasised the need for a stronger, deeper and broader understanding of the benefits and negative impacts of the sharing economy, on not just businesses, but on social connections and trust, and on communities and the environment.

A3. REFORMING THE SCHOOL CURRICULUM

A3.1 Some Post-Its suggest that Singapore should go further in fostering inter-disciplinary thinking in universities and schools. In addition, one Post-It suggested that institutes of higher learning should allow/encourage self-designed majors at tertiary level to foster cross-disciplinary exposure.

A3.2 Another suggestion was to step up efforts to groom entrepreneurs in Singapore, including courses, training, funding and advice on business and other matters.

A4. Developing Downstream Innovation Capability

A4.1 One Post-It noted that Singapore should learn from past mistakes in innovation, possibly in reference to Professor Arnoud De Meyer's mention of the life sciences, especially in issues of implementation. Another Post-It recommended more funding for businesses to exploit their intellectual property.

A5. Innovation Ideas and Habits

A5.1 A Post-It noted that originality is crucial to innovation, and Singapore should create "Uniquely SG" policies and initiatives to address/tackle difficult socio-economic issues, rather than looking abroad always and aspiring to be like others.

A5.2 A number of suggestions noted that habits of thought and action such as social attitudes towards failure, and openness to alternative points of view, must change to foster an innovative society. This requires changing policies, such as bankruptcy laws, and mindsets, such as the validation of passion over social perceptions of success.

A5.3 Some suggested giving university students a mandatory "gap year" for them to explore their interests. Others emphasised institutional and cognitive flexibility: "We need to learn when to bend or change the rules when reality no longer suits the rules", echoing Mr Sanyal on the importance of systemic deep flexibility.

A5.4 Other Post-Its noted the importance of “slack time” in allowing employees to step back and create innovative projects, similar to Google’s employee policy, which gives 20% of working time to work on personal projects and interests. The possible benefits include personal R&D and incubation of ideas in free time.

A5.5 A Post-It suggested that the government take the lead in technological adoption by encouraging the civil service and GLCs to go “paperless”.

A6. TRAINING AND INDUSTRIAL ATTACHMENTS

A6.1 One Post-It suggested developing training and industrial attachment for professionals to be Industry 4.0 ready. This requires sponsors to nurture SME for the relevant industry, and blurring the divide between white- and blue-collar workers in a digital world.

A7. DEVELOPING SMES

A7.1 Post-Its noted that there is a fine balance between helping SMEs and making them too complacent and reliant. The way to do this is to ensure the right business environment and platforms for firms to compete on a level playing field, (e.g., small vs small firms, not small vs large firms). Another Post-It suggested doing away with competitive tenders to develop local industry on identified critical technology.

A7.2 To assist the Internationalisation and scaling up of SMEs, build knowledge based networks, a common platform, and training/upgrading at specific industry level, such as by Water Academy at WaterHub.

SPEAKERS AND CHAIRPERSONS

PANEL 1: INDUSTRIES OF THE FUTURE

TAN Kim Song is currently a Faculty Member at the School of Economics and Director of the Master of Applied Economics Program at the Singapore Management University (SMU). He has previously worked in various investment banks, primarily in the fixed income market; and as a journalist with the Singapore Press Holdings. Professor Tan holds a PhD in Economics from Yale University and a Bachelor of Economics (First Class Honours) from Adelaide University.

Arnoud DE MEYER is the fourth President of the Singapore Management University. Previously, he was Director of Judge Business School at the University of Cambridge, where he was Professor of Management Studies and Fellow of Jesus College. He was associated for 23 years with INSEAD where he held various senior academic and administrative positions, including as founding dean of INSEAD's Asia Campus in Singapore.

Professor De Meyer has a Master of Science in Electrical Engineering, and a MBA and PhD in Management from the University of Ghent in Belgium. He also pursued his studies as Visiting Scholar at the Sloan School of Management, Massachusetts Institute of Technology (US). He serves on several boards including the Human Capital Leadership Institute, National Research Foundation, Singapore International Chamber of Commerce, Singapore Symphonia Company Limited and Temasek Management Services. He is an external director of Dassault Systèmes SA (France) and also Chair of the Strategic Advisory Committee of VITO, the Flemish Institute for Technological Research (Belgium).

John H. L. PANG is Assistant Chair (Research) and Associate Professor at the School of Mechanical and Aerospace Engineering of Nanyang Technological University Singapore. He received his PhD degree in 1989 and BSc degree in 1985 from the University of Strathclyde, Glasgow, UK. His research interests are in Additive Manufacturing, Remanufacturing, Materials-Process-Performance (MPP) research in Laser Cladding, Mechanics of Lead-Free Solder

Materials, Design for Reliability (DFR), Structural Integrity of Welded Joints. He has published over 185 peer-reviewed journal and technical conference papers and has a SCI Web-of-Science (PANG JHL OR PANG HLJ), h-Index of 29, and over 2,500 citations. He serves in the Editorial Advisory Board of the International Journal of Fatigue. He was Associate Editor in the IEEE Transactions on Components and Packaging Technology and Advanced Packaging, ASME Journal of Electronic Packaging. He is a Fellow of the American Society of Mechanical Engineers (Fellow-ASME).

Richard LIEW is a Professor in the Department of Civil and Environmental Engineering at the National University of Singapore. He is a Professional Engineer in Singapore, and Chartered Professional Engineer of the Association of South East Asian Nations and the United Kingdom. He is a Fellow of the Academy of Engineering Singapore, an Honorary Fellow and the Past President of Singapore Structural Steel Society and Honorary Fellow of the Hong Kong Institute of Steel Construction. He has been involved in research and practice in offshore and marine, defence and civil infrastructural works. He interacts closely with the steel industry in the Asian region serving as an expert and technical advisor in several large-scale construction projects. He is one of the key persons responsible for the development of Singapore's codes of practices for steel structures.

Russell GRUEN is the Vice-Dean of Research and Professor of Surgery in the Lee Kong Chian School of Medicine, and Director of the Nanyang Institute of Technology in Health and Medicine, at the Nanyang Technological University. He is also a Consultant General Surgeon at Tan Tock Seng Hospital. Prior to coming to Singapore in August 2015, Professor Gruen was Professor of Surgery and Public Health at Monash University, Director of Australia's National Trauma Research Institute, and a trauma surgeon at The Alfred, the busiest trauma centre in Australia. Professor Gruen's research training includes a PhD in health systems research from Flinders University in 2004, a Harkness Fellowship in Health Policy at Harvard School of Public Health, a Fellowship in Medical Ethics at Harvard Medical School, and the Advanced Management Program at Harvard Business School.

In Australia he secured as lead investigator over A$16 million of competitive research funding, including a programme grant in brain injury research, two national randomised trials, the Australian Trauma Registry, and an Australia-India trauma system development programme. He has published over 160 articles, including 18 as first or senior author in high impact journals. He held Medical Postgraduate, Career Development, and Practitioner Fellowships from the National Health and Medical Research Council (NHRMC), and received the John Mitchell Crouch Fellowship, the highest academic award of the Royal Australasian College of Surgeons. He chaired the NHMRC Research Translation Committee for Injury Prevention, the Evidence and Research Committee of the WHO Global Alliance for Care of the Injured, and he led a clinical series on trauma in *The Lancet*, and was a *Lancet* Commissioner in Global Surgery.

Professor Gruen has a broad view of health systems of many types and at many levels, ranging from molecular processes and functional anatomy through to the organisation and delivery of health services. His work is by its nature interdisciplinary, bringing together ideas and expertise from diverse fields such as medicine, engineering, philosophy, and economics. It is also highly translational, with strong emphasis on what works best for the benefit of patients. In 2012 he was profiled in *The Lancet* under the headline “Russell Gruen: Precision and Progress in Trauma Care”.

YU Han is a Lee Kuan Yew Postdoctoral Fellow at the Joint NTU-UBC Research Centre of Excellence in Active Living for the Elderly (LILY), Nanyang Technological University (NTU), Singapore. He obtained his PhD and BEng in Computer Engineering (1st Class Honours) from the School of Computer Engineering, NTU in 2014 and 2007, respectively. From 2008 to 2012, he held the prestigious Singapore Millennium Foundation (SMF) PhD scholarship. He worked as a systems engineer in Hewlett-Packard (HP) Singapore Pte Ltd from 2007 to 2008.

In both 2014 and 2015, he has been one of the world’s top 10 finalists for the Global Young Scientists Summit (GYSS) Singapore Challenge Competition to showcase his research to the President of Singapore Dr Tony Tan Keng Yam. In 2015, he co-founded the Association for

Crowd Science and Engineering (ACE) and currently serves as a member of its Executive Council. His research spans artificial intelligence (AI), algorithmic crowdsourcing, trustworthy computing, and software engineering. He has published over 75 research papers in leading international journals and conferences including Proceedings of the IEEE, Decision Support Systems, AAAI/IAAI, AAMAS, ASE, IJCAI, and IUI. His research work has received six Best Paper, Best Poster, Best Demo, and Best Video Awards from prestigious international conferences including ICCT'11, WI-IAT'15, IJCAI'15, AAAI-16, and SCSM'16.

LAM Kwok Yan is a Professor at the Nanyang Technological University (NTU), Singapore. He has been a professor of the Tsinghua University in China (2002–2010) and a faculty member of the National University of Singapore and the University of London since 1990. He was Visiting Scientist at the Isaac Newton Institute of the Cambridge University, and Visiting Professor at the European Institute for Systems Security. In 1997, he founded PrivyLink International Ltd, a spin-off company of the National University of Singapore, specialising in e-security technologies for homeland security and financial systems. In 2012, he co-founded Soda Pte Ltd, which won the Most Innovative Start Up Award at the RSA 2015 Conference. In 1998, he received the Singapore Foundation Award from the Japanese Chamber of Commerce and Industry in recognition of his Research and Development achievement in information security in Singapore. Professor Lam received his BSc (First Class Honours) from the University of London in 1987 and his PhD from the University of Cambridge in 1990. His research interests include distributed systems, IoT security infrastructure, distributed authentication, biometric cryptography, homeland security and cyber security.

PANEL 2: ECOSYSTEM OF THE FUTURE ECONOMY

Euston QUAH is Head, Division of Economics at the Nanyang Technological University (NTU), Singapore, and an Adjunct Principal Research Fellow of the Institute of Policy Studies at the National University of Singapore (NUS). He was formerly Chair, School of Humanities and Social Sciences at NTU; Vice-Dean, Faculty of Arts and Social Sciences; Deputy Director of the Public Policy Programme (now called the Lee Kuan Yew School of Public Policy); and headed

the economics department at NUS. A prolific writer, Professor Quah has published over 100 papers in major internationally refereed journals and opinion pieces. His most recent work is a paper in an international publication on cost-benefit analysis for Oxford University Press, 2013, and a lead journal article in UK's *World Economy* in 2015. Two books on cost-benefit analysis were published by Routledge in 2007 and 2012, respectively. His work on cost-benefit analysis (with EJ Mishan) was recommended for reference by the US White House, Office of Management and Budget for use by government agencies applying for project grants. He was co-author of an Asian edition of the best-selling *Principles of Economics* with Gregory Mankiw of Harvard University, in its second edition since 2013.

Professor Quah advises the Singapore Government in various ministries and was a Member of the Prime Minister's Economic Strategies Sub-Committee on Energy and the Environment. He had served on the Boards of Energy Market Authority, Fare Review Mechanism Committee of the Ministry of Transport, and presently sits on the Boards of the Energy Studies Institute at NUS, and the Energy Market Company. In 2016, Professor Quah was appointed a Member of the Social Sciences Research Council of Singapore. He is also a Review Panel Member for the Bill and Melinda Gates Foundation project hosted by the Overseas Development Institute, London; and in 2015 was inducted as a Fellow Member of the prestigious learned society, European Academy of Science and Arts. Professor Quah is Editor of the *Singapore Economic Review* since 2002, and the President of the Economic Society of Singapore since 2009. He has been invited by Stanford University, Princeton University, the USA Inter-Pacific Bar Association, WWF for Asia, UNESCAP, Earth Institute of Columbia University (Asian Meetings), ADBI and ADB to speak at their functions and conferences and he is one of the most highly cited and influential university economists in Singapore.

John POWERS is Research Fellow at the Lee Kuan Yew Centre for Innovative Cities, Singapore University of Technology and Design. His interests in international and comparative regional economic development have led him to focus on planning and economic theory to study questions of innovation and how economic and organisational learning takes place in metropolitan regional systems. His doctoral

research examined the micro foundations of such learning processes in the indigenous portion of the ICT sectors of Dublin, Ireland and Beijing in the Peoples' Republic of China. His current research areas relate to the economics of technological change; innovative regions; how capabilities develop dynamically; and the interrelationships between concepts of justice, equity and economic growth in cities.

Dr Powers has over a dozen years of management consulting and international experience for Booz Allen Hamilton as well as full-time positions with the World Bank and the Organisation for Economic Co-operation and Development (OECD). This work has been focused on international development, economic policy and growth strategy, privatisation and public-private partnership development, infrastructure planning and investment, and public sector reform. These activities have entailed extensive in-country roles across Africa, East and South East Asia, Europe, the Balkans and North America. Mr Powers received his master's degrees in city and regional planning from MIT, a master's degree from the Université de Paris (Sorbonne), and his PhD in urban planning from Columbia University.

LOH Han Tong is the Deputy President (Academic) and Provost of Singapore Institute of Technology (SIT). Prior to this appointment, Professor Loh was the Vice-Provost overseeing education initiatives, faculty management and programmes administration. Professor Loh was a Colombo Plan Scholar, who graduated with First Class Honours in Bachelor of Engineering from University of Adelaide, Australia in 1979. He went on to obtain his Masters of Engineering from NUS in 1983 and his PhD in Mechanical Engineering from University of Michigan, Ann Arbor, United States of America in 1989 under the NUS Overseas Postgraduate Scholarship.

Prior to joining SIT, Professor Loh spent over 30 years as an academic staff in the Mechanical Engineering Department at the National University of Singapore (NUS). During his 30-year tenure with NUS, he held several academic leadership positions, including Vice Dean of the Faculty of Engineering, Deputy Head of the Department of Mechanical Engineering, Director of Education in the Design Technology Institute Limited and Director of Bachelor of Technology Programme (BTech Programme) in the Faculty of Engineering. He was Visiting Scholar at Stanford University and a Fellow of the

Singapore MIT Alliance. Professor Loh's research interest is in the area of product design through computer technologies. He has more than 80 publications in internationally refereed journals and has two patents to his name.

Professor Loh is active in community service. He was the Chairman of the Moulmein Watten Neighbourhood Committee; a member of the Moulmein Constituency Citizen Consultative Committee; Vice Chairman of Moulmein-Kallang GRC NC Task Force; and part of the 1st PA NC Coordinating Council. For his outstanding service to the Moulmein Constituency, Professor Loh was awarded the Commendation Service Award in 2008 and the Merit Service Award by People's Association in 2013. Professor Loh has been appointed a Board Member of the Engineering Accreditation Board since 1 May 2016. He is also a Fellow of the Institution of Engineers, Singapore. For his dedication to the education sector, Professor Loh was awarded the Pingat Bakti Setia (Long Service Award) by the Prime Minister's Office in 2013.

Walter THESEIRA is Senior Lecturer of Economics at the School of Business, SIM University. Dr Theseira earned his PhD in Applied Economics and Managerial Science from the Wharton School, University of Pennsylvania, and holds undergraduate and masters' degrees from the University of Chicago. His research and teaching cover applied microeconomics, behavioural and experimental economics. His current research interests include structural social security reforms; online markets for lending and charitable giving; low-income families and policy; and consumer finance and debt.

He was the academic co-investigator of the Singapore Retirement and Health Survey. He served as a research consultant with the Economist Service of the Ministry of Trade and Industry, where he advised on empirical policy research covering education, social mobility, trade, and other areas. Other public sector collaborations include studies of the free travel programme and transport choice behaviour with the Land Transport Authority, and social transfers with the Ministry of Finance. He served on the Government Parliamentary Committee on Finance and Trade and Industry as a Resource Panel Member, as well as on the JC Economics Syllabus Development

Committee for the Ministry of Education, and on the Ministry of Law's Moneylending Advisory Committee.

Francis YEOH has been involved in various aspects of Research and Development, technology management, startup companies, venture funding, innovation and entrepreneurship over the last 30 years. He had been a research scientist, research institute director, Internet startup Chief Executive Officer, investor, professor and government policymaker. He holds a BSc (Hon) and PhD in Electrical Engineering, from Loughborough University (UK) and a Masters in Management from Massachusetts Institute of Technology.

He stepped down as the first Chief Executive Officer of the National Research Foundation (NRF) of Singapore in 2012 after more than six years. While at the NRF, he initiated and implemented many new national initiatives in research, innovation and enterprise, including major international research collaborations, national innovation challenges, proof-of-concept grants, early stage venture funds and technology incubation programmes.

Dr Yeoh is presently Professorial Fellow for Entrepreneurship at the School of Computing, National University of Singapore, overseeing the school's entrepreneurship efforts, teaching entrepreneurship and mentoring university startup companies. He is also Executive Director for the Mediapreneur Incubator, a corporate incubation programme for media startups under Singapore's MediaCorp Pte Ltd. He serves on government panels awarding startup grants as well as grants to social enterprises.

NG Teck Khim is an Associate Professor of Practice in the School of Computing, National University of Singapore (NUS). His research interest is in geometrical computer vision such as reconstructing 3D from 2D images. He is also interested in sports video analytics, assistive devices for the handicapped, audio processing, and image/audio applications on mobile devices. Assoc. Prof. Ng obtained his bachelor's and master's degrees from the National University of Singapore in 1988 and 1992, respectively. He later received his PhD from Carnegie Mellon University in 1999. His PhD thesis topic was on reconstructing 3D large scenes from 2D images.

Assoc. Prof. Ng served in Defence Research and Development for the Ministry of Defence of Singapore for the most of his career. He also served a year in Media Development Authority as Programme Director. Prior to joining NUS, he was the Head of Signal Processing Lab in Defence Science Organisation (DSO) National Laboratories.

David CHAN is Lee Kuan Yew Fellow, Professor of Psychology and Director of the Behavioural Sciences Institute at the Singapore Management University (SMU), Adjunct Principal Scientist at the Agency for Science, Technology and Research (A*STAR), and Co-Director of the Centre for Technology and Social-Behavioural Insights jointly established by A*STAR and SMU. He has received numerous international awards and is the first non-American to receive the Distinguished Early Career Contributions Award from the Society for Industrial and Organisational Psychology. His works have been cited over 3,000 times in various disciplines.

He has served as editor or board member on several journals, and he is elected fellow of several international psychological associations. He is consultant to numerous organisations in the public, private and people sectors on issues involving social and behavioural sciences. He serves on various national councils, advisory panels and board of directors in Singapore and the US. He is a recipient of the Outstanding Volunteer Award from the Ministry of Social and Family Development. He is an invited columnist for *The Straits Times* where he writes regularly on social issues, and a consultant for Channel NewsAsia on several documentary and related programme series.

PANEL 3: FUTURE WORK

Jonathan ASHERSON, a Chartered Engineer with a BSc (Hons) degree in Mechanical Engineering, is Regional Director ASEAN and Pacific at Rolls-Royce plc., based in Singapore. Before coming to Singapore in 1999 he was the Regional Executive for Rolls-Royce in Kuala Lumpur, Malaysia. He joined Rolls-Royce from Siemens AG in 1995, where he was Head of the Regional Competence Centre for Industrial Power, Asia Pacific, based in Kuala Lumpur. He spent 15 years working for Siemens in various roles in Germany, the US, China and Malaysia.

Mr Asherson has been on a range of advisory committees for various educational and research institutions in Singapore, and a past president of the Singapore British Chamber of Commerce. He was a board member of the Economic Development Board of Singapore (EDB) from 2007–2011 and was a member of the Steering Committee of the Applied Study in Polytechnic and ITE Review (ASPIRE). He is a board member of the Singapore International Chamber of Commercial (SICC) and an advisor to the Singapore Institute of International Affairs (SIIA). He sits on the Advisory Council on Community Relations in Defence (ACCORD) and is also a Council Member of the Singapore National Employers' Federation (SNEF). Mr Asherson is on the Committee on the Future Economy (CFE), targeting sector and market growth, and an advisor to the University of Birmingham in Asia.

Mr Asherson received an OBE in 2010 and was conferred the Public Service Medal (Friends of Singapore) Award under the Singapore National Day Awards in 2010. He was awarded an honorary Doctorate of Science from Kingston University in 2010.

WONG Su-Yen is Chief Executive Officer of the Human Capital Leadership Institute, which was established by the Ministry of Manpower, the Economic Development Board and the Singapore Management University to develop global leaders with a strong understanding of leading in Asia, as well as to build Asian leaders with the ability to lead on the global stage. She is Non-Executive Chairman of the Board of Nera Telecommunications, a global telecom and IT solutions provider that operates in Asia, Middle East, Europe and Africa listed on the Singapore Exchange Mainboard. Concurrently, she is an Independent Director at MediaCorp, Singapore's leading media company; at NTUC First Campus, which is the largest provider of childcare services in Singapore; and at Yoma Strategic Holdings.

Previously, she was Chairman (Singapore) for Marsh & McLennan Companies, and Managing Director, South East Asia at Mercer. Prior to that she was Asia Managing Partner for the Communications, Information & Entertainment practice at Oliver Wyman.

She brings over 20 years' experience in business strategy, organisation transformation, human capital and leadership

development. She has been based in various cities across Asia since 1997, and has worked with leading organisations across North America and Asia in a broad range of industries including high-tech, financial services, oil and gas, retail, consumer goods, and the public sector. Ms Wong is an active member of the Singapore Institute of Directors, Women Corporate Directors, and the Young Presidents' Organisation. She holds a BA (summa cum laude) in music and computer science from Linfield College and an MBA from the University of North Carolina at Chapel Hill.

Luuk VAN BREDA has over 35 years' experience on projects in the fields of Business Management, Project Development and Implementation. His work has taken him across all five continents and he has been closely involved in projects ranging in size from US$5 million to US$350 million. In the Asian region, Dr van Breda has worked on Projects for the Asian Development Bank (ADB) and World Bank and has been stationed in Indonesia (five years), Philippines (three years), Thailand (three years) and Singapore (10 years). Dr van Breda has worked on Projects in Middle East, Africa and South America. He has a deep understanding of regional markets and his professional experience with organisations of all sizes, from SMEs to large domestic and international corporates in both the private and public sector ensures that Dr van Breda has a strong understanding of all of the major business drivers.

Dr van Breda has spent the last six years creating, developing and delivering a sophisticated and detailed training methodology, which includes four main pillars, which are aimed specifically at enhancing performance in: communication, negotiation, presentation and listening skills specialties; business performance improvement; strategy development and implementation; well developed communication and presentation skills; organisational and capability skills; team development; development and delivery of training programmes in educational institutions; and commercial organisations. Dr van Breda is an accomplished public speaker and is highly experienced in running and organising discussion seminars on topics related to doing business in a rapidly changing world.

TAN Eng Chye is Deputy President (Academic Affairs) and Provost of the National University of Singapore (NUS). He obtained his

Bachelor's degree in Mathematics with first-class honours in 1985 at NUS and his PhD at Yale University in 1989. He oversees NUS' faculties and schools by providing strategic directions and setting academic policies. His responsibilities include admission policies and processes, educational quality assurance, budget and resource allocation for the faculties and schools, and the development and implementation of new educational initiatives. Professor Tan is also responsible for the appointment, promotion and tenure process, as well as the reward and incentive systems for academic staff.

PANEL 4: PRODUCTIVITY AND INNOVATION

Manu BHASKARAN is an Adjunct Senior Research Fellow at the Institute of Policy Studies. Mr Bhaskaran co-leads the Institute's work in the area of economics. He is also concurrently Partner and Member of the Board, Centennial Group Inc, a policy advisory group based in Washington DC, where he heads the Group's economic research practice. His major area of research interest is the Singapore economy and the policy options it faces.

Prior to his current positions, he worked for 13 years at the investment banking arm of Societe Generale as its Chief Economist for Asia. He began his professional career at Singapore's Ministry of Defence, focusing on regional security and strategic issues. Mr Bhaskaran graduated from Cambridge University with a Masters of Arts and also has a Master's in Public Administration from Harvard University.

Alpesh PATEL is an Associate Principal at McKinsey & Company and the Director of the McKinsey Innovation Campus (MIC) in Singapore. With over 15 years of experience in operations, he is an expert in operations and manufacturing and has deep expertise in motorsports and the automotive industry.

Dr Patel's work includes a large number of productivity diagnostics and operations transformation programmes for industrial and transport players in South East Asia, including offshore rig manufacturers, port operators, transit bus and rail companies, and shipping lines. He has also led economic, social and branding impact studies, from transnational rail projects, country logistics reforms, and iconic sporting events. In addition to serving clients, MIC in

partnership with the Singapore government, drives the development of intellectual property by bringing together global experts in a collaborative setting. As leader of MIC, Dr Patel collaborates with colleagues to pursue cutting-edge insights in key topics such as energy efficiency, economic trends in Asia, digital and productivity. He is currently driving “Project Lighthouse” within McKinsey, which involves the setup of a new generation Industry 4.0 Center of Excellence and Incubator in Singapore.

Prior to joining McKinsey, Dr Patel worked for the Ferrari Formula One Team as a Senior Aerodynamicist, where he ideated and tested novel aerodynamic concepts with the objective of relentlessly adding performance on an already over-optimised project, contributing to world championship titles in 2004, 2007 and 2008. He also led key initiatives to improve the effectiveness of flow simulation tools and transferred know-how to the company’s road car product development division. Prior to Ferrari, he developed flow simulation software for the aeronautics and aerospace industries at an engineering company. Dr Patel holds an MBA from the University of Chicago Booth School of Business and a MEng and PhD in Computational Fluid Dynamics from the Université Libre de Bruxelles.

Ivan PNG is Distinguished Professor in the NUS Business School and Department of Economics at the National University of Singapore. His research focuses on the economics of innovation. He is the author of *Managerial Economics*, which has been published in multiple editions. He received the NUS-UCLA Executive MBA Teaching Excellence Award in 2008 and 2011. Dr Png was a member of the Trustworthy Computing Academic Advisory Board, Microsoft Corporation, 2006–2010, and nominated MP (10th Parliament of Singapore) in 2005–2006. In a key Parliamentary contribution, he successfully advanced the reduction in record-keeping from seven to five years. He plays tennis with colleagues and the violin (both badly) for leisure.

Sanjeev SANYAL is an economist, urban theorist and best-selling author. He was Deutsche Bank's Global Strategist and a Managing Director till end-2015 and was named Young Global Leader 2010 by the World Economic Forum. In 2007, he was awarded the Eisenhower Fellowship for his work on urban dynamics and was also honoured by the Singapore government at the World Cities Summit 2014. He has

been a Visiting Scholar at Oxford University, Adjunct Fellow at the Institute of Policy Studies, Singapore and a Senior Fellow of the World Wide Fund for Nature. He currently serves as a member of the Committee on the Future Economy (Future City Sub-Committee) established by the Singapore government to work out long-term economic strategies for the city-state.

Mr Sanyal attended Shri Ram College of Commerce in Delhi and Oxford University where he was a Rhodes Scholar (1992–1995). His best-selling books include *Land of the Seven Rivers*, *The Indian Renaissance* and *The Incredible History of India's Geography*, all published by Penguin. He was given the inaugural International Indian Achievers Award for his contributions to literature in 2014. He is a Fellow of the Royal Geographical Society, London, and of IDFC Institute, Mumbai.

PANEL 5: GLOBALISATION AND REGIONALISATION

FAIZAL Bin Yahya is a Senior Research Fellow at the Institute of Policy Studies. Prior to joining the Institute of Policy Studies he was an Assistant Professor in the South Asian Studies Programme, Faculty of Arts and Social Sciences, National University of Singapore. Concurrently, he was a Visiting Research Fellow at the Institute of Southeast Asian Studies from 2008 to 2009 (ISEAS).

He has also served in the Ministry of the Environment and Water Resources (International Policy) and the Ministry of Foreign Affairs (MFA) as a Foreign Service Officer. He was a member of the Singapore Delegation to the United Nations General Assembly (UNGA) in 1998 and was also involved in multilateral meetings dealing with environmental issues such as climate change and transboundary hazardous wastes. Some of his research interests include human capital, social capital, multicultural and societal issues. He attained his PhD in Economics in 2000 from the University of Sydney, Australia and was an Australian Overseas Post graduate Research Scholar from 1994 to 1998.

Deborah ELMS is Executive Director of the Asian Trade Centre in Singapore. She is also a senior fellow in the Ministry of Trade and Industry's (MTI) Trade Academy. Dr Elms' present research involves

the Trans-Pacific Partnership (TPP), Regional Comprehensive Economic Partnership (RCEP), ASEAN Economic Community (AEC) negotiations and global value chains.

Previously Dr Elms was head of the Temasek Foundation Centre for Trade & Negotiations (TFCTN) and a senior fellow of international political economy at the S. Rajaratnam School of International Studies at Nanyang Technological University. She has also provided consulting on a range of trade issues to governments including the United Arab Emirates, Sri Lanka, Cambodia, Taiwan and Singapore. Dr Elms publishes the Talking Trade Blog.

Francis HUTCHINSON is Senior Fellow and Coordinator of the Regional Economic Studies Programme at the ISEAS-Yusof Ishak Institute. He holds an MA in Social and Political Sciences from the University of Cambridge, MPhil in Development Studies from the University of Sussex, and a PhD in Public Policy and Administration from the Australian National University.

Dr Hutchinson's research interests include local economic development, industrialisation, innovation, global value chains, federalism and decentralisation. He has carried out applied research for the World Bank, UNDP, UNICEF, UNESCO and the Australian International Aid Agency, as well as political risk consultancy firms such as Oxford Analytica. He is also the author of *Mirror Images in Different Frames? Johor, the Riau Islands, and Competition for Investment from Singapore* (ISEAS, 2015), and co-editor of *Asia and the Middle Income Trap* (Routledge, 2016).

NUNGSARI Ahmad Radhi was appointed as the Managing Director of Prokhas Sdn Bhd (Prokhas) on 1 September 2013. He is concurrently the Principal Officer of DanaInfra Nasional Berhad (DanaInfra), the Special Purpose Vehicle raising funds for the Klang Valley Mass Rapid Transit project in the Greater Kuala Lumpur region. Both Prokhas and DanaInfra are fully-owned companies of Minister of Finance, Incorporated, Malaysia.

Prior to joining Prokhas, he was an Executive Director at Khazanah Nasional. In his career of almost 30 years, he has been an academic, a Member of Parliament, a consultant, a columnist and a policy

advocate. His professional interest is in microeconomic aspects of policy and strategy research. He is trained in economics and mathematics and holds a PhD from the Krannert School of Management, Purdue University.

PANEL 6: RESPONDING TOGETHER

Chaly MAH recently retired as the Chief Executive Officer of Deloitte Southeast Asia and Chairman of Deloitte Singapore. He has been with the firm for over 38 years, including five years with its Melbourne office. He was the Chief Executive Officer of Deloitte Asia Pacific and member of Deloitte Global Executive in 2007–2015. Mr Mah was the Vice Chairman of Deloitte Touche Tohmatsu Limited's Global Board of Directors (2015–2016) which represents the interests of its member firms and their partners.

He has extensive experience serving both multinational and local companies across a wide spectrum of industries specialising in financial services, telecommunications and technology, real estate, private equity and manufacturing. He has served and advised companies with operations in the Asia Pacific region, in the areas of mergers and acquisitions and corporate finance. In his role as Chief Executive Officer of Deloitte South East Asia, Mr Mah is responsible for ensuring the firm delivers on its vision and strategy on the development of regional and country business plans, client service and talent, brand building activities, quality assurance and risk management, and ensuring the country practises operating as one firm in South East Asia meet their measures of success.

Mr Mah is the Chairman of Singapore International Chamber of Commerce and Chairman of the Singapore Accountancy Commission. He is a member of the National University of Singapore Board of Trustees and Chairman of the National University of Singapore Business School Accounting Advisory Board. He also serves on the Boards of the Singapore Economic Development Board and Sentosa Development Corporation. He served on the board of Singapore Land Authority in 2007–2014 and as its Chairman in 2010–2014. Mr Mah is the Singapore Non-Resident Ambassador to Papua New Guinea. He was awarded the Public Service Medal (PBM) in 2014 for his contribution to public service. Mr Mah graduated with a Bachelor of Commerce degree from the University of Melbourne. He

is an associate member of the Institute of Chartered Accountants in Australia and a fellow member of CPA Australia as well as the Institute of Singapore Chartered Accountants.

Janet ANG is Vice President, Industry Solutions Sales Team, IBM Asia Pacific covering Australia & New Zealand, India, ASEAN and Korea. Ms Ang is also a Member of the IBM Industry Academy.

In her current role, Ms Ang is responsible for leading IBM's industry value creation for its Asia Pacific clients across the key industries — Financial Services, Government & Healthcare, Industrial, Telco & Media, and Distribution — with Industry Solutions that bring together IBM's portfolio of Cognitive Solutions, Cloud Platform Infra-structure and Systems of Engagement solutions as well as eco-system partner offerings. She also leads the charge for helping cities in Asia become smarter, cognitive cities.

Ms Ang was previously the Managing Director of IBM Singapore from July 2011 to May 2015, and earlier from May 2001 to December 2003. She had been on two international assignments and have lived and worked in Tokyo and Beijing for three and eight years, respectively. She serves on various committees and boards in the community. She graduated with a Business Administration degree (Honours) from the National University of Singapore and is happily married with four daughters.

Edwin KHEW is Managing Director of Anaergia Singapore Pte Ltd, global environmental waste to energy technology and management company with its global headquarters in Toronto, Canada and headquarters for Asia in Singapore. He is also a former Nominated Member of Parliament (NMP) and currently the Chairman of the Sustainable Energy Association of Singapore (SEAS), the President of the Institution of Engineers, Singapore (IES), Supervisory Board Member of Solar Energy Research Institute of Singapore (SERIS) and Chairman of the Singapore Standards Council. Mr Khew represents SEAS on the Asian Development Bank (ADB) Energy for All Partnership's (E4ALL) Steering Committee as its Co-Chair and is Chairman of its Enterprise Development Working Group.

He has an Executive MBA from the National University of Singapore, a Bachelor's Degree in Chemical Engineering from the University of Queensland, Australia, is a Fellow of the Institute of Engineers, Singapore, a Fellow and Chartered Engineer of the Institute of Chemical Engineers (UK), and a professional engineer of the Professional Engineers Board, Singapore. Er. Khew was awarded the Public Service Medal (PBM) by the President of Singapore during Singapore's National Day in 2014.

Patrick TAY is Assistant Secretary-General of National Trades Union Congress (NTUC). He is Director of NTUC's Legal Services Department, and its Professionals, Managers and Executives (PME) Unit. Concurrently, he is an elected member of the NTUC Central Committee, Executive Secretary of the Singapore Manual and Mercantile Workers' Union (SMMWU) and Adviser/Trustee to several key unions in Singapore. He also serves on the boards of Economic Development Board and Workforce Development Agency. Mr Tay is the Supervising Lead for the Labour Movement's Financial and Business Services Cluster and Healthcare Cluster. He currently co-chairs the Financial Sector Tripartite Committee with the Monetary Authority of Singapore.

As an elected Member of Parliament of West Coast GRC, he chairs the West Coast Town Council and is Vice-Chair of the Southwest Community Development Council. Besides chairing the Government Parliamentary Committee (GPC) for Manpower, he is also on the GPCs for Law and Home Affairs. Mr Tay graduated with a Bachelor of Laws (Honours) in 1995 and Master of Laws in 1999, both from the National University of Singapore (NUS) and in 2014, he attended the Advanced Management Programme (AMP) from Harvard Business School (HBS). He is an Advocate & Solicitor (Supreme Court of Singapore), an Associate Mediator with the Singapore Mediation Centre and Fellow of the Singapore Institute of Arbitrators. He has been involved in industrial/employee relations since 2002 and has been deeply involved in collective bargaining, dispute resolution and complex negotiations including representing workers/unions at the Industrial Arbitration Court (IAC).

DIALOGUE SESSION WITH CFE MEMBERS

LEE Tzu Yang chairs the board of the Esplanade, the national performing arts centre, and was the first chairman of the School of the Arts, the first specialised arts school in Singapore for 13 to 18 year old students. In 2011 he led the Arts and Culture Strategic Review commissioned by the Singapore government.

He graduated from the London School of Economics and Political Science in 1976. From 1979 he worked for Shell in various operational, commercial, corporate, portfolio and shareholder roles, both in Singapore and internationally, and retired in 2014 as chairman of Shell Companies in Singapore. He has worked in different countries and markets on downstream energy issues, deregulation and globalisation, and with a range of stakeholders on technical, human and regulatory factors in change, at urban growth, development and sustainability.

Currently he serves on the academic panel of the Institute of Policy Studies and the advisory board of the Centre for Liveable Cities, as Deputy Chairman of the Singapore University of Technology and Design (SUTD) and Chairman of the Middle East Institute at National University of Singapore (NUS). He is chairman of the Casino Regulatory Authority, and a member of the Council of Presidential Advisers as well as the Legal Service Commission. He previously served as a member of the NUS Board of Trustees, is a past chairman of the Singapore International Chamber of Commerce, and was the first chairman of the Workplace Safety and Health Council of Singapore till he stepped down earlier in 2016.

S ISWARAN joined the Singapore Administrative Service in 1987. He served in the Ministries of Home Affairs and Education, was seconded to the National Trades Union Congress, and later to the Singapore Indian Development Association as its first Chief Executive Officer. Mr Iswaran was Director for International Trade at the Ministry of Trade and Industry in the lead up to Singapore's hosting of the WTO Ministerial Conference in 1996. He then joined the private sector, as Director for Strategic Development at Singapore Technologies Pte Ltd. Later, as Managing Director at Temasek Holdings, he undertook investments, takeover, buy-out and merger transactions in the

pharmaceuticals, biotech, hi-tech manufacturing, transport and logistics sectors.

Mr Iswaran has been elected as a Member of Parliament in five General Elections since 2 January 1997. Prior to his Cabinet appointment in 2006, he served on several Government Parliamentary Committees, and served as the Deputy Speaker of Parliament from September 2004 to June 2006. Mr Iswaran is currently the Minister for Trade and Industry (Industry), focusing on economic restructuring, productivity growth, and creating a vibrant domestic economy and enterprise ecosystem. He also oversees the Agency for Science, Technology and Research; Energy Market Authority; International Enterprise Singapore; Singapore Tourism Board; Sentosa Development Corporation; and SPRING Singapore.

Mr Iswaran read Economics at the University of Adelaide and graduated with First Class Honours. He also holds a Masters in Public Administration from Harvard University.

GOH Swee Chen has been Chairman of Shell Companies in Singapore since October 2014. Concurrent to her country chair role, Ms Goh is also Vice President, Lubricants – Asia Pacific, a role she undertook since 2011.

Ms Goh joined Shell in 2003 and was with Procter & Gamble and IBM before this. A global leader, she had lived and worked in Singapore, Malaysia, Netherlands, Australia, US, Japan and China. She spent a large part of her career in global roles, leading significant businesses with multinational teams. She has a diverse professional background having spent her career in IT, Real Estate, Business Improvement and running large Profit and Loss businesses.

Other than chairing the Shell Companies in Singapore, Ms Goh also chairs/sat in the Board of several Shell Joint Venture in China and Saudi Arabia. She is also a Board Member of Singapore International Chamber of Commerce, Advisory member of NUS Master of Science (Environmental Management) Programme and a Member of the Singapore National Climate Change network. She graduated with a BSc from Victoria University and an MBA from Chicago Booth. She is married with three children

Caesar SENGUPTA is Vice President of Product Management at Google, leading the Next Billion Users initiative for the company. Previously at Google, Mr Sengupta led product management for Chromebooks and core software client products including Google Toolbar and Google Desktop.

Mr Sengupta has more than 15 years of experience developing consumer and enterprise technology products. Before joining Google, he held engineering and research positions at Encentuate Inc. (acquired by IBM) and Hewlett Packard Labs. He holds 15 patents in Operating Systems Design and Expert Finding Systems.

Mr Sengupta has a Master's Degree in Computer Science with a distinction in research from Stanford University, where he was awarded the Christofer Stephenson Memorial Award for the best Master's research. Mr Sengupta also has an MBA from the Wharton School, University of Pennsylvania.

Mark LEE is the Chief Executive Officer of Sing Lun Holdings Limited, an apparel investment company that holds interests in apparel manufacturing, sourcing and supply chain management. He is responsible for the overall strategic planning and direction of the Group and has 17 years of experience in the apparel industry.

Mr Lee holds a Bachelor of Business (Marketing) degree and an Advanced Diploma in Market Research from Monash University in Australia. He began his career in the IT industry before joining Sing Lun, the family's apparel business. He worked to take the company on a successful IPO on the main board of the Singapore Stock Exchange in 2000 and thereafter went on to effectively more than quintupled the company's turnover from US$45 million in 1999 to US$235 million during his tenure through a series of organic growth, M&As and buyouts. The Group now consists of more than 6,000 workers in its total workforce, and have manufacturing and sourcing offices are located in Singapore, Malaysia, Vietnam, Cambodia, Sri Lanka, and China. Some of its customers include The North Face, Under Armour, Puma and Macy's Departmental Store.

In recognition for his entrepreneur spirit, Mr Lee was awarded Most Outstanding Entrepreneur during the Asia Pacific Entrepreneur

Awards 2010 in Singapore. He is also the winner of the prestigious EY Entrepreneur of the Year (Manufacturing) in 2015. He currently serves as President for Singapore Textile and Fashion Federation (Taff), and is Chairman of Textile and Fashion Federation Training Centre (TaF.tc) academic and examination board. Mr Lee is also one of 30 members of the Committee for Future Economy (CFE) set up by the Singapore government in 2016 to develop economic strategies to position Singapore well for the future. He also serves as Vice-Chairman of the innovation subcommittee within the SME Committee set up by Singapore Business Federation. Mr Lee is a Council Member at Singapore Human Resource Institute, an EXCO member of Entrepreneur's Organisation (Singapore Chapter) in 2013/14, and he is a member of Young President's Organisation (Singapore Chapter).

Mr Lee is a Director of Sing Lun Investments Pte Ltd, which is his family's private philanthropic and investments arm. Mr Lee also serves as Treasurer and as a Council Advisory Committee at Tampines Junior College in Singapore.

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Faizal bin YAHYA is a Senior Research Fellow at the Institute of Policy Studies. Prior to joining the Institute of Policy Studies he was an Assistant Professor in the South Asian Studies Programme, Faculty of Arts & Social Sciences, National University of Singapore. Concurrently, he was a Visiting Research Fellow at the Institute of Southeast Asian Studies from 2008 to 2009 (ISEAS). He has also served in the Ministry of the Environment and Water Resources (International Policy) and the Ministry of Foreign Affairs (MFA) as a Foreign Service Officer. Some of his research interests include human capital, social capital, multicultural and societal issues. He attained his PhD in Economics in 2000 from the University of Sydney, Australia and was an Australian Overseas Post graduate Research Scholar from 1994 to 1998.

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