Analysis of the Singaporean ICT cluster

Public management for competitiveness - 2020/21

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1 SINGAPORE'S FACT SHEET

1.1 Geography, demographics and culture

Singapore is a city-state founded in 1819 by Sir Stamford Raffles as a trading post of the British Empire on a pre-existing settlement that dates back to the 14th century. It is located at the southern tip of the Malaysian peninsula, about 97 kilometers north of the equator. The country's territory is composed of one main island and 63 islands and islets amounting for a total of 725.7 km. There are no distinctive seasons in Singapore. Indeed, there is an almost uniform temperature and the same holds for pressure. The humidity is high and there is ample rainfall. This suggests a rainforest climate[1]. The population of Singapore stands at just over 6.2 million[2]. There is, however, a demographic problem: the fertility rate is 0.8 children per woman, the lowest in the world (a rate of 2.1 is required for the reproduction of the species). From a linguistic point of view, the British descent is evident since the lingua franca (official language used for documents) is English, spoken as mother tongue by about 37% of the population; Chinese (35%) and Malay (10%), a language symbolically chosen in the immediate post-independence period as a sign of détente with neighboring countries. Singapore has the sixth best health system in the world and the lowest infant mortality rate. Singapore's population is normally housed in new cities[3]. The literacy rate of the population aged 15 years and above is 97.5% while 57.3% of residents aged 25 years & over have post-secondary qualifications. The country has 2 universities that are ranked in the world QS top 15, one of which is a technical university. With Chinese (76.2% of the population), Malays (15.0%), and Indians (7.4%) ethnicities, Singapore is a multiracial and multicultural nation. The rest of the population is composed of Chinese Singaporeans but there are Eurasians as well.[4] Singapore is driven by a culture of order, efficiency and cleanliness that is rooted both in the societal and individual level. Singapore ranks as an economy with comparatively

[1] https://globaledge.msu.edu/countries/singapore/statistics
[2] https://www.bbc.com/news/world-asia-15961759
[3] https://en.wikipedia.org/wiki/Demographics_of_Singapore
[4] https://en.wikipedia.org/wiki/Demographics_of_Singapore

high income disparity, at a value of 0.481 (0.462 after government transfers and taxes), higher than most other industrialized economies. Only Hong Kong and a handful of Latin American countries report higher levels of inequality throughout a broader sample of countries. (Ketels, 2009)

1.2 Transports and infrastructures

Transportation in Singapore is mostly land-based. Via buses, taxis and ridesharing services, many parts of Singapore, including the islands, are accessible by road. Inside Singapore, the second major mode of transport is rail (Mass Rapid Transit and Light Rail Transit). Ferry boat services link the main island of Singapore with the other islands. There are two bridges, the Causeway and the Second Connection, that connect Singapore to Malaysia[5]. The main aviation hub in Asia is the Singapore Changi Airport which has six local scheduled service airlines and represents the cornerstone of the extensive geographical connectedness of Singapore.[6] Currently, 95% of Singapore's electricity is derived from natural gas, while the remainder is generated from coal, gasoline, waste, and solar power. In terms of cost-effective and stable renewable sources of energy, Singapore is limited.[7]

Infrastructures in Singapore are extremely developed and technological[8] because Singapore's Infrastructural Development has been guided and driven by government agencies set up for the purpose of facilitating delivery of information, goods and services, and supports economic growth.[9] The road system is extended, and it has the first congestion pricing scheme ever designed to limit traffic (Singapore Area Licensing Scheme). This is a technological system, because tolls are all electronic. Three civil airports are present. Furthermore, Singapore has a port which is the second in the world in terms of cargo tonnage, behind Shanghai, and shipping tonnage. Today, the nation is known as

[5] https://en.wikipedia.org/wiki/Transport_in_Singapore
[6] http://www.international-airport.eu/en/singapore-airport/
[7] https://globaledge.msu.edu/countries/singapore/statistics
[8] https://www.businesstimes.com.sg/government-economy/singapore-has-the-best-infrastructure-in-the-world-survey
[9] https://journal.isca.org.sg/2018/07/23/positioning-singapore-as-asias-infrastructure-hub/pugpig_index.html

an international telecommunications center, an accomplishment driven by the long-term vision of Singapore that high-quality telecommunications is one of the vital drivers of its economic development. There are also a huge number of computer users in Singapore and most households have computers and Internet connections. Around 89% of resident households has access to computers and about 98% of households with school-going children has access to computers at home (2019). The nation appears to be one of the few countries in the world where broadband internet connectivity is freely accessible in every spot of the country to virtually any person.[10]

1.3 Historical, political, social and legal context (Porter, 2009)

For over 100 years, Singapore was under British control, which explains the current membership in the Commonwealth and the Western-like development model. But when, during World War 2, the British failed to defend the colony from the Japanese, it ignited a deep anti-colonial and nationalist feeling that, combined with the decisions of the neighbors, later led to the independence of Singapore in 1965.[11] After independence, Singapore experienced some problems: the territory was sandwiched between Malaysia and Indonesia, two large and unfriendly nations, lacking natural resources, hygiene, infrastructure and sufficient supplies of water.[12] Lee Kuan Yew's People Action Party (PAP)[13] started experimenting globalization and creating an atmosphere that was secure, corruption-free and tax-poor to attract investors.[14] The most feasible solution at this stage to Singapore's economic development was in fact to embark on a comprehensive program of industrialization, but, due to the lack of industrial tradition, the citizens had to sacrifice a large portion of their freedom for a more draconian, but business friendly, autocratic government. All independent labor unions were repressed and consolidated in one group controlled by the PAP. Driven by a common fear of communism, in 1967 nations in the region founded an economic community to accelerate economic growth (in order to reduce

[10] https://www.en.wikipedia.org/wiki/Telecommunications_in_Singapore.com
[11] https://www.medium.com/@rutujavispute/singapore-the-way-to-global-city-f6631c04d49c
[12] www.thoughtco.com/singapores-economic-development-1434565
[13] https://www.cfr.org/backgrounder/singapore-small-asian-heavyweight
[14] www.thoughtco.com/singapores-economic-development-1434565

protests) and mutual assistance, the ASEAN (Association of Southeast Asian Nations). Now it includes ten Countries from South-East Asia (Singapore, Vietnam, Malaysia, Brunei, Indonesia, Cambodia, Myanmar, Thailand, Laos and Philippines). The organization shares a single market, institutionalized in 2015 but whose features started to be visible and effective in 1992 with the introduction of AFTA (the Asian Free-Trade Agreement), thanks to which custom tariffs were gradually lowered and were completely zeroed in the mid-2010s. Unlike its neighbors, where there was an uncertain political and economic climate, Singapore was very stable at the time.[15] As stated before, Singapore is a parliamentary republic, based on a Constitution that includes many civil rights, including free press and association. Since these rights can be suspended by the Parliament, despite a Western liberal economic model, in Singapore freedom of speech and association are not complete, because they are conceded and then restricted in the same article in the Constitution. Public order is indeed the priority, also with regards to the possible contrasts that might arise in the city due to the differentiated demographic context (racial, linguistic, religious). Hence, de-facto censorship to journalists and manifestants is possible and often implemented because of the Internal Security Act, the Sedition Act and the Official Secrets Act. Mass surveillance is also a common practice, meaning that the right to privacy is not considered a priority as security and order. Although Singapore has a very low index of freedom of the press (Score: 67 and 148th), it ranks among the first countries in the world in almost all the indices related to business and economy.[16] [17]

1.4 Economic context[18]

Since the 1980s, Singapore turned into an increasingly important industry, financial, transport and communications hub in the Asia-Pacific region and its development was due to different growth drivers. Nonetheless, manufacturing still played an important role in the economy, with its share of GDP over two decades remaining above 25% for most years. Knowledge-intensive business services and manufacturing indeed stayed the main drivers of the economic development of

[15] www.thoughtco.com/singapores-economic-development-1434565
[16] https://globaledge.msu.edu/countries/singapore/indices
[17] https://en.wikipedia.org/wiki/Singapore
[18] https://www.worldbank.org/en/country/singapore/overview

Singapore since the 1990s. (Edquist, 2009) Singapore became an enabling location for high tech entrepreneurship and basic R&D since the ending of 90s. Nowadays, Singapore has a highly developed free-market economy with an open environment free from corruption and characterised by stable prices and a very high per capita GDP. The country is indeed now classified as an "high income economy". The actual currency in Singapore is the Singapore dollar. Singapore's GDP ranks between 318.652 billion to 372.063 billion US dollars from 2016 to 2019 with a GDP Growth Rate of 3.139% in 2018.[19] Because of these figures and thanks to the government's nudges and incentives towards high quality of life (welfare measures such as baby bonus, subsidized healthcare and laptops for students with low income) Singapore is 9th in the world for HDI (0.935 in 2019).[20] Indeed, although the country's economy experienced a setback and a contraction of 0.6% in 2009 because of the global financial crisis, it has continued to grow since 2010. Since 2012 the growth started to slow down as Singapore was reaching the high-income levels and, consequently, the structural growth was decelerating as well. In 2017 growth accelerated again reaching 3.6% of growth rate and consolidating the role of Singapore as a global economy. Some other important measures are indicative of the good and successful economic context. Both inflation and unemployment are currently low while the FDI (net inflows) are high and around US$ 100 billion in 2019.[21] Despite its small size, the country has developed strong trade agreements (DHL Global Connectedness Index: nation's integration into the world-87,3 and 2nd) with several countries in the United States, South America, Europe and Asia.[22] More than 3000 companies that are affirmed at multinational level operate in the country. They totalize more than two-thirds of Singaporean manufacturing output and direct export sales. Singapore has also signed the Trans-Pacific Partnership Comprehensive and Progressive Agreement (CPTPP) and engaged in negotiations for the Regional Comprehensive Economic Partnership (RCEP).[23] The index of economic freedom is around 90/100 and indicates a high degree of economic autonomy of the country from the government.[24] The economy of Singapore is a mixed economy. Indeed, free-market policies and practices

[19] https://globaledge.msu.edu/countries/singapore/economy
[20] https://www.singstat.gov.sg/
[21] https://globaledge.msu.edu/countries/singapore/economy
[22] https://globaledge.msu.edu/countries/singapore/indices
[23] www.indexmundi.com/singapore/economy_profile.html
[24] https://globaledge.msu.edu/countries/singapore/indices

are strongly advocated by the country, but this has also come hand in hand with strong government interference, especially imposing macro policies and interfering with major input factors such as land, labor and capital resources.[25] Both types of market management have a strong impact on the economy. This type of economics' model has demonstrated to be unique in history and proved to be successful in Singapore. For this reason, it has been called the Singapore Model.[26] Despite this is the fundamental model leading in Singapore's economy, due to the aforementioned shared culture and the big amount of policies issued by the state, it's possible to affirm that the perception of the interventions of the state is considered particularly pervasive. In the investment phase, a strong and efficient government role was beneficial when the main competitive advantages in the actual market were efficiency and reliability. However, the government's role in the years tried to shift to the one of improving the business environment and having less involvement in the competitive process. The general political and economic situation of the country allows it to have a country risk rating of A2[27]. That means that the business environment is stable and efficient, there is a low probability for corporate default, but some improvements can still be put in place. Singapore is the second on 190 economies in the ranking of the ease of doing business, according to the latest World Bank annual ratings (Ease of doing business index)[28]. Singapore passed from the third position in 2015 to the second one in 2016, keeping this ranking till 2019. Swiss business school IMD ranked Singapore as the world's most competitive economy (Global Competitiveness Index: competitiveness of a country based on enabling high productivity levels- 84.8 and 1st).[29] Some reasons why U.S. companies should consider to export to Singapore can be summarized as following: major ICT, distribution, and logistics hub; lack of corruption; favorable tax codes; strong intellectual property protection; English speaking population.[30] In order not to be heavily dependent on external markets, the government had

[25] www.economywatch.com/world_economy/singapore/structure-of-economy
[26] https://www.economywatch.com/world_economy/singapore/structure-of-economy
[27] https://www.coface.com/Economic-Studies-and-Country-Risks/Singapore
[28] http://documents1.worldbank.org/curated/en/688761571934946384/pdf/Doing-Business-2020-Comparing-Business-Regulation-in-190-Economies.pdf
https://www.doingbusiness.org/en/data/exploreeconomies/singapore
https://www.doingbusiness.org/content/dam/doingBusiness/country/s/singapore/SGP.pdf
[29] https://globaledge.msu.edu/countries/singapore/indices
[30] https://www.export.gov/article?series=a0pt0000000PAuoAAG&type=Country_Commercial__kav

to adopt economic policies to shield the country from global market shocks and to establish economic initiatives and industries that could meet the external market needs. In this way the economy of Singapore has shown stunning resilience to financial crises such as the 1997 Asian Financial Crisis or the 2008 Global Financial Crisis, and it is the only Asian country to have AAA credit ratings from Standard & Poor's, Moody's and Fitch, all three major credit rating agencies. The major contribution to GDP is given by the services, immediately followed by industry, manufacturing and agriculture.[31] Top industries are electronics, chemicals, financial services and oil drilling equipment. The three main exported goods (2019) are electrical machinery, industrial machinery including computers and oil and mineral fuels.[32] In addition, Singapore has drawn significant investments in various industries, such as advanced engineering, pharmaceuticals and the development of medical technology.[33] In 2016, they launched the so called Industry Transformation Map (ITM): industry-specific road maps whose aim was to join trade associations and chamber, enterprises and the government in order to make them work together to help each sector take a clear direction for the future. Direct links between related and complementary industries were created with the consequence of identifying six clusters, namely manufacturing (precision engineering, electronics, marine & offshore and aerospace, and energy & chemicals), built environment (construction, real estate, environmental services and security), trade and connectivity (air transport, sea transport, land transport, logistics and wholesale trade), essential domestic services (healthcare and education), modern services (professional services, ICT & media, and financial services) and lifestyle (food services, food manufacturing, retail and hotels). The vision of this approach was to position Singapore as the key location for technology innovation and enterprises among the most important Asian regions, in order to create a "global Asia node" (Heng).[34] The Global Innovation Index (includes information

[31] https://www.singstat.gov.sg/
[32] https://globaledge.msu.edu/countries/singapore/economy
[33] www.clustercollaboration.eu/sites/default/files/d3.2_preparatory_briefing_singapore_20180905_vf.pdf
[34] https://www.straitstimes.com/business/economy/singapores-23-key-industries-to-be-grouped-into-6-clusters-as-economy-begins-next

regarding innovation which range from political environment to education, infrastructure and business sophistication- 59.8 and 5th)[35]demonstrates this effort.

2 DIAMOND FOR SINGAPORE'S DEVELOPMENT

FACTOR CONDITIONS:

- Small country in the form of a city-state
- Strategic position for South East Asian sea routes (port hub)
- Not rich in natural resources (water, coal, petroleum)
- Increasingly aging population (increasing dependency ratio)[36]
- Low skilled people attracted
- Heterogeneous population: diversity
- English language
- Pro-immigration government
- Good quality of the education system and R&D centers
- Culture for order and safety, security, cleanliness, respect, meritocracy
- Very advanced infrastructure thanks to the government investments
- Gender inequality in the workforce
- History of low press freedom

Singapore has always benefited from a large internal supply of workers, however this supply is likely to shrink in the near future. This is mainly due to the combination of an increasing dependency ratio (especially the old one) and a

[35] https://globaledge.msu.edu/countries/singapore/indices
[36] https://globaledge.msu.edu/countries/singapore/statistics

decreasing trend in natality. That means that in the near future, the young population, entering the labour market, will not be enough to substitute the current working population (causing also problems in terms of economic sustainability). The increasingly aging population, therefore, will naturally lead to the necessity of attracting people from abroad to increase the workforce. On the contrary, the small size of the country reduces the attractiveness of the domestic market for foreign investors and talents. Still regarding the consequences of the limited dimensions, it is possible to state that they make it easier to reach consensus on policies, especially since there is no conflict between rural and metropolitan areas. Indeed, metropolitan areas like Singapore have an advantage in that public services can usually be offered more efficiently. Since the lack of resources poses a selected disadvantage to the location, Singapore's Government decided to focus on the outside to make the country more competitive. Therefore, it opened the economy by attracting foreign investors and firms and increasing the connectivity and the integration with the world. This process was also favored by the location of the country at a major global shipping route, which provides significant opportunities for the specialization of the economy. The ethnic diversity can provide a further interesting foundation for an open society, attractive for foreign talents (which can be nonetheless discouraged by the gender inequality that is strongly settled in the workforce). This is further enhanced by the fact that the English language is widely spoken and there are pro-immigration policies. Factors that can dissuade talents from coming to Singapore, on the other hand, can be a strong culture for order and cleanliness, combined with a history of low press freedom. Due to an economic, governmental and organizational effort, Singapore enjoys a high level of educational institutions and R&D centers as well as an advanced general infrastructural system.

FIRM STRATEGY, STRUCTURE AND RIVALRY:

- Public agencies are treated like private ones because aimed at gaining profits (more than 450 public-sector firms)
- Clear strategic vision of the government about the clusters' development
- Government imposed top-down cheap labor costs

- Top-down monetary policy
- Mixed economy: both state intervention and free market competition
- Good investment climate
- ASEAN and 20 FTAs also with several countries in the United States[37]
- Simple administrative routines for companies
- Dependence on international and regional markets because of its small size

The context for strategy and rivalry demonstrates that Singaporean government had a clear vision aimed at taking the needed steps to transition from a manufacturing economy (industry-based) to a knowledge-based economy (clusters-based) and increasing the innovation capacity of the local firms. This is why it is possible to talk in the case of Singapore of a government-driven economic development. The role of the neighbors (ASEAN) was fundamental for Singaporean economy context's exploitation. Indeed, Singapore has always been seen as different from its neighbors because of its size and its government but has been able to exploit nearby countries' resources when it lacked them.[38] Moreover, Singapore's competitive landscape is characterized by the historical presence of a huge amount of firms driven by the MNCs' need for a presence in the region that led them to set their regional headquarters in Singapore, contributing to the creation of a strong competitive environment. However, given the larger size of neighboring countries, Singapore has always tried to affirm its supremacy detaching from them. Indeed, analysts say that the fissures continue to thwart the region's ability to compete collectively against the economies of India and China. As explained in the CIA country profile, the government is trying to restructure the economy, which relies too much on foreign labour and to increase productivity growth and wages. Moreover, the government imposes in a top-down way not only the monetary policy (including exchange rate) but also wages and, in general, as low as possible labour costs (in order to increase operational effectiveness), in this way also influencing employment conditions. ASEAN and 20 FTAs have been keys for economic

[37] http://www.insis.com/en/articles/singapore-s-free-trade-agreements
[38] https://www.nytimes.com/2007/03/15/world/asia/15iht-singapore.4922379.html

development given the capital attraction strategy from abroad but at the same time demonstrate how Singapore is dependent on foreign countries because of its small size. The simplification of administrative routines for companies represents a help by the government for the business environment and since it is mainly realized through ICT solutions, it is a strong boost for this cluster. Furthermore, ICT has been pervasive also (and even more) in public agencies, which are treated as private ones, namely for-profits companies.

RELATED AND SUPPORTING INDUSTRIES:

- Tradition in manufacturing
- Precision engineering and electronics manufacturing
- Construction and real estate
- Domestic services sector
- Logistics and transports
- Government-driven IT cluster
- Refinery industry
- Financial services
- Cybersecurity directly connected to the advanced development and diffusion of the IT cluster
- Biopharmaceutical industry[39]

All the most important mentioned industries in Singapore have not strong relationships dictated by relationships in their value chain (vertical or horizontal relationships). Indeed, the government fostered the development of these industries facilitating their ties in a top-down manner. Due to the possibility of strengthening simple and unitarian policies, the government was able to make the industries work together and help each other imposing a single way of production.

[39] The emerging clusters are distinguished by the blue color

Another demonstration of the government's desire to induce entrepreneurs and managers of capital to increase efficiency and benefit from relative spill-over effects is the decision of creating not natural clusters, but clusters that have been specifically designed by government's experts to increase productivity in light of the overall government vision. The consolidation of Singapore as a financial center throughout the years supported the growth of all the other clusters through the attraction of foreign investments (FDIs). Going more in depth, the historical tradition in manufacturing evolved in the development of precision engineering and electronics manufacturing. Moreover, the need for increasingly developed infrastructures and the high density of the country's population led to the establishment of the construction and real estate sector together with the expansion of the domestic services sector and logistics and transports (in particular shipment due to the factor conditions). In addition the strategic location (75% Chinese import passes from Malacca's strict) and the maturity of the logistic sector also affirmed Singapore as an oil and petroleum products hub. Emerging clusters are the cybersecurity one, connected to the advanced development and diffusion, driven by the government[40], of the IT cluster, and the biopharmaceutical industry, which also had a positive impact on healthcare's sector.

DEMAND CONDITIONS:

- Absence of sophisticated demand
- High population responsiveness
- Openness to foreign countries (and FDIs)

Being Singapore an economy in transition and a small developing country, it lacked a sophisticated demand for specific products and services. It was therefore the government to induce a strong demand for some sectors, both with procurement and with different initiatives, readily welcomed by citizens and SMEs. Given the peculiar history of colonization characterising the country, the population has always had the urge to reaffirm their independence. This

[40] https://www.csa.gov.sg/

willingness has led them to seek external recognition from other countries by opening to commercial relations with them.

3 ICT CLUSTER'S FACT SHEET

The main sectors in the cluster are IT services, the telecommunication services and the ICT infrastructures one, all industries that are growing. This is demonstrated by the positive trend of the revenues as well as the growth of employment in the sector (which is one of the main objectives of the implemented policies, as it will be discussed later). Many noteworthy companies belonging to these industries are present in Singapore because many of them decided to set their regional headquarters here (for the already mentioned reasons). About 59% of the tech multinational companies have chosen to set up their regional headquarters. However, Singapore is not attracting only big MNCs (Salesforce, Dell, Intel, Google, Hewlett Packard Enterprise, Amazon, Trend Micro, Apple, Symantec, IBM, Microsoft, Cisco System, Facebook, Alibaba, Palo Alto Networks, Oracle, Custodio Technologies), but there are also some international startups (YITU, Uber, Zendesk, Freshworks, Stripe). There is also a startup local environment that led to the growth of some so called "regional stars". These industries are in expansion not only in revenue, but also in job opportunities and vacancies (Sea/Garena, Lazada, Carousell, Trax Image Recognition, Go-Jek, Grab, Advance.AI).

Some enabling conditions have led Singapore to have a particularly advanced electronics sector. These conditions include: political stability, business friendly government, the willingness of the government to accept FDI (like in the case of Israel) and the cheap labor costs, as we've seen in the general diamond. Electronics sector was seen as a means to increase attractiveness and develop operational efficiency in a lot of different sectors. The attractiveness generated by this emerging sector led to the attraction of more FDIs and the possibility to foster the development of new clusters. The ICT is an example of these. However, the ICT is only one of the clusters that the government, through a top-down intervention, decided to create. In Singapore, indeed, we can talk about an original planned economy, which transitioned to a cluster-based economy mostly through the support and the direction given by the government policies. The ICT

cluster in particular can be considered as a policy-driven cluster because as it often happens in economies in transition, there was not initially a sophisticated demand, but the demand was launched by the birth of e-government.

Furthermore, Singapore is the second most attractive destination for global talent and in the world startup talents. Finally, regarding business, it has the first most innovative economy in SEA and is the first for IP protection in Asia.

4 GENERAL DIAMOND FOR SINGAPORE'S ICT CLUSTER (Porter, 2008)

FACTOR CONDITIONS:

- Small country (→ easiness of policies design and implementation)
- Not rich in natural resources (→ push for alternative sources of development)
- Increasingly aging population and pro-immigration government (→ push for attracting ICT-specialized talents from abroad)
- English language (→ increase easiness of communication and connectedness)
- Good quality of the education system and R&D (→ creation of an attractive educational environment and IFC's engagement)
- Culture for order and safety, security, cleanliness, respect, meritocracy and informed and aware population (→ easiness of policies responsiveness by citizens and ICT businesses)
- Very advanced telecommunication infrastructure (→ ready advanced basis for ICT services)
- Strong government authority (→ push for the use of new technologies)

FIRM STRATEGY, STRUCTURE AND RIVALRY:

- Public agencies treated like private ones (→ efficiency of and through ICT in public agencies)
- Government policies on labor market and wages (→ influence on employment conditions in ICT sector)

- Mixed economy: both state intervention and free market competition (→ initial investments in ICT solutions fostered by the government)
- Good investment climate (→ openness to FDIs)
- Extensive freedom to ICT private sector (→ privatization of some strategic business areas such as ISP market)

RELATED AND SUPPORTING INDUSTRIES:

- Electronics (Hardware)
- Computer programming and consultancy (softwares)
- Telecommunications Services
- IT services
- Content Services
- The Digital Media & Entertainment Sector
- Education and Learning
- Financial Services
- Healthcare and Biomedical Sciences
- Manufacturing and Logistics
- Tourism, Storage & Hospitality
- Land & Transport
- Other business services
- Public services
- Wholesale and retail
- Construction
- Accommodation and food service activities
- Cybersecurity, Internet of Things and Artificial intelligence

DEMAND CONDITIONS:

- Creation of induced ICT demand by the government (e-government)
- High population responsiveness (especially SMEs) to the government-induced development

HISTORY OF MAIN ICT POLICIES

As the demographic and social conditions demonstrate, almost 50 years ago, Singapore faced issues of overcapacity in the city, miserable living conditions and almost the total absence of infrastructure. The access to information was a milestone in the step between this image of Singapore and the city-state we know nowadays. The ICT journey began in 1980 with the launch of the "National Computerisation Plan " enhanced by the National Computer Board (NCB) whose objectives were: computerising Singapore's Civil Service, coordinating computer education and training, and developing the local computer services industry.[41] [42]

In 1986, the National IT Plan adopted a policy to expand the local IT industry and laid the groundwork for a national broadband infrastructure. So far, the plans have the same focus: developing ICT capabilities through computerization, investment and ICT manpower. In 1991, the National Technology Plan (NPT) was designed to encourage the advancement of technology in Singapore by the National Science and Technology Board. The National Science and Technology Board then founded a nationwide computer network named Technet (NSTB). Targeted at the R&D community and academic institutions and run by the NUS, the network connected institutions to each other and the Internet became the first Internet Service Provider in Singapore (ISP). In April 1992, with the corporatisation of Singapore Telecom, officially recognized as the Telecommunication Authority of Singapore, Singapore took the first steps towards telecom deregulation (TAS). Having purchased the government-funded Technet for $2.5 million, Sembawang Corp's Pacific Internet (PacNet) became Singapore's second ISP in September 1995. From now on, the competition for ISPs in the area will get much tighter. PC ownership has been stimulated by the liberalisation of the ISP industry. In December 1999, the government announced the creation of a new regulatory entity: the Infocomm Development Authority (IDA). Among the many roles of IDA was the development of the ICT sector in Singapore, making ICT widely available to all Singaporeans, as well as licensing and regulatory duties. In 2000, the "Infocom 21" strategy was to build an IT-savvy economy and culture. On the first of August 200At the event, Mr Yeo Cheow Tong,

[41] https://graphics.straitstimes.com/STI/STIMEDIA/Interactives/2015/10/35-years-of-ict/supercharging-singapore/the-1980s.html
[42] https://services.hbsp.harvard.edu/api/courses/760287/items/710483-PDF-ENG/sclinks/ce9be1de8a425c657f33fc9a07665163

Minister of Communications and Information Technology, announced the Government's initiatives to dot-com Singapore's private sector covering six strategies: laying a solid foundation for e-business; catalyzing digital transformation; stimulating customer demand; branding Singapore as a trusted global dot-com hub and an e-business thought leadership center. Then in May 2005, as a demonstration of the ability to make Singapore a global city powered by infocomm (mainly thanks to the development of a super-fast Next Generation Nationwide Broadband Network (NGNBN)) and a desirable mix of technology, infrastructure, business and workforce, a Singapore ten-year information technology masterplan called iN2015 was introduced. iN2015 was led by the Singapore Infocomm Development Authority (IDA) with a multi-agency work aimed at the co-creation of the commercial, public and individual sectors. The "Intelligent Nation 2015" strategy created many opportunities for the ICT workers and paved the way for the wireless and wired infrastructure of the next decade. The aim was twofold: to lift the infocomm industry's added value and the generation of 80,000 additional jobs. In addition, they planned to enter at least 90% of homes using broadband internet and to guarantee 100% ownership of computers for all school-going children's homes.[43] IDA has now partnered with the Urban Redevelopment Authority of Singapore to build the Jurong Lake District smart area and is already considering Singapore's upcoming 'Smart Country' program in the prospect of completion of the iN2015 program. While from 2000 to 2006, under the e-Government Action Plan I and II, policies centered on moving online services and providing people with open, integrated and value-added public services to get citizens closer to each other, from 2006 to 2010, under the i-Gov2010 programme, the goal was to develop an integrated infrastructure to promote closeness of citizens to the government through ICT's solutions, allowing better public services' delivery and access. (Vu, 2013) Simplifications of administrative routines for corporate ties with the government have also been achieved thanks to these initiatives. In addition, a plan to turn Singapore into a "vibrant global information and arts city" was launched by the Ministry of Information, Communications and Arts (MICA). This is why, through the use of emerging technology, the Singapore Film Commission and the Singapore Media Academy have sought to promote film production and the work

[43] https://www.zdnet.com/article/pushing-singapores-ict-ahead-to-2015/

of media professionals. The regional polytechnics and universities started offering digital media and animation programs. Animation studios and computer game developers such as Koel, Lucas films and Electronic Arts were drawn to Singapore. After the success of eGov2010 and earlier programs, the eGov2015 strategy was introduced in 2011. The government defined three main trends driving the masterplan: global developments in ICT, particularly in mobile technologies; a better educated and more knowledgeable population; the movement towards open data and open government. The Personal Data Protection Act (PDPA) took place in steps, beginning with the establishment on January 2, 2013 of the Personal Data Protection Commission (PDPC). The law's objective is the one of preventing the misuse of personal information through the governance of how businesses collect, use, protect, correct and provide access to personal data. Singaporean firms had at least 18 months to comply with the new legislation, which contained data privacy requirements. The Government of Singapore was commended for its transparent digital policy, providing the best online services in the world, in the World Economic Forum Global Information Technology Survey 2014.[44] In October 2014, the government unveiled plans to carry out 1,000 sensors throughout the island to track everything from air quality to water level. The sensors will support previously announced projects, including security cameras in Little India and Geylang. The Prime Minister revealed the city-state's idea of a smart nation in December 2014. The vision is to improve the living conditions of people and to create more opportunities through ICT. The smart nation project is an attempt by the government to co-develop with the business and citizens creative people-centric solutions.[45] To organize the initiative, a national program office was created, headed by a cabinet minister. The three focus areas underpinned by cybersecurity are elderly people, transport and records (in order to improve decision making). The "Smart Nation Platform" would broaden existing networks of ultra-high-speed optical fibers in terms of infrastructure, for much greater ubiquitous connectivity. Although the project of the smart nation is not about technology, technology plays a significant role. IoT, 3D printing, big data and robotics include some of the enabling technologies listed that have immense potential and will have an impact. Sharing government data with the public to promote co-creation of solutions is one of the main

[44] https://www.edb.gov.sg/en/our-industries/information-and-communications-technology.html
[45] https://www.csc.gov.sg/articles/digital-government-smart-nation-pursuing-singapore's-tech-imperative

areas of the project. To understand the reasons why Singapore insists on its Smart Nation strategy, the key forces behind this strategy must be illuminated. As the population ages and the inflow of immigration slows down (given the limited physical space), labor may expand more slowly as a development force. Moreover consumption as a percentage of GDP would likely increase compared to investment. Total factor competitiveness, which can be accomplished by a combination of technologies and a better market functioning facilitated by an efficient digital government, would therefore have to be the primary contributor to development and prosperity. In 2016, GovTech was formally introduced as the organization tasked with realizing and extending the Smart Nation Network in order to better focus on this strategy. The Government of Singapore only declared in 2017 that GovTech, the Smart Nation Program Office, the related Ministry of Finance and the Ministry of Communications and Information departments would come together to form the Smart Nation and Digital Government Party (SNDGG). In 2016, the Tanjong Kling Data Centre Park (DCP) became operational as the Infocomm Development Authority of Singapore, the Singapore Economic Development Board and JTC Corporation worked together on the development of a data center park (DCP) to improve Singapore's role as an economic and ICT hub. In addition to attracting multinational corporations to set up their headquarters and premium data center operations in Singapore, by having more premium data centers such as banks and telco carriers located there, the DCP has also helped develop Singapore as an ICT and media hub. This hub was able in incentivizing tech and media companies to host their services and content for the entire region in Singapore.[46] Finally, in 2018, the Digital Government Blueprint was announced, outlining the Singapore Government's vision and plans for a Digital Government. The DGB is a five-year initiative developed by the Smart Nation and Digital Government Group (SNDGG) to use digital technology with the objective of changing how the government of Singapore connects with the public.[47] The DGB builds on the foundations laid by previous e-Government masterplans. In support of Smart Nation, it is a declaration of the government's aim and commitment to better exploit data and harness emerging technology and

[46] https://www.imda.gov.sg/-/media/Imda/Files/Industry-Development/Infrastructure/DCP-media-factsheet.pdf?la=en
[47] http://web.archive.org/web/20200815165622/https://www.smartnation.gov.sg/whats-new/press-releases

to support greater efforts to create a digital economy and digital society. The DGB outlines a six-fold strategy to develop a digital government: to align services around people and business needs; to improve policy, organizational and technical integration; to build common digital and data platforms; to operate efficient, resilient and safe systems to increase our digital capacity for innovation; to co-create with citizens and businesses; and to promote innovation. In 2020, GovTech partnered with the Ministry of Health to establish the TraceTogether software to support the nationwide touch tracing efforts. It includes the TraceTogether App and TraceTogether Token. The government also launched SafeEntry, a national digital check-in system that records mobile numbers and NRIC of people visiting selected public locations, hotspots, as well as critical service workplaces, has been introduced to monitor and prevent the transmission of COVID-19, performing activities such as contact monitoring and COVID-19 cluster detection. Furthermore, the already existing health-related app "Moments of Life" was improved and rebranded as LifeSG. With an enhanced user interface, the app also provides users with access to more than 40 services that will be tailored for people, providing users with better digital access to health services.[48] [49] (Lam, 2007) (Saravanakumar, 2020)

4.1 Role of university landscape in cluster development

With both public and private universities that offer degree programmes across various different disciplines, Singapore has a wide university landscape. Different government agencies, such as the Ministry of Education (MOE), the Ministry of Trade & Industry (MTI), the Ministry of Manpower (MOM), are working in tight connection with these universities with the objective of providing the economy with a pool of skilled labour and of increasing the employability of students. The Autonomous Universities (AUs) are publicly funded and represent institutions for higher education. They are corporatised with a Board of Trustees and, due to their independence, are free to decide their strategic vision; as a result, they are key in the ties between the needs of the industry and the outcome of the research processes. The key component of a research-intensive technical university is represented by these industrial partnerships, ensuring that research

[48] http://web.archive.org/web/20201119095916/https://www.tech.gov.sg/who-we-are/our-journey
[49] https://www.thoughtco.com/singapores-economic-development-1434565

activities retain their societal and industry relevance. Meanwhile, Nanyang Technological University has been active in attracting technologically sophisticated MNCs to the campus such as Lockheed Martin, Rolls-Royce, Johnson Matthey, ST Engineering, BMW Group. In the consortium for joint research, SIT (Singapore Institute of Technology) is involved, in particular for new platform technology. With the five polytechnics, the IDA and business heads, SIT leads while working with them. With the goal of fostering close business links between SIT and the industry, an Enterprise and Innovation Hub was created (Ming, 2014).

4.2 IFC and their role in Singapore's ICT cluster economic development

The Government of Singapore is also contributing to the design and implementation of partnerships between the university and industry. This is a multi-agency initiative to build an atmosphere conducive to the promotion of closer relations between the university and industry. Moreover, MTI and MOE work together with industries to understand their needs and concerns; in particular MOM plays a supporting role in striving to develop progressive workplaces and a productive workforce.[50][6] The Research, Innovation and Enterprise 2015 (RIE2015) plan was developed by the Government of Singapore to further improve research, with the goal of attracting and cultivating scientific talents through the allocation of scholarships and fellowships as well. The AUs contribute to the core R&D initiatives of Singapore and support the long-term vision of the Singapore Government of being an entrepreneurial, research-intensive and creative in the economy's interventions. Moreover, the Industry Alignment Fund has been set up to enable public researchers to collaborate more closely with industry, with a specific focus on the economic outcomes of R&D. Another basis is represented by the Technology Transfer Office Fund, which aims at creating a culture of innovation and enterprise at the AUs. With regard to ICT regulation, the most important government branches in Singapore are the Ministry of Communications and Intelligence (MCI), the Info-communications Media Development Authority (IMDA), and the Government Technology Agency (GovTech). MCI is responsible for the ICT industry's policies and

[50] https://www.mti.gov.sg/Resources/Economic-Survey-of-Singapore/2020/Economic-Survey-of-Singapore-Second-Quarter-2020

operational matters, while IMDA controls the Singapore ICT sector in general[51]. GovTech, a separate organization, tackles problems related to government digital services and applied technology and serves as the Smart Nation and Digital Government Community (SNDGG) implementation agency. SGTech is Singapore's premier trade organization for the tech industry. It aims at creating an ecosystem that anticipates developments, creates sustainable community-building strategies while encouraging the development of the technology industry in both strategic and emerging sectors. The more than 700 members of SGTech range from inventive start-ups, SMEs and top multinational companies. The Chapters are: AI & High-Performance Computing Chapter (AI&HPC); Singapore Enterprise Chapter (SEC); Smart Nation Chapter (SNC); Cyber Security Chapter (CSC); Cloud & Big Data Chapter (CBDC); and Digital Transformation Chapter (DxC).

4.2.1 Association of the Telecommunications Industry of Singapore

Association of the Telecommunications Industry of Singapore (ATiS)[52] was established in 1986. ATiS's main objective is to develop, promote and protect the free trade of ICT products, technologies and services in Singapore. Service providers and owners, suppliers of equipment, distributors and retailers, value-added resellers, system integrators, consultants and R&D organizations are members of ATiS. Through hosting frequent workshops and info-sharing sessions, ATiS aims to keep its members updated with up-coming innovations and industry updates. ATiS also participates in international/regional conferences and exhibitions, promotes networking sessions with global trading partners, represents industry on national standards committees and maintains frequent dialogs between industry and government. One key international event is the ASEAN Telecommunications Ministers Meeting (TELMIN). The Telecommunications and Information Technology Senior Officials Meeting (TELSOM) and its Working Groups carry

[51] https://www.straitstimes.com/singapore/new-boards-appointed-for-restructured-technology-info-communications-and-media-government

[52] https://www.clustercollaboration.eu/sites/default/files/d3.2_preparatory_briefing_singapore_20180905_vf.pdf

out the four objectives of the e-ASEAN Framework Agreement, among which it stands for the development and the strengthening of the ICT sector's competitiveness.[53]

5 ICT IN-DEPTH ANALYSIS

The Infocomm and Communication Technology (ICT) industry in Singapore is a crucial enabler for virtually every industry field and has strengthened the competitiveness of Singapore by increasing efficiency and changing market processes in sectors such as banking, services and manufacturing. The birth of SingTel, the first business of the future cluster, took place in 1988 with the appearance of the first mobile phones. There was a recognition in the early 1990s that fast technological developments would quickly spawn new forms of telecommunications networks. Later on, SingTel's monopoly on basic telecommunications services came to an end due to the corporatisation of the TAS. Subsequently, new ISPs and cell phone service providers arrived on the scene. The first Internet access service for the public in Singapore was introduced by SingTel in July 1994 and came at a time of increasing internet awareness and interest among scholars as well. It provided access to the Internet, an e-mail service, and a collection of web news stories such as UseNet News, called SingNet. The Singapore One consortium of TAS, NCB, then-SBA (Singapore Broadcasting Authority), NSTB and EDB (Economic Development Board) had an ambitious proposal at the end of the 1990s that included an island link as a first step. A competitive content and service industry is expected to emerge with broadband connectivity in place. The budding third generation (3G) mobile networking technologies began to attract substantial interest in 2001. SingPass, a system that helps people and permanent residents to access government e-services with a single login, such as tax filing and work permit applications, was unveiled in 2003. The new NGNBN, unveiled by IDA in 2007, also heralded the division of powers in the new framework of the market, where the contractor and controller of the fibre network (the network corporation or NetCo) will be a distinct party from the operator of the

[53] https://asean.org/asean-economic-community/asean-telecommunications-and-it-ministers-meeting-telmin/

network (the operating company or OpCo) and would sell bandwidth at wholesale rates to retail service providers. In developing a lively and dynamic broadband industry, this "structural separation" was instrumental. The Infocomm industry's structure from 2000 to 2007 is well reflected by the industry's sales, which can be summarized as in the graph[54] (Appendix A). IDA unveiled a nationwide framework for protecting internet purchases in 2011, following the announcement of the eGov masterplan (Lim, 2018). In 2012, in combination with the release of select 4G phones, all three telcos introduced 4G networks. In 2013, the situation was as follows: 5% of companies perceived Infocomm, the use of computers, the Internet and broadband by firms continued to grow. The proportion of businesses using computers and the Internet rose from 83% in 2011 to 87% in 2013, and from 81% in 2011 to 86% in 2013, respectively. The proportion of businesses used broadband rose from 78% in 2011 to 86% in 2013. In 2013, the proportion of businesses that had a web presence stood at 46%, compared to that in 2012. In the information & communications, financial and insurance activities and business services industries, the use of Infocomm was most important. The percentage of businesses using mobile networks to engage consumers has risen dramatically, from 27% in 2012 to 42% in 2013. It is most widely used by businesses to deliver goods and promotional material to their clients. Companies with Virus Checking/Protection Softwares, followed by Firewall and Anti-Spyware Software, have increased security adoption by Infocomm, becoming the most commonly accepted security measure among all businesses. Fibre and wireless broadband began to overtake ADSL and cable modem as the Internet access choice for households with 62% of resident households using fibre broadband in 2014 from 25% in 2012) and 56 percent using cellular broadband in 2014 (up from 38% in 2012). The most frequently cited reason for not using the Internet is "Lack of knowledge, skills or confidence". More than 8 in 10 residents of Singapore have installed anti-virus software and security patches on computers used to access the Internet at home, but acceptance rates for installing anti-virus software on smartphones have been comparatively lower. While the share of companies concentrated in Infocomm stayed equal in these years, the spread of tech in industries and its usage changed, changing also, as a consequence, the stakeholders of the cluster. Indeed,

[54] https://wiki.nus.edu.sg/display/cs1105groupreports/Singapore%27s+ICT+and+its+development

Infocomm usage was the most prevalent in the business services, education and information & communications sectors in 2014. In October 2014, after the Smart Nation was revealed, it was clear that Smart Nation had to reflect on five main fields in which emerging technology in Singapore plays a key role: transport; home and environment; business productivity; health and enabled ageing; and public sector services. The findings were quickly apparent as the in2015 masterplan came to an ending. The income of the ICT industry saw a Compound Annual Growth Rate (CAGR) of 15.7% for the period 2009 to 2014, based on a manpower analysis in 2015, touching $167.1 billion in 2014. In 2015, businesses continued to extend the usage of computers, the Internet and broadband, and the sectors of education, information & communication and business services were the top three sectors that embraced Infocomm in 2015. From 49% in 2013 to 61% in 2015, the percentage of businesses that used mobile networks to engage consumers rose dramatically. It is easy to observe how the structure of the cluster's associated industries shifted a lot from 2015 to 2016 with respect to other business sectors. The intermediate outcomes of 2018 included a varied composition of the ICT cluster (Appendix B) and numerous primary adjustments following all the policies carried out from 2015 to 2016: the Internet rose from 88% in 2016 to 91% in 2018. Indeed, from 87% in 2016 to 90% in 2018, broadband increased and cloud computing service was about 23 percent in 2018. The three industries with the largest acceptance of Infocomm in 2018 were infocomm and media, business services and education. The participation of companies in e-commerce operations rose to 21 percent in 2018, after staying at about 13 percent in the previous 3 years. Cybersecurity acceptance patterns have stayed similar (from 46% in 2016 to 45% in 2018), with the most widely accepted cybersecurity metric by all businesses, led by firewalls, being Virus Checking or Protection Software. The cluster map represents the cluster’s exact structure. (Appendix C) There are more than 150,000 ICT professionals currently in Singapore. Both general public and companies have been pushed towards the invention of impactful tech solutions that will solve problems in the main areas, improving the Smart Nation eco-system. Examples of projects underway include: Smart Home technologies by Housing and Development Board (HDB); a committee on Autonomous Road Transport; the arrangement of a Centre for Healthcare Assistive and Robotics Technology (CHART) at Changi General Hospital to

promote cooperation between academia, business and academic organizations, to develop robotics and assistive technology-leveraged healthcare solutions. The government has improved an open data repository, in light of the mission of fostering a culture of creativity and maintaining progress, and will continue to release more government data in machine-readable format with the aim of allowing public and third-party developers gain insights and make good use of them in designing solutions. In order to reach insights and better quality of lives, Smart Nation will concentrate on data and their capacity to be transferred, gathered and make sense. In Singapore, developers can exploit a variety of occasions, especially related to developing applications and contributing to building the infrastructure of the Smart Nation.[55] There are four main tech priorities, which will need to be addressed in the future: cybersecurity; Internet-Of-Things; Immersive Media; Artificial Intelligence (or AI) & Data Science. There is opportunity for education/training sector in the ICT sector. With rapid technological growth as well as modifications in market models and customer habits, the process of employment has changed, and the industry has been encouraging the building of digital skills such as Business Analytics, Cloud Infrastructure, and Green ICT, in order to create a pool of potential and Smart Nation-ready, highly trained ICT practitioners.[56]

5.1 COMPETITORS

5.1.1 Global competition

By looking at some indexes on the cluster's global competitiveness and performance it is possible to identify the main global competitors of Singapore. In particular, Singapore is in the top 20 countries and it scores very high in the ICT Development index (Score: 8.05) used to monitor and compare developments in information and communication technology (ICT) between countries over time. Singapore, indeed, represents the best technology hub in Southeast Asia and the most developed example of smart city around the world. This index also allows us to identify the main

55 https://www.clustercollaboration.eu/sites/default/files/d3.2_preparatory_briefing_singapore_20180905_vf.pdf

56 https://www.austrade.gov.au/Australian/Export/Export-markets/Countries/Singapore/Industries

competitors in ICT development, both those performing better than Singapore such as Iceland and South Korea and those having a lower performance such as Israel and Finland. Moreover, Singapore is a very innovative economy, strongly interconnected with the world also thanks to its very advanced communication and digital infrastructures that are the best in Asia. This results in the value of the Networked Readiness index evaluating the propensity of a country to develop a network of information and communication technologies, with Singapore being the best scoring country in the world immediately followed by Finland, Sweden and Norway.[57]

5.1.2 Regional competition as an Asia hub

Competition is not only from Singaporean companies, but also from Asian rivals such as: Japan, which currently leads in mobile services; Korea, in multimedia and broadband services; Hong Kong, in broadcasting and media services. In general, the main threats to Singapore's status as an Asian hub are contenders like the already mentioned Hong Kong, Bangkok, Jakarta and Kuala Lumpur. These cities offer scale and scope economies that Singapore cannot offer, as well as favourable cost structures. Despite the competition, Singapore still offers deep economies of scope but in terms of output in the area of innovation and local start-ups there has not been a great performance. Commercialization of technology and creating successful startups are measures where Singapore still lag the best competitor cities in the area of innovation. Particularly, the areas of competition are innovation commercialization, enterprise creation and creating many more global companies from the local environment. A figure of these characteristics is highlighted by the improvement that Singapore can make in sustaining its start-ups beyond the initial start-up phase. Another indicator that these conditions can represent a threat from competitors is the lack of focus of the government on the venture capitalist market. The Singaporean government usually allocates money to entities like NRF, Temasek and other agencies but has not created a Venture Building Fund that can strategically look for the assets and technologies that can be invested to create future companies.[58]

[57] https://globaledge.msu.edu/countries/singapore/indices
[58] https://medium.com/venture-views/futile-for-singapore-to-compete-on-old-formulas-inderjit-singh-dhaliwal-47e16bda9c1d

5.1.3 Standards

Standards have a crucial role in supporting new technologies development and adoption. IMDA partners both in Singapore and abroad are government departments and agencies, a range of institutions, technical bodies and the infocomm industry. They are collaborating in order to make standards based on the consensus as part of the Singaporean infocomm and media's sector guidelines and practices. In promoting and encouraging the industry's involvement in local and international ICT standards forums, the IMDA Standards Team plays a vital role. Furthermore, professional committees and working groups composed of technical experts from industry, academia and research institutes are also named to establish and promote national infocomm standards and to take part in international activities of standardization of infocomm.

6 RESULTS OF THE ANALYSIS OF THE ICT CLUSTER IN SINGAPORE

The study showed that the ICT sector in Singapore is a key enabler for almost every sector of the industry and has strengthened Singapore's competitiveness by increasing efficiency and transparency.

The cluster is a policy driven cluster since at its beginning it lacked sophisticated demand and the government decided to guide his development, also through a mostly government-induced demand.

It is possible to identify some clear causes of success of the development of the cluster in:

- the clear strategic vision for the cluster by the government demonstrated with its brave and risky investments aimed at financing remarkable policies: indeed, the government initial objective was the one of accelerating routines and Singapore’s growth but also making citizens closer to the government through a direct line supplied by ICT solutions for public services’ delivery and access.

- the competitive environment (due to partial privatization) has worked in favor of the collaboration and the further good competition of companies and industries
- the fact that since the beginning (1994) Singapore's government stored data made the city a Data hub and this supported along the years the decision-making processes
- the low cost of use of the infrastructures (thanks to telecommunications liberalization) and the extensive connectedness given by the broadband in different spots of Singapore's territory represented the basis for ICT's solutions adoption
- ICT solutions were seen as a way to emancipate after years of limited freedom of press and this was exploited by the government because it was used as a channel to reacquire citizens' trust
- the effective implementation of the policies thanks to the authoritative government, the culture for order and the small country size that allowed simple policies to be easily digested by the population: this was also enhanced by the stability of the political and social environment, which helped in the sustainability of the cluster's growth.

7 FUTURE CHALLENGES

From the analysis carried out so far, we have identified some challenges Singapore is going to face from now on. An incumbent problem is demographic: the increasingly aging population and the lowering birth rate are going to reshape the contribution of Singapore's labor utilization to productivity. Moreover, the city-state dependence on the US demonstrated by the trade agreements is something too settled and could lead to problems once the link is broken. Still in the governmental areas of interest, the pandemic management has to be handled in a way that is consistent with the cultural, social and economic environment in order to be effective.[59] The same is valid for the deglobalization issue, which could be further impactful if we consider Covid-19 effects.[60] Going more in depth into the ICT cluster, it is

[59] https://www.nordeatrade.com/fi/explore-new-market/singapore/economical-context
[60] https://ipscommons.sg/singapores-road-to-recovery/

important to notice how it will be affected by a shortage of highly specialized people which could slow down the development of the cluster. The latter must envisage a way to include not only sustainable resources for its development but also standards, which, as demonstrated by the European experience, lead to an increase of efficiency and transparency in the industry. Moreover, the presence of standard could help in the missing coordination that industries of a typical originally policy driven cluster do not foster naturally with the final objective of mutual exploiting spillover effects. Another important challenge is the one of the excessive storage of data, which will lead to big data and privacy issues emergence (in particular ethical issues).

8 RECOMMENDATIONS

In response to these challenges and in order to foster the long term sustainability of this contextualized business environment, while improving the already affirmed Singapore's competitive position, it is possible to come up with recommendations both for the government and for the business actors. In particular, the government should envisage a regulation on data protection as new emerging technologies gather more and more data and this becomes particularly important when dealing with healthcare data used in the pandemic IT's solutions. The pandemic highlighted the necessity of Singapore's supply chain networks diversification and this would involve collaborating more with neighbours countries and also utilising more 'near shore' high-tech industrial parks and developing new ones in order to achieve both resilience and the economy of scale necessary to compete with competitors as a regional Asian hub. Furthermore, the government should promote the resilience of FDIs with the aim of strengthening its independence and fill the ICT skilled people shortage through policies that imply not only better conditions for future employers but also for families. Another recommendation is to reallocate funds towards new agencies that can strategically look for the assets and technologies that can be invested to create future companies and commercialize technology in a way that benefits the local startup environment with the aim of sustaining the growth of local companies. Moreover, as far as the cluster is concerned, the government should liberalize (as Estonia did) only those emerging sectors that are going to be

merged with the actual members of the cluster in order to make competition among firms arise and foster the run to the improvement of their innovation capacity. At the same time, the government should not be less present in the cluster, since its intervention is still perceived as fundamental in Singaporean mixed economy, being ready to internalize the new sectors in the cluster in a strategic way. In order to increase their innovation capacities, firms should design policies, which may be able to reduce the gender gap in ICT, train insiders on advanced topics and implement sustainable supply practices. In addition, firms should be in charge of FDI's resilience in order not to suffer from the deglobalization effects on their value chain. Finally, adherence to standards regarding cybersecurity could represent a competitive advantage for firms when compared to others companies in Asia.

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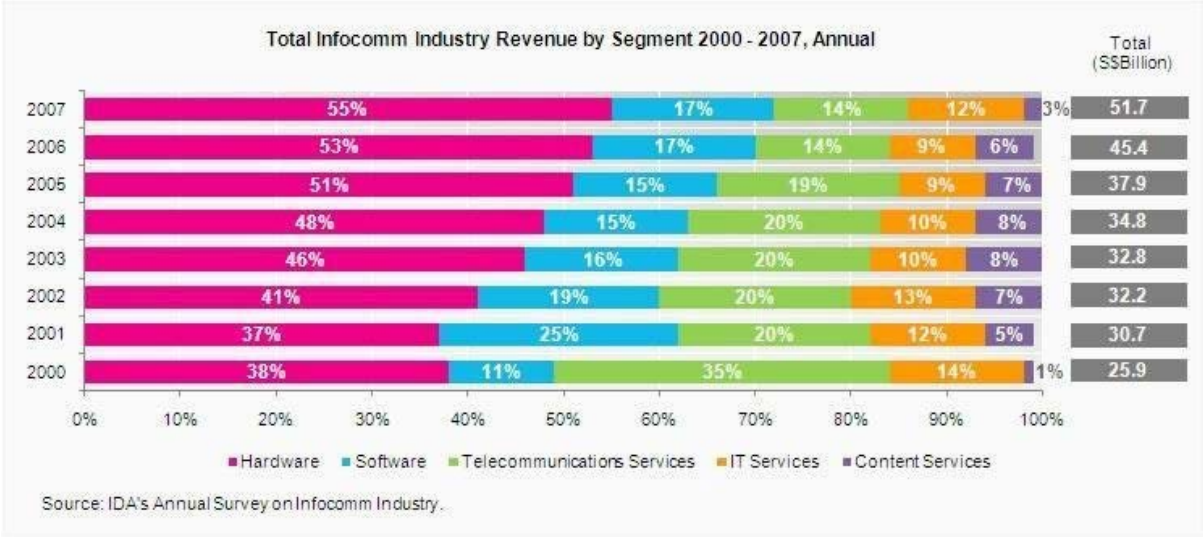
9 Appendix A



10 Appendix B

Sources: IMDA annual survey on infocomm usage by enterprises respectively for 2015 and 2016.

Chart 2.5: Infocomm usage by sector

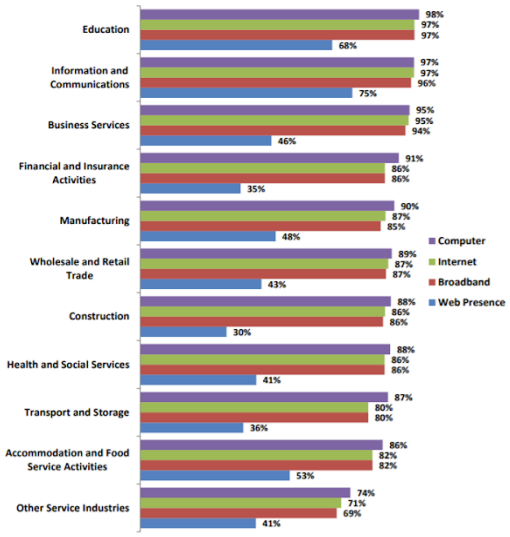
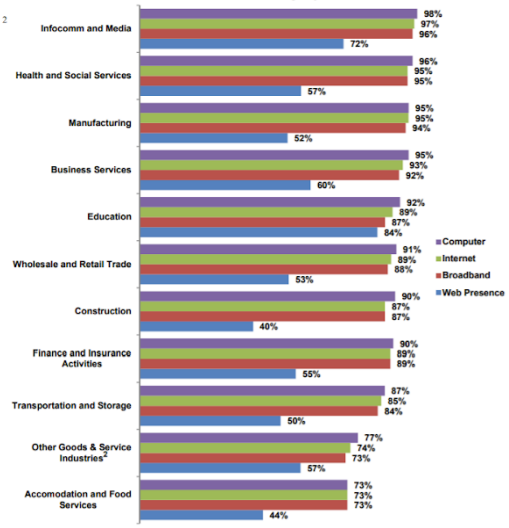


Chart 2.5 Infocomm usage by sector



11 Appendix C