OUR HONG KONG FOUNDATION
團結香港基金

Building the Technology Bridge for Scientific Breakthroughs: Developing an Innovation Hub of the Future

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Executive Summary

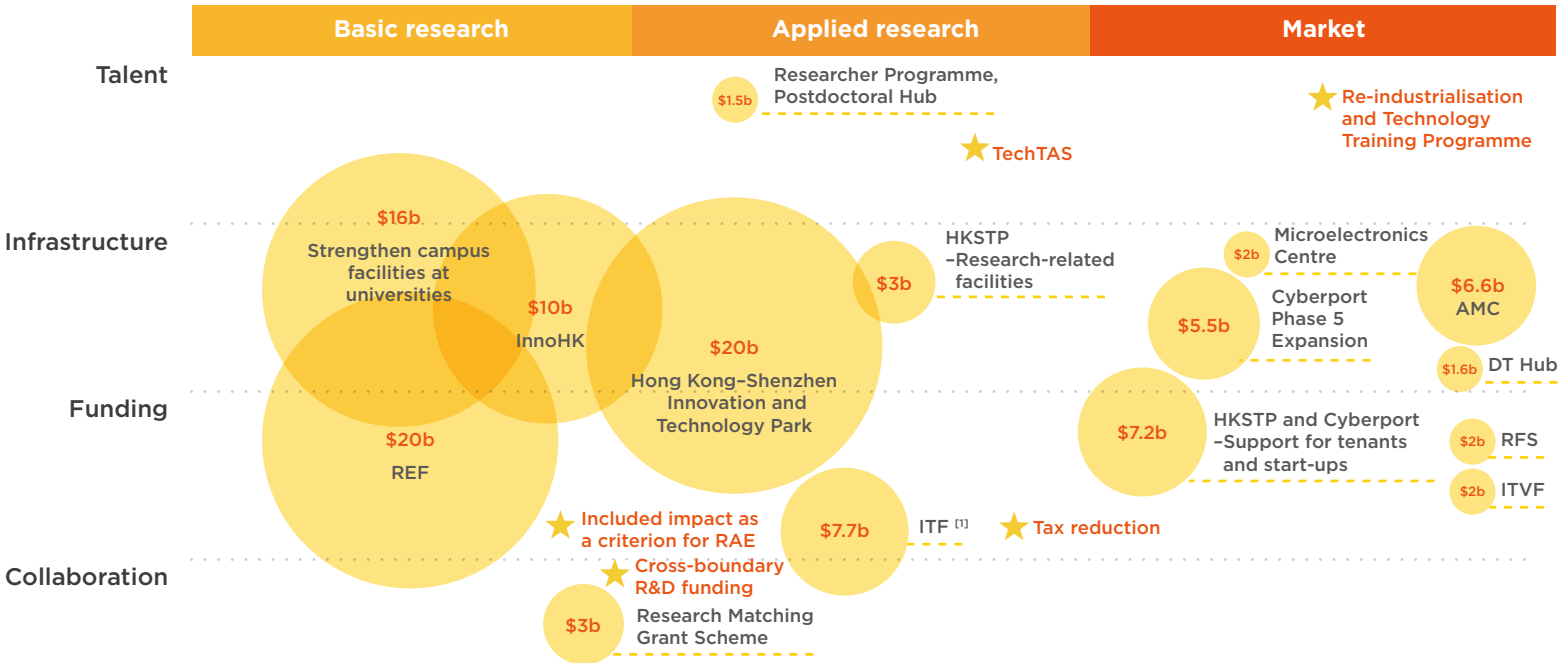
Universities' Research is the Competitive Edge for the Development of the Innovation and Technology Ecosystem in Hong Kong

Since December 2015, when Our Hong Kong Foundation (OHKF) published its first science and technology innovation report, entitled *The Ecosystem of Innovation and Technology in Hong Kong*, the Government has devoted significant efforts to boosting the development of science and technology innovation in Hong Kong, largely consistent with the recommendations that OHKF has put forward **(Figure I)**.

A lot of our recommendations were related to universities because they are potentially the game-changer for the entire ecosystem. Hong Kong has a relative competitive edge in certain areas of basic research, and it is vital that Hong Kong capitalises on this edge. In fact, according to the 2021 QS World University Rankings, six of the seven Hong Kong universities listed in the ranking saw an improvement from the previous year, demonstrating that the quality of basic research continues to rise in Hong Kong.

Furthermore, 50.4% of Hong Kong's total expenditure in research and development (R&D) took place in universities in 2018. This shows that universities play a dominant and outsized role in Hong Kong's innovation ecosystem, as university research constitutes a much lower portion of the overall R&D spending in the United Kingdom (23.6%) and the United States (12.9%).

Figure I. The current Government's efforts to boost the development of science and technology innovation in Hong Kong



Notes:

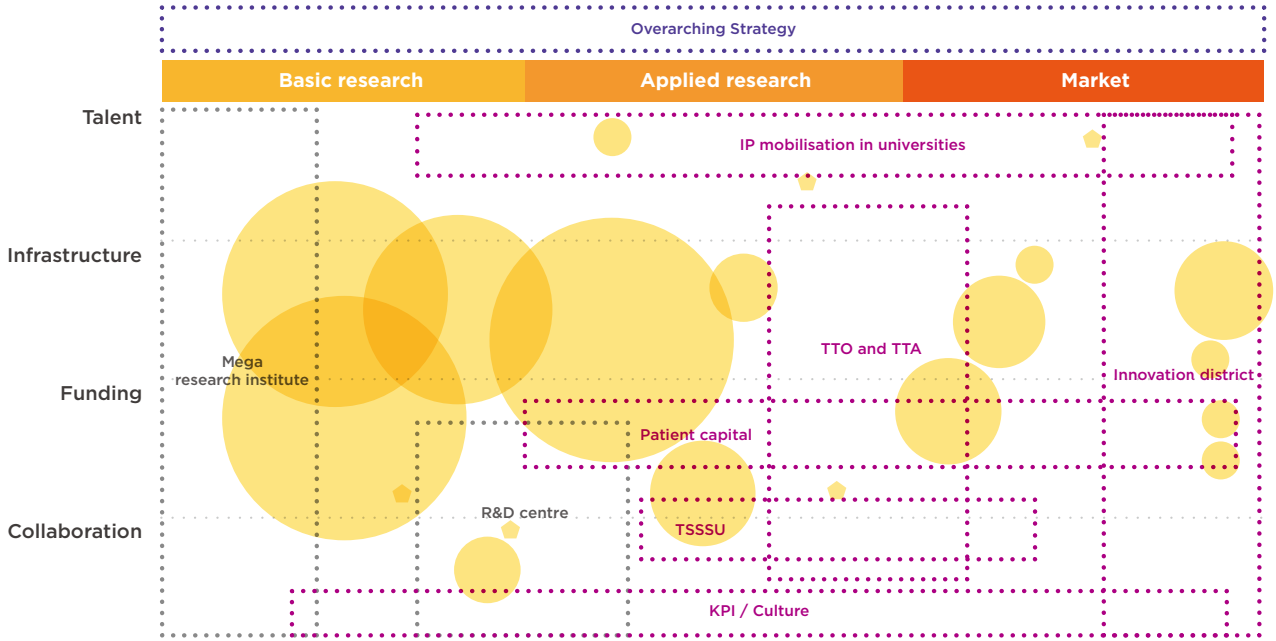
[1] This amount is sourced from seven funding schemes that support R&D, including the Innovation and Technology Support Programme, the Mainland–Hong Kong Joint Funding Scheme the Guangdong–Hong Kong Technology Cooperation Funding Scheme, the Partnership Research Programme, the Midstream Research Programme for Universities, the Enterprise Support Scheme and the Research and Development Cash Rebate Scheme.

[2] This list is not exhaustive and only includes schemes that are over HKD 1 billion and some of the most significant policies.

[3] REF stands for Research Endowment Fund. ITF stands for Innovation and Technology Fund. TechTAS stands for Technology Talent Admission Scheme. AMC stands for Advanced Manufacturing Centre. DT Hub stands for Data technology Hub. RFS stands for Re-industrialisation Funding Scheme. And ITVF stands for Innovation and Technology Venture Fund.

Hong Kong is beginning to reap the benefits from these policy initiatives, and there is a stronger momentum driving the local innovation ecosystem forward. Nonetheless, there remain significant gaps that the Government must address, particularly in strengthening basic research and knowledge transfer (between the stage of applied research and market). Therefore, OHKF released its second science and technology innovation report focusing on basic research (the grey dotted lines and the delineated areas in **Figure II**), entitled *Unleash the Potential in Science and Technology Innovation: Develop Hong Kong into an International R&D Powerhouse*, in December 2019. This third report focuses on knowledge transfer (the purple dotted lines and the delineated areas in **Figure II**).

Figure II. Recommendations by Our Hong Kong Foundation (dotted lines)



Note: [1] TTO stands for Technology Transfer Office. TTA stands for Technology Transfer Alliance; TSSSU stands for Technology Start-up Support Scheme for Universities.

Knowledge Transfer, together with Teaching and Research, are Commonly Accepted to be the Three Main Missions of Universities

Beyond the traditional missions of teaching and research, universities across advanced economies are increasingly focusing on their third mission of knowledge transfer. Knowledge transfer drives innovation by transforming knowledge generated in laboratories into actual products and services that could deliver economic and social benefits to society. One of the most famous examples is the discovery of penicillin, which was discovered by Alexander Fleming by accident. Researchers at the University of Oxford built upon Fleming's findings and managed to turn penicillin into a life-saving drug that became the hallmark of modern science. Fast forward to the present day, university researchers, collaborating with various commercial partners, may once again save the day with their COVID-19 vaccines. In Hong Kong, spin-off companies from universities, such as SenseTime, Xcelom, and DJI, have generated disruptive technologies with transformative impacts on the world as well.

Nevertheless, beset by a late start and without a full appreciation of the importance of knowledge transfer, universities in Hong Kong are lagging behind their foreign peers, such as the University of Oxford, Harvard University, Stanford University, and Massachusetts Institute of Technology (MIT), across a broad range of knowledge transfer indicators.

- In 2019, the Chinese University of Hong Kong (CUHK) was granted the most patents among Hong Kong universities, with 202 patents, compared with 434 granted to the University of Oxford and 781 to MIT.
- The cumulative number of active spin-off companies associated with each local university in 2019 ranged from 10 to 29, compared with 109 for the University of Cambridge and 145 for the University of Oxford. In addition, 25 and 24 new spin-off companies were formed at MIT and Stanford University (respectively) in 2019 alone.
- The combined total income from intellectual property (IP) rights in 2019 for all Hong Kong universities totalled HKD 100.1 million, which is dwarfed by the HKD 762.8 million generated by Harvard University and HKD 799.1 million generated by the University of Oxford.
- In 2018, the income from IP accounted for 0.26% of the University of Hong Kong (HKU)'s research expenditure, comparing to 2019 figures of 5.69 % for Cambridge University and 15.22% for the University of Oxford.

Strengthening Knowledge Transfer is the Key to Unlocking the 'Treasures' in Universities for the Development of Innovation and Technology Ecosystem

Given this circumstance, this report will put forward seven recommendations, including twenty detailed suggestions. By strengthening knowledge transfer, Hong Kong can better tap into the 'treasures' (scientific research findings) in the universities to foster a vibrant innovation and technology ecosystem. We believe these recommendations will enable Hong Kong's world-class basic research to be transformed into viable products and services that will exert profound economic and social impacts and lead Hong Kong to a better tomorrow.

RECOMMENDATION 1.

Foster a culture conducive to knowledge transfer in universities by enhancing the assessment framework and funding allocation linkage

Although the University Grants Committee (UGC) and Hong Kong universities have recognised knowledge transfer as the third mission of universities, they have yet to fully embrace it. Although a culture that is conducive to knowledge transfer has improved over the last few years, it remains largely absent among campuses in Hong Kong. The Government, as the primary funder of universities, has a responsibility to foster such a culture.

To begin with, the Government should gather and disclose more data related to universities' knowledge transfer activities, taking note of such data disclosure in the United States and the United Kingdom. The second step should be to enhance the assessment framework for knowledge transfer to make it comparable to the audits conducted by the Quality Assurance Council and the Research Assessment Exercise, which would respectively correspond to the university's mission of teaching and research. The third step should be to simultaneously increase the recurrent funding for knowledge transfer while allocating such funding based on the enhanced assessment framework. Finally, technology transfer offices (TTOs), which serve as an integral knowledge transfer infrastructure for universities, should be able to keep a percentage of the net profit generated from their university's IP based on their performance to further stimulate a culture conducive to more active knowledge transfer.

RECOMMENDATION 2.

Enhance IP mobilisation by offering more flexibilities and options for researchers to commercialise their research

Hong Kong universities trail behind in institutional IP policy with relatively conservative terms, stifling the mobilisation of IP and thus hindering knowledge transfer. For example, patents created by faculty members and staff are owned by universities unless inventors buy out the patent at relatively unaffordable prices, whereas some global peers allow inventors to assume full ownership if the invention is independently commercialised. In terms of licensing revenue sharing, Hong Kong universities distribute only 25% to 50% of revenues to inventors under university-led commercialisation processes, while overseas institutions adopt more generous revenue-sharing terms. Therefore, we recommend that local universities provide greater flexibility in regards to patent ownership and licensing policies.

As well as IP policy, outside practice regulations should be relaxed to create more flexibilities for faculty members and staff to commercialise their research. Currently, academic personnel are only permitted four days per month for outside practice. To align with innovative universities abroad, Hong Kong universities should relax their outside practice regulations, for example, to allow and encourage activities related to knowledge transfer during vacation and annual leave.

RECOMMENDATION 3.

Improve university research commercialisation through Technology Transfer Offices and a Technology Transfer Alliance

University TTOs serve as a key infrastructure for knowledge transfer and commercialisation. To enhance the effectiveness of such technology transfer units, we recommend that TTOs should provide more dedicated and specialised staffing support for researchers and constitute governing committees with more industry practitioners. Furthermore, we recommend that local TTOs band together to form a technology transfer alliance (TTA). While TTOs focus more on the earlier stages of research commercialisation, the TTA will concentrate on establishing and maintaining a university–industry network, by providing a platform to match technological needs with solutions, and by hosting exhibitions and roadshows.

RECOMMENDATION 4.

Strengthen the Technology Start-up Support Scheme for Universities

To enhance the commercialisation of R&D outcomes and increase entrepreneurial support for start-ups, we recommend that universities strengthen the education and training components of Technology Start-up Support Scheme for Universities (TSSSU) and conduct co-assessment with private incubators and accelerators. More importantly, we recommend that TSSSU establish two phases of funding. While the first phase will provide a condition-free grant for verifying technical feasibility and developing prototypes, the second phase will require start-ups to seek funding from private investors or collaborate with industry partners to test the commercial viability of the start-up. It is equally important that the Government offers tax incentives to encourage private investment in TSSSU start-ups.

RECOMMENDATION 5.

Utilise the Future Fund to provide patient capital and deep-technology investment strategy to nurture local spin-offs

One of the notable competitive edges in universities' research in Hong Kong is in biotechnology, which is a classic example of 'Deep Tech'. Deep Tech can have big social impacts, but it also requires substantial R&D costs, as well as long time to reach the so-called 'market-ready' maturity. Deep Tech would need capital that has a much longer investment horizon than most of the private funds currently in the market. One of the few prominent examples is IP Group, a leading intellectual property commercialisation company that aims to evolve great ideas into world-changing businesses.

We understand that the Government announced in the 2020-21 Budget to use a portion of the Future Fund to invest directly in projects with a 'Hong Kong nexus' and this portion is called 'the Hong Kong Growth Portfolio'. We are supportive of this to increase the productivity of local strategic industries. It would be even better if the Hong Kong Growth Portfolio would be used, not only to support local industries, but also to invest in local Deep Tech coming out from our universities. This would increase the long-term productivity of our economy, create more options for our universities researchers, and potentially generate new industrial opportunities. This can be done by engaging companies similar to IP Group in a classic Limited Partner / General Partner arrangement.

RECOMMENDATION 6.

Establish a high-level Science and Development Office to advise the Chief Executive and the Cabinet, provide strategic directions for overall public R&D funding, and identify use cases to be piloted by public bodies

We are pleased to see that the Government has set up both the Steering Committee on Innovation and Technology (SCIT) and the Committee on Innovation and Technology and Re-industrialisation (CITR) to co-ordinate cross-departmental implementations and to steer strategies on innovation and technology development respectively. The Innovation and Technology Bureau (ITB) is actively engaged with both committees with its Secretary serving as a member.

However, innovation and technology do not happen in the vacuum. Instead, they are integral parts of the general economic and societal developments. CITR needs to be tasked to create an overall blueprint for these developments and more importantly, to detail roadmaps of how innovation and technology can facilitate and accelerate these developments. Such overall blueprint needs substantial inputs related to the global trends in science and corresponding industrial development.

Referring to economies such as the United States and Singapore which established a separate organisation to advise governments from scientific perspectives, this report proposes to establish a Science and Development Office (SDO) in Hong Kong. Led by a Chief Science and Development Officer and comprised of academics and scientists, the SDO is in place to serve as a scientific advisor via providing forward-looking vision and highlighting emerging global trends in science and corresponding industrial development to the Chief Executive and the Cabinet.

In addition, as discussed in our previous report, the SDO needs to provide strategic directions for the overall public R&D funding, so that these public R&D fundings are less fragmented, and share common standards and goals. Finally, taking 5G as an example, the Government needs to be supportive in piloting some of the use cases to help create the innovative and sustainable ecosystem, and to materialise its investment of public R&D funding.

RECOMMENDATION 7.

Develop the Kowloon Bay Action Area into a world-class innovation district

In Hong Kong, major science and technology innovation infrastructures, namely the Hong Kong Science and Technology Parks (HKSTP), Cyberport, and the upcoming Lok Ma Chau Loop, are all far away from the central business districts. Nevertheless, many cities around the world have recognised the remarkable shift in the spatial geography of innovation and have developed urban innovation districts to drive knowledge transfer and commercialisation. Prominent examples include Boston's Innovation District and 22@Barcelona.

Given Kowloon East's pilot role in exploring the feasibility of developing a smart city, it is an ideal location to be developed into such a world-class innovation district, along with its convenient transportation, its pilot role to test proof of concept trials as well as its proximity to university and R&D centres. As a sizable and undeveloped plot of land in Kowloon East, Kowloon Bay Action Area would be the most suitable spot. By taking reference from overseas innovation districts, we propose that one-third to one-half of the Kowloon Bay Action Area should be earmarked for expansion of HKSTP and Cyberport, office space for AI and fintech firms, the TTA, mega research institutes, and innovation-related government departments. As the planning of the Kowloon Bay Action Area is in full swing, it is a timely opportunity to unleash its full potential via fitting our recommendations into the Government's current development schedule.

CONCLUSION

This report has proposed seven broad recommendations to drive knowledge transfer, so as to enable Hong Kong's world-class basic research to transform into viable businesses that could exert influential social and economic benefits. By strengthening knowledge transfer, we believe Hong Kong can foster a vibrant innovation ecosystem and position itself as an international innovation powerhouse.

Summary of Recommendations

RECOMMENDATION 1.

Foster a culture conducive to knowledge transfer in universities by enhancing the assessment framework and funding allocation linkage

1A: Create a comprehensive and comparable database of universities' knowledge transfer activities
1B: Enhance the assessment framework for universities' knowledge transfer activities
1C: Increase knowledge transfer funding and link universities' knowledge transfer performance to funding allocation

RECOMMENDATION 2.

Enhance IP mobilisation by offering more flexibilities and options for researchers to commercialise their research

2A: Provide clear guidelines and flexible policies on patent ownership
2B: Increase incentives in licensing terms and revenue-sharing policies
2C: Support spin-off companies with more flexible financial terms
2D: Relax outside practice regulations and expand hours for knowledge transfer activities

RECOMMENDATION 3.

Improve university research commercialisation through Technology Transfer Offices and a Technology Transfer Alliance

3A: Recruit external talent for technology transfer management
3B: Establish an alliance of technology transfer offices

RECOMMENDATION 4.

Strengthen the Technology Start-up Support Scheme for Universities

4A: Strengthen entrepreneurship education and training for TSSSU applicants

4B: Foster stronger integration with private incubators and accelerators

4C: Establish two phases of funding to encourage start-ups to seek private investment and foster collaboration with industries

4D: Offer tax incentives to encourage private investment in TSSSU start-ups

RECOMMENDATION 5.

Utilise the Future Fund to provide patient capital and deep-technology investment strategy to nurture local spin-offs

RECOMMENDATION 6.

Establish a high-level Science and Development Office to advise the Chief Executive and the Cabinet, provide strategic directions for overall public R&D funding, and identify use cases to be piloted by public bodies

6A: Establish a Science and Development Office

6B: Provide strategic directions for overall public R&D funding

6C: Identify use cases to be piloted by public bodies

RECOMMENDATION 7.

Develop the Kowloon Bay Action Area into a world-class innovation district

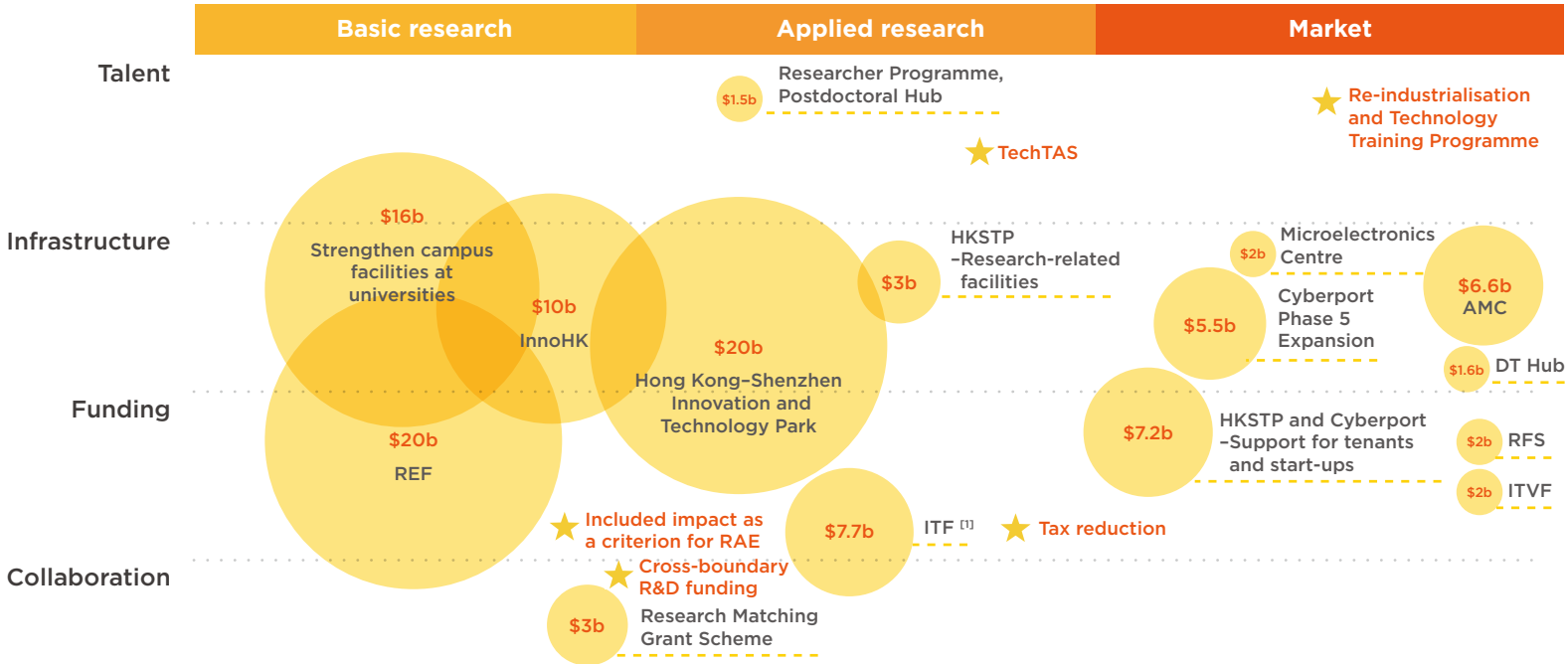
Introduction

As many economies in the world transform themselves to become innovation driven, Hong Kong is no exception. In the past few years, the Government of the Hong Kong Special Administrative Region (the Government) has placed science and technology innovation at the forefront of its agenda, and Hong Kong is beginning to reap the benefits of this.

Since Our Hong Kong Foundation (OHKF) published its first science and technology innovation report in December 2015, entitled *The Ecosystem of Innovation and Technology in Hong Kong*, the Government has devoted significant efforts to boosting the development of science and technology innovation in Hong Kong. They committed over HKD 100 billion to building and enhancing the local ecosystem along the eight major areas set out in *The Chief Executive's 2017 Policy Address*.[1] Among the policies that are aligned with the recommendations we laid out in our previous report are the inclusion of the impact factor in the Research Assessment Exercise (RAE), the Government's injection of HKD 20 billion into the Research Endowment Fund, and tax deduction for research and development (R&D) expenditure. In this report, we put the measures and initiatives enacted under the current Government into four categories: talent, infrastructure, funding, and collaboration, across three periods: basic research, applied research, and market **(Figure 1)**.

[1] The eight areas are: increasing resources for research and development (R&D), pooling together technology talent, providing investment funding, providing technological research infrastructure, reviewing existing legislations and regulations, opening up government data, leading changes to procurement arrangements, and strengthening popular science education.

Figure 1. The current Government's efforts to boost the development of science and technology innovation in Hong Kong



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Universities' Research is the Competitive Edge for the Development of Innovation and Technology Ecosystem in Hong Kong

A lot of our recommendations were related to universities because they are potentially the game-changer for the entire ecosystem. Hong Kong's universities are internationally renowned for conducting world-class basic research, and it is vital that Hong Kong capitalises on such edge. In fact, six of the seven local institutions listed in the 2021 Quacquarelli Symonds (QS) World University Rankings saw an improvement from the previous year **(Table 1)**. This improvement stems from an increase in academic reputation and citations per faculty, which are the two research-focused metrics among the six metrics evaluated in the rankings,[2] indicating that the quality of basic research in Hong Kong's universities continues to rise.

Table 1. Hong Kong universities' performance in QS World Rankings 2020 and 2021

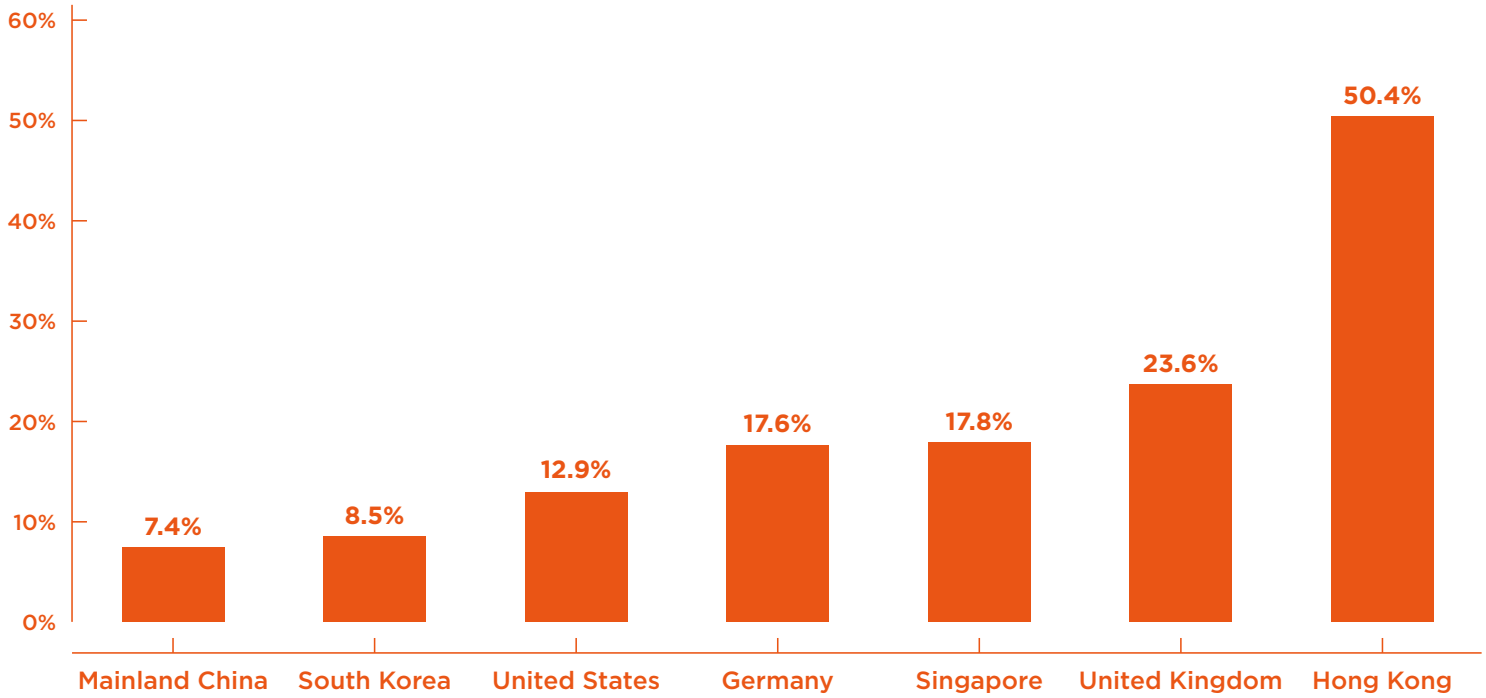
Institution	2020 ranking	2021 ranking
The University of Hong Kong (HKU)	25	22
The Hong Kong University of Science and Technology (HKUST)	32	27
The Chinese University of Hong Kong (CUHK)	46	43
City University of Hong Kong (CityU)	52	48
The Hong Kong Polytechnic University (PolyU)	91	75
Hong Kong Baptist University (HKBU)	261	264
Lingnan University (LU)	591–600	571–580

Source: QS Quacquarelli Symonds (UK)

[2] The four remaining metrics are: employer reputation, faculty/student ratio, international faculty ratio, and international student ratio.

Furthermore, although Hong Kong only represents 0.10% of the world's population, universities in Hong Kong account for 1.01% of the world's highly cited researchers, according to the Web of Science Group's *Highly Cited Researchers 2019*. This demonstrates the outsized international impact of the city's basic research, which can further be seen from the R&D expenditure perspective. In 2018, 50.4% of Hong Kong's total expenditure in R&D (HKD 12.4 billion of a total HKD 24.5 billion) was in the higher education sector. This compares to just 23.6% in the United Kingdom, 17.8% in Singapore, 12.9% in the United States, and 7.4% in mainland China **(Figure 2)**. The sheer excellence of Hong Kong's basic research has also been laid bare during the COVID-19 pandemic, when local researchers have pioneered global efforts to study the novel coronavirus. For example, in late January 2020, a team of researchers at the University of Hong Kong (HKU) was the first to publish an academic paper that proved the existence of human-to-human transmission of COVID-19. As such, it is by no means an exaggeration to say that universities will be the game changer if Hong Kong is to succeed as an innovation powerhouse.

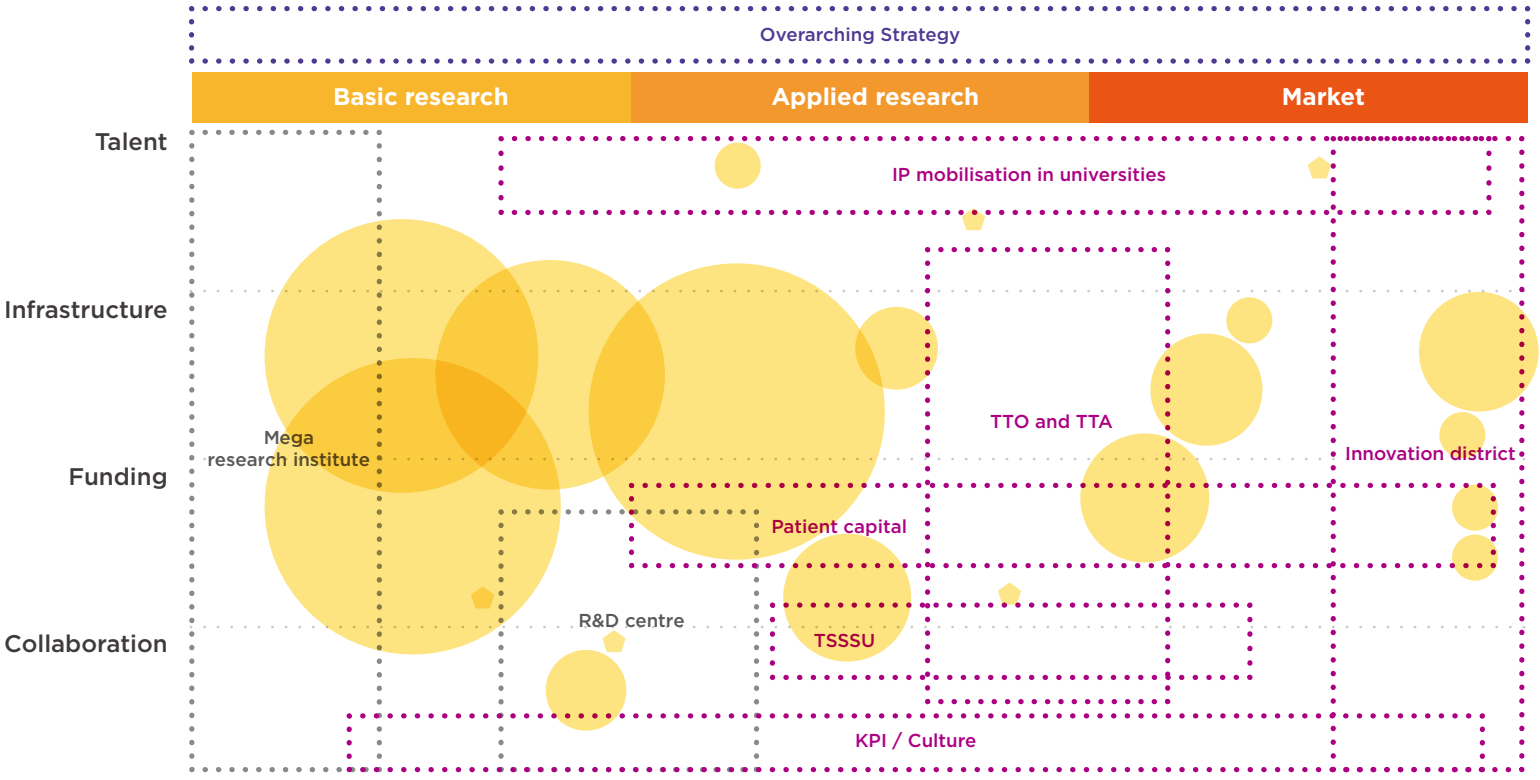
Figure 2. International comparison of the percentage of R&D performed by the higher education sector (2018)



Sources: The Census and Statistics Department, the Congressional Research Service (US), Department of Statistics (Singapore), *BusinessKorea* (South Korea), the Office for National Statistics (UK), Caixin Global (mainland China), and Statistisches Bundesamt (Germany)

While Hong Kong is indeed catching up with the rest of the world, there remains a lot to be done if Hong Kong aims to leapfrog ahead and become an innovation powerhouse. As a result, in December 2019, OHKF published its second science and technology innovation report, entitled *Unleash the Potential in Science and Technology Innovation: Develop Hong Kong into an International R&D Powerhouse*. In this report, OHKF made a series of recommendations to further strengthen Hong Kong's basic research with the aim of transforming Hong Kong into an international R&D powerhouse. We recommended that the Government establish interdisciplinary and cross-institutional mega research institutes and increase the funding autonomy and flexibility for R&D centres. This would complement the Government's dedication of resources into basic and applied research **(Figure 3)**. Despite a range of new policies announced by the current Government, there remain insufficient initiatives targeted at knowledge transfer, as evidenced by the gaps between the applied research and the market stages. Therefore, OHKF is publishing its third science and technology innovation report to provide a series of policy recommendations to fill those gaps.

Figure 3. Recommendations by Our Hong Kong Foundation (dotted lines)



Note: [1] TTO stands for Technology Transfer Office. TTA stands for Technology Transfer Alliance; TSSSU stands for Technology Start-up Support Scheme for Universities.

Knowledge Transfer, together with Teaching and Research, are Commonly Accepted to be the Three Main Missions of Universities

Curiosity-based basic research is fundamental to ground-breaking innovation, and Hong Kong must consolidate its strength in this respect. Nevertheless, as economies around the world dedicate more resources to driving innovation as a source of economic growth, universities are no longer seen as intellectual sanctuaries that are isolated from the rest of society. Rather, they are seen as an integral part of the local innovation ecosystem, responsible for generating economic and social benefits through their research.

In fact, throughout the last century or so, many of the world's most disruptive technologies came from universities. A prime example is penicillin. Before the discovery of penicillin, there was a very realistic chance that a simple cut or a scratch would prove lethal. Alexander Fleming, Professor of Bacteriology at St. Mary's Hospital Medical School, London, discovered penicillin by accident in 1928, and he published his findings in 1929. Researchers at the University of Oxford built upon Fleming's findings and managed to turn penicillin into a life-saving drug that became the hallmark of modern medicine.

Even in Hong Kong, universities have generated disruptive technologies that have transformed the world. For example, Professor Dennis Lo from the Chinese University of Hong Kong (CUHK) has been a pioneer in developing non-invasive prenatal diagnostic tests for multiple genetic diseases. This has given birth to a spin-off company, Xcelom. Professor Tang Xiaoou, also a professor at CUHK, founded SenseTime, which specialises in developing artificial intelligence (AI) algorithms. SenseTime became the world's most valuable AI company in 2018. Meanwhile, DJI, the world's dominant manufacturer of drones, is the brainchild of Hong Kong University of Science and Technology (HKUST) Professor Li Zexiang and his student Frank Wang.

As such, knowledge transfer, which is defined as 'the systems and processes by which knowledge, including technology, know-how, expertise and skills are transferred between higher education institutions and society, leading to innovative, profitable or economic or social improvements' by the University Grants Committee (UGC), the non-statutory body that advises the Government on the funding and strategic development of higher education in Hong Kong, has widely been recognised as the 'third mission' of universities, after teaching and research.[3] The third mission will by no means jeopardise the strength of basic research, but rather, reinforce it. Top universities such as Massachusetts Institute of Technology (MIT), Stanford University and Harvard University not only excel in fundamental scientific discoveries, but also pioneer in knowledge transfer that exerts a profound impact to benefit the society as a whole.

Some of the earliest roots of the third mission of universities can be traced back to the land-grant universities that were established in the United States under the Morrill Act, which was signed by President Abraham Lincoln in 1862. The Morrill Act gave public land to the states in exchange for the states using the money from sales of the land to establish at least one college specialising in agriculture and mechanical arts. A set of legislations endowed three missions for these land-grant universities: education, research, and extension. Extension was included as the government deemed that knowledge generated from public funding should be extended to those who are unable to attend higher education institutions. Renowned universities, such as MIT, Cornell University, and the University of California, are all examples of land-grant universities.

Over the course of the twentieth century, knowledge transfer has become an intrinsic part of universities around the world, driven internally by the desire to generate new revenue streams and externally by governmental and societal pressures that demanded universities play a greater role in delivering economic and social benefits. Universities created technology transfer offices (TTOs) to facilitate the commercialisation of research, with MIT being one of the first when it established its Technology Licensing Office in 1945. Stanford University and the University of Oxford also created their own TTOs in 1970 and 1988 respectively. Concurrently, governments have also initiated efforts to promote technology transfer. In the United States, the Bayh-Dole Act, which was enacted in 1980, was seen as a landmark piece of legislation that spurred the country to become a global innovation superpower by allowing universities, instead of the government, to retain the intellectual property (IP) that they created and to take the lead in patenting and licensing ground-breaking discoveries.

[3] Zomer and Benneworth (2011)

Hong Kong Universities' Weakness in Knowledge Transfer

However, universities in Hong Kong have been slow in adopting the third mission. Although the UGC officially recognises knowledge transfer as the third mission of universities in its mission statement, recurrent funding to support knowledge transfer has only been provided since the 2009/10 academic year. While HKUST and the Hong Kong Polytechnic University (PolyU) established TTOs in 1991 and 2000 respectively, the two largest universities in Hong Kong, HKU and CUHK, only founded their TTOs in 2006 and 2009 respectively **(Table 2)**.

Table 2. International comparison of the establishment of universities' TTOs

University	Year of establishment [1]
Massachusetts Institute of Technology	1945
Stanford University	1970
University of Oxford	1988
HKUST	1991
PolyU	2000
HKU	2006
CUHK	2009

Note: [1] This represents the year in which the respective university's technology transfer office (TTO) was established in its contemporary form, although some universities had established entities that had similar roles to a TTO.
Sources: Universities' websites

The late adoption of the third mission among Hong Kong universities may partially explain why Hong Kong universities perform poorly internationally in driving innovation. *The World's Most Innovative Universities 2019*, a ranking compiled by Reuters **(Table 3)**, identifies universities that do the most to 'advance science, invent new technologies and power new markets and industries' using three broad criteria:

1) Total number of patents filed
2) The success rate of patents filed
3) The institution's commercial impact score[4]

Table 3. Top 10 universities in *The World's Most Innovative Universities 2019*

Ranking	University
1	Stanford University
2	Massachusetts Institute of Technology
3	Harvard University
4	University of Pennsylvania
5	University of Washington
6	University of North Carolina at Chapel Hill
7	KU Leuven
8	University of Southern California
9	Cornell University
10	Imperial College London

Source: Reuters

[4] How often an institution's basic research influences commercial R&D activity, as measured by academic papers cited in patent filings.

As shown, universities in the United States dominated these rankings, with eight of the top ten places. European institutions fared well in the full list, while numerous universities from South Korea, Japan, mainland China, and Singapore were also among the world's best universities in driving innovation. None of Hong Kong's universities managed to make it to the world's top 100.

Hong Kong's universities can only be found on the regional *Asia's Most Innovative Universities* ranking, which is also compiled by Reuters using the same methodology as the world ranking. CUHK, HKUST, and HKU were ranked 26th, 34th, and 54th respectively out of the top 100 institutions on the regional ranking **(Table 4)**. The three Hong Kong universities scored relatively low across the board for the three components evaluated.

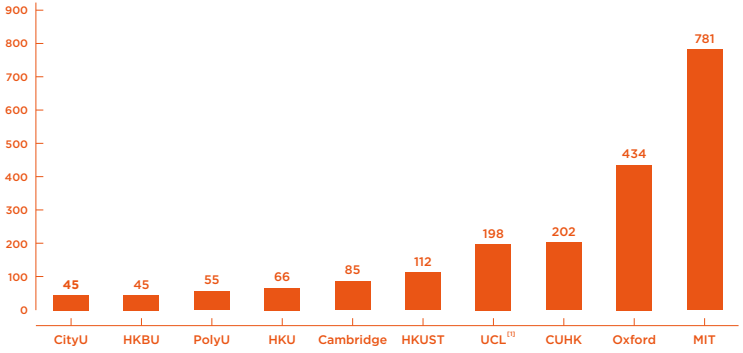
Table 4. Selected universities in *Asia's Most Innovative Universities 2019*

Ranking	University
1	Seoul National University
2	Korea Advanced Institute of Science and Technology
3	Pohang University of Science and Technology
4	Tsinghua University
5	The University of Tokyo
8	National University of Singapore
26	**The Chinese University of Hong Kong**
34	**The Hong Kong University of Science and Technology**
54	**The University of Hong Kong**

Source: Reuters

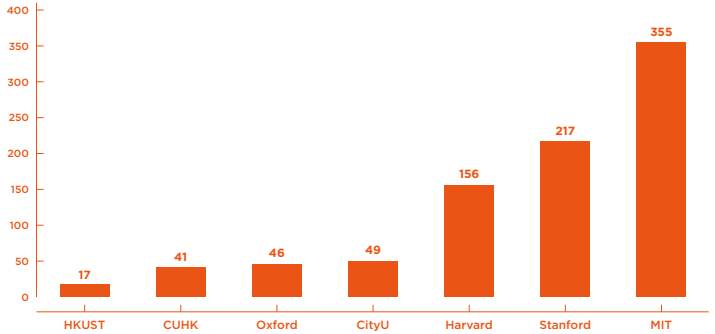
More specifically, the weakness of Hong Kong universities in knowledge transfer is evident from the data on their commercialisation activities, which are a core component of knowledge transfer. The first sets of data are related to patents granted globally **(Figure 4)** and the second set of data illustrates patents granted only in the United States, by university **(Figure 5)**. Filing a patent is generally the initial step in the commercialisation of university research, and the number of patents granted is an indication of the ability of a university to produce unique and innovative technologies that could benefit society at large. In both sets of data, the majority of universities in Hong Kong lag significantly behind their peers in the United Kingdom and the United States.

Figure 4. Total number of patents granted globally, by university (2019)



Note: [1] UCL stands for University College London.
Sources: Higher Education Statistics Agency (UK), University Grants Committee, Massachusetts Institute of Technology (US)

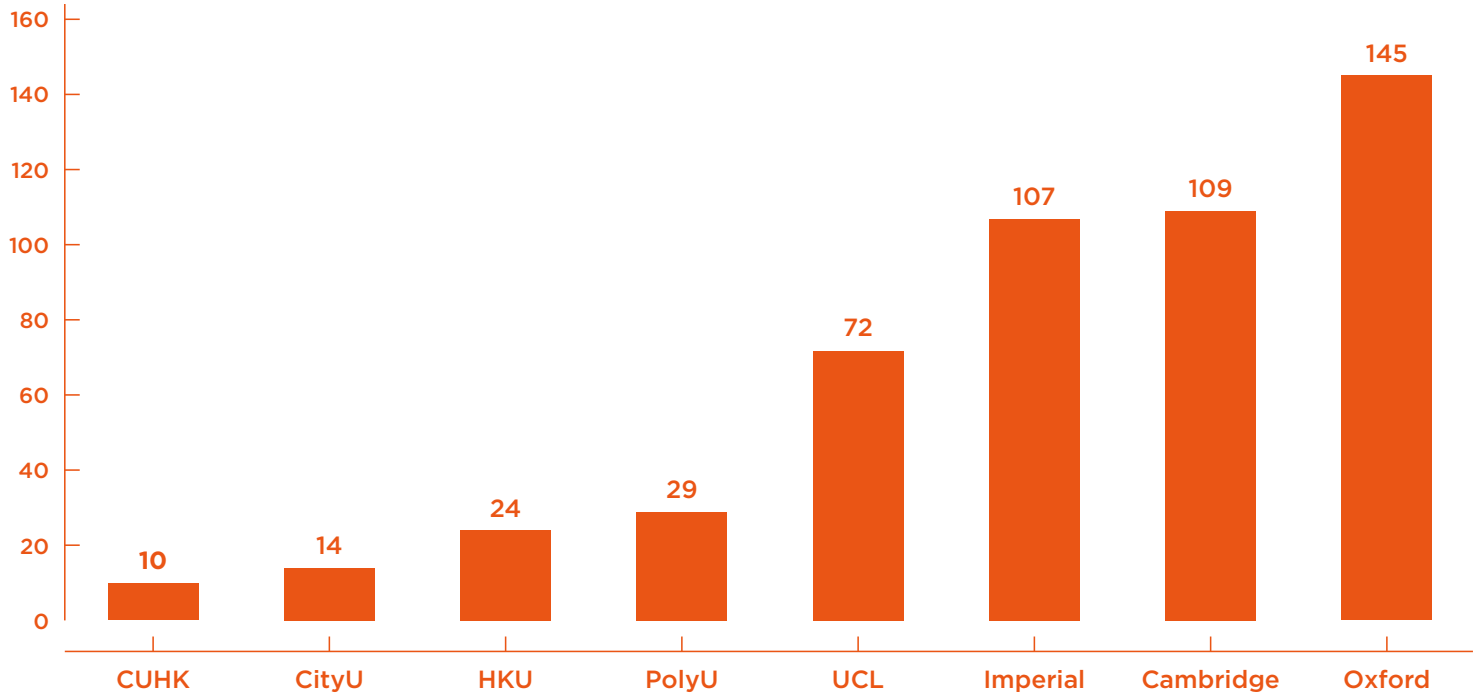
Figure 5. Total number of US patents granted, by university (2019)



Sources: Intellectual Property Owners Association (US), the National Academy of Inventors (US), HKUST

In the commercialisation process, owning a patent only means that the protected technology or know-how has the potential of being commercialised. The patent must be licensed or sold to an existing company or a spin-off company for the patented knowledge to generate an impact in society. Therefore, the cumulative number of active spin-off companies affiliated with a university partially reveals a university's ability to realise the commercialisation potential of its research. As creating a spin-off company requires the researchers responsible for generating the knowledge to possess entrepreneurial ambitions and skills, the data would also serve as a proxy for a university's ability to promote and nurture entrepreneurial talents. The data in **Figure 6** reveals that universities in Hong Kong lag significantly behind universities in the United Kingdom in producing spin-off companies. While the data for the cumulative number of active spin-off companies is not available for universities in the United States, MIT and Stanford University reported that 25 and 24 new spin-offs were respectively formed in 2019 alone. Meanwhile, the National University of Singapore reported that 25 spin-offs were formed in the 2018/19 academic year. This indicates that some of the best universities in the United States and Singapore generate more spin-offs in a year than the surviving spin-offs cumulatively generated by most of the best universities in Hong Kong.

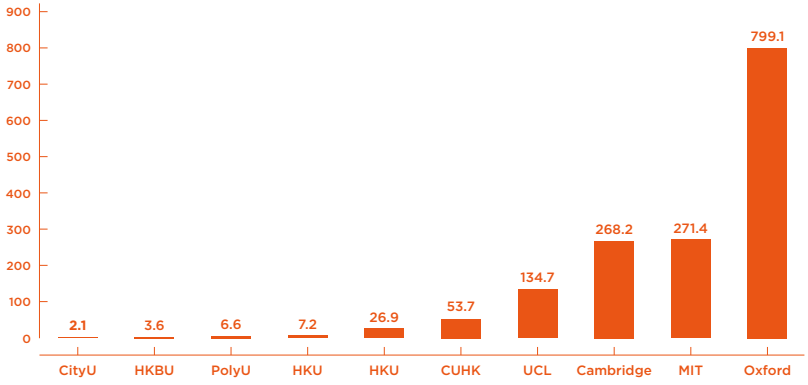
Figure 6. Total number of active spin-off companies by university (2019)



Sources: Higher Education Statistics Agency (UK), University Grants Committee

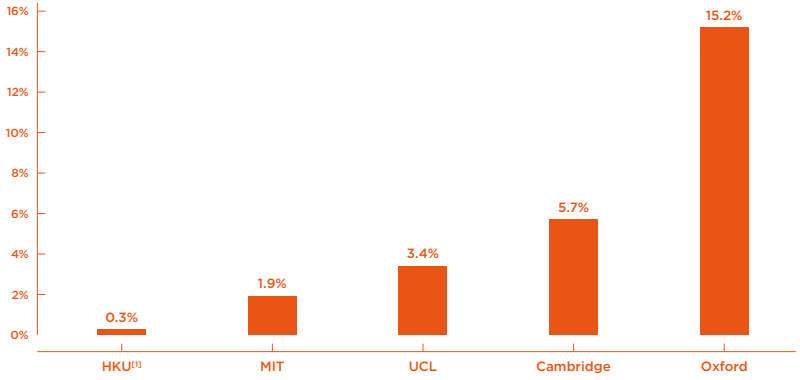
A broader and more comprehensive indicator of a university's commercialisation capability is its total income from IP rights, as this would capture income generated through both the licensing and spin-off routes to commercialisation. According to the data collected from universities in Hong Kong, the United Kingdom, and the United States **(Figure 7)**, the performance of Hong Kong's universities is far outstripped by that of universities in the United Kingdom and the United States. To ensure a fairer comparison, each university's research expenditure is also taken into account **(Figure 8)**. Research expenditure is the raw input in the knowledge transfer cycle, while income from IP rights is a measurement of the final outcome. When these are considered, the comparison is even starker. It also highlights the fact that, while universities in the United States generate more income from IP in general, universities in the United Kingdom are better at commercialising their research for each dollar that is invested in research. This may stem from the fact that universities in the United States are usually privately funded and spend more on basic research, while universities in the United Kingdom, being publicly funded, have more obligation to generate economic benefits for society at large. While total income from IP rights only focuses on the economic impact generated and does not necessarily capture the non-financial benefits to society, this set of data is the clearest indication yet of the weak commercialisation capabilities of Hong Kong's universities.

Figure 7. Total income from intellectual property rights, by university (in million HKD) (2019)



Sources: Higher Education Statistics Agency (UK), University Grants Committee, Massachusetts Institute of Technology (US)

Figure 8. Intellectual property income as a proportion of research expenditure, by university (2019)



Note: [1] The figure for the University of Hong Kong is from 2018.
Sources: Higher Education Statistics Agency (UK), University Grants Committee, Massachusetts Institute of Technology (US)

Even from a qualitative perspective, universities abroad have produced many famous spin-offs and start-ups as part of their knowledge transfer efforts, while Hong Kong has relatively few success stories. In the United States, Stanford University has given birth to Google, Hewlett-Packard, and Snapchat; MIT is associated with Akamai Technologies and Dropbox; while Harvard University can tell stories about Microsoft and Facebook. Meanwhile, among all the universities in Hong Kong, the success stories have always been limited to SenseTime, Xcelom, and DJI.

Strengthening Knowledge Transfer is the Key to Unlocking the 'Treasures' in Universities for the Development of Innovation and Technology Ecosystem

Given this circumstance, this report will put forward seven recommendations, including twenty detailed suggestions. By strengthening knowledge transfer, Hong Kong can better tap into the 'treasures' (scientific research findings) in the universities to foster a vibrant innovation and technology ecosystem. We believe these recommendations will enable Hong Kong's world-class basic research to be transformed into viable products and services that will exert profound economic and social impact, and lead Hong Kong to a better tomorrow.

CHAPTER 1

Foster a Culture Conducive to Knowledge Transfer in Universities

Although the UGC and individual Hong Kong universities have recognised knowledge transfer as the third mission of universities, they have yet to fully embrace it. Even though a culture that is conducive to knowledge transfer has improved over the past few years, it remains largely absent among campuses in Hong Kong. The Government, as the primary funder of universities, has a responsibility to foster such a culture. The Government could do so by establishing a framework to assess universities' knowledge transfer efforts based on a set of key performance indicators (KPIs). However, before an assessment framework can be drawn up, a comprehensive and comparable set of data must be collected. The UGC does not currently collect some key data from universities about their knowledge transfer activities compared with other economies.

Insufficient Collection of Data Related to Universities' Knowledge Transfer Activities

Under the current data-collection arrangement (in place since recurrent funding for knowledge transfer was made available in the 2009/10 academic year), data related to universities' knowledge transfer activities are collected through annual knowledge transfer reports that each university has to submit to the UGC. The UGC has set forth a list of KPIs for universities to report on. Similarly, the Higher Education Statistics Agency (HESA) is the official agency responsible for collecting information from higher education institutions in the United Kingdom, but individual universities in the United States, such as MIT and Stanford University, publish their own statistics on their knowledge transfer activities. In addition, the Association of University Technology Managers (AUTM), a US-based non-profit group that educates on and promotes knowledge exchange around the world, collects data on knowledge transfer from its member universities, which include most universities in the United States and numerous international institutions elsewhere. Over the years, AUTM has developed itself as a global leader in the field of technology transfer and is now generally considered to be the 'gold standard' in terms of collecting data on knowledge transfer activities.

In comparing the data collected by the UGC from Hong Kong universities with data from HESA, AUTM, MIT, and Stanford University, it is vividly clear that the UGC has not collected sufficient data from universities **(Table 5)**. Data collected on knowledge transfer can be sorted into three categories: commercialisation, industry collaboration, and local development. In this comparison, the focus will primarily be on data regarding commercialisation. For one, Hong Kong has relatively comprehensive data on industry collaboration. For another, data on local development is not collected in the United States, where most universities are privately funded and are not obliged to disclose information on how they have contributed to the development of their locality.

Table 5. Comparison of international knowledge transfer KPIs

	UGC	HESA	Stanford	MIT	AUTM
Research expenditure	✗	✓	✓	✓	✓
Invention disclosure	✗	✓	✓	✓	✓
Patents filed	✓	✓	✓	✓	✓
Patents granted	✓	✓	✓	✓	✓
Licence	✓✗ (only accumulative)	✓	✓	✓	✓
Income-producing technology	✗	✓	✓	✗	✗
IP income	✓	✓	✓	✓	✗
IP income distribution	✗	✗	✓	✗	✗
Spin-offs	✓✗ (only accumulative)	✓	✓	✓	✓
Spin-offs to Series A	✗	✗	✗	✗	✗

Sources: University Grants Committee, Higher Education Statistics Agency (UK), Stanford University (US), Massachusetts Institute of Technology (US), Association of University Technology Managers (US)

In terms of the collection of data on commercialisation, the UGC is comparable to the United Kingdom and the United States when it comes to data about the number of patents filed, the number of patents granted, and the total income generated from IP rights. However, the UGC does not collect data on the following items:

1) Research Expenditure

Data on research expenditure records the amount of financial input that is devoted to research and enables analysis of the commercialisation ratio of a university's research. Currently, Hong Kong universities generally disclose the amount of external funding they have received. However, the amount of funding received is not often equal to the amount expended. In addition, Hong Kong universities receive block grants from the UGC that are far larger than any external funding amounts they receive, so reporting the amount of external funding they have received does not realistically reflect their annual expenditure on research.

2) Invention Disclosure

Invention disclosure is when faculty members, staff, or students formally disclose their inventions and knowledge to the university's TTO, marking the first step in the commercialisation process. The number of invention disclosures would therefore reveal a more comprehensive picture of the commercialisation activities taking place within a university, even if the disclosed invention was not taken forward in the commercialisation process.

3) Licensing

For data on licensing, the UGC only collects the cumulative figure from each university over the years, which precludes useful evaluation and comparison of each university's commercialisation activities each year.

4) Income-Generating Technologies

The UGC does not collect figures on the number of income-generating technologies. This data would allow a more in-depth assessment of the performance of each university's commercialisation activities.

5) Breakdown of IP Income Distribution

The UGC does not collect the breakdown of the IP income distribution between inventors, departments, and schools, which prevents a more comprehensive assessment of the performance of each university's commercialisation activities.

6) Spin-offs

As with the licensing data, the UGC only collects the cumulative figure for the number of spin-offs from each university over the years. Spin-offs are a specific subset of start-ups in which the company must utilise technologies that were discovered within the university. This, once again, precludes useful evaluation and comparison of each university's commercialisation activities each year.

7) Spin-offs Reaching Series A Funding

Finally, Series A funding follows pre-seed and seed funding, in which the spin-off company has already developed a strong foundation and is seeking more funding to fuel its expansion and development. Data on the number of spin-offs reaching Series A funding would be a clear indication of the quality of spin-offs that are produced from each university. This would also highlight whether universities support their spin-offs sufficiently.

RECOMMENDATION 1.

Foster a culture conducive to knowledge transfer in universities by enhancing the assessment framework and funding allocation linkage

Recommendation 1A : Create a comprehensive and comparable database of universities' knowledge transfer activities

We recommend that **the UGC collects the following data (Table 6) from each university on an annual basis**. In addition to the data on commercialisation, **the UGC should formulate KPIs to measure the contribution of each university to local development**. An important KPI that the UGC should include in this regard is the number of start-ups and social enterprises established by each university annually. Beyond that, as there are few established and benchmarked KPIs on local development around the world, the UGC should formulate these KPIs in consultation with universities, while referring to the KPIs used by other sources, such as HESA and the QS Stars university ratings.[5] HESA collects data on how much income each university receives from regeneration and development programmes, which provide funding for universities to invest in projects that would be beneficial to the local community. Meanwhile, the QS Stars ratings measure the amount of money invested in community projects within 200 kilometres of an affiliated campus, support of charitable causes, proportion of graduates employed within the region and of students who come from the region, and environmental initiatives.

Table 6. Recommendations for new knowledge transfer KPIs

1. Annual research expenditure
2. Number of new technology disclosures
3. Number of new licences/option agreements
4. Number of income-producing technologies
5. Gross royalty revenue from IP distributed to inventors/departments/schools
6. Number of new spin-offs formed
7. Number of new spin-offs that have reached Series A financing

[5] The QS Stars university ratings provide an in-depth review of each institution.

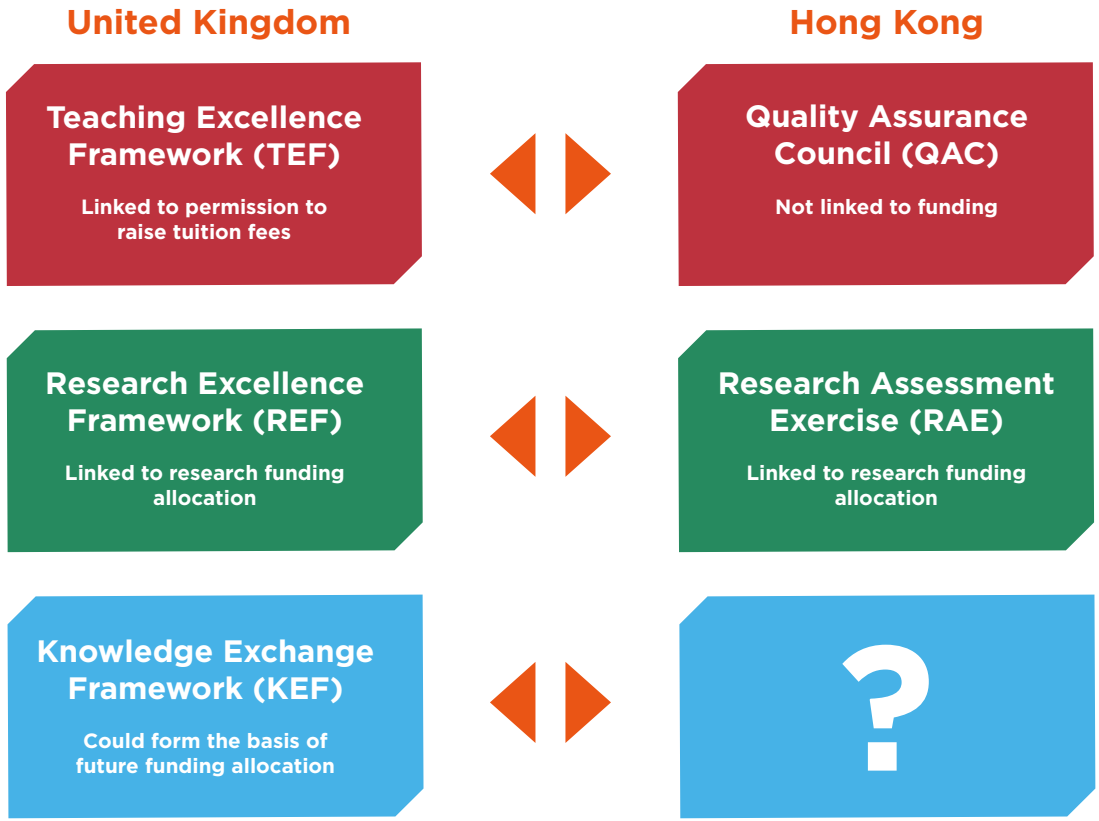
Beyond data collection, the UGC should publish data about knowledge transfer on the statistics page of its website. Currently, the statistical tables on the UGC website include data on students, graduates, staff, grants/finance, and research projects. Instead of simply publishing each university's knowledge transfer report on a separate webpage, **the UGC should integrate the existing information with the recommended additional data from each university to form a comprehensive database that is publicly accessible on its statistics page**. The UGC would then be in line with the databases that are created by HESA and AUTM.[6] By setting up this database, the UGC would enable universities in Hong Kong to compare their knowledge transfer activities from previous years with the activities of local and international institutions. This would ensure greater accountability for universities and encourage them to take their third mission more seriously.

Enhancing the Assessment Framework for Knowledge Transfer

On top of collecting comprehensive data and creating a comparable and transparent database, the UGC should take a more forceful step towards making universities realise their third mission. Under the current assessment frameworks, Hong Kong has two assessments of its universities: one focuses on teaching and one focuses on research. The Quality Assurance Council (QAC) carries out quality audits periodically to ensure that the quality of teaching in each university is up to standard. Meanwhile, the Research Assessment Exercise (RAE) is conducted periodically to evaluate the standard of research outputs by each university. The RAE determines the research portion of the block grant each university receives from the Government each year. These policies in Hong Kong have their roots in the United Kingdom, such that the QAC audits and the RAE correspond respectively to the Teaching Excellence Framework (TEF) and the Research Excellence Framework (REF), which assess the quality of teaching and research in universities in the United Kingdom. However, Hong Kong does not have an assessment framework for knowledge transfer that is comparable to the Knowledge Exchange Framework (KEF) in the United Kingdom **(Figure 9)**.

[6] Database is only accessible to AUTM members. Non-members have to pay a subscription fee to access it.

Figure 9. Comparison between the United Kingdom's and Hong Kong's assessment frameworks for universities' 'three missions'

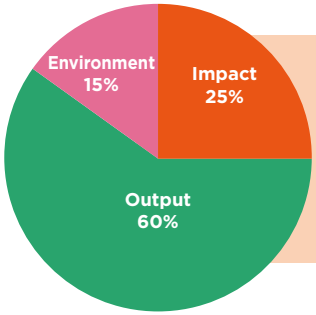


Sources: Times Higher Education (UK), Research England (UK), and University Grants Committee

Under the assessment framework in the United Kingdom, a university's research impact is assessed in both the REF and KEF **(Figure 10)**. In the upcoming REF exercise in 2021, the weighting for impact will increase from 20% (used in 2014) to 25%. The REF assesses impact through case studies, which allow each university to provide evidence of their economic and social impact in a qualitative manner. Meanwhile, the KEF assesses the impact of each university's research in a quantitative manner. The KEF encompasses seven areas of a university's knowledge exchange efforts, from research partnerships to IP and commercialisation, and public and community engagement.

Figure 10. The United Kingdom's assessment framework for universities' research impacts

Research Excellence Framework



In REF 2021, the weighting for impact has increased from 20% to 25% (after introducing impact in REF 2014)

Impact is assessed through case studies, which allow universities to provide evidence of their economic and social impact in a qualitative manner

Knowledge Exchange Framework

- Research partnerships
- Working with business
- Working with the public and third sector
- Skills, enterprise, and entrepreneurship
- IP and commercialisation
- Local growth and regeneration
- Public and community engagement

KEF provides quantitative KPIs to assess seven areas of universities' knowledge exchange efforts

Source: Research England (UK)

In fact, the KEF is a new assessment framework that has only been implemented in 2020 **(Figure 11)**. Its roots can be traced back to 2014, when the government of the United Kingdom asked the Higher Education Funding Council for England (HEFCE) to develop a knowledge exchange performance framework. A group chaired by Professor Trevor McMillan, the vice chancellor of Keele University, subsequently submitted a report on principles and good practice to the government in 2016. The government formally announced the creation of the KEF in 2017 and a technical advisory group was formed to advise on the metrics that would be included in it. When announcing the government's decision, former Science Minister Jo Johnson said 'it is noteworthy that the UK university system has public frameworks to track two of the missions of universities – the REF for research and the Teaching Excellence Framework (TEF) for teaching outcomes – but nothing for the third mission of knowledge exchange and engagement.' A consultation and a pilot exercise were launched in 2019, and the first iteration of the KEF will be conducted in the second half of 2020.

Figure 11. Timeline of the development of the Knowledge Exchange Framework in the United Kingdom

Source: Research England (UK)

Although Hong Kong does not have an assessment framework for knowledge transfer that is comparable to the KEF in the United Kingdom, knowledge transfer forms part of the assessment in the University Accountability Agreement (UAA). The UAA was created by the UGC in 2016 to increase universities' accountability, and it contains both sector-wide performance measures and institution-specific KPIs. The UAA covers five domains: 1) quality of teaching and learning, 2) quality of research, 3) knowledge transfer, 4) internationalisation, 5) financial health and institutional sustainability. However, compared to the KEF, the UAA's sector-wide performance measures for knowledge transfer are much less comprehensive **(Table 7)**. More importantly, it is unclear how universities will be held accountable under the terms of the UAA, as it is not tied to funding allocation.

Table 7. Comparison of KPIs related to knowledge transfer evaluated in the UAA and the KEF

	University Accountability Agreement (UAA) (sector-wide performance measures)	Knowledge Exchange Framework (KEF)
IP income	Total IP income received by the university proper	Licensing and other IP income as a proportion of research income
Spin-offs	N/A	Average external investment per formal spin-off
	N/A	Estimated current turnover of all active firms per active spin-off
	Net income from start-ups	N/A
Collaborative research	N/A	Co-authorship with non-academic partners as a portion of total outputs
Income from collaborative / contract research	Total income from collaborative research and contract research	Contribution to collaborative research as a proportion of public funding
		Contract research income with non-SME / SME business / the public and third sector normalised for institution size by higher education institution (HEI) income
Start-ups	N/A	Graduate start-ups rate by student full-time equivalent (FTE)
Local development	N/A	Regeneration and development income normalised for institution size by income

Sources: University Grants Committee, Research England (UK)

Recommendation 1B : Enhance the assessment framework for universities' knowledge transfer activities

Therefore, this report recommends that the **UGC enhance the assessment framework for universities' knowledge transfer activities so that is comparable to the KEF in the United Kingdom**. This can be done either by strengthening the knowledge transfer component of the UAA by referring to the KEF to fill in the gaps in the UAA **(Table 8)** or by creating a new knowledge exchange assessment exercise that is equivalent to the QAC audits for teaching and the RAE for research. The UGC should also observe how the KEF ensures that the metrics allow fair and equal assessment by weighting each university's performance by its size and research income. For example, instead of measuring the total income from collaborative research as the UGC does currently, the KEF measures the contribution to collaborative research as a proportion of public funding. In addition, the UGC should work in close proximity with each university to ensure that the enhanced assessment framework for knowledge transfer will not unduly increase the administrative burden for universities and faculty members. Enhancing the assessment framework for knowledge transfer would facilitate a constructive competitive dynamic between universities that would incentivise them to take their third mission more seriously.

Table 8. Recommendations for new knowledge transfer KPIs in the UAA

1. Average external investment per formal spin-off
2. Estimated current turnover of all active firms per active spin-off
3. Co-authorship with non-academic partners as a portion of total outputs
4. Graduate start-up rates by student (FTE)
5. Graduate social enterprise rate by student (FTE)[1]

Note: [1] This is altered from the KEF to fit the specific context in Hong Kong.

Recommendation 1C : Increase knowledge transfer funding and link universities' knowledge transfer performance to funding allocation

Currently, there are two pots of money related to knowledge transfer provided by the Government. The first is the HKD 8 million per year that the Innovation and Technology Fund (ITF) provides for each TTO in a university.[7] The second is the UGC's earmarked funding for knowledge transfer, which, in the 2016–19 triennium, is valued at HKD 62.5 million per year for all universities. When combined, these two pots of money would be worth HKD 110.5 million per year. It should be recognised, nonetheless, that even at HKD 110.5 million per year for all eight universities in Hong Kong, the amount remains insufficient to effectively encourage a culture that is conducive to knowledge transfer on campuses. As a point of reference, the Office of Technology Licensing at Stanford University alone had an operating expense, excluding patent expenses, of approximately HKD 63 million in the 2019 financial year. Meanwhile, Oxford University Innovation, the technology transfer arm of the University of Oxford, similarly had an operational budget of HKD 62 million in the 2019 financial year. Therefore, to fully support universities' efforts, **the Government should significantly increase the recurrent funding for knowledge transfer**. On top of that, to increase the incentive for each university to realise their third mission, **the allocation of the increased recurrent funding should be tied to the university's performance in the enhanced assessment framework laid out above**. This arrangement would be similar to how the research portion of the block grant is partially allocated according to university's performance in the RAE.

[7] This was doubled from HKD 4 million per year for each technology transfer office to HKD 8 million since the 2019-2020 financial year.

Nevertheless, to maximise the incentive for universities and TTOs to pursue knowledge transfer, **TTOs should be allowed to keep a percentage of the net profit generated from their university's IP, with the percentage determined based on the enhanced assessment framework**. By transforming TTOs into profit centres, **universities and the Government would gradually support TTOs to become financially independent entities**, as TTOs are able to generate sufficient revenue if a culture that is conducive to knowledge transfer develops on campuses. This model would be similar to those of Oxford University Innovation and Imperial Innovations, which are the technology transfer arms of the University of Oxford and Imperial College respectively. Both companies are financially independent entities separate from their respective institutions. Imperial Innovations was even listed on the Alternative Investment Market of the London Stock Exchange before being bought by IP Group, a British-based IP business investing in university spin-off technology companies, which will be further discussed in Chapter 5. In Chapter 3 of this report, we will further analyse the performance of TTOs and provide recommendations on how to strengthen them.

CHAPTER 2

Enhance IP Mobilisation in Universities

Research and teaching activities in universities often generate results in forms such as inventions, publications, and prototypes that are protectable by IP law. According to the World Intellectual Property Organization, an institutional IP policy is a prerequisite for successful collaboration between academia and commercialisation partners. An IP policy typically deals with issues such as ownership of and right to use IP; procedures for identification, evaluation, protection, and management of IP; and guidelines on the sharing of profits from successful exploitation of IP. It is important that the IP policy supports innovation and development by encouraging researchers to exploit inventions so that the potential benefits to society are realised.

Although Hong Kong is regarded as home to some of the world's leading universities, many overseas institutions have taken greater leaps forward, experimenting with generous terms that drive innovation and knowledge transfer. Furthermore, providing flexibility to increase research commercialisation will enable Hong Kong universities to remain competitive in terms of innovation. The union of top intellectual talent, critical infrastructure, and funding into meaningful partnerships has enabled academic personnel to lead innovation pipelines globally. By providing flexible and attractive terms for professors and researchers, universities can encourage talent to engage in the translation of innovative research into new or enhanced products and services.

Conservative Patent Ownership Policies

A patent is a form of IP protection that gives its owner the right to exclude others from making, using, selling, or importing the invention or know-how in a particular jurisdiction. While a variety of patent ownership frameworks are employed in economies such as the United Kingdom and Canada, Hong Kong universities trail behind with more conservative terms. For example, patents that are owned by the University of Cambridge in the creation stage can be transferred to inventors in the filing stage when commercialised through personal efforts. The University of Toronto also outlines clear roadmaps for purchasing patents. At the time of creation, the University of Toronto adopts a joint-ownership model with inventors, but the 'Inventor's Choice' policy allows inventors to assume full ownership if independently commercialised. The University of Waterloo is the most generous runner in this space, empowering inventors with patent ownership in both the creation stage and the filing stage. In mainland China, there are also cities pioneering aggressive IP policies. For example, in August 2020, Shenzhen stipulated that higher education institutions and research institutes should give the principal investigators or their team the IP ownership or the long-term licensing right of results generated from projects primarily or fully funded by the government. In contrast, patents in Hong Kong universities are owned by universities unless inventors buy out the patent and recover all costs related to research, filing, and legal fees **(Table 9)**.

Table 9. Patent ownership policies among selected universities

University	Patent ownership (creation stage)	Patent ownership (filing stage)
HK universities	Owned by university	Owned by university unless inventors buy out the patent at a price that covers costs of research, patent filing, legal proceedings, etc.[1]
University of Cambridge (UK)	Owned by university	Owned by inventors if commercialised via their own efforts
University of Toronto (Canada)	Owned jointly by university and inventors	Owned by inventors if commercialised via their own efforts
University of Waterloo (Canada)	Owned by inventors	Owned by inventors
Karolinska Institutet (Karolinska Institute, Sweden)	Owned by inventors	Owned by inventors
Università di Bologna (University of Bologna, Italy)	Owned by inventors	Owned by inventors

Note: [1] Some local universities provide further flexibility. For instance, if the inventor develops a spin-off, HKUST accepts 3% of the company's shares under the HKUST Entrepreneurship Program and transfers the ownership of a patent at a low cost when specified requirements are met.
Sources: Policy guidelines from each university

Some universities in Hong Kong have started experimenting with new models and practices in order to support research commercialisation. For instance, HKUST may decide to transfer the ownership of a patent to the inventor or an assignee if they meet specified milestones and utilise the IP in an effective and responsible manner. According to the HKUST Technology Transfer Center, the assignee needs to demonstrate conditions including the commitment to economic and social benefits in the commercial exploitation of the IP in line with HKUST's mission, and the ability to raise funds and achieve minimum sales in a certain period of time. However, some stakeholders we interviewed mentioned that the patent ownership policies in some universities are less transparent or set a high price that includes a significant amount of research cost, thus discouraging further development of inventions.

RECOMMENDATION 2.

Enhance IP mobilisation by offering more flexibilities and options for researchers to commercialise their research

Recommendation 2A : Provide clear guidelines and flexible policies on patent ownership

In view of this, we recommend that **Hong Kong universities provide clear guidelines and flexible policies on patent ownership and buyouts**. Transparent communication and open dialogue about the pricing process among inventors, investors, and institutions should determine a patent buyout price that is beneficial for all parties involved. **From the early stages, universities can offer their licensees, which can be the inventors, the investors, or other third parties such as R&D centres, the first right to buy out patents**. Universities can offer prices associated with direct patent expenses, such as patent registration and attorney fees, or consider transferring the patent ownership in exchange for company equity if a spin-off company demonstrates its ability and commitment to economic and social benefits.

Unattractive Licensing Terms

Overseas universities' generous proprietorship terms similarly extend to their licensing revenue-sharing agreements. Licensing revenue is any payment made to an IP holder for the right to use the IP. Generally speaking, distribution of revenue depends on whether the university or the inventor pays the cost for the patent filing. In Canada, the University of Waterloo guarantees inventors 100% of revenue from independent commercialisation, while the University of Toronto allows inventors to take up to 75% of the revenue. In the United Kingdom, inventors at the University of Cambridge receive 100% of the first GBP 75,680 and 85% of revenue above that. Hong Kong universities produce slim margins for inventors, by comparison, delivering only 25% to 50% of the revenue from university-led commercialisation processes. Furthermore, in Hong Kong, independent commercialisation activities yield disparate revenue-sharing returns for inventors at between 33 % and 80 % of the revenue **(Table 10)**.

Table 10. Revenue-sharing policies of selected universities

University	Revenue sharing	
	Patenting through universities (university : inventors)	Patenting through inventors (university : inventors)
HKU	The university, the relevant department, and the inventor will share the revenue equally	
CUHK	45 (university) : 30 (faculty) : 25 (inventor)	15 (university) : 10 (faculty) : 75 (inventor)
HKUST	50 : 50	20 : 80
PolyU	55 (university) : 10 (faculty) : 35 (inventor)	33 (university) : 33 (faculty) : 33 (inventor)
CityU	70 : 30	50 : 50
University of Cambridge (UK)	Inventors receive 90% of first GBP 151,359, 60% of next GBP 151,359, and 34% above GBP 302,718	Inventors receive 100% of first GBP 75,680, and 85% above that
University of Toronto (Canada)	40 : 60	25 : 75
University of Waterloo (Canada)	25 : 75	0 : 100

Note: [1] The University of Cambridge adjusts the funding threshold regularly. The numbers in the table are as of 31 August 2020.
Sources: Policy guidelines from each university

Recommendation 2B : Increase incentives in licensing terms and revenue-sharing policies

The licensing terms and revenue-sharing policies in universities should support and encourage researchers who would like to commercialise their research results. Therefore, we recommend that **universities in Hong Kong increase the portion of licensing revenue received by inventors**. HKUST provides relatively attractive incentives, and other local universities are encouraged to meet or even exceed this benchmark. As universities possess considerable institutional autonomy, and no single model can be applied across all institutions from different countries, universities should explore and experiment with the most suitable and lenient licensing terms and licensing revenue-distribution ratios to provide researchers with more incentives to conduct knowledge transfer.

Insufficient Flexibility in Licensing Terms

As mentioned in Chapter 1, spin-offs are a specific subset of start-ups in which the companies utilise technologies discovered in the university. When a spin-off company is created, IP generated by the university is usually licensed to the spin-off. Most of the spin-off companies have limited cash flow and can hardly pay universities a huge licensing fee or cost of patent. Thus, if the inventor chooses to develop spin-off companies, some local and overseas universities (including HKUST and Stanford University) accept a small, minority share of equity in the company as part of the financial terms of the licence or as a return for other entrepreneurial support. HKUST accepts 3 % of the spin-off company's shares under the HKUST Entrepreneurship Program, while Stanford University accepts equity, which is typically less than 5% ownership, as part of the licensing term. Yale University also provides attractive licensing terms, such as replacing upfront payment for the licence with a liquidity event. According to Yale University's Office of Cooperative Research, the 'liquidity event' payment is 1 % of the company's value upon sale or initial public offering (IPO), but this can be significantly reduced if companies have paid patent expenses and other bills on time.

Recommendation 2C : Support spin-off companies with more flexible financial terms

Universities in Hong Kong can take note of the above-mentioned **flexible approaches to supporting spin-off companies, such as accepting a small share of equity as part of the financial terms**. In other words, universities could allow spin-off companies to pay their licensing fee with the companies' equity stake, as part of the licensing agreement. Although there is no golden ratio, the principle is that universities should help to minimise the financial pressure of spin-off companies, which need to ration their precious equity and cash at early stages.

Restrictive Guidelines for Outside Practice

Beyond IP policies, other rigid bureaucratic policies within Hong Kong universities similarly discourage faculty members and staff from commercialising their research. Institutions provide little flexibility to professors and staff members by restricting their time spent and income earned on outside practices, clinical services, and consulting. These are deemed as 'one day per week' activities, as academic personnel are permitted to use only four days per month and a fifth of their workload to pursue such professional work. According to the UGC, all institutions limit faculty and staff members to spending less than an equivalent of one day per week in a year of 52 weeks, inclusive of holidays and annual leave, on pursuing outside practice **(Figure 12)**. This indicates that staff members face restrictions on their amount of outside work even during their holidays and annual leave. These policies within academic institutions effectively deter bright minds from driving knowledge transfer and catalysing innovation.

Figure 12. ‘One day per week’ activities among HK universities

All institutions limit the extent to which a staff member may spend time on outside activities. Limits include:

4 Days
per calendar month

1/5
of the staff member’s full time workload

≤ 1 day per week in a year of 52 weeks inclusive of holidays / annual leave

University Grants Committee

Source: *Financial Affairs Working Group Report*, UGC (2013)

Academic institutions abroad, by comparison, have been active in incentivising researchers to increase research commercialisation. MIT states:

> **“The Institute’s policies governing outside professional activities are designed to encourage active participation in research enriched in many cases by interaction with industry, business, government, and other activities and institutions.”**

Source: ‘Outside Professional Activities’, MIT Office of the Vice President for Research

> **“The obligation inherent in full-time service is difficult to define since, in academic life, it means far more than a stated number of hours per week… This obligation, therefore, must remain loosely defined, depending upon principle rather than formula.”**

Source: ‘4.3 Full-Time Service’, MIT Policies and Procedures

Since 2015, MIT professors have had full autonomy over the hours they spend on outside professional activities, and staff members are only obligated to report the nature of their professional activities to prevent conflicts of interest.

Recommendation 2D : Relax outside practice regulations and expand hours for knowledge transfer activities

Knowledge transfer from universities represents a key pillar in driving an economy's innovation and economic growth. By recognising the emphasis on intellectual flexibility within other elite research institutions worldwide, academic bodies in Hong Kong hold the ability to close the innovation gap. In view of this, this report recommends that **outside practice regulations should be revised to foster activities that encourage knowledge transfer mechanisms**. Relaxing restrictions on the academic community and expanding the hours available for knowledge transfer activities will engage more research talents to conduct knowledge transfer and research commercialisation. For instance, **activities related to knowledge transfer should at least be allowed during holidays and annual leave**. As a result, professors and researchers would have more freedom in arranging their professional lives and fulfilling universities' third mission of knowledge transfer.

CHAPTER 3

Improve University Research Commercialisation through Technology Transfer Offices and Technology Transfer Alliance

Technology transfer units of universities are the bridges between universities and industry, and they are key infrastructure for knowledge transfer and commercialisation. In Chapter 1, under Recommendation 1C, this report has already touched upon TTOs and has put forward the following suggestions:

1) The Government should substantially increase the recurrent funding for knowledge transfer.
2) The allocation of the increased funding should be tied to universities' performance in the enhanced assessment framework.
3) Each TTO should be allowed to keep a percentage of net profit generated from the university's IP, with the percentage determined by their performance in the enhanced assessment framework.
4) Universities and the Government should support TTOs to gradually become financially independent entities.

In this chapter, we will further analyse the performance of TTOs and provide recommendations on how to strengthen them.

Technology transfer units can be organised in the form of TTOs (such as those at MIT, Stanford University, and CUHK), technology transfer companies (TTCs) owned by the university (such as Oxford University Innovation, Cambridge Enterprise, and HKUST R and D Corporation), or a mix of both (such as at HKU). In addition to those that operated and financed independently from the university administration, some technology transfer units are even acquired by or in collaboration with IP Group. This will be elaborated on in Chapter 5.

In general, TTO personnel provides administrative support for researchers, including but not limited to patent filing and management; explores the commercial potential of research output; offers business and legal consultancy; and liases with technology seekers, investors, and other external parties. Some TTOs have also established their own business networks and entrepreneurial funding schemes, to enable university researchers to promote and commercialise their outputs, and to enable the industry to identify their needs and liaise with university research partners. Above the TTOs and TTCs, the Committees on Technology Transfer or Boards of Directors supervise and advise the work of TTOs and TTCs.

Lack of External Representation in Technology Transfer Units

Unlike their counterparts in many world-leading universities, the TTOs and the committees that supervise the TTOs in Hong Kong universities lack external representation. On the Boards of Directors or Committees on Technology Transfer in the top universities in Israel and the United Kingdom, external members, such as business leaders, entrepreneurs, and scientists, account for a significant proportion of members. Particularly in Israel, external members may even constitute more than half of the Board or the Committee, while university representatives take fewer than half of the seats. On the contrary, in Hong Kong, committee members are mostly university professors or staff **(Table 11)**. Therefore, it is difficult for these committees to gauge market needs and to effectively guide and advise universities in pursuing knowledge transfer and commercialisation.

Table 11. The composition of Technology Transfer Committees (as of June 2020)

	Israel	UK	HK
Boards of Directors / Committees on Technology Transfer	University professors and staff (<50%)  Business leaders, scientists, and entrepreneurs (>50%)	University professors and staff (50–75%)  Business leaders, scientists, and entrepreneurs (25–50%)	Mostly composed of university professors and staff

Note: [1] The Israeli universities selected for comparison include The Weizmann Institute of Science, The Hebrew University of Jerusalem, and Tel Aviv University. The UK universities selected for comparision include the University of Oxford and the University of Cambridge.
Sources: Universities' websites

A similar problem arises when we consider technology transfer units only. While the technology transfer teams in Israeli and United Kingdom universities are largely composed of PhD degree holders, with diverse backgrounds in a combination of science and business, their counterparts in Hong Kong are, unfortunately, mainly made up of administrative staff **(Table 12)**. This lack of business and industry experience has largely restricted the capabilities of TTOs, making some TTOs no more than administrative offices and limiting their roles to mostly patent filing and management.

Table 12. The composition of Technology Transfer Offices (as of June 2020)

	Israel	UK	HK
Team	• PhD holders in science (20–50%) • Combined background in science and industry • Talents in business development, IP, and tech management, etc.	• PhD holders in science (35–70%) • Combined background in science and industry • Talent in business development, IP, and tech management, etc.	Most are administrative staff

Note: [1] The Israeli universities selected for comparison include The Weizmann Institute of Science, The Hebrew University of Jerusalem, and Hadassah Medical Center.
The UK Universities selected for comparision include the University of Oxford, the University of Cambridge, and Imperial College London.
Sources: Universities' websites

Moreover, on average, there is less professional support provided by Hong Kong's TTOs than by their counterparts elsewhere in the world. The number of professional staff in TTOs, which excludes administrative, finance, and IT personnel, per 100 faculty members, is much lower in Hong Kong universities than in top universities in the United States and the United Kingdom **(Figure 13)**. Insufficient professional support may largely restrict TTOs' capabilities in technology transfer. Research commercialisation requires not only inputs from researchers, but also adequate business and legal support from TTOs.

Figure 13. Number of professional staff in TTOs per 100 faculty members (as of June 2020)

Massachusetts Institute of Technology	2.7
University of Oxford	3.0
University of Cambridge	3.9
California Institute of Technology	6.7

vs.

The Hong Kong University of Science and Technology	1.6
The University of Hong Kong	2.0
The Chinese University of Hong Kong	2.8

Notes:
[1] We define professional staff as all staff minus administrative, finance, and IT staff.
[2] Instead of faculty members, the University of Oxford and the University of Cambridge report the number of academic staff, which results in slightly underestimated numbers in this table.
Sources: Universities' websites

RECOMMENDATION 3.

Improve university research commercialisation through Technology Transfer Offices and a Technology Transfer Alliance

Recommendation 3A : Recruit external talent for technology transfer management

We recommend **recruiting more professional and external talent for technology transfer management**.

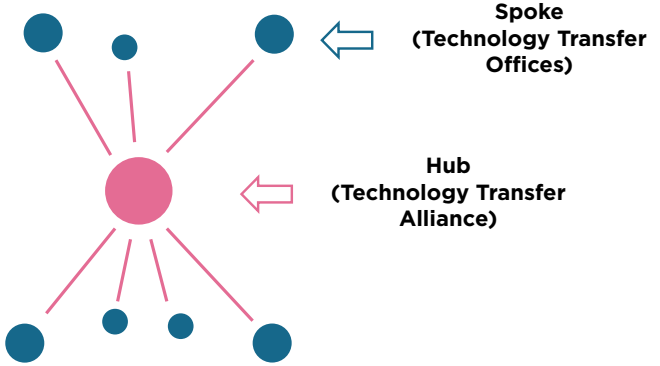
On one hand, the universities should invite more external members, including successful entrepreneurs, business leaders, and investment experts, to join the Committees on Technology Transfer. On the other hand, **the leadership teams of TTOs themselves should have diverse backgrounds in a combination of science and industry. The universities should also recruit more professionals for TTOs**, in particular legal and technology management experts, who can provide dedicated support for researchers. According to the stakeholders we interviewed, there are currently very few legal professionals in Hong Kong who specialise in IP protection. As a result, having more legal and technology management professionals in TTOs would improve IP protection for universities and researchers.

Recommendation 3B : Establish an alliance of technology transfer offices

Another recommendation to strengthen the knowledge transfer infrastructure in Hong Kong's universities is to **establish an alliance of TTOs, or a technology transfer alliance (TTA)**. TTAs help realise the benefits of economies of scale in TTOs, leading to the bundling of inventions across universities, lower operation costs, and better access to personnel with superior commercialisation expertise. In 2013, the Organisation for Economic Co-operation and Development (OECD) introduced this organisational structure as a 'hub-and-spoke' model, where a TTA serves as the 'hub' in between the 'spokes' of TTOs **(Figure 14)**.

Figure 14. Technology Transfer Alliance: 'hub-and-spoke' model

Technology Transfer Alliance 'hub-and-spoke' model



Strategic bridge between universities and the industry

1. One-stop shop for technology offers
   One central contact point for firms
2. Network of information and experts
3. Technology transfer sharing and training
4. Annual reviews, strategy planning,
   and consistent policy implementation

Source: OECD

While TTAs have increasingly become a global trend **(Table 13)**, the management and ownership of TTAs vary across countries. Some TTAs are initiated and managed by the government, such as Knowledge Transfer Ireland (KTI) in Ireland and Innovate UK's Knowledge Transfer Network (KTN) in the United Kingdom, while some are consortiums among universities, research institutes, and relevant associations, such as TransferAllianz in Germany and the Israel Tech Transfer Network (ITTN) in Israel.

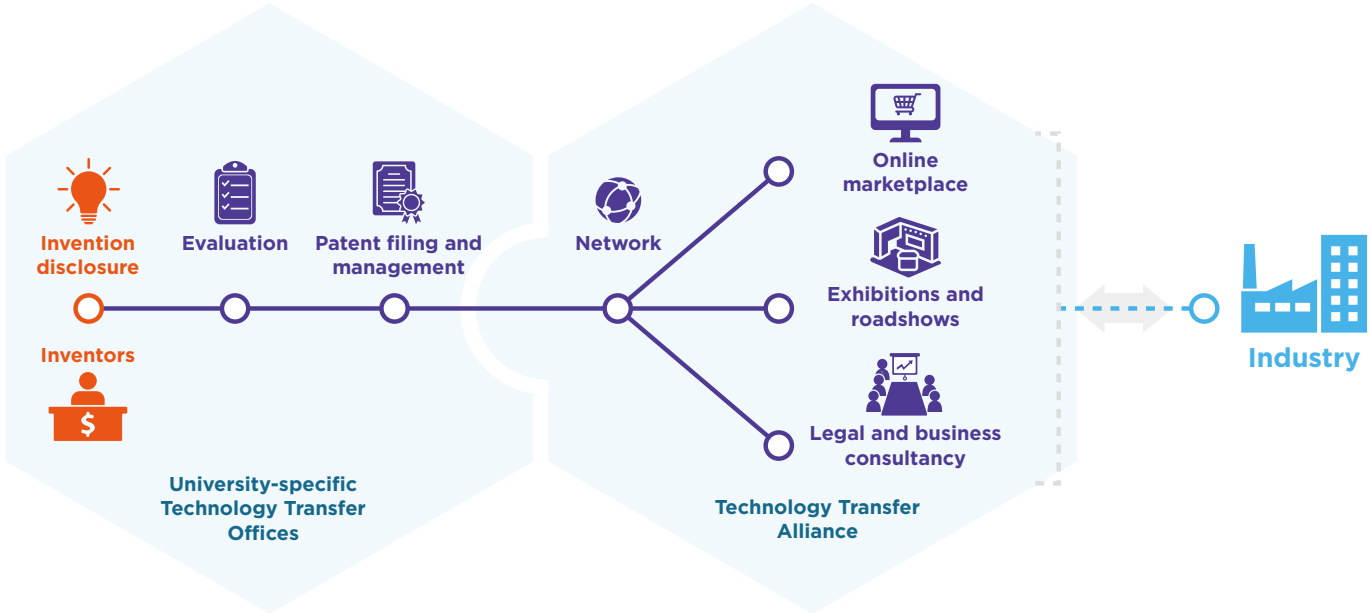
Table 13. A global trend of TTA

Country	Germany	Italy	Israel	Ireland	UK	Switzerland
Name of TTA	TransferAllianz	NETVAL	Israel Technology Transfer Organization (ITTN)	Knowledge Transfer Ireland (KTI)	Knowledge Transfer Network (KTN)	Advanced Manufacturing Technology Transfer Centers
Year of establishment	1994	2002	2004	2013	2014	2019

Sources: The respective transfer alliances' websites

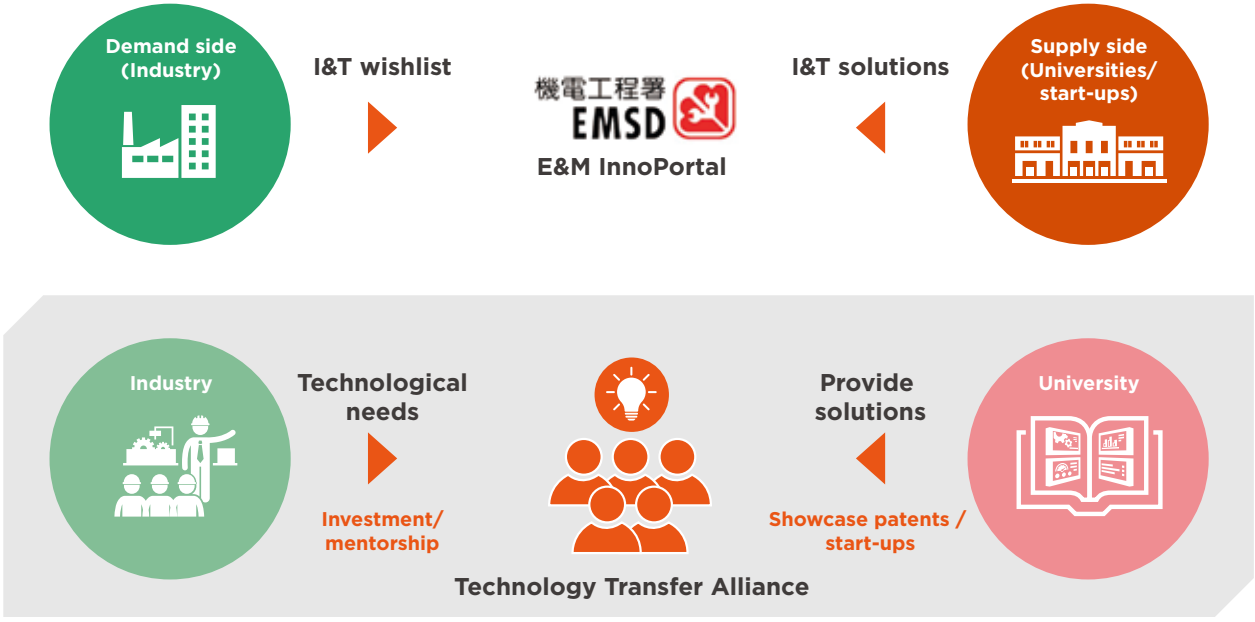
With a TTA in place, the TTOs and the TTA will be able to specialise in different functions **(Figure 15)**. The TTOs will focus more on the earlier stages of research commercialisation, that is, invention disclosure, research evaluation, and patent filing and management. Meanwhile, the TTA will concentrate on the later stages of technology transfer, namely establishing and maintaining a university–industry network, by developing an online marketplace and providing a platform for exhibitions and roadshows as well as legal and business consultancy.

Figure 15. Functions of TTOs and TTA



A successful reference for establishing an online platform is the E&M InnoPortal, launched and managed by the Electrical and Mechanical Services Department (EMSD) in Hong Kong. Such a platform facilitates the process of matching technological demands with technological solution supply. The E&M InnoPortal collects and consolidates technology demands from various government departments, public bodies, and the E&M industry, and matches them with technology solutions from tech start-ups, universities, and R&D centres. Similar to this arrangement, a TTA could develop an online and offline marketplace as a platform for connecting technological needs from the industry with potential solutions from universities **(Figure 16)**.

Figure 16. TTA: Strengthening collaboration between industry and universities

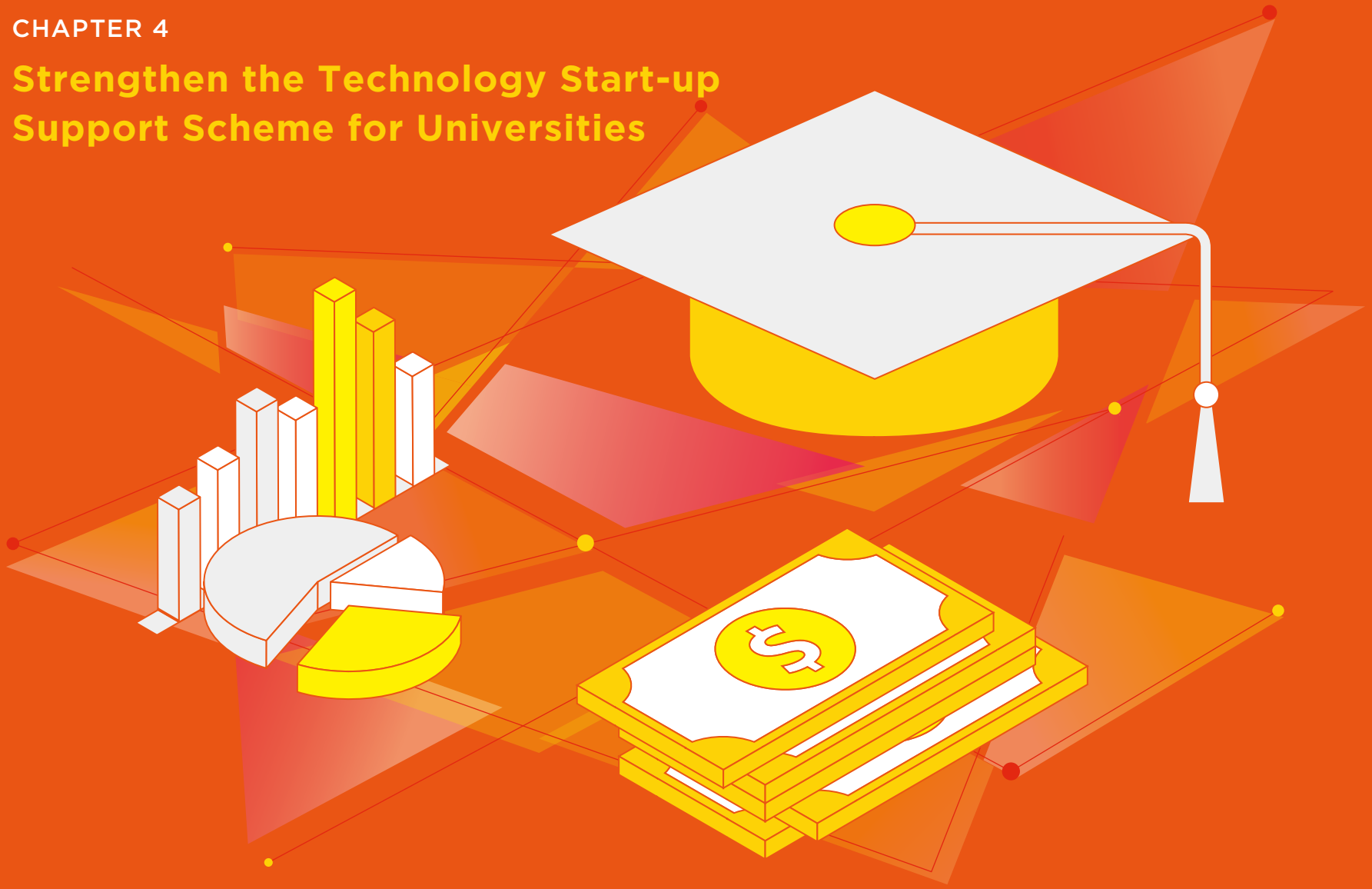


Source: Electrical and Mechanical Services Department

Moreover, Hong Kong lacks professionals with technology transfer and management expertise. With a TTA in place, we could better pool these limited yet critical resources and exploit the synergies of collaboration, increase visibility for industry partners, and reduce operational and marketing costs for universities. Therefore, we recommend the Government, in a joint effort with local universities, establish an alliance among TTOs. There are several options for a TTA location, such as the Hong Kong Science and Technology Parks (HKSTP), Cyberport, or a separate venue co-owned and co-managed by the universities. A TTA would better connect university research with industries, provide tech transfer best-practice sharing and training for each TTO, establish an online platform, and host exhibitions to liaise between technological offers from universities and needs from the industry.

CHAPTER 4

Strengthen the Technology Start-up Support Scheme for Universities



As well as the technology transfer units of universities, a comprehensive technology start-up support scheme can facilitate knowledge transfer effectively. The Technology Start-up Support Scheme for Universities (TSSSU) was launched in Hong Kong in 2014 under the Innovation and Technology Fund (ITF), with the aim of encouraging and supporting students and faculty members in universities to establish technology start-ups or commercialise their R&D outcomes by forming spin-offs. An annual funding of up to HKD 8 million is provided to each of the six UGC-funded universities,[8] and each funded start-up may receive up to HKD 1.5 million each year for up to three years. A technology start-up is eligible for TSSSU if the team forming the start-up consists of any mix of students, including alumni, and faculty members.

In total, across all six universities, TSSSU has disbursed HKD 142.6 million to 240 start-ups from the 2015/16 academic year to the 2019/20 academic year. Now going into the sixth year of its implementation, TSSSU has generally been well received. The scheme has been credited with fostering a stronger entrepreneurial culture on campuses and incentivising the commercialisation of R&D outcomes. Despite its success, we believe TSSSU still has room for improvement. As TSSSU has remained largely unchanged since its establishment six years ago, it is now timely for it to perform an in-depth evaluation of the scheme and review how it could be enhanced to further promote technology entrepreneurship in local universities.

[8] The University of Hong Kong, The Chinese University of Hong Kong, The Hong Kong University of Science and Technology, The Hong Kong Polytechnic University, The City University of Hong Kong, and The Hong Kong Baptist University

RECOMMENDATION 4.

Strengthen the Technology Start-up Support Scheme for Universities

Recommendation 4A : Strengthen entrepreneurship education and training for TSSSU applicants

As the Innovation and Technology Commission (ITC) allows each university to administer their TSSSU funding with a high degree of autonomy, the TSSSU selection process and eligibility vary across universities. Among the six universities, it is worth highlighting the best practice training and education requirements that some universities have implemented. In particular, PolyU has an eligibility requirement that the start-up team must have completed the university's own Lean Launchpad Programme, unless they are already in or have graduated from a recognised external pre-incubation or incubation programme. Outstanding teams from the Lean Launchpad Programme are also given priority in the selection process.

The Lean Launchpad Programme deserves special mention, since the programme is modelled after the National Science Foundation's[9] renowned Innovation Corps (I-Corps) programme in the United States. In essence, I-Corps is a standardised and intensive experiential education programme in entrepreneurship with the aim of encouraging university researchers to commercialise their R&D outputs. The I-Corps curriculum is based on the lean start-up model presented in the best-selling book *The Four Steps to the Epiphany* by Steve Blank, and the programme is characterised by its hands-on and immersive learning. As of spring 2019, 1,315 teams have gone through the I-Corps programme with 644 start-up businesses formed since the programme began in 2012. The success of I-Corps has led other countries, notably Singapore and Ireland, to adopt its model.

[9] The National Science Foundation is an independent agency of the United States government that is responsible for supporting basic research and education in the non-medical fields of science and engineering.

Given the global success of I-Corps, this report recommends that **the I-Crops model is expanded to a territory-wide platform available to all six universities that receive TSSSU funding.** The platform could be run jointly by HKSTP and Cyberport, or the UGC could earmark a portion of TSSSU funding for the introduction of the I-Corps programme at each individual university. Universities should also **encourage prospective TSSSU applicants to apply for the programme** or should even provide incentives, such as prioritising applicants who have completed this programme. Introducing the I-Corps model throughout Hong Kong would ensure that TSSSU applicants are equipped with the necessary entrepreneurship education and training to succeed. Nevertheless, to avoid duplication of resources, applicants who already have sufficient prior entrepreneurial education should not be encouraged to attend the I-Corps programme.

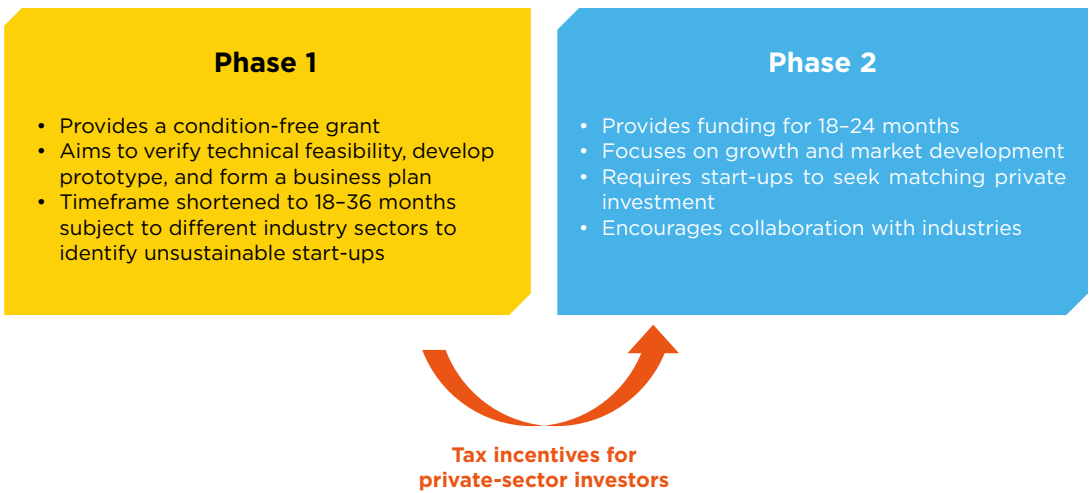
Recommendation 4B : Foster stronger integration with private incubators and accelerators

Another best practice among some universities' TSSSU programmes that should be replicated across all universities is integration with private incubators and accelerators. In 2019, HKU conducted co-assessment with HKSTP, where HKU's TSSSU applications would be simultaneously reviewed by HKSTP for admission into their incubator programmes. CUHK similarly has an option for teams to submit a dual application to HKSTP's incubation programme and CUHK's TSSSU programme. At PolyU, applying teams are required to have been admitted to or have graduated from a qualified pre-incubation or incubation programme, which includes programmes offered by HKSTP and Cyberport. As TSSSU only provides funding for start-ups, the integration of TSSSU with private incubator programmes ensures that start-ups leverage the mentorship resources provided by these incubators and receive comprehensive support to maximise their ability to succeed. Therefore, we recommend that **all universities conduct co-assessment with private incubators and accelerators,** such as HKSTP and Cyberport, to make sure that all TSSSU-funded start-ups will receive maximum support.

Recommendation 4C : Establish two phases of funding to encourage start-ups to seek private investment and foster collaboration with industries

TSSSU funding has been critical to supporting early-stage start-ups from local universities. To meet the growing capital demand from these start-ups, we recommend that the Government increase the funding under TSSSU for each university. In addition, these start-ups must seek private investment in order to stay afloat and succeed in the long run. By seeking private investment, TSSSU-funded start-ups benefit from market validation and opportunities to collaborate with industry partners. According to statistics from the Innovation and Technology Bureau, in 2016/17 and 2018/19, 95 start-ups received a total of HKD 277 million in follow-up investments from either the public or private sector. While the aforementioned statistics are promising, we believe TSSSU should **establish two phases of funding to further encourage start-ups to seek private investment and foster collaboration with industries (Figure 17).**

Figure 17. Recommended two phases for TSSSU



Under the proposed two phases, the primary aim of phase 1 is to allow start-ups to get their company up and running and to serve as a trial period for testing whether the start-up's technology and business model could be successful. As such, under this phase, TSSSU should provide a condition-free grant to fund start-ups rather than using the reimbursement model of its current arrangement. Start-ups often face a severe cash-flow problem so awarding funding by reimbursement is counterproductive to supporting these technology start-ups from universities. The timeframe of this phase should be around 18 to 36 months, subject to the nature and sector of the start-up. **In the second phase, the start-up should be required to seek funding from private investors, which the TSSSU funding will match at a predesignated ratio up to a set ceiling, while the start-up is also encouraged to collaborate with industry partners.** If the start-up fails to garner private investment or secure collaboration with industry partners after phase 1, this would indicate that the commercial viability of the start-up is questionable and it is therefore unsuitable for the continuation of public funding while the start-up considers further developing their product. In a way, the Government would be outsourcing the assessment of whether the start-up deserves the continuation of TSSSU funding to the private market. The funding for the second phase should last for around 18 to 24 months, by which point the start-up should be capable of raising funds by themselves in the private market. Funding during phase 2 should focus on market development and growing the business. Matching private funding with TSSSU funding would enable start-ups that receive market validation to access a deeper pocket, thus helping them to expand further. Meanwhile, collaboration with industries would better guarantee that R&D results are successfully translated into real-world impacts.

Recommendation 4D : Offer tax incentives to encourage private investment in TSSSU start-ups

While encouraging start-ups to seek private investment will facilitate their development, it is equally important that there is a sufficient supply of private capital that is available to be invested in TSSSU-funded start-ups. With limited private investment for start-ups available in Hong Kong in general, private investors are even less willing to fund high-tech start-ups from local universities. This is because they seek short-term investment returns that high-tech start-ups can hardly deliver and they are less familiar with the technologies coming out of universities. To resolve this pressing problem, this report recommends that the Government **offer tax incentives to encourage private investment in TSSSU start-ups**. By doing so, the Government would allocate capital resources to supporting TSSSU start-ups through utilising market mechanisms rather than through public reallocation, which is subjected to bureaucracy and regulations.

We note that some associations and companies, including the Hong Kong Institute of Certified Public Accountants and Ernst & Young, have emphasised the importance of similar tax incentives for investment in early-stage innovation companies **(Table 14)**. Income tax relief for start-up investors is the most suggested option. To ensure an adequate pool of private funds for investing in local technology start-ups, especially TSSSU-funded start-ups, we believe the Government should take action on these recommendations.

Table 14. Tax incentive measures proposed by other parties

Party	Suggestion
Ernst & Young	Corporate and individual taxpayers who can commit a minimum of HKD 500,000 to a qualifying start-up should enjoy a tax deduction of 50% of the amount of the investment in the year they made the investment, subject to a cap of HKD 1 million for each year of assessment.
Hong Kong Institute of Certified Public Accountants	Venture funds and angel investors should be given tax incentives to invest in start-ups.
The Taxation Institute of Hong Kong	Tax incentives such as income exemption or tax credits should be offered to those investing in local start-ups engaged in I&T, subject to certain conditions (e.g. the start-ups must hire a certain percentage of local I&T talent).
Professor Kevin Au, Director of Centre for Entrepreneurship, CUHK	Some of the tax incentives the Enterprise Investment Scheme (EIS) used to encourage angels to invest in private companies can be adopted, including tax relief at the basic rate and income tax relief on losses.

Sources: Measures of tax incentives proposed by Ernst & Young, Hong Kong Institute of Certified Public Accountants, The Taxation Institute of Hong Kong, and Professor Kevin Au

In particular, we think the Government should take note of the schemes offered in the United Kingdom, namely the Enterprise Investment Scheme (EIS) and the Seed Enterprise Investment Scheme (SEIS). According to a report published by the European Commission in 2017, the SEIS and the EIS are ranked first and second respectively in terms of effectiveness of incentivising private investors to invest in start-ups and SMEs **(Table 15)**. Both the EIS and the SEIS enable individual investors to:

1. **claim income tax relief against the amount of income tax they need to pay**
2. **claim the amount of capital loss against their income as loss relief if they incur a loss**
3. **claim capital gains tax relief on any gains made on their investment**

These tax incentives should be carefully designed to take into account of Hong Kong's existing tax structure. The fact that Hong Kong has no capital gains tax places the city in a favourable starting position. Income tax relief should be prioritised as it serves as a foremost measure to address investors' aversion to risk. The provision of loss relief should also be considered to support the reduction of risk of investing in university start-ups.

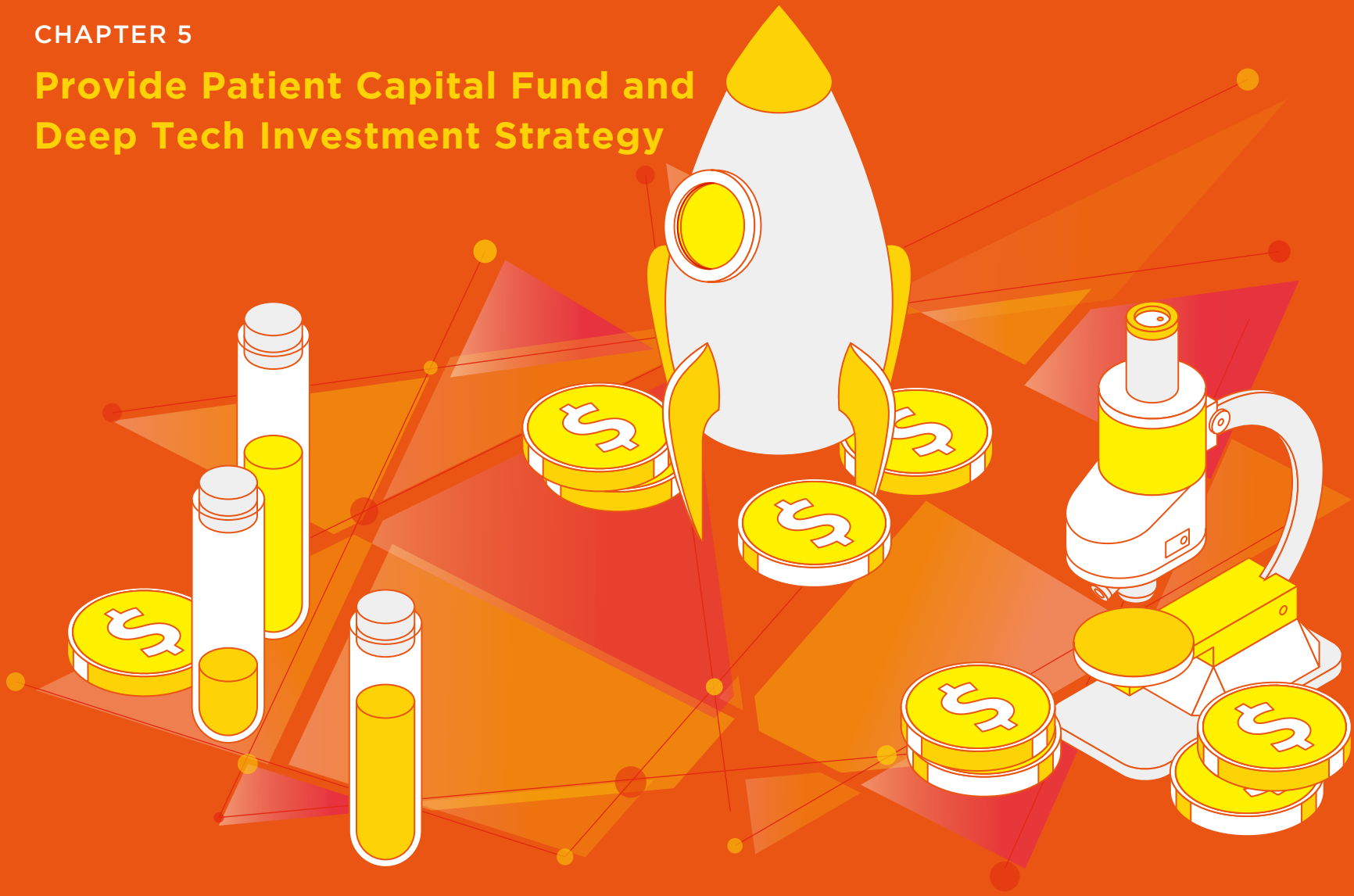
Table 15. Top five tax incentives for private investment in SMEs and start-ups

Rank	Country	Scheme	Income Tax Relief	Loss Relief	Capital Gains Tax Relief
1	United Kingdom	Seed Enterprise Investment Scheme	✓	✓	✓
2	United Kingdom	Enterprise Investment Scheme	✓	✓	✓
3	France	'Madelin' tax reductions	✓	✗	✓
4	United Kingdom	Social Investment Tax Relief	✓	✓	✓
= 5	United Kingdom	Venture Capital Trust	✓	✗	✓
= 5	Germany	INVEST – Venture Capital Grant	✓	✗	✓

Source: European Commission

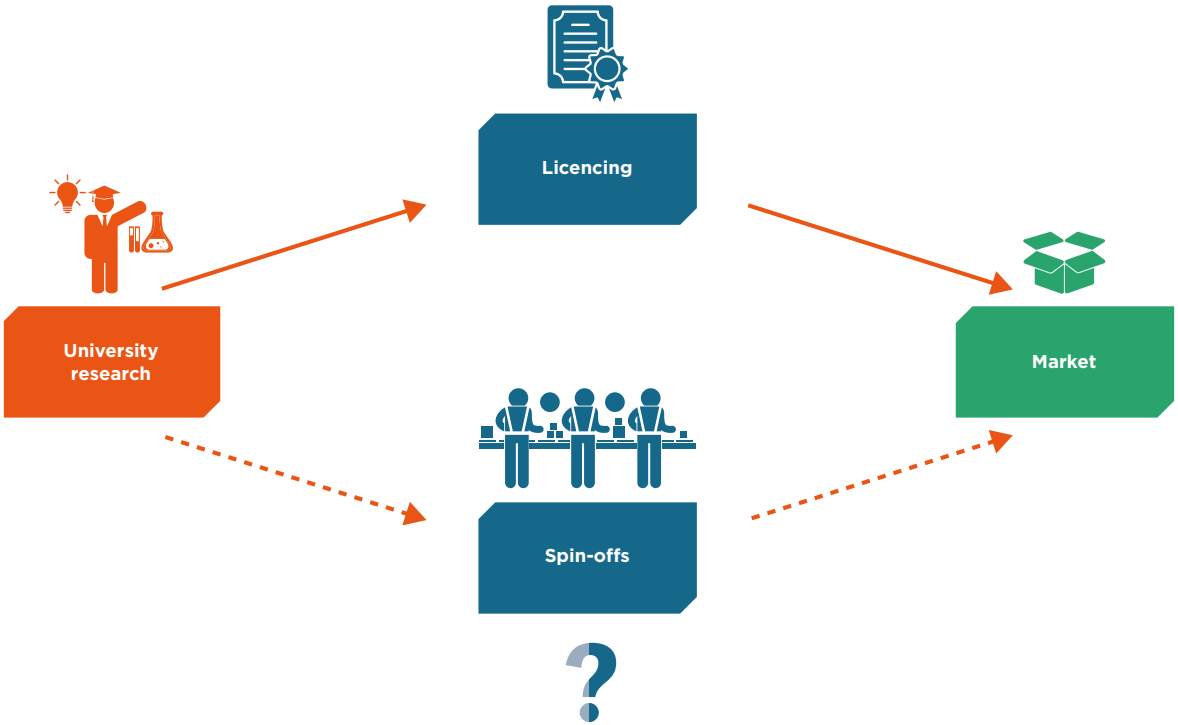
CHAPTER 5

Provide Patient Capital Fund and Deep Tech Investment Strategy



There are two ways of bringing university research to the market **(Figure 18)**. The first is licensing technologies to a third party. In our previous report *Unleash the Potential in Science and Technology Innovation: Develop Hong Kong into an International R&D Powerhouse*, we suggested that the Fraunhofer[10] model could be adopted in Hong Kong to transform basic research into products or services by fostering collaboration between universities and industries. Another approach to commercialising university research is to establish spin-off companies.

Figure 18. Two ways to bring university research to the market



[10] Fraunhofer, Europe's largest application-oriented research organisation, bridges the innovation gap between universities and industry.

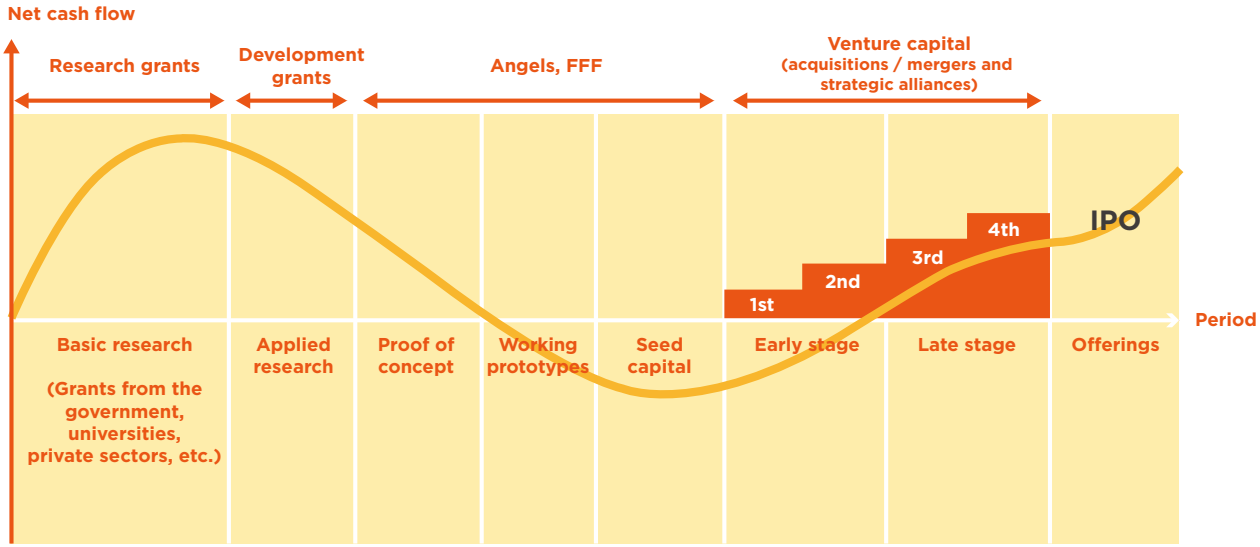
Lack of Patient Capital for Developing Hong Kong's Strengths in Deep Tech

In recent decades, funding vehicles have emerged around the world to provide so-called 'patient capital' for early-stage deep technology companies with long R&D horizons. Deep tech is different from general tech, as it tends to advance scientific and technological frontiers by relying on strong fundamental research, such as biotechnology. According to the report *The Dawn of the Deep Tech Ecosystem* released by Boston Consulting Group (BCG), deep tech has three primary attributes in a business context, which are a big impact, a long time to reach market-ready maturity and a significant amount of capital. Patient capital is the money catering to such lengthy R&D processes and high demand of funding to enable these deep tech ventures to exert social impacts by addressing pressing issues and offering significant technological advances. Hong Kong universities are at the frontier of deep-tech basic research, especially in biotechnology. However, current facilitators such as TSSSU or local private venture capital (VC) firms are unable to provide sufficient necessary support to bring university research from the lab to the market, especially with the limitations in traditional VC funds.

Constraints in Traditional VC Funds

Investing in deep-tech companies is often considered high risk, given the capital-intensive nature and extended timeframe for reaching market-ready maturity. A fairly large amount of capital is allocated to the basic research stage, but the availability of capital decreases over time from applied research to working prototype stage **(Figure 19)**. Although angel investors and VCs can provide financial support to spin-offs, it is still difficult for deep-tech companies to obtain enough funding, both in terms of value and time span. This mismatch has created a funding gap for nurturing deep-tech companies, which strangles them in their cradles. Moreover, traditional VCs generally invest for a five- to seven-year timeframe with a total ten-year fixed-term period. Therefore, they prefer to invest in companies that possess more market-ready technologies. Research by Boston Consulting Group and Hello Tomorrow points out that public-private financing schemes play an increasingly important role to fund deep tech along their life cycles.

Figure 19. Traditional venture capital underserves the market



Source: IP Group

Examples of Failure to Support Spin-offs of Outstanding Local Deep-Tech Research

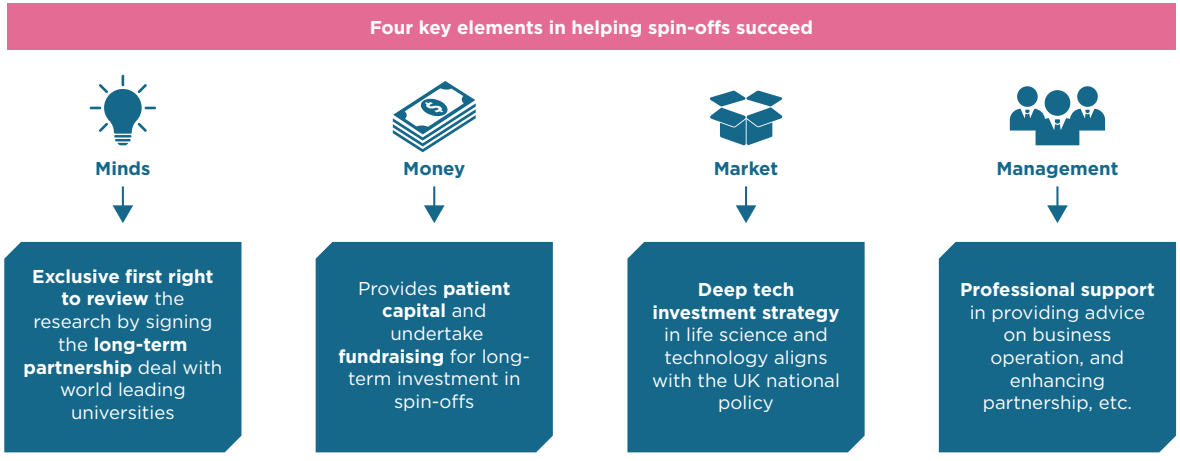
When describing the innovative technology investment environment in Hong Kong, it is commonly said that investing in high-tech will get you into trouble, while investing in low-tech can make you quick money. This has prevented many local investors from investing in deep-tech projects. As a result, Hong Kong has lost many golden opportunities to develop its own story and brand. For example, a PolyU research team has spent years developing an automated multiplex diagnostic system, which can detect 40 pathogens (including COVID-19) within an hour. However, this locally invented product did not get sufficient funding from the Innovation and Technology Bureau at its early commercialisation stage. In contrast, the Shenzhen government has signalled their intent to provide the research team with the necessary funding, as well as manufacturing support. In another case, the 0.25-inch electronic liquid crystal display for Google Glass invented by HKUST also failed to receive any Government support. The research team had spent around ten years inventing, developing, and commercialising this high-resolution small display technology. However, after the disclosure of the invention, no local VCs were interested in investing. A Taiwanese company finally invested in this technology and developed it as a Google Glass display component in 2014.

In light of the constraints of traditional VCs and the insufficient support for university spin-offs, we suggest setting up a professional arm to transform university research into viable deep-tech companies in a more effective and innovative manner.

Introduction of the IP Group Model

A UK-based company, IP Group can serve as a great example for Hong Kong's reference. IP Group is a pioneer in providing patient capital to university spin-offs, evolving disruptive deep tech such as biotech and clean tech into world-changing businesses along the journey from 'cradle to maturity'. According to a report released by the European Association of Research and Technology Organisations in 2017, there are four key elements in developing a successful spin-off company: minds, management, market, and money. The IP Group business model optimally targets these four key elements **(Figure 20)**.

Figure 20. IP Group's features and functions



Sources: European Association of Research and Technology Organisations, IP Group *Annual Report and Accounts 2019*

In terms of 'minds', IP Group pioneered the concept of the long-term partnership model with world-leading universities in the United Kingdom, the United States, Australia, and New Zealand to ensure a continuous pipeline of potentially strong intellectual property across the globe. There are 32 universities partnering with IP Group, 17 from the United Kingdom, 6 from the United States, 8 from Australia and 1 from New Zealand (see examples in **Table 16**). Under these exclusive long-term partnerships, IP Group has the first right to review and invest in the technology developed in the universities. As a result, university spin-offs can have fast access to seed funding, while they are also provided with better post-incorporation support and access to IP Group's network of follow-on investors.

Table 16. Examples of universities partnering with IP Group

United Kingdom Universities	Time
King's College London	25 years deal
University of Bath	
University of Leeds	
United States Universities	**Time**
Columbia University	1.5 years deal
University of Pennsylvania	
Australia / New Zealand Universities	**Time**
The University of Melbourne	20 years deal
The University of Queensland	
UNSW Sydney	
The University of Auckland	

Source: IP Group

In terms of 'money', through its strong partnerships with different universities, IP Group has developed a strong pipeline of compelling deep-tech opportunities and has supported the resulting spin-offs with long-term patient capital to accelerate their growth. For example, for 13 years, IP Group has invested in Iksuda Therapeutics, a biotechnology company spun off from the University of Bath, specialising in the development of next-generation biotherapeutics. Oxford Nanopore Technologies (ONT), a world leader in nanopore DNA sequencing platform, is a spin-off that IP Group has invested in for 15 years (see the case study below). Xeros Technology, a University of Leeds spin-off focusing on reinventing water-intensive industrial and commercial processes, has been invested in by IP Group for 18 years. IP Group's permanent capital structure, which is unconstrained by any traditional fixed-life VC fund approach, enables deep-tech spin-offs to pursue a more ambitious growth plan than would otherwise have been possible.

In terms of 'market', IP Group focuses on game-changing deep-tech sectors. Although there is no generally recognised definition for deep tech, it usually refers to technology that is based on intensive scientific research, backed by patent, and has the potential to have a profound impact on society. IP Group's foresight in life science serves as a good example. IP Group signed a long-term partnership with the University of Bristol due to its strength in medical research.The University of Pennsylvania also built a strong partnership with IP Group to develop translational medicine and therapeutics. In addition to life science, IP Group also touches on advanced materials, engineering, and clean energy. Recently, IP Group established a relationship with the University of New South Wales (UNSW Sydney) to research software defined networking and artificial intelligence. Princeton University also signed an agreement with IP Group to cultivate spin-offs in nanotechnology.

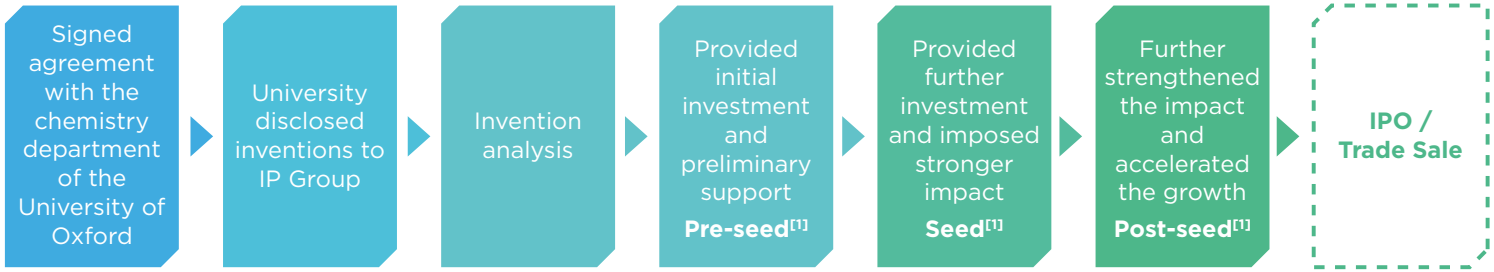
In terms of 'management', IP Group headhunts deep tech and business experts to refine and facilitate the commercialisation process. IP Group provides professional support such as legal consultation, accounting services, and business operation advice to minimise the chances of an early-stage company failing. If companies are developing well in later stages, IP Group also helps spin-offs look for co-investors to further strengthen their partnerships internationally.

Case Study: Oxford Nanopore Technologies (ONT)

Oxford Nanopore Technologies (ONT) is a UK-based company, spun off from the chemistry department of the University of Oxford, which develops the world's first and only nanopore DNA sequencing platform. IP Group signed a 15-year agreement with the university's chemistry department in 2000. It has been investing in ONT in exchange for a stake in the company since 2005, after the technology was disclosed under the agreement. The fair value of ONT has now reached GBP 1,580 million (approximately HKD 15.8 billion). IP Group owns 16.7% of ONT shares and ONT has become the largest portfolio company in IP Group as of end-2019.

There are three phases for IP Group's investment: incubation, seed, and post-seed. In each phase, IP Group provides spin-off companies with capital, professional support, and talent. Since 2005, IP Group has helped find co-investors and assisted ONT in raising more than GBP 550 million. Besides funding support, IP Group provides operational, legal, and business support, and contact with potential partners. With IP Group's help, in 2009 ONT entered into a strategic alliance with Illumina, the world's leading company focused on the analysis of genetic variation and biological function for new DNA-sequencing technology. IP Group has also aided in the recruitment of experienced, high-calibre individuals to lead the business and has worked with the leadership team to improve its performance. Meanwhile, IP Group conducts invention analysis after each phase to see whether the company is still a worthy investment. After years of development, ONT remains in the private market, but it could choose to enter the public market or conduct a trade sale at a later date. The outline of the development process is shown in **Figure 21**.

Figure 21. Outline of the development process of partnership between IP Group and Oxford Nanopore Technologies



Note: [1] Invention analysis will be done right after each step to make sure the company is on track.

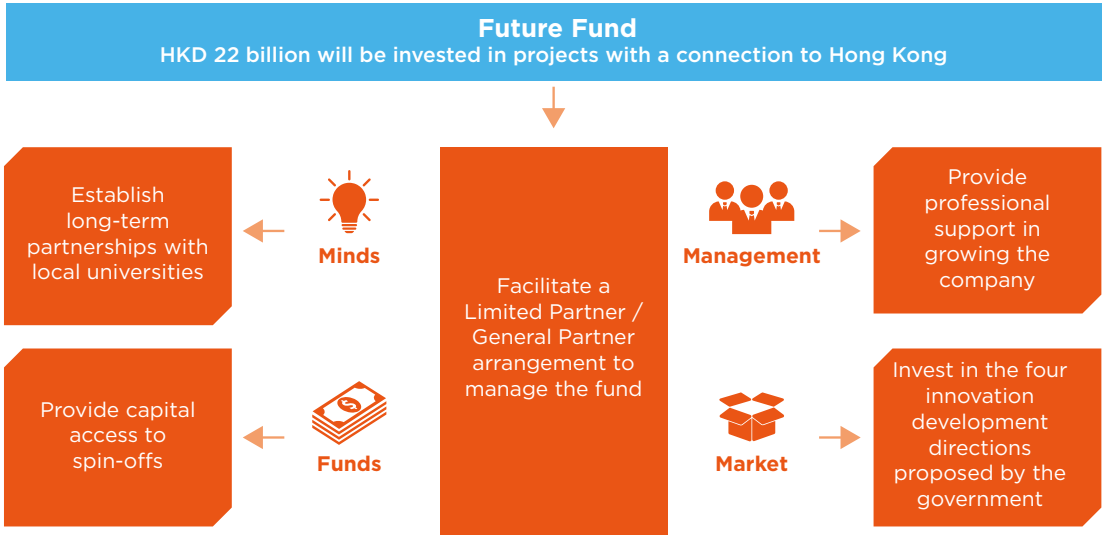
Sources: IP Group, and Oxford Nanopore Technologies

RECOMMENDATION 5.

Utilise the Future Fund to provide patient capital and deep-technology investment strategy to nurture local spin-offs

The Government established the Future Fund (HKD 220 billion) from land sales to prepare for the needs of society in the future. This year, the Government announced that they will invest 10%[11] of the Future Fund (HKD 22 billion) to establish a Hong Kong Growth Portfolio to make strategic investments in projects with a Hong Kong nexus. To strengthen knowledge transfer in Hong Kong, we recommend that the Government facilitate a **classic Limited Partner/General Partner arrangement to manage this portion of the Future Fund, so that deep-tech spin-off companies from local universities can be specifically targeted for patient capital and other relevant support (Figure 22)**.

Figure 22. Utilising Future Fund to faciliate university spin-offs



Source: Government of the Hong Kong Special Administrative Region

[11] From *Summary of Recommendations of the Group of Experienced Leaders on Future Fund* (2020).

Under such a structure, the Government would serve as the limited partner that provides funding, while inviting an independent professional party to act as the general partner representing the Government in managing the funding, on at least two conditions. The first condition is that they **develop long-term partnerships with local universities**, while the second is that they **focus the investment on deep-tech spin-offs from universities**. The universities will benefit from forming long-term partnerships, as they will be able to translate their scientific research into market-ready products or solutions and generate greater knowledge spillover and social and economic impacts. In addition, if scientific research generated in the lab can be spun off into viable companies, universities will be able to receive more IP income.[12] Furthermore, the Future Fund **should align its investment strategies for deep tech with the overarching I&T strategies as advised by the Chief Science and Development Officer**. As further discussed in Chapter 6, we recommend the Government establish a Science and Development Office (SDO) chaired by the Chief Science and Development Officer, which would advise the Government on formulating overarching strategies for Hong Kong's science and technology innovation development. Standing at the Greater Bay Area perspective, the SDO should also co-ordinate with the Government and mainland authorities for the use cases in commercialising these deep tech.

Utilising a portion of the Future Fund in reference to the IP Group model would greatly enhance the ability for disruptive and technology-intensive IP generated in universities to be commercialised and introduced to the market.

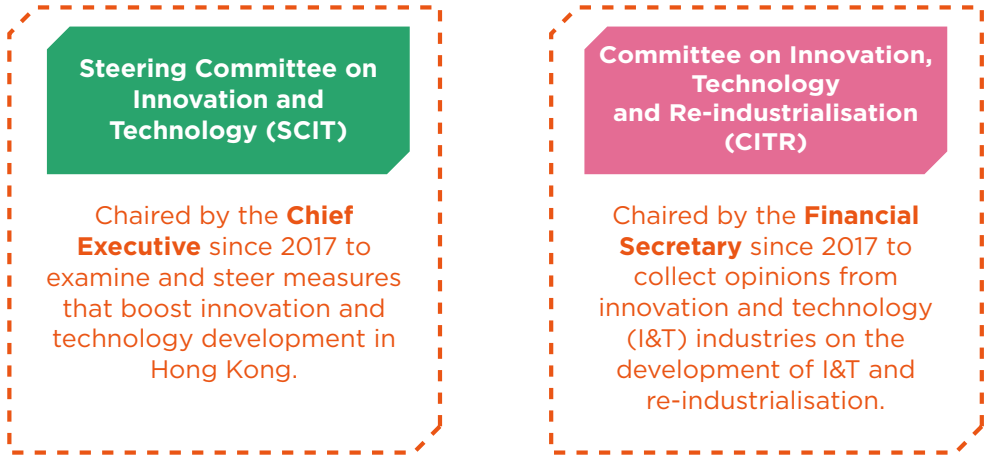
[12] Another potential benefit for universities is that the general partner could donate to universities to strengthen their research infrastructure. For example, IP Group invested GBP 20 million in the completion of a new chemistry building at the University of Oxford in 2005. Receiving funding to enable the completion of university buildings and to subsidise the purchase of lab equipment provides an additional incentive for universities to form partnerships with the general partner.

CHAPTER 6

Establish a High-Level Science and Development Office to Advise the Chief Executive and the Cabinet

The Government has set up several bodies and committees in order to collect opinions, formulate strategies, and steer measures that enhance Hong Kong's innovation and technology development. These bodies include the Steering Committee on Innovation and Technology (SCIT) and the Committee on Innovation, Technology and Re-industrialisation (CITR)[13] **(Figure 23)**. The Innovation and Technology Bureau (ITB) is actively engaged with both committees with its Secretary serving as a member. However, innovation and technology do not happen in the vacuum, but they are integral parts of the general economic and societal developments. An overarching strategy and effective implementation to achieve diffusion of technology and accelerate these developments are needed. In our previous report, *Unleash the Potential in Science and Technology Innovation: Develop Hong Kong into an International R&D Powerhouse*, which mainly focused on the R&D environment, we recommended that Hong Kong establish an overarching entity to formulate R&D strategy and align all R&D funding from various Government agencies. In this chapter, we will further analyse the issues in the existing structure.

Figure 23. Existing bodies and committees in Hong Kong



Source: GovHK

[13] The Chief Executive's Council of Advisers on Innovation and Strategic Development is another high-level body that advises the Chief Executive on Hong Kong's future development, strategies for driving innovation, and directions for economic development.

Lack of Forward-looking Vision from Scientific Perspectives

In Hong Kong, there is a lack of forward-looking vision from scientific perspectives and the Government has only minimal strategic plans for the development of science, technology, and innovation. There is no statutory or advisory body to provide long-term insight, especially in important scientific fields. As a result, the policies and measures that are made and taken may not address the key issues and global trends in science and technology.

The responsibilities of such an advisory body cannot be fully handled by the CITR. The CITR was established to advise the Government on matters relating to the promotion of innovation and technology (I&T) development and re-industrialisation in Hong Kong, and to put forward appropriate development strategies. The CITR is chaired by the Financial Secretary, and committee members are drawn primarily from the I&T and industrial sectors so that experts can work to enhance collaboration among stakeholders. Despite the gathering of great minds and the reasonable terms of reference set by the Government, the CITR merely provides opinions regarding limited topics proposed by the Government and does not develop overarching strategies for the overall development of science, technology, and innovation.

Insufficient R&D Funding Coordination

As discussed in the OHKF report *Unleash the Potential in Science and Technology Innovation: Develop Hong Kong into an International R&D Powerhouse* released in December 2019, the current R&D funding system in Hong Kong is incoherent and poorly coordinated. There are primarily five agencies that provide R&D funding within the Government, resulting in fragmented funding sources. Such fragmentation gives rise to a range of problems for the ecosystem. The foremost problem is the lack of an overarching vision for R&D in Hong Kong, given divided objectives among different funding agencies. Secondly, the funding schemes administered by various funding bodies do not share common standards and goals, not conducive to researchers to apply and obtain relevant grants. Thirdly, fragmentation causes the overlapping of resources.

At the same time, communications between existing bodies and departments remain insufficient, resulting in the absence of strategic coherence and coordination within the Government. The SCIT, chaired by the Chief Executive, was established in December 2017 with the aim of progressing the development of I&T in Hong Kong. The SCIT set out to steer collaboration and participation between bureaux and departments, starting from the most senior level officials, including two Secretaries of Departments, ten Directors of Bureaux and six Permanent Secretaries and Heads of Departments. The establishment of the SCIT shows that the Government endeavours to promote the development of I&T in Hong Kong. Nevertheless, it has not unleashed its full potential and should take further steps towards encouraging cross-bureau collaboration.

Absence of Use Cases Piloted by Public Bodies

There is currently inadequate adoption of local technology among public bodies, which is not conducive to the commercialisation of research outcomes from local universities. Investors from the private sector are less willing to put up substantial capital until the technology reaches a market-maturity stage and achieves a certain level of scaling.

The development of 5G is one of the many examples that indicates the lack of use cases piloted by the public sector in Hong Kong. Speaking of 5G development, there are two main separate technical approaches. The first one is 'Low to Mid-Band Spectrum' which focuses on the part of the electromagnetic spectrum below 6 GHz, primarily in the 3 and 4 GHz bands. The second approach is 'High-Band Spectrum', or more commonly known as 'mmWave', which focuses on the spectrum between ~24 and 300 GHz. Economies like the United States and Japan are taking the second approach to a large extent. However, mmWave has a relatively higher infrastructure cost as the mmWave network would require densely populated base stations within a geographic area to ensure stable connectivity. In contrast, the Low to Mid-band Spectrum, adopted by economies such as South Korea, can leverage on existing 4G infrastructure, resulting in a faster rollout time in 5G development and a lower implementation cost. South Korea, for example, has achieved over 90% population coverage by 2019. 5G development

in Hong Kong could be much accelerated if the existing infrastructure is better utilised. While the infrastructure for 5G is a propellant, the industry application, especially use cases in public sectors, is key for the full rollout of 5G. Many economies such as mainland China and South Korea have already taken great strides forward in fostering Government-led use cases. For example, Beijing Daxing International Airport has introduced a 5G-based smart travel system, which enables facial recognition for check-in and security clearance as well as a paperless luggage tracing system using surveillance cameras under 5G system. South Korea even established the world's first 5G-based urban autonomous driving test bed in Seoul City in 2019 to provide application scenarios for 5G. In comparison, Hong Kong lacks of enough 5G application among public bodies. We are supportive of the Public Sector Trial Scheme that subsidises the production of prototypes and conducting of trials in the public sector, but it would be even better if the scheme facilitates the 5G adoption by public bodies. For example, although the MTR has been working with various telecom operators to provide 5G coverage along major MTR lines, it has not yet disclosed any plan to utilise 5G other than to support mobile communications for passengers traveling on the MTR. Another example is The Airport Authority Hong Kong (AAHK), which has announced the initiatives of 'Smart Airport Development' and is still in the stage of undertaking studies of the integration of 5G technologies in airport operations.

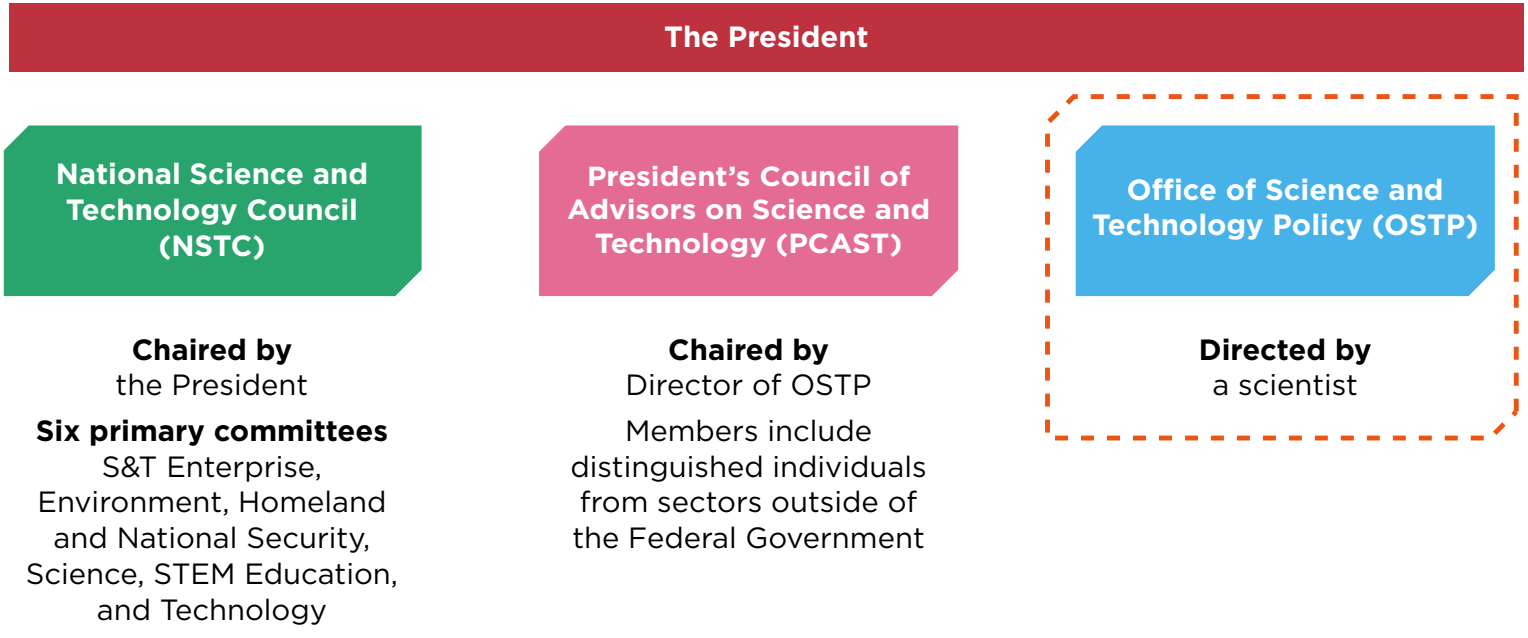
Another issue that needs to be addressed is the deficient policy instruments for procurement of local innovation. Although Government procurement is one of the eight major areas for innovation and technology development as announced in *The Chief Executive's 2017 Policy Address*, there is still insufficient support for state-of-the-art products and services developed in Hong Kong. According to the Government, biotechnology, AI and robotics, smart city technologies, and fintech are the four areas in which Hong Kong has notable strengths, and thus they will focus the efforts on these aspects. However, the lack of strategic planning and corresponding public procurement policies to foster local spin-offs mean that it would be very difficult, if not unlikely, for many inventions and relevant deep-tech applications from local universities to be adopted in Hong Kong.

Case Studies from the United States and Singapore

Seeing that science and technology are the key drivers of economic growth, economies such as the United States and Singapore attach great importance to their strategy formulation and implementation process.

As one of the global leaders in science and technology, the United States established several science and technology policy entities in the White House, including the National Science and Technology Council (NSTC), the President's Council of Advisors on Science and Technology (PCAST), and the Office of Science and Technology Policy (OSTP) **(Figure 24)**.

Figure 24. Science and technology policy entities in the White House



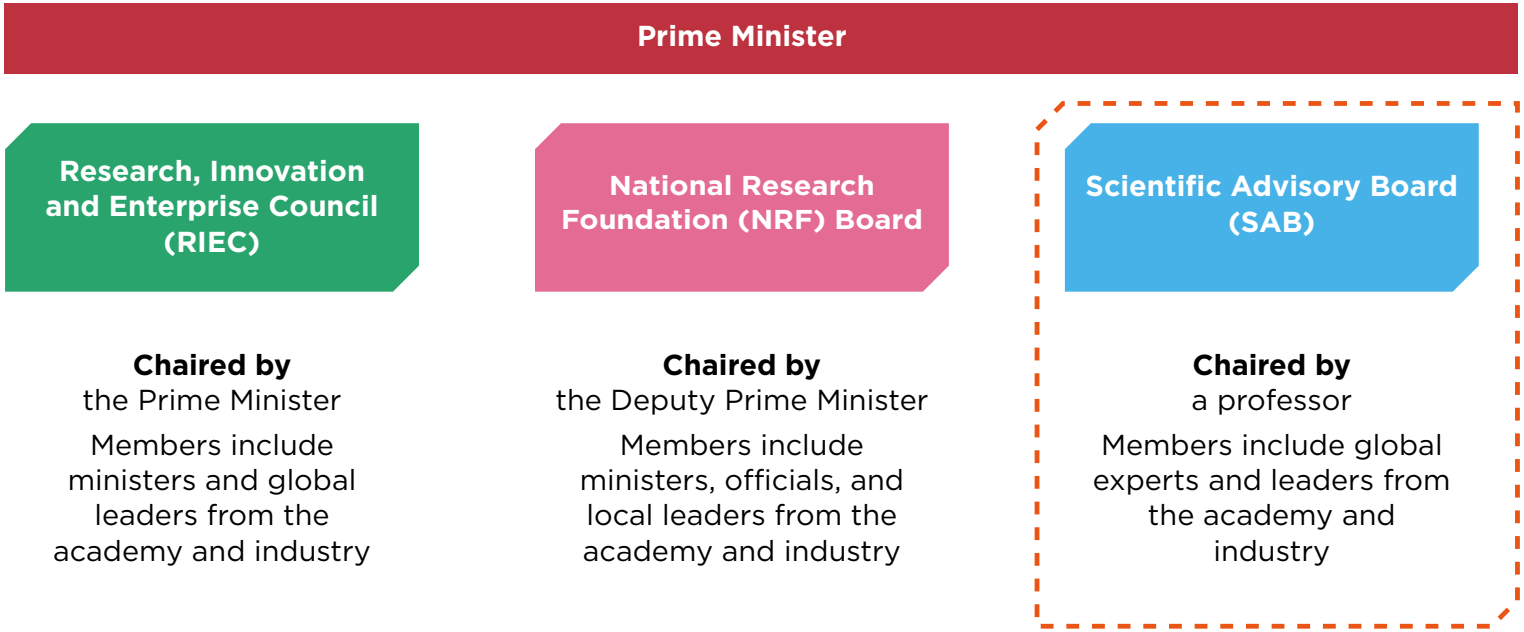
Source: Congressional Research Service (US)

Science and technology policy issues tend to reach the presidential level if they involve multiple agencies. The United States Congress set up the OSTP in 1976 to provide the President with a trusted source of information and advice. The OSTP director, who might also be appointed as the Assistant to the President for Science and Technology (APST), advises on the scientific, engineering, and technological aspects of issues that require attention at the highest level of government. In addition, the OSTP serves as a source of scientific and technological analysis and judgement for the President with respect to major policies and plans. The APST also chairs the PCAST[14] and administers the NSTC.[15]

Singapore and Hong Kong share a lot of similarities. As a small open economy, Singapore strives to become a vibrant science and technology hub. Our 2019 report introduced the National Research Foundation (NRF) of Singapore, which was established in 2006 within the Prime Minister's Office. The NRF sets Singapore's national direction for R&D and re-develops the strategic plan every five years. The governance of the NRF involves the Research, Innovation and Enterprise Council (RIEC); the NRF Board; and the Scientific Advisory Board (SAB) **(Figure 25)**.

[14] The PCAST is an advisory board composed of external representatives with diverse perspectives and expertise to advise the President on science, technology, education, and innovation policy
[15] The NSTC is an interagency body that aims to coordinate science and technology policy across the federal government. Under the NSTC, there are six primary committees set up to ensure that policy decisions and implementation processes are consistent with the President's stated goals.

Figure 25. Governance of the National Research Foundation (NRF), Singapore



Source: National Research Foundation (Singapore)

Realising the importance of advice from experts in scientific areas, Singapore set up the SAB, a multi-disciplinary international board with expertise in broad areas of technology, to advise on the NRF's policies and programmes. Appointed by the Chairman of the NRF Board, the members of the SAB include eminent international research leaders. The SAB aims to identify important areas of research as well as global trends in basic and investigator-led research. It also reviews and advises on proposals and plans prepared by the NRF.

RECOMMENDATION 6.

Establish a high-level Science and Development Office to advise the Chief Executive and the Cabinet, provide strategic directions for overall public R&D funding, and identify use cases to be piloted by public bodies

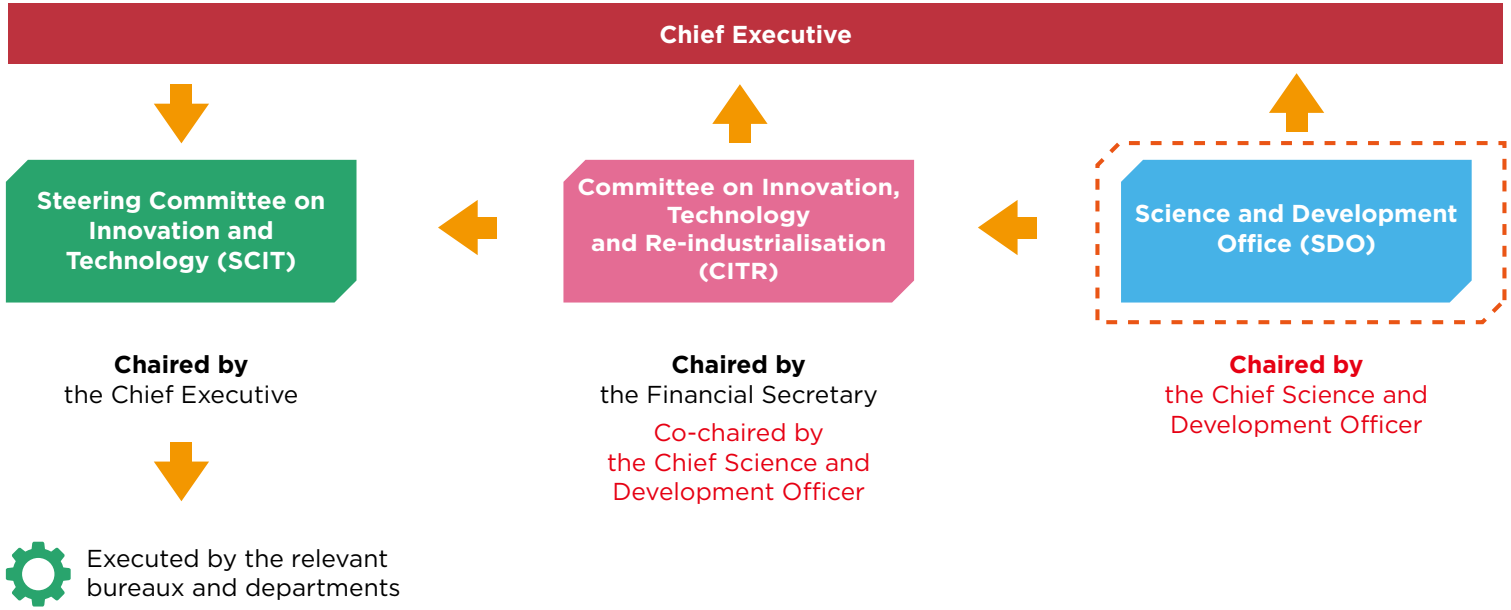
Recommendation 6A : Establish a Science and Development Office

Hong Kong can refer to the United States and Singapore to establish a separate organisation to advise the Government from scientific perspectives. We recommend that **the Government improve its existing structure of policy entities on science, technology, and innovation by clarifying the responsibilities of the CITR, the SCIT, and a Science and Development Office (SDO) proposed below, and by identifying how these bodies can support each other (Figure 26)**.

First, we recommend that the **Government establish an SDO with the aim of providing forward-looking insight into the long-term development of science and technology in Hong Kong**. As in the SAB in Singapore, the members of SDO should comprise scientists and experts in different fields of science and technology, including AI, biotechnology, fintech, and smart city technologies. The Chief Science and Development Officer, director of the SDO, should not only bring their expertise to the Government, but also possess enough industry knowledge to boost technology transfer and diffusion. With a strong focus on promoting science, technology, and innovation in Hong Kong, the **SDO will need to advise on the proposals, blueprints, and plans prepared by the CITR**.

In order to drive general economic and societal developments, CITR needs to be tasked to **create an overall blueprint** for these developments and more importantly, to **detail roadmaps** of how innovation and technology can facilitate and accelerate these developments. As a gathering of external experts and Government officials, the CITR has great potential to serve the role. The proposed SDO can serve an advisory role similar to the OSTP in the United States and the SAB in Singapore, and can advise the CITR. The CITR **should be co-chaired by the Chief Science and Development Officer so as to devise overarching strategies that incorporate global trends and corresponding industrial development in the long run**.

Figure 26. Proposed leadership and organisational structure in Hong Kong



Recommendation 6B : Provide strategic directions for overall public R&D funding

As discussed in our previous report, the Government should guide R&D funding allocations to better align all R&D funding from various Government agencies. In this report, we further recommend that the **SDO should provide strategic directions for such overall public R&D funding**, so that these public R&D funding are less fragmented, and share common standards and goals.

Apparently, this cannot be done without a coherent coordination within the Government. We further suggest that the SCIT, led by the Chief Executive, should set up cross-bureau committees and task forces at the departmental level to monitor day-to-day operations and ensure effective implementation of the high-level strategies laid out by the CITR. Such high-level leadership would ensure sufficient collaboration and participation across bureaux and departments.

Recommendation 6C : Identify use cases to be piloted by public bodies

The Government needs to be supportive in **piloting some of the use cases** to help create the innovative and sustainable ecosystem, and to materialise its investment of public R&D funding. In other words, the adoption of new technology in the public sector should be facilitated to promote the realisation of universities' research outcomes and to scale up local technology start-ups before private sector starts injecting investments. Take 5G as an example. The Government should encourage public bodies such as MTR, airport or ports to become an early customer of 5G related technological innovations. In addition, given Kowloon East's pilot role in exploring the feasibility of developing a smart city, it is also an ideal location to promote the use cases of 5G by public bodies in areas such as autonomous driving and Internet of Things, among other instances. In Chapter 7 of this report, we will discuss the development of Kowloon East in more detail.

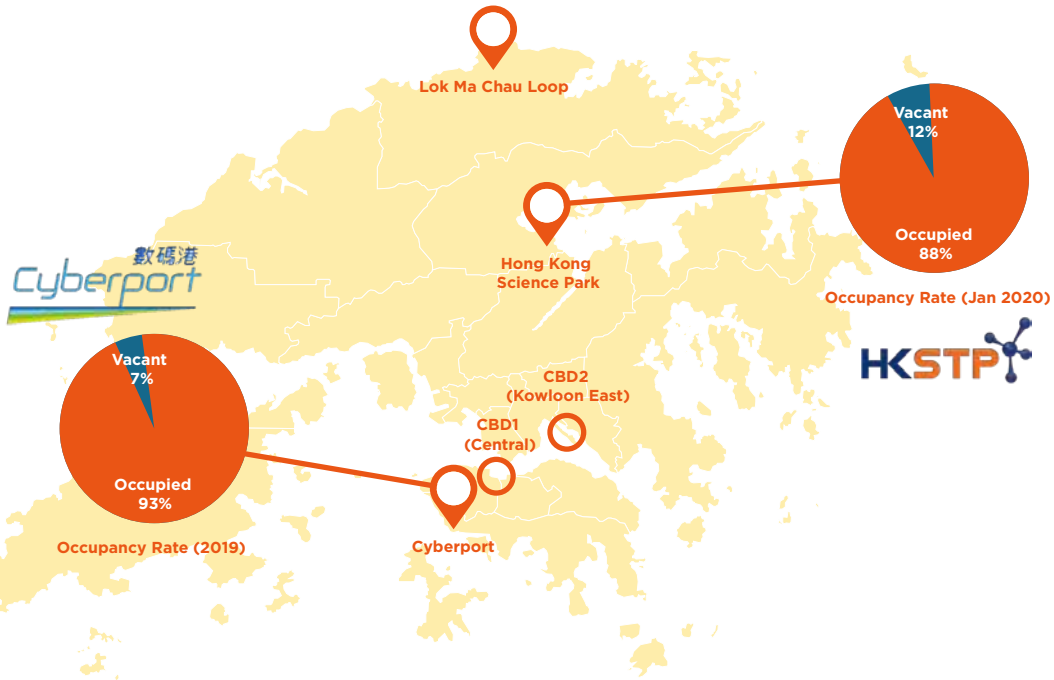
It is equally important that all departments should adopt a public procurement system that supports local innovations. Many economies have developed their procurement policies and processes to foster potential local start-ups and enhance Government administrative efficiency. In Singapore, local start-ups can get preference in government procurement if they are accredited under the Green Lane program. If Hong Kong strives to be a world-class smart city, policies and measures such as the procurement processes should be reviewed thoroughly and made more holistic.

CHAPTER 7

Develop Innovation Districts in Hong Kong

The Hong Kong Science and Technology Parks (HKSTP) and Cyberport are the two major pieces of innovation and technology (I&T) infrastructure in Hong Kong. While both are considered to have been critical in supporting Hong Kong's I&T industry over the past two decades, both are near full capacity, even after several expansions. As of January 2020, HKSTP was 88% occupied, while Cyberport's occupancy rate as of 2019 was 93%. Therefore, in view of their commitment to strengthening Hong Kong's innovation capabilities, the Government has proposed to develop the Hong Kong-Shenzhen Innovation and Technology Park in Lok Ma Chau Loop into the third major piece of I&T infrastructure. Critically, however, all three of these facilities are far from Hong Kong's two central business districts (CBDs), Central and Kowloon East **(Figure 27)**.

Figure 27. Hong Kong lacks an innovation district in a central business district



The Rise of Innovation Districts

Over the past few decades, there has been a remarkable shift in the spatial geography of innovation. In the late twentieth century and early twenty-first century, innovation clusters usually took the form of science parks in suburban areas. The most famous example is Stanford Research Park, around which Silicon Valley grew and developed. The geography of science parks reflected the historic perception that research should be isolated. However, as open innovation has increasingly been recognised, along with heightened urbanisation that an innovation cluster can bring to the surrounding area, innovation districts have been springing up in urban areas across the world.

Innovation districts, by definition, are geographic areas where leading-edge anchor institutions and companies cluster and connect with start-ups, business incubators, and accelerators. Innovation districts can bring an array of benefits to the cities or regions that they are located in. Firstly, innovation districts can foster a culture of open innovation and can maximise the knowledge spill-over effects. Secondly, clustering of a variety of technology companies, universities, and other tech-related institutions can foster cross-industry collaboration. Proximity to research facilities and other businesses can also enhance the commercialisation of research. Thirdly, innovation districts can help to diversify a city's economy and support long-term economic growth. Finally, innovation districts can generate more accessible, higher quality jobs, which promotes more inclusive growth for a wider demographic.

For example, Boston's Innovation District is considered to be one of the most successful and renowned examples of innovation districts **(Figure 28)**. Envisioned by former Boston mayor Thomas Menino in 2010, the Innovation District is located on 1,000 acres of underdeveloped land on South Boston's waterfront peninsula. The mayor aimed to leverage the existing Greater Boston innovation base, which includes Harvard University and MIT, to create a place where the best ideas and brightest entrepreneurs would come together to strengthen one another. Through the efforts of the Boston Redevelopment Authority, the lead agency in developing the innovation district, the district has attracted many renowned institutions. This includes Fraunhofer, Europe's leading research organisation, which established the Fraunhofer Center for Sustainable Energy Systems in the area. In 2011, Babson College began offering classes and conferences for its MBA courses in the district.

After being offered a USD 12 million tax break, Vertex Pharmaceuticals, a global biotechnology drug developer, relocated its global headquarters into the district.

As well as renowned institutions, the innovation district also aims to attract entrepreneurs and start-ups. To support them, the city government mandated an 'innovation component' in the area, whereby 15% of all new office and rental developments must be earmarked for entrepreneurs and start-ups. Furthermore, to foster a culture of open innovation, public spaces in the district are used for testing new innovations in street lighting, waste collection, management solutions, and new digital technologies. In the three years since the launch of the innovation district, it had created more than 5,000 new jobs and attracted 200 start-ups. 40% of the companies in the area were housed in shared workspaces.

Figure 28. Overview of Boston's Innovation District

Government departments	Mayor's Office (New Urban Mechanics) and Boston Redevelopment Authority		
Anchor institutions	Babson College	Fraunhofer Institute	MassChallenge
Nearby universities	MIT	Harvard University	
Global headquarters	Vertex	~USD 12 million in tax breaks	

By the summer of 2015:

- >5,000 new jobs
- >200 start-ups
- 40% of companies housed in shared workspaces

Source: Brookings Institution

Around the world, each innovation district has its own unique evolution and various initiatives have been taken to develop them **(Table 17)**, including the 'innovation component' introduced in Boston. 22@Barcelona and Brainport Eindhoven developed their innovation districts by identifying areas of comparative advantage and specialising in them. Meanwhile, innovation districts more closely linked to nearby universities have been developed through the establishment of mega research institutes, such as the Francis Crick Institute in the Knowledge Quarter in King's Cross, London and the Broad Institute in Kendall Square in Cambridge.

Table 17. International comparison of initiatives to develop innovation districts

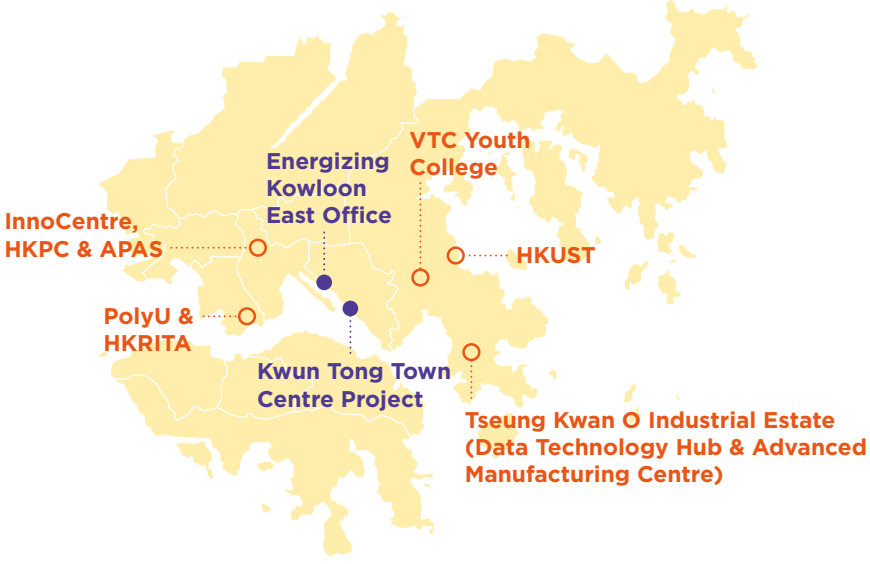
Innovation District	Suggestions
Boston's Innovation District	The district includes an **'innovation component'** for new office and retail developments, where **15% of the space is earmarked for entrepreneurs and startups**
22@Barcelona	Barcelona has identified its comparative advantage and focused on developing five key clusters in the **information and computer technology (ICT), media, medical-tech, energy, and design industries**
Eindhoven	Eindhoven's traditional comparative advantage in **precision machinery** is the very cluster promoted in the innovation district
King's Cross Knowledge Quarter (London)	The **mega research institute, Francis Crick Institute**, was built to become the focal point of the innovation district
Kendall Square (Cambridge, United States)	Located right next to the Massachusetts Institute of Technology and Harvard University, **Broad Institute**, a **mega research institute** cofounded by the two universities, is located in the innovation district

Sources: The respective innovation districts' websites

Constructing an Innovation District in Kowloon East

Due to the monumental shift in the spatial geography of innovation, it is crucial for Hong Kong to develop its own innovation district, and Kowloon East is the prime location for doing so. Not only does Kowloon East have a strong infrastructure network, but it also benefits from a range of nearby innovation-related facilities **(Figure 29)**. This includes higher education institutions, such as PolyU, HKUST, and the Vocational Training Council's Youth College. The area also neighbours a number of research facilities, such as the Hong Kong Research Institute of Textiles and Apparel (HKRITA), the Automotive Platforms and Application Systems (APAS) R&D Centre, the Hong Kong Productivity Council (HKPC), and InnoCentre. The nearby Tsueng Kwan O Industrial Estate, which includes the Data Technology Hub and the Advanced Manufacturing Centre, further complements the entire innovation ecosystem. Locating the innovation district in this area would foster synergies with the nearby innovation resources.

Figure 29. Existing innovation-related facilities near Kowloon East



Developing an innovation district in Kowloon East aligns with the Government's existing plans and initiatives. In *the 2011–12 Policy Address*, the Chief Executive announced a plan to transform Kowloon East into a second CBD (after Central) to sustain Hong Kong's economic development. Kowloon East is also designated as Hong Kong's pilot area for exploring the feasibility of developing a smart city, and trials such as the Smart Crowd Management System and Energy Efficiency Data System have been conducted there over the past few years. Furthermore, *Hong Kong 2030+: Towards a Planning Vision and Strategy Transcending 2030*, a comprehensive strategic plan laid out by the Government, proposes establishing an Eastern Knowledge and Technology Corridor. This corridor would extend from the Lok Ma Chau Loop in the north through Sha Tin, Tai Po, Kowloon Tong, and southwards to Kwun Tong North, ending at Tsueng Kwan O. It would connect with the second CBD in Kowloon East. The aim of this corridor is to capitalise on the existing innovation and knowledge bases in the area and strengthen the development of I&T in Hong Kong. Taking the above into account, Kowloon East seems to be the most logical and beneficial area to develop an innovation district.

Zooming in on Kowloon East, the Kowloon Bay Action Area presents an optimal destination. To further the aim of developing Kowloon East into a second CBD, the Chief Executive's *2013 Policy Address* proposed to relocate government facilities from the Kowloon Bay Action Area to free up more space for commercial development. The area spans about 17 hectares, with a gross developable land area of about 7 hectares, which is divided into six development lots **(Figure 30)**. Among the six development lots, two have been sold for commercial or office development, while the remaining four are government facilities that are in the process of being relocated. A Preliminary Outline Development Plan was developed in 2016 and a finalised Recommended Outline Development Plan is anticipated to be completed in 2020. Because the area is convenient, sizable, and undeveloped, it fits the criteria for an innovation district.

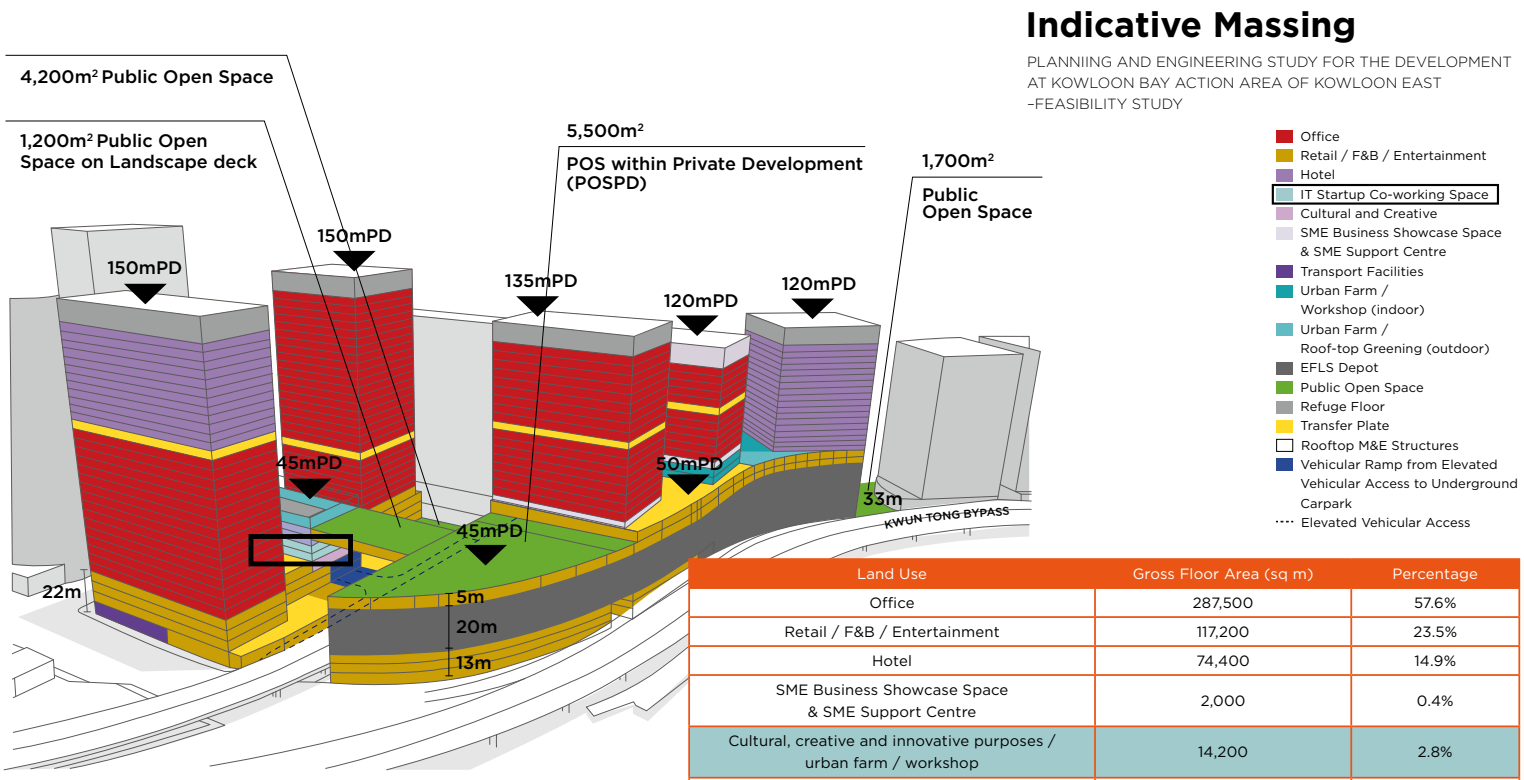
Figure 30. Overview of the Kowloon Bay Action Area

Lot	Size (sq m.)	Status
1	9,500	To relocate the Kowloon Bay Police Vehicle Detention and Examination Center
2	17,000	Demolishing a waste recycling center
3	8,400	To relocate a maintenance depot
4	16,750	To relocate two vehicle examination centers
5	3,800	Sold for commercial / office development
6	6,800	Sold for commercial / office development

Sources: Kwun Tong District Council, Energizing Kowloon East Office

Nevertheless, under the Preliminary Outline Development Plan, only 2.8% of the gross floor area is earmarked for the category 'Cultural, creative, and innovative purposes/urban farms/workshop' **(Figure 31)**. It would be a significant missed opportunity not to further utilise this land to strengthen Hong Kong's development in science and technology innovation.

Figure 31. Proposed Planning and Engineering Study for the Development at Kowloon Bay Action Area



Land Use	Gross Floor Area (sq m)	Percentage
Office	287,500	57.6%
Retail / F&B / Entertainment	117,200	23.5%
Hotel	74,400	14.9%
SME Business Showcase Space & SME Support Centre	2,000	0.4%
Cultural, creative and innovative purposes / urban farm / workshop	14,200	2.8%
Transport Facilities	4,000	0.8%
Total	**499,300**	

Source: Kwun Tong District Council

RECOMMENDATION 7.

Develop the Kowloon Bay Action Area into a world-class innovation district

To strengthen technology transfer and develop Hong Kong into an innovation powerhouse, constructing an innovation district is necessary. Therefore, we recommend **developing the Kowloon Bay Action Area into a world-class innovation district**. This would integrate perfectly with the Eastern Knowledge and Technology Corridor proposed in the Hong Kong 2030+ plan **(Figure 32)**. While the Sha Tin, Clear Water Bay and Kowloon Tong stretch of the corridor, which would cover several universities, would focus on basic research, the Kowloon East stretch would include the innovation district and would focus on applied research and commercialisation. The Tseung Kwan O stretch, which would cover the Tseung Kwan O Industrial Estate, would focus on advanced manufacturing. Alternatively, the Tai Po Industrial Estate offers another route for manufacturing. Thereby, with the development of the Kowloon Bay Action Area into an innovation district, the Eastern Knowledge and Technology Corridor would cover the entire research and development 'corridor' from basic research to applied research, commercialisation, and manufacturing.

Figure 32. Imagining the Eastern Knowledge and Technology Corridor

Deconstructing the Innovation District

The proposed innovation district at the Kowloon Bay Action Area should contain the following components.

1. Expansion for Cyberport and HKSTP

Cyberport and HKSTP are both crucial for Hong Kong's development in science and technology innovation. As mentioned above, both sites are near capacity and the innovation district would offer an ideal location for their expansion. More importantly, setting up branches in the innovation district could enhance the opportunities for Cyberport and HKSTP to connect their companies with the private sector, which would further drive collaboration and encourage commercialisation.

2. Office space for AI and fintech firms

Currently, under the Revitalisation of Industrial Buildings scheme (revised in 2018), 10% of the floor area of wholesale converted industrial buildings is to be designated by the Government for specific uses that would bring wider community benefits, such as the creative and I&T industries. Following the 'innovation component' mandated in Boston's Innovation District, we propose that the Government should go further by requiring 10-30% of floor area in new office and retail developments to be designated for AI and fintech firms, which are two of the four focus areas that the Government has identified for Hong Kong's development in science and technology innovation. This approach would be similar to other innovation districts, such as in Barcelona and Eindhoven, where each district specialises in particular areas in which the city has a comparative advantage.

The benefits of locating AI and fintech firms in a CBD are best illustrated through the example of Level39 in London's Canary Wharf. The area is one of the main financial centres of the United Kingdom and the world, and it is home to the regional and global headquarters of some of the major banks. Recognising the importance of innovation, the Canary Wharf Group, a property developer that owns a sizable portion of the region, decided to set up Level39 at the heart of Canary Wharf. Level39 is a co-working space dedicated to supporting start-ups in the fields of fintech, cybersecurity, and smart city technology. The unique location of Level39 allows start-ups to be only minutes away from relevant, well-financed customers. Over the years, Level39 has expanded into a vibrant three-floor community, spanning 7,400 square metres in One Canada Square. It hosts more than 1,250 leaders in fintech, cybersecurity, and smart city technology.

3. Technology Transfer Alliance

In Chapter 3, we recommend that an alliance of TTOs should be established to strengthen universities' capabilities in technology transfer. The proposed TTA should set up their office in the innovation district, given that the area is near several universities and is also the ideal location for connecting with other stakeholders in the innovation ecosystem.

4. Research facilities

The Government's study of the feasibility of developing Kowloon East into a smart-city district proposed creating an innovation-oriented platform in Kowloon East to provide a testbed or demonstration ground for smart-city projects to maximise the synergies created through government-industry-university collaborations. Following along the Government's direction, we believe that the innovation district should include various research facilities to involve scientists in the district. The research facilities could take the form of a mega research institute, which we proposed in our previous report, *Unleash the Potential in Science and Technology Innovation: Develop Hong Kong into an International R&D Powerhouse*. To create vibrant innovation ecosystems, mega research institutes have been developed in both Kendall Square, Cambridge, and the Knowledge Quarter, King's Cross, both of which are innovation districts

that are closely connected with nearby universities. The Government should also encourage branches of R&D centres, including the creative research infrastructure we proposed in the report in 2020, entitled *Innovating Creative Cultures—Arts Tech*.

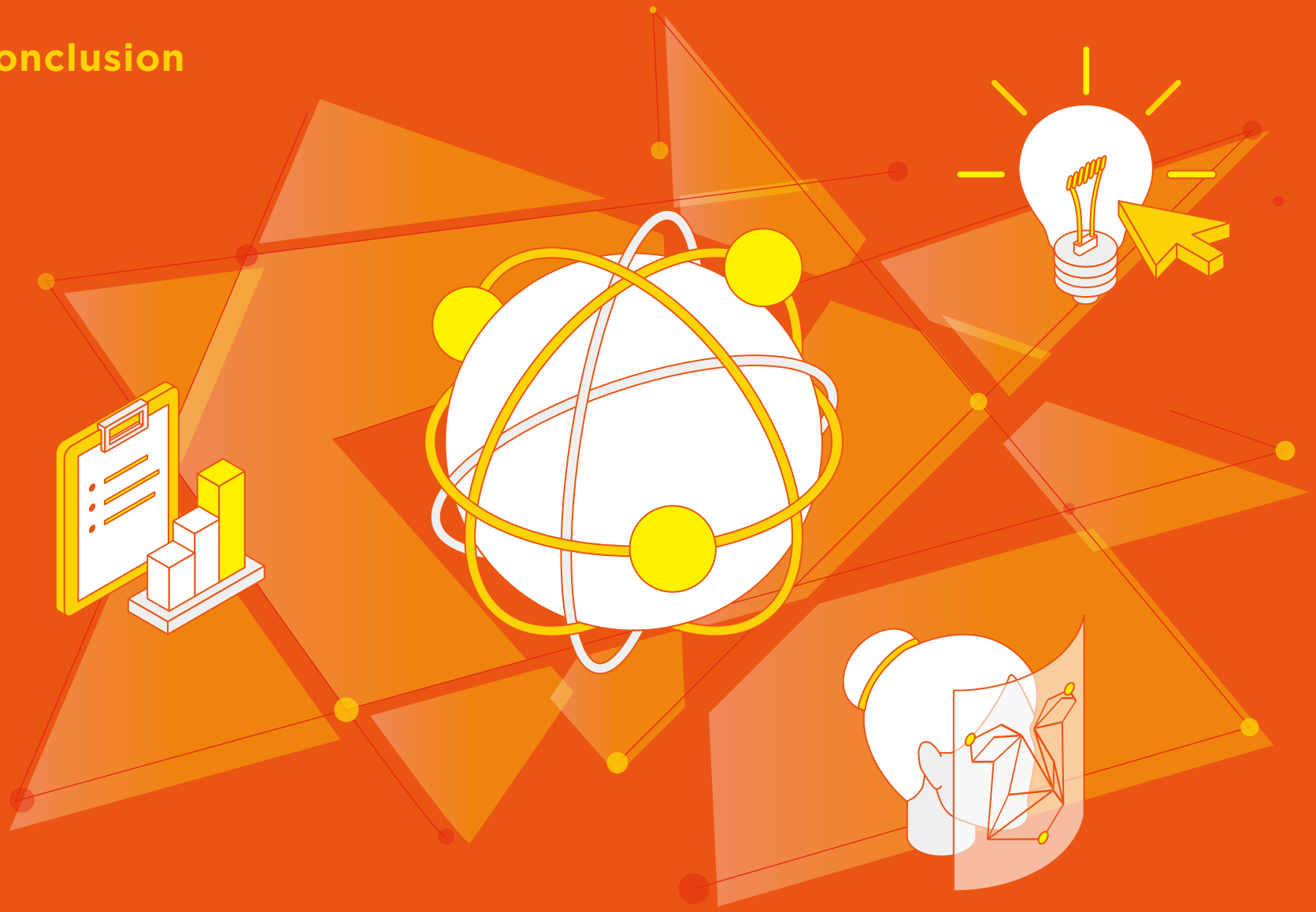
5. Innovation-related government departments

The Government's participation in the innovation district is necessary to facilitate and support the development of science and technology innovation in Hong Kong. As such, innovation-related departments, such as the Innovation and Technology Bureau, the EMSD, the Development Bureau, the Transport Department, InvestHK, the Office of the Privacy Commissioner for Personal Data, and the Hong Kong Monetary Authority, should relocate or set up offices within the innovation district. This would create effective communication channels in the area and ensure frequent and timely interactions with companies, entrepreneurs, researchers, and users.

Finally, to map the proposed innovation district onto the Kowloon Bay Action Area, we have to consider the sizes of the various components we recommend including above. Having considered the sizes of existing R&D infrastructures in Hong Kong and overseas,[16] we propose **earmarking approximately one-third to one-half of the Kowloon Bay Action Area for building a world-class innovation district**. As the planning of the Kowloon Bay Action Area is in full swing, it is a timely opportunity to unleash its full potential via fitting our recommendations into the Government's current development schedule.

[16] In Hong Kong, each phase of the Hong Kong Science Park ranges from a gross floor area (GFA) of 105,000 m^2 to 120,000 m^2. For Cyberport, Phases 1 to 4 have a GFA of 119,000 m^2, while Phase 5 will have a GFA of 66,000 m^2. Overseas mega research institutes the Broad Institute and the Francis Crick Institute have GFAs of 35,000 m^2 and 91,000 m^2 respectively. In terms of R&D centres, the Fraunhofer Institute for Production Systems and Design Technology in Berlin has a GFA of 12,700 m^2.

Conclusion



Make no mistake, Hong Kong has indeed come a long way in science and technology innovation over the past few years. As stated in the introduction, the Government has devoted substantial resources to transforming Hong Kong into an innovation-driven economy. Nevertheless, there remain serious gaps in knowledge transfer. To fill in the existing gaps, this report has proposed seven broad recommendations for driving knowledge transfer to transform university research into tangible services or products.

With Hong Kong's long-standing competitive edge in basic research, it is high time for Hong Kong to address the gaps in technology transfer to build a solid foundation as an innovation hub.

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