**Review on Development of ICT Industry**

**Introduction**

The Education Bureau (EDB) of the Hong Kong Special Administrative Region (HKSAR) Government assisted the Information and Communications Technology (ICT) industry to setup its Industry Training Advisory Committee (ITAC) with a view to promoting the Qualifications Framework (QF) to the industry. In 2019, the ITAC kicked start the work of production of progression pathways and revision of Specification of Competency Standards (SCS) for the industry. In consideration of the present conditions and future development of ICT as well as the new skills and knowledge required, the above SCS formulated would not only set out the competency standards at various levels required by the future development of the industry, but also act as a set of unified benchmarks for human resources management. This could provide a comprehensive training framework for the improvement of the service quality of the industry.

2. This Section presents a review of the development of ICT industry including review of the global and local ICT industry development, the development of emerging technologies, impact on competency requirements and identification of Specification of Competency Standards (SCS) for update and development.

**A Recap of the Global Development Trends of ICT Industry**

3. The global ICT industry is under rapid development. Both business operations and personal lives are becoming more digital, more connected and increasingly more automated. According to the CompTIA research[1], the global ICT industry business is estimated to reach US$5.2 trillion in 2020. The United States remains the largest technology market in the world representing 32% of the total business value (approximately US$1.7 trillion). The Asia region accounts for the second largest market (21% of the total business value) with technology expenses mainly on the areas of infrastructure setup and research & development (R&D) activities. The Western Europe stays at the third position of the global technology business value with a sharing of 20%.

4. The advancement of the emerging technologies has led to the transformation of job nature and induced new skill requirements. From the Table 1.1, the top demanding new technology skills include big data analysis, app/web-enabled marketing, IoT applications, machining learning and cloud computing. According to the World Economic Forum[2], at least 133 million new ICT job roles will be generated globally by 2022 as a result of the new division of labour between humans, machines and algorithms. In addition to the strong demand of technology skills, management skills including creative thinking, problem-solving and negotiating are also highly required for the ICT workforce.

[1] Research Report, CompTIA (November 2019)
[2] www.weforum.org

| Technology | Percentage of respondents that likely to adopt |
|---|---|
| User and entity big data analytics | 85% |
| App- and web-enabled marketing | 75% |
| Internet of things | 75% |
| Machine learning | 73% |
| Cloud computing | 72% |
| Digital trade | 59% |
| Augmented and virtual reality | 58% |
| Encryption | 54% |

Table 1.1: Technologies by proportion of companies likely to adopt them by 2022 (projected) *(source: www.weforum.org)*

5. Filling the knowledge and skill gaps for ICT workforce is a major challenge faced by business companies worldwide. Many companies started to develop their own training programmes to upskill their employees. The topic of ICT manpower training will further be discussed in the below paragraphs.

6. The US ICT industry has a market-oriented economy structure mainly including extensive provision of innovative technology services across different business sectors and exports of technology products and services to other countries. In 2018, the majority of the ICT workforce in US involves in the categories of Software, IT and Business Services, and Emerging Technologies development (Table 1.2).

| Key Career Categories | ICT Workforce |
|---|---|
| Software | 18% |
| Devices plus Infrastructure | 17% |
| IT and Business Services | 30% |
| Telecom Services | 13% |
| Emerging Technologies (such as IoT, AI, Blockchain etc.) | 22% |

Table 1.2: ICT Key Career Categories of US market 2018 *(Source: CompTIA)*

7. A further breakdown of the key technology employment growth drivers of the US market from 2010-2018 is shown in Table 1.3. From the Table, the category Software Developers and Application accounts for the largest actual number of employment growth (+386,900) revealing the strong talent demand in supporting the technology service development in the past few years. For other conventional technology positions (such as System Analysts and Network Architect), the employment growth is relatively mild. On the other hand, it is observed that the categories Cybersecurity Analyst and Technology Occupation have high percentage increase of employment growth showing the rising needs of these new technology skills.

| Key Technology Employment | Actual change | Percentage change |
|---|---|---|
| Software Developers and Applications | +386,900 | +76% |
| IT Support Specialists | +190,200 | +43% |
| Technology Occupation, Others* | +138,900 | +69% |
| Systems Analysts | +90,000 | +17% |
| CIOs / IT Managers | +82,900 | +28% |
| Industrial Engineers | +69,800 | +34% |
| Mechanical Engineers | +64,800 | +27% |
| Web Developers | +58,800 | +56% |
| Cybersecurity Analysts | +52,500 | +91% |
| Network Architects | +50,800 | +45% |
| **Total** | **1,185,600** | **44%** |

Table 1.3: Key Technology Employment Growth Drivers in US (2010-2018) *(Source: CompTIA)*

**Note: include positions such as videogame developers, business intelligence analysts, IT project management etc.*

8. In global terms, Europe has no massive software industry[3]. However, Europe does innovate in ICT through technology applications in other industries. For example, BMW and Airbus are the major companies embracing the Internet of Things (IoT) to develop advanced transportation systems[4]. The telecom companies such as Vodafone, Telefonica, Nokia and Ericsson are the major multinationals with telecom operations spanning several continents. London, as one of the world's financial centers, hosts vigorous FinTech industry with keen talent demand in big data analysis and other technology-based financial services. Ireland is the second largest exporter of computer and IT services in the world that its ICT sector accounts for more than €50 billion of the nation exports per annum[4].

9. In 2018, around 8.9 million professionals worked as ICT specialists across the 28 member states under the European Union (EU). In 2020, the European market is projected to be lacking more than 0.67 million ICT professionals due to the rapid growth of technology-driven business ecosystem[5]. Both small-medium enterprises (SMEs) and multinational companies are competing for ICT professionals for their business development. Among the spectrum of job vacancies, two segments are particularly in high demand including 1) ICT professionals with strong communication and project management skills; and 2) workforce with entry-level programming skills[6].

[3] Association for Computing Machinery (2019)
[4] www.enterprise-ireland.com
[5] www.eu-startups.com (2019)

10. To build the long-term strategic digital capacities and facilitate the wide deployment of digital technologies in EU, the European Commission has proposed the "Digital Europe Programme" with €9.2 billion of funding to support the EU ICT development for 2021-2027[6]. The Programme has identified several key areas for technology investment including supercomputing, artificial intelligence and cybersecurity. In addition, the Programme will provide funding to nurture advanced digital skill workforce through the following initiatives.

- Support the design and delivery of short-term trainings and courses for entrepreneurs, small business leaders and the workforce
- Support the design and delivery of long-term trainings and Master's courses for students, IT professionals and the workforce
- Support on-the-job trainings and traineeships for students, young entrepreneurs and graduates.

11. Europe is a leading region in data privacy protection. Their General Data Protection Regulation (GDPR) provides a regulatory model that aims to protect consumers and increase control over their personal data via informed consent. For companies with business operations in Europe, the GDPR may lead to their increased compliance risks, growing costs to maintain the data storage systems and fulfill compliance requirements.

12. Israel is not a state member of EU but it has significant ICT development and achievement in recent years. Israel's ICT industry was initially fueled by the defense-related research and development (R&D) needs. The Israel government has invested a lot to nurture the technology talents that it attracted many multinational companies, including Intel, IBM, Google, Cisco, Apple etc., to invest and setup research centres in Israel to take the advantage of the local talent. Nowadays, Israel has become the global leading ICT development hub in software, data communications, hardware design and cybersecurity. It has attracted 19% of global investment in cybersecurity, ranks number one globally in R&D expenditures per GDP, and attracts the highest rate of venture capital funding per capita in the world[7].

**Development of ICT Industry in Mainland China**

13. The ICT industry is a major driving force of the Mainland China economy. It is estimated that the Mainland China ICT market reaches $8.1 trillion in 2021 representing 55% of the national GDP[8]. The competitiveness of the Mainland China ICT companies keeps growing as the quality of domestic hardware, software, and services has continued to improve. In 2017, the Mainland China's ICT imports totaled $528 billion while exports totaled $781 billion[10].

[6] www.ec.europa.eu/digital-single-market/
[7] Start-up Nation Central (SNC) and PwC Israel (2018)
[8] www.export.gov (2019)

14. Certain technology sectors (e.g. smart phone devices) are predicted to reach saturation that could not further boost national economy growth. It is believed that integrating ICT technologies into and transforming traditional industries will be the fuel of the future national economy growth. As announced in the China's Made in China 2025 initiative, the industrial big data and industrial internet are the two major areas to support the new development of Mainland China's technology market[10]. Alibaba has also listed several potential technology areas for economy growth including real-time urban simulation, development and applications of AI, 5G networks for new applications, smart vehicles and commercial applications of Blockchain. In addition, the Mainland China business companies are willing to apply and develop immersive technology (AR/VR) products for entertainment and business services markets.

15. On the other hand, technology talent supply is a critical challenge facing by the Mainland China ICT industry. The challenge is analyzed as below.

Gap between the talent supply and demand

According to statistics from China's National Bureau of Statistics and Ministry of Education[9], the ICT industry showed demand for a total of 7.6 million educated talents in 2017, while the number of ICT graduates per year has not yet exceeded 1 million. There is a huge gap between the supply of talent and the demand for it, and the rapid development of the ICT industry will further widen this gap. The overall talent deficit is projected to rise to 12.4 million by 2020[10].

Mismatch between talent quality and industry demand

As the ICT industry develops, the trend of supply chain segmentation continues to reshape the structural demand for talent. Instead of professionals who specialize in a single area, ICT talent with diverse skill sets are expected by business companies. Companies may look for talents who have a comprehensive knowledge of multiple areas such as technology, product, marketing, business, and communication.

16. To fill the gap of talent supply, some Mainland China giant technology companies (such as Alibaba and Huawei) have established their own ICT training and certification programmes with training contents focusing on their own product specifications and company standards. Beside to offering the training programmes on their own, these giant companies also seek collaboration with educational institutions to expand the supply of technology talent.

17. The Mainland China's technology policy presents another challenge on the ICT industry development. In addition to commercial concern, the Mainland China authority would also consider national security in setting up the ICT policy. For example:

[9] https://support.huawei.com/learning/news/

Cybersecurity Law

On June 1, 2017, Mainland China established the first Cybersecurity law as a framework to regulate China's networks on national security grounds and for the supervision of the ICT sector more generally. The law details the security obligations of internet products and service providers, institutes rules for the transmission of data, and enhances the rules on personal data protection. Lack of clarity about how the law will be enforced remains a top concern for many ICT companies in Mainland China.

18. In view of the extensive cross-border business operations and the frequent travel between Mainland China and Hong Kong, there is a need for the Hong Kong ICT practitioners to understand the details and the compliance requirements of the relevant Mainland China's technology regulations in order to ensure smooth business operations in Mainland China.

The Greater Bay Area (GBA)

19. In 2018, the Chinese Government committed to developing an international innovation and technology hub in the Guangdong-Hong Kong-Macao Greater Bay Area (GBA) that serves as a leading force for national innovation development. To support the GBA development, the China Government has announced the following technology initiatives:

- strengthen the coordination of policies in areas such as intellectual property protection, market regulation, financial technologies, talent cultivation and the commercial application of technological achievements
- establish several major technological infrastructure facilities, cross-study platforms, as well as emerging innovative research in the GBA
- remove barriers that hinder the free flow of talent, technologies, capital, equipment, information and other innovative elements in the GBA

20. According to some study reports[10&11], the GBA has a high proportion of high level talent in the areas of manufacturing, consumer goods and ICT with over 25 percent having overseas learning experience and more than 30 percent holding a master's degree and above. Among the ICT relevant specialties, the majority of the talent possesses computer science qualification.

21. The reports pointed out that the demand for quality technology workforce in the GBA is particularly acute in four fast-growing industries including research and development within innovative technologies, financial services, trade and logistics, and the medical industry. R&D in technology lacks of professionals in areas of data scientists, cloud architects, user interface designers, solution engineers and artificial intelligence. There is a need to upgrade the gap of the current technology workforce in the GBA.

[10] GBA talent study report by the Tsinghua University's School of Economics and Management and LinkedIn in 2019
[11] Decoding the Outline Development Plan for Guangdong-Hong Kong-Macao Greater Bay Area 2019

22. The reports examined that among the GBA eleven cities, Shenzhen, Guangzhou and Hong Kong are rated as the top cities where digital talent is concentrated. It is further analyzed that Guangzhou has the most balanced talent distribution among industries; Shenzhen highlights the talent in ICT relevant industries while Hong Kong mainly has talents in the financial and education industries.

23. According to the reports, the number of talent exchange between Hong Kong and other GBA cities lags far behind that of Shenzhen and Guangzhou. There is room for Hong Kong to further strengthen talent exchange with other GBA cities especially the necessity for favorable policies to incentivize the youth of Hong Kong.

24. In summary, the development of emerging technologies is changing the global business ecosystem. Different nations have been setting up policies to support and upgrade the ICT skill workforce training. The demand for ICT workforce with new skills/knowledge is keen especially in the areas of big data analysis, AI, cybersecurity, IoT applications and cloud computing etc. Business companies has also positioned ICT as an integral part of their strategy planning process that the ICT workforce is also expected to enhance their competence in business management. In addition to university academic path, industry professional training/certification could be considered as an alternative pathway to fill up the technology gap of ICT workforce. If university programmes and/or industry certifications are developed with reference to industry competence standard, it would facilitate the recognition of the outcomes of training by the industry.

**Development of ICT Industry in Hong Kong**

25. In 2017, the ICT industry generated US$13.6 billion of value added, contributing to round 4% of the Hong Kong GDP.[12] The ICT infrastructure of Hong Kong plays an important role to maintain its leading business position in the Asia-Pacific region especially in the age of e-business and digital social media. According to the Global Innovation Index 2019, Hong Kong ranked fourth worldwide in technological infrastructure. The ranking indicates the readiness of the Hong Kong's infrastructure and market to support the development of digital economy.

26. In the following paragraphs, the Hong Kong ICT industry would be reviewed from the public policy, economic, social and technological aspects to explore the future development direction of the industry.

**Public Policy Factor**

27. Focusing on technology related public policies, the two major initiatives including the Hong Kong Smart City Blueprint and the Greater Bay Area would definitely impact on the coming Hong Kong ICT industry development and the technology talent requirements.

[12] "2018 Economic Background and 2019 Prospects", HKSAR Government

Smart City Blueprint

28. In 2017 the HKSAR Government published the Smart City Blueprint[13] outlining the Government's vision to build Hong Kong into a world-class smart city. The Blueprint covers six areas including "Smart Mobility", "Smart Living", "Smart Environment", "Smart People", Smart Government" and "Smart Economy". Three digital infrastructures will be developed to support the Smart City Blueprint including "eID", "Pilot Multi-functional Smart Lampposts Scheme" and "Next Generation GovCloud and Big Data Analytics Platform".

29. According to the study by Sharing Economy Alliance[14] in 2018, Hong Kong came last in developing innovation and technology out of other Asian cities such as Taipei, Shenzhen, Seoul and Singapore. Lack of sufficient technology talent supply is considered as a major factor of holding back the Hong Kong smart city development. According to a study report[15], over 70% of the Hong Kong CIOs commented that IT security, software/application development (including Java/Python developers and UI developers etc.) and database management are the most difficult functional areas to source skilled IT workforce.

30. To support the ICT industry development and talent development, the HKSAR Government has announced the following policies in recent years.

2017 Government Policy Address

- Earmarked HK$500 million for the Innovation and Technology Bureau (ITB) to help the government in applying technology to improve the quality of public services
- Promoted establishment of a Common Spatial Data Infrastructure (CSDI) to enable sharing of geospatial data and support the Smart City Blueprint of Hong Kong
- Introduced the Technology Voucher Programme to facilitate the adoption of technology by small-and-medium enterprises (SMEs) for upgrading and improving productivity

2018 Government Policy Address

- Injected $20 billion into the Research Endowment Fund of the Research Grants Council and launched a $3 billion Research Matching Grant Scheme
- Expedited re-industrialization by establishing a $2 billion re-industrialization funding scheme to subsidize manufacturers to set up smart production lines in Hong Kong and allocating $2 billion for building manufacturing facilities required by the advanced manufacturing sector in industrial estates
- Promoted technology transfer by increasing the funding support to the Technology Transfer Offices of universities, the Technology Start-up Support Scheme for Universities, as well as the State Key Laboratories and Hong Kong branches of the Chinese National Engineering Research Centre

[13] https://www.smartcity.gov.hk/
[14] https://sharingcitiesalliance.com/
[15] Robert Half Technology Salary Guide 2019

2019 Government Policy Address

- Extended the coverage of the Technology Talent Admission Scheme to companies outside the Hong Kong Science and Technology Parks Corporation and Cyberport and to cover new technology areas
- Extended the coverage of the Researcher Programme, Postdoctoral Hub and Public Sector Trial Scheme to all technology companies conducting research and development activities
- Injected $500 million into the Social Innovation and Entrepreneurship Development Fund to further promote social innovation

2018-19 Government Budget

- The Government identified four areas for technology development including biotechnology, artificial intelligence, smart city and financial technologies (Fintech). Additional funding was allocated to promote the innovation and technology development that include:
  - HK$10 billion additional injection to the Innovation Technology Fund (ITF)
  - HK$10 billion to support the establishment of two research clusters on healthcare technologies, artificial intelligence and robotics technologies
  - HK$200 million to Cyberport to enhance support for start-ups and promote development of a digital technology ecosystem
  - HK$100 million to Cyberport to promote the development of eSports

Integration with the Greater Bay Area (GBA)

31. Shenzhen has a strong pool of ICT talent while Hong Kong mainly has talents in the financial and education industries. The Hong Kong Government has reviewed its role in the GBA development by changing from a connector to being a more proactive participant with the following technology related initiatives[16].

32. The four fast-growing industries in the GBA includes research and development of innovative technology, financial services, trade and logistics, and the medical industry. The above initiatives by the HK Government could support the technology talent demand of R&D activities, FinTech and trade and logistics. On the other hand, Hong Kong has existing advantage of providing high standard medical service. Future development of digitalization of the industry operation should have great potential market in Hong Kong and the GBA.

33. The development of Hong Kong Smart City and the GBA would continuously drive substantial demand of technology talent. It is observed that the Hong Kong's R&D investment has kept improving. According to the WIPO (World Intellectual Property Company)[17], Hong Kong ranked 13th worldwide under the Global Innovation Index (GII)[18] in 2019 as compared to 16th in 2017. The ranking in 2019 is also the third position in Asia that just

[16] Decoding the Outline Development Plan for Guangdong-Hong Kong-Macao Greater Bay Area 2019
[17] Global Innovation Index (2019)
[18] https://www.globalinnovationindex.org/Home

behind Singapore and South Korea. On the other hand, together with the Shenzhen innovation and technology sector, the Shenzhen-Hong Kong technology cluster ranked the world's second largest on the GII 2018. It is expected the continuous investment on R&D schemes could further support the R&D talent supply for the ICT industry growth.

Other Government Policies

34. In the 2017-18 Budget, the Financial Secretary highlighted eSports as a new potential sector to boost the local digital entertainment and ICT industries. The Hong Kong Government has injected a funding of HK$100 million to Cyberport to promote the development of eSports. Although Hong Kong is not a major game development hub, the development of eSports industry could induce other demand of technology talent including digital content production, social media marketing, network infrastructure setup and online broadcasting etc.

35. The Hong Kong's start-up ecosystem keeps growing in recent years with the increasing funding supports. According to the survey by InvestHK[19], in 2017, there is a record of steady growth of the number of start-ups (+16%) and the number of staff employed in these start-ups (+21%) as compared with the previous year. Major focus of the Hong Kong ICT start-ups includes software as a services (SaaS), Internet of Things (IoT), data analytics, biotech, Artificial Intelligence (AI), robotics, Virtual Reality (VR) and Augmented Reality (AR). In terms of application development, Fintech, Smart City and Smart Home, healthcare and big data applications are also popular. The growth of the local start-up ecosystem is benefited by the increasing investment on R&D activities from the Hong Kong Government, and the global and local trend of emerging technology applications in finance and e-business sectors.

**Economic Factors**

36. The high rent in Hong Kong has speeded up the companies' pace to develop e-business[20] in order to reduce the rental cost. It is estimated that the revenue in the Hong Kong e-business market amounts to US$4,784 million in 2019 while the revenue is expected to show an annual growth rate of 7.9%, resulting in a market volume of US$6,484 million by 2023[21]. To catch up the rapid growth of e-business market, business companies have to consider which technologies fit into their business the best. According to a study report (Table 1.5), building omni-channel business platforms and social media platform for consumer engagement are the most important concern by Hong Kong companies, followed by big data application development. The rapid development of e-business depends on the supply of technology talent including digital media production and marketing, big data applications and mobile apps development etc..

[19] https://www.investhk.gov.hk/en.html

[20] Definition of e-business: "all business activities conducted through electronic means, including all business activities involved in various stages of the business cycle from marketing, advertising, ordering, delivery, payment to stock replenishment." (www.legco.gov.hk)

[21] KPMG and GS1 Survey Analysis (2017)

| Area | | Percentage |
|---|---|---|
| 1 | Building omni-channel business platforms | 31 |
| 2 | Popular social media platform for consumer engagement | 25 |
| 3 | Adopting big data analytics | 17 |
| 4 | Building up mobile commerce | 11 |
| 5 | Adopting Internet of Things | 9 |
| 6 | Adopting cloud computing technologies | 6 |
| 7 | Others | 1 |

Table 1.5: The most important digital innovation technology for business development *(Source: KPMG and GS1 Survey Analysis (2017))*

37. Online cross-border trading is another growth area for the Hong Kong business companies especially for e-business in China. According to Agreement Ten of the Mainland and Hong Kong Closer Economic Partnership Arrangement (CEPA) Supplementary[22], service providers in Hong Kong are allowed to set up joint ventures to provide online data processing and transaction processing business (operating e-business sites) in Guangdong province. Hong Kong business companies could make use of the support from CEPA to strengthen the development of the cross-border e-business in the Mainland.

38. More companies are entering the Hong Kong's FinTech sector to offer innovation solutions to the local and global markets in areas such as payment systems and data analytics. To support the development of Hong Kong FinTech market, the Hong Kong Monetary Authority (HKMA) has launched the upgraded version of the FinTech Career Accelerator Scheme to nurture the talent. In addition, in the 2017-18 Budget, the Hong Kong Government has provided HK$2 billion for the technology start-ups to support the FinTech industry. It is expected that the talent demand in relevant FinTech areas would keep growing.

39. Hong Kong is developing data center business by taking its advantages including location as an international investment hub, free flow of information and proximity to the Mainland China. The development drives the talent demand of data scientists and cyber security specialists.

40. It is also observed that more Hong Kong technology and business companies are moving towards to a more Agile methodology of project-based work to replace the waterfall management approach. Companies hiring management staff are therefore, looking for candidates who are not only technically capable but also have the software skills (such as collaboration and adaptability etc.) to work in an Agile workplace.

[22] "Overview of Internet in Hong Kong", HKTDC Research

41. On the other hand, the Mainland China recorded a slowdown of economy growth with the 2018 GDP at 6.5% only, which is the lowest in the past 28 years. However, the giant technology company Alibaba reported that their ebusiness sales volume was still under double-digit growth despite the overall slowdown of the nation economy. Alibaba commented that their business growth heavily depends on the rapid and diversified development of ebusiness marketing channels.

**Social Factors**

42. Social factors, including population statistical data such as the age of population and its distribution, their education, living attitude and consumption pattern, etc., will affect the preference of consumers, thus influencing their demands on different products and services.

43. Hong Kong's communications and Internet infrastructure is advantageous to the development of online shopping, especially for the younger generation. According to a survey[23], Hong Kong ranked tenth in the Asia Pacific region on the popularity of online shopping (with China ranked the first and India ranked the second). By considering the factors affecting online shopping behavior, secure payment facility remains to be a top factor, along with the reputation of the website or merchant and the items' prices or monetary value. As online shopping continues to develop as one of the most significant consumption activities in Hong Kong, it would further drive the demand of technology talent in areas of digital media production, digital marketing, cybersecurity and mobile apps development etc.

**Technology Factors**

44. The comprehensive and advanced ICT infrastructure in Hong Kong includes the 100% coverage of mobile network, the fastest Internet connection speed in the world, numerous free public Wi-Fi points and high mobile device penetration rate.

| **HK ICT Infrastructure** | **Figures** |
|---|---|
| Mobile Services | |
| ▪ Mobile network operators | 4 |
| ▪ Mobile subscriber penetration rate | 259.9% |
| ▪ Mobile broadband customers (2.5G/3G/4G) | 18,573,243 |
| Internet Services | |
| ▪ Registered customer accounts with broadband access | 2,699,029 |
| ▪ Household broadband penetration rate | 93.2% |

Table 1.6: Key statistics of ICT infrastructure in Hong Kong

*(Source: Office of the Communications Authority)*

[23] "Hongkongers Continue to Embrace Online Shopping", Mastercard Survey (2018)

45. The ICT infrastructure could well support local and overseas business companies to carry out frequent e-business activities and foster the development of technology-based business applications. With the growing demand on obtaining faster and reliable consumer service, business companies are driven to further develop business and technology applications. In addition, Hong Kong's advancement of data centre and cloud computing service also supports business companies to develop innovation and technology initiatives to meet the local and global business opportunities brought by emerging technologies.

**Impact on Competency Requirements and Manpower Development in Hong Kong**

46. The increasing adoption of internet stimulated the growth in all facets of economic interactions that achieving the global transferability of skill and knowledge. The ICT industry itself also breaks the geographical constraint especially through the flourishing global outsourcing services. An advantage of the Hong Kong ICT professionals is their language competency of Chinese and English communication that enable them to work with clients from Mainland China and other countries. The language competency is important in matters of collection and preparation of the system specifications, communication with clients and preparation of the user manual etc. In particular, the China Government's initiative to develop the Greater Bay Area (GBA) into an international innovation and technology hub would continuously drive substantial demand of technology talent.

47. ICT is a vast sector that is continuously splintering off into subsectors. There is an array of career paths for professional development. As the impact of digitalization is growing exponentially, the global technology manpower demand is keen. ICT professionals could develop themselves into different technology specialists to catch the new technology career opportunities. On the other hand, ICT is a team-based industry requiring professionals with transversal skills including communication, problem solving, collaboration, project management and team skills. The ICT professionals could also further develop their career into different managerial positions.

48. Major emerging technologies, including Blockchain (distributed ledger technology), Artificial Intelligence (AI), Virtual Reality (VR), Internet of Things (IoT), 5G network and Cloud computing etc., are rapidly redefining global business and society development. The new business ecosystem however, has brought several challenges to the business companies today including the demand of production efficiency, expansion into new markets and the competition on new products for a global consumer base. Business companies have to consider which technologies fit into their business the best. They have to place more priority on how technologies could support potential market penetration across different channels, how to apply the technologies to enhance customer services and how technologies could innovate their business. Large number of ICT professionals now are therefore, employed by companies from different industry sectors. For instance, the IDC Research (IDC FutureScape: WorldWide IT Industry 2019) indicated that 46% of the US ICT workforce is employed by technology companies while 56% of the ICT workforce is employed by companies from different industry sectors.

49. The increasing adoption of ICT in government and public utility organizations has brought advancement in public service standard in terms of improving efficiency and transparency. To deliver more robust and user-friendly digital services to citizens, many cities have been increasing the investment on technology hardware and manpower development. A stable source of ICT professionals is crucial to deploy and maintain these digital services as any failure of the systems, such as the electricity and telecommunication systems, would bring adverse impact to the society operation. Therefore, there is a need to have a well-established framework to develop and monitor the competency requirements for the ICT professionals, and to recognize their standard of competency, particularly in the new technology areas.

50. The advancement of the emerging technologies has led to the transformation of job nature and induced new skill requirements. From the Table 1.1, the top demanding new technology skills include big data analysis, app/web-enabled marketing, IoT applications, machining learning and cloud computing. According to the World Economic Forum[24], at least 133 million new ICT job roles will be generated globally by 2022 as a result of the new division of labour between humans, machines and algorithms. In addition to the strong demand of technology skills, management skills including creative thinking, problem-solving and negotiating are also highly required for the ICT workforce.

| Technology | Percentage of respondents that likely to adopt |
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| User and entity big data analytics | 85% |
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| Augmented and virtual reality | 58% |
| Encryption | 54% |

Table 1.1: Technologies by proportion of companies likely to adopt them by 2022 (projected)
*(source: www.weforum.org)*

**Identification of Competency Standards for Updating and the Vocational Qualifications Pathways (VQP)**

51. Having reviewed the development of ICT industry and the impact of development of emerging technologies, this section provides a suggested list of emerging areas and management skills for updating the competency standards in order to support the Hong Kong ICT industry development, and for the technology workforce catching up with the competence requirements in view of technology development. To make sure the competency requirements are relevant and applicable to that of principal job posts in the industry, the VQP under respective emerging area has been drawn up with reference to the Manpower Survey Reports and in consultation with relevant stakeholders to serve as a basis for working out the competency requirements. The emerging areas

[24] www.weforum.org

and management skills identified are listed below:

| 1 | **Emerging Area** | **AI/Machine Learning** |
|---|---|---|
| | Proposed Functional Area(s) | Design, Development and Maintenance / Software Products & Software Services<br>Application Support / Operation and Support |
| | Details of competency requirements | Architecture design of the software/system, requirement identification of software release, risk assessment, testing, online payment, payment security |

| 2 | **Emerging Area** | **Cloud Computing** |
|---|---|---|
| | Proposed Functional Area(s) | Architecture / Software Products & Software Services<br>Network Support / Operation and Support |
| | Details of competency requirements | Cloud adoption – infrastructure concern, business workflow reconfiguration, risk management and resources optimization for cloud computing |

| 3 | **Emerging Area** | **Information Security** |
|---|---|---|
| | Proposed Functional Area(s) | Information Security / Software Products & Software Services<br>Security Support / Operation and Support |
| | Details of competency requirements | Cybersecurity policy setup, evaluation and management of cybersecurity threats, development and implementation of security measures, plan for disaster recovery, stakeholder management in relation to cybersecurity issues |

| 4 | **Emerging Area** | **Data Science** |
|---|---|---|
| | Proposed Functional Area(s) | Design, Development and Maintenance / Software Products & Software Services<br>Application Support / Operation and Support |
| | Details of competency requirements | Database administration, predictive analytics, data visualization, data management/policy |

| 5 | **Emerging Area** | **eSports Technology** |
|---|---|---|
| | Proposed Functional Area(s) | DMT architecture / Digital Media Technology |
| | Details of competency requirements | Network infrastructure setup, online broadcasting, cost optimization, troubleshooting, |

| | | |
|---|---|---|
| **6** | **Emerging Area** | **Internet of Things (IoT)** |
| | Proposed Functional Area(s) | Architecture / Software Products & Software Services<br>Systems & Hardware Support / Operation and Support |
| | Details of competency requirements | Business operation model with IoT, hardware/software requirements |

| | | |
|---|---|---|
| **7** | **Management Skills** | |
| | Proposed Functional Area(s) | Strategic Management / Software Products & Software Services<br>Project Management / Software Products & Software Services |
| | Details of competency requirements | Innovation management, the role of ICT in business strategy setup, regulatory compliance (including Mainland China and Europe Union ICT policies) |

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