HKPC x HKU

Reindustrialisation Study - Hong Kong

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Executive Summary

Does Hong Kong have the right conditions to be reindustrialised? Can companies with the right potential grasp the wave of reindustrialisation initiatives to facilitate the city's long overdue third economic transformation? To shed light on these questions, this report aims to analyse the current performance and the future potential of three advanced manufacturing industries, in which Hong Kong is often perceived to have comparative advantages – FoodTech, GreenTech and HealthTech.

In collaboration with the HKU Business School, the Hong Kong Productivity Council (HKPC) conducted the "Reindustrialisation Study – Hong Kong" from July to September 2021 to explore the conditions, feasibility and challenges facing Hong Kong's manufacturing firms in the three industries. Based on our own designed survey completed by 184 companies from these industries operating in Hong Kong, we identify the challenges facing manufacturers in Hong Kong, their major markets, their intention to implement Industry 4.0 technologies and difficulties encountered during the process, as well as their expectations about Hong Kong's reindustrialisation. Besides studying these three sectors, we explore Hong Kong's capacity to become one of the global semiconductor centres. The key findings of the survey can be summarised in the following four areas, namely market orientation, Industry 4.0 technologies, research and development (R&D), and talent.

About Market Distribution:

- 90%, 37% and 22% of surveyed companies considered Hong Kong, Mainland China and Southeast Asia as their main target markets, respectively.
- These shares vary across industries:
    - FoodTech: 98%, 28% and 20% of companies considered Hong Kong, the Mainland and South East Asia as their main target markets respectively
    - HealthTech: 74%, 49% and 36% of companies considered Hong Kong, the Mainland and Europe as their main target markets respectively
    - GreenTech: 90%, 39% and 24% of companies considered Hong Kong, the Mainland and South East Asia as their main target markets respectively

About Industry 4.0:

- **Awareness:** About half of the companies surveyed said they are aware of Industry 4.0
- **Advantages:**
  - The surveyed companies generally believe that increased productivity, reduction in production costs, and increased flexibility in operation are the main advantages brought by Industry 4.0 technologies
  - 83% of FoodTech companies, 64% of HealthTech companies and 71% of GreenTech companies believe that enhanced production efficiency is the primary advantage of adopting Industry 4.0 technologies
- **Land required:** 44% of FoodTech companies, 46% of HealthTech companies and 38% of GreenTech companies said less than 10,000 square feet are required
- **Main challenges posed by space limitation**: Insufficient space to set up an automated production line, inadequate unloading space and floor ceilings being too low
- **Establishment of production lines:**
  - 52% of companies said they have plans to move or extend their production lines to Hong Kong
  - By industry: 74% FoodTech, 41% HealthTech and 62% GreenTech companies said they have plans to move or extend their production lines to Hong Kong

About R&D Activities:

- 58% of surveyed companies said they have invested in R&D. By industry, 79% FoodTech, 65% HealthTech, 36% GreenTech companies said they have invested in R&D
- 16% of companies said they have plans to move or extend R&D to Hong Kong. By industry, 24% FoodTech, 23% HealthTech, and only 4% GreenTech companies said they have such plans
- 73% FoodTech, 50% HealthTech and 75% GreenTech companies said they are engaged in R&D activities in Hong Kong

- Key factors for attracting companies to engage in R&D activities in Hong Kong: Availability of higher education institutions locally (46%), skilled local R&D talent (37%), close proximity to production facilities (36%), R&D infrastructure (31%), funding (29%) and presence of local R&D community/related services (27%)

About Talent: Among companies surveyed, only 28% are confident of finding suitable talent for i4.0 related work in the next one to two years, 33% in the next three to four years, and 37% in the next five years.

This study shows that companies consider the local market in Hong Kong, and the neighbouring regions, including Mainland China and Southeast Asia as their main target markets. About 30-40% of companies believe that a plant area of 10,000 square feet or less is sufficient.

With its free port, unrestricted access to funds, sound intellectual property (IP) protection system, solid foundation for R&D in local universities, and experiences of local industries in international marketing and sales, Hong Kong has the necessary conditions to be a global advanced manufacturing centre. In addition, as a highly export-oriented open economy, in conjunction with the National 14th Five-Year Plan which clearly supports the city's development as an international innovation and technology (I&T) hub, Hong Kong can make use of the Guangdong-Hong Kong-Macao Greater Bay Area (GBA) as an entry point to integrate itself into the overall development of Mainland China, and effectively leverage on its strategic position in China's domestic and external circulation development.

Given the aforementioned strengths Hong Kong has in research, infrastructure and talent, strategic government supports can help release the city's great potential, permitting a steady development of reindustrialisation and the "Made in Hong Kong" brand to shine again. Hong Kong should also grasp the emerging opportunities arising from the post-pandemic new normal, the changing geopolitical landscape, and new government initiatives to transform itself into a technology and innovation hub.

Apart from the questionnaire, this study also invited large-scale local companies for focus group discussions. Many of them were of the view that the "new generation semiconductors" have the potential to develop into an emerging industry of reindustrialisation. At present, the world is facing the problem of chip shortage, while

Mainland China also intends to develop its own new generation of semiconductor technology and the entire supply chain. As such, Hong Kong can target the market's demand for third-generation semiconductors, such as establishing a chip design centre, and cooperating with national policies in the short term to encourage semiconductor-related companies from all over the world to settle here. Hong Kong, as the core hub of the external circulation, and with a good IP protection system, has an absolute advantage in attracting a new generation of semiconductor manufacturers to set up factories in Hong Kong, converging the entire new generation of semiconductor industry chain through the Northern Metropolis in the long run. The semiconductor industry has been a traditional industry in Hong Kong in the 1980s and 1990s. There are already many companies engaged in the semiconductor business in Hong Kong, producing integrated circuits used in watches and clocks, calculators, and domestic appliances. Local OEMs have undertaken the production of critical components for world-renowned brands, and the "Made in Hong Kong" brand is a guarantee of confidence. Hence, attracting semiconductor manufacturers to set up factories in Hong Kong is conducive to the development of reindustrialisation.

For the three traditional industries, technology transformation is irreversible. In terms of FoodTech, 'Future Technology' includes many food or materials made from synthetic organisms. The use of R&D and innovative thinking not only can produce food, but also alleviate various environmental problems. Synthetic biotechnology has the greatest potential to spark a reindustrialisation revolution in the future, and let Hong Kong's industry and sustainable development shine.[1] In terms of HealthTech, it can optimise the production of Chinese and Western medicines, expand the production of vaccines and foster the development of life science. The report also found that over 60% of green companies require more than 10,000 square feet of plant space to set up production lines in Hong Kong, partly because the recycling industry in Hong Kong has not made use of advanced technology, which can help reduce the demand for space. Hence, leveraging advanced technologies can help reduce both land and production costs.

Besides focus-group interviews and large-scale surveys, the HKU Business School research group also conducted in-depth literature review and country case studies to draw

[1] This is reference to HKPC news press
https://www.hkpc.org/en/about-us/media-centre/press-releases/2021/reindustrialisation-study-hongkong

key policy suggestions to facilitate reindustrialisation and innovation in Hong Kong. The report showcases the successes of and policies behind the industrial development of three small open economies – Israel, Singapore, and Switzerland. These three economies were chosen as our benchmark country case studies because of their remarkable similarity to Hong Kong in terms of population, labour costs and economic development, but yet they have much higher share of advanced manufacturing in their respective GDP, compared to Hong Kong's 1% manufacturing share in GDP.

Chapter 1: Introduction: Why Does Hong Kong Need Reindustrialisation?

For decades, Hong Kong has been playing an important role as an intermediary between the Mainland Chinese economy and the rest of the world. It has served as both a regional trade and financial hub, facilitating the two-way trade and financial flows between China and other countries. However, the ongoing deglobalisation, partly accelerated by the geopolitical tension between superpowers and the COVID-19 pandemic, will continue to pose significant challenges to the city's role as a trade and financial intermediary. Despite the stellar performance of the financial sector during the COVID pandemic, the city's increasing specialisation in finance and the real-estate continued sector will worsen the already substantial income and wealth inequalities. The city needs more diverse economic activities and jobs to foster sustainable economic growth.

As such, a third economic transformation for the city is needed, picking up where it left off from the first transformation in the 1960s, when Hong Kong transited from an economy specialised in primary sectors to one that specialised in manufacturing sectors, and the second one in the 1990s, when it rapidly evolved into a service-based economy. It should leverage the pressure from the pandemic and the US-China tension to turn crises into opportunities. Hong Kong's third economic transformation, unlike the previous two, relies on government support to foster the creation of a knowledge economy buttressed on science and technology (S&T) and research and development (R&D). Such transformation should be accompanied with reindustrialisation, which should lead to an expansion of good jobs with upward mobility.

The double whammy of the social movement in 2019 and the COVID-19 pandemic in 2020 has dragged Hong Kong's economy to its slowest growth on record.[2] The retail, tourism, and hospitality industries, in which many low-income workers and small-medium enterprises (SMEs) are concentrated, were hit the hardest. However, Hong Kong has long been suffering from structural economic problems, as characterised by a heavy reliance on a few service sectors and rising income and wealth inequalities. The four pillar industries promoted by the

[2] According to the Hong Kong Institute of Economics and Business Strategy's Macroeconomic Forecast, Hong Kong's gross domestic product is forecasted to decline by 7.2% in 2020, compared to 2019.

Government – financial services, tourism, trading and logistics, and professional services – constantly account for around 60% of the city's GDP. Such heavy reliance on the four pillar industries limited job diversity and spillover to other sectors on the one hand, and subjected its economy to an excessive amount of external macroeconomic volatility on the other. But in fact, among the four pillar industries, only finance saw significant wage and employment growth.[3] The median wages of the other three industries were significantly lower and grew much slower over the last two decades, sometimes even declining.

The employment share of the four pillar industries has in fact been declining since 2011, largely driven by the decline in employment in the tourism-related (i.e., retail-accommodation-restaurant) and trading and logistics sectors, which was not completely offset by the mild employment growth in finance and professional services. The employment in these two service sectors that pay relatively lower income has actually been shrinking since 2010 and 2013, respectively.

Replacing the shrinking share of the three pillar industries is not high-tech knowledge-intensive sectors, which Hong Kong, as an advanced economy, should have specialised in. Instead, more low-income service jobs, particularly in retail and personal services, were created in the past two decades. Similar to the US (Autor, 2019), the Hong Kong's job market has become more polarised, with increasing shares of both high- and low-income jobs displacing middle-income jobs, including administrators, production workers, and sales professionals. According to the data from Hong Kong's Population Census, the share of low-income jobs in total employment grew even faster than that of high-income jobs between 2011 and 2016. Amid the global trends of deglobalisation and de-intermediation, the prevalence of trading and logistics and the related service industries in Hong Kong's economy and employment will likely continue to decline,[4] while the tourism and hospitality sector, which has been ravaged by the COVID-19 pandemic, will probably take years to recover back to its pre-pandemic level. Against this backdrop, Hong Kong's economic and productivity

[3] According to Hong Kong's Population Census, the median monthly salary of workers in finance has increased from 16,000 HKD in 1996 to 26,000 HKD in 2016, a 63% growth in 20 years.
[4] As a matter of fact, the share of global exports in global GDP has been declining since 2010. The annual growth rate of global exports has been around 3%, compared to the 7% average for the period between the early 1990s and 2008.

growth have been slowing, while both income and wealth inequalities rose to a level that makes it one of the most unequal cities on earth.[5]

The Hong Kong Government should leverage the risks posed by the changing domestic, regional and global environments to implement the necessary policies that can facilitate the long overdue third economic transformation. The best outcome of such transformation is one that can foster inclusive and sustainable economic growth, creating multiple innovative knowledge-intensive sectors and good jobs that offer opportunities for upward mobility and on-the-job training. This third economic transformation, unlike the first two, requires stronger-than-ever government support, partly because of a different global economic environment and mostly because of the stronger positive externalities associated with knowledge- and R&D-intensive activities.

The key purpose of reindustrialisation is to create good job opportunities that are associated with upward mobility, on-the-job training and more diverse career paths for young people. Reindustrialisation is also important to help complete the ecosystem for scientific research and start-ups. In 2019, the manufacturing sector accounted for less than 1% of Hong Kong's GDP, while in the other three "Asian Tigers", namely Taiwan, South Korea and Singapore, manufacturing accounted for 30%, 25% and 20% of their GDP, respectively. Although manufacturing employment shares are typically lower than GDP shares due to automation and outsourcing of jobs, these East Asian examples show that manufacturing can rejuvenate in advanced economies. Their successes in manufacturing are obviously not only due to more effective cost control, given their high labour costs compared with emerging markets, but their strategic adoption of technology, automation, supply chain management, and marketing in international markets. In other words, the main challenges facing advanced economies' reindustrialisation are typically not related to high production costs, but more about how to improve industrial firms' production efficiency, product quality, market positions, facilitated by government policies.

One may ask: what comparative advantages does Hong Kong still have in manufacturing? Given Hong Kong's mature medical sector and its world-class medical experts

[5] According to the authors' calculation, Hong Kong's TFP growth was also sliding, from an average 2.9% in 1980s to 1.8% in 2010s. Its Gini coefficient has risen from 0.45 in 1980 to 0.54 in 2016.

and researchers, the city still has the potential to be a production and design hub for high value-added products in the medical, biotech, and pharmaceutical sectors. In the HealthTech sector, digitalisation and the adoption of artificial intelligence will be the trends. There should be constructive cross-overs between the medical professionals and the computer science/ engineering community. The Hong Kong Government should leverage on the COVID-19 pandemic to industrialise and commercialise research findings in the medical and biotech fields, for designing and even producing vaccines and testing kits. The sector should also optimise Hong Kong's unique expertise in both Chinese and Western medicines to produce differentiated health supplements and pharmaceutical products for the global markets. The background of the HealthTech sector, which includes the research, design and manufacturing of health supplements, medical devices and pharmaceutical products, will be discussed in Chapter 4; while the survey results for existing companies in HealthTech together with the other two industries will be reported in Chapter 6.

Besides, Hong Kong's relatively strong performance in the food industry, together with the reputation of the many companies as quality and safe food manufacturers in the region, suggests significant room for technological upgrading and more innovation in the industry. That is a reason why we choose FoodTech to be a target industry to conduct our survey. The current status of the food industry will be discussed in Chapter 3.

With its small geographic size, Hong Kong obviously has limited potential to engage in large-scale production, and most of the companies should not target their sales only to local consumers. That said, as we also found out in our survey, the local market is large enough to support testing facilities and initial sales of new products. In some situations, the government may want to play the role as a pioneer consumer of new products designed and innovated by local companies, as a way to offer them experience and feedbacks. Chapter 2 will discuss the policies of Israel, together with those of Singapore and Switzerland. These three benchmark countries have implemented policies to strategically attract foreign direct investment and create markets for local companies.

Some sectors appear to have a more local market by nature. For instance, the handling of the huge amount of waste produced by households and restaurants in a city with 7.5 million people and 1,106 km² space is challenging. Any solutions, technologies, and business models that can help address the waste problem facing Hong Kong will permit the city and other crowded metropolitans worldwide to tackle their respective environmental challenges. Chapter 5 will explore Hong Kong's potential to develop the GreenTech sector.

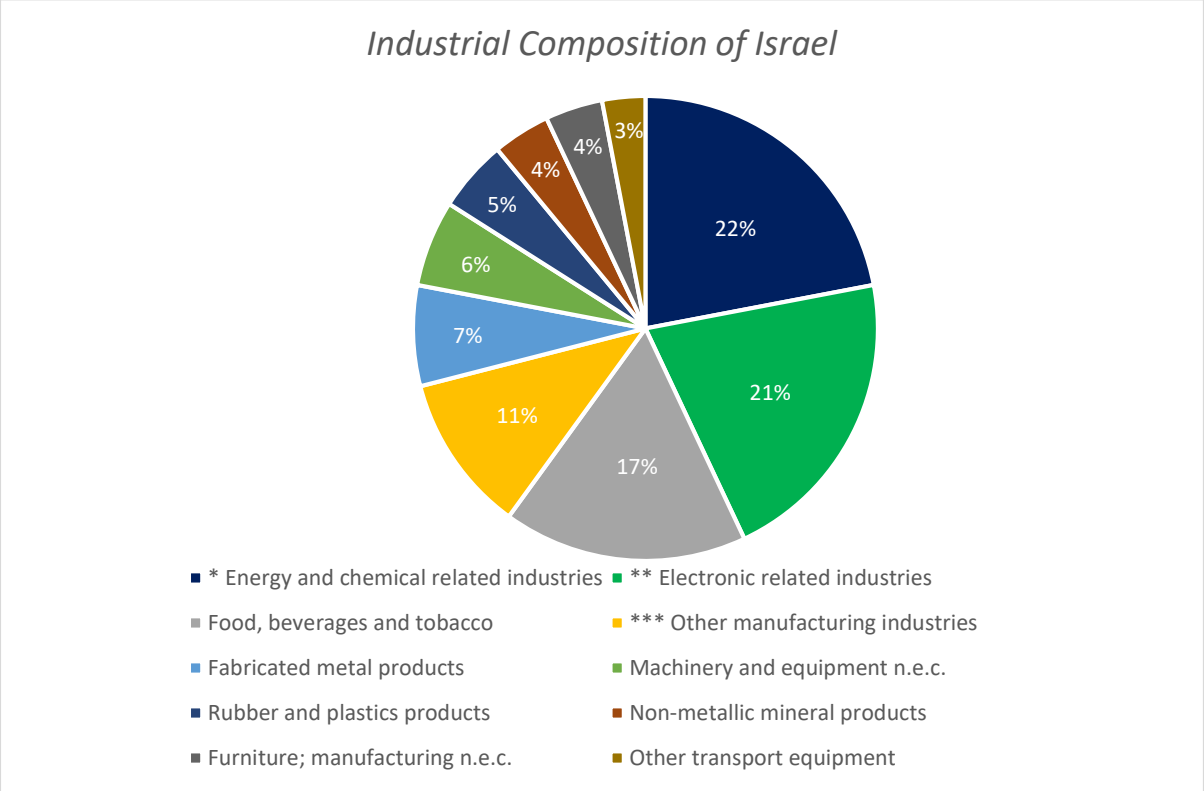
Chapter 2: Industrialisation Experiences in Benchmark Countries: Israel, Singapore, and Switzerland

This chapter aims to showcase the successes of and policies on industrial development of three small open economies – Israel, Singapore, and Switzerland. We choose these three economies as our benchmark country case studies because of their remarkable similarity to Hong Kong in terms of population, labour costs, and economic development. Specifically, Switzerland has a population of 8.6 million and the USD 86,601 GDP per capita in 2019, while Singapore has a population of 5.7 million, with GDP per capita equal to USD 59,797 in 2019. Israel, on the other hand, has a population of 9.2 million and GDP per capita equal to USD 43,610. Hong Kong has a similar population (7.5 million) and GDP per capita hovering around USD 46,323, which is lower than those of Singapore and Switzerland, but above that of Israel.

Despite the differences across these three nations, each managed to excel in advanced manufacturing. The shares of manufacturing in GDP for 2019 in Israel, Switzerland and Singapore are 11%, 18%, and 20%, respectively. These numbers contrast sharply with Hong Kong's 1% manufacturing share in its GDP. The question that one should ask is "Why is Hong Kong's manufacturing share in its GDP so low?" The answer cannot simply be high labour, land or production costs, as it is as expensive if not more so to run a business in Switzerland or Singapore, if not in Israel.

2.1 Israel's Successes in Manufacturing

Let us first start by analysing the manufacturing performance of Israel. Similar to Hong Kong, Israel lacks natural resources and has to rely on high value-added industries and foreign capital. But instead of specialising in financial and professional services, Israel's foreign capital absorption of over USD 18.2 billion in 2019 was mainly concentrated in three industrial sectors – manufacturing, information and communication, as well as technology, according to the 2020 United Nations Conference on Trade and Development (UNCTD) World Investment Report. Figure 1 shows that in Israel in 2017, the leading manufacturing industries were energy- and chemical-related industries, followed by electronic-related industries and food, beverages and tobacco, respectively.



* This category includes: (1) Coke, refined petroleum products, nuclear fuel; (2) Chemicals and chemical products
** This category includes: (1) Office, accounting and computing machinery; (2) Radio, television and communication equipment; (3) Medical, precision and optical instruments
*** This category includes other small industries

Data source: UNIDO

Figure 1: Industrial Composition of Israel

2.2 Israel's Main Industrial Policies

To facilitate the development of advanced manufacturing, which contributes to a significant transformation of Israel from a "Start-up" nation to a "Scale-up" nation, the Israeli government has implemented a combination of policies since 2016, including but not limited to (1) curating the start-up environment; (2) incentivise companies' R&D activities through various policies; (3) attract foreign talent, especially those who were originally from Israel, to join its workforce; (4) create market demand for technologies, especially from SMEs; (5) establish research centres. Figure 2 illustrates how interaction and synergy between different stakeholders in the innovation ecosystem contribute to Israel's path to become a global leader in technology and innovation.

Figure 2: The Innovation Ecosystem of Israel

The Israeli government established an independent public institution – Israel Innovation Authority – in 2016 to promote the development of Israel's innovative and technology industries, including but not exclusively the establishment of incubators to nurture local S&T start-ups, entrepreneurs and talent. The authority also supports various types of companies, both start-ups and large companies, to carry out industrial R&D projects, regardless of their countries of origin. In addition, financial incentives were provided to attract foreign direct investment. Specifically, R&D funds and tax deduction were used to encourage local Israeli companies to conduct R&D projects jointly with foreign companies. For instance, Israel's Innovation Authority's *Bilateral R&D Incentive Program* (2021) offers funding to foster diversification of risks in R&D and support the search for foreign technology partners. Such

funds also encourage foreign companies to develop technology-intensive products or upgrade existing technologies.[6]

Beyond R&D funds, the Office of the Chief Scientist of the Ministry of Industry (OCS), Trade and Labor also provides bi-national funds for competitive but collaborative R&D programmes. Partnered countries include Australia, Britain, Canada, Singapore, South Korea and United States. Finally, Israel also has various R&D agreements with other international partners.

Besides, the government focused on attracting foreign and returnee scientists. The Ministry of Aliyah and Integration – The Center for Integration in Science assists new immigrants with relevant qualification and experience to find jobs in academia and businesses. According to the website of the Ministry of Aliyah and Integration, the centre provides guidance to candidates to identify job opportunities in the I&T sector. In addition to matching individual applicants with jobs, the centre also works with placement counsellors to steer applicants' vocational orientation. The centre offers financial assistance to employers for employing immigrant or returnee scientists, subject to certain proposed terms for specific scientific work.

The centre also runs a scholarship scheme for doctorates and postdoctoral research students, who are required to volunteer 24 hours every year to work in the industry. As such, the students become experienced and connected with the industry, which in turn increase their employability. The eligible applicants for the scholarship should be new immigrants who, at the time of their candidacy, are in Israel for no more than two years. Such candidates must be below 37 years of age and are accepted for research studies at a recognised university in Israel.

Importantly, the Israeli government took the lead to raise market demand for technologies, and create business references for new firms, especially those that require initial testing of innovations. Government departments and organisations often work

[6] Financial support of up to 50% of the Israeli company's approved R&D expenditure and parallel support from the foreign government for the foreign company's expenditure. Companies operating in National Development Zones are eligible for 10% additional support. Companies operating in the areas around the Gaza Strip are eligible for 25% additional support.

together to cultivate S&T development and formulate various policies to facilitate the industry.

Israel's Ministry of Finance takes the lead to finance and subsidise projects. The Ministry of Science, Technology and Space funds the operation of eight regional R&D centres to attract young scientists to participate in R&D, and support collaboration with talent from the international community. The Planning and Budgeting Committee of the Council for Higher Education allocates resources to advanced institutes to promote targeted scientific research.

Another important element of Israel's R&D success is related to its military force. The training obtained from compulsory military service by the country's young generation has produced a group of all-rounded individuals for entrepreneurial activities and challenging R&D activities. Like the U.S. in the 60s during the cold-war era, technologies developed for military purposes often had widespread commercial and scientific values. Additionally, in the internet-driven age, talents trained in the cyber and intelligence agencies gain first-hand experience to lead in the related sectors after they leave those agencies. These young talents trained in the military-related sectors constitute a talent pool for both the public and private sectors.

An important part of Israel's innovation development is its well-developed venture capital (VC) and private equity ecosystem. The Israeli government offers strong support to those companies. Yozma, a pioneer in Israel's VC industry which received significant government support, is an example.[7]

Moreover, Israel's policy makers have strong commitment and vision to support SMEs. From 2003, the authority has initiated issuing loan guarantees to assist the establishment and expansion of existing SMEs across all sectors in Israel. Whereas in the latest SME business funding, the government-guaranteed loan declined by about 13% from 2016 to ILS 1,600 million, the overall credit for SMEs has increased by ILS 15 million. The Israeli government individual loan guarantees cover 70% of the loans issued to large businesses and 85% to new businesses.

[7] Nab (2019) Innovation Lessons from Israel, The 'Start-Up Nation'

2.3 Challenges Ahead for Israel

A major challenge to Israel's economy is its lack of natural resources. Raw materials for construction are mostly imported. Their market prices are greatly affected by the fluctuations in international prices and exchange rates. Of the 22,072 square km area of the State of Israel, 98% of the state being land area, with the remaining 2% is the Sea of Galilee and the Dead Sea.[8] Only the Sea of Galilee provides the source of natural drinking water. To turn risks into opportunities, Israel increased the efficiency of water use in in agriculture by exploiting drip irrigation, hydroponic agriculture and applying artificial intelligence in the water management ecosystem. Around 93% of Israel's wastewater is purified nowadays, which shows that the country is in a leading position in water purification, recycling and desalination.

Geopolitical and national security issues are also day-to-day issues that the Israeli government and citizens need to tackle. The situation in Israel and Palestine has remained unstable. That said, its military needs and related R&D expenses have created leading technologies in machine learning and vision technologies. For instance, Iron Dome was invented in response to rockets.

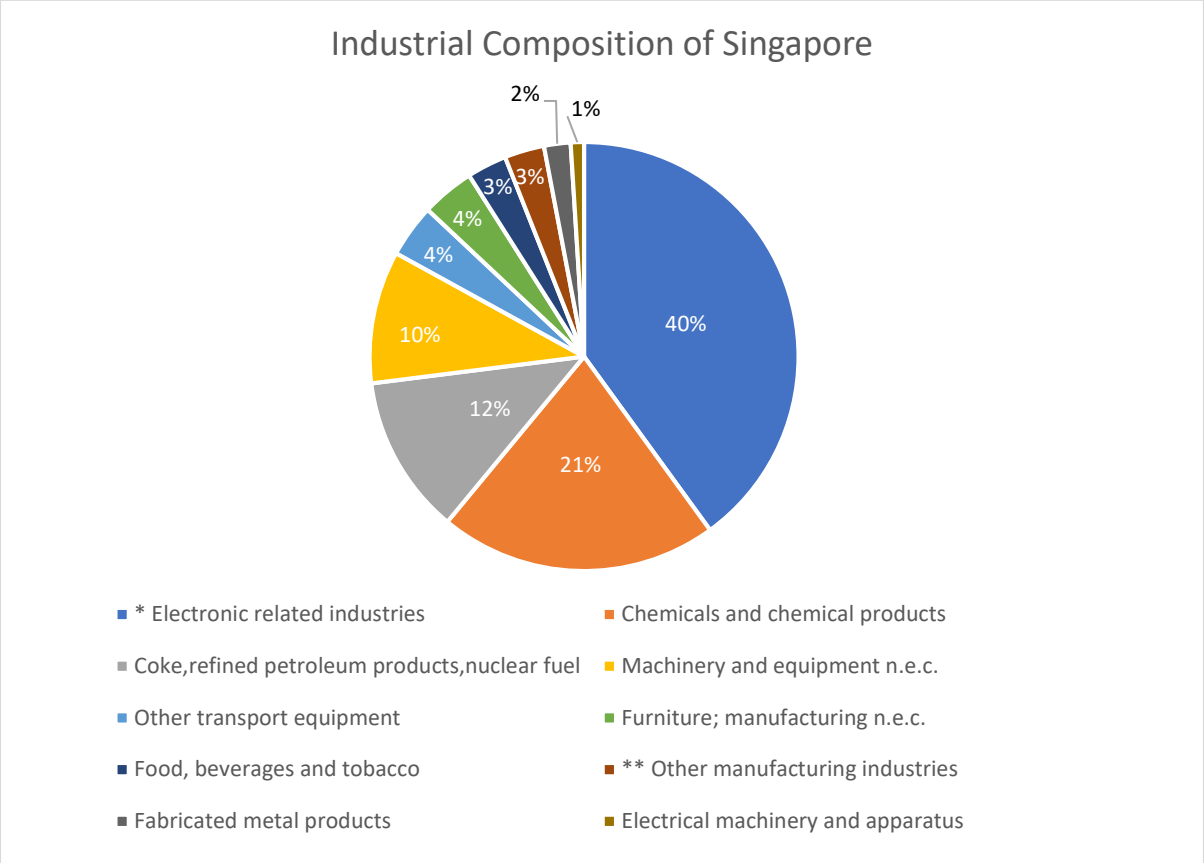
2.4 Singapore's Successes in Manufacturing

Singapore is a small city state constantly adapting to the changing world order. In the post-trade war and COVID era, businesses and investors around the world are still coping with increased uncertainty. The Singaporean government has positioned itself as a centre of innovation and R&D, actively supporting local companies to achieve the goals.

Singapore has a diverse economic structure. In 2020, manufacturing industries contributed about 21% to Singapore's GDP and 12% of jobs, while wholesale trade and finance together contributed about 17% and 16% of the country's GDP, respectively. Against the backdrop of the global epidemic, Singapore's manufacturing industry has ridden on the trend and has grown for six consecutive months since July 2020, reaching an annual growth rate of 7.3%. Its manufacturing expansion is mainly due to the growth of biomedical manufacturing, electronics, and precision engineering industries. Furthermore, the output

[8] The Jerusalem Post (2021) Israel can make 'big difference' in the world's water crisis

levels of semiconductors, measuring equipment, optical instruments, and metal precision components all have increased. As Figure 3 shows, the leading manufacturing industries of Singapore in 2018 were electronic-related industries (40% of Singapore's total manufacturing value-added), followed by chemicals and chemical products (21%) and coke, refined petroleum products, nuclear fuel (12%), respectively.



* This category includes: (1) Office, accounting and computing machinery; (2) Radio, television and communication equipment; (3) Medical, precision and optical instruments.
** This category includes other small industries

Data source: UNIDO

Figure 3: Industrial Composition of Singapore

2.5 Development of Innovation and Technology in Singapore

The success of Singapore's manufacturing can be attributed to its government's emphasis on intellectual property rights protection, attracting foreign direct investment (FDI),

partnership with foreign research institutions, partnership with the private sector, and strategic management of the innovation ecosystem.

Singapore's strong intellectual property protection institutions, stable business environment and pro-business policies have attracted many world-leading manufacturing companies to establish their affiliates there, especially in the electronic, semiconductor and chemical sectors. In 2020, the Singapore Economic Development Board attracted a total of S$17.2 billion in fixed-asset investment, the highest in 12 years, of which the electronics and chemical industries accounted for 38% and 24% respectively.[9]

The Singaporean government also has a strong commitment to R&D and maintains diverse partnerships with the private sector. Singapore is committed to investing about 1% of its GDP in research, innovation and enterprise each year from 2021 to 2025.[10] Beyond financial support, the government also provides quality workplaces and event venues for start-ups, accelerators and venture capitalists. Such as Blocks 71, 73 and 79, which are located close to public and private research institutes to facilitate public-private partnerships (PPP) between academia and industry. The Singaporean government also actively supports the development of local manufacturing companies, and assists them to become industry leaders. Specifically, Enterprise Singapore launched projects such as the Scale-up SG, which are 12-18-month programmes aiming to help selected high growth potential local companies expand effectively, become leaders in their fields and be groomed into future global champions.[11]

In 2021, the Singaporean government announced a 10-year "Manufacturing 2030" vision, aiming to grow Singapore's manufacturing sector by 50% of its current value (S$106 billion), maintaining a 20% GDP share.[12] The Singaporean government facilitates the Southeast Asia Manufacturing Alliance, which was established in 2021. The alliance looks forward to providing a "Singapore +1" strategy for international and Singaporean manufacturing companies interested in expanding in Southeast Asia, building a network of industrial parks and promoting the development of global diversified supply chains. Many

[9] Department of Statistics Singapore (2021) *Singapore Economy Facts and Figure*
[10] Prime Minister's Office Singapore (2020) *DPM Heng Swee Keat at the RIE2025 Press Conference*
[11] Scale-up SG (2019) Enterprise Singapore launches Scale-up SG to transform high-growth enterprises into future global champions
[12] Minister of Trade and Industry Singapore (2019) Speech by Dr Koh Poh Koon, Senior Minister of State for Trade and Industry, During the Committee of V Supply Debate Under Head

multinational corporations (MNCs) take Singapore as a springboard to the rest of Asia and beyond.

According to Professor Wong Poh Kam, the director of NUS Entrepreneurship Centre of National University of Singapore, the success of Singapore R&D is based on a unified approach to attract FDI.[13] Its government provides not only incentives, but also actively creates a business environment for foreign businesses. The government aims to shift from primary dependence on foreign investment to a more balanced economy with a diversified enterprise ecosystem that includes both foreign MNCs and indigenous enterprises.

1. An MNC-Leveraging Model: State policies attract MNC investment in high-tech and knowledge-intensive activities. Tax incentives are often provided to attract investment in targeted industries, and promote investment in infrastructure and manpower training. Immigration policy has been revised to become more inclusive. English language has remained to be the medium of instruction in schools. There are also state programmes to promote technology transfer from MNC headquarters to their affiliates in Singapore.
2. The government implements state programmes to promote technology transfer from the parent companies to their local subsidiaries. Policy incentives for intrafirm technology transfer, industrial upgrading, and manpower training are offered. The government promotes indigenous innovation by investing in strategic, economically relevant, and science-based research capabilities, ranging from life science to interactive digital media.
3. The Singaporean government also establishes globally competitive universities and public research institutes. Initiatives include but not limited to facilitating National University of Singapore (NUS) to become a leading global university. International collaborative R&D hub is created through partnering with globally leading universities such as MIT & ETH. one-north, a major science park that includes Biopolis & Fusionpolis, and the government's "Smart Nation" initiative, are some of the other notable examples.

[13] Wong Poh Kam (2017) Ecosystem for Entrepreneurship & Innovation

2.6 Challenges for Singapore

Similar to Hong Kong SAR, Singapore is highly dependent on foreign trade, and thus is highly sensitive to the changes in the external environment. Recently, it faced a set of unfavourable factors such as intensifying international trade frictions, weak external market demand, and slowing world economy. In addition, it also faces a variety of uncertainties. Internally, even Singapore has been one of the most politically stable countries in Southeast Asia with its leading political party, the People's Action Party under the leadership of the Lee Family since 1959, the country's current prime minister, Lee Hsien Loong, will step down soon without a certain successor yet.

Like many other developed nations, the country has experienced population decline and ageing. To maintain a vibrant labour force, its government has relaxed restrictions to attract many immigrant workers from Southeast Asian countries. As a result, Singapore's overall population expanded by more than 1.6 million since 2000, with the ratio of non-residents increasing significantly from less than 20% to 30% over 21 years.[14] That said, the increased foreign population posed challenges to social cohesion in local community and workplace.

Finally, the government's objective to promote national champions in individual industries may not be favourable for the smaller firms, which may have the better potential to contribute to Singapore's economic growth. For instance, Singapore's government and sovereign wealth fund Temasek tend to pick winners or focus on supporting select industry clusters.

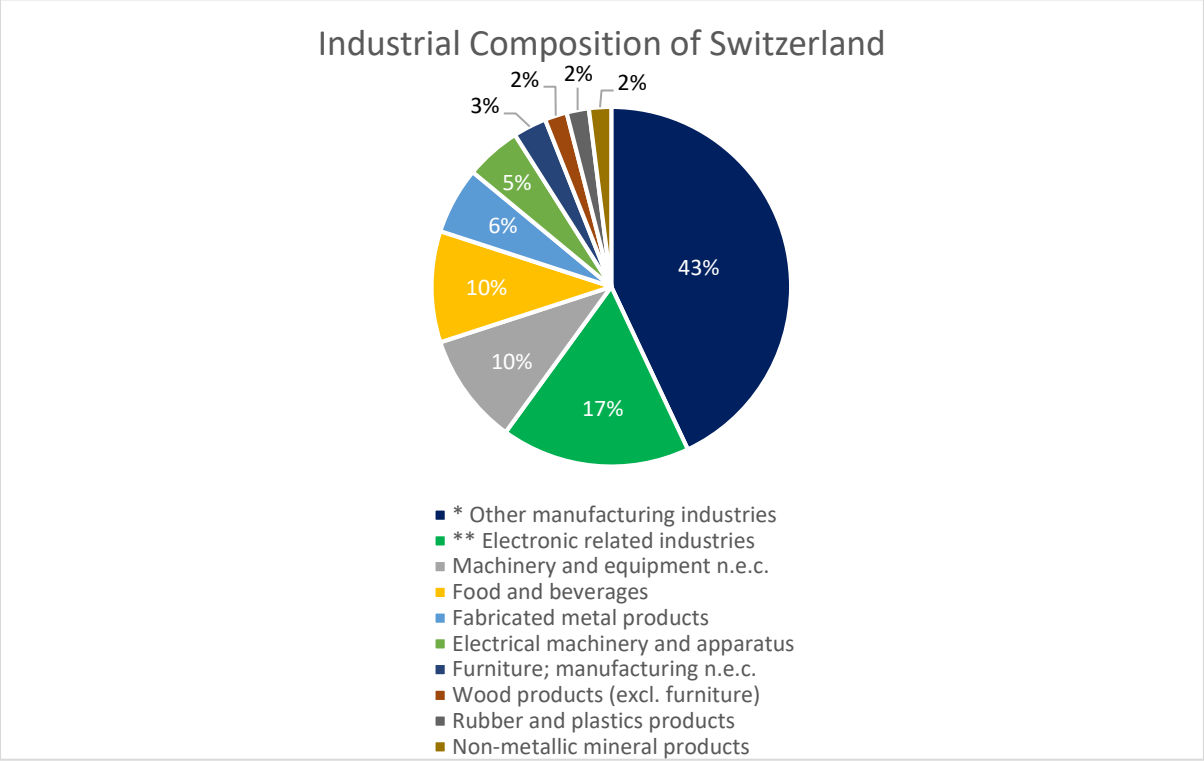
[14] Gllian Koh (2017) People, Politics and Public Policy in Singapore

2.7 Switzerland's Successes in Manufacturing

Switzerland has world-class companies in finance and manufacturing. The country is skill-abundant and specialised in delicate, low-polluting, brand-named manufacturing industries, especially in biotechnology and pharmaceuticals, precision machinery, and watches. Luxury and high-end manufacturing can create high value added to support the country's high wages. Besides, Switzerland provides high-end tourism and hospitality. Around 74% of Switzerland's GDP came from services, while 25% came from manufacturing.[15] To encourage R&D, Switzerland spends close to 3% of its GDP, which is more than CHF 18.5 billion (around USD 21 billion). More than three quarters of this funding came from the private sector.

As Figure 4 shows, the leading manufacturing industries of Switzerland (in 2018) were other manufacturing industries (43%), which include manufacturing services, followed by electronic-related industries (17%) and machinery and equipment (10%), respectively.

[15] Statistics Singapore (2021) Swiss Economy Facts and Figure



* This category includes other small industries and those unspecified industries.
** This category includes: (1) Office, accounting and computing machinery; (2) Radio, television and communication equipment; (3) Medical, precision and optical instruments.

Data source: UNIDO

Figure 4: Industrial Composition of Switzerland

2.8 Development of Innovation and Technology in Switzerland

Switzerland has developed a high-quality industrialisation and technological superiority over the past few decades. Supported by its government's policies, local and multinational companies optimise their production processes and establish high-performing production facilities in a business-friendly environment. Figure 5 illustrates Switzerland's innovation ecosystem.

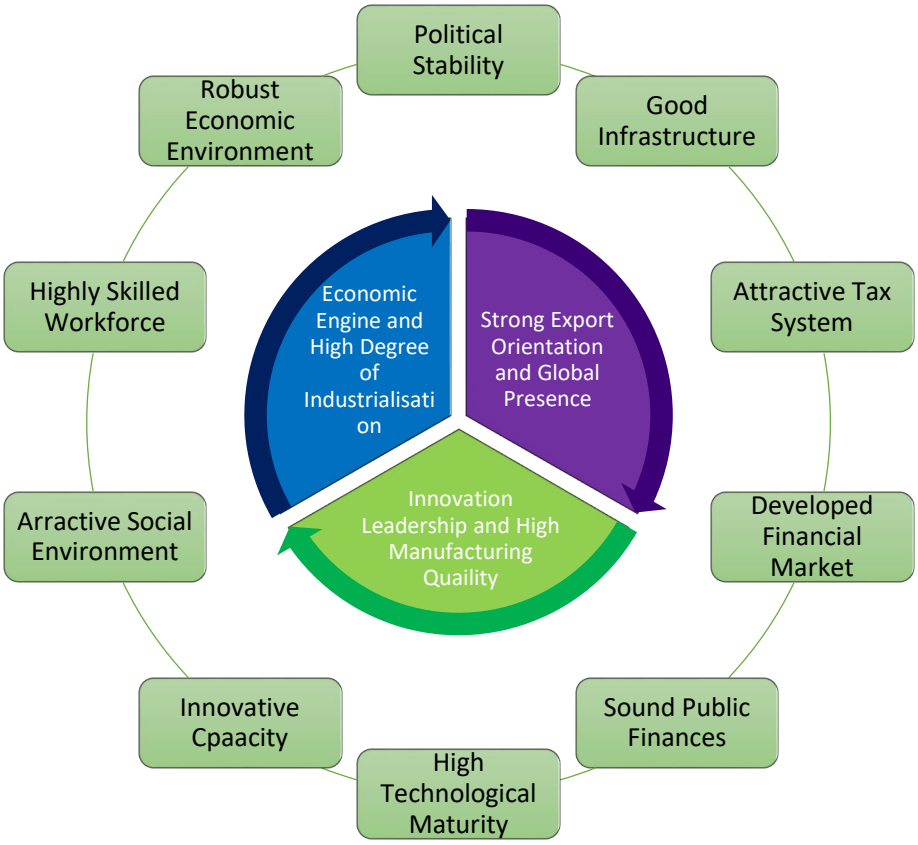


Figure 5: Switzerland's Innovation Ecosystem

Switzerland adopts liberal labour laws in order to nurture a specialised talent pool. Vocational training in Switzerland is labour market oriented and aims to strike a balance between theoretical and practical knowledge. Having young and well-trained workplace-oriented taskforces, Switzerland's education policy contributes increased efficiency and lower costs for smart industrial production. In addition, Switzerland's liberal labour laws enable companies to employ and dismiss workers within short notices.

Meanwhile, Swiss' strong industrial clusters buttressed on high innovation capacity provide a suitable environment for companies to operate in different segments of a supply chain, from research institutions and upstream manufactured suppliers to service providers. Take the Swiss Smart Factory (SSF) as an example. SSF is a private non-profit organisation providing R&D support and transfer of Industry 4.0 technologies. It connects national and international networks to promote Swiss' innovation and start-ups, and transfers research outcomes into commercialised products.

Last but not least, Switzerland's products are always associated with the so-called "Swiss Premium". Customers are willing to pay higher prices for "Made in Switzerland" products, which are often perceived to be of higher quality, more reliable, durable, and technologically advanced. As such, the Swiss government imposes strict regulations and standards on the "Made in Switzerland" label. A company that wants to use the "Made in Switzerland" label for its industrial products needs to have at least 60% of the product's manufacturing costs incurred in the country.[16]

The success of Switzerland's manufacturing shows that a financial centre can also be strong in manufacturing. Despite Switzerland's high income, its productivity and wage growth have been slowing down since the 2008-2009 global financial crisis. The Swiss government relies on Industry 4.0 technologies and digitalisation to promote the country's innovation-led economic growth. The Swiss government adopted digital technologies and raised data availability, aiming to empower the country's governance on the one hand, and benefiting businesses and workers on the other. In particular, the 2020-2023 eGovernment Strategy Switzerland aims to:

1. Establish the essential foundation to facilitate labour market evolution and foster transformative and interdisciplinary studies, according to the government's *Human Resource Strategy 2020-2023* document.
2. Make the local labour market more adaptive to future changes and be prepared for the future demand for human resource by focusing on youth development and education, according to the government's *Strategy for Vocational Education and Training 2030* document.
3. Evaluate the strategic targets and the ecosystem of ICT development, which will in turn be used to promote digitalisation of the economy, according to the government's *2020-2023 ICT Strategy* document.

[16] Switzerland Global Enterprise (2020) Advanced Manufacturing in Switzerland

2.9 Challenges for Switzerland

Among the challenges facing export-oriented Switzerland, the Swiss franc appreciation in recent years has increased the prices of Swiss products for foreign customers. Although the Swiss National Bank (SNB) applied intervention policies to slow down the Swiss franc appreciation, Switzerland's flexible exchange rate regime may be compromised. Besides, the negative interest rate policy formulated by the SNB to prevent inflation has created an unfamiliar and more challenging environment for banks and companies to operate their businesses.

In addition to the unconventional monetary policy, Switzerland also faces increasing international competition. For example, the Swiss textile machinery industry is currently facing intense competition from China. Many Swiss companies have set up more affiliates in China, causing the exports of Swiss to decline in the past few years.

Chapter 3: Current Status of FoodTech

The rest of the report will focus on analysing the current status and our firm survey results of the three industries - FoodTech, HealthTech and GreenTech. We focus on these three industries because of their significance to Hong Kong's economy in the present and future.

The reason why we choose FoodTech as the first focus industry is for the important status of the food industry in Hong Kong's economy. Many traditional food manufacturers established their brand names and reputation as safe food producers in the past, both locally and globally. They continued to expand despite the shrinking status of manufacturing in Hong Kong. The reason why we choose HealthTech as our second focus industry is for the city's existing strength in basic research and practical experiences in medical and health-related fields. Some of the advantages are also related to the city's vibrant food industry, which include many health supplement producers. The reason why we choose GreenTech as our third focus industry is obviously related to the challenges the city faces to handle an increasing amount of wastes produced by both households and commercial activities, when the scope for landfills is becoming more constrained. Solutions to the city's waste and environmental challenges will improve environmental conditions in not only Hong Kong but also other crowded urban areas around the world that face similar challenges.

3.1 Background of the Food Industry in Hong Kong

Despite the rapidly shrinking share of manufacturing value added in Hong Kong's economy, the "food, beverages and tobacco products" sector has become increasingly important. According to the data from the Hong Kong Census and Statistic Department (2005-2019), it's the value added of the sector has been increasing from 4.4% in 1973 to 34.1% in 2019 in the city's shrinking manufacturing value added. Despite the declining number of manufacturing companies (from 9,358 in 2013 to 7,251 in 2019), employment in the "Food, Beverage and Tobacco Manufacturing" industry has actually increased from 30,037 (2013) to 34,053 (2019). Besides, Hong Kong's food manufacturers are often perceived as high-quality producers by global customers with good brand names and high safety standards. There are

certainly significant economic benefits to apply Industry 4.0 and other new industrial technologies to leverage on Hong Kong's existing competitive advantage in the food industry.

3.2 Reasons Behind Food Manufacturers' Hesitation to Return to Hong Kong

Reindustrialisation was first proposed in the HKSAR Chief Executive's Policy Address in 2016. Many Hong Kong-invested manufacturers in Mainland China, including some food manufacturers, have planned to relocate part if not all of their production processes back to Hong Kong. However, the challenges related to the lack of land and floor space, in addition to high production costs in Hong Kong, have prevented some of them from moving forward. Among them, Kam Hing Food Factory Limited and Hoi Tin Tong Company Limited expressed concerns in a past interview that land allocation is one of the most important considerations for their businesses and operations to return to Hong Kong.[17]

3.3 Expectations from Food Manufacturers

Although rental costs in Mainland China have been rising, they are still relatively lower than the average rental cost in Hong Kong. Some food manufacturers hope that the Hong Kong Government, with the assistance of industrial associations, can build industrial parks with low-cost premises and supporting facilities to support their re-establishment in Hong Kong. They also highlighted that industrial parks permit more efficient sharing of resources, such as logistics, water supply and eco-friendly sewage treatment. The related cost saving will create a win-win situation for the government, food manufacturers and food consumers.

3.4 Support from the HKSAR Government

The HKSAR Government's Innovation and Technology Bureau has provided funds to foster reindustrialisation. For instance, the Bureau allocated two billion HKD to launch the Re-industrialisation Funding Scheme in 2020. However, the outcomes have not been obvious yet. As figure 6 shows, the value added of "Electrical, Electronics and Optical Products" accounted

[17] HKPC (2016) 製造業回流香港研究報告

for a mere 3.6% of Hong Kong's manufacturing value added, despite receiving proportionally the largest funding (34%). In contrast, the "Food, Beverage and Tobacco Manufacturing" industry, which accounted for over one-third of Hong Kong's manufacturing value added, received negligible funding.

Industry	Cases		Amount (Million Dollar)		Average Amount (Million Dollar)
Biotechnology	313	11%	679	7%	2.17
Electric and Electronic	654	24%	3,431.60	34%	5.25
Environmental Protection	128	5%	306.9	3%	2.40
Information Technology	529	19%	2,468.10	25%	4.67
Industry	842	30%	2,185.60	22%	2.60
Textile/ Clothing/ Footwear	179	6%	509.9	5%	2.85
General (Cross Industry)	22	1%	127.8	1%	5.81
Others	99	4%	362.6	4%	3.66
Total	2,766	100%	10,071.50	100%	3.64

Figure 6. Distribution of Approved Funding among Different Technology Areas (As of March 31, 2021)

Source: Innovation and Technology Bureau, HKSAR

Similar to the "Made in Switzerland" label, the "Made in Hong Kong" label bears the reputation of safe and high-quality products, buttressed on Hong Kong's strong regulatory framework on food safety. As such, stakeholders in the industry expected the Government to leverage on the "Made in Hong Kong" label, while manufacturers could also focus on adopting and developing new technology that can generate high manufacturing value-added. Leveraging Industry 4.0 technologies, such as robotics and artificial intelligence, advanced food manufacturing could be one of the engines for Hong Kong's reindustrialisation.

3.5 Local Food Manufacturers' Investment in Industry 4.0

Let us use a few case studies to illustrate what Hong Kong's food manufactures have done to prepare themselves for Industry 4.0 technologies. These examples could inspire others on how to use different technologies to lower production costs, increase production flexibility, and enhance product quality.

Case 1: Central Kitchen One Ltd (CK One)[18]

Central Kitchen One (CK One) originally produced prepared foods for chain restaurants. The pandemic-triggered reduction in sales has encouraged the company to seek transformation. After two months of research, CK One launched small-packaged prefabricated food in the market. Despite the positive response, the company was still operating below its original production capacity. The founder of the company, Arist Wong, learned about how "smart manufacturing" from the Hong Kong Productivity Council (HKPC) could help increase productivity. Mr Wong then applied for the subsidies from the Re-industrialisation Funding Scheme to purchase some smart production equipment, hire consultants, train employees, and launch products to meet consumers' needs more quickly.

Case 2: Sun Fat Heung Food Products Ltd (新佛香食品有限公司(壹品豆品))[19]

Sun Fat Heung Food Products Ltd adopted Smart Operations in 2020 to automate more production processes, raise product quality and strengthen supply chain management. GS1 Hong Kong introduced the Enterprise Resource Planning (ERP) system and redesigned their supply chain. In addition, the company applied artificial intelligence, video analytics and other technologies in their smart operations, which allowed the senior managers to obtain real-time production data, such as information on whether products' expiry dates is clearly stamped on the products' labels; or to calculate production levels of different products. These new technologies have helped improve quality by reducing human errors caused by manual processes.

In addition, GS1 HK promoted the installation of smart sensors in factories to measure environmental indicators including temperature, humidity, air quality and noise to ensure

[18] HK01 (2021) 疫下食品製造商申資助推智慧生產 學者倡再工業化促進就業
[19] GS1 HK. (2020) The Survival Kit of "Made-in-HK" Brand: Go Digital • Go Smart • Go Perseverance

quality and occupational safety. A real-time operation information chart is also designed to allow factory personnel to grasp the performance and efficiency of the production process, and assist the company to make effective analysis and evaluation, and even be able to take prompt action before an incident occurs.

Case 3: Large food chain restaurants (Design, provision and set up of low temperature liquid chilling system)[20]

HKPC provided the enterprise with automated designs that can help reduce manpower required for handling packaged food. The company also used low-temperature liquid freezing technology to significantly shorten the cooling time of food by 60%, which guarantees food safety but cuts operating expenses by 50%.

Case 4: A local manufacturer of fresh fruit juices (High Pressure Processing Technology for Fresh Fruit Juices Preservation)[21]

HKPC developed a fully automated bi-vessel High Pressure Processing System (20 litres each) for the enterprise that applies a pressure transfer mechanism to save energy. This technology has many benefits, including effective shelf-life extension up to 20 times, energy saving (up to 40-50% with the pressure transfer system), and saving of operating costs as only two operators are required.

Case 5: Cantonese-style restaurant enterprise – Lei Garden Group[22]

Lei Garden Group partnered with HKPC to design the first smartified Cantonese cuisine production line based on various smart and Industry 4.0 technologies. These technologies include: Cyber-Physical Production Systems (CPPS), Industrial Internet of Things (IIoT), Real-Time Data Acquisition (production data, machines data, quality data and energy data) and Human-Machine Interface (HMI). A smart manufacturing system was developed to visualise key parameters (e.g. food temperature) for Cantonese cuisine, in order to achieve real time process monitoring for quality and efficiency enhancement. In addition, these smart

[20] HKPC (2021) Design, provision and set up of low temperature liquid chilling system
[21] HKPC (2021) High Pressure Processing Technology for Fresh Fruit Juices Preservation
[22] HKPC (2021) Cantonese-style restaurant enterprise

technologies can reduce labour consumption and maintain food quality, and are flexible for handling multiple cooking methods.

Case 6: Hang Heung Cake Shop[23]

By setting up smart production lines to automate the production of different Chinese cakes, Hang Heung Cake Shop was able to improve the product quality and output level. The use of sensors to replace human hands for temperature monitoring greatly improved occupational safety and reduced the demand for labour.

Thus, it can be seen that Industry 4.0 technologies can add value to enterprises in the food manufacturing industry. In this particular case, even if the entire production process is labour intensive, production automation can still be adopted. Food industry involves a wide range of activities, ranging from fishery and agriculture to food manufacturing technology, plastic packaging, testing and certification, logistics and sales, and food waste treatment. Innovative technologies are introduced in different segments of the food supply chain to raise both production capacity and efficiency.

Case 7: Swire Coca-Cola, Hong Kong[24]

Since 2012, Swire Coca-Cola Hong Kong has utilised "Radio Frequency Identification" (RFID) technology in trucks and parking lot systems to enhance the efficiency of transportation and distribution, and to improve existing cargo transportation, loading and unloading facilities. Since the start of the project, the company's average number of trucks loaded per working day and the utilisation rate of the loading/unloading area have increased by 8-10%, while the average cargo loading, unloading and queuing time were reduced by 13-14%. In addition, the company could collect real-time data so that timely management decisions can be made. In 2016, the company extended the application of RFID technology to other areas to enhance services and speed up truck traffic.

[23] HKDC (2021b) 周浩鼎走訪傳統老餅家智能化工廠 探討工業 4.0 再工業化
[24] GS1 HK. (2017b) Swire Coca-Cola HK

Case 8: Cafe Deco Group (峰景餐廳集團)[25]

Cafe Deco Group has adopted a global barcode system to manage its diversified food items, and meet various objectives including improving product traceability, inventory transparency, and cost-effectiveness of stock management. Under the barcode system, the group can now use automated data to track the food usage, streamline procedures, and strengthen connections with various stakeholders in the supply chain. The group also made good use of barcodes to reduce human errors caused by manual operations. At the same time, the group further expanded the usage of the barcode system in warehouses to increase storage accuracy.

Case 9: Café de Coral Group[26]

Two years ago, staff of Café de Coral Group still had to manually enter and confirm a large number of delivery orders, payment and payment notices every day. This procedure was not only too time-consuming, but often affected by human errors. After adopting ezTRADE, a B2B e-commerce platform based on EANCOM/EDIFACT standards which can be used by companies and their trading partners to exchange electronic information at every stage of the supply chain, the group's employees now spend only 5 minutes, compared to 30 minutes in the past, to verify and approve payments for each supplier, and the efficiency is significantly improved by 6 times. This is because the system's pre-verification process improves the quality of payment notices and allows employees to approve payment notices in batches.

[25] GS1 HK. (2017a) Cafe Deco Group
[26] GS1 HK. (2018) Café de Coral Holdings Limited

Chapter 4: Current Status of HealthTech

4.1 Background

Many economies are experiencing population aging. The demand for medical and elderly-assistance services and products has never been higher, and is expected to grow further. There are tremendous opportunities for investment and development in related industries. Since early 1990s, many Hong Kong manufacturers started moving their production to Mainland China to lower production costs, leaving quality control, marketing, research and development, design, after-sales services, and procurement of material and equipment in Hong Kong.

There are about 250 biotechnology-related companies, 160 medical and health equipment manufacturers in Hong Kong in 2021.[27] The Chinese Central Government has long emphasised the important role of the Guangdong-Hong Kong-Macao Greater Bay Area (GBA hereafter) in promoting the development of national science and technology. In the "Guangdong-Hong Kong-Macao Greater Bay Area Outline Development Plan" released in 2019, biomedicine is listed as a new pillar industry in the GBA. Research in biotechnology done by many Hong Kong's universities is world-renowned. For instance, in 2020, the University of Hong Kong's team successfully developed the world's first nasal spray coronavirus vaccine. Professor Dennis Lo of the Chinese University of Hong Kong also invented the non-invasive prenatal diagnosis technology, which has been widely used in nearly 100 countries.

In the meantime, Hong Kong was Asia Pacific's largest IPO centre for biotech companies, the second largest in the world. By the end of June 2021, 67 medical and health companies have been listed on the Hong Kong Stock Exchange,[28] and the initial public offering has raised HKD 209 billion, reflecting the continuous maturity of Hong Kong's biotechnology ecosystem.

[27] HKTDC (2021a) Biotechnology, Medical & Healthcare Industry in Hong Kong
[28] HKCD (2021a) 香港成亞太生科融資中心 上半年逾 50 家生物醫藥企業排隊上市

4.2 Reasons Behind Health-related Manufacturers' Hesitation to Return to Hong Kong

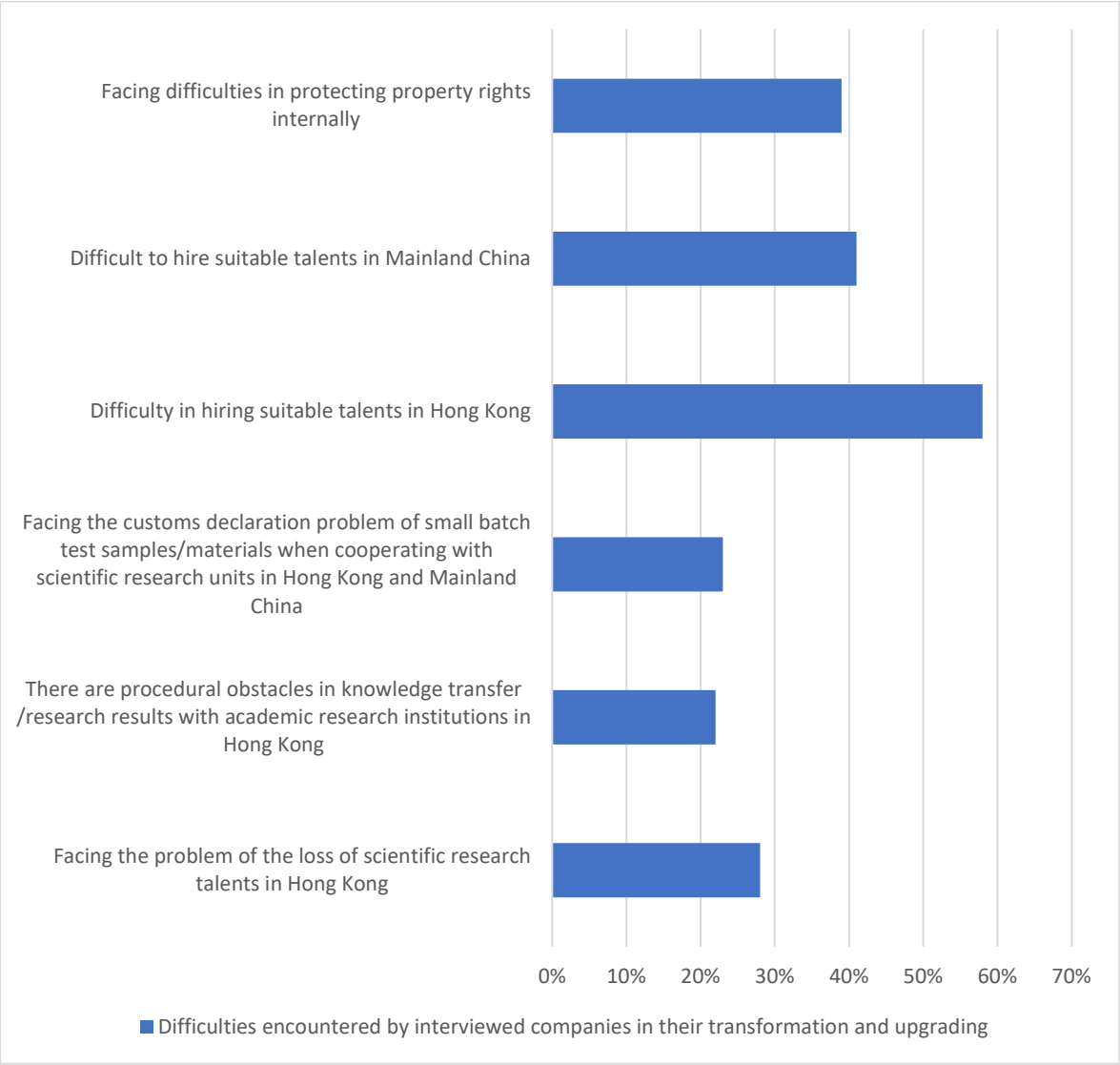


Figure 7: Difficulties encountered by interviewed companies in their transformation and upgrading

Source: Hong Kong Centre for Economic Research, the University of Hong Kong

Based on a survey conducted by Hong Kong Centre for Economic Research, University of Hong Kong in 2017, the results showed that 58% of the interviewed companies encountered difficulties in recruiting suitable talents in Hong Kong, 17% higher than in

Mainland China. [29] The cost of hiring R&D talents in Hong Kong is higher than that in the Mainland, naturally due to the housing and expected salary cost.

Since Hong Kong lacks locally-trained R&D talents, companies often need to recruit personnel from the Mainland or overseas. The recruitment and training costs are relatively high. In addition to the fierce competition in international scientific research human resources, Hong Kong has a high rate of R&D talent loss. Local scientific research employees in Hong Kong corporates are usually only willing to work for two to three years in the same company. It is therefore attractive for the scientific talent to seek opportunities in foreign countries or Mainland China. Furthermore, there is a shortage of talent in the medical field in Hong Kong. It is especially difficult for HealthTech start-ups to recruit suitable professionals. Companies are also concerned about the long processes to apply for government funding, especially for start-up companies that have limited administrative resources. In addition, from our survey focus group discussion, Hong Kong's "Government-Industry-University-Research" collaboration is insufficient and fails to strengthen the industry's R&D capabilities.

4.3 Expectations from Health-related Manufacturers

The "Made in Hong Kong" label is one of the major selling points of Hong Kong local manufacturers. It successfully acts as an assurance of quality. Potential clients are willing to pay a premium to buy Hong Kong manufacturers' products.

Moreover, Hong Kong's medical market will benefit from the synergies of the GBA development. Mainland citizens have a huge demand for medical services and they generally hold a positive impression about Hong Kong's medical system. Many of them have been using Hong Kong's private medical services for years. Such situation will attract many overseas medical technology companies with interest in the GBA market to establish a base in Hong Kong.

In recent years, different public bodies offer various support schemes for HealthTech companies. Examples include the 4-year "Incu-Bio Programme" of the Hong Kong Science and Technology Parks, which provides biomedical start-ups with a complete working space and

[29] Federation of Hong Kong Industries (2017) The way forward for HK industries

marketing support, assistance in contacting potential investors, customers and the media, and matching funds.[30]

4.4 Support from the HKSAR Government

In view of the fact that the HealthTech industry is regarded as a strategic industry and cannot develop on its own with the market alone, the Government should take lead to formulate a blueprint for the industry's development. Professor Ronald Li [31] from the University of Hong Kong has been researching artificial hearts for years and has successfully created the world's first mini artificial heart. He believes that the Hong Kong Government can act as an intermediary to better integrate Hong Kong's five major innovation and technology advantages, including scientific research and technology, education, medicine, finance, business, and law, to improve the innovation and technology ecosystem.

Furthermore, companies in the industries actively seek for government funding schemes and grant supports, and establish fundraising platforms. In the early stage of the growth of HealthTech companies, it was necessary to complete a lot of preliminary work for entering the market, such as developing product prototypes and publishing medical papers to gain confidence and recognition from the medical community. The development cycle of HealthTech start-up companies is generally between 5 and 10 years, and the shortage of funds in the seed stage is quite serious.

Last but not least, Hong Kong's public sector procurement policy weakens the competitiveness of SMEs and local start-ups. Hong Kong's public procurement procedures are regulated by the "Stores and Procurement Regulations" under the "Public Finance Ordinance", and must also be consistent with the principles of the World Trade Organization (WTO)'s "Agreement on Government Procurement (GPA)" for those who intend to participate in public procurement,[32] which creates a fair and open competitive environment for providers of products or services.[33]

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[30] HKSTP (2021a) INCU-BIO

[31] Ming Pao (2016) 早年培植首個迷你人造心臟 港幹細胞權威 研迷你人助試藥

[32] The Government of Hong Kong Special Administrative Region: Financial Services and the Treasury Bureau (2021) Guide to Procurement.

[33] Although the WTO GPA has a mechanism for negotiation for exemptions among contracting members, the Hong Kong Government did not propose any negotiation requirements for exemptions when it signed the WTO GPA in 1997, which greatly weakened the flexibility of public procurement as an economic policy.

Though the Hong Kong government revised the policy in 2019 to allow various procurement departments to increase the weights on technical content and to increase the chance of winning for the bids that entail innovative elements, whether such policy can effectively enhance SMEs and start-ups' chances to obtain the government's procurement contracts is yet to be seen.

4.5 Local HealthTech Manufacturers Investing in Technology 4.0

Case 1: Professor Dennis Lo's Fetal DNA Tests of Down Syndrome and other Genetic Diseases

New horizons for the future of humanity

Professor Dennis Lo's research team analysed fragmented DNA in pregnant women's plasma to detect whether their infants will have genetic diseases. For example, some babies suffer from "Congenital Adrenal Hyperplasia" (CAH), and their reproductive organs are abnormal due to hormonal imbalance after birth. The new technology provides non-invasive prenatal testing of the fetus in the 8th week of pregnancy, which allows early prenatal intervention and avoids multiple risky operations after the baby's birth.

After 20 years of hard work, Professor Lo pioneered a genetic prenatal diagnostic test, which enables pregnant women to undergo "non-invasive" prenatal examinations to detect whether the fetus has Down syndrome. Compared to previous invasive testing, the test is much safer in terms of lowering the risk of miscarriage during testing. Because of this innovation and many other related contributions, in 2021, Professor Lo won the Breakthrough Prize, which is often referred to as the "Oscars of Science" to honour a world-renowned scholar who has done paradigm shifting research in the Fundamental Physics, Life Sciences and Mathematics. Professor Lo was often hailed as "the Hong Konger closest to winning Nobel Prize".[34]

Challenges faced

The fetal DNA test developed by Professor Lo initially experienced the shortage of funding as it was not favoured by most investors. Pregnant women in Hong Kong should have

[34] HK01 (2017) 最接近諾貝爾獎的港人　無創產檢之父盧煜明：搞科研要人才及投資

been the first to benefit from the non-invasive prenatal testing, but due to lack of investment, customers in 90 foreign countries benefited from the technology first. Professor Lo attributed the difficulty for his company to take off in Hong Kong to the lack of entrepreneurs with rich scientific knowledge in the city. Most Hong Kong's investors did not appreciate the potential financial returns and were averse to risks from investing in scientific research.[35]

Case 2: Po Sum On (保心安) Pharmaceutical Factory[36]

Product modernisation and "Made in Hong Kong" to enhance brand value

Traditional industries are also in need of business upgrade towards new technologies and smart manufacturing to adapt to the changing times and enhance competitiveness, as well as to retain the traditional brand value to win the market. HKPC recently helped a GMP accredited Proprietary Chinese Medicines manufacturer, founded a century ago, to develop and build an intelligent automatic packaging system, which can fulfil the complicated and stringent packaging requirements for Chinese medicine products, resulting in improved packaging quality.

Challenges faced

Traditional Chinese medicine factories embrace "ancient production methods". The preparations and formulas cannot be changed casually and should follow the drugs product license from the Department of Health. It is not easy for Chinese medicine factories to pursue modernisation; even just adopting modern machinery for production. Most operation processes today still rely on manual works despite the advanced business development. While most of the existing technical staff are retiring soon, it is increasingly difficult to recruit skilful operators or young trainees. No automatic packaging machines specifically designed for traditional Chinese medicine industry are available in the market.

Achievement

Po Sum On then collaborated with the Hong Kong Productivity Council (HKPC) to develop a dedicated fully automated packaging machine, which enables all-in-one production

[35] Takungpao（2018）盧煜明：港缺乏科學知識企業家

[36] Unwire.pro (2016) 傳統工業青黃不接　保心安藥廠用新角度來看「工業 4.0」

from wrapping glass bottles with instruction sheets, packaging, sealing to quality assurance for different processes and appearance. The capacity of the system is 3,000 bottles per hour, with an intelligent control software to fulfil the complicated and stringent production and packaging requirements for Chinese medicine products. The automated machine is required to fit for different sizes of various packaging materials, and hence machine vision systems are applied to monitor entire system performance, ensuring no conformation and appearance defects in packaged bottle and instruction sheet for better product packaging quality and robustness and the assurance to comply with GMP-related rules and regulations.

In addition, the new machine can also help enhance production management and market competitiveness by capturing real time data of production, machine, quality and energy with a built-in system, not only for the closer monitoring of the entire system performance, but also for the preparation for the deployment of Industrial Internet of Things (IIoT) in the factory.

Case 3: Bright Future Pharmaceutical (澳美製藥)[37]

Made in Hong Kong, as a reliable, effective and trustworthy brand

The building of smart factories enabled Bright Future to predict maintenance requirements, increase productivity, enhance agility, and improve safety and employee satisfaction. Meanwhile, it has simplified and automated production processes, which reduced the change of human errors that lead to accidents and work-related injuries. By doing so, the instant responses and productivity are improved.

[37] Bright Future (2020) Information for Bright Future's worldwide customer and business partners December 2020

Case 4: Time Medical (美時醫療)[38]

Take part in HKTDC's 'T-BOX' Programme, to upgrade technology and expand international market

Time Medical is mainly engaged in hospital imaging technology. During the COVID-19 pandemic, the company launched a new product called a disinfection robot. The robot has three disinfection modes that achieve a sterilisation rate of more than 99.9%. However, as an SME, the company lacks international connection to promote and sell the robot in the global market. Time Medical has joined the Hong Kong Trade Development Council (HKTDC)'s support scheme T-box to solve the problem.

The HKTDC has established a large database (T-box) to match SMEs with overseas buyers. The T-box service can overcome challenges faced by SMEs in developing markets, and help them save the detours of exploration and directly connect them with the right customers.

Case 5: HKUST x Chiaphua Industries (捷和實業)[39]

Government-Industry-Academia collaboration leads to a huge success

A team led by Prof. Yeung King-lun, Professor of the Department of Chemical and Biological Engineering and the Division of Environment and Sustainability at the Hong Kong University of Science and Technology (HKUST) has developed a new type of multi-layered antimicrobial coating (MAP-1), which can effectively kill viruses, bacteria and even spores that are extremely difficult to kill. This innovation can help in the fight against COVID-19.

With funding support from Chiaphua Industries and the Innovation and Technology Commission, HKUST set up a joint laboratory with Chiaphua Industries to translate conceptual ideas and research on innovative environmental health technologies into tangible products to address societal needs.

[38] HKTDC (2020) 升級轉型　突破挑戰：醫療科技新市場

[39] The Hong Kong University of Science and Technology: School of Engineering (2021) HKUST Develops New Smart Antimicrobial Coating in Fight Against COVID-19

Case 6: Precision Robotics (普銳醫療)[40]

World's leading technology company's surgical robot R&D centre in Hong Kong

Precision Robotics, which was spun off from the Hamlyn Centre of Imperial College London, began research and development of surgical robots in Hong Kong in 2018 to respond to global health challenges through technological innovation.

With the objective to develop safe, effective and easy-to-use medical technology, Precision Robotics has been focusing on scientific research and innovation, especially clinical translation, to directly benefit patients with global diseases. Precision Robotics has also benefited from the advantages brought by Hong Kong's medical and healthcare equipment industry, including top suppliers in the value chain, ranging from electronics, metals, plastics and sophisticated engineering capabilities. Given Hong Kong's strength in design, development, production capacity, together with its robust legal and intellectual property protection systems, multinational medical device companies will find Hong Kong to be an attractive market to develop new technologies and achieve commercialisation.

Professor Guang-Zhong Yang, founder of Precision Robotics, was confident in establishing an office in Hong Kong. He reasoned that Hong Kong enjoys unique advantages in important areas such as financing, product development, production, and clinical trials all in one place. The Hong Kong office of Precision Robotics focuses on product design and development as a forerunner to promote commercialisation of medical robots. At a later stage, when the clinical data is approved by the National Food and Drug Administration, the U.S. Food and Drug Administration, and other jurisdictions in Australia and Southeast Asia, they will conduct clinical trials in the Hong Kong market.

[40] 投資推廣署 (2018) 以醫療機械人 重塑醫療未來

4.6 Unique Advantages for HealthTech Manufacturers Investing in Hong Kong

According to Professor Dennis Lo, Hong Kong's multiple sources of talent, abundant venture capital funding, and ancillary factors such as the legal and intellectual property rights protection systems have made it the ideal innovation and scientific ecosystem.[41] The Hong Kong Government promotes the development of innovation and technology in eight areas, four of which directly promote "reindustrialisation", including:[42]

- Increase scientific research resources;
- Train scientific and technological talents;
- Provide venture capital;
- Build innovative technology infrastructure facilities.

For HealthTech companies such as medical technology and equipment ones, they may consider carrying out key production procedures that involve key scientific research or sophisticated testing procedures in Hong Kong to protect intellectual property rights and product quality.

In the past, "Made in Hong Kong" only represented products that were produced in Hong Kong. However, after years of digitalisation and global sourcing of manufacturing and the transformation of Hong Kong into a service-oriented economy, "Made in Hong Kong" should be understood in a broader sense as Hong Kong-funded manufacturers engaging in scientific research, design and production management of diversified products, that have Hong Kong's inputs and craftsmanship embedded.

[41] HKSTP (2021c) Professor Dennis Lo: Overcoming Challenges and Sustaining Vision to Changing Millions of Lives

[42] Institute of Entrepreneurship, The Hong Kong Polytechnic University (2021) 驅動「香港再工業化」：香港再工業化是否已萬事俱備？

Chapter 5: Current Status of GreenTech

5.1 Background

Given Hong Kong's small geographic size and population density, environmental issues are always pressing. The recycling industry has thus gained increasing attention. The previous 3Rs (Reduce, Reuse, Recycle) have become the current 5Rs (Refuse, Reduce, Reuse, Repair, Recycle). To alleviate the landfill pressure in Hong Kong, the Hong Kong SAR Government has actively advocated the development of local recycling industry to extend the life of waste and turn them into valuable products and materials for domestic sales or even exports.

According to the statistics of the Environmental Protection Department (EPD) of HKSAR, the total amount of solid waste dumped in Hong Kong's landfills has been decreasing significantly since 2002, and only increased slowly since 2011 (see Figure 8). In 2019, solid waste dumped into Hong Kong's landfills amounted to 5.71 million tons, of which more than 70% came from the city's solid wastes (4.04 million tonnes) and 25% from construction wastes. Figure 8 also shows that domestic waste was the main source of solid waste in Hong Kong. The disposal volume in 2019 was on average 6,554 tonnes per day (amounting to 2.39 million tonnes annually).

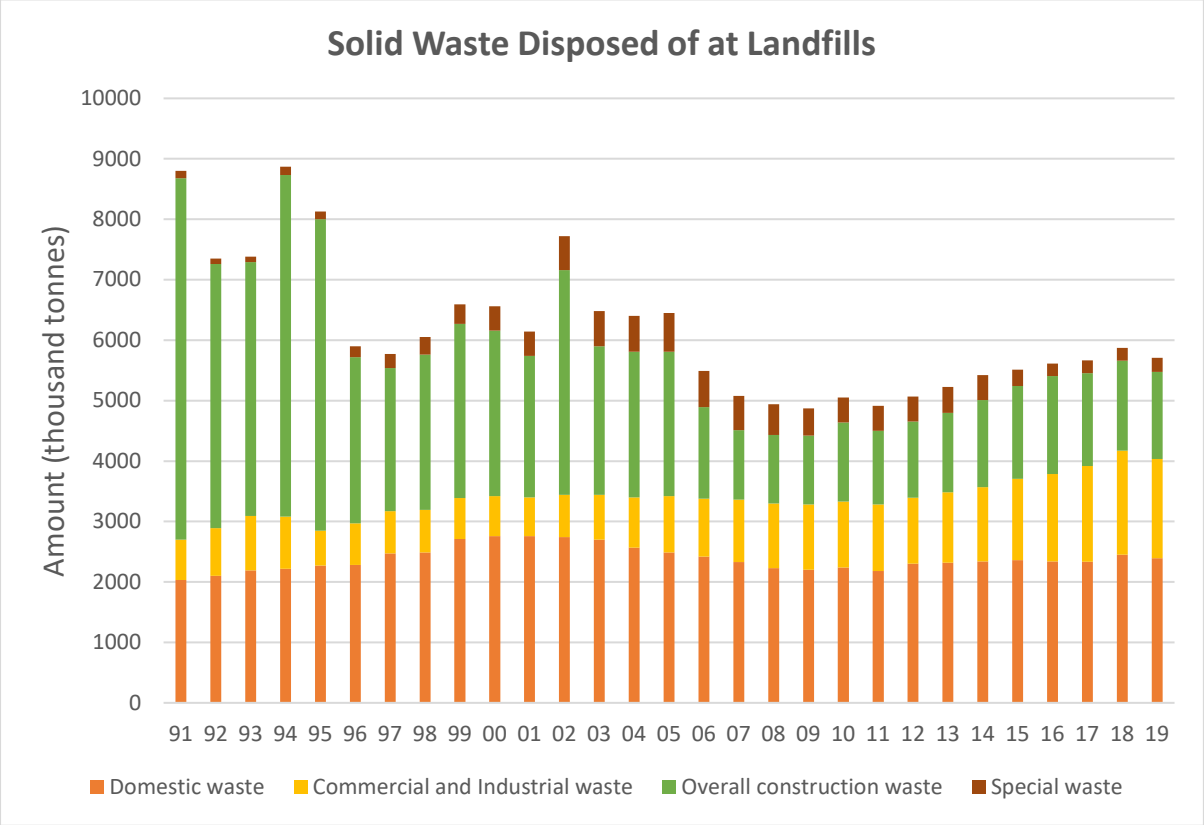


Figure 8: Volume of solid waste disposed at landfills by major waste category

Source: Environmental Protection Department, HKSAR

According to the 2019 Monitoring of Solid Waste in Hong Kong report, food waste accounted for the most (30%) of the city's solid waste disposal in landfills every day, with a daily disposal volume up to 3,353 tonnes, of which about 70% was from households (Figure 9a, 9b). As the industrial and commercial wastes are more concentrated and have a higher recycling value, relatively more industrial and commercial food waste have been recycled, and it is about 1,000 tonnes disposed each day.

Figure 9a. Composition proportions of Hong Kong's solid waste disposed of at landfills in 2019 - by major waste types

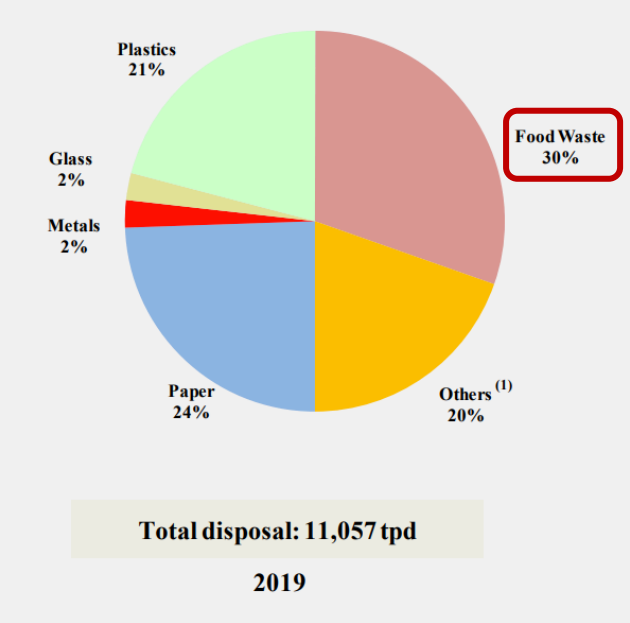
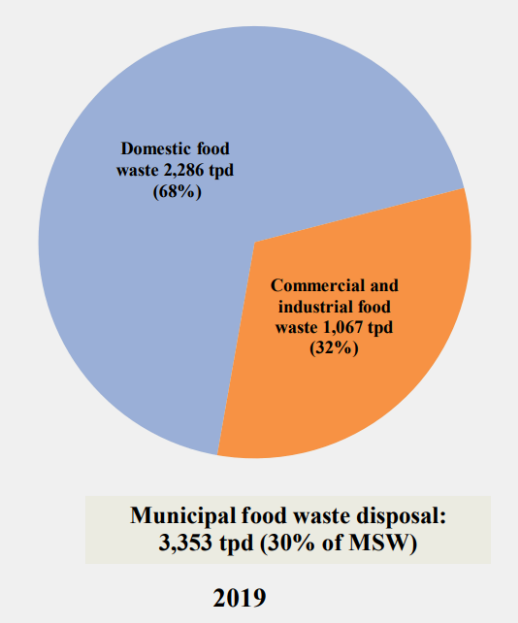


Figure 9b. Composition and proportion of overall urban food waste disposed of at landfills in 2019 - by waste type



Source: Monitoring of Solid Waste in Hong Kong - Waste Statistics for 2019

Although Hong Kong has 762 recyclers, collectors or both, on average, only 6% of the city's solid wastes were recycled locally from 2015 to 2019, with the remaining 94% being exported to Mainland China (Figure 10). This reflects that recycling activities and absorption of recycled materials in Hong Kong are still at a very preliminary stage, and have much room for growth.

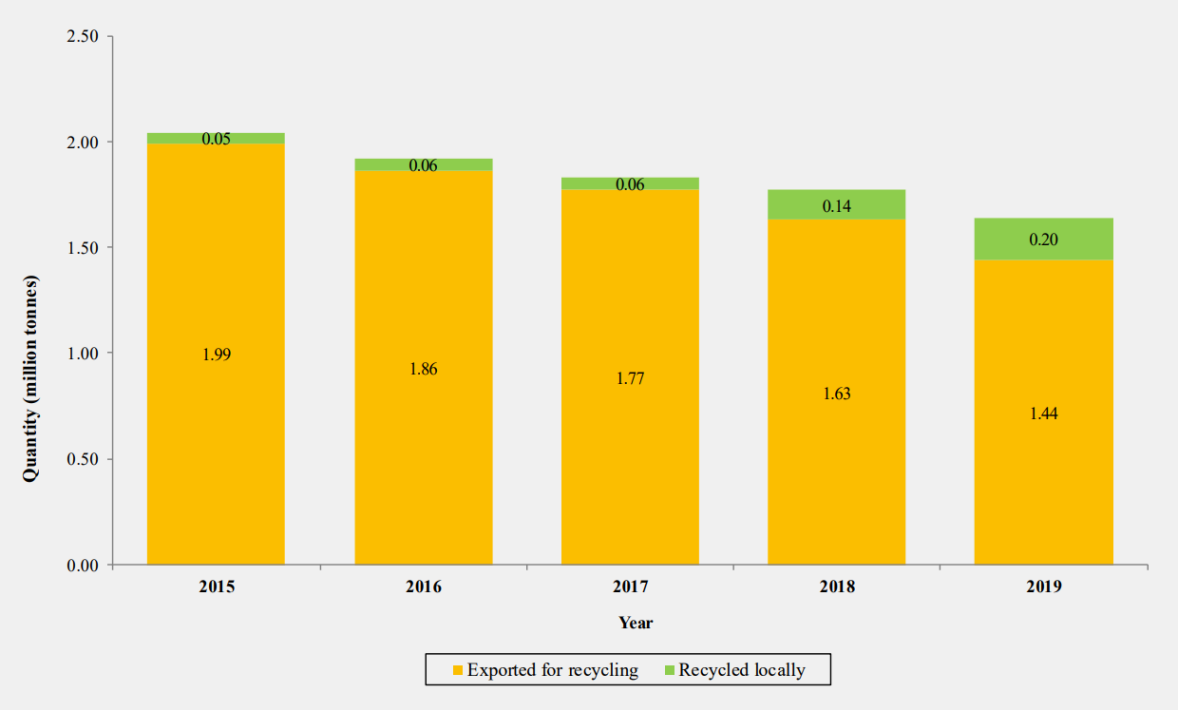


Figure 10: Volume of recyclable materials recovered from solid waste (2015 – 2019)

Source: Monitoring of Solid Waste in Hong Kong - Waste Statistics for 2019

The recycling rate of the city's solid waste has gradually increased since 1999, and even exceeded half reaching 52% in 2010. However, since Mainland China has (1) tightened the imports of plastic waste since 2011, (2) launched the "Operation Green Fence" in early 2013, (3) began to adopt a tougher waste paper import policy three years ago by gradually reducing its quota,[43] and even (4) launched the " Implementation Plan on Advancing Reform of the Administration System on Import of Solid Wastes through Prohibiting Import of Foreign Rubbish" in July 2017, blocking the way out recycling companies that previously relied on exporting to the Mainland. With Mainland China's increasingly stringent waste import regulations, the prices of wastes and recycled materials have fallen, reducing the profits of waste exports and Hong Kong's recycling rate since 2010 to a record low of 29% in 2019 (see Figure 11).

[43] From the national approved import quantity of 33 million tons in 2017 to 14 million tons in 2019, making a reduction of more than half in two years

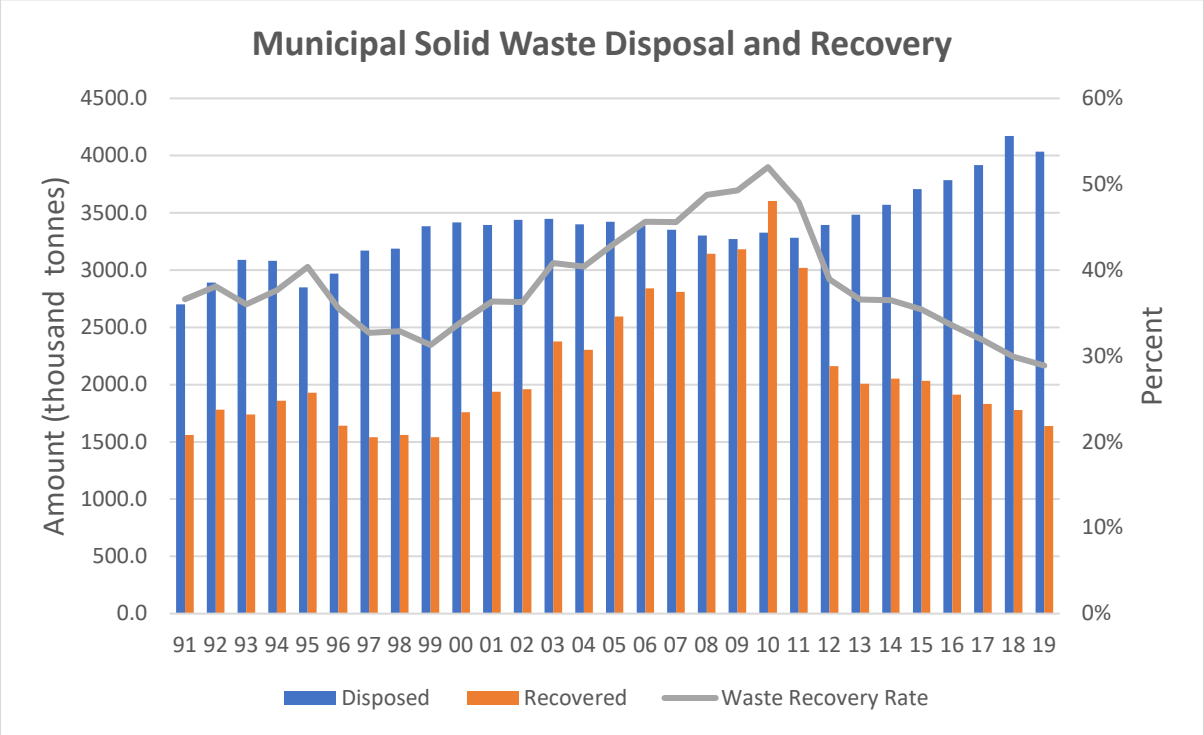


Figure 11: Volume of solid waste disposed of and recycled in Hong Kong

Source: Environmental Protection Department, HKSAR

5.2 Support from the HKSAR Government

To support the development of the environmental protection industry, the Government injected funding to the Innovation and Technology Fund, the SME Development Fund, the Environment and Conservation Fund, as well as the Hong Kong Science and Technology Parks Corporation. Furthermore, in the 2020-21 Budget, it was announced that HK$200 million will be allocated to establish a new Green Tech Fund and an additional HK$1 billion will be injected to the Recycling Fund to support more focused and relevant R&D projects to promote the development and application of carbon reduction and green technologies.

In addition, there are currently six central processing parks for solid waste in Hong Kong, namely:

1. *T·PARK*, which was opened in 2015, employs advanced incineration technology to convert sludge produced by the sewage treatment plants into electricity. T·PARK currently can handle 2,000 tonnes of sludge per day. It is not only self-

sufficient, it can also send surplus electricity to the public grid, meeting the electricity demand of about 4,000 households each year.

2. *WEEE·PARK*, which was fully operated since March 2018, is responsible for the processing and recycling of waste electrical and electronic products. To improve the local capacity of "turning waste into resources" and repairing recycled electrical appliances, WEEE·PARK processes 30,000 tonnes of controlled electrical and electronic waste (the regulated electrical equipment are collectively referred to as "four electrical appliances and one computer", which include air conditioners, refrigerators, washing machines, televisions, computers, printers, scanners and monitors) each year, and has processed more than 50,000 tonnes of controlled wastes of electrical and electronic products.
3. In order to handle food waste more properly, the EPD opened the first phase of the organic resource recycling centre (*O·PARK1*) in Siu Ho Wan in July 2018, using biological treatment technology – composting and anaerobic decomposition – to convert food waste into useful compost products and biogas. O·PARK1 aims to handle 200 tonnes of food waste each day.
4. The *O·PARK2* project has been launched and is expected to be operative in 2023, with the capacity of converting 300 tonnes of food waste into electricity every day. In addition to self-sufficiency, the surplus electricity is also sent to the public grid providing enough electricity for about 5,000 households each year.
5. *Y·PARK*, which has been put into operation since June 2021, mainly collects and treats garden waste for transforming into different useful resources, such as compost and mulch for gardening and planting, leavening agent for composting, and substrate for mushroom culture. The treated large trunks and branches are used to produce planks or beams, providing a stable supply of wood to support related industries, such as furniture manufacturing, decoration, and wooden art. In addition, Y · PARK also provides raw materials for the production of biochars in the future. The garden waste is converted into biochar through pyrolysis, which can be used as soil conditioner, filter material for filtering pollutants, planting soil and animal feed additives, etc. The use of these biochars can preserve the carbon molecules in it and help reduce carbon emissions.

6. *I·PARK* (Integrated Waste Management Facility) is a waste-to-energy facility using advanced incineration technology, which can process 3,000 tonnes of the city's solid waste per day. The energy generated during the process will be used to generate electricity, thereby reducing the use of fossil fuels to generate electricity and avoiding the generation of methane from disposed waste at landfills. This will help reduce Hong Kong's greenhouse gas emissions and combat climate change.

Apart from the above six parks, the Government has also established the EcoPark in Tuen Mun, hoping to provide a longer-term land lease at affordable rents to encourage the industry to set up production lines and introduce advanced technology to produce useful products from local recycled materials. Unfortunately, since its operation in 2007, the park has already reached saturation, limiting companies to engage in high value-added recycling.

The industry hopes that the Government can allocate more land in the new development areas to expand the environmental protection parks to support the recycling industries, making them an important pillar of Hong Kong's "reindustrialisation" and creating diversified employment opportunities for the next generation.

5.3 Opportunities

The environmental protection industry has great potential for development in Hong Kong. According to the statistics from the HKSAR's Census and Statistics Department, the value added of the environmental protection industry in 2019 was close to HK$9.9 billion, representing an increase of 141% from HK$4.1 billion in 2008 (see Figure 12).

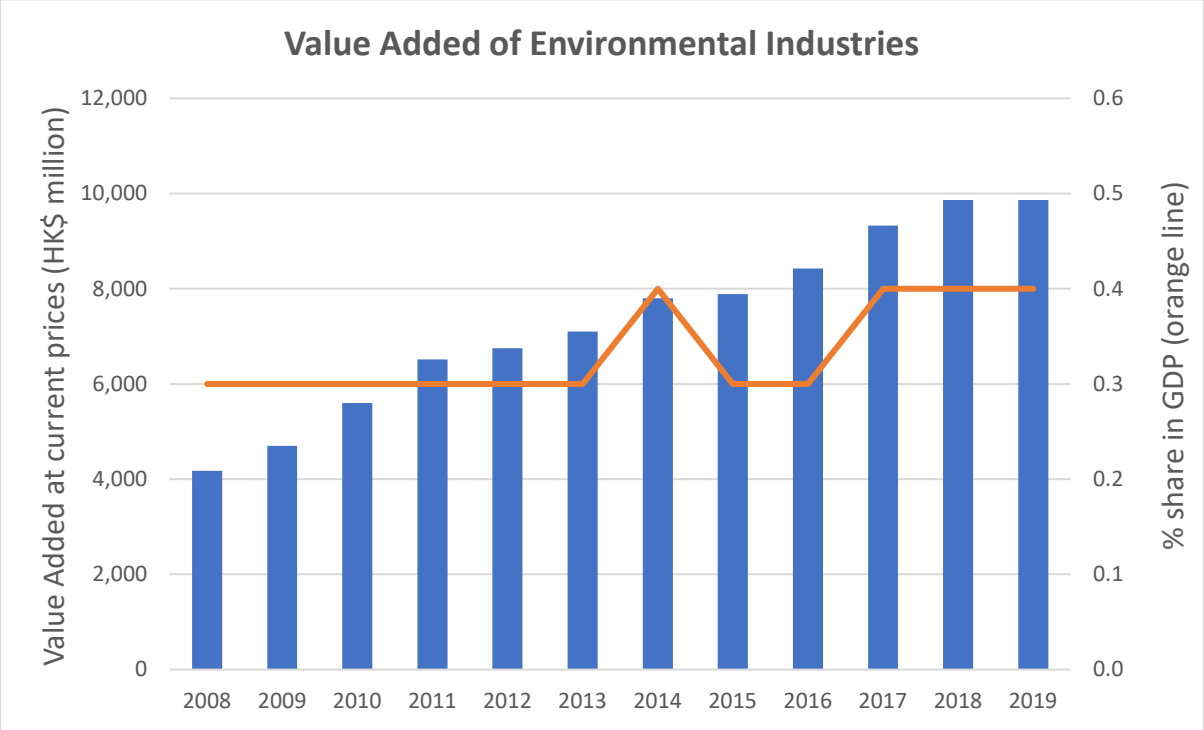


Figure 12: The value-added of Hong Kong's Environmental Protection Industry

Source: Census and Statistics Department, HKSAR

In addition, as the demand for new household appliances and digital products continue to increase, the service life of electronic products tends to be downward sloping, leading to an increasing demand for the recycling of "e-waste". While the global e-waste production is between 40 million and 50 million tonnes every year, Hong Kong produced about 70,000 tonnes of electronic wastes every year, according to the EPD data.

It can thus be seen that the recycling industry has its prospects and opportunities. If Hong Kong's recycling industry wants to grasp the emerging opportunities, the entire industry chain may need to consider upgrading the industrial chain by adopting more advanced technologies in order to expand its own recycling capacity.

The success of the environmental protection industry can improve not only the environment, but also job diversity. According to the latest report of the International Renewable Energy Agency in 2020, the renewable energy industry alone has created 11.5 million jobs worldwide. The report also predicts that the number of jobs will increase to 42 million by 2050. In Hong Kong, according to the statistics from the Census and Statistics

Department, there were 44,670 people who directly or indirectly participated in environmental protection and recycling activities in 2019. Their share has been increasing slightly from 0.9% in 2008 to 1.2% in 2019 (see Figure 13).

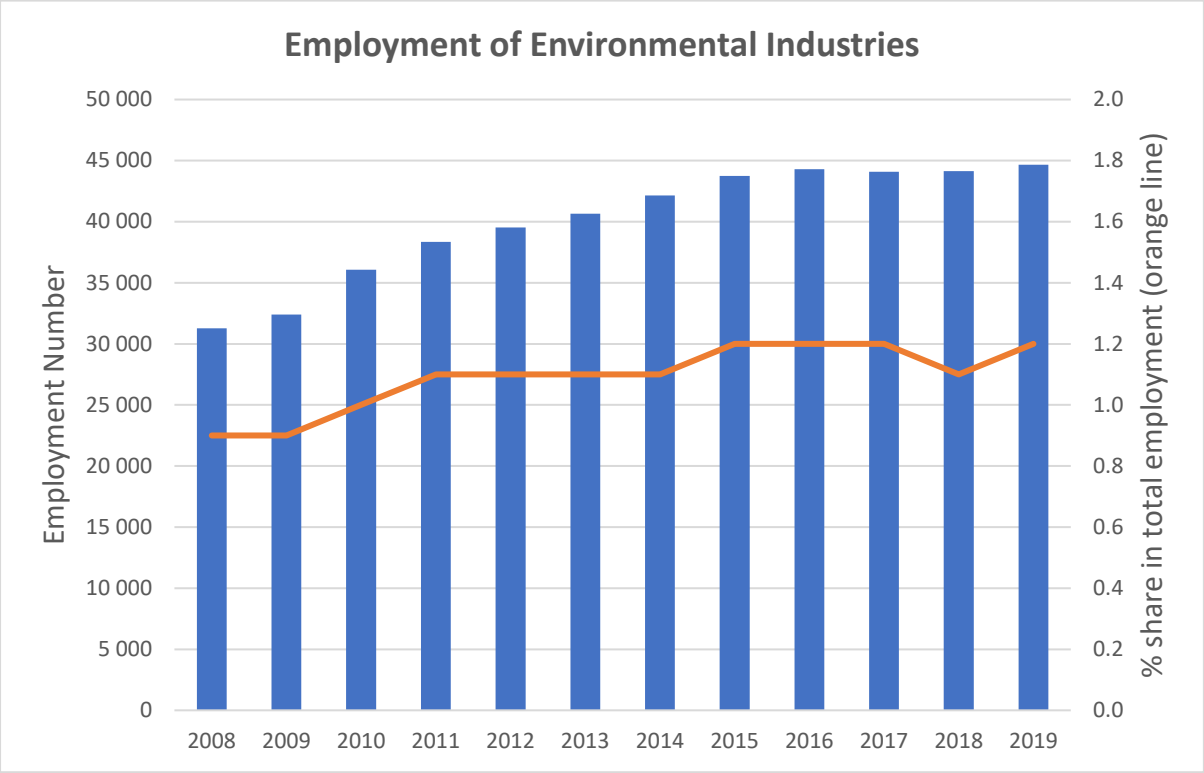


Figure 13: Employment in Hong Kong's Environmental Industry

Source: Census and Statistics Department, HKSAR

5.4 Reindustrialisation and GreenTech

In order to make the environmental protection industry an important pillar of reindustrialisation, the Government may consider implementing the "polluter-pays" scheme stated in the 2005 "A Policy Framework for the Management of Municipal Solid Waste (2005-2014)", together with the "user pays" principle so that an optimal "garbage levy" is used as an economic incentive to encourage the public, industrial and commercial sectors to reduce the use and sales of non-recyclable items or packaging, while encouraging waste sorting and recycling.

Moreover, the government is working on accelerating the implementation of garbage sorting in the community. Although Hong Kong produces a large amount of recyclable garbage every day, the distribution of garbage is very scattered. If recyclers want to collect them from different locations, the transportation costs would be high. Therefore, the Government should take reference from neighbouring regions in Asia, such as Japan and Taiwan, which have more mature recycling industries, and formulate a new mechanism to subsidise the transportation expenses so as to provide economic incentives for recyclers to ultimately increase the recycling rate in Hong Kong.

Once garbage is properly recycled, the recycling industry can seize the opportunity to build a waste-to-material industry (轉廢為材工業) in Hong Kong and gradually improve the local industrial chain in a sustainable economy. In addition to the environmental protection industry, GreenTech also plays an important role in reindustrialisation by assisting manufacturing firms to adopt smart and clean production technologies.

Case 1: Hydrogen produced from kitchen waste for power generation (廚餘製氫，用以發電)

A GreenTech company has developed the technology to recombine biogas from anaerobic decomposition of kitchen waste into hydrogen, which is then converted into electricity – a real example of turning waste into treasure. It has not only greatly reduced both the amount of food waste and the load of the incineration plant, but also helps increase the proportion of renewable energy, diversifying sources of energy supply and driving economic development.

Case 2: Controlling smoke emission for Wo Hop Shek Columbarium & Crematorium by using "Qing Yan" Eco-Joss paper furnace (「清煙」環保化寶爐)

The Hong Kong Productivity Council (HKPC) has installed two types of air pollution control devices for the Wo Hop Shek Columbarium and Crematorium in Fanling – an environmentally friendly stove and an incense smoke collector. Both devices use HKPC's patented environmental protection technology.

- "Qing Yan" Eco-Joss paper furnace – 15 of these environmental protection furnaces are installed in two locations to reduce the black smoke generated from burning of joss papers.
- Three brand new joss stick smoke collectors are installed in the auditorium of the crematorium to remove the smoke generated when burning joss sticks in the altar.

Case 3: Wastewater Treatment Technical Assistance Service for Bean Products Manufacturing Industry (BM-COMBO 膜生物污水處理系統)

HKPC introduced the HKPC-patented BM-COMBO technology for two traditional soybean products manufacturing factories in the New Territories to upgrade their wastewater treatment facilities and reduce environmental pollution.

Case 4: Modification of The Existing Wastewater Treatment Plants and Supply and Installation of a New Wastewater Recycling System

HKPC helped improve the sewage treatment facilities of a garment manufacturing group in Dongguan by installing a sewage recycling system. Hence, the factory is able to meet relevant wastewater discharge standards and water reuse requirements. After the installation, the daily wastewater discharge was reduced from 337 to 195 cubic metres, and about 60% of the wastewater could be recycled and reused.

Case 5: Developing innovative solar power management solutions to make renewable energy more widely adopted

New Energy Financing and Consulting Limited (NEFIN) mainly provides solar power solutions, including technical research, application procurement, design and construction, management and maintenance, and targeted services such as project financing, as well as promoting the usage of solar energy. In addition, NEFIN uses Internet of Things to manage solar power stations in different regions and optimises the efficiency of solar power storage, bringing Hong Kong to a green future.

Case 6: Replacing single-use plastics by harnessing the vast potential of natural plant fibre – Nature's woven green fabric

The patented green composite material (GCM™) developed by Ecoinno Co., Ltd. makes use of renewable natural polymers as raw materials. After reorganisation, GCM™ products can make full use of the significant characteristics of plant fibre, such as complete biodegradation n the natural environment within 75 days, resistance to extreme freezing and extreme heat, water and oil, extreme hardness, airtight (its low air permeability is comparable to metals). The products can also be tested and approved by the U.S. Food and Drug Administration (FDA) confirming to be toxic- free.

Tableware made of GCM™ can be used in catering industry packaging. Taking water cups as an example. Plastic cups usually contain toxic substances when exposed to high temperature, while paper cups are too soft and less durable. GCM™'s high-performance materials provide enough hardness, and at the same time light enough and can be decomposed naturally. Decomposable environmentally-friendly tableware made by Ecoinno is expected to be available for sale in the near future.

Chapter 6: Survey Results

6.1 Research Methods

A survey with 42 questions was designed for companies in Hong Kong. Besides basic economic data such as sales and employment, the survey requested the firms to answer multiple-choice questions over five categories, namely (1) challenges they encountered in doing business in Hong Kong; (2) their research and development (R&D) activities; (3) their understanding of Industry 4.0 technologies and prospects for adopting those technologies in both the short run (1-2 years) and medium run (3-5 years); (4) the expectations about R&D activities and market expansion in different regions; and finally, (5) their expectations about the future of Hong Kong as an innovation and technology hub. The appendix contains the full questionnaire for readers who are interested in the details.

The survey was conducted between July and September 2021, and was sent to a total of 391 companies. Targeted companies include those in the so-called foundation industries (metal, plastic, molding, electronics, etc), FoodTech, HealthTech and GreenTech industries. Among the 391 firms we approached, 213 completed the survey (i.e., a 54% response rate), of which 37% are from GreenTech industry, 31% from FoodTech, 21% from HealthTech, and 11% from the foundation industries.[44] This report focuses on the 184 firms from the three targeted industries. Figure 14 shows the distribution of the responding companies by sector.

[44] It is true that most responding firms did not answer every single question in the survey, but we reassure that the average response rate per question is over 60%, with many questions having a 90% plus response rate. The seemingly lower average response rate is related to the low responses to questions which some firms may be unfamiliar with (e.g., certain type of Industry 4.0 technologies), or open-ended questions that require firms to provide more detailed answers.

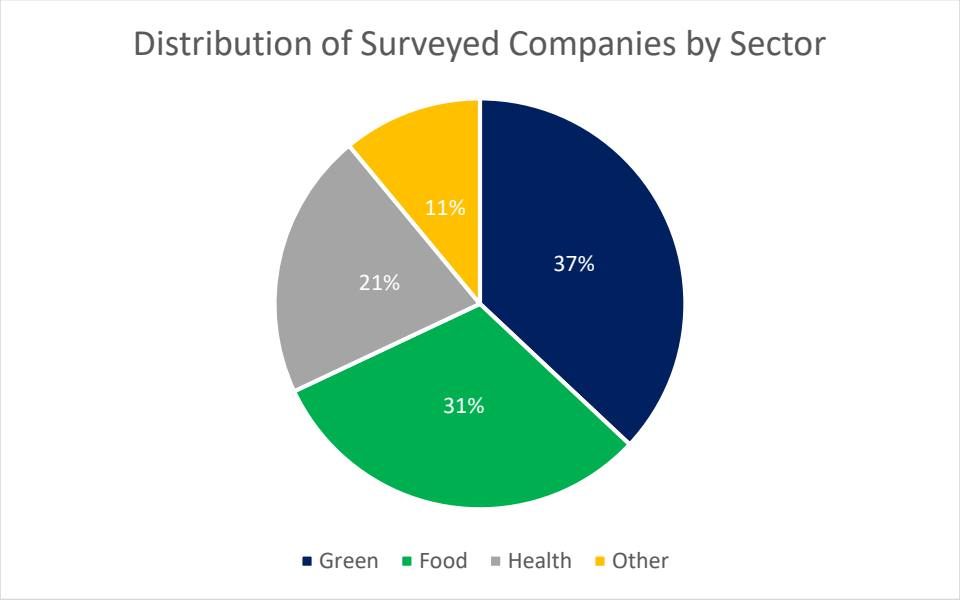


Figure 14: Distribution of Surveyed Companies by Sector

As reported in Figure 15, the surveyed firms' activities span different types of operations – 26% are Original Equipment Manufacturers (OEM), 19% are Original Design Manufacturers (ODM), 34% are Original Brand Manufacturers (OBM), and 21% are others, meaning that they engage in non-manufacturing activities such as post-manufacturing sales and pure design or research and development (R&D).

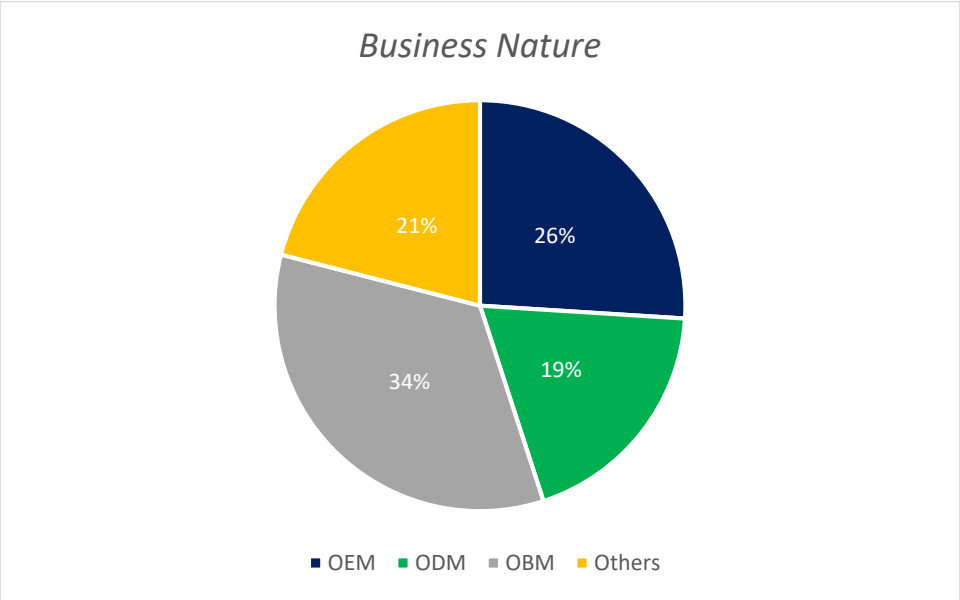


Figure 15: Business Nature

6.2 Main Survey Findings

Main Markets

The first set of questions the survey posed to companies is about their main markets. In contrast to the common perception that Hong Kong's economy is too small and thus unimportant for most manufacturers, we find from the survey that a majority of the responding firms still consider Hong Kong as a main market, especially in the food industry. Specifically, we find that 90% of the surveyed companies considered Hong Kong as their main market, followed by 37% reporting Mainland China as their main market, and 22% mentioning Southeast Asia.

These shares vary across industries. As Figure 16 shows, among the responding companies in FoodTech: 98%, 28% and 20% of companies considered Hong Kong, Mainland China and Southeast Asia as their main target markets, respectively; while for those in GreenTech: 90%, 39% and 24% of companies considered Hong Kong, Mainland China and Southeast Asia as their main target markets respectively. Of the three industries, perhaps those in HealthTech relied relatively less on sales in the local market, but even so, 74% of the surveyed companies in HealthTech say that Hong Kong is their main market, followed by 49% Mainland China and 36% Europe.

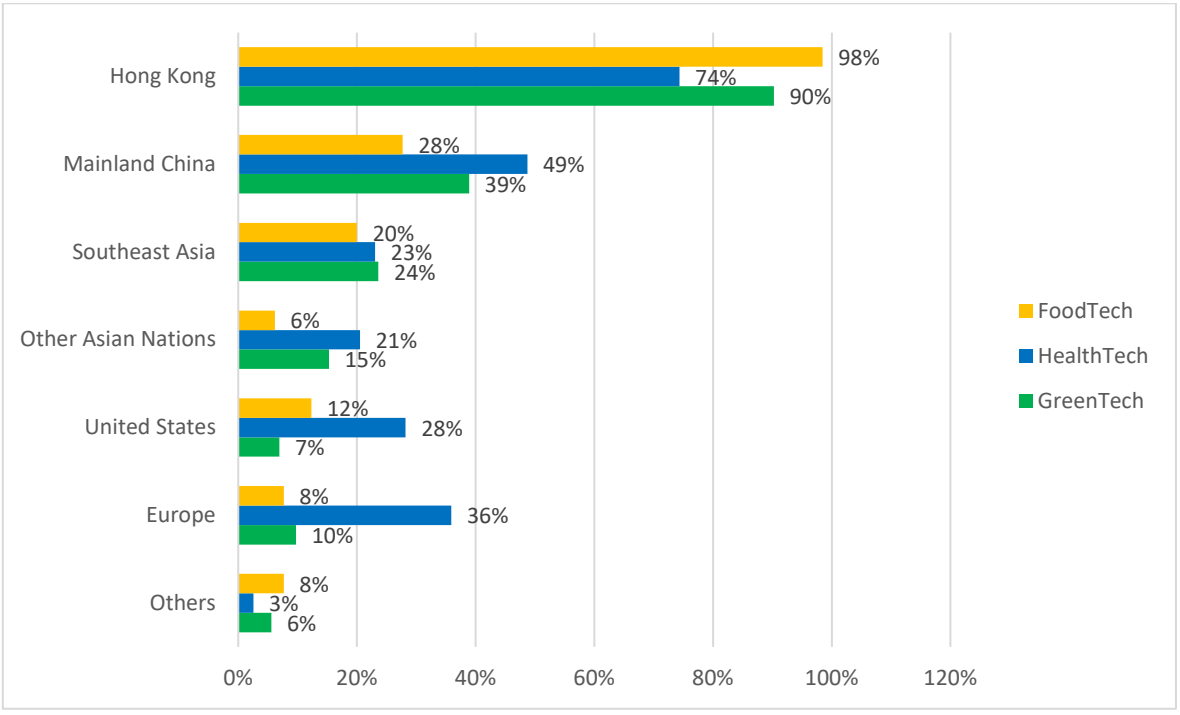


Figure 16: Surveyed Firms' Main Markets

Space Limitation

The survey also asked the companies about their space requirement for business operation. 44% of FoodTech companies, 46% of HealthTech companies and 38% of GreenTech companies said less than 10,000 square feet are required, implying that for all sectors, over half of the companies consider that limited supply of industrial space still poses challenges to their operation and plans to relocate production to Hong Kong.

Besides the desire to have more floor space, they also expressed concerns that space is insufficient for setting up automated production lines or for unloading, or floor ceiling is too low. Specifically, as Figure 17 shows, 80% of FoodTech companies, 63% of HealthTech companies and 54% of GreenTech companies said that space is insufficient to establish automatic production lines. 59% of FoodTech companies, 43% of HealthTech companies and 32% of GreenTech companies said that unloading space is inadequate; while 54% of FoodTech companies, 40% of HealthTech companies and 24% of GreenTech companies said floor ceiling is too low. These numbers in general suggest that different manufacturing industries face different kinds of operation challenges in Hong Kong, and hence policies to promote reindustrialisation need to be flexible. Expecting that any one-size-fits-all strategy will work may not be realistic.

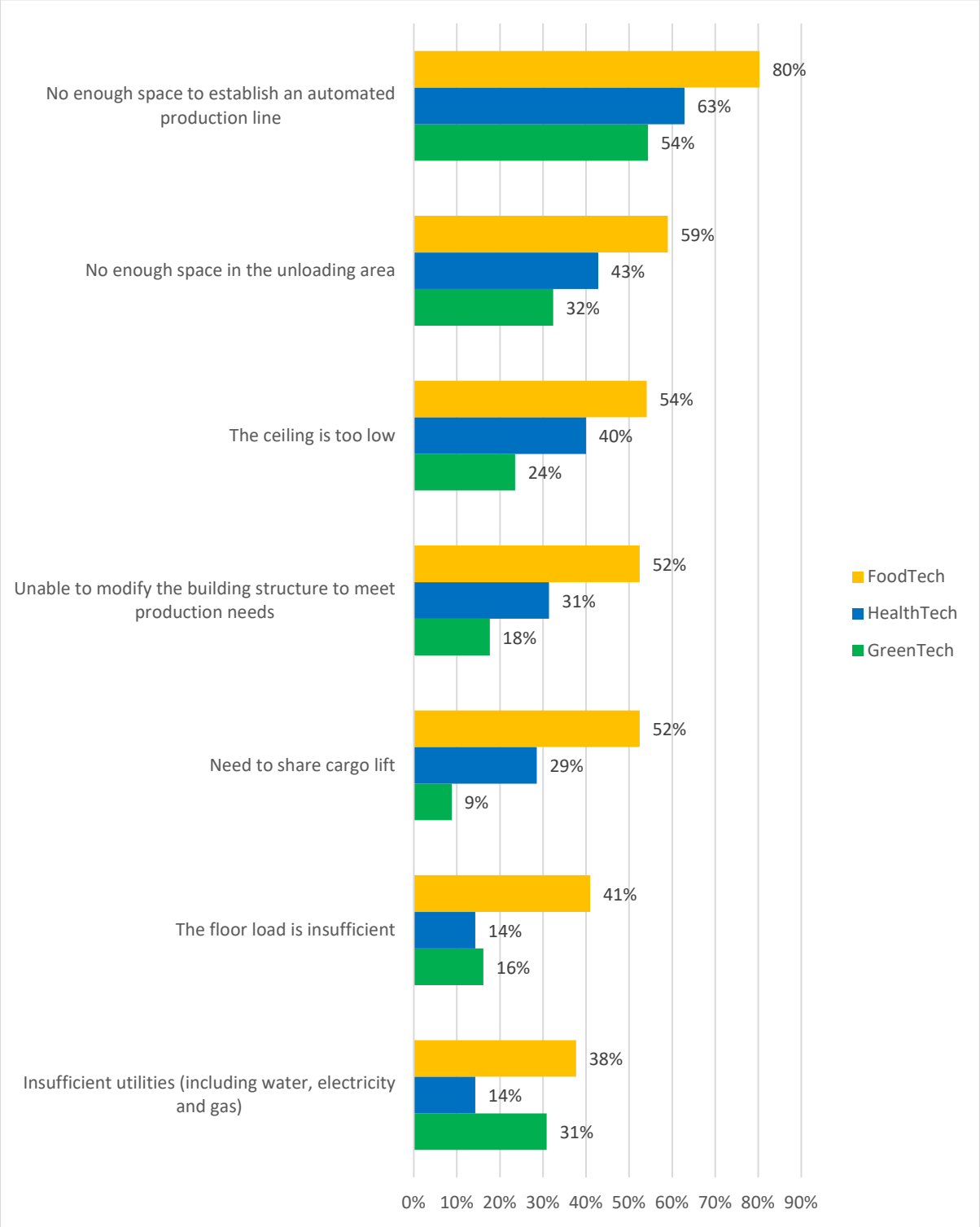


Figure 17: Challenges Facing Manufacturers in Hong Kong

About Industry 4.0

Our survey also asked the companies about their understanding of Industry 4.0 and challenges faced when adopting Industry 4.0 technologies. We find that about half of the

surveyed companies have heard of Industry 4.0. Its awareness, however, varies significantly across industries – 56% of the FoodTech companies, 73% HealthTech and only 28% GreenTech companies have heard of Industry 4.0.

Regarding the benefits of adopting Industry 4.0 technologies, most of the surveyed companies believe that they can increase productivity, reduce production costs, and increase flexibility in operation. Specifically, as Figure 18 shows, 74% of the surveyed firms across all industries believe that such technologies can enhance production efficiency, while 59% of them expect that they can reduce the cost of production, followed by 57% of them expecting that they can enhance operation flexibility.

Some interesting variations occur across industries. As Figure 19 shows, 83% of FoodTech companies, 64% of HealthTech companies and 71% of GreenTech companies believe that Industry 4.0 technologies can enhance production efficiency, while 74% of FoodTech companies, 48% of HealthTech companies and 48% of GreenTech companies expect that such technologies can reduce the cost of production. 63% of FoodTech companies, 48% of HealthTech companies and 57% of GreenTech companies expect that those technologies will enhance the flexibility of operation. It is worth noting that over half (52%) of the GreenTech companies also believe that the technologies can encourage product innovation.

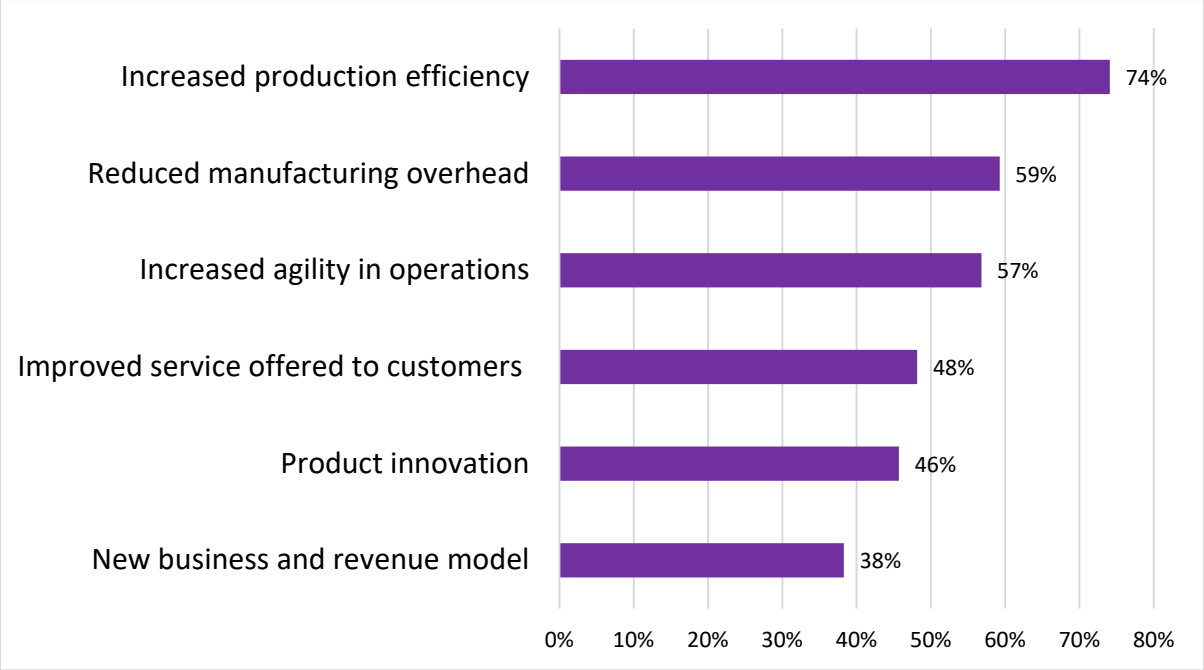


Figure 18: Benefits from Adopting Industry 4.0 Technologies

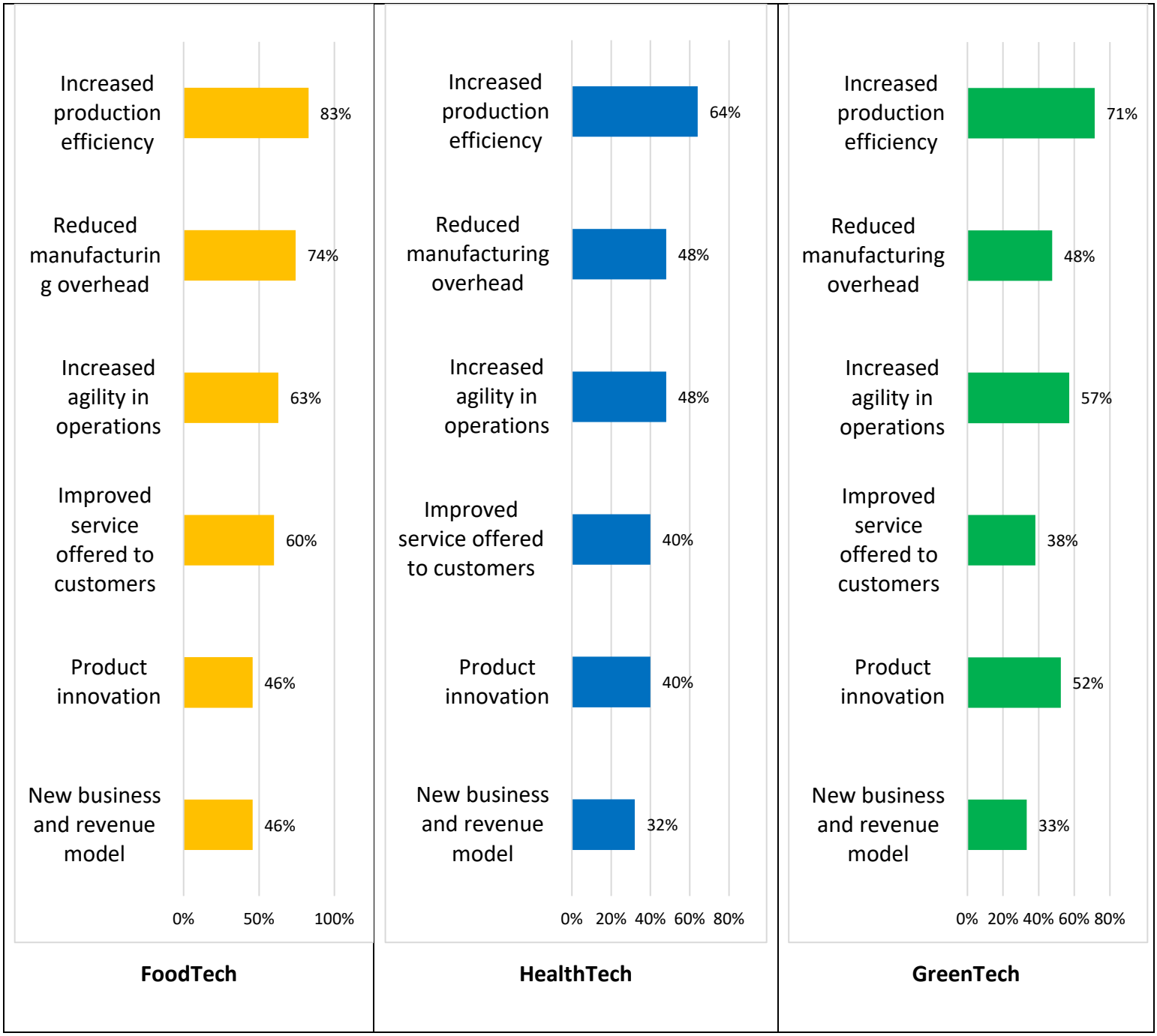


Figure 19: Benefits from Adopting Industry 4.0 Technologies (by Industry)

When asked about what Industry 4.0 technologies are important to the companies, the responses are diverse and wide-ranged. The top six Industry 4.0 technologies are (1) cyber security, (2) human-machine interface (HMI), (3) sensors, (4) data analytics and artificial intelligence, (5) robotics and automation, and (6) Internet of Things (IoT). (see Figure 20).

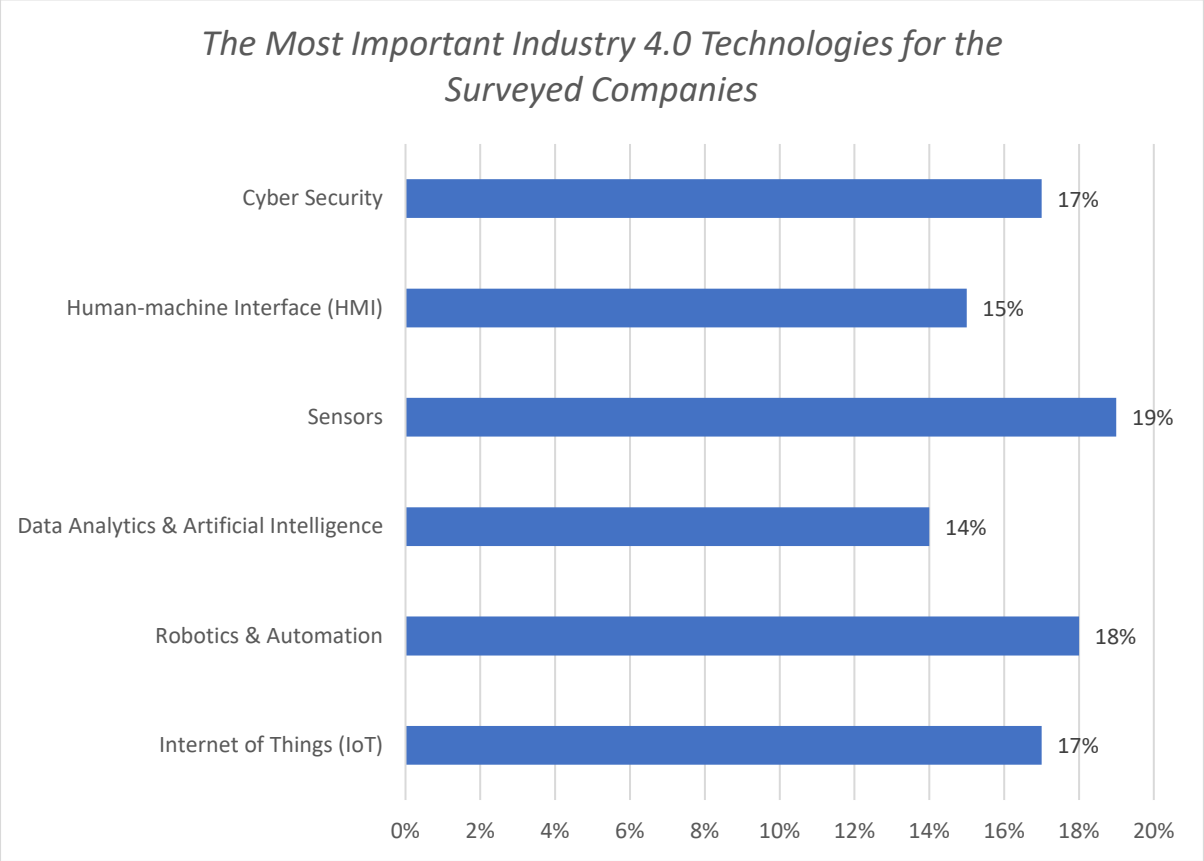


Figure 20: The Most Important Industry 4.0 Technologies for the Surveyed Companies

About R&D Activities

We also asked the companies to reveal their engagement in R&D. 58% of companies said they have invested in R&D. Across industries, FoodTech is the one that has the largest fraction of companies reporting investment in R&D (79%), followed by HealthTech companies (65%), and GreenTech companies (only 36%). Of those who report to have R&D activities, 73% of the FoodTech companies, 50% of the HealthTech companies, and 75% of the GreenTech companies said they have R&D activities in Hong Kong, suggesting that the city still has a clear comparative advantage in industrial R&D (see Figure 21).

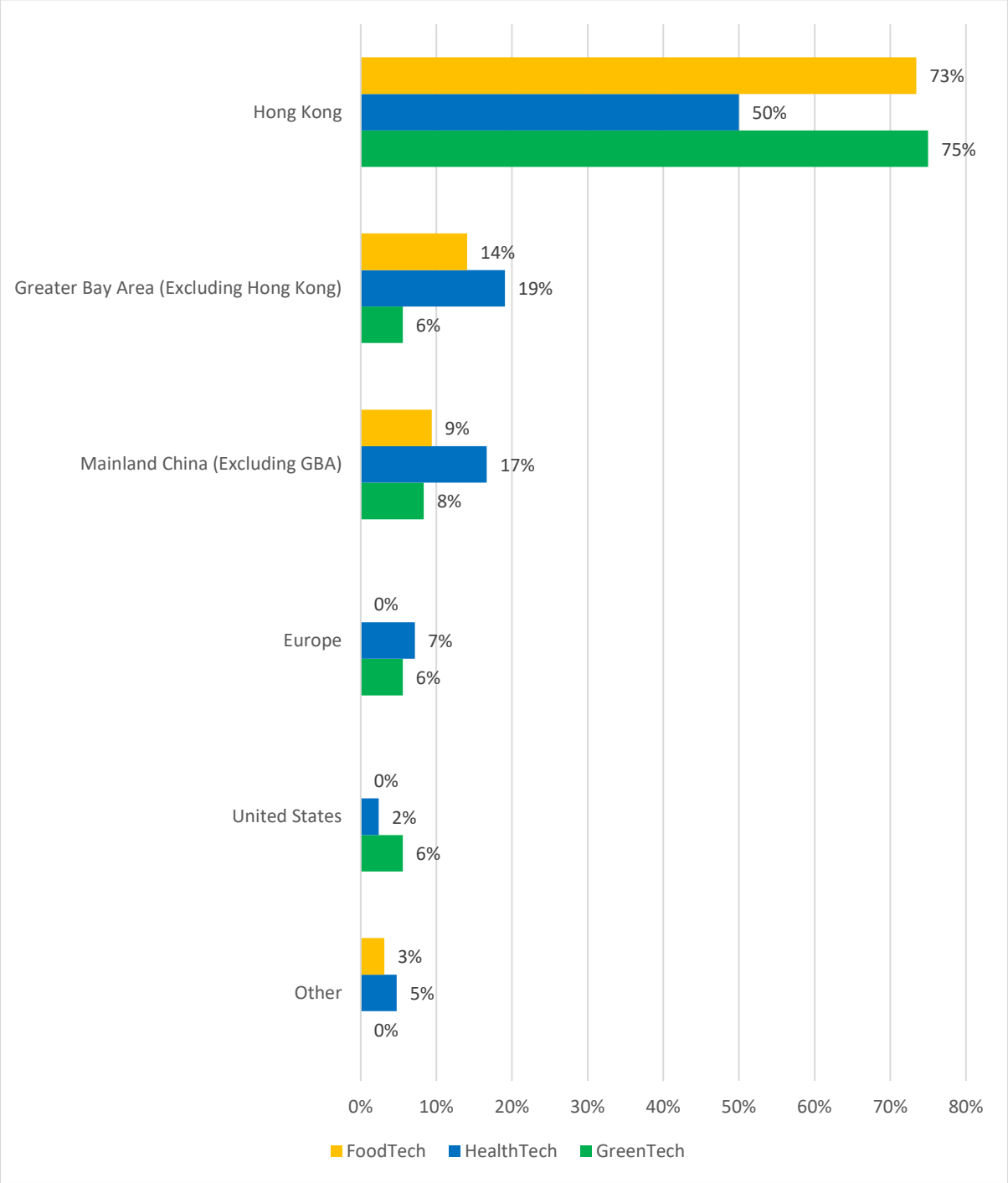


Figure 21: Locations of R&D

When asked about the key factors that determine their R&D location choices, 66% said that the main consideration is the quality of the R&D infrastructure, followed by the abundance of skilled local R&D talents (64%) and the proximity to production facilities (62%). It highlights the importance of having R&D and production to be co-located, or at least not geographically too separated.

Local regulations (53%) are considered as the fourth most important factor affecting the location of R&D. Subsidies for R&D activities (51%), the presence of local R&D communities and related services (49%), and surprisingly, the existence of tertiary education institution in the region (42%) are only considered as the fifth to seventh most important factors (see Figure 22).

Figure 23 shows some variation about these responses across industries. While the quality of the R&D infrastructure was still considered to be the most important determinant of the R&D location for FoodTech and HealthTech companies, it is not as important for GreenTech. Instead, GreenTech companies considered the supply of skilled researchers as the main consideration for a place to be an R&D centre.

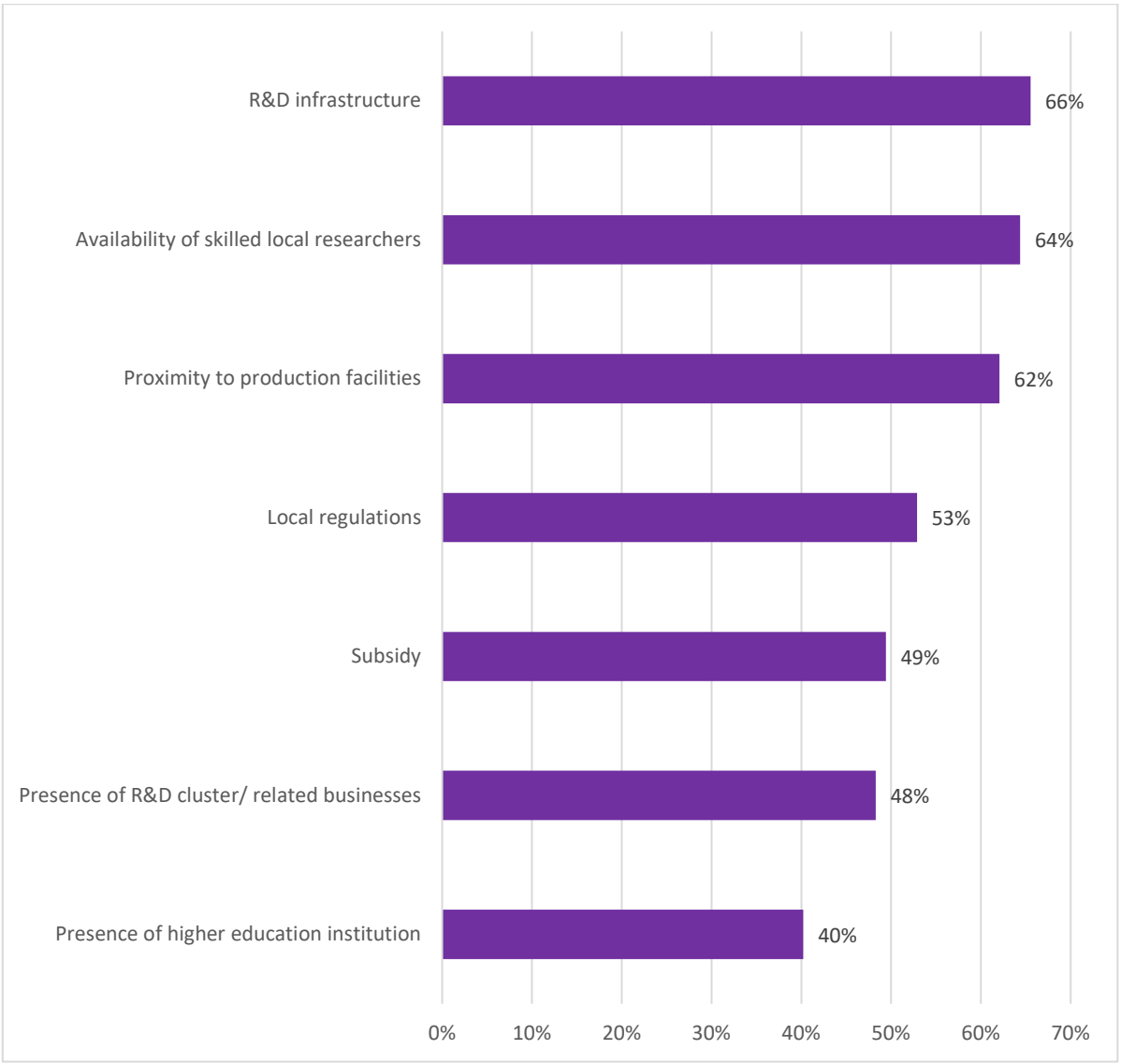


Figure 22: Factors Attracting Firms to Conduct R&D at a Certain Location

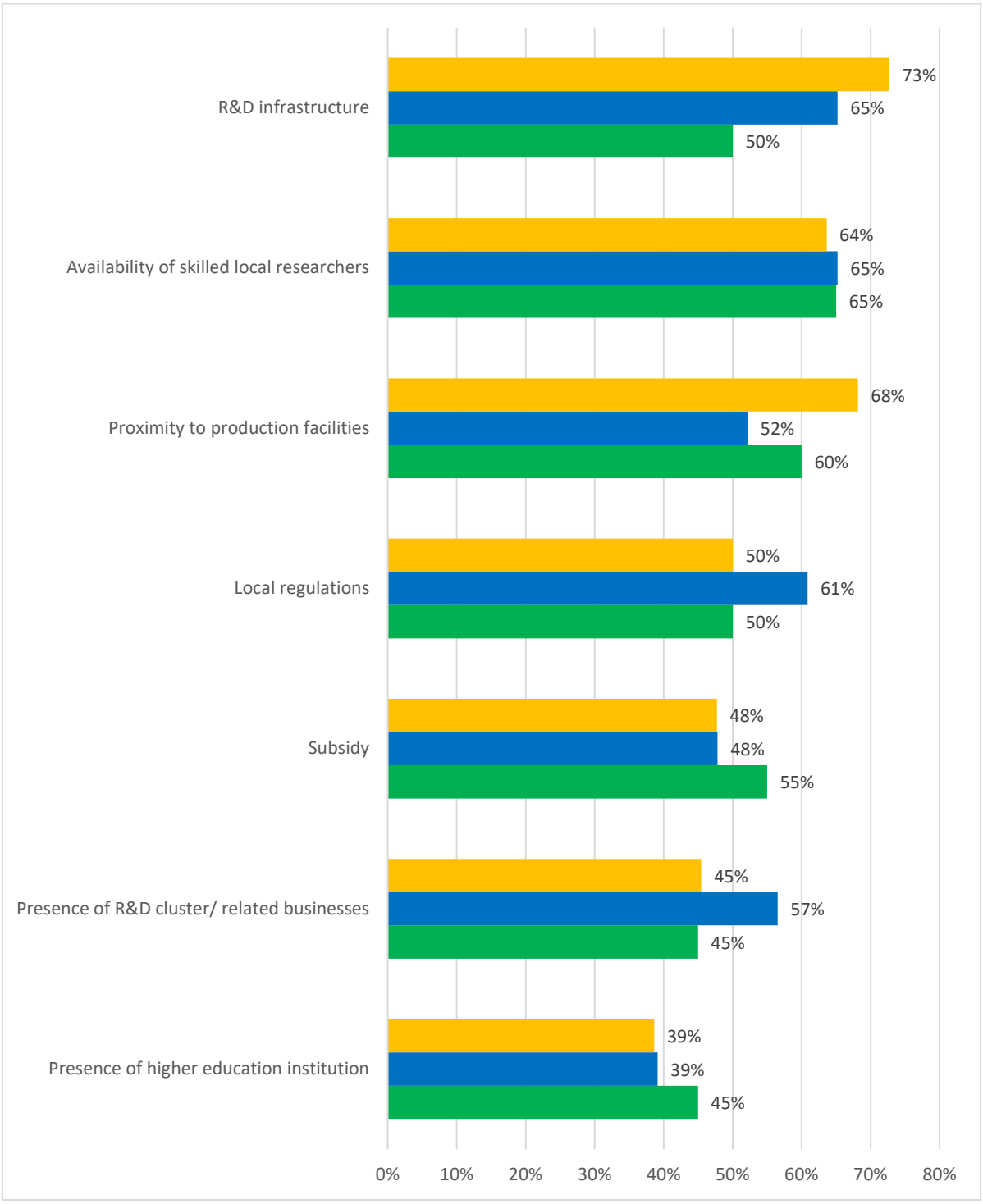


Figure 23: Factors Attracting Firms to Conduct R&D at a Certain Location (by Industry)

When we asked companies about the reason of choosing Hong Kong to be their R&D centre, we find quite a different set of reasons compared to those reported in Figure 23. As Figure 24 reports, 46% of the companies that conducted R&D in Hong Kong claimed that it is

because of the existence of tertiary education institutions in Hong Kong. This top reason is consistent with the consensus about Hong Kong's competitive advantage in higher education and basic scientific research. In the 2021 QS World University Rankings, Hong Kong is the only city in the world with 4 universities being ranked in Top 50.[45] The second most important reason for them to conduct R&D in Hong Kong is the supply of skilled researchers (37%).

Similar to the general patterns as reported above, the third most relevant factor for a place to be a R&D centre is the proximity to nearby production facilities (36%). Consistent with the prevailing views in Hong Kong, subsidies and the existence of research communities and related services are not considered as so important for Hong Kong to be chosen as a R&D location (only 29% and 27%, respectively).

Figure 25 shows the responses by industry. One notable finding is that HealthTech companies considered the existence of tertiary education institution locally to be the primary factor for them to conduct R&D in Hong Kong, compared to significantly lower fractions of companies in the other industries seeing that as the main determinant.

[45] https://www.topuniversities.com/university-rankings/world-university-rankings/2021

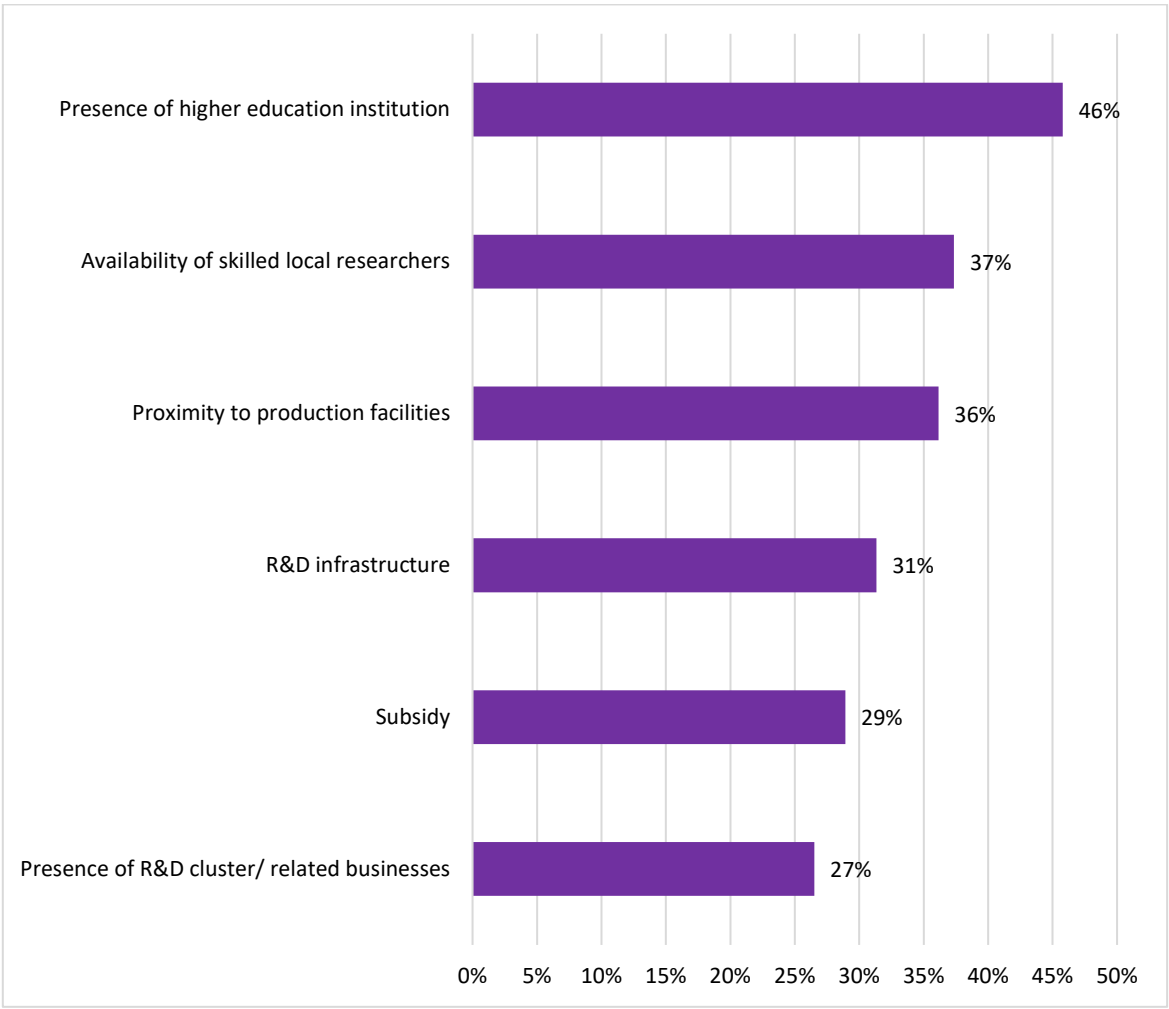


Figure 24: Factors Attracting Firms to Conduct R&D in Hong Kong

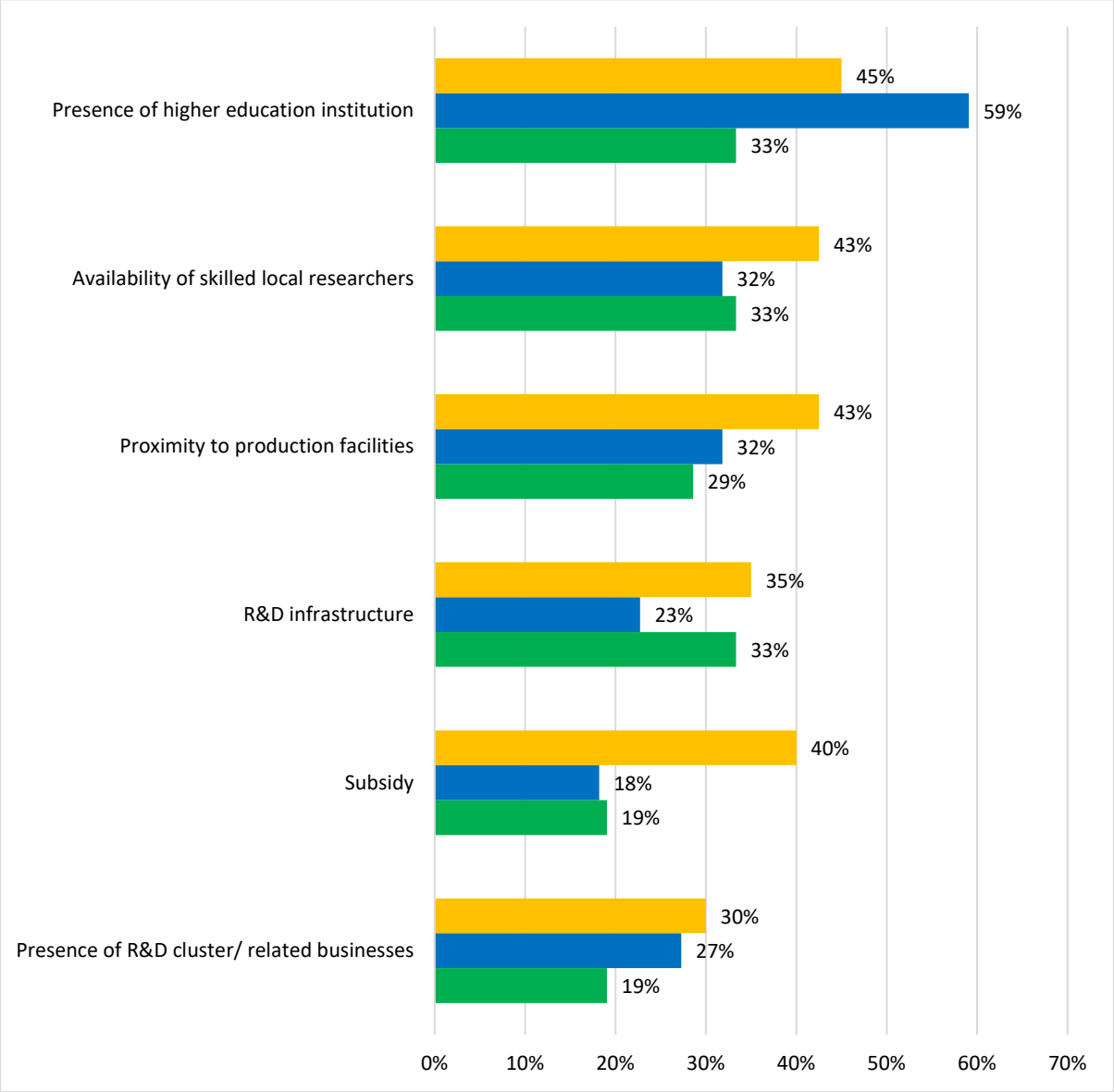


Figure 25: Factors Attracting Firms to Conduct R&D in Hong Kong (by Industry)

Plans for the Future

In the survey, we also asked companies about their future plans on market expansion, relocation of R&D as well as operation. Despite all the challenges especially related to the shortage and space and availability of the right talent, it is encouraging to learn that 52% of companies said they have plans to move or extend their production lines to Hong Kong. Such intention is the strongest among firms in FoodTech, with 74% expressing interest to do so, compared to only 41% in HealthTech and 62% in GreenTech companies.

In addition, 16% of the surveyed firms also reported to have plans to relocate or expand existing R&D in Hong Kong, especially in the FoodTech and HealthTech industries, in which 24% and 23% of the respondents respectively have plans to do so. In GreenTech, however, only 4% of the surveyed companies plan to do so.

Despite the plans to expand both operation and R&D in Hong Kong, surveyed companies are aware of the challenges to hire the right talent. Only 28% of the surveyed firms expressed confidence in finding suitable talents for advanced manufacturing and Industry 4.0 technologies in the next one to two years; 33% were confident to do so in the next three to four years, while 37% were confident about the prospect in the next five years.

Besides the short supply of the suitable talents, companies also report a variety of challenges they expect to encounter when implementing Industry 4.0 technologies. As reported in Figure 26, 26% of the surveyed firms consider "insufficient funds" as the most challenging barrier to overcome to implement Industry 4.0 technologies, followed by 15% of the companies reporting "insufficient infrastructure" to be the main challenge. 14% of the respondents mention difficulty to hire talents as the key challenge.

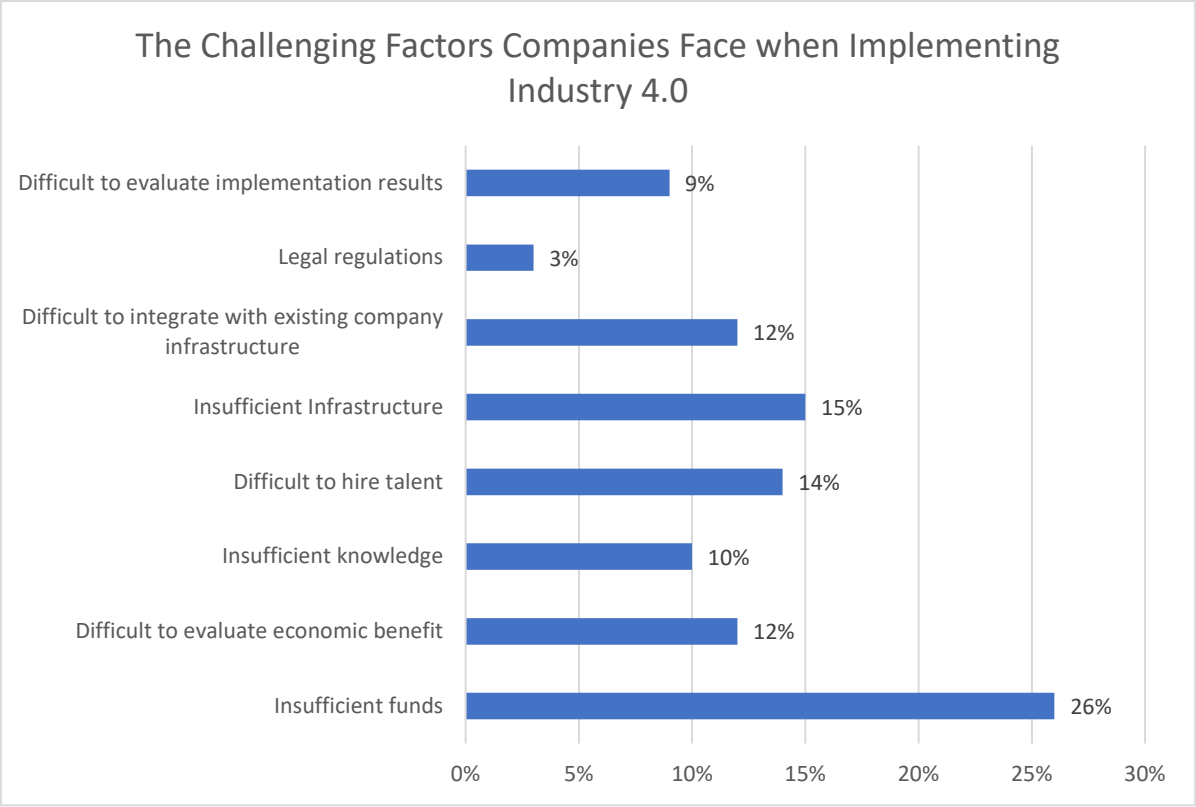


Figure 26: The Challenging Factors Companies Face when Implementing Industry 4.0

Surveyed companies also reveal that in the next 5 years, the market they would most likely expand business to is Hong Kong (34%), followed by the Greater Bay Area (25%), Southeast Asia (11%), Europe (10%), and the rest of Mainland China (9%). Only about 5% of the surveyed companies plan to expand in the US market in the next 5 years (see Figure 27).

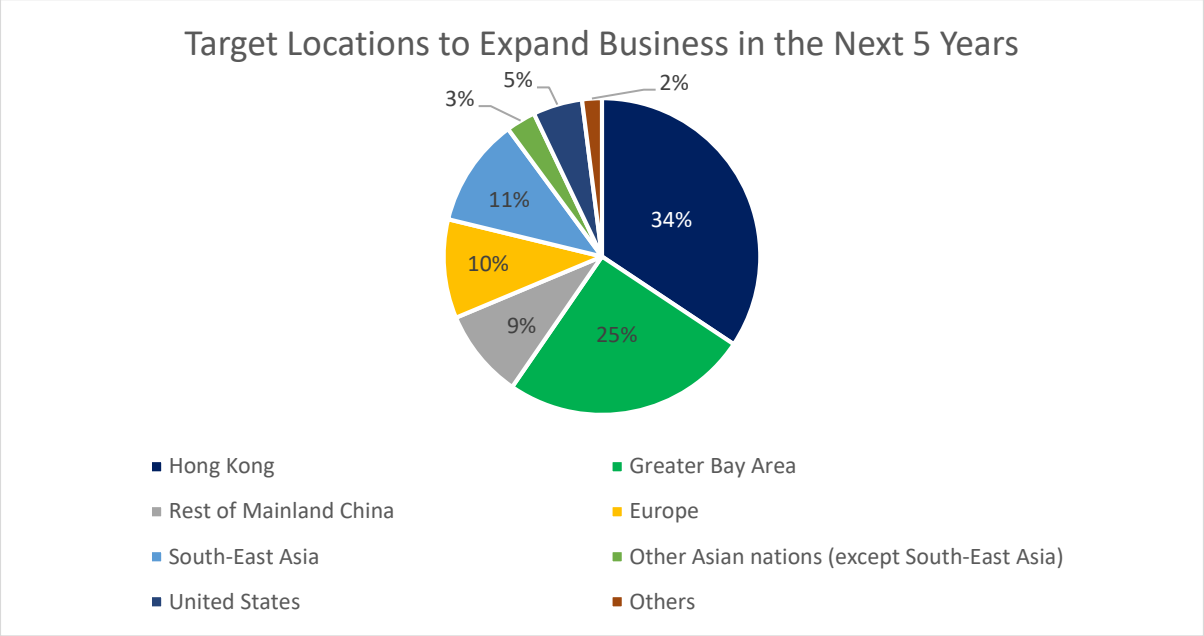


Figure 27: Target Locations to Expand Business in the Next 5 Years

Expectations about Hong Kong's Reindustrialisation

The survey also asked companies about their views on Hong Kong's future as an economy buttressed on R&D and advanced manufacturing. Figure 28 shows that 33% of the surveyed companies expect that the R&D infrastructure in Hong Kong will become more mature in the next 1-2 years, while less than 37% of them did not expect that to happen. Over a longer horizon, 38% of them expect it to be more mature over 3-4 years, as compared to 37% of them who did not expect that to happen. Over an even longer run, significantly more companies become optimistic – 47% of the respondents expect the infrastructure to become more mature 5 years and plus from now; compared to 29% of them that remain pessimistic about that.

Similar patterns were observed for the questions about their prospects on Hong Kong's Industry 4.0 ecosystem. Specifically, as Figure 29 shows, 33%, 35% and 42% of the surveyed companies expect that the Industry 4.0 ecosystem will become more mature in the next 1-2 years, 3-4 years, and 5+ years, respectively.

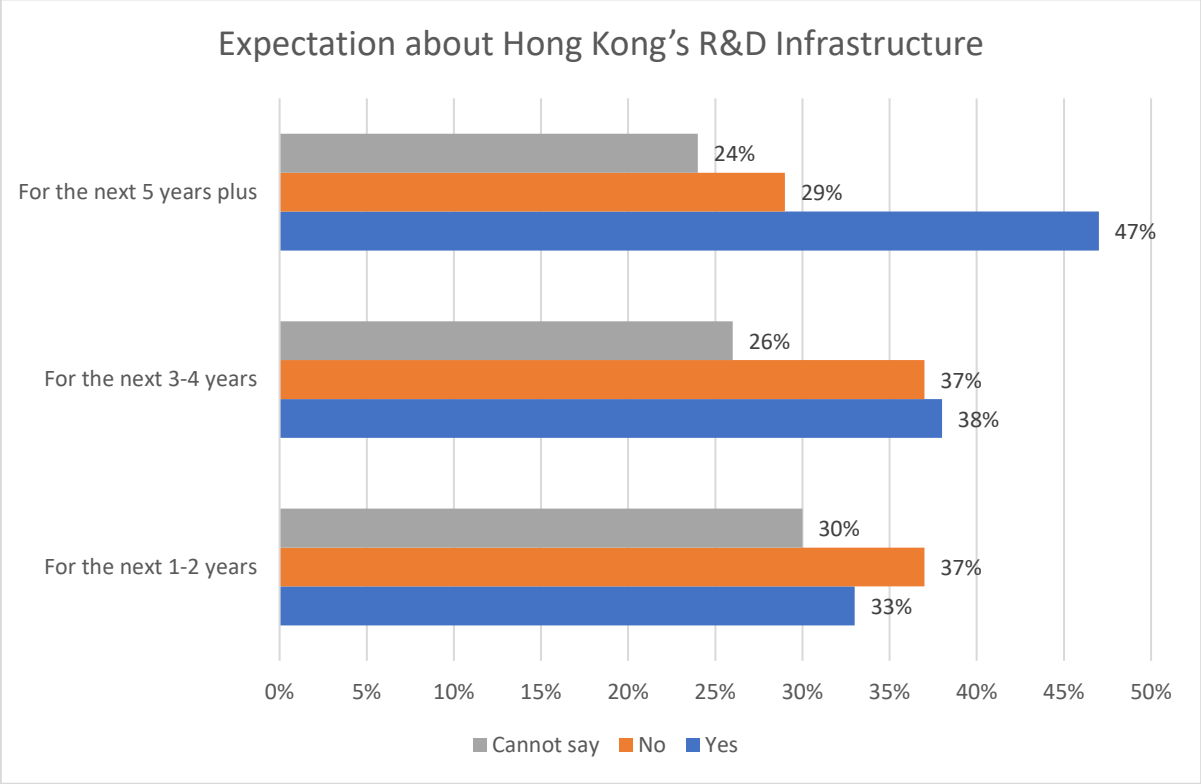


Figure 28: Expectation about Hong Kong's R&D Infrastructure

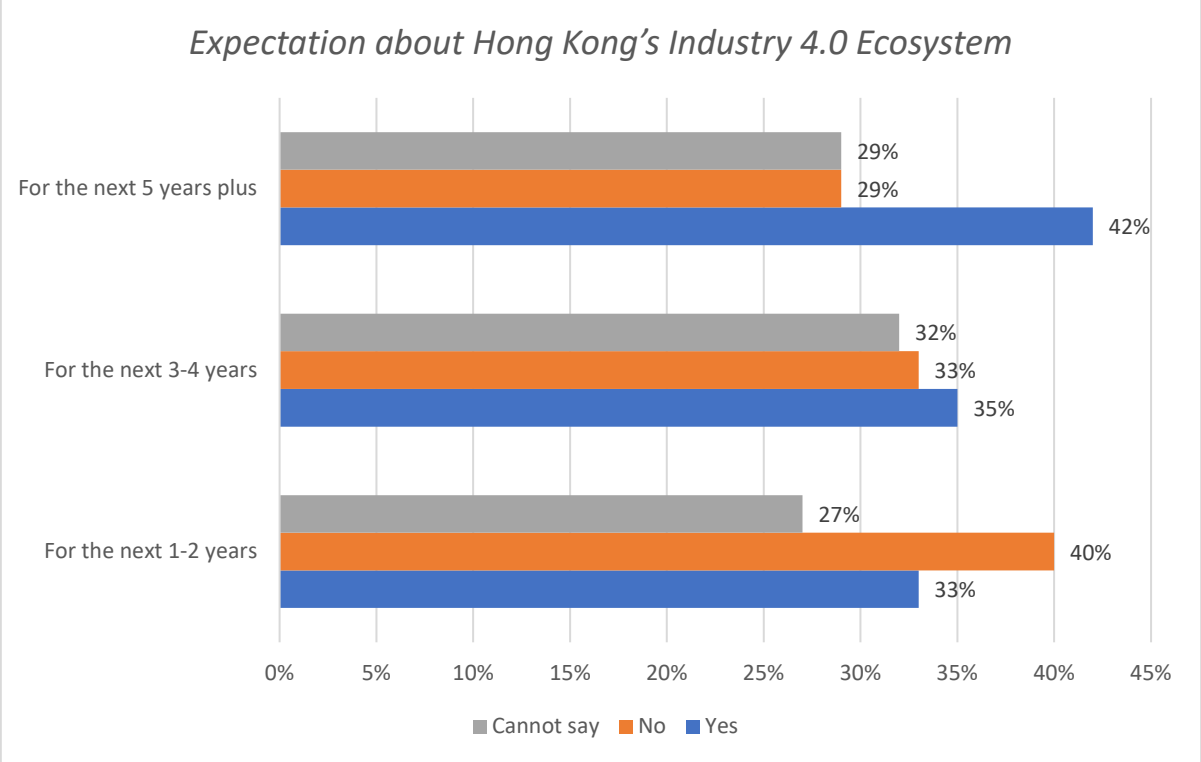


Figure 29: Expectation about Hong Kong's Industry 4.0 Ecosystem

Chapter 7: The Emerging Industry: Semiconductor

7.1 Background

At present, the world is facing the problem of chip shortage. Delivery of products that relied on semiconductors such as vehicles have been severely delayed. World-leading semiconductor producers such as TSMC and Samsung have been producing chips at their full capacity. Unexpected factors such as the surging demand for products like computers and electric vehicles and supply chain disruption related to the COVID-19 pandemic further exacerbated the shortage of microchips.

Meanwhile, Mainland China intends to develop its own new generation of semiconductor technology and consolidate its supply chain. As such, Hong Kong can target the market's demand for third-generation semiconductors by establishing a chip design centre and cooperating with China's national policies in the short run to attract companies in semiconductor industry globally to establish their affiliates in the city. With well-established legal and IP protection systems, together with its unique role of China's "international circulation" strategy, Hong Kong should leverage these advantages to attract a new-generation semiconductor manufacturer to set up factories in the city. In the long run, the city's government proposed Northern Metropolis, which is planned to be developed as a new central business district focusing on technology and innovation, can be home for the new-generation semiconductor industry chain.

The semiconductor industry has been a traditional industry in Hong Kong in the 1980s and 1990s. Since then, there are already many companies engaged in the semiconductor business in Hong Kong, producing integrated circuits used in watches and clocks, calculators, and domestic appliances. Local OEMs have undertaken the production of critical components for world-renowned brands, and the "Made in Hong Kong" brand has been gained international trust. Hence, building the semiconductor industry by first attracting global established semiconductor companies to establish their affiliates in Hong Kong can be an important driver of city's reindustrialisation.

The semiconductor sector covers a variety of workmanship, each of which can be developed into a large-scale industry, such as:

- Integrated Circuits (IC) design;
- manufacture of die covers;
- manufacture of monocrystalline silicon wafers;
- packaging;
- testing and application;
- Sales, distribution and sourcing activities.

The supply chain of semiconductor production is complex and involves many different types of technologies and investments. Semiconductor companies along the supply chain tend to be clustered with other related technology companies to benefit from better collaboration and technology spillover in the nearby regions.

Currently, there are some semiconductor component producers in Hong Kong. They are usually engaged in the production in three stages in the semiconductor supply chain:

- IC packaging manufacturing;
- distribution value-added services; and
- IC design.

Hong Kong's semiconductor industry began in the 1960s, when some of the well-known international companies in the industry, such as Fairchild, Motorola and Fujitsu, all invested in Hong Kong. They outsourced the product packaging to the factories in Hong Kong. After the manufacturing had been moved to Hong Kong, some marketing companies began to establish their offices in Hong Kong, and from the 1980s, some international technology giants, such as Motorola, set up research and development centres in Hong Kong.

7.2 Hong Kong as a Distribution Centre of Semiconductors

According to the export figures, Hong Kong is deemed to be an important centre for semiconductor and related industries. Electronics continues to remain Hong Kong's largest exports, accounting for 72% of Hong Kong's total exports in 2020. These exports include high-tech products, such as telecommunications equipment, semiconductors and computer-related products. The main export markets of these products are Mainland China, EU, ASEAN

and the US.[46] Hong Kong was the world's largest IC exporter by value in 2019, the world's second largest exporter of computer components and camcorders; and the world's third largest exporter of video recording equipment and telephones/mobile phones. That said, the majority of these exports are reexports of electronics produced in other economies, particularly Mainland China.

Hong Kong is an important trading hub for electronic parts and components in Asia-Pacific. Many items from the US, Europe, Japan, Taiwan, and South Korea are re-exported via Hong Kong to Mainland China, and vice versa. A number of multinational parts and component manufacturers have set up offices in Hong Kong, engaging in sales, distribution and sourcing activities in the region. Some Hong Kong companies also have their own sales offices and/or representative offices in Mainland China and other overseas markets.

Regarding finished goods, Hong Kong companies mostly produce on an ODM basis for reputable brands in overseas markets. Some of these major buyers have set up offices in Hong Kong for the convenience of direct sourcing in the region. Hong Kong companies also sell products to specialised importers and traders in North America and Europe, who further distribute the merchandises through their own channels or re-sell to their clients. That said, Hong Kong does have its own brands in the industry, such as *Truly*, *V-Tech*, *Group Sense*, *Venturer*, *GP* and *ACL*. Their sales network covers not only the developed countries, but also economies in Latin America, Eastern Europe and various regions in Asia.

7.3 Future Development Path

Currently, Hong Kong has two main advantages in its semiconductor industry: IC design and marketing. For IC design, compared with those in Mainland China, Hong Kong's IC design companies enjoy several advantages. It enjoys a more diversified global market. It also has more developed and globally recognised IP protection law, which should encourage many foreign semiconductor companies to establish their affiliations for R&D, design and even

[46] HKTDC (2021b) Electronics Industry in Hong Kong

production in Hong Kong. It has well-established infrastructure, which guarantees high quality and stable supply of water and electricity, both essential inputs for chip production. The geographical size of Hong Kong is small, but its market awareness is strong. For instance, the annual Hong Kong Electronics Fair, one of the most influential consumer electronics shows in Asia and even the world, has also become an important platform for major chip manufacturers to release new products and implement strategic transformation.[47] Last but not least, Hong Kong's international financial market and venture capital industry can attract foreign companies to the city to raise funds for their business and development.

There are obvious challenges for the development of the semiconductor sector in Hong Kong. IC design companies typically prefer to be located near the manufacturers, and most Hong Kong IC design companies choose to seek opportunities in certain market segments, with relatively limited product lines. They tended to work with Hong Kong manufacturers that aimed at entering the overseas markets, while historically overlooked the rapidly growing Mainland Chinese market.

Nowadays a new "shop-factory" trend has appeared in IC design companies.

1. Hong Kong's companies are responsible for product definition, design, and intellectual property management (upstream shops);
2. Mainland Chinese companies are responsible for further design, foundry and closed testing and large-scale production (factories);
3. Hong Kong's companies are responsible for marketing, market development, sales, and post-sales relationship management and maintenance (downstream shops).

7.4 Hong Kong's Advantages

The excellent transport and information systems in Hong Kong can provide the best support for business people and professionals, especially those in marketing, sales, distribution and sourcing, to cope with the rapidly changing needs of the global market and keep informed about the latest market and technical information. Besides, the advantages of efficient customs declaration logistics and zero-tariff policy will continue to permit Hong Kong

[47] https://event.hktdc.com/fair/hkelectronicsfairae-en/HKTDC-Hong-Kong-Electronics-Fair-Autumn-Edition/

to be an important hub of the semiconductor component distribution. Because of the city's long history of internationalisation and business activities with both East and West, the city still has a comparative advantage to recruit foreign talent to work in Hong Kong.

The Chinese government has launched a series of initiatives to promote the development of 5G technology and infrastructure. Hong Kong can grasp this momentum to develop its semiconductor industry. As early as April 1, 2020, Hong Kong has officially entered the 5G era, and its 5G coverage has gradually expanded from core areas to cover mainstream infrastructure, landmarks, shopping malls and parks. It is ranked the first in the world in terms of 5G coverage.

Hong Kong had the experience in producing electronics and electrical products, plastic and metal parts, and mould making. The city also emphasises highly productive and efficient management, possesses rich experience in quality control, and has close connection with overseas markets. Besides, many business groups in Hong Kong have already established their reputation and foundation in procurement and supply chain management of the automobile industry. Since the quality of automotive parts and components is closely related to the safety of road users, the quality requirement and standards of the automobile parts and components are extremely high. Automobile manufacturers are in general extremely demanding and require high transparency of the entire production process. In light of this, automobile companies conduct feasibility studies and have set up a complete information system for the safekeeping of all information concerning R&D and production. Today, automobile manufacturers in Europe, the US and Mainland China often purchase electronic parts and components produced in Hong Kong. Hence, Hong Kong's electronic parts and component industry should move fast and exploit Hong Kong's geographical advantage as part of the integrated electronic production supply chain in the Guangdong-Hong Kong-Macao Greater Bay Area (GBA).

7.5 Main Institutions and Innovation Associations

Case 1: Hong Kong Applied Science and Technology research Institute (ASTRI)

Project Highlights

1. Hardware Accelerated 3D Conversion System
2. Narrowband Internet of Things (NB-IoT)
3. Bluetooth Low Energy (BLE) 4.2 and 5 solution
4. Visually Enhanced Ultra Hi-Def technology.

Case 2: National Engineering Research Centre for Application Specific Integrated Circuit System (Hong Kong Branch)

The Hong Kong Branch of National Engineering Research Centre for Application Specific Integrated Circuit System (CNERC) was established on 21 June 2012, with the approval from State Ministry of Science and Technology. The Hong Kong Branch operates within the infrastructure of Hong Kong Applied Science and Technology Research Institute (ASTRI). It cooperates with the National ASIC System Engineering Research Centre of Southeast University and RF Integrated Circuits and Systems Engineering Research Centre of Southeast University. The Hong Kong branch focuses on microelectronics and integrated circuits (IC) and systems, conducting research, technology transfer, and talent training in the fields of mixed signal systems IC, advanced digital systems and packaging.[48]

7.6 Focus Group: Interviews with Semiconductor Experts

This section summarises the insights from interviews with the corporate leaders of the semiconductor industry in Mainland China.

After Hong Kong's sovereignty was handed over to Mainland China in 1997, Hong Kong's light industry gradually moved northward to the Pearl River Delta region where

[48] ASTRI (2021b) National Engineering Research Centre for Application Specific Integrated Circuit System (Hong Kong Branch)

business costs were significantly lower. However, Hong Kong did not immediately give up on manufacturing; instead, it tried to upgrade its manufacturing industries.

In 1999, Richard Chang, who resigned from TSMC, wanted to implement the "Silicon Port" project in Hong Kong, but at that time, Hong Kong public opinion questioned it as a type of land speculation.[49] The Hong Kong Government ultimately did not proceed with the project.

Meanwhile, Shanghai attracted the implementation of such plan and established SMIC with the preferential measures such as almost no land rental fee and five-year tax exemption. At present, it has developed seven factories. After being listed on the China Science and Technology Innovation Board, its stock price has soared all the way, with its market value once exceeded 600 billion yuan.

To Hong Kong, perhaps it is a mistake to miss SMIC. These high-end manufacturing industries not only occupy a relatively small area, they created high value added but little pollution. They also provide a large number of high-quality jobs for highly educated students with science and engineering in Hong Kong.

Now is the beginning of a new round of super technology cycles for the semiconductor industry.

As illustrated in Figure 30, the first cycle of the semiconductor industry that was started by Information Revolution 1.0, which featured broadband internet and rising demand for computers. The second cycle that began from Information 2.0 in 2010s, which featured 3G and 4G communication along with the surging demand for mobile devices. The world is currently undergoing the Information Revolution 3.0 cycle. The first half of the current cycle is the energy revolution, ranging from the research and production of electric vehicles to photovoltaic products. The second half of the current cycle is the development of supercomputers and autonomous driving. The current super cycle of the semiconductor industry has been driven by the global transition to alternative energy due to climate change concerns, as well as digitalisation of economies. The development of science and technology is already actively going on within the energy revolution.

[49] https://www.bbc.com/zhongwen/trad/business-54072377

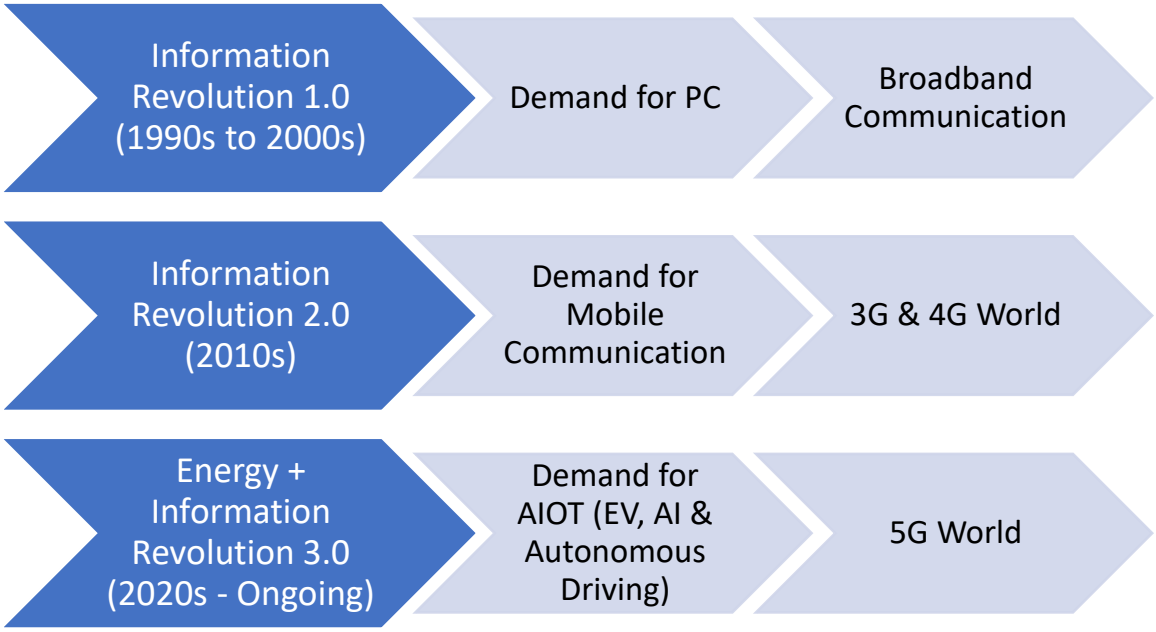


Figure 30: Three Waves of Semiconductor Super Cycles

A market research conducted by IC insights showed that the semiconductor industry was expected to grow strongly, ranging from 3 percent to 34 percent on a year-on-year basis across different manufacturers for the third quarter in 2021.[50] Since the demand for servers in data centre, enterprise computing, 5G smartphones and related infrastructure still remains very strong, it is expected that the semiconductor shortage will remain to be a concerning issue for many manufacturing industries.

7.6.1 Challenges

Sino-U.S. Tensions

The U.S. government's sanction on SMIC hindered China's efforts to develop its own chip manufacturing capacity.

The US is likely to continuously restrict the development of certain technology sectors in Mainland China. It will incentivise the Chinese Central Government to strengthen its policy and financial support for the entire chip supply chain. In the context of the ongoing global

[50] EPSNews (2021) IC Insights: Chip Makers Bullish on Q3 Revenue

digitalisation process, the importance of foundry capacity has become prominent and has gradually become a strategic asset. As Figure 31 shows, only 6% of the market share of semiconductors used in Mainland China were produced by foundries there in 2021. The Chinese Central Government thus hopes to increase this proportion by 2025. Such objectives are consistent with the "Domestic Circulation" part of the government's proposed "Dual Circulation" strategy. In that part, technological autonomy and dependence on domestic demand have become the focus. Basic science research, design, and production of semiconductors are all important parts of such strategy.

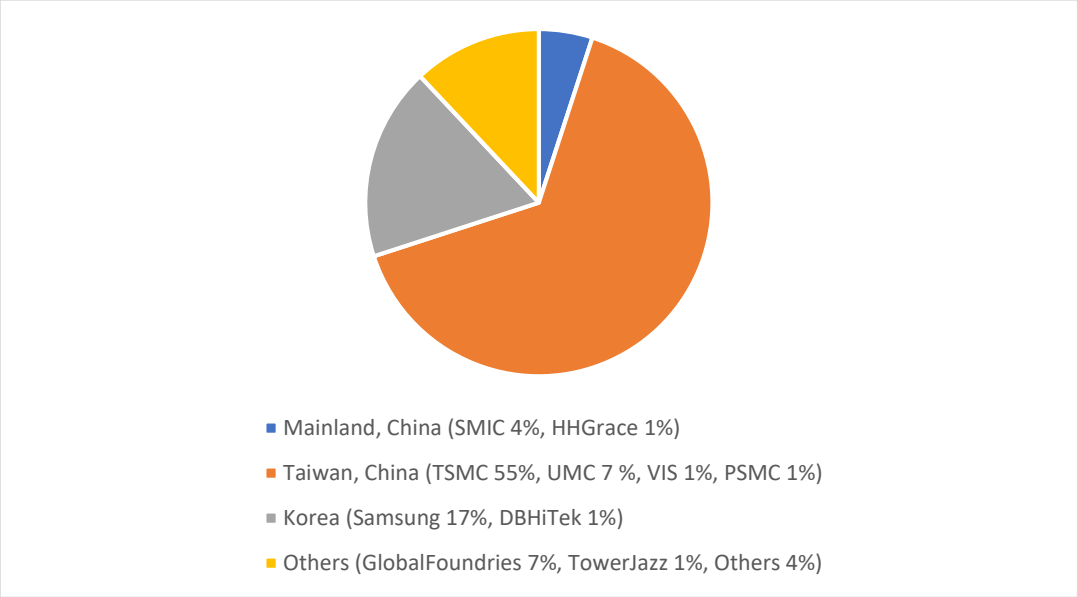


Figure 31: Global Distribution of Foundry Revenue US$95 Billsion (2021)

Taking the largest foundry SMIC in Mainland China as an example: in August 2021, SMIC has announced its 2021 Q2 performance, with revenue of US$1.3 billion, a year-on-year growth of 43.2% and a month-on-month increase of 21.8%. The capacity utilisation rate is 100.4% in full production.[51]

[51] SMIC（2021）中芯国际发布 21Q2 财报，全年营收成长和毛利率目标上调为约 30%

Human Capital Development

Some may be concerned about the lack of semiconductor experts and related talents in Hong Kong. During the focus-group discussion, semiconductor professionals have advised Hong Kong to recruit talents globally and train them locally.

- *Top talents:* Hong Kong's wages for global talents are really competitive. Many foreigners like the international culture of Hong Kong, an intangible asset that many Asian countries do not have.
- *Mid-level talents*: Local universities should target to nurture more talents with science and technical backgrounds, which will be in high demand around the world.
- *Entry grade talents*: Education background is becoming less important. Companies should be able to offer suitable internships, mentorship programs, rotating positions, and on-the-job training to their junior employees. For instance, a leading mainland Chinese semiconductor company took 5% of its profits to train interns and junior staff. There were also partnerships with universities to hire a large fraction of former interns. Through such partnerships, companies can recruit and nurture passionate talents to work in the semiconductor industry in the future.

The HKSAR Government can also work with the foundry sector, to train secondary school graduates who fail or do not want to enter universities. The semiconductor industry usually can offer relatively high salary. A win-win solution can thus be created to offer promising career paths for the teenagers who lack academic motivation, help reduce income disparity in the economy, and diversify the city's economic structure.

7.6.2 Hong Kong as a Supporting Hub for China's Semiconductor Production

Amid the recent Sino-US trade tension, the semiconductor foundry has become the focal point. The demand and supply of semiconductors will continue to increase in the foreseeable future. Yet, there are obvious bottlenecks and constraints in the supply chains. For instance, wafer generation is the most capital-intensive part of the semiconductor supply chain. The constrained supply of wafer will drive the input costs of the entire semiconductor supply chain to its downstream, all the way to design companies. In the context of the continuous global economic digitalisation, the importance of foundry capacity has become prominent and has gradually become a strategic asset for many countries. The self-sufficiency

rate of China's foundry is still low, and its industry leaders such as SMIC and Hua Hong Semiconductor have set up clear plans to expand their capacities.

Although Hong Kong may face certain pressure from the US in the Sino-US trade tension, the retractations are still relatively less than Mainland China. For instance, the US government so far has no intention to suppress China on its development of 28nm+ semiconductor. Given Hong Kong's relatively low level of development in the semiconductor supply chain, the city could start with a relatively less technologically advanced type of semiconductors. Besides, 28nmn+ semiconductors are very popular in the market, especially from the electric vehicle industry, which is the fastest growing market segment of the automobile industry with supportive policies from both Chinese and the US governments, among others.

7.6.3 Semiconductor Industry as a Pivot for Hong Kong's Reindustrialisation

In conclusion, there are clear opportunities for Hong Kong to grasp to develop its own semiconductor industry. In the short term, there will be continuous shortage of chips, due to the changing geopolitical and economic landscapes in the post-pandemic global economy. In the longer term, the Chinese Central Government's national strategy is to develop technological independence. The potential development of Hong Kong's semiconductor sector will enhance its own economic growth based on reindustrialisation and innovative activities, and concurrently support Mainland China's overall long-term plan. The demand for semiconductors from Artificial Intelligence of Things (AIoT) and related products (e.g., electric vehicles, cloud computing, etc.) together with 5G will only grow further.

The sector is not as hard to start as many would expect. With an initial investment of more than HK$10 billion to build a foundry in Hong Kong, the potential profit margin can be increased by 20% and above. Since Hong Kong currently lacks such facilities, it will naturally need to rely on foreign direct investment, but the government needs to provide the basic infrastructure, land, and inputs (e.g., electricity and water). In 1999, Hong Kong has missed the golden opportunity to develop semiconductors, and is now far behind mainland China and Asian Tigers. The HKSAR Government should take positive steps to build (1) R&D centres, (2) design centres, and (3) foundry sites for the semiconductor industry.

Chapter 8: Conclusion with Policy Suggestions

The "big market, small government" non-intervention policy advocated by the Hong Kong Government under the British colonial rule in the 1960s and 1970s might be an appropriate economic policy approach and mindset in the absence of severe market failure. However, the Government must change course when the situation changes. There is still little consensus about what the Hong Kong Government ought to do to incentivise companies and individuals to engage in more innovative activities, which generate positive externalities in the economy.

Gruber and Johnson (2019) in their book *Jump-Starting America* identified 102 U.S. cities as having the fundamentals to be transformed into new-economy cities, including Detroit that was hit hard by de-industrialisation. What is missing, according to the authors, is strong and committed financial and policy support from the U.S. Federal Government, which used to fund many R&D and S&T projects that propelled the country's rapid economic and productivity growth during the Cold War period.

Based on company surveys, focus-group discussions, literature review, and country case studies, this study aims to offer some initial ideas about the steps to reindustrialise Hong Kong. The company surveys show that many of them (58% of the surveyed companies) have been conducting R&D in Hong Kong, and many have plans to expand both production (52%) and R&D (16%) in Hong Kong in the near future. These figures show that the path of Hong Kong's reindustrialisation is promising. Of note, a majority of the companies in the three target industries covered by our survey consider Hong Kong as the main market (over 90% of the surveyed firms), followed by the Greater Bay Area, Southeast Asia, and the rest of Mainland China, suggesting that local demand is an important part to foster Hong Kong's potential transformation into an advanced manufacturing city.

The lack of industrial development in Hong Kong is an outcome of many intertwined problems, ranging from the mismatch between the demand and supply of talents, the lack of funding for manufacturing expansion, and the shortage of land. To facilitate the city's economic transformation, a piecemeal approach may not work and a strategic package that includes multiple policies is needed.

Any good industrial policy needs to address the talent shortage problem. When it comes to the overall economic development of Hong Kong, the main obstacle is usually not the shortage of capital, but the lack of suitable talents. As such, the pre-requisite of reindustrialisation is undoubtedly first solving the talent shortage. According to our survey, only 28% of the surveyed companies expect to find suitable talents for Industry 4.0-related work in the next one or two years. In the medium and long term, only 33% and 37% expect to find suitable talents in the next three to four years and five years, respectively.

Hong Kong has always had many local talents and experienced professionals, especially in the financial, medical, legal, and tertiary education sectors. However, a substantial amount of knowledge and R&D in those sectors have not been commercialised to benefit the market, in terms of job or product creation. The linkages of Hong Kong's traditional pillar industries with the rest of the economy have been rather weak, with the exception of the financial industry, which has helped develop other high-skilled professional services such as the legal industry.

Another reason for the weak linkage across industries is the shortage of mid-skilled S&T talents.[52] The reason for the shortage can in turn be attributed to the mismatch of supply and demand in the labour markets. Expecting stable and high-income careers after graduation, university students in Hong Kong often prefer to study medicine, law, and business administration, rather than science and technology subjects. A key reason is that the labour market does not offer sufficient opportunities for science and engineering graduates to apply their knowledge. It is thus a "chicken or the egg" dilemma. Hence, to solve the shortage in supply of mid-skilled talents, perhaps it is more crucial to tackle the lack of labour demand first. To this end, the Government may consider using part of the substantially increased R&D expenditure to establish research institutions to design and even produce products and technologies. The pilot areas of research can be biotechnology, medical science, and financial technology, in which Hong Kong currently has a comparative advantage. Our study shows that companies have intention to adopt Industry 4.0 technologies and increase

[52] Examples: "Hong Kong banks struggle to plug tech talent shortage" *Hong Kong Business* https://hongkongbusiness.hk/hr-education/news/hong-kong-banks-struggle-plug-tech-talent-shortage; "Hong Kong IT leaders welcome government's support in easing skills shortage" https://www.roberthalf.com.hk/press/hong-kong-it-leaders-welcome-governments-support-easing-skills-shortage

R&D spending in the three selected Tech industries. We also discuss why semiconductor is a new industry that Hong Kong needs, in order to facilitate reindustrialisation on one hand, and help motivate the young generation to study STEM and participate in research and innovative activities on the other.

Given Hong Kong's small size, it obviously needs to rely on foreign talents and cooperate with partners abroad. These are the approaches adopted by the governments of Israel, Singapore, and Switzerland, the three benchmark countries that share very similar geographic and economic conditions with Hong Kong, but achieved much better performance in manufacturing and innovative activities. The Hong Kong Government may draw lessons from the governments of these three benchmark countries to design policy packages, including but not exclusive to tax benefits, to attract overseas and China's new-economy companies to set up affiliates in Hong Kong. The goal is to transfer technology and knowhow, and to ultimately create high-tech jobs in Hong Kong. That said, given the current talent shortage in Hong Kong, there should not be any domestic labour requirements for those foreign investors. Instead, if the Hong Kong Government wants those foreign companies to employ local talents, it can consider subsidising the local labour costs. Such policies to attract foreign companies to first help increase local demand for technology workers can alleviate the shortage of talent supply and effectively enhance the S&T and research environment in the medium run.

Besides increasing the supply of mid-level talents, the Hong Kong Government can simultaneously increase the supply and quality of scientists and researchers from local universities. It should also be noted that most of the doctoral students trained in Hong Kong are from outside Hong Kong, particularly from Mainland China. Given that the education and training provided by universities in Hong Kong are globally recognised, increasing the intake of university students in Hong Kong can contribute not only to filling up the talent gap in the local labour market, but also supplying talents for research institutions, companies, and universities in Mainland China and aboard. Hence, besides planting the seeds for Hong Kong's ultimate economic transformation, increasing the supply of researchers can help raise Hong Kong's strength and connectivity as a global knowledge and science centre.

Regarding policies to attract foreign talents, the Hong Kong Government may consider fine-tuning and expanding the scale of existing talent programmes. Based on our focus-group interviews with some local start-up business owners, some existing employment contracts for foreign skilled workers and the bundled arrangement to employ local staff appear to be rigid. It is understandable that the Hong Kong Government wants to protect jobs for the locals. However, it is worth noting that research shows that creating jobs in the high-tech sector can generate a strong multiplier effect on other job markets, including those in non-tech and traditional service sectors.[53]

The Hong Kong Government should offer holistic packages to attract leading S&T experts in academia and the industry to work in Hong Kong. Given the rising tension between China and the West, in particular the U.S., some S&T experts may be encouraged by certain push factors to consider overseas career opportunities. Besides financial incentives, leading experts are typically concerned about the research environment and living conditions of Hong Kong. To attract experienced and globally competitive talents, more staff quarters need to be built, like those constructed decades ago to attract foreign senior academics to join local universities. The opening of InnoCell near the Hong Kong Science Park in 2021 is a good step towards solving the housing problems for foreign talents, but more is needed. The proposed Northern Metropolis that plans to allocate more land to advanced manufacturing and innovative activities should help address the talent shortage problem.

While the severe land shortage has been a well-known barrier to Hong Kong's economic development, many Industry 4.0 technologies can be used to overcome the challenges arising from limited land supply. In fact, by 2017, 40% of the industrial buildings were still used for storage purposes. According to our surveys, about one-third of the respondents needed less than 10,000 square feet space, but found the type of factory space and facilities inappropriate to adopt Industry 4.0 technologies (e.g., ceiling height and space in the loading areas). Thus, many industrial buildings that were built before the 1990s have

[53] Specifically, Moretti (2012) finds empirically that a high-tech job created in the U.S. can lead to five other positions added in the economy, including those in high- and low-skilled service sectors. In this regard, creating high-tech jobs can expand the diversity of jobs and foster inclusive economic growth.

become less suitable for advanced manufacturing in the 21st century. They either need to be substantially modified or replaced by new ones.

Finally, any good policy needs to be promoted with good marketing campaigns to gain stakeholders' support. S&T, R&D, start-ups and reindustrialisation all seem to be remote and unrelated to the livelihood of most Hong Kong citizens. Without seeing the direct benefits, people may pessimistically deny the urgent policies needed to diversify the Hong Kong economy. When promoting the much-needed industrial policies, the government should emphasise that a reindustrialised economy can help foster inclusive economic growth. "Inclusivity" should be a criterion for regular policy reviews. As Rodrik and Sabel (2019) pointed out in their paper *Creating a Good Jobs Economy*, sustainable and inclusive economic growth should create good jobs. In addition to providing workers with sufficient wages to meet basic living needs, good manufacturing jobs should provide them with on-the-job learning opportunities, as well as aspiration for upward mobility, motivation for work and job loyalty. Existing research based on other countries' experiences has shown that high-tech manufacturing, compared with most service industries, are more likely to create good jobs and support a city's long-run economic growth.

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Appendix: Questionnaire

This survey aims to collect opinions from the representatives of Hong Kong's industrial sector about the challenges they face and the prospects they have about reindustrialisation in Hong Kong.

The results from the survey will be used for the research behind the report published jointly between the Hong Kong Productivity Council ("HKPC") and the University of Hong Kong (HKU) Business School. The report is scheduled to be published in Nov 2021. The objective of the report is to arouse more discussions about the necessary conditions for reindustrialisation to take place in Hong Kong.

Data disclaimer:
The responses collected from this survey will be used strictly for the research behind the report published jointly between the Hong Kong Productivity Council ("HKPC") and the University of Hong Kong (HKU) Business School. All data will never be released and be used for non-research purposes.

Data storage:
All Data will be deleted by Nov 30, 2021 once the results are used to produce the report.

A: Contact Information

Company Name: _____ Industry: _____

Contact Person: _____ Position: _____

Phone Number: _____ Email: _____

B: Control Information

1. Headquarters : _____

2. Annual Sales Figures:
   <u>In 2020</u>
   ☐ HK$ < 10 M ☐ HK$ >= 10 M - 30 M ☐ HK$ > 30 M - 60M
   ☐ HK$ > 60 M - 500 M ☐ HK$ > 500 M
   <u>In 2019</u>
   ☐ HK$ < 10 M ☐ HK$ >= 10 M - 30 M ☐ HK$ > 30 M - 60M
   ☐ HK$ > 60 M - 500 M ☐ HK$ > 500 M

3. Current and Planned Production Base (can choose more than one option)

	Current	Location	Planned	Preferred Location
Hong Kong	☐	_____	☐	_____
Mainland China	☐	_____	☐	_____
Other location	☐	_____	☐	_____

4. Business Nature (can choose more than one option)
   ☐ OEM (Original Equipment Manufacturing)
   ☐ ODM (Original Design Manufacturing)
   ☐ OBM (Original Brand Manufacturing)
   ☐ Others, e.g.: _____

5. Major client
   ☐ Companies_____ ☐ General Consumers
   ☐ Other (please specify_____)

6. Major markets
   ☐ Hong Kong ☐ Mainland China ☐ Europe ☐ Southeast Asia ☐ Other Asian nations (except Southeast Asia and China) ☐ United States ☐ Other: _____

7. Number of Employees: (Office) _____ (Factory)_____

C: Current situation

Facilities

1. Is it difficult to find suitable factory buildings/ facilities in Hong Kong? _____
   (1: very easy to 5: very difficult)

2. What are the problems with existing factory buildings/ facilities in Hong Kong? (tick all that applies)
   ☐ The ceiling is too low ☐ The floor load is insufficient
   ☐ There is not enough space to establish an automated production line
   ☐ There is not enough space in the unloading area ☐ Need to share cargo lift
   ☐ Insufficient utilities (including water, electricity and gas)
   ☐ Unable to modify the building structure to meet production needs ☐ No problem
   ☐ Other (please specify): _____

3. How much space do the company need to setup a production line in Hong Kong?
   ☐ 1,000 sq. ft or below ☐ 1,000 – 9,999 sq. ft ☐ 10,000 – 29,999 sq. ft
   ☐ 30,000 – 69,999 sq. ft ☐70,000 – 99,999 sq. ft ☐ 100,000 sq. ft or above
   ☐ Other (please specify): _____

4. How much factory rent cost does the company expect to be able to afford?
   ☐ Below HK$10 per sq. ft ☐ HK$10 – 14 per sq. ft ☐ HK$15 – 19 per sq. ft
   ☐ HK$20 – 24 per sq. ft ☐ HK$25 – 29 per sq. ft ☐ HK$30 – 34 per sq. ft
   ☐ HK$35 per sq. ft or above

Research and Development

5. Where does company conduct R&D activities? (please tick all that applies)
   ☐ Hong Kong ☐ Greater Bay Area ☐ rest of Mainland China ☐ Europe
   ☐ United States ☐ Other (_____)
   ☐ No, please jump to **"Industry 4.0"**

6. Does the company have a permanent R&D team: ____ (yes/no)
   If yes to the above, how has the team size changed in the past 3 years?
   ☐ Increase ☐ Decrease ☐ No change

7. Education level of R&D personnel in the company

	% of personnel
PhD degree	
Master's degree	
Bachelor's degree	
Higher Diploma and Associate Degree	
No degree	

8. Spending on R&D (in HKD) yearly
   In 2020
   ☐ HK$ < 10 M, ☐ HK$ >= 10 M - 20 M, ☐ HK$ > 20 M - 40M, ☐ HK$ > 40 M
   In 2019
   ☐ HK$ < 10 M, ☐ HK$ >= 10 M - 20 M, ☐ HK$ > 20 M - 40M, ☐ HK$ > 40 M

9. Does the company own any intellectual property rights (IPR)___ (Yes/No)

10. Rate the relevance of the following factors in determining the location of R&D activities.
    (1: least relevant. 5: most relevant.)

	1	**2**	**3**	**4**	**5**
Availability of skilled local researchers					
Presence of higher education institution					
R&D infrastructure					
Proximity to production facilities					
Presence of R&D cluster/ related businesses					
Subsidy					
Local regulations					

11. Following the previous question and rate Hong Kong's readiness based on the following factors.
(1: least ready. 5: most ready.)

	1	2	3	4	5
Availability of skilled local researchers					
Presence of higher education institution					
R&D infrastructure					
Proximity to production facilities					
Presence of R&D cluster/ related businesses					
Subsidy					
Hong Kong Government have made adequate support for the needs of people with disabilities.					

12. What challenges does the company face when they carry out **R&D** in Hong Kong?
*Please list all the challenges the company faces and as specific as possible.
Your answer would help us understand the shortcomings of Hong Kong and make the research paper's output more relevant for the industry.

_____

Industry 4.0

1. Does the company know about the Industry 4.0 concept?
☐ Not understand at all, please jump to **"D: Expectations"**
☐ Superficially understand, but it is not important to the company.
☐ Superficially understand, the company wants to know more to realise its potential.
☐ Have enough knowledge and have some pilot projects in progress.
☐ Thorough understanding, master the concept well and applied across the company.

2. What are the potential benefits of Industry 4.0 that help transform the company?
☐ Reduced manufacturing overhead ☐ Production efficiency
☐Increased agility in operations ☐ Improved service offered to customers
☐ New business and revenue model ☐ Product innovation
☐ Other (Please specify_____)
☐ No benefit

3. Rate the following Industry 4.0 technology in terms of importance to the company's operation. (1: least important; 5 most important)

	1	2	3	4	5	Never Heard of it
Internet of Things (IoT)						
Robotics & Automation						
Data Analytics & Artificial Intelligence						
Sensors						
Human-machine Interface (HMI)						
Cyber Security						
Others (Please specify _____)						

4. Following the previous question, please state the stages of implementation in the company.

	Implemented and **have** further plans to update	Implemented and **do not** have further plans to update	Planning in progress	No plan
Internet of Things (IoT)				
Robotics & Automation				
Data Analytics & Artificial Intelligence				
Sensors				
Human-machine Interface (HMI)				
Cyber Security				
Others (Please specify _____)				

5. Are you aware of local, regional, or national **facilities/ initiatives/ ecosystem** to support the company in implementing Industry 4.0? If yes, please specify.
   ☐ Hong Kong ☐ Greater Bay Area ☐ rest of Mainland China
   ☐ Others (please specify _____)

6. Challenges in using facilities: _____

7. Challenges in applying for financial support: _____

8. What talent the company requires to implement the concept of Industry 4.0?
   _____

9. If the company decides to implement new industry 4.0 strategy, how would the company carry out the design and implement the strategy?
   ☐ In house research, planning and implementation
   ☐ Hire private consultants
   ☐ Hire government-linked consultants e.g., HKPC
   ☐ Other (please specify _____)

10. What are the challenges the company facing or foreseeing while incorporating the concept of Industry 4.0? (1: least challenging to 5: most challenging)

	1	2	3	4	5
Insufficient funds					
Difficult to evaluate economic benefit					
Insufficient knowledge					
Difficult to hire talent					
Insufficient Infrastructure					
Difficult to integrate with existing company infrastructure					
Legal regulations					
Difficult to evaluate implementation results					
Others (Please specify _____)					

D: Expectations

Operation and Markets

1. Whether the company has plan to move/expand operations to/in Hong Kong

	Yes	No
At least 10% of production processes		
At least 25% of production processes		
At least 50% of production processes		
All the production processes		
Research and development		

2. Whether the company has plan to move/expand operations overseas

	Yes	No
At least 10% of production processes		
At least 25% of production processes		
At least 50% of production processes		
All the production processes		
Research and development		

3. If the company has plans to move/ expand operations overseas, where will be the primary target country? (Take one that applies)

	Primary Target Market
Greater Bay Area	
Rest of Mainland China	
South-East Asia	
Other Asian nations (except South-East Asia)	
Other nations (please specify)	

4. Does the company have any plans to transform or expand to a different industry? (If yes, please specify the industry)

	Changing to new industry	Expanding to new industry
Next 1-2 years	Yes_____/No	Yes_____/No
Next 3-4 years	Yes_____/No	Yes_____/No
Next 5 years	Yes_____/No	Yes_____/No

5. Whether the company plans to expand the R&D team?
   ☐ next 1-2 years ☐ next 3-4 years ☐ next 5 years ☐ No Plan

6. Whether the company has formulated any plan for implementing the Industry 4.0 concept?
   ☐ next 1-2 years ☐ next 3-4 years ☐ next 5 years ☐ No Plan

7. In the next 5 years, where do you think your market will most likely expand?

	State 1 for the most likely; 2 for the likely, and 3 for the least likely
Hong Kong	
Greater Bay Area	
Rest of Mainland China	
Europe	
South-East Asia	
Other Asian nations (except South-East Asia)	
United States	
Other: _____	

Infrastructure (land, building, and facilities)

8. Does the company expect Hong Kong's R&D infrastructure to become more mature in the future?

	Yes	**Partially Yes**	**No**	**Cannot say**
For the next 1-2 years				
For the next 3-4 years				
For the next 5 years plus				

9. Does the company expect Hong Kong's Industry 4.0 infrastructure to become more mature in the future?

	Yes	**Partially Yes**	**No**	**Cannot say**
For the next 1-2 years				
For the next 3-4 years				
For the next 5 years plus				

Ecosystem (integrations and supporting industries) and Talent

10. Does the company expect Hong Kong's Industry 4.0 ecosystem to become more mature in the future?

	Yes	Partially Yes	No	Cannot say
For the next 1-2 years				
For the next 3-4 years				
For the next 5 years plus				

11. Does the company expect that it would be easier to find matching talent for R&D and Industry 4.0 implementation in Hong Kong?

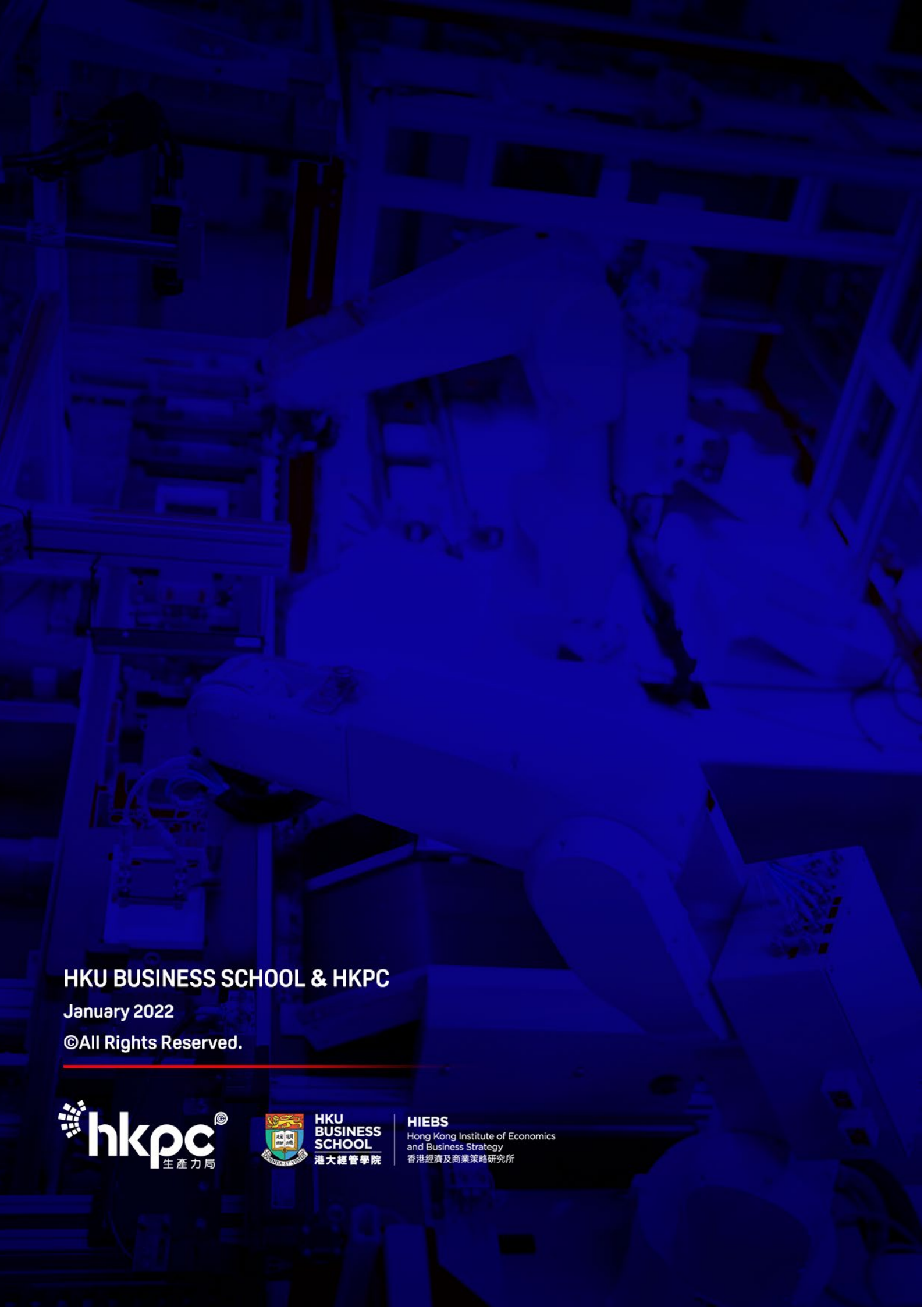
	Yes	Partially Yes	No	Cannot say
For the next 1-2 years				
For the next 3-4 years				
For the next 5 years plus				

12. Any other feedback on Industry 4.0 in Hong Kong?

_____

_____

***** END *****



HKU BUSINESS SCHOOL & HKPC

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