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Abstract: The preparatory briefing on Singapore is the result of the collection of relevant cluster information in the country, including business and sector trends, cluster policies and programmes, as well as a cluster mapping. This document is intended to provide an overview of the country's opportunities for European cluster organisations and SMEs.

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1 Objective of the report

The aim of this preparatory briefing is to provide up to date information on the cluster landscape in Singapore in order to support European cluster organisations and their SME members explore the potential for collaboration and market opportunities. More specifically, this briefing paper provides an overview of the country's economy and sectoral trends/strengths where clusters contribute. In addition, it outlines the existing cluster community, the cluster policies, local support to clusters and the cluster programmes - including their historical development and internationalisation activity when appropriate.

A complementary discussion paper is available that provides an overview on the existing EU-Singapore cluster cooperation, presents related good practices/success stories and opportunities for future exchange, including recommendations for an EU-Singapore cluster policy dialogue (non-public information).

2 Singapore Economy: focus on sectoral trends

2.1 Overview

Since its independence in 1965, Singapore weathered many economic crises and is currently enjoying sustainable economic growth. The country has a highly developed and successful free-market economy due, in part, to a remarkably open and corruption-free environment, stable prices, very low unemployment rate, and a Gross Domestic Product (GDP) per capita higher than that of most developed countries¹. As an island nation with the competitive advantage of its location in the heart of Southeast Asia, Singapore has an excellent transportation system, a highly-educated workforce, and a high standard of living.

Fifty years ago, the city-state of Singapore was an undeveloped country with a GDP per capita less than €271^{2,3}. Today, it is one of the world's fastest-growing economies with a GDP per capita of €51,000⁴, which is the 6th highest in the world⁵. According to the World Bank, the GDP growth rate has been amongst the world's highest, at a relatively constant average of 7.7% since independence and reaching 9.2% in the first 25 years⁶.

The high GDP growth rate is positively influenced by a business-friendly environment. Singapore ranks second in both the World Bank's Doing Business 2018⁷ and the World Economic Forum's Global Competitiveness Report 2016-2017⁸. In addition, a Euromoney Country Risk survey released in March 2018 found that Singapore is ranked the least risky country in the world for investments across 15 dimensions relating to economic, political, and structural risk⁹. The survey explained Singapore's legal framework and public policies are generally favourable toward foreign investors, which are not required to enter into joint ventures or concede management control to local interests. Singapore places no restrictions on reinvestment or repatriation of earnings or capital. The judicial system, which includes international arbitration and mediation centres and a commercial court, upholds the sanctity of contracts, and decisions are transparent and effectively enforced.

The world's rapid industrialisation in the 1960s catapulted the nation's development trajectory with manufacturing becoming the main driver of Singapore's economic growth¹⁰. In the early 1970s, by consistently implementing its open and outward-oriented economic development strategy, Singapore

¹ "Singapore" [Online]. Available: www.forbes.com/places/singapore/ [2018, June]

² Oanda, 1 US \$ = 0.85 euro, 14th of June 2018

³ Ping, Z (2018). "Singapore's Economic Development" [Online]. Available: www.thoughtco.com/singapores-economic-development-1434565 [2018, June]

⁴ Oanda, 1 US \$ = 0.85 euro, 14th of June 2018

⁵ Ibid³

⁶ The World Bank in Singapore [Online]. Available: www.worldbank.org/en/country/singapore/overview [2018, June]

⁷ Doing Business 2018, Economy Profile Singapore, A World Bank Group Flagship Report

⁸ Schawb, K., *The Global Competitiveness Report 2016-2017* (Geneva: the World Economic Forum, 2016), Pg. 7.

⁹ The 2017 A.T. Kearney Foreign Direct Investment Confidence Index [Online]. Available: www.atkearney.com/documents/10192/12116059/2017+FDI+Confidence+Index+-+Glass+Half+Full.pdf/5dced533-c150-4984-acc9-da561b4d96b4 [2018, June]

¹⁰ Ibid⁶

reached full employment and joined the ranks of Hong Kong, South Korea and Taiwan as Asia's newly industrialised countries (known as the Four Asian Tigers) with the manufacturing and services sectors remaining the twin pillars of Singapore's high value-added economy¹¹. Currently, the main drivers of the Singapore economic growth are manufacturing, finance & insurance, and wholesale & retail trade¹². In 2016, Singapore was the 14th largest export economy in the world with a total of €31.5 billion in exports and €19.5 billion in imports, resulting in a positive trade balance of €12 billion¹³. According to the Economic Survey of Singapore in 2017, the main destinations of Singaporean exports were China (14.5%), Hong Kong (12.3%), Malaysia (10.6%), the EU (8.4%), and Indonesia (7.5%).

From a strict investment perspective, one of the nation's earliest strategies was creating the Economic Development Board (EDB)¹⁴ as a replacement for the Singapore Industrial Promotion Board. The aim of EDB is to make Singapore an attractive destination for Foreign Direct Investment (FDI)¹⁵. As a result, during the following decades the FDI inflows to Singapore increased rapidly. According to the 2017 UN World Investment Report, Singapore's FDI inflows stood at €54.2 billion¹⁶ in 2016. This inflow of FDI put Singapore among the top five host economies in Asia alongside China, Hong Kong, India and Vietnam¹⁷.

Of equal importance to Singapore's economic achievements is a set of National Science and Technology Plans and sound macroeconomic and fiscal policies. The first National Technology Plan (1991-1995) was established by the Agency for Science, Technology and Research (A*STAR), resulting in significant investment in R&D¹⁸. In fact, four more S&T Plans were implemented in subsequent years, leading Singapore's transformation into an innovation driven, knowledge-based economy. Due to its valuable work, Thomson Reuters has ranked A*STAR as one of the world's Top 25 Global Innovators (Government) at the 9th position¹⁹.

The fiscal policies have been directed primarily at promoting long-term economic growth, rather than cyclical changes or unsustainable income. As a result of its healthy fiscal position and consistent budget surpluses over the years, Singapore has attained a high level of foreign reserves and the strongest sovereign credit rating for long-term foreign-currency debt in Asia²⁰.

The corporate landscape in Singapore consists of business entities such as companies, partnerships, sole proprietorships, limited liability partnerships (LLP), limited partnerships (LP), and also the government-linked corporations (GLCs). Singapore's corporate governance system is built almost entirely on

¹¹ Winkler, J. (2017). The 4 Asian Tiger Economy Growth [Online]. Available: www.docurex.com/en/four-4-asian-tigers-economy-growth/ [2018, June]

¹² Economic Survey of Singapore 2017, Ministry of Trade and Industry, Republic of Singapore

¹³ Singapore Profile at The Observatory of Economic Complexity [Online]. Available: <https://atlas.media.mit.edu/en/profile/country/sgp/> [2018, June]

¹⁴ www.edb.gov.sg/

¹⁵ The Asian Tigers [Online]. Available: <http://developmentandglobalisation.weebly.com/the-asian-tigers.html> [2018, June]

¹⁶ Oanda, 1 US \$ = 0.83 euro, 31st December 2017

¹⁷ World Investment Report 2017, Investment and The Digital Economy, United Nations

¹⁸ RIE2020 Plan [Online]. Available: www.nrf.gov.sg/rie2020 [2018, June]

¹⁹ www.a-star.edu.sg/Portals/81/Data/News%20And%20Events/Editorial/GII%202016%20Chapter%2010.pdf

²⁰ The Singapore Economy [Online]. Available: www.sgs.gov.sg/The-SGS-Market/The-Singapore-Economy.aspx [2018, June]

companies owned by concentrated block-shareholders. In fact, over 90% of Singapore's publicly listed companies have block shareholders who exercise controlling power²¹.

With GLCs seen as an important engine in the development of the Singapore economy, the main method chosen by the government is to balance its control over GLCs. The Government appoints top civil servants to the boards of the GLCs. These civil servants serve a monitoring function only and normally do not interfere in the management of the company. The boards of GLCs are policy boards rather than functional (managerial) ones²². Thus, despite the dominant ownership and control of the government, GLCs are professionally-managed with limited interference from the government. This approach allows the GLCs remain innovative and competitive. In addition, in keeping with the goal of fostering good governance, the government also has a zero-tolerance approach to corruption. These practises significantly support Singapore's efforts to maintain its economic growth.

2.2 Opportunities for Europe – investment, trade and science, technology & innovation cooperation

As one of the largest global market players, the European Union (EU) sees Singapore as an important economic and trade partner. The EU and Singapore have a long history of excellence in various fields, from business to culture. According to EU External Action Services (EEAS), Singapore's relations with the EU go back decades with the legal basis of the 1980 EC-ASEAN (Association of South East Asian Nations) Cooperation Agreement²³. The EC-ASEAN Cooperation Agreement established a framework for commercial, economic and development cooperation between the European Economic Community and Indonesia, Malaysia, the Philippines, Singapore and Thailand²⁴. Based on this, both regions (EU and Singapore) established the new Partnership and Cooperation Agreement (PCA) in March 2010 that gave the EU-Singapore relations a new foundation, which is wider, up-to-date and more comprehensive²⁵. The PCA is a vehicle for developing broad-based and mutually-beneficial cooperation between the EU and Singapore as there are many cooperation opportunities to be exploited such as trade, non-proliferation, security, energy, maritime transport, air services, and science and technology.

Following the first PCA, in 2013 the EU-Singapore Free Trade Agreement (EUSFTA) was made as one of the first 'new generation' bilateral agreements between the regions²⁶. The data shows Singapore is by far the EU's largest ASEAN partner. With total bilateral trade in goods of €53.3 billion in 2017 and trade in services of €44.4 billion in 2016, Singapore accounted for just under one-third of EU-ASEAN trade in

²¹ Tan, C., Puchniak, D.W., et. al., "State-Owned Enterprises in Singapore: Historical Insights into a Potential Model for Reform," NUS Law Working Paper 2015/003, March 2015 www.law.nus.edu.sg/wps/0001.html

²² Ibid²¹

²³ EU and Singapore conclude negotiations on a Partnership and Cooperation Agreement [Online]. Available: https://eeas.europa.eu/headquarters/headquarters-homepage/10069/eu-and-singapore-conclude-negotiations-partnership-and-cooperation-agreement_en [2018, June]

²⁴ Summary of Treaty of the Cooperation Agreement between the European Economic Community and ASEAN [Online]. Available: <http://ec.europa.eu/world/agreements/SummartOfTreatyAction.do?step=0&treatyld=373> [2018, June]

²⁵ Ibid²³

²⁶ Singapore and the EU [Online]. Available: https://eeas.europa.eu/delegations/singapore_kk/2370/Singapore%20and%20the%20EU [2018, June]

goods and services²⁷. The trade balance between the EU and Singapore (top five categories) in 2016 can be seen in Table 1 - EU Imports of Goods From Singapore - Top Five Categories and Table 2 - EU Exports of Goods To Singapore - Top Five Categories.

TABLE 1 - EU IMPORTS OF GOODS FROM SINGAPORE - TOP FIVE CATEGORIES²⁸

Imports 2016	EU Import of Goods From Singapore	
Product	Value (Million €)	Percent of Total (%)
Chemicals and related products	7,678	39.50
Machinery and appliances	6,464	33.25
Miscellaneous manufactured articles	2,190	11.30
Mineral fuels, lubricants and related materials	1,117	5.70
Other	1,022	5.30

TABLE 2 - EU EXPORTS OF GOODS TO SINGAPORE - TOP FIVE CATEGORIES²⁹

Exports 2016	EU Exports of Goods To Singapore	
Product	Value (Million €)	Percent of Total (%)
Machinery and transport equipment	14,737	46.90
Chemicals and related products	4,356	13.90
Miscellaneous manufactured articles	3,865	12.30
Mineral fuels, lubricants and related materials	3,313	10.50
Manufactured goods classified chiefly by material	2,059	6.60

Singapore is in effect the EU's 5th most important partner for trade in services overall – ahead of Japan, Norway and Russia. From Singapore's perspective, the EU remains the most important partner for services trade, ahead of the United States, the ASEAN countries and Japan. The services sectors include: manufacturing services; maintenance and repair services; transport; travel; construction; insurance and pension services; financial services; charges for the use of intellectual property; telecommunications, computer, and information services; personal, cultural, and recreational services; government goods and services; and other business services³⁰.

As previously mentioned, the PCA was established to create mutual benefits for the EU and Singapore. The EUSFTA has helped the EU become Singapore's most important trade partner when considering goods and services together³¹. The agreement establishes the conditions for EU businesses to take full

²⁷ Ibid²⁶

²⁸ EU-Singapore Trade & Investment 2017 report, EEAS [Online]. Available: https://eeas.europa.eu/delegations/singapore_en/29066/EU-Singapore%20Trade%20&%20Investment%202017%20Booklet [2018, June]

²⁹ Ibid²⁸

³⁰ Ibid²⁸

³¹ Key Elements of the EU-Singapore Trade and Investment Agreements [Online]. Available: http://europa.eu/rapid/press-release_MEMO-18-3327_en.htm [2018, June]

advantage of the opportunities created in Singapore as the business and transport hub of Southeast Asia. The purpose of the agreement is to eliminate customs duties of both parties, facilitate regional and global value chains, remove technical and non-tariff barriers to trade in goods, facilitate trade through enhanced customs cooperation, open up services and investment markets in a comprehensive way, bring new tendering opportunities for EU bidders, protect intellectual property rights, include binding commitments on trade and sustainable development, and ensure a high level of investment protection³². It is expected that this Free Trade Agreement will attract more and increase both regions' trade and investment.

Not only has Singapore been an important trade partner and investment location for Europe for many years, but it has identified R&D as being at the crux of its long-term economic competitiveness too. In terms of science and technology cooperation, the EU and Singapore are working together in strategic areas to promote research and innovation cooperation. Singapore has set for itself similar objectives and adopted comparable approaches to research that make it a natural partner for cooperation with the EU.

In the areas of R&D, Singapore's involvement in projects organised by the European Commission (EC) started more than 10 years ago in 1994 with the 4th Framework Programme³³. Since then, there have been significant increases in the number of proposals involving Singapore-based organisations. The Framework Programme remains an excellent platform for Singapore to cooperate with the EU in S&T.

Under the 6th Framework Programme (FP6) and 7th Framework Programme (FP7) several successful projects were undertaken by European and Singaporean partners. Currently, Singaporean organisations and universities, including the National University of Singapore and Nanyang Technological University, are actively involved in a number of projects within the EU's Horizon 2020 programme³⁴. In addition, both regions maintain scientific, research and innovation cooperation, such as:

- **The EU Centre in Singapore** is a project funded by the EU, in partnership with the National University of Singapore and the Nanyang Technological University. The project was launched in 2008 with the aim to promote knowledge and understanding of the EU and its policies. Its outreach activities and publications help raise greater awareness about cooperation between Singapore and the EU, including on research and innovation cooperation opportunities.³⁵
- **EURAXESS ASEAN** is a network of researchers of all disciplines and at all career levels in ASEAN. It is part of the multidisciplinary EURAXESS network that unites thousands of researchers from 40 European countries as well as China, India, Japan, Latin America, Caribbean States, and North

³² Ibid³¹

³³ The European Union and Singapore: R&D Cooperation for the Future 2007, Directorate-General for Research, European Commission

³⁴ Please see annex 6.1 for listed projects funded under FP6, FP7 and H2020

³⁵ www.eucentre.sg

America in one global community. EURAXESS is dedicated to helping researchers mobilise in order to work together across borders.³⁶

In addition to the above activities, the key EU-Singapore projects in the S&T field resulting from both region partnerships are indicated in the Annex³⁷.

Despite the excellent economic performance, openness of investment in the country and strong level of collaboration, there are some challenges to be considered when entering the Singaporean market. Those considerations are primarily related to the increased business costs, mostly in rental, limited human resources and expensive overhead cost³⁸. In addition, the cost of living in Singapore is relatively higher than other Southeast Asian countries. Therefore, a company's capital and funds will be very high. Local workforces expect higher salaries and rental costs for offices and establishments are high. On top of that, advertising and promotional services are also considered high.

Nonetheless, the advantages of the bilateral cooperation and exploring more potential collaboration seem greater than the challenges for EU competitiveness.

2.3 Sectoral strengths

Singapore aims to become a hub for technology, innovation and enterprise in Asia and around the world. The Singaporean economy depends heavily on exports, particularly of electronics, petroleum products, chemicals, medical and optical devices, pharmaceuticals, and on Singapore's vibrant transportation, business, and financial services sectors³⁹. Singapore has attracted major investments in key sectors such as advanced manufacturing, pharmaceuticals, and medical technology production and will continue efforts to strengthen its position as Southeast Asia's leading financial and technology hub⁴⁰. According to the Ministry of Trade and Industry Republic of Singapore, Singapore economy is structured mainly by Goods Producing Industries (24.8%), Services Producing Industries (71.3%), and Ownership of Dwellings (3.9%). The overall economic structure of Singapore in 2017 can be seen in Table 3 - Singapore Overall Economy 2017.

TABLE 3 - SINGAPORE OVERALL ECONOMY 2017⁴¹

Structure of economy	Nominal Value Added Share (%)	Real Growth (%)
TOTAL	100.0	3.6
Goods Producing Industries	24.8	5.7
Manufacturing	19.2	10.1

³⁶ <https://euraxess.ec.europa.eu/worldwide/asean>

³⁷ The Annex contains information about relevant organisations, selected projects and clusters.

³⁸ Top 10 challenges of doing business in Singapore [Online]. Available: www.tmf-group.com/en/news-insights/business-culture/top-challenges-singapore/ [2018, June]

³⁹ Singapore Economy Overview, The World Factbook [Online]. Available: www.cia.gov/library/publications/the-world-factbook/fields/2116.html [2018, June]

⁴⁰ Ibid¹

⁴¹ Structure of Singapore Economy 2017, Ministry of Trade and Industry Republic of Singapore

Structure of economy	Nominal Value Added Share (%)	Real Growth (%)
TOTAL	100.0	3.6
Construction	4.3	-8.4
Utilities	1.3	0.0
Other Good Industries	0.0	-8.4
Services Producing Industries	71.3	2.8
Wholesale & Retail Trade	17.6	2.3
Transportation & Storage	7.2	4.8
Accommodation & Food Services	2.1	1.2
Information & Communications	4.2	3.3
Finance & Insurance	13.3	4.8
Business Services	14.8	0.6
Other Services Industries	12.0	2.6
Ownership of Dwellings	3.9	4.8

From the current economic structure, manufacturing and services are the twin engines of growth in the Singapore economy. For the whole of 2017, all sectors contributed positively to GDP growth, except for the construction sector (Table 3). Among the Services Producing Industries, the wholesale & retail trade sector registered the strongest share, followed by the business services, finance & insurance, and other services industries (i.e. Public Administration & Defence; Education, Health & Social Work; Arts, Entertainment & Recreation; and others segments). However, the strongest growths within the services producing industries are coming from transportation & storage and finance & insurance. The growth in the transportation & storage sector was primarily supported by the water transport and air transport segments⁴².

The manufacturing sector has always been a mainstay of Singapore's economic growth despite the absence of natural resources or an agricultural base⁴³. The current growth in manufacturing was primarily driven by the electronics (33.5%) and precision engineering (17.8%) with the largest share still in electronics (29.2%), followed by biomedical manufacturing (19.3%), and chemicals (19.1%)⁴⁴. The electronics sector in Singapore is also included as a key sector.

Singapore is also focusing on logistics sector, which is positioned to tap Asia's rising middle class and take advantage of the growth and new wave of e-commerce in the country and neighbouring countries (i.e. Malaysia, Indonesia)⁴⁵. Logistics is a critical enabler of Singapore's economy. In 2016 alone, the transportation and storage sector, which includes logistics, contributed about 8% to Singapore's GDP and about 7% of total employment⁴⁶. Thus, it is one of the priorities of Singapore under its Logistics

⁴² Economic Survey of Singapore 2017, Ministry of Trade and Industry Republic of Singapore

⁴³ Barbara Leitch Lepoer, ed. *Singapore: A Country Study*. Washington: GPO for the Library of Congress, 1989. [Online]. Available: <http://countrystudies.us/singapore/35.htm> [2018, June]

⁴⁴ Ibid⁴²

⁴⁵ E-Commerce Trends and Challenges: A Logistics and Supply Chain Perspective, TLI – Asia Pacific White Papers Series, 2016

⁴⁶ Report of the Committee on the Future Economy 2017 Singapore

Industry Transformation Map (ITM) strategy which supports companies to leverage technology and adopt best-in-class supply chain practices. In addition, the logistics industry skills framework is crucial for the nation and aims to support Singaporeans to upgrade their skills and take on jobs in this sector.

Furthermore, the Information and Communication Technology (ICT) sector is a key enabler for almost every industry sector and has enhanced Singapore's competitiveness by raising productivity and transforming business processes in industries like finance, services and manufacturing⁴⁷. Singapore is ready to embrace the digital economy, with the possibilities and benefits it will bring. The Information and Communication Media sector (ICM) Industry Transformation Map will be driving the national movement for digitalisation. The ICM Industry Transformation Map not only impacts the ICM sector. It is set to multiply growth across every sector, by leading the way in preparing Singapore for the Digital Economy⁴⁸.

Lastly, the government of Singapore also pays attention to the essential domestic services such as Healthcare and Education. Especially, in healthcare, the needs of Singaporeans have grown rapidly, due to the ageing population, higher chronic disease incidence and rising public expectations⁴⁹. On the other hand, Singapore's medical knowledge and technologies are also advancing, bringing about new possibilities to prevent, diagnose and treat diseases. The government agencies such as A*STAR, National Healthcare Group (NHG), SPRING Singapore and Biotech Connection have come together to organise the recent Open Innovation Challenge in Healthcare (or OICH), which aims to foster clinician-industry collaborations in innovation and shorten time-to-market of healthcare solutions⁵⁰. In addition, Singapore is a growing medical technology (medtech) manufacturing hub for global original equipment manufacturers (OEMs) and specialist medtech equipment R&D, designers and manufacturers. There are also more than 50 companies undertaking biomedical sciences R&D, including drug discovery, translational and clinical research, in collaboration with key research institutes in Singapore⁵¹.

Due to its synergies with the EC strategy for the near term and the EU industrial cluster community, the fields that seem to offer more potential for cluster cooperation between the EU and Singapore among the emerging industries listed above are:

- Electronics;
- Transportation & Storage (Logistics);
- Information & Communication; and
- Healthcare and medical technologies.

⁴⁷ ICT to Singapore Trends and Opportunities, Australian Trade and Investment Commission. [Online]. Available: www.austrade.gov.au/Australian/Export/Export-markets/Countries/Singapore/Industries [2018, June]

⁴⁸ www.imda.gov.sg/sgdigital/sgd-empowering-possibilities/infocomm-media-industry-transformation-map

⁴⁹ Speech By Mr Gan Kim Yong, Minister For Health, at the Futurehealth 2017 Conference, at The Lee Kong Chian School of Medicine on Wednesday, 8 November 2017, 10.40am

⁵⁰ Ibid⁴⁹

⁵¹ Health and medical to Singapore Trends and Opportunities, Australian Trade and Investment Commission. [Online]. Available: www.austrade.gov.au/Australian/Export/Export-markets/Countries/Singapore/Industries/Health-and-medical [2018, June]

2.3.1 Electronics

Electronics is one of the key industries for the economy of Singapore. Started in the 1960s, Singapore's electronics industry consisted mainly of labour-intensive system-assembly of consumer products such as television sets and transistor radios. Over the years, the sector has evolved in tandem with advances in technology and the needs of the market. Today, the sector comprises a portfolio of high-value components, such as Radio Frequency (RF) filters and semiconductor integrated circuits, which are the core components of many products that are indispensable in daily life. Singapore's electronics industry is an integral part of the global supply chain for many products such as mobile devices and cars to automation equipment. In 2016, electronics manufacturing contributed 4.4% to Singapore's GDP and employed about 70,000 workers⁵².

The growth in electronics was driven largely by the semiconductor segment, which made up about 70% of electronics manufacturing output⁵³. Trends such as smart cars and Internet of Things drive demand for semiconductors. The emergence of new application areas such as autonomous vehicles (AVs), artificial intelligence (AI) and healthcare, which are enabled by electronics, has brought about new growth opportunities for the industry. These new applications are expected to drive greater diversity of demand for electronics and advancements in hardware. To tap into these opportunities, the companies are embracing open innovation as a means to co-innovate and co-develop system solutions.

International electronics companies and leaders of the electronics industry are also designing the future in Singapore. Their research institutes work with pioneers such as NVIDIA, Infineon, and Micron to push the boundaries of AI, AVs and Industry 4.0. Singapore's electronics manufacturing sector is getting a leg-up, with the aim of continuous growth.

In 2017, Singapore launched the Electronics ITM, which lays the framework to grow the electronics industry. Through the ITM, Singapore expects to grow the electronics sector to have a manufacturing value-add of €18.6 billion⁵⁴ and introduce about 2,000 new professionals, managers, executives and technicians jobs by 2020⁵⁵. Those objectives are expected to be achieved by setting up a two-pronged strategy to grow the industry. Firstly, Singapore will diversify into new growth opportunities in the electronics sector. Secondly, it will transform the current base of electronics manufacturing and attract new investments in high-value components. The emerging global trends such as rapid urbanisation, energy conservation, and ageing populations pose new problems for the Singapore market, which in turn allows for new opportunities for the electronics industry in Singapore. There are four new growth areas that have been identified; they are namely green electronics, bio-electronics, plastic electronics

⁵² Speech by Mr S. Iswaran, Minister for Trade & Industry (Industry), tt Opening of JTC Nanospace and Launch of The Electronics Industry Transformation Map on 20 September 2017, 9:00am, at 11 Tampines Industrial Crescent

⁵³ Chia Yan Min. *Positive charge for Singapore's electronics industry*. [Online]. Available:

www.straitstimes.com/business/economy/positive-charge-for-electronics-industry [2018, June]

⁵⁴ Oanda, 1 US \$ = 0.84 euro, 31st of August 2017

⁵⁵ Ibid⁵²

and security. By 2020, the contribution to electronics output from these new growth areas is expected to triple to 30% of the electronics output⁵⁶.

According to the Economic Development Board (EDB) of Singapore⁵⁷, Singapore will compete in the global electronics market through the following attributes:

- Singapore has one of the most diverse semiconductor industries in the Asia Pacific. Some of the world's biggest pure-play foundries have manufacturing facilities in Singapore, as do many other top outsourced semiconductor assembly and test companies. Beyond semiconductors, Singapore is also a key node in the global supply chain for products ranging from storage and memory products to microelectromechanical systems (MEMS). These manufacturers are supported by a rich ecosystem of leading materials & equipment and electronics manufacturing services players. Looking ahead, the Electronics ITM aims to grow the sector by transforming the current installed base of companies through productivity, automation, and upgrading the manufacturing product mix.
- Singapore trains over 13,000 engineers and technicians annually, ensuring a steady stream of talent to the industry. EDB partners companies through various platforms such as the Singapore Industry Scholarships (SgIS), Industry Postgraduate Programme (IPP), and the EDB-NVIDIA Future Talents Program to groom the next generation of foundry engineers, IC designers, and AI talent.
- A focus on electronics forms the backbone of AI, enabling devices to see, think, and talk to each other. With Singapore's Smart Nation 2020 vision, the country is committed to partner companies worldwide to design, develop and test-bed new solutions like intelligent homes, AVs, and "lights out", fully automated factories. The Smart City of the future is being created in Singapore, with NXP empowering the next generation of connected cars and Intel's solutions for the smart home. Companies also pick Singapore as their partner to pioneer advanced manufacturing technologies, with industry leaders Micron and HP Inc setting up their lead site for manufacturing analytics and 3D printing in the country.

2.3.2 Transportation & Storage (Logistics)

Today the small city-state is home to the world's largest transshipment container port, linked to over 600 ports worldwide⁵⁸. Singapore Changi airport is also voted the best international airport, and is served by about 6,800 weekly flights to 330 cities⁵⁹. According to 2016 World Bank's Logistic Performance Index (LPI), Singapore is considered as one of the world's most important logistic hubs and ranked 1st in Asia

⁵⁶ Leading Sectors for U.S. Exports in Singapore, Export.gov [Online]. Available: <https://2016.export.gov/singapore/doingbusinessinsingapore/leadingindustrysectors/index.asp> [2018, June]

⁵⁷ Electronics: Plugged into the Future, Economic Development Board Singapore [Online]. Available: www.edb.gov.sg/en/our-industries/electronics.html [2018, June]

⁵⁸ Lam, Yin Yin, et. al. *Three factors that have made Singapore a global logistics hub*. World Bank Group. 2017. [Online]. Available: <http://blogs.worldbank.org/transport/three-factors-have-made-singapore-global-logistics-hub> [2018, June]

⁵⁹ Singapore Changi Airport named as the World's Best Airport 2016. [Online]. Available: www.airlinequality.com/news/airport_awards_2016/ [2018, June]

(since 2007) and 5th in the world⁶⁰. The highly strategic geographical position also increases the importance of Singapore in the transportation and storage sector. One-seventh of the world's container transshipment throughput is handled by Singapore⁶¹. Singapore is also a chosen base in Asia for the Centres of Excellence and Innovation for leading logistics players such as SingPost, SATS, DB Schenker, Kuehne+Nagel, DHL, UPS, and Yamato⁶².

Comprising over 5,000 firms covering contract logistics, freight forwarding and trucking, the Logistics industry is part of the Transport & Storage sector that employed over 230,000 workers and contributed 7.4% of Singapore's GDP in 2015⁶³. According to the Department of Statistics of Singapore, more than 12,000 establishments in Singapore are working in the transport and storage services industry in 2016. From this figure, around 43.5% (5,400) companies are operating in land transport and 26.6% (3,300) are operating in water transport. The industry generated €16.9 million⁶⁴ value added with almost half of it generated by water transport.⁶⁵

In 2016, the country launched the Logistics Industry Transformation Map (ITM). The ITM sets out the plan to transform Singapore's logistics industry to capture the growth opportunities, while dealing with the challenges that the industry will face such as limited land for new facilities, slowing local employment growth, and increased competition from the region. This plan is the collaborative effort of the Economic Development Board (EDB), International Enterprise Singapore (IE Singapore), JTC Corporation (JTC), SPRING Singapore and Workforce Singapore (WSG), in partnership with industry players, unions, and trade associations.

The Logistics ITM has identified strategies to catalyse enterprise level efforts to transform and grow the industry through productivity and innovation. Strategies will also focus on developing strong local talent and enterprises, strengthening trade associations to be change agents and improving Singapore's overall logistics landscape. The overview of the Logistics ITM strategies can be seen in Figure 1 and further explanation on the Logistics ITM policies and programmes will be discussed in Section 4.

⁶⁰ Arvis, Jean-François, et.al. *Connecting to Compete, Trade Logistics in the Global Economy*. World Bank. 2016. [Online]. Available: https://wb-lpi-media.s3.amazonaws.com/LPI_Report_2016.pdf

⁶¹ Logistics and Supply Chain Management: Best in Class, Economic Development Board Singapore [Online]. Available: www.edb.gov.sg/en/our-industries/logistics-and-supply-chain-management.html [2018, June]

⁶² Speech by Mr S. Iswaran, Minister for Trade & Industry (Industry), at The Ground-Breaking Ceremony of JTC Logistics Hub @ Gul and Launch of The Logistics Industry Transformation Map on 16 November 2016, 10:00am, at 3 Gul Circle

⁶³ Ibid⁵²

⁶⁴ Oanda, 1 S \$ = 0.65 euro, 31st of December 2016

⁶⁵ Singapore Transport and Storage Services Industry, 2016. [Online]. Available: www.singstat.gov.sg/modules/infographics/-/media/6189DAF672734CDE9ACE651A23D095B8.ashx [2018, June]

Focus 1: Enabling enterprises through innovation, productivity and talent

- Directly supporting companies to tap on suitable process methodologies and technologies
- Implementation assistance will also be made available to enterprises that adopt impactful productive technologies that are new to Singapore or the industry
- For SMEs, the Government will invest in next generation facilities with high specifications units that encourage co-location of companies
- Bolster the logistics innovation eco-system by helping companies to build differentiating capabilities through the establishment of Centres of Innovation and Centres of Excellence in Singapore
- Help mid-careerists from other sectors transit smoothly into the industry Through the Adapt and Grow initiative which includes the Logistics Professional Conversion Programmes by Workforce Singapore
- Singapore will also support the current logistics workforce to acquire niche and emerging skills aligned to Logistics ITM through the Industry Catalyst Programme

Focus 2: Transforming the industry for long-term growth

- Support the adoption of technology and the deepening of specialisation into sectors such as food and healthcare through the development of specialised logistics handling capabilities.
- Involve the Trade Associations and Chambers (TACs) to amplify the impact through projects that will optimise resource utilisation across industry players
- Improve Singapore domestic logistics system to deliver resource optimisation for enterprises and the public

FIGURE 1 - SINGAPORE'S LOGISTICS ITM STRATEGIES⁶⁶

With the rise of digitally enabled logistics services and the emergence of new delivery capabilities, including autonomous vehicles and 3D printing, the sector is also experiencing significant transformation. In November 2017, the Infocomm Media Development Authority (IMDA) of Singapore revealed its approach to helping the Logistics sector digitalise through the Logistics Industry Digital Plan (IDP) for SMEs and through Innovation Initiatives⁶⁷. Holistically, this will help SMEs level up as well as push ecosystem-wide innovations for the sector, driving competitive advantage in a Digital Economy. The guide targets local SME logistics companies operating in the areas of freight forwarding, warehousing and storage and/or land transportation in Singapore. It aims to provide them a guide to digital solutions that are specific to enhancing logistics operations and businesses and step-by-step advice on the digital solutions required at each stage of their business growth in the Digital Economy.⁶⁸

Another effort taken to improve the Logistics sector's performance in Singapore is by broadening its external market connection. Due to its relatively small local market, the Singapore government has taken a proactive expansion policy to increase its market. For instance, the Civil Aviation Authority of Singapore has concluded Air Service Agreements with 140 countries in order to increase its flight

⁶⁶ Adapted from: Logistics Industry Transformation Map to Strengthen Singapore's Position as a Globally Leading Logistics Hub. EDB Singapore Press Release 2017. [Online]. Available: www.mti.gov.sg/MTIInsights/SiteAssets/Pages/ITM-TransportandLogistics/Logistics.pdf [2018, June]

⁶⁷ ICM Innovations Help Logistics Sector Push New Boundaries and Synergise Across Ecosystem. IMDA Press Release 2017. [Online]. Available: www.mti.gov.sg/MTIInsights/SiteAssets/Pages/ITM/Images/ICT%20Media%20ITM%20-%20Media%20Release%20-%20Logistics%20Industry%20Digital%20Plan.pdf [2018, June]

⁶⁸ Logistics Industry Digital Guide for SMEs. IMDA Singapore 2017. [Online]. Available: www.imda.gov.sg/-/media/imda/files/industry-development/small-and-medium-enterprises/smes-go-digital/logistics-industry-digital-guide-for-smes.pdf?la=en [2018, July]

connections⁶⁹. Singapore is also part of the Multilateral Agreement for the Liberalisation of Air Transport signed between Brunei Darussalam, Chile, New Zealand, Singapore and the United States of America that grants open skies arrangements between the signatories⁷⁰. There is also a multilateral agreement signed with the ASEAN Member States to liberalise air services including transport and logistic. These proactive approaches attract companies to Singapore, which positively impacts the Logistics sector.

2.3.3 Information & Communication Technology (ICT)

In Singapore, the Information and Communication Technology (ICT) sector is a key enabler for almost every industry sector and has enhanced Singapore's competitiveness by raising productivity and transforming business processes in industries like finance, services and manufacturing. ICT is one of the strongest economic sectors in Singapore. As of 2016, it generated €115 million⁷¹ in revenues and employing more than 180,000 people⁷². Since 2015, Singapore is leading the world in terms of generating economic impact investments in ICT⁷³.

Dubbed as an information and technology hub in the Asia Pacific, Singapore is a regional base for most of the world's top ICT multinationals including Microsoft, Oracle, Amazon Web Services, Google, as well as international technology start-up companies. Singapore has an open business environment encouraging competition. Therefore, foreign ICT companies and talent can build on and complement Singaporean ICT businesses. Singapore is also a global data management hub connected to 15 active submarine communication cable systems, with a total submarine cable capacity of 114 Tbps and more than 50% of the commercial carrier and carrier neutral data centre space in Southeast Asia⁷⁴.

Singapore is ranked first in the Network Readiness Index (NRI), which measures the performance of 139 economies in leveraging information and communications technologies to boost competitiveness, innovation and well-being⁷⁵. Its outstanding performance is underlined by the fact that it ranks 1st in the world in three of the four sub-indexes (i.e. Environment, Usage, and Impact). Overall, Singapore achieved this rank to a large extent as a result of a strong government commitment to the digital agenda. It is also supported by some of the fastest broadband services available and smart digital services that enable seamless transactions.

This achievement is supported by the high-quality skillset, effective policy-making bodies, as well as high-quality ICT infrastructure. The most important government agencies in Singapore with respect to ICT policy are the Ministry of Communications and Information (MCI), the Info-communications Media

⁶⁹ Liberal Aviation Policy, Ministry of Transport Singapore. [Online]. Available: www.mot.gov.sg/about-mot/air-transport/aviation-hub/liberal-aviation-policy [2018, July]

⁷⁰ Air Services Policy: Adopting A Progressive Approach, Civil Aviation Authority of Singapore (CAAS). [Online]. Available: www.caas.gov.sg/about-caas/areas-of-responsibility/growing-singapore-as-a-global-air-hub/air-services-policy [2018, July]

⁷¹ Oanda, 1 S \$ = 0.65 euro, 31st of December 2016

⁷² SingStat Table Builder, Department of Statistic Singapore. [Online]. Available: www.tablebuilder.singstat.gov.sg/publicfacing/loadCurrentTable.action [2018, July]

⁷³ Baller, S., et.al. *The Global Information Technology Report 2016, Innovating in the Digital Economy*. World Economic Forum. [Online]. Available: www3.weforum.org/docs/GITR2016/GITR_2016_full%20report_final.pdf [2018, July]

⁷⁴ ICT to Singapore, Trends & Opportunities, Australian Trade and Investment Commission. [Online]. Available: www.austrade.gov.au/Australian/Export/Export-markets/Countries/Singapore/Industries [2018, July]

⁷⁵ Baller, S., et.al. *The Global Information Technology Report 2016, Innovating in the Digital Economy*. World Economic Forum. [Online]. Available: www3.weforum.org/docs/GITR2016/GITR_2016_full%20report_final.pdf [2018, July]

Development Authority (IMDA), and Government Technology Agency (GovTech). MCI is responsible for the policy and operational action in the ICT industry; while the ICT sector in Singapore is regulated by IMDA. A separate agency, the GovTech handles issues related to government digital services and applied technology, and acts as the implementing agency for the Smart Nation and Digital Government Group (SNDGG) initiative.

The Singaporean government also has a number of initiatives and programmes that help to strengthen its expertise in ICT. Within the ITM strategy, the Singapore government launched the ICM ITM in 2017. The ICM ITM details the government's plans to transform the Information, Communication and Media (ICM) sector. Another initiative is the Smart Nation Singapore that aims to harness ICT, networks and big data to create tech-enabled solutions⁷⁶. Launched in November 2014, Smart Nation Singapore encourages ICT start-ups to harness big data and IoT to come up with innovative ICT solutions. Smart Nation Singapore is coordinated by the Smart Nation and Digital Government Office in the Prime Minister's Office and supported by various government agencies. There are also policies in place to facilitate innovation and nurture a culture of experimentation, innovation, risk-taking, and eventual adoption of new ideas. There are already 16 applications developed within this initiative and divided into four main themes: health, living, mobility and services. To further support the growth of this initiative, in 2017, the Singapore government announced €1.48 billion⁷⁷ funds to invest in technologies such as data analytics, sensors and related software and systems⁷⁸.

There are significant opportunities that can be leveraged in Singapore's ICT sector, particularly those related to developing applications and contributing to building the Smart Nation Singapore infrastructure. Four key frontier tech capabilities of focus are: Cybersecurity; Internet-of-Things (IoT); Immersive Media; and Artificial Intelligence (AI) & Data Science. There are also opportunities in the education/training sector related to ICT, since this sector is one of the key priorities of the nation to address an ICT labour workforce need.

2.3.4 Healthcare and Medical Technologies

Singapore's healthcare system is established and recognised internationally, with care options within the public and private sector. According to the World Health Organization (WHO), Singapore's healthcare system ranks 6th globally and offers the 4th best healthcare infrastructure in the world in 2015⁷⁹. It is also ranked 2nd by Bloomberg Healthcare Efficiency Index 2016⁸⁰. It serves as the healthcare and medical hub of the region and is arguably Asia's best healthcare system. Singapore has achieved extraordinary results both in the high quality of its healthcare system and in controlling the cost of care, in per capita terms and as a percentage of Gross Domestic Product (GDP). Its healthcare expenditures

⁷⁶ Why Smart Nation. Smart Nation and Digital Government Office. [Online]. Available: www.smartnation.sg/about/Smart-Nation [2018, July]

⁷⁷ Oanda, S\$1= €0.62, 31st of December 2017

⁷⁸ www.tech.gov.sg/Media-Room/Media-Releases/2017/05/Government-to-Partner-Industry-to-Spark-Innovation-and-Build-Capabilities-in-a-Smart-Nation

⁷⁹ Singapore: Healthcare Overview. US Commercial Services. 2015. [Online]. Available: http://files.export.gov/x_5985.pdf [2018, July]

⁸⁰ Bajpai, P. (20018). Singapore – A Strong & Growing Healthcare Industry. [Online]. Available: www.biospectrumasia.com/analysis/25/10531/singapore-a-strong-growing-healthcare-industry.html [2018, July]

are the lowest of all the high-income countries in the world⁸¹. Singapore achieved this by implementing the right strategies from a governmental perspective that provide various approaches to domestic issues especially in healthcare.

There is a dual system of healthcare delivery in Singapore. Both public and private providers of healthcare are regulated by the Ministry of Health (MOH)⁸² and its statutory boards. The international healthcare accreditation body, Joint Commission International (JCI)⁸³ has accredited 11 hospitals and three medical centres in Singapore⁸⁴. Singapore's healthcare system is designed on an integrated care model platform which provides holistic and integrated care. An overview of Singapore's public hospitals and national specialty centres are provided by Figure 2. Seven new hospitals and 12 to 14 additional polyclinics have been announced to be added to be public healthcare system by 2030⁸⁵. Singapore is also home to a thriving private medical practice that provides more options to residents and attracts medical tourists. The private healthcare sector is expected to ramp up to meet demands as well, giving rise to potential for medical devices and technologies for new hospitals and upgrades of existing facilities.

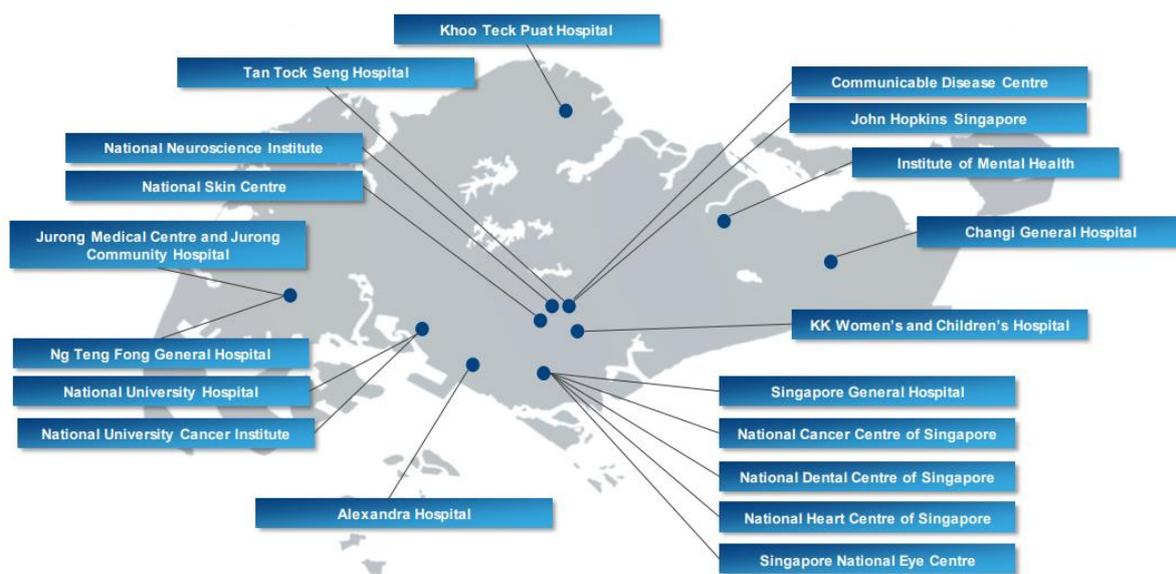


FIGURE 2 - HOSPITALS AND NATIONAL SPECIALTY CENTRES WITHIN THE PUBLIC HEALTHCARE SYSTEM⁸⁶

⁸¹ The Singapore Healthcare System: An Overview. [Online]. Available: www.brookings.edu/wp-content/uploads/2016/07/affordableexcellence_chapter.pdf [2018, July]

⁸² www.moh.gov.sg/

⁸³ www.jointcommissioninternational.org/

⁸⁴ Health and medical to Singapore, Trends and opportunities. Australian Trade and Investment Commission. [Online]. Available: www.austrade.gov.au/Australian/Export/Export-markets/Countries/Singapore/Industries/Health-and-medical [2018, July]

⁸⁵ Ibid⁸⁴

⁸⁶ Opportunities Within the Healthcare Sector in Singapore (2015) Business Sweden Singapore. [Online]. Available: www.business-sweden.se/contentassets/4e16e1cdc4d242c49d3ae90abe4c5ec3/business-sweden-singapore_report-on-opportunities-within-healthcare.pdf [2018, July]

With the global trend of an ageing population, increasing disease burdens and rising healthcare expenditure, healthcare and biomedical players in Singapore are in a good position to grow and capture the new opportunities that may arise. Demand for state of the art medical technologies is also expected to grow as Singapore strengthens its reputation as the region's healthcare hub and centre for healthcare excellence offering first class healthcare delivery systems and facilities to both its resident population and the international patient market. Singapore serves as a showcase for healthcare delivery and medical technology, while also providing an important gateway to the regional ASEAN (Southeast Asia) economies. The three key healthcare strategies Singapore is pursuing are clinical research, improving long-term care and moving towards more sophisticated care.

Singapore has also established itself as a leading country in biomedical sciences manufacturing and R&D activities⁸⁷. In addition, it also provides numerous opportunities for private enterprise to partner with its public-sector research institutes, clinical-research units in hospitals as well as international research organisations. There are more than 50 companies undertaking biomedical sciences R&D, including drug discovery, translational and clinical research, in collaboration with key research institutes in Singapore. Particularly for biomedical manufacturing, Singapore is a trusted and competitive manufacturing site for many biomedical companies. Singapore's deep base of skilled talent, strong manufacturing capabilities and thriving research ecosystem have drawn companies to set up their manufacturing operations in Singapore including some of the top pharmaceutical, biology and medical technology companies in the world such as GlaxoSmithKline, Novartis, Merck, Amgen, Medtronic, Becton Dickinson, Alcon and Life Technologies⁸⁸. To date, Singapore is home to the seven leading biopharmaceutical companies and 25 medical technology companies⁸⁹.

In addition, healthcare and biomedical are one of the four domains that is being funded under Singapore's Research Innovation Enterprise 2020 (RIE2020) plan⁹⁰. In order to gain international competitiveness, Singapore relies on building solid private-public partnerships such as the ones between major national research institutes and biomedical giants, as well as in promoting an increasingly vibrant pool of local companies with innovative products in medical technology, biopharmaceuticals and complementary health products that include supplements and traditional medicine.

The government remains committed to maintaining the high standards of the healthcare system, as shown by increasing healthcare spending to S\$ 12 billion (€ 7.5 billion⁹¹) a year by 2020, which is three times the amount spent in 2011⁹². The government has also categorised healthcare as one of the main

⁸⁷ Bajpai, P. (20018). Singapore – A Strong & Growing Healthcare Industry. [Online]. Available:

www.biospectrumasia.com/analysis/25/10531/singapore-a-strong-growing-healthcare-industry.html [2018, July]

⁸⁸ Pharmaceuticals & Biotechnology, EDB Singapore. [Online]. Available: www.edb.gov.sg/en/our-industries/pharmaceuticals-and-biotechnology.html [2018, July]

⁸⁹ Pharmaceuticals & Biologics Industry, Agency for Science, Technology and Research Singapore. [Online]. Available: www.a-star.edu.sg/Collaborate/Industry-Sectors/Pharmaceuticals-Biologics [2018, July]

⁹⁰ Getting the Formula Right to Boost Singapore's Health and Biomedical Sector, Agency for Science, Technology and Research Singapore. [Online]. Available: www.a-star.edu.sg/News-and-Events/A-STAR-INNOVATE/Index/Getting-the-formula-right-to-boost-Singapores-health-and-biomedical-sector [2018, July]

⁹¹ Oanda, S\$1= €0.62, 20th of July 2018

⁹² Ibid⁸⁴

sectors under the ITM. In 2012, the government launched the Healthcare 2020 Masterplan as an essential measure to enhance the accessibility, affordability, and quality of healthcare to better meet the needs of Singaporeans⁹³. One strategy being adopted to better integrate care across different settings is re-organising the healthcare system into Regional Health Systems (RHS)⁹⁴. Each RHS will comprise an acute general hospital working closely with community hospitals, nursing homes, home care and day rehab providers, as well as polyclinics and private General Practitioners (GPs) within the geographical region. The government is also giving emphasis on providing more affordable primary and long-term care for Singaporeans, changing the insurance scheme, subsidising more drugs, and enhancing job satisfaction in the sector.

From the EU-Singapore trade perspective, according to the EU-Singapore Free Trade Agreement (EUSFTA), the pharmaceuticals and medical devices is included as a key sector that constitutes non-tariff barriers to EU-Singapore trade. The EU and Singapore agree to use international standards, practices and guidelines for pharmaceutical products and medical devices, particularly those developed by international standard-setting bodies. The agreement encourages transparent and non-discriminatory procedures for listing, pricing and reimbursement of pharmaceuticals. This is important for both partners.

While Singapore is heavily dependent on imported health and medical products, there are opportunities for: advanced and cost-effective medical devices and equipment; disposables; generic drugs for expiring patented drugs (asthma and high cholesterol); and home care products. In addition, as this is an advanced market, health and medical products with international accreditation are highly sought after. There are also opportunities for biomedical science organisations to consider foreign direct investment into Singapore, especially in the area of: pharmaceutical manufacturing, drug discovery, clinical trials, and biotechnology research. In the medical technologies segment, European medtech businesses can position themselves to tap into the growth of the Singapore fast-growing medtech R&D and design and manufacturing sector.

⁹³ Estopace, E. (2012). *Singapore's Healthcare 2020 Masterplan explained*. eGov Innovation Singapore. [Online]. Available: www.enterpriseinnovation.net/article/singapores-healthcare-2020-masterplan-explained [2018, July]

⁹⁴ Health Scope Newsletter Issue 1 (2012). *Healthcare 2020: Improving Accessibility, Quality & Affordability*. Ministry of Health Singapore. [Online]. Available: www.moh.gov.sg/content/dam/moh_web/healthscope/archive/2012/MOH%20Healthscope_July-August%202012%20Issue.pdf [2018, July]

3 Cluster community in Singapore

3.1 Cluster mapping

Singapore has restructured the economy repeatedly, adapting to evolving global as well as domestic circumstances, to maintain and strengthen its global position over the years. The Committee on the Future Economy (CFE) is an example of the government's efforts in this regard. The CFE was created in January 2016 to develop economic strategies for the next decade⁹⁵, replacing the Economic Strategies Committee (ESC) that had this responsibility for the period of 2010-2016⁹⁶.

In regard to economic development, the CFE studied global trends and re-examined Singapore's operating assumptions and model to chart out the next phase of its economic transformation. The next phase of Singapore's economic transformation involves strengthening linkages between complementary industries by grouping them into clusters. All sector-specific roadmaps for key industries have been published in the Singapore's ITM, which was launched as part of a S\$4.5 billion (€2.9 billion⁹⁷) industry transformation package in Budget 2016⁹⁸.

The primary 23 sectors were grouped by the government into six clusters to maximise opportunities for collaboration⁹⁹. The six clusters are each led by a minister and at least one private sector or union representative and overseen by the Future Economy Council (FEC). The FEC is chaired by the Minister of Finance and comprised of members from government, industry, unions, and educational and training institutions¹⁰⁰. A separate council, the Council for Skills, Innovation and Productivity (CSIP) is overall responsibility for the implementation of the ITMs. To do so, the CSIP has established six subcommittees. Each cluster subcommittee is responsible for one of the six clusters: Manufacturing, Built Environment, Trade & Connectivity, Essential Domestic Services, Modern Services, and Lifestyle. Each of the subcommittees oversee a group of ITMs within the same broad cluster of industries. An overview of the six clusters and their lead agency is provided by Table 4 - List of ITM Clusters and Industries.

⁹⁵ Report of the Committee on the Future Economy Singapore 2017

⁹⁶ Economic Strategies Committee (ESC) Recommendations [Online]. Available: www.mof.gov.sg/Resources/Economic-Strategies-Committee-ESC-Recommendations [2018, July]

⁹⁷ Oanda, S\$1= €0,64, 31st of December 2016

⁹⁸ Industry Transformation Maps (ITMs), Ministry of Trade and Industry [Online]. Available: www.mti.gov.sg/MTIInsights/Pages/ITM.aspx [2018, July]

⁹⁹ Min, C. Y. 2018. *Singapore's 23 key industries to be grouped into 6 clusters as economy begins next phase of transformation: Heng Swee Keat*. The Straits Times Singapore [Online]. Available: www.straitstimes.com/business/economy/singapores-23-key-industries-to-be-grouped-into-6-clusters-as-economy-begins-next [2018, July]

¹⁰⁰ About Future Economy Singapore [Online]. Available: www.gov.sg/microsites/future-economy/about-us/about-the-future-economy-council [2018, July]

TABLE 4 - LIST OF ITM CLUSTERS AND INDUSTRIES¹⁰¹

Cluster	Sector	Lead Agency
Manufacturing	Energy & Chemicals	The Singapore Economic Development Board (EDB) - www.edb.gov.sg
	Precision Engineering	
	Marine & Offshore	
	Aerospace	
	Electronics	
Built Environment	Construction (incl. Archi & Engineering services)	Building and Construction Authority (BCA) - www.bca.gov.sg
	Real Estate	Council for Estate Agencies (CEA) - www.cea.gov.sg
	Cleaning	National Environment Agency (NEA) - www.nea.gov.sg
	Security	Ministry of Home Affairs (MHA) - www.mha.gov.sg
Trade & Connectivity	Logistics	EDB - www.edb.gov.sg
	Air Transport	Civil Aviation Authority of Singapore (CAAS) - www.caas.gov.sg
	Sea Transport	Maritime and Port Authority of Singapore (MPA) - www.mpa.gov.sg
	Land Transport (incl. Public Transport)	Land Transport Authority (LTA) - www.lta.gov.sg
	Wholesale Trade	Enterprise Singapore (ES) - www.enterprisesg.gov.sg
Essential Domestic Services	Healthcare	Ministry of Health Singapore (MOH) - www.moh.gov.sg
	Education (Early Childhood and Private Education)	Ministry of Education (MOE) - www.moe.gov.sg
Professional Services	Professional Services	EDB - www.edb.gov.sg
	ICT and Media	Ministry of Communications and Information (MCI) - www.mci.gov.sg
	Financial Services	Monetary Authority of Singapore (MAS) - www.mas.gov.sg
Lifestyle	Food Services	Enterprise Singapore (ES) - www.enterprisesg.gov.sg
	Retail	
	Food Manufacturing	
	Hotels	Singapore Tourism Board (STB) - www.stb.gov.sg

¹⁰¹ Integrated Roadmaps to Drive Industry Transformation, Media Factsheet – Industry Transformation Maps, Ministry of Trade and Industry Singapore

3.2 Clusters in Electronics, Transportation & Storage (Logistics), Information & Communications, and Healthcare & Medical Technologies

There are excellent examples of clusters, which are represented by industry groups and associations, within the sectors highlighted earlier by this briefing: Electronics, Transportation & Storage (Logistics), ICT, and Healthcare & Medical Technologies. The following is a sample of the cluster representative organisations categorised by the sectors they represent.

3.2.1 Electronics clusters

Electrical, Electronics & Allied industries Industry Group

Singapore Manufacturing Federation (SMF)¹⁰² is the largest national organisation representing the interests of manufacturing and manufacturing-related industries since 1932. SMF is a forefront trade federation serving the manufacturing community by driving digitalisation, innovation-led productivity, business transformation and internationalisation towards enhancing the competitiveness of its member companies. SMF has more than 3,000 member companies comprising local SMEs and leading multinational companies¹⁰³. Member companies are categorised into 10 Industry Groups and supported by Centres of Excellence to address each industry's unique and specific needs and interests.

SMF collaborates with local and overseas government agencies, industry partners and enterprises to provide key services such as: representing members' views in formal dialogues with the authorities; increasing business opportunities through local and international trade fairs and missions; building capabilities through conferences, seminars, workshops and other industry-specific programmes; and transforming businesses with business model innovation.

The Association of Electronic Industries in Singapore

The Association of Electronic Industries in Singapore (AEIS)¹⁰⁴ is a non-profit organisation and the only industry association representing the electronics business in Singapore. AEIS represents all facets of the electronics and support services industries. It covers manufacturers of industries electronics, electronic components and consumer electronics products as well as industrial companies associated with the electronics industry.

Since its inception in November 1973, AEIS has played a vital role in promoting the industries not only within Singapore but also in the international business community. This is achieved through its ongoing trade development efforts to help Singapore companies better penetrate and favourably position themselves in the overseas markets. The association is operated by an Executive Council Members¹⁰⁵

¹⁰² www.smfederation.org.sg

¹⁰³ Overview SMF. [Online]. Available: www.smfederation.org.sg/about-us/overview [2018, July]

¹⁰⁴ www.aeis.org.sg

¹⁰⁵ About AEIS [Online]. Available: www.aeis.org.sg/About%20AEIS.html [2018, July]

and funded by the membership fees and sponsorship from partners or alliances. To date, AEIS has approximately 150 organisational members and 4 honorary members¹⁰⁶.

The Association has strong alliances with other organisations in Asia and globally such as: Semiconductor and Electronics Industries in the Philippines, Japan Electronics & Information Technology Industries Association, The Hong Kong Electronic Industries Association, Hong Kong Semiconductor Industry Council, Electrical and Electronics Institute Thailand, ELCINA Electronic Industries Association of India, Russian Association of Manufacturers of Electronics and Electronic Devices, and many others¹⁰⁷.

Singapore Semiconductor Industry Association

Singapore Semiconductor Industry Association (SSIA)¹⁰⁸ members include companies and organisations throughout all parts of the complex and comprehensive value chain – IC design companies, manufacturers, fabless companies, equipment suppliers, photovoltaic companies, EDA and material suppliers, training and service providers, IP companies, research institutes and academia, as well as individual members.

The association started in 2005 under the name “MIDAS” and is operating with an extended charter under the new name “SSIA” since early 2010. The association’s mission is to steer, advocate and facilitate the full value chain of the semiconductor industry in Singapore. It is operated by a dedicated Secretariat Team under the supervision of the Executive Committee and Board of Advisors. The association is funded by membership fees and sponsorship from partners. SSIA has more than 100 corporate members, 9 Academia, 2 Research Institutes, 5 Associate/Chambers of Commerce, 8 IoT Workgroup, and a Government Agency (Singapore Economic Development Board)¹⁰⁹.

The Centre of Innovation for Electronics & IoT

The Centre of Innovation for Electronics & IoT (COI-EIoT)¹¹⁰ was jointly established by SPRING Singapore (now Enterprise Singapore) and Nanyang Polytechnic (NYP) in 2008. Since its inception, COI-EIoT has played the role of a national centre for electronic innovations and IoT solutions providing critical support to local enterprises. COI-EIoT partners are local enterprises, largely SMEs, working alongside them in developing business growth and competitiveness through innovation, capabilities development and productivity.

COI-EIoT’s mission is to be a national centre of excellence for electronic innovations supporting enterprises to drive growth through innovation, talent development and productivity. It has been providing holistic innovation and capabilities development support which range from translational R&D, technology feasibility studies, product/system design & development, test & measurement, test-

¹⁰⁶ Our Members [Online]. Available: www.aeis.org.sg/Members.html [2018, July]

¹⁰⁷ Our Alliances [Online]. Available: www.aeis.org.sg/Alliances.html [2018, July]

¹⁰⁸ <https://ssia.org.sg/>

¹⁰⁹ SSIA Members [Online]. Available: <https://ssia.org.sg/ssia-members/> [2018, July]

¹¹⁰ About COI-EIoT [Online]. Available: www.electronics-coi.sg/about-us/about-coie.html [2018, July]

bedding, IP translation, business leadership, partnership networking, manpower training, to facilitating funding access.

3.2.2 Transportation & Storage (Logistics) clusters

The Singapore Logistics Association

The Singapore Logistics Association (SLA)¹¹¹ was founded in 1973 under the name Singapore Freight Forwarders Association. It was renamed Singapore Logistics Association in 1999. SLA aims to represent Singapore logistics with a mission to promote professionalism and excellence of the logistics industry. Its growing membership of 567 business entities¹¹² offers a diverse scope of logistics and ancillary support services. As a trade association, SLA seeks to fulfil its objects in close collaboration and engagement with logistics companies and professionals, institutions and academia, industry organisations and partners, government agencies as well as international organisations and businesses.

The association supports its members through access to industry and trade information, increased business opportunities as well as updated information regarding trading condition. The association is operated by a dedicated team of SLA Secretariat and overseen by the SLA Council and General Members¹¹³. The association is funded by the membership fees and sponsorship.

SAAA@Singapore

SAAA@Singapore¹¹⁴ or previously Singapore Aircargo Agents Association (SAAA) was established in 1971 by the Managing Director of Singapore Baggage Transport Agency Pte Ltd. Its purpose was to advocate the promotion, protection and development of the business of carriage of goods by air transportation, as well as enhancing competitiveness of the Air Cargo Forwarding business. SAAA was an amalgamation of six pioneering cargo agents.

In the 70s, numerous new international agents were setting up their offices in Singapore. This became a growing concern for the local agents and it prompted SAAA to step in and help upgrade their services and skills to meet new challenging demands. SAAA had since grown its membership base and works closely with various government bodies and organisations to develop and propel the local Air Transportation industry. A rebranding exercise was completed and on 1 October 2013, SAAA@Singapore was officially launched by the Senior Minister of State, Ministry of Transport and Ministry of Finance. The significant change is that SAAA@Singapore is now encompassing all air logistics related sectors to better represent the industry.

The association is operated by a dedicated team of SAAA@Singapore Secretariat and overseen by the Council Members. The association is funded by the membership fees and sponsorship from partners. To date, SAAA@Singapore has more than 100 members¹¹⁵. Besides providing the services as mentioned

¹¹¹ www.sla.org.sg

¹¹² About SLA [Online]. Available: www.sla.org.sg/hive/sla/aboutUs [2018, July]

¹¹³ Organisation Chart SLA [Online]. Available: www.sla.org.sg/hive/sla/organisation [2018, July]

¹¹⁴ www.saaa.org.sg

¹¹⁵ Member's Category [Online]. Available: www.saaa.org.sg/members-category/ [2018, July]

above, SAAA@Singapore through the SAAA Cargo Services Pte Ltd (SCS) is also providing training as SCS is now accredited¹¹⁶ by the International Air Transport Association (IATA) as an Authorised Training Centre to conduct courses such as IATA Cargo Introductory Course, Professional Conversion Programme for Air Freight Officer and Air Freight Executive, etc.

The Container Depot and Logistics Association Singapore

The Container Depot Association Singapore (CDAS) was formed in 1991 as one of the logistics and transport associations in Singapore, with the aim of providing assistance to members and players in the industry at large. It was renamed in 2017 to the Container Depot and Logistics Association Singapore¹¹⁷ to encompass a wider scope of work and to be aligned with the nature of the logistics supply chain¹¹⁸. Through working with other logistics associations, as well as various government agencies and authorities, CDAS has helped to enhance the working methods and relationships of the port operators and the land transport businesses. It also works closely with Enterprise Singapore to embark on various projects to help the local SMEs to grow.

Over the years, CDAS has been actively involved with various government statutory boards such as Enterprise Singapore, IMDA, IE Singapore, Land Transport Authority, JTC Corporation, WSH Council and Singapore Customs to embark on projects and outreach sessions to help the Logistics industry. CDAS also works closely with other Trade Association and Partners – Singapore Logistics Association (SLA), Singapore Transport Association (STA), PSA and Jurong Port, to bring about positive changes to the industry.

The association is funded by the membership fees and sponsorship from partners. CDAS has around 60 associate member, 2 affiliate members, and 17 ordinary members¹¹⁹. CDAS provides services¹²⁰ such as Transport Integration Platform (TRIP), Electronic Container Trucking System (eCTS), Container Management System (CMS), Containerized Traffic System (CTS), etc. It also provides training courses and other relevant events.

3.2.3 Information & Communication Technology clusters

SGTech

SGTech¹²¹ is a premier trade association for the tech industry in Singapore. SGTech tries to create an ecosystem that anticipates trends and develops sustainable initiatives to strengthen the community and

¹¹⁶ Training History [Online]. Available: www.saaa.org.sg/training/history/ [2018, July]

¹¹⁷ <http://cdasalliance.sg/>

¹¹⁸ About CDAS [Online]. Available: <http://cdasalliance.sg/about/> [2018, July]

¹¹⁹ Members List CDAS [Online]. Available: <http://cdasalliance.sg/members-list/> [2018, July]

¹²⁰ Services CDAS [Online]. Available: <http://cdasalliance.sg/services/> [2018, July]

¹²¹ www.sgtech.org.sg

help the industry grow. SGTech's 700+ members range from innovative start-ups, SMEs to top multinational corporations¹²².

SGTech's mission is to sharpen and deepen its focus on 3 key value propositions (i.e. Empower Business, Advocate for Industry, and Support Singapore) for its members and to the community. SGTech is operated by the SGTech Secretariat that provides the infrastructural and human resources necessary to realise SGTech's mission and vision. A small and dedicated team of highly experienced officers implements and executes a wide range of programmes and services that add value to the members and SGTech Council. SGTech is funded by membership fees and sponsorship.

SGTech's Chapters offer focused support and development to both strategic and emerging sectors in the technology industry. The Chapters are: Cloud & Big Data Chapter (CBDC); Cyber Security Chapter (CSC); Digital Transformation Chapter (DxC); Singapore Enterprise Chapter (SEC); AI & High-Performance Computing Chapter (AI&HPC); and Smart Nation Chapter (SNC).

In addition, SGTech provides many initiatives such as 123 Jumpstart Start-Up and industry survey¹²³. 123 Jumpstart Start-Up¹²⁴ is a start-up engagement programme that aims to help start-ups grow and succeed. To achieve this, they provide four forms of assistance to start-ups: Funding, Talent & Capabilities, Network and Services.

Association of the Telecommunications Industry of Singapore

Association of the Telecommunications Industry of Singapore (ATIS)¹²⁵ was established in 1986. ATIS champions industry issues on behalf of the ICT industry in Singapore. It seeks to provide a common platform for all members of the industry to interact, work together and position Singapore as a leading global ICT hub. ATIS's main objective is to develop, promote and protect the free trade of ICT products, technologies and services in Singapore. This encompasses persons, companies, organisations and societies engaged or having an interest in the ICT industry.

ATIS members come from all areas of the ICT industry including service providers and operators, equipment manufacturers, distributors and dealers, value-added resellers, system integrators, consultants and R&D organisations¹²⁶. ATIS seeks to keep its members abreast with up-coming technologies and industry updates by organising regular seminars and info-sharing sessions. ATIS reinforces its presence in the industry by participating in international/regional conferences and exhibitions, facilitating networking sessions with foreign trading partners, representing the industry in

¹²² About SGTech [Online]. Available:

www.sgtech.org.sg/Web/About/About_SGTECH/SGTECH/Web/About/About_Us.aspx?hkey=fc05c09d-c1a2-470c-aae0-c44c8f4023e0 [2018, July]

¹²³ SGTech Initiatives [Online]. Available:

www.sgtech.org.sg/Web/Initiatives/SGTECH/Web/Initiatives/Initiatives.aspx?hkey=78f2abc2-1bbd-4e2e-a14a-1876e4a92ca4 [2018, July]

¹²⁴ www.sgtech123js.com

¹²⁵ www.atis.org.sg

¹²⁶ About ATIS [Online]. Available: www.atis.org.sg/about-us [2018, July]

national standards committees and establishing regular dialogues between the industry and the Government.

Tanjong Kling Data Centre Park

The Infocomm Development Authority of Singapore, Singapore Economic Development Board and JTC Corporation are working together on the development of a data centre park (DCP) to strengthen Singapore's position as an economic and ICT hub, the Tanjong Kling Data Centre Park (DCP) became operational in 2016¹²⁷. The project is funded by The Infocomm Development Authority of Singapore, Singapore Economic Development Board and JTC Corporation.

Besides attracting multinational companies to set up their HQ and premium data centre operations in Singapore, the DCP will also help to establish Singapore as an ICT and media hub by having more premium data centres such as banks and telco carriers located there. Such data centre infrastructure will attract world-class Internet and media companies to host their content and services in Singapore; thus, attracting more Internet traffic and international network providers.

3.2.4 Health and Medical clusters

The public healthcare system comprises three integrated healthcare clusters, anchored by a regional Hospital working with a variety of Primary, Intermediate and Long-Term care sector and support services to deliver patient-centric care. The healthcare clusters are the National Healthcare Group (NHG), Singhealth, and National University Health System (NUHS). All healthcare clusters are supported by the Agency for Integrated Care (AIC), which has been set up to smooth the transition of patients from one care setting to another¹²⁸. Besides the healthcare clusters, there are also other medical technology clusters or associations that are relevant to this area.

National Healthcare Group

The National Healthcare Group (NHG)¹²⁹ is a leader in public healthcare in Singapore, recognised at home and abroad for the quality of its medical expertise and facilities. Care is provided through an integrated network of six primary care polyclinics, acute care and tertiary hospitals, national specialty centres and business divisions.

NHG's vision is "Adding Years of Healthy Life". This vision goes beyond merely healing the sick to the more difficult and infinitely more rewarding task of preventing illness and preserving health and quality of life. With some 18,000 staff, NHG aims to provide care that is patient-centric, accessible, seamless, comprehensive, appropriate and cost-effective. As the Regional Health System (RHS) for Central

¹²⁷ Establishment of a Data Centre Park (DCP), Info-communications Media Development Authority Singapore [Online]. Available: www.imda.gov.sg/industry-development/infrastructure/next-gen-national-infocomm-infrastructure/data-centre-park/establishment-of-a-data-centre-park-dcp [2018, July]

¹²⁸ Health and medical to Singapore, Trends and opportunities. Australian Trade and Investment Commission. [Online]. Available: www.austrade.gov.au/Australian/Export/Export-markets/Countries/Singapore/Industries/Health-and-medical [2018, July]

¹²⁹ <https://corp.nhg.com.sg/>

Singapore, it is vital for NHG to partner and collaborate with stakeholders, community advisors, and voluntary welfare organisations.

The NHG is operated by Senior Management and overseen by the Board of Directors. The members of NHG include¹³⁰: Tan Tock Seng Hospital (TTSH); The Institute of Mental Health (IMH); Khoo Teck Puat Hospital (KTPH); Yishun Community Hospital (YCH); The Woodlands Health Campus (WHC); National Healthcare Group Polyclinics (NHGP); The National Skin Centre (NSC); Admiralty Medical Centre (AdMC); National Healthcare Group (NHG) College; National Healthcare Group Diagnostics (NHG Diagnostics); National Healthcare Group Pharmacy (NHG Pharmacy); Primary Care Academy (PCA); and NHG-Johns Hopkins Singapore Institute.

SingHealth

SingHealth¹³¹ is Singapore's largest group of healthcare institutions. The group was formed in 2000 and consists of four public hospitals across the island, five national specialty centres and a network of nine polyclinics. The group operates Singapore General Hospital, Changi General Hospital, KK Women's and Children's Hospital and Sengkang Health. The group runs five national specialty centres which include National Cancer Centre Singapore, National Heart Centre Singapore, Singapore National Eye Centre, National Dental Centre Singapore and the National Neuroscience Institute. It also runs SingHealth Community and Primary care such as SingHealth Community Hospitals and SingHealth Polyclinics¹³².

The National University Health System

The National University Health System (NUHS)¹³³ is an integrated Academic Health System and Regional Health System that delivers value-driven, innovative and sustainable healthcare. Throughout the history of the institution members, their staffs have worked across the health system to advance the tripartite missions of achieving clinical excellence, developing the next generation of healthcare professionals, and changing the natural history of chronic diseases through research.

NUHS leverages its unique position as an academic health system to tap into the wealth of resources residing within the National University of Singapore (NUS). Through collaborations with NUS faculties, they are able to draw upon the academic, research and creative capabilities to develop solutions for existing and emerging health and healthcare needs of the Singapore population. As part of the regional health system responsibility, NUHS works in close collaboration with community hospitals, general practitioners, family medicine clinics, nursing homes and other community and social partners to provide integrated care to the community.

Institutions in the NUHS group include: community hospitals¹³⁴ - National University Hospital (NUH), Ng Teng Fong General Hospital, Jurong Community Hospital and Alexandra Hospital (2018); National Specialty Centres - National University Cancer Institute, Singapore (NCIS), National University Heart

¹³⁰ Members of NHG [Online]. Available: <https://corp.nhg.com.sg/Pages/default.aspx> [2018, July]

¹³¹ www.singhealth.com.sg

¹³² SingHealth Hospitals [Online]. Available: www.singhealth.com.sg/Pages/home.aspx [2018, July]

¹³³ www.nuhs.edu.sg

¹³⁴ Corporate Profile NUHS [Online]. Available: www.nuhs.edu.sg/about-us/corporate-profile.html [2018, July]

Centre, Singapore (NUHCS) and National University Centre for Oral Health, Singapore (NUCOHS); a polyclinic group - the National University Polyclinics (NUP); a medical centre – Jurong Medical Centre; and academic health sciences institutions – NUS Yong Loo Lin School of Medicine (including the Alice Lee Centre for Nursing Studies), NUS Faculty of Dentistry and NUS Saw Swee Hock School of Public Health.

With member institutions under one academic health system, NUHS creates synergies as a fully integrated cluster to provide seamless care from prevention to home care, and with their academic institutions, to continue to develop solutions for Singapore’s healthcare challenges, and nurture the next generation of healthcare professionals.

Medical Technology Industry Group

Medical Technology Industry Group (MTIG) is one of the industry groups within the Singapore Manufacturing Federation (SMF). Since 1998, MTIG members include both international and national companies in the Singapore medical technology industry. These member companies partner with SMF relevant stakeholders to facilitate a communication platform which would advocate safety, effectiveness and reliability in the development of medical technologies to fulfil the required needs and conditions for the end users.

MTIG objectives include¹³⁵: connecting member companies with each other to uncover more market opportunities; shaping policies through dialogue with government stakeholders; representing industry with one voice; and delivering value added training workshops and programs to build capabilities for the member companies. MTIG has 16 main Committee Members representing various MedTech companies.

The Association of Medical Device Industry Singapore

The Association of Medical Device Industry Singapore¹³⁶ (AMDI) was incorporated in January 2011. AMDI serves as a key representative body for the medical device industry in Singapore. It aims to advocate good practices and promote high industry standards among the trade. AMDI’s main objectives include: representing the medical equipment and medical device industry in Singapore in the engagement and dialogue with regulators and effective dissemination of information to industry members; organising trade missions for members; and cooperating with various trade commissions¹³⁷.

The association provides several activities to its members including networking opportunities; business matching opportunities; dialogues with relevant government agencies; providing industry news updates; various trade missions and exhibitions; interactive seminars and training programmes; and joint activities with Singapore MedTech.

¹³⁵ About Medical Technology Industry Group [Online]. Available: www.smfederation.org.sg/membership/industry-groups/medical-technology [2018, July]

¹³⁶ <http://amdi.org.sg/>

¹³⁷ Who We Are, AMDI [Online]. Available: <http://amdi.org.sg/about-amdi/who-we-are/> [2018, July]

Diagnostics Innovation Cluster / Diagnostics Development (DxD) Hub

Singapore capitalised on its long-standing relationships with major pharmaceutical companies and created the Diagnostics Development (DxD)¹³⁸ Hub, which helps to accelerate the transformation of Intellectual Properties (IPs) into clinically validated diagnostic devices that are ready for subsequent market adoption. DxD Hub is a national initiative led by ETPL, the commercialisation arm of the Agency for Science, Technology and Research (A*STAR).

The DxD Hub was launched in 2014¹³⁹. Partners of the hub include SingHealth, National University Health System, National Healthcare Group and the Singapore Clinical Research Institute. Multinational companies such as Johnson & Johnson Innovation, Thermo Fisher Scientific, along with SMEs and start-ups such as AITbiotech, Gencurix, HistoIndex, iPtec, InvitroCue and MiRXES, are among the early supporters of the DxD Hub.

Leveraging Singapore's strengths and leading clinicians and medical consortiums in areas such as oncology, ophthalmology, infectious and cardiac diseases, the DxD Hub develops diagnostic solutions tailored to diseases predominantly found in Asia. Over 5 years, the DxD Hub targets to license diagnostics technologies to multinational companies, SMEs and start-ups, complete commercial contracts, attract industry co-funding, and help establish local and foreign start-ups.

¹³⁸ Diagnostics Development Hub (DXD) [Online]. Available: <https://www.etpl.sg/innovation-offerings/diagnostics-development-hub-dxd> [2018, July]

¹³⁹ Innovation & Enterprise Cluster Fund, National Research Foundation Singapore [Online]. Available: <https://www.nrf.gov.sg/innovation-enterprise/innovation-enterprise-cluster-fund> [2018, July]

4 Cluster policies and programmes in Singapore

4.1. The cluster policy in Singapore

The Industry Transformation Maps (ITMs) initiative put in place by the government has encouraged industry clusters. The ITMs have developed further by taking a "cluster-based approach", aimed at creating synergies and strengthening linkages across multiple industries. The clusters categorised by ITMs represent over 80% of the country's GDP in 2017¹⁴⁰.

The programme also aimed at integrating different restructuring efforts, taking a targeted and industry-focused approach to address issues and deepen partnerships between government, firms, industries, trade associations and chambers. The objective of the ITMs is to keep Singaporean industries competitive and generate growth for Singapore. Each ITM is tailored to the needs of the industry. In developing these ITMs, the government examined deeply the industry landscape, the future trends and needs to set out a suite of initiatives to systematically raise productivity, develop skills, drive innovation, and promote internationalisation, so as to catalyse transformation and achieve the stated vision of each industry.

The ITMs will also address the government's role as facilitator and enabler of industry upgrading, for example, by creating a regulatory environment that is conducive for innovative business models, or setting national standards to promote technology adoption. By the beginning of 2018, all the ITMs Clusters were launched by the Singaporean Ministry of Trade and Industry as seen in Figure 3.

MANUFACTURING	BUILT ENVIRONMENT	TRADE & CONNECTIVITY	ESSENTIAL DOMESTIC SERVICES	MODERN SERVICES	LIFESTYLE
<input checked="" type="checkbox"/> Precision Engineering	<input checked="" type="checkbox"/> Construction	<input checked="" type="checkbox"/> Wholesale Trade	<input checked="" type="checkbox"/> Healthcare	<input checked="" type="checkbox"/> Professional Services	<input checked="" type="checkbox"/> Food Manufacturing
<input checked="" type="checkbox"/> Energy & Chemicals	<input checked="" type="checkbox"/> Real Estate	<input checked="" type="checkbox"/> Land Transport	<input checked="" type="checkbox"/> Education	<input checked="" type="checkbox"/> Financial Services	<input checked="" type="checkbox"/> Food Services
<input checked="" type="checkbox"/> Marine & Offshore	<input checked="" type="checkbox"/> Security	<input checked="" type="checkbox"/> Sea Transport		<input checked="" type="checkbox"/> ICT and Media	<input checked="" type="checkbox"/> Hotels
<input checked="" type="checkbox"/> Aerospace	<input checked="" type="checkbox"/> Environmental Services	<input checked="" type="checkbox"/> Air Transport			<input checked="" type="checkbox"/> Retail
<input checked="" type="checkbox"/> Electronics		<input checked="" type="checkbox"/> Logistics			

FIGURE 3 - LIST OF LAUNCHED ITMs¹⁴¹

The ITMs functions much like a master plan. They outline broad policy goals and directions and lays out some of the policy frameworks that can lead towards the attainment of the main goals¹⁴². As explained in the Report of the Committee on the Future Economy¹⁴³, each ITM puts forward a growth and

¹⁴⁰ Integrated Roadmaps to Drive Industry Transformation, Media Factsheet – Industry Transformation Maps, Ministry of Trade and Industry Singapore

¹⁴¹ Industry Transformation Maps (ITMs), Ministry of Trade and Industry Singapore [Online]. Available: www.mti.gov.sg/MTIInsights/Pages/ITM.aspx [2018, July]

¹⁴² Jie, W.J. 2017. *Commentary: A clear path to transforming Singapore's financial services sector*. Channel News Asia. [Online]. Available: www.channelnewsasia.com/news/business/commentary-a-clear-path-to-transforming-singapore-s-financial-9371262 [2018, July]

¹⁴³ Report of the Committee on the Future of Economy Singapore 2017

competitiveness plan, which is developed based on the input from government agencies, unions, industry partners and Trade Associations and Chambers (TACs).

Besides implementing a competitiveness plan as explained above, each of the ITMs also analyses opportunities to tap stakeholders such as TACs to perform cluster-like activities. For example, in the Electronics industry, EDB together with Enterprise Singapore are working with the Singapore Semiconductor Industry Association (SSIA), as a key partner for industry development. In support of the Electronics ITM, SSIA has set out a three-year plan to transform its charter and expand its resources to better support the industry¹⁴⁴. SSIA has already taken an active role in key industry programmes, such as serving as the administrator for Workforce Singapore's Professional Conversion Programme (WSG's PCP). The association has also embarked on a leadership programme to groom the next generation of Singaporean leaders for the industry. This example of TACs involvement is expected to be followed by other clusters.

In addition, the subcommittee on Future Growth Industries and Markets of Singapore has identified the key industry clusters¹⁴⁵ (such as healthcare and urban solutions) and internationalisation opportunities in Singapore, given global trends and Singapore's comparative advantages. The subcommittee has also established the strategies to develop these clusters and address the growth opportunities. The growth markets with which Singapore is currently focused on developing stronger ties are Southeast Asia (SEA), China and India to be followed by the USA, Australia, and the EU.

4.2 Electronics policies and programmes

The ITM for electronics has established two strategies to ensure the growth of Singapore's electronics industry¹⁴⁶. The first strategy is focused on diversification into new growth markets such as urban mobility and healthcare. The second strategy is focused on transforming the existing base of electronics manufacturing and attracting new investments in high-value components through the adoption of robotics and automation.

To accomplish the first strategy, the government is committed to strengthening the innovation ecosystem to harness new growth opportunities and diversification. The economic agencies will organise multi-party innovation platforms that will bring together multinational companies, SMEs, as well as research institutions and institutes of higher learning, to collaborate and develop new solutions. In addition, with the merger of SPRING and IE to form a new agency, Enterprise Singapore, the electronics-related SMEs and start-ups can look forward to better support to develop comprehensive corporate strategies. Enterprise Singapore will complement EDB's role in driving more collaboration between multinational companies, innovative start-ups, as well as large and small local enterprises. The

¹⁴⁴ Speech by Mr S. Iswaran, Minister for Trade & Industry (Industry), tt Opening of JTC Nanospace and Launch of The Electronics Industry Transformation Map on 20 September 2017, 9:00am, at 11 Tampines Industrial Crescent

¹⁴⁵ Committee Explores Opportunities in Future Growth Industries and Markets to Strengthen Singapore's Competitiveness, Press Release, Ministry of Trade and Industry 2016

¹⁴⁶ Ibid¹⁴⁴

two agencies will reinforce each other's strengths, to enhance the competitiveness of the companies and build the electronics industry of tomorrow.

For the second strategy, to support the transformation of the electronic manufacturing industry, the government is also committed to working with the private sector, trade chambers as well as associations such as SSIA. Singapore will also continue to attract high value-add activities and capture new growth areas. Given the short product life cycles in electronics, Singapore is prepared to invest early in building infrastructure to support more investments. JTC nanoSpace is one example. The facility is strategically located within Tampines Wafer Fab Park and offers a plug-and-play, quick-start solution that meets the requirements of semiconductor operations. EDB and JTC have secured Austria Mikro System Sensors Asia, a global leader in sensors manufacturing, as the anchor tenant for nanoSpace. Singapore will continue to invest in next generation infrastructure solutions to attract multinational companies and grow local companies.

In addition to the above strategies, to ensure that Singaporeans are equipped with the necessary skills and to ensure Singapore has a growing and competent talent pool, the Skills Framework for Electronics initiative was established¹⁴⁷. It aims to develop skills and promote lifelong learning and is an integral component of the Electronics Industry Manpower Plan. The framework contains information on trends, career pathways, occupations, job roles, skills and competencies as well as training programmes that could support individuals, employers and training providers develop skills needed in the electronics sector.

4.3 Transportation & Storage (Logistics) policies and programmes

The importance of maintaining Singapore's position as a globally leading logistics hub and continuously adapting to the global trend such as digital transformation in the transportation and logistics sector is emphasised by the launch of Singapore's Industry Transformation Map (ITM). Particularly for logistics, the main objective is to reinforce Singapore's position as a globally leading logistics hub through operations excellence, innovation and a strong Singaporean core as well as creating S \$ 8.3 billion (€ 5.2 billion¹⁴⁸) added values and introducing 2,000 new PMET jobs by 2020¹⁴⁹.

To achieve this objective, the government identified several strategies and programmes within its Logistics ITM. The first strategy is to support enterprise-level efforts to transform and grow through productivity and innovation. The strategy aims to nurture a strong Singaporean core through talent development. This in turn will help the companies, in particular the SMEs, to scale-up and

¹⁴⁷ Skills Framework for Electronics, Skills Future Singapore [Online]. Available: www.skillsfuture.sg/skills-framework/electronics [2018, July]

¹⁴⁸ Oanda, 1 S \$ = 0.65 euro, 31st of December 2016

¹⁴⁹ Logistics Industry Transformation Map to Strengthen Singapore's Position as a Globally Leading Logistics Hub, EDB Singapore Media Release 2016

internationalise. This has been done by leveraging technology and adopting best-in-class supply chain practices to improve productivity.

The government is also investing in next-generation infrastructure solutions with high specification units that provide opportunities to deploy automation. The JTC Logistics Hub @ Gul is a prime example of such an initiative. It is aimed at catalysing the growth and transformation of the industry while improving land productivity that will help reduce the transport cycle and boost efficiency, benefiting especially SME logistics companies¹⁵⁰. Beyond efficiency and productivity gains, the co-location of depot operators and logistics companies in the Logistics Hub also promotes collaboration, which enhances the competitiveness of the logistics value chain.

In order to address a talent need, the government launched the Skills Framework for Logistics¹⁵¹. The Skills Framework will be a guide for individuals and companies on the career pathways, job roles, requisite skills and wages of jobs in the logistics industry.

In addition to Logistics ITM policies and programme, in 2017 the government announced a S\$20 million (€12.5 million¹⁵²) investment in transforming Singapore's urban transport and logistics¹⁵³. As part of this initiative, the Singapore Urban Logistics programme was launched to analyse challenges in the logistics sector as well as to identify technologies that will be able to improve Singapore's supply chain processes and improve its efficiencies.

The government also launched the Transport Integrated Platform (TRIP) in November 2017 to help the many players along the logistics supply chain achieve seamless end-to-end tracking of goods and cut down on unnecessary trips and delays¹⁵⁴. The platform is one of the projects being handled by the Logistics Alliance, an industry group formed by CDAS, SAAA@Singapore, Singapore Logistics Association, and the Singapore Transport Association, together with the government agency SPRING and the Centre of Innovation for Supply Chain Management at Republic Polytechnic¹⁵⁵. In addition to the TRIP platform, other projects that the Logistics Alliance will tackle include development of technology-based solutions and better recruitment and retention of workers.

¹⁵⁰ Woo, J. 2016. JTC Corp building 'next-gen' logistics hub. The Straits Times Singapore. [Online]. Available: www.straitstimes.com/business/companies-markets/jtc-corp-building-next-gen-logistics-hub [2018, July]

¹⁵¹ www.skillsfuture.sg/skills-framework/logistics

¹⁵² Oanda, S\$1= €0.62, 31st of December 2017

¹⁵³ Launch of Urban Logistics Technology Roadmap, 12 Additional Malls to Benefit from Tech-Enabled Process Re-Engineering, Info-communications Media Development Authority 2017 [Online]. Available: www.imda.gov.sg/about/newsroom/media-releases/2016/launch-of-urban-logistics-technology-roadmap [2018, July]

¹⁵⁴ Williams, A. 2017. *Logistics industry group launches tech platform for seamless tracking of goods*. The Straits Times Singapore [Online]. Available: www.straitstimes.com/business/economy/logistics-industry-group-launches-tech-platform-for-seamless-tracking-of-goods [2018, July]

¹⁵⁵ Leow, A. 2017. Logistics sector pooling resources to upgrade, innovate. The Straits Times Singapore [Online]. Available: www.straitstimes.com/business/companies-markets/logistics-sector-pooling-resources-to-upgrade-innovate [2018, July]

4.4 Information & Communications policies and programmes

In 2017, the Infocomm Media Development Authority (IMDA) released the ITM for the ICT and Media sector. This initiative is in direct support of the Modern Services cluster, which is comprised in part of the ICT sector. The ITM aims to grow the ICT industry's added value by 6% each year as well as create more than 13,000 new jobs and 210,000 related sector workers by 2020¹⁵⁶. To achieve this goal, the ITM established three strategies: invest and build capabilities in four frontier technologies; strengthen the core of the ICT sector and prepare the next generation of ICT professionals and companies for future job roles and business opportunities; and guide companies and workforces from the other sectors in adopting digital technology to improve productivity and efficiency.

Invest and build capabilities in four frontier technologies

The ITM will invest and build capabilities in four frontier technologies: Artificial Intelligence (AI) and data analytics, cybersecurity, immersive media and internet of things. AI Singapore¹⁵⁷ was set up in May 2017 with an S\$150 million (€ 93,891,200¹⁵⁸) fund to catalyse, synergise and boost Singapore's AI capabilities. AI Singapore is driven by a government-wide partnership involving the National Research Foundation (NRF), the Smart Nation and Digital Government Office (SMART), the Economic Development Board (EDB), the Infocomm Media Development Authority (IMDA), SGInnovate, and Integrated Health Information Systems. In regard to cyber security, a National Cybersecurity R&D Programme¹⁵⁹ was established to develop R&D expertise and capabilities in cybersecurity for Singapore. It aims to improve the trustworthiness of cyber infrastructures with an emphasis on security, reliability, resiliency and usability. Under immersive media, the Minister for Communications and Information announced in April 2018¹⁶⁰ that IMDA is partnering with Tan Tock Seng Hospital and visual effects company SideFX Studios to introduce Virtual Reality (VR) for clinical training. And finally, IoT systems, 5G mobile networks, sensor networks, as well as the Nationwide Broadband Network in Singapore will be enhanced to enable businesses to leverage high-speed networks, real-time communications and high-accuracy location positioning. These initiatives follow existing improvements that the government has already implemented.

Strengthen the core of the ICT sector, and prepare the next generation of ICT professionals and companies for future job roles and business opportunities

The government has initiatives designed to strengthen the core of the ICT sector such as Accreditation@SGD, Talentguru and Strategic Partners Program. Accreditation@SGD is a programme that was launched in July 2014 to endorse promising and innovative Singapore-based high-growth ICM

¹⁵⁶ Infocomm Media Industry Transformation Map (ITM), IMDA Singapore [Online]. Available:

www.mti.gov.sg/MTIInsights/SiteAssets/Pages/ITM/Images/ICT%20Media%20ITM%20-%20Media%20Release_v2.pdf [2018, July]

¹⁵⁷ www.aisingapore.org

¹⁵⁸ Oanda, 1 US \$ = 0.83 euro, 31st December 2017

¹⁵⁹ National Cybersecurity R&D Programme, National Research Foundation Singapore [Online]. Available:

www.nrf.gov.sg/programmes/national-cybersecurity-r-d-programme [2018, July]

¹⁶⁰ Leong, C. 2018. *Singapore's Digital Economy gunning for four key areas*. IMDA Singapore [Online]. Available:

www.imda.gov.sg/infocomm-and-media-news/buzz-central/2017/6/singapores-digital-economy-gunning-for-four-key-areas [2018, July]

product companies positioning them as qualified contenders to government and large enterprise buyers, to provide potential end users with the assurance of the accredited companies' product core functionalities and ability to deliver; and to build an innovative technopreneur ecosystem to drive economic growth that inspires the younger generation and builds more innovative products and tech product companies that can scale overseas. Talentguru is an initiative designed to prepare people for the digital economy through training and professional development. The initiative consists of a skilled based career development platform expected to address the challenges of skill gaps and talent shortages in the ICT sector. Finally, the Strategic Partners Programme (SPP) focuses on encouraging the development of partnerships in order to tap into new market opportunities. In many cases, the partnerships are between SMEs and multinational companies such as IBM, Microsoft and Samsung.

Guide companies and workforce from the other sectors in adopting digital technology to improve productivity and efficiency

SMEs Go Digital is an initiative that was established in 2017¹⁶¹ to help SMEs build stronger digital capabilities to seize the opportunities for growth in the digital economy. Building on the foundation of Enhanced iSPRINT, SMEs Go Digital takes a more structured and inclusive approach towards the adoption of digital technologies by SMEs. The programme involves three key players in the area: SMEs, Infocomm Media vendors, and industry partners.

4.5 Healthcare and Medical Technologies policies and programmes

In order to implement the Healthcare ITM that has been launched in 2017 and to achieve the Beyond Healthcare 2020 vision in Singapore, the government has established a collaboration with union partners, economic agencies, Skills Future SG and Workforce Singapore through the Essential Domestic Services Subcommittee¹⁶². The Healthcare ITM sets out three key focus areas: building a strong local core through jobs and skills development; enhancing productivity to enable healthcare workers to work smarter; and catalysing innovation by working with service providers, industry partners, educational and research institutions, and Singaporeans to develop tomorrow's solutions.

Building a strong local core through jobs and skills development

This strategy aims to attract more of the local workforce into the healthcare sector and develop new skills for aged care. Given the growth in healthcare needs, the government is expecting the demand for healthcare human resources to continue to grow in the future. Thus, the government is providing multiple pathways to attract mid-career people to enter the healthcare sector. This is further supported through more advancement opportunities for community nurses. Some of the programmes or initiatives for developing nursing skills, general health professionals, pharmacy technicians and support care staff

¹⁶¹ SMEs Go Digital, IMDA Singapore [Online]. Available: www.imda.gov.sg/industry-development/programmes-and-grants/small-and-medium-enterprises/smes-go-digital [2018, July]

¹⁶² Speech By Mr Gan Kim Yong, Minister for Health, at The Futurehealth 2017 Conference, at The Lee Kong Chian School of Medicine on Wednesday, 8 November 2017, 10.40am

include:¹⁶³ SkillsFuture Initiatives for the Healthcare Workforce (i.e. SkillsFuture Study Award For Healthcare Sector Ministry of Health (MOH), SkillsFuture Credit, SkillsFuture Earn & Learn Programme (ELP) for nursing diploma graduates, the Singapore Workforce Skills Qualifications System for Healthcare Support (HCS WSQ) Framework, and many others).

Enhancing productivity to enable healthcare workers to work smarter

This strategy aims at enhancing productivity by streamlining workflows for healthcare workers to focus more on patient care and scaling assistive equipment and cost-effective technologies to lighten the workload, especially for the ageing workforce. Therefore, the government and sector related stakeholders are seeking and implement advanced technologies such as¹⁶⁴ tele-health technologies. In addition to implementing relevant technologies, the government is putting emphasis on programmes designed to enhance productivity such as the Singapore Health Services' (SingHealth) Match-A-Nurse programme, and Prescription in a Locker Box (Pilbox).

In line with the shift towards patients being cared for at home, SingHealth is field testing its latest effort the Match-A-Nurse programme, which is currently in a pilot stage. This programme links Singapore General Hospital (SGH) patients who require home nursing services to nurses living or working close to them. Patient requests are listed on a platform and nurses have to 'bid' for the jobs. Patients who have used the application say it gives them comfort that they can receive care from a professional nurse at home and they do not need to go to the hospital frequently.

The introduction of electronic medical records, integrated business software and automation has made dispensing of medicine a much safer and more efficient process for the patient and the pharmacist. For example, not only patients can get medicine delivered to their homes, they can also use the Prescription in a Locker Box (Pilbox), introduced at Marine Parade SingHealth Polyclinic in May 2016. Instead of crowding the pharmacy, patients can pick up medicine at their convenience from the Pilbox. They scan a QR code on their payment receipt and receive an access code via their mobile phone to unlock it.

Catalysing innovation by working with service providers, industry partners, educational and research institutions, and Singaporeans to develop tomorrow's solutions

This strategy aims to partner with industries by introducing innovative and patient-centric solutions, and deploying them in new hospital environments. This encourages meaningful private sector participation in service delivery through initiatives such as the Primary Care Network.

As part of the government's effort to enhance primary care, MOH has introduced the Primary Care Networks (PCN)¹⁶⁵ scheme to encourage private general practitioner clinics to organise themselves into networks that support more holistic and team-based care. The inaugural PCN application call was held in April 2017. MOH has appointed eight new PCNs as a result of the call. As of January 2018, a total of

¹⁶³ Healthcare Manpower Plan 2020, SkillsFuture Singapore 2016. [Online]. Available: www.moh.gov.sg/content/dam/moh_web/PressRoom/Highlights/2016/2020%20Healthcare%20Manpower%20Plan.pdf [2018, July]

¹⁶⁴ Healthcare Manpower Plan 2020, SkillsFuture Singapore 2016. [Online]. Available: www.moh.gov.sg/content/dam/moh_web/PressRoom/Highlights/2016/2020%20Healthcare%20Manpower%20Plan.pdf [2018, July]

¹⁶⁵ Primary Care Networks, Ministry of Health Singapore [Online]. Available: www.moh.gov.sg/content/moh_web/home/our_healthcare_system/Healthcare_Services/Primary_Care/primary-care-networks.html [2018, July]

ten PCNs represented more than 300 general practitioner clinics. Under the scheme, patients receive care through a multi-disciplinary team (including doctors, nurses and primary care coordinators) for more effective management of their chronic conditions. Patients are also able to access additional ancillary and support services provided by the PCN.

In addition to Healthcare ITM strategies, the government seek to develop innovative healthcare services, drugs and devices that will deliver better health outcomes and enable a sustainable healthcare system. As part of Singapore's Research, Innovation and Enterprise (RIE) 2020¹⁶⁶ initiative, public research agencies plan to develop an ecosystem that better enables translation of research to improve health outcomes. The ecosystem will be supported by building a strong core and pipeline of Singapore researchers, clinician-scientists, innovators, entrepreneurs and investors. Five therapeutic focus areas have been identified by the MOH based on factors such as disease impact, scientific excellence in Singapore and national needs:¹⁶⁷ (i) cancers, (ii) cardiovascular diseases, (iii) diabetes mellitus and other metabolic / endocrine conditions, (iv) infectious diseases, and (v) neurological and sense disorders.

The Health and Biomedical Sciences (HBMS) agencies are developing research roadmaps to determine specific problem statements and priorities for each of the identified therapeutic areas of focus. These include pathways to translate research discoveries into healthcare solutions, innovative medicines or medical devices so as to create value. Singapore is also diversifying its industry focus beyond the pharmaceutical and biologics, and medical technology sectors, to include personal care, and food and nutrition, which had demonstrated the potential for economic growth, and where R&D can play an important differentiating factor. The above mentioned initiatives are examples of this diversification.

In addition, the Singaporean government has started a number of programmes that are focussed on nurturing collaboration between scientists and industry experts. Companies and research performers may directly discuss potential partnerships, or connect with the Biomedical Sciences Industry Partnerships Office (BMS IPO), jointly established by A*STAR, EDB and MOH to facilitate partnerships between research performers and companies with a strong R&D commitment to Singapore and

Lastly, another effort taken by Singapore to remain as a hub for the world's leading medical technology manufacturers, is making substantial investments in the field of advanced manufacturing technologies to support its growing biomedical technology. For instance, through the EDB, Singapore launched a US\$ 250 million (€ 157 million¹⁶⁸) Partnerships for Capability Transformation (PACT) programme. The PACT programme encourages mutually beneficial collaborations between companies¹⁶⁹. The PACT brings together four existing schemes: EDB and Spring respective Partnerships for Capability Transformation (Pact) schemes; Spring's Collaborative Industry Projects; and IE Singapore's Global Company Partnership Grant. Projects may be related to capability development or joint business development.

¹⁶⁶ www.nrf.gov.sg/rie2020

¹⁶⁷ Health and Biomedical Sciences, RIE 2020 Plan [Online]. Available: www.nrf.gov.sg/rie2020/health-and-biomedical-sciences [2018, July]

¹⁶⁸ Oanda, 1 S \$ = 0.62 euro, 25th of July 2018

¹⁶⁹ Heng, J. 2018. *Singapore Budget 2018: Pact scheme to include tie-ups among SMEs*. The Business Times Singapore [Online]. Available: www.businesstimes.com.sg/government-economy/singapore-budget-2018/singapore-budget-2018-pact-scheme-to-include-tie-ups-among [2018, July]

5. Conclusion

Throughout the years Singapore has been one of the most innovative and attractive city-nations for global industrial investment. The country is set to remain the world's most investor-friendly location through 2018, retaining its top spot from the 2009-13 period¹⁷⁰. Singapore is continuously reshaping its industrial structure to maintain economic growth and optimise its strength. The current policies are shaping the Singaporean main industries into new clusters and developing them further by taking a "cluster-based approach", aimed at creating synergies and strengthening linkages across multiple industries.

The cluster community in Singapore, which has matured, is now being shaped specifically to address various challenges faced by each of the industries; while maximising inter-industry synergies. The Committee on the Future of Economy of Singapore was established by the government to suggest relevant recommendations and policies that are aligned with the global industry trends and technological developments. The role and involvement of SMEs and start-ups alongside large corporations are considered crucial in Singapore's effort to achieve the main goal of its current industrial transformation roadmap.

The World Economic Forum's "Global Competitiveness Report 2017" measured Singapore's "State of Cluster Development" a 5.18 out of 7, which places Singapore in the top 10 countries in this category, ahead of Japan¹⁷¹. Singapore offers various programmes and initiatives that support global investment and collaboration. The country has a low rate of corporate tax, indirect tax, as well as personal tax. One of Singapore's strengths is its Intellectual Property Law that is much ahead of other Asian and neighbouring countries in Southeast Asia. This law covers industry designs, copyrights, trademarks, and trade secrets.

Singapore understands that it has many industries that contribute to the economic growth; nevertheless, it is also focusing on several key industries that are believed to strengthen the nation's potential position within the world economy. Those key industries include electronics, logistics, ICT, and healthcare (medical technologies). Particularly in the electronics industry, one of the biggest contributors to the manufacturing sector in Singapore, the highly developed nature of its industrial clusters has helped Singapore to be one of the most diverse semiconductor industries in the Asia Pacific¹⁷².

As Singapore defines its industrial cluster as the group or collection of companies from relevant industries, and not from its geographic area (due to the size of the country), many of the cluster community in Singapore are comprised of business associations and official industrial groups. Those business associations help shape the industrial growth in each area and play an important role in

¹⁷⁰ Business Environment Rankings 2014. *Which country is best to do business in?* The Economist Intelligence Unit [Online]. Available: www.iberglobal.com/files/business_climate_eiu.pdf [2018, July]

¹⁷¹ State of Cluster Development 2017, The World Bank [Online]. Available: https://tcddata360.worldbank.org/indicators/cluster.dev?country=SGP&indicator=597&viz=line_chart&years=2007,2017 [2018, July]

¹⁷² Electronics, EDB Singapore [Online]. Available: www.edb.gov.sg/en/our-industries/electronics.html [2018, July]

supporting the government to implement the main Industrial Transformation Maps. The business associations are operating similarly as other countries geographical clusters (e.g. in US, China, or EU) such as providing various services to their members for instance by organising business networking events, developing trainings, certifications, informing standardisation, and many others.

The government's commitment to implementing the strategies recommended by the Committee on the Future of Economy Singapore is also shown in its infrastructure development and national budget allocation. Regarding infrastructure development, the government launched all of the 23 ITMs between 2017 and 2018, and appointed each of the government agencies to oversee the full implementation of the ITMs including the need of building relevant infrastructure such as science parks, ports, etc. Concerning the national budget, the government allocated a specific portion of its budget towards R&D. The budget on R&D is implemented through a series of policies, plans and strategies for research, innovation and enterprise under the RIE 2020 plan. This fund that is operated by the Singapore National Research Foundation (NRF) aims to transform Singapore into a vibrant R&D hub that contributes towards a knowledge-intensive, innovative and entrepreneurial economy; thus, making Singapore a magnet for excellence in science and innovation.

The concept of cluster in Singapore is different from the European one but there is a tendency towards a common model. The EU and Singapore share a common strategy in terms of emerging industries, globalisation, and future developments, placing their focus on ICT (Digital Economy), electronics (strongly related to Industry 4.0), healthcare and medical technology advancement, and logistics hub. This presents a wide range of opportunities for cooperation in R&D, innovation, business development and trade.

In this regard, the EU cluster community is well positioned to collaborate with the Singaporean cluster community; thus, deepening and expanding the existing bonds between both regions and strengthening synergies. For instance, according to the internationalisation survey conducted by the ECCP in 2017, Singapore is among the most popular target countries within the EU cluster community¹⁷³.

¹⁷³ www.clustercollaboration.eu/news/analysis-survey-amongst-eccp-profiled-cluster-organisations-executive-0

6. Annex

6.1 EU-Singapore R&DI projects

TABLE 5 - EU-SINGAPORE RESEARCH, DEVELOPMENT AND INNOVATION SELECTED PROJECTS

PROJECT	DESCRIPTION
SEA-EU-NET - 10 /2012-09/ 2016	<p>SEA-EU-NET 2 - EU-ASEAN S&T cooperation to jointly tackle societal - will build upon and leverage strong EU-SEA S&T relationships developed through past support and coordination actions, to deepen engagement and build momentum in S&T cooperation. It broadens the scope of EU-SEA cooperation (including Singapore) through stimulating sustainable innovation collaborations. SEA-EU-NET 2 will focus on three societal challenges: Health, Food security and safety, and Water management, where the greatest opportunities can be leveraged from joint EU-SEA research. SEA-EU-NET 2 will serve as a platform for all stakeholders across governments, funders, practitioners, and the private sector, to ensure a complete and integrated approach to developing sustainable STI collaboration to jointly tackle societal challenges. It will focus on:</p> <ul style="list-style-type: none"> • Dialogue: To strengthen bi-regional and bilateral EU-ASEAN dialogues in S&T cooperation • Decision-Making: To report to policy makers in both Europe and Southeast Asia in order to pave the way to implement new ambitious bi-regional activities in STI • Jointly Tackling Societal Challenges: To focus on joint efforts on a selected set of thematic areas, namely Health, Food security and safety, and Water management. In focussing on these topics, the project will evaluate EU-SEA S&T cooperation, run workshops to bring scientists together, support young scientists develop new funding schemes to broaden and deepen the collaboration • Networking: To network different stakeholders to build bi-regional networks and to strengthen research capacity • Sustainability: To ensure that all activities deliver impact beyond the lifespan of the project in order to develop sustainable partnerships <p>The project will have lasting impact on (1) a structured and substantiated policy dialogue between ASEAN and EU, (2) the promotion of the ERA in SEA, (3) the role of EU as major partner in research cooperation and innovation by jointly tackling societal challenges, (4) the development of new funding schemes in research and academic mobility.</p> <p>Website: https://sea-eu.net/</p>
VIAJEO PLUS 05/2013-04/2016	<p>The goal of Viajeo PLUS was to benchmark outstanding solutions for innovative and green urban mobility in Europe, Latin America, China and Singapore. The Viajeo PLUS engaged with leading European innovative organisations and academic institutes and cooperate with cities across Europe, Latin America, China, Singapore and MPCs to facilitate the sharing of good practices and demonstration of innovative solutions.¹⁷⁴</p>

¹⁷⁴ https://cordis.europa.eu/project/rcn/109827_en.html

PROJECT	DESCRIPTION
	<p>The last Viajeo PLUS City Showcase Singapore took place on 16-17 November 2016. It was organized by the International Association of Public Transport (UITP) and ERTICO – ITS Europe, with the support of the Singapore Land Transport Authority (LTA). It aimed at facilitating knowledge exchange between Singapore and Europe on innovative and efficient urban mobility solutions.</p> <p>Website: http://viajeoplus.eu</p>
DengueTools 09/2011-04/2016	<p>DengueTools aimed to provide better diagnosis, surveillance, prevention as well as prediction and/or prevention of the spread of Dengue fever to previously uninfected regions (including Europe) in the context of climate change. The project developed a rapid diagnostic assay for resource-limited settings that can be used as point-of-care, is portable, provides rapid results and is inexpensive. Novel tools for vector monitoring will be tested. The project proposed to propose to develop a comprehensive, early warning, laboratory-based sentinel surveillance system that integrates clinical, entomological, environmental, socio-economic, and weather/climate indices to evaluate predictive capability for epidemic dengue.¹⁷⁵ The National University of Singapore was the project partner of DengueTools.</p> <p>Website: www.denguetools.com</p>
INFORM 07/2009-06/2012	<p>INFORM aimed to reinforce the international dimension of EU research on nanomaterials in formulations in the Asia-Pacific region. Three mechanisms was implemented to reach the widest possible audience: (1) yearly major events that introduced a new concept to scientific gatherings and a departure from conventional meetings, (2) a researchers exchange program to seed new collaborations, facilitate joint projects and the realisation of future coordinated calls, and (3) the creation of a website devoted to nanomaterials in formulations, that included up to date and reliable information on the newest research developments, funding opportunities, regulations, events and links to other nanotechnology initiatives.¹⁷⁶</p> <p>Website: https://cordis.europa.eu/project/rcn/91315_en.html</p>
EPIC 02/2017-07/2019	<p>The project aims to improve cooperation in the area of information and communication technologies between Europe and three partner countries in the Asia-Pacific (Australia, New Zealand, Singapore). EPIC will foster cooperation in ICT research, technology development and innovation-related topics at the policy and the researcher level. The initiative builds on cooperation policy dialogues, the analysis of research capabilities, and on recommendations from previous projects involving these countries. The project follows a topically expanding methodology: cooperation will start from a small set of joint and/or global challenges and continue to expand areas as the project progresses. Initial topics include smart nations, resilient and sustainable cities, open and digital science.¹⁷⁷</p> <p>Website: https://epicproject.eu/</p>

¹⁷⁵ https://cordis.europa.eu/project/rcn/100455_en.html

¹⁷⁶ https://cordis.europa.eu/project/rcn/91315_en.html

¹⁷⁷ https://cordis.europa.eu/project/rcn/207663_en.html

PROJECT	DESCRIPTION
DNASURF 12/2017-11/2021	DNASURF will establish a global network of excellence for the exchange of research staff and transfer of knowledge, to provide high-level training and career advancement opportunities, focus on interdisciplinary DNA technology with a view to the development of innovative solutions for DNA molecular diagnostics. It brings together leading academic and commercial scientific groups from 3 European and 4 non-European countries who will study complementary aspects of DNA synthesis, DNA nanoarchitectures, DNA at surfaces, and DNA for biomedical devices. ¹⁷⁸ The National University of Singapore is the project partner of DNASURF. Website: https://cordis.europa.eu/project/rcn/212987_en.html
MAKERS 01/2016-12/2018	MAKERS will bring together leaders from business, academia and policy to study issues related to the drivers and dynamics of sustaining the competitiveness of EU manufacturing sectors. The project's innovative research, training and mobility activities will address key concerns related to the historic opportunity for the EU to lead a manufacturing renaissance that not only upgrades existing manufacturing competences but, more importantly, develops new technological capabilities across EU regions to support regional industrial resilience for more distributed and sustainable socio-economic growth and prosperity. ¹⁷⁹ The National University of Singapore is the project partner of MAKERS. Website: www.makers-rise.org
IDENTITY 01/2016-12/2019	IDENTITY aims at consolidating the integration of multimedia forensics into the forensic science. Multimedia forensics is concerned with the development of scientific methods to extract, analyse and categorize digital evidence derived from multimedia sources, such as imaging devices. For example, developing technologies to identify, categorise and classify the source of images and video, as well as to authenticate and verify the integrity of their content. Since the enabling technologies in multimedia forensics are similar to those used for identification and verification purposes in biometric forensics, the integration of these areas is seamless. ¹⁸⁰ Nanyang Technological University is a project partner of IDENTITY Website: https://cordis.europa.eu/project/rcn/200056_en.html

¹⁷⁸ https://cordis.europa.eu/project/rcn/212987_en.html

¹⁷⁹ https://cordis.europa.eu/project/rcn/200193_en.html

¹⁸⁰ https://cordis.europa.eu/project/rcn/200056_en.html

6.2 ESCP-4i Targeting Singaporean Market

TABLE 6 - ESCP-4i TARGETING SINGAPOREAN MARKET

Acronym	ESCP-4i name	Sector(s)	Targeted third countries	No. of SME includes	Clusters
COSMENERG-4i	Global Clusters for Renewable Energy and Environmental Technologies	Environmental Services PROTECTING MAN AND ENVIRONMENT › Environment › Environmental Engineering / Technology	Singapore, Indonesia, Israel, Jordan, Malaysia, Qatar, United Arab Emirates, Viet Nam	350	Partners including: <ul style="list-style-type: none"> • Netzwerk Energie & Umwelt e. V. (Germany) • ArchEnergy Cluster (Hungary) • GREEN ENERGY Romanian Innovative Biomass Cluster (Romania)
ESCT Go Global	European SmartCityTech Go Global	Information Technology and Analytical Instruments ELECTRONICS, IT AND TELECOMMS › Electronics, Microelectronics › Digital Systems, Digital Representation	Singapore, India, United States	3017	Partners including: <ul style="list-style-type: none"> • House of Energy (Denmark) • Cluster SCC - Fondazione Smart Cities & Communities - Lombardia (Italy) • BrainsBusiness - ICT North Denmark (Denmark) • GAIA.-Association of Knowledge and Applied Technologies industries in the Basque Country (Spain) • Systematic Paris-Region (France) • DSP Valley (Belgium)
LASER-GO GLOBAL	European Cluster Partnership in Photonics for Health	Lighting and Electrical Equipment BIOLOGICAL SCIENCES › Medicine, Human Health › Medical Technology / Biomedical Engineering	Singapore, Australia, Canada, Israel, Japan, New Zealand, Republic of Korea (South Korea), United States	240	Partners including: <ul style="list-style-type: none"> • Optence e.V., Kompetenznetz Optische Technologien Hessen/Rheinland-Pfalz



D.3.2 - Preparatory Briefing on Singapore

Acronym	ESCP-4i name	Sector(s)	Targeted third countries	No. of SME includes	Clusters
MobiGoIn-Action	Mobility Goes International - In Action	Transportation and Logistics ELECTRONICS, IT AND TELECOMMS>IT and Telematics Applications › Applications for Transport and Logistics	Singapore, Canada, China, United States	1270	Partners including: <ul style="list-style-type: none">• Baden Württemberg: Connected e.V. (Germany)• MOV'EO (France)• Fondazione Torino Wireless (Italy)• Media Evolution Southern Sweden (Sweden)

6.3 Relevant organisations in Singapore

TABLE 7 - RELEVANT ORGANISATIONS IN SINGAPORE FOR CLUSTER COOPERATION AND BUSINESS SUPPORT

ORGANISATION	WEBSITE
Enterprise Singapore	https://www.enterprisesg.gov.sg/
EU Centre in Singapore	http://www.eucentre.sg/
Enterprise Europe Network Singapore	http://www.een-singapore.sg/
Singapore Manufacturing Federation	http://www.smfederation.org.sg/
Economic Development Board Singapore	https://www.edb.gov.sg/
South-East Asia IPR SME Helpdesk	http://www.southeastasia-iprhelpdesk.eu
EU Gateway Business Avenues	https://www.eu-gateway.eu/
EU-Asia Centre	http://www.eu-asiacentre.eu/
EU-ASEAN Business Council	https://www.eu-asean.eu/
Mission of the EU to ASEAN	https://eeas.europa.eu/delegations/association-southeast-asian-nations-asean_en
European Chamber of Commerce in Singapore	https://eurocham.org.sg/
Singapore-Central Europe Chamber of Commerce	http://scecham.eu/
French Chamber of Commerce in Singapore	http://www.fccsingapore.com/
British Chamber of Commerce in Singapore	https://www.britcham.org.sg/
Singaporean-German Chamber of Industry and Commerce	https://www.sgc.org.sg/
Singapore International Chamber of Commerce	https://www.sicc.com.sg/
SME Portal Singapore	https://www.smeportal.sg
Startup SG	http://www.startupsg.net/
The Agency for Science, Technology and Research (A*STAR)	https://www.a-star.edu.sg/